DOCUMENT RESUME

ED 287 665 SE 048 616

TITLE	Industrial Technology. Iowa Developed Energy Activity Sampler, 6-12. Revised.
INSTITUTION	Iowa State Dept. of Education, Des Moines.
SPONS AGENCY	Iowa State Dept. of Natural Resources, Des Moines. Energy Div.
PUB DATE	87
NOTE	82p.; For a prior revision, see ED 275 522. Some illustrations may not reproduce well.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Conservation (Environment); Elementary Secondary Education; *Energy Conservation; *Energy Education; *Environmental Education; *Industrial Education; Interdisciplinary Approach; *Learning Activities; Piagetian Theory; Power Technology; State Curriculum Guides; Technological Advancement
IDENTIFIERS	*Iowa

ABSTRACT

The revised Iowa Developed Energy Activity Sampler (IDEAS) was compiled using the original IDEAS program and the Energy Conservation Activity Packets (ECAPS). This document is one of the series of revised IDEAS booklets, and provides activities for teaching industrial arts/technology education. The activities are intended to present energy principles in an interesting manner and to develop student skills in acquiring information and making well-informed decisions about energy issues. Each of the 17 activities in this document includes: (1) the subject area for which the activity was written; (2) the grade level; (3) a brief statement about the activity itself; (4) the objective(s) of the activity; (5) a list of materials needed; (6) the approximate amount of time needed for the activity; (7) a more complete description of the activity, including the various components of the activity and their relationship to Jean Piaget's learning cycle (awareness, concept development, application); and (8) some follow-up/background information. In some activities the original source of the activity is also given. The focal points of the entire document are energy concerns, impacts, choices, challenges, and conservation. (TW)

State of Iowa
DEPARTMENT OF EDUCATION
Grimes State Office Building
Des Moines, Iowa 50319-0146

Funds for development and printing provided
under contract to the Department from the

Energy Division
Iowa Department
of
Natural Resources

Table of Contents

INDUSTRIAL/TECHNOLOGY EDUCATION

REVISED IOWA DEVELOPED ENERGY ACTIVITY SAMPLER - IDEAS

INTRODUCTION TO IDEAS

The revised IDEAS were developed from the Energy Conservation Activity Packets, (ECAPS), by Ruth Bakke, and Iowa Developed Energy Activity Sampler (IDEAS), developed by Dr. Doris G. Simonis under the auspices of the Iowa Energy Policy Council and the Iowa Department of Public Instruction, now the Iowa Department of Education. An "infusion model" was used as a basic framework which recognized the interdisciplinary nature of energy education concepts. These included:

1. Energy is basic.
2. Energy usefulness is limited.
3. Environment is impacted by energy exchanges.
4. Energy conservation is needed.
5. The future of energy is ours to shape and share.

The revised IDEAS adheres to these concepts and provides activities that utilize a learning cycle to develop a knowledgeable student population concerning energy matters. Decision-making skills are emphasized and developing an energy conservation ethic is a major goal.

Under the joint sponsorship of the Iowa Department of Education, Duane Toomsen, Environmental and Energy Education Consultant, and the Energy Division of the Iowa Department of Natural Resources, Dr. W. Tony Heiting, Coordinator; the revised Iowa Developed Energy Activity Sampler (IDEAS) was created to meet the continuing need for energy education from the 1980's into the twenty-first century.

Conservation of natural resources and environmental awareness has been mandated by the State of Iowa to become a part of the quality education experienced by Iowa's future citizens in grades K-12. Energy is an integral part of our nation's natural resource base. The major emphasis of IDEAS is to provide uniquely designed K-12 classroom activities that are adaptable into various classroom situations, i.e., highly populated, urban schools to less populated rural facilities. The focal points of IDEAS are: energy concerns, impacts, choices, challenges, and conservation.

Revised IDEAS adopts a learning cycle strategy based upon the learning theory of Jean Piaget. The cycle has three phases: awareness, concept development and application. Activities are loosely structured to allow for student exploring, hypothesizing, and decision-making.

Awareness activities encourage students to experience a new idea, phenomenon or perception. A variety of experiences should stimulate the students' interest, appreciation, and initiate a positive attitude toward the concept to be formulated. Concept development involves the building of a concept of energy based upon the awareness phase. Concept development may include such activities as reading, performing experiments, solving problems, group interactions, games and role-playing in order to reinforce the developing concept. The application phase is designed to enable the student to apply the new concept to various situations or problems. Application activities may include the same types of activities plus a gamut of others, including debates, panels, simulations, surveys, designing, constructing and community or school projects.

This learning cycle approach integrates content with processes and encourages the development of higher level reasoning and thinking skills. The interdisciplinary importance of energy education is emphasized.

The activity format used in the revised edition of IDEAS includes a title, subject and grade level designation, a short description of the activity, learning objectives, materials needed, approximate time required, and descriptions of the three phases of the activity. A suggested evaluation section has been included, in most packets, to assist the instructor and/or learner in determining the extent to which each learner achieved each objective. Follow-up or background information and a detailed activity description complete the format.

Iowa is an excellent example of how energy is an interrelated and interdependent resource. Iowa imports 98% of the energy it uses and has a high potential for reducing its dependence on outside energy sources through conservation and alternative energy forms. Iowa's current energy dependence has a major impact on Iowa's economy and the ability of the state to compete in the industrial and agricultural community. All segments of Iowa's society involving service-related employment, agriculture, and industry, are impacted by energy costs and availability.

The most obvious means of energy reduction is energy conservation. More efficient use of energy resources available in Iowa (i.e. coal, wind, hydro, solar, gasohol, biomass) can have a significant impact on the cost of production/distribution factors as fossil fuels begin to diminish in the twenty-first century.

The revised IDEAS were developed by classroom teachers who realize the need to provide students with an enriched curriculum. Iowa's tradition of excellence in education has always pointed toward an improved future for our youth. IDEAS will provide the creative educator with a multitude of activities from which they can choose, adapt, and improve.

The professional educator who uses IDEAS may adapt the activities for any classroom setting. Students will be given the basis to form an energy attitude, ethic, and philosophy which will serve them and the citizens of Iowa throughout life.

Members of the IDEAS Revision Committee

Duane Toomsen, Environmental and Energy Consultant, Department of Education

Dr. Tony Heiting, Research/Education Director, Energy Division, Iowa Department of Natural Resources.

Dr. Bob VanDen Branden, University of Northern Iowa, editor.

The following were responsible for the grade and/or subject level indicated:

Primary	Linda Scheuermann	Roland-Story Elementary School Story City, Iowa
Intermediate	Janey Swartz	Sac and Fox Settlement School Tama, Iowa
Home Economics	Viki Van Ryswyk	Lewis Central High School Council Bluffs, Iowa
Industrial Arts and Technology Education	Alan Glass	Ballard High School Huxley, Iowa
Language and Creative Arts	Dr. Doug Larche	Grandview College Des Moines, Iowa
Mathematics	Dorothea Trost	Sutherland Community High School, Sutherland, Iowa
Science	Peggy Steffen	Ottumwa High School Ottumwa, Iowa
Social Studies	Steve Heiting	Oskaloosa High School Oskaloosa, Iowa

Advisory members included:

Dr. Lynn Glass, Iowa State University
Brian Johnson, Iowa Power and Light

Special Tribute to Jody Cosson, Des Moines Graphic Artist

Notebook Cover by Carol Doerr

RESOURCE ORGANIZATIONS

Iowa Department of Natural Resources, Energy Division,
Wallace Building, Des Moines, Iowa 50319

CAREIRS (Conservation and Renewable Energy Inquiry and Referral Service)
800-523-2929.

Iowa Energy Extension Service, Iowa State University,
110 Marston Hall, Ames, Iowa 50011. 515/294-6978

National Energy Foundation, 4980 West Amelia Earhart Drive
Salt Lake City, Utah, 84116. 801/539-1406

Energy and Self-Reliance Center, 3500 Kingman Boulevard
Des Moines, Iowa 50311. 515/277-0253

National Energy Information Center, EI-20, Energy Information
Administration, Forrestal Building, Room 1F-048
Washington, D.C. 20585. 202/252-8800

New York Energy Education Project and the
Solar Energy Project, SUNY at Albany, 1400 Washington Avenue
P.O. Box 22100, Albany, New York 12222

Ministry of Energy, 56 Wellesley Street West,
Toronto, Ontario, M7A2B7, Canada

NATAS (National Appropriate Technology Assistance Service) 800-428-2525.

The NEED Project, P.O. Box 2518, Reston, Virginia 22090
703/860-5029

U.S. Government Printing Office, Washington, D.C. 20402

Your local public utility

INDUSTRIAL ARTS/TECHNOLOGY EDUCATION

INTRODUCTION

The study of energy technologies is a vital concern of all curricular areas, but no discipline is better suited to address this concern than industrial arts/technology education.

Technology education addresses four major "systems" in our environment: construction, manufacturing, communication and transportation. Energy is not listed as one of these four major human endeavors or "systems" specifically, but none of these systems would be able to operate without energy. Energy is an integral part of each of these systems, so a study of energy technologies should be involved with each system.

The activities included in the industrial arts/technology education booklet have been specifically selected from a wide variety of activities. Activities are included which cover many different facets of energy education and may be infused in classes concerned with any of the major systems addressed by technology education.

These activities are also flexible and can be adapted to fit varying teacher styles and differing classroom facilities. The teacher may use an activity as is, or adapt it to best serve the needs of the particular classroom situation or unit being studied.

The underlying purpose of this booklet is to provide the teacher with a source of quality activities which will aid in the students' understanding of energy technologies and give them a chance to experience these technologies firsthand.

HERO'S STEAM JET ENGINE

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

The ancient scientist Hero, constructed a simple steam engine (jet propelled) as early as 100 B.C. Hero is considered to be the first to convert the power of steam into useful energy. Hero's engine demonstrates the basic principles of steam power and it provides an excellent graphic of the process of putting the power of steam into motion.

OBJECTIVE

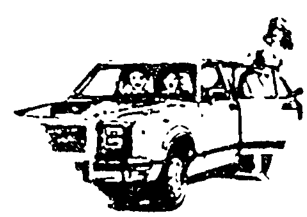
At the end of this activity, each student will be able to: 1) describe how steam is used to create mechanical energy. 2) Explain how energy is converted from heat to water to steam to mechanical energy. 3) Construct a simple steam engine.

MATERIALS

empty tin can with lid (empty 1/4 pint paint cans work well)
3/4" plywood; 9" x 9"
1" x 2" pine; 16" long
a heat source (Sterno Canned Heat, bunsen burner, etc.)
thin flexible wire; 24" long, or nylon braided fishing line
eye hook or staple (large)
4d or 6d finish nails; approx 4
wood glue (may substitute Elmer's white glue)
propane torch, bunsen burner, or soldering iron
solid wire solder
paste soldering flux
1/8" brass tubing, or 1/16" brass tubing approx 2"
hand or electric drill
1/8 and 1/16" drill bit
scratch awl or ice pick
stick pin, hat pin or safety pin

TIME

4 - 5 class periods



LEARNING CYCLE

AWARENESS - Discuss steam technology and the history of the steam engine. What role did the steam engine play in our industrial past? Explain the major parts of a simple steam engine (heat source, boiler, and jets or piston)

CONCEPT DEVELOPMENT - Construct the model steam engine. Describe the major parts of the steam engine as each is constructed. What is the purpose for each part? Test the steam engine when completed. How do the energy conversions take place?

APPLICATION - List other energy conversions which occur in modern day internal combustion engines and jet engines? Could this engine be adapted for some other practical purpose?

EVALUATION - 1) Have the students record the time it takes for the can to begin rotating after the heat source is placed under it. 2) Have the students list and explain the operation of the major parts of a steam engine. 3) Have students list the energy conversions that take place.

FOLLOW-UP/BACKGROUND INFORMATION

Try making a steam boiler with more jets, or place the steam jets in a different position or arrangement. Test many models of steam boiler tanks.

SOURCE OF ACTIVITY

Developed by Alan R. Glass.

ACTIVITY

A. Making the Boiler

1. Using the 1/8" or 1/16" drill bit, drill 2 small holes in the 1/4 pint paint can on opposite sides of the can. The holes should be approximately 1/2" down from the top rim.

2. Place the scratch awl in the hole and bend it to the right until it forms a tangent to the can. This will allow jet tubes to be parallel to the boiler.

3. Cut two pieces of 1/8" or 1/16" brass tubing, one inch long each.

4. Place tubes in holes and prepare for soldering.

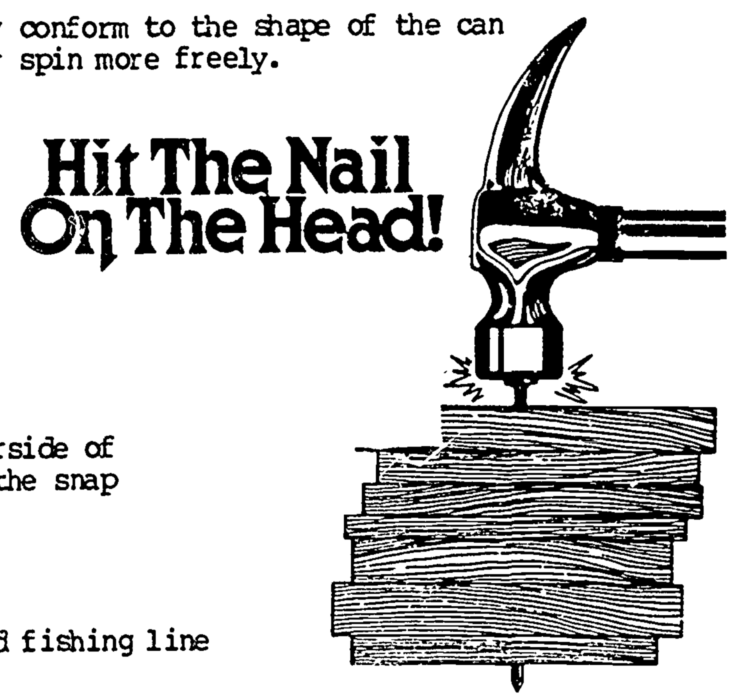
5. Apply paste flux to tubes around the hole.

6. Heat the tubes and can, then apply solder to the holes around the tubes so they are airtight.

7. Drill three holes in the rim of the can lid, equally spaced apart. Use electric drill or hand drill with 1/8" drill bit.

8. Squeeze end of tubes almost completely shut when using 1/8" tubing (leave pinhole opening) a smaller hole means more pressure coming out of the boiler. Use a stick pin to check that the tubes have not been soldered shut or are plugged.

Note: When can is cool, bend tubes so they conform to the shape of the can (around the can), this will help the boiler spin more freely.



B. Making the Stand

1. Cut plywood to 9" x 9"

2. Cut 1" x 2" into a 6" and a 10" piece.

3. Apply glue and nail together as shown in diagram.

4. Nail the large staple to the underside of the top of the frame. Make sure the snap swivel is connected.

C. Assembling the Engine

1. Cut the thin wire or nylon braided fishing line into three 5" pieces.

2. Attach wire or line to the holes in the can lid and to the snap swivel. Center the swivel over the can. Form a tripod with the wire or line and tie a know at the top of the tripod.

D. Operation of the steam jet engine

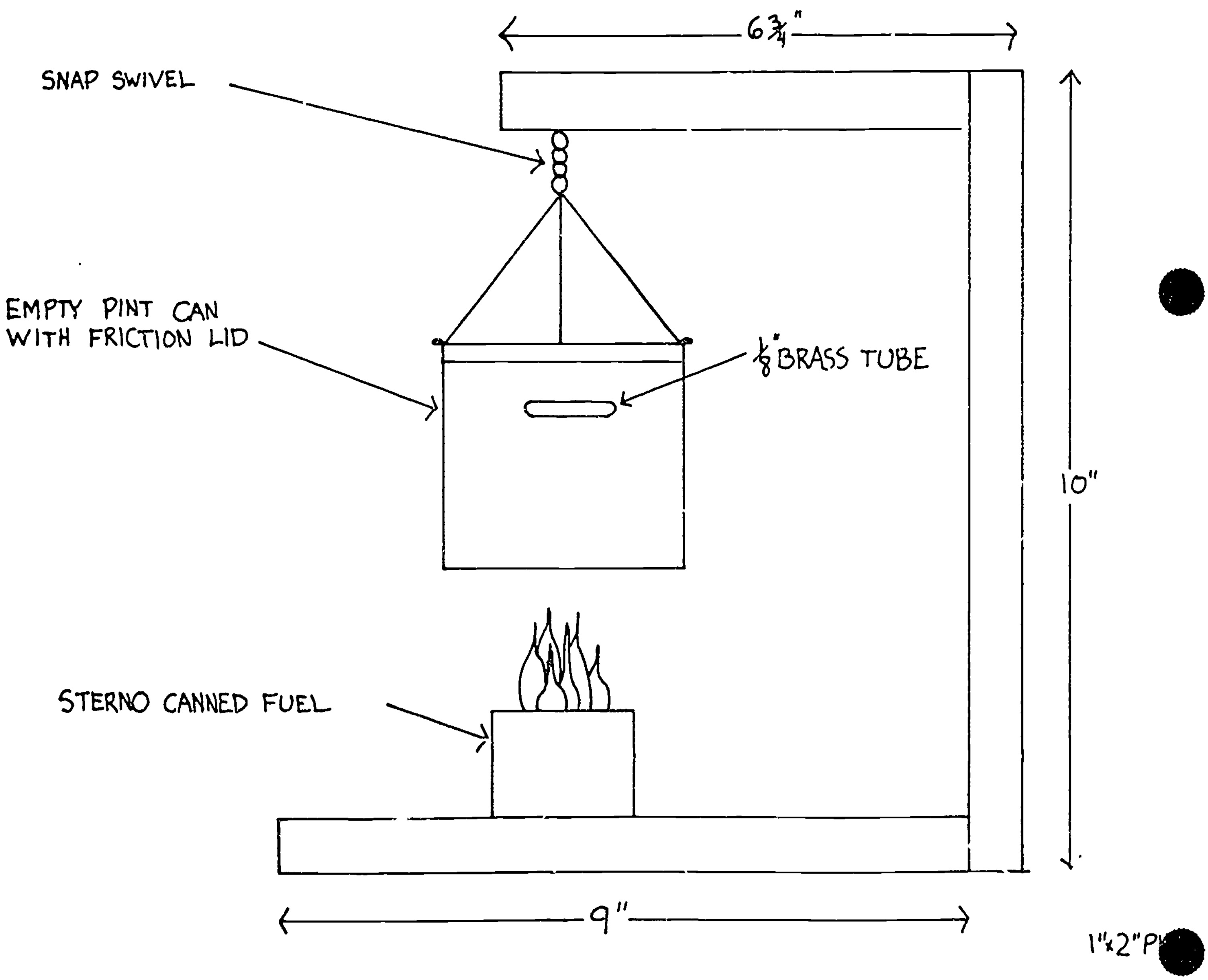
1. Place water in the boiler to a depth of about 1/2". Place lid on can tightly.

2. Hang boiler on snap swivel hook and place heat source below the boiler.

3. Light the heat source and position it directly below the boiler.

It will take about five to ten minutes for the boiler to reach adequate pressure to begin rotating. It may be necessary to remove heat source from below the boiler at times if boiler motion becomes unstable.

If the can does not begin to rotate after 5 minutes, use the propane torch to apply heat to the bottom rim of the can to start rotation of the can.



CANNED SUNSHINE

SUBJECT Industrial Technology LEVEL 6 - 12

ACTIVITY IN BRIEF

You can get some basic information about collecting solar energy by building and testing a simple passive solar collector. This activity uses empty coffee cans to prove how the sun heats up water in containers painted black.

OBJECTIVE

Each student will be able to: 1) describe how a flat plate solar collector works to heat water, and 2) identify the major parts of a flat plate collector.

MATERIALS

one large can, about 12-14 cm diameter and 14-17 cm tall (a 3# coffee can or 2 1/2# vegetable fat can will do).
one smaller can, about 10 cm diameter and 1 cm or more shorter than the large can. (It must fit inside the larger can with room for a layer of insulation between the can bottoms and sides.) punch can opener
standard laboratory thermometer (registering to 110 C)
watch or clock with second hand
plastic can lids, plastic wrap, waxed paper, colored cellophane, etc. as available
duct tape rubber bands
insulating materials: shredded paper, cotton, styrofoam, fiberglass, wood shavings, sawdust, cork, popcorn, as available
paint and brushes or spray paint (flat black enamel)
graph paper

TIME

3 class periods

LEARNING CYCLE

AWARENESS · Discuss energy conversion, and how solar energy is converted to heat. Explain how glazing holds heat in a flat plate collector.

CONCEPT DEVELOPMENT - Have students construct a coffee can collector. Place them in the sun and collect temperature readings. Plot the readings on a graph and compare. Try different types of insulators and repeat the data taking.

APPLICATION - What happens when insulation is placed between the two cans. What materials would be good insulators. How is this simple collector similar to commercially produced collectors? Design a model solar collector large enough to heat the classroom.

EVALUATION - 1) Have the students describe in a paragraph how a flat plate collector heats water. 2) Have the students list the five main parts of a flat plate collector. 3) Have the students draw a diagram of a flat plate collector. Have students identify the five major parts.

FOLLOW-UP/BACKGROUND INFORMATION

Basic information on solar collectors is provided on the next two pages. Use it for your information only, or make copies for your class.

This activity could be done with various-sized shoe boxes instead of cans. However, cans are sturdier and once painted and punched, the same ones may be used by several classes and/or reused on successive days without breaking down.

This procedure is based on the use of a standard household can opener. Warn students to avoid running fingers over the raw edges. A metal punch would make neater holes and eliminate need for the duct tape, if someone other than the students can prepare the cans ahead of time. Use a backing to prevent denting the can.

Collect cans or boxes well in advance of starting the activity. Be sure you have enough of the same sizes so that assemblies are comparable. Recommended are 1 lb. and 3 lb. coffee cans plus their plastic lids; 2 1/2 - 3 lb. vegetable fat cans with plastic lids; #2 1/2 size fruit cans (1 lb., 13 oz. net wt.) and large tuna fish cans (13 1/2 oz. net wt.).

The "advanced canning research" suggestion number 4 (for high school students) can best be done using the fruit, tuna, and 1 lb. coffee cans (all use the same size lid) for the inner can, thus keeping glazed area constant while varying the depth and volume of the can. Results can be expressed quantitatively and should suggest the advantage of a "flat plate" conductor over one that is deeper relative to sun-exposed surface.

Also, this advanced activity raises some interesting questions on heat vs. temperature. If all three collectors are receiving the same amount of sunlight (having the same kind and amount of surface exposed to the sun), why don't all three reach the same temperature at the same time? This is an opportunity to describe temperature as an <u>average</u> heat of the surroundings, not total heat.

The basic activity will probably require three days total: one for construction of the collectors, one or two for data collection, and one for graphing and interpreting the results.

Divide the class into several groups, each of which is assigned different combinations of glazing and insulating materials. Be sure that each group collects data under the same atmospheric conditions to eliminate differences in amount of sunlight available. Ideally, you will have an outside table or some large boards that everyone can use. Tilt the table or boards just enough that the can shadows are as small as possible, and no can is in a shadow. You will get best results when the sun is striking the collector covers as directly as possible.

Results will vary, depending on combination of insulation and glazing used and depending on the time of day and time of year. The greater the insulation and the better the insulation, the higher the temperatures expected. When air is the fluid conductor, a second layer of glazing (on the outer can) with air space between it and the inner can will usually increase the rate at which the temperature rises.

Evaluate students on ability to follow instructions and to work with others; on organization and analysis of the data gathered, including graphs prepared and explained, and on answers to the questions. A sample graph is provided from "Solar Energy Project" of the State Education Department of New York. This activity is an adaptation of one included in their 1979 publication.

Encourage "outside research" on solar collectors and answers to question six. If possible, identify a local contractor, utility or business representative who can provide information on types of solar collectors now in use and possibilities of jobs making or servicing them. Have this person visit the class or suggest a time when students may visit or telephone to obtain additional information.

The hole-punching routine is based on the assumption that you have 25-30 cm long Celsius thermometers already in stock. <u>If</u> reliable small thermometers are available (for example, those from A.S. & E., 955 Massachusetts Ave., Cambridge, MA. 02139 for about .71 each) and <u>if</u> all your cover materials are transparent, holes may be unnecessary. The thermometer can stand inside the can or box and be read through the cover. Eliminating holes means that opaque covers cannot be tested, but another variable may be introduced instead. Water or other liquids may be used for the collecting fluid.

<u>SOLAR COLLECTORS</u>:

A collector for a solar heating system has five basic parts:

1. The <u>cover</u> or glazing material which (ideally) lets in almost all of the incoming solar radiation; does not let energy out again; is unbreakable; can withstand a wide range of temperatures without cracking or decomposing.

2. The collector <u>plate</u> which absorbs the energy admitted by the cover and is usually metal (copper and aluminum are typical choices); is almost always covered with a dark coating that has to be stable at high temperatures. (Black paint for example.)

3. The <u>housing</u> or collector box surrounds and/or supports the other parts of the collector.

4. The <u>insulation</u> surrounds all unglazed sides of the collector box in order to reduce conduction losses.

5. The <u>fluid</u> (either air or a liquid, commonly water and antifreeze) which transfers solar heat to another substance to be heated (air in living areas or a storage medium).

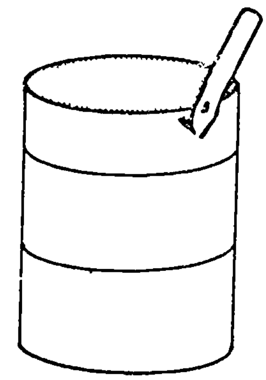
SOURCE OF ACTIVITY

<u>Iowa Developed Energy Activity Sampler</u> (I.D.E.A.S.)
Adapted by Alan Glass.

ACTIVITY

1. Paint or spray the inside of the smaller can with black paint.

2. Punch one hole in the side of the small can, just big enough for the thermometer to slip through. (Position the hook-type can opener on the upper, open edge of the can. It will be easy to push in and all holes made will be the same distance from the top edge.)

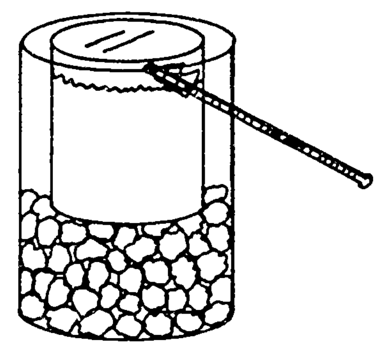


3. Punch a hole in the larger can the same way.

4. Choose one of the cover materials to stretch across the top of the small can. If necessary, secure it with a rubber band.

5. On the bottom of the larger can, put a layer of insulating material thick enough to raise the smaller can, when placed in it, so that its hole, and that of the larger can line up.

6. Insert the thermometer bulb into the smaller can. Adjust the thermometer position so that you can easily read the mercury. Then close any irregular outside edges of your punched openings by taping small pieces of duct tape over any exposed areas.



7. Place your collecting cans in the sun and record the inside temperature each minute for 20 minutes. (If you have an outside table or a piece of board that everyone can use, tilt the surface until the cans' shadows are minimized. You will get best results when the sun is hitting the can coverings as directly as possible. However, all cans should be positioned alike. In order to allow fair comparisons of your results using different materials, the collecting conditions must be the same.)

8. Have a classmate or the teacher record the air temperature of the surroundings while the collectors are "working".

9. Plot the data on a graph. Put temperature on the vertical axis and time on the horizontal axis. Use the background air temperature data also for a "base-line" comparison.

10. Cool down your cans and then put insulating material in all the space between the two cans.

11. Repeat procedures number 7 and number 8.

12. Compare results on the graph you already made. Connect the new data points with colored or dotted lines to distinguish them from the original ones.

13. Compare results with those of classmates who used different cover materials and/or different insulation.

Questions:

1. According to class results, which type of cover material appeared to be most effective? (Look for change in air temperature achieved as a measure of collector performance.)

2. Which type of insulation seemed to work best?

3. Why is it necessary to use insulation in a solar collector?

4. Of the materials that the class tested, which combination of glazing and insulation material would you recommend for a demonstration collector?

5. The collector you just used is like many used in solar-heated hot air systems. Can you identify the five basic components in a solar collector, using yours as a model?

6. If you were building a roof top collector for your home or school, what kinds of materials would you need?

Advanced Canning Research:

1. Put a lid on the outer can as well as on the inner one. Compare results with those from standard procedure.

2. Try different colors on the inner can surface. Is red or blue or green as effective as black? How does a shiny (unpainted) tin can perform?

3. Try painting the outer can as well. Does this affect collector performance?

4. Follow the procedure previously described with three different sizes of inner cans. A one-pound coffee can, no. 2 1/2 size fruit can, and 13 1/2 oz. tuna can, for example, all have the same diameter (about 10 cm) but different heights (approximately 13.8 cm, 11.7 cm, 5.7 cm respectively). Look for a relationship between temperature change, volume of air heated, and area of the glazed surface exposed to the sun.

5. Must the cover admit light to be effective? Use a foil-covered can lid (shiny), a black-painted foil cover, and a black polyethylene cover as alternative "controls". Do they heat up as well as the clear-covered can? Do they cool as quickly? (Record cooling data every minute for 20 minutes with cans in the shade.)

6. Consider effects of wind, clouds, or extreme environmental air temperatures on a solar collector. Discuss ways to measure these effects.

7. Try tilting otherwise identical can collectors at various angles. Measure temperature changes as before. Do results suggest any improvements that would increase efficiency of a solar collector?

A $.79 SOLAR COLLECTOR

SUBJECT Industrial Technology LEVEL 6 - 8

ACTIVITY IN BRIEF

In this activity, the students will be constructing a simple, inexpensive solar panel which can be used to demonstrate and experiment with the fundamental principles of solar energy.

OBJECTIVE

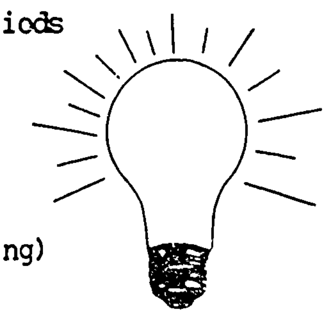
At the end of this activity, each student will demonstrate how water is heated by sunlight in solar collectors, and how sunlight is converted to hot water.

MATERIALS

thermometer
rotary can opener
empty 3.8 liter milk carton (1/2 gal. size)
newspaper
aluminum foil (one piece approximately 60 cm long)
a 1.38 liter juice can (Hi-C juice can)
flat black paint
a 60 cm piece of 6mm flexible copper tubing. (May use 3/8" tubing)
small pieces of wire, 1/16" drill bit, hand drill (if needed)
masking tape
plastic report cover
plastic or rubber hose to fit the tubing, approx. 2-3 ft. long

TIME

1 - 2 class periods



LEARNING CYCLE

AWARENESS - The students will study pictures and diagrams of commercial and large scale solar collectors and discuss their operation.

CONCEPT DEVELOPMENT - The students will build a simple solar collector and test it to determine the results of using solar energy to heat water.

APPLICATION - Discuss how this basic collector could be improved to make more water hot, or how to make the water hotter. What is the difference between this simple collector and the collectors found on many building rooftops?

EVALUATION - 1) Have the students record the change in temperature between the inlet and outlet water after the collecter has been in the sun for 15 minutes. Continue to check the temperature each 15 minutes for one hour. What change occurred? 2) Have the students list the five main components of this flat plate collector. 3) Have the students draw a diagram of a simple flat plate collector with all major parts labeled.

FOLLOW-UP/BACKGROUND INFORMATION

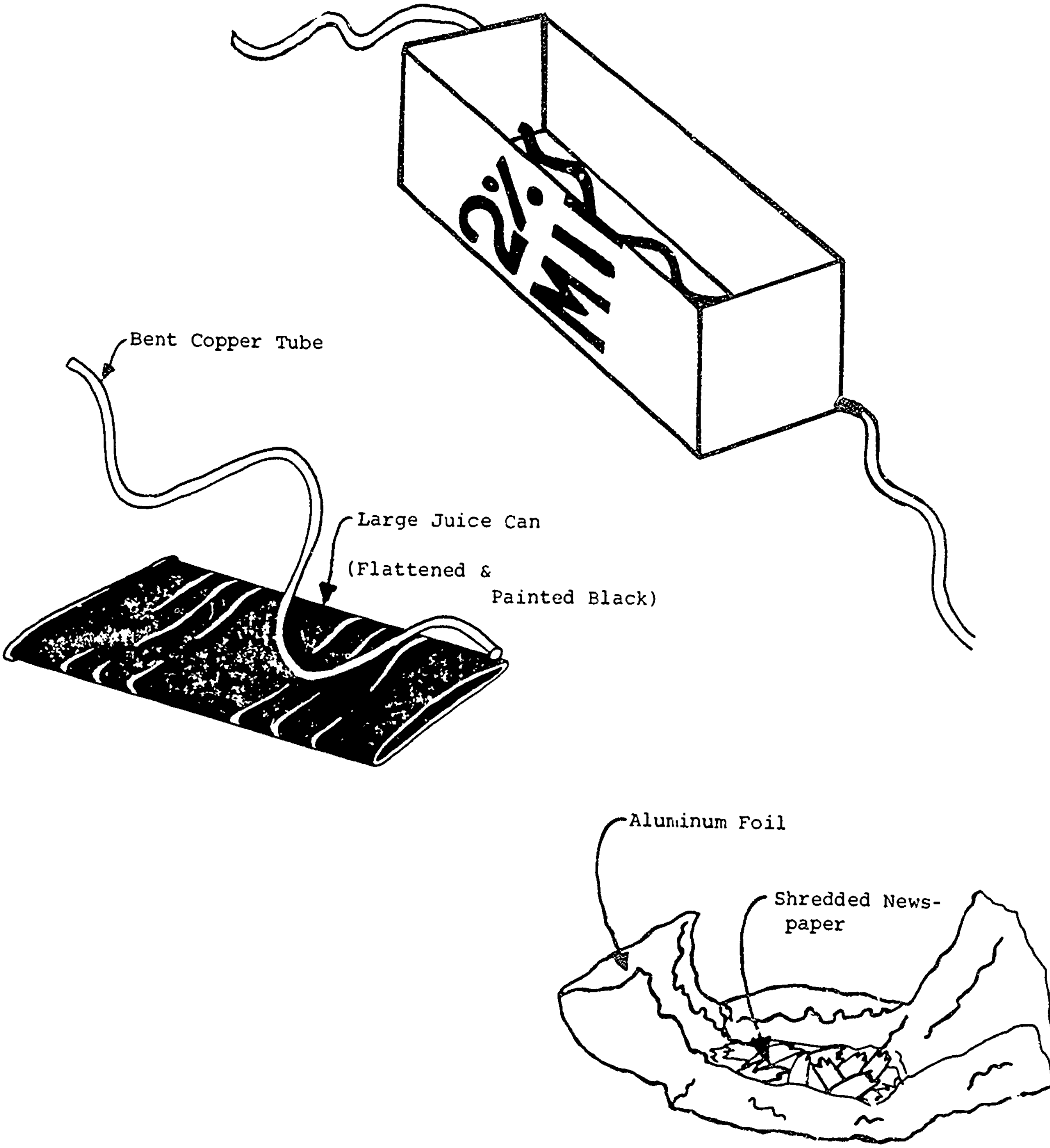
Take a field trip to a manufacturer of commercial solar collectors or to a building which uses solar hot water. Test your collectors, and record data as to the length of time required to heat up a specific amount of water on consecutive days. Try painting some collectors different colors. Try tilting collectors at different angles.

SOURCE OF ACTIVITY

Ann Lewis, Moscow High School with assistance from Wayne Hager, Associate Professor, University of Idaho and Aleta Sonnenberg, Graphic Artist, University of Idaho, Moscow, Idaho. Energy and Man's Environment; Salt Lake City, Utah. Adapted by Alan Glass.

ACTIVITY

1. Close up the spout of the milk carton and staple it shut.
2. Cut out one side of the box (one of the long sides).
3. Make two holes approximately 6mm in diameter (use a pencil) in both ends of the box. (Locate the holes at opposite corners and not too close to the edge.) This is where the tubing will go through.
4. Paint the whole inside black.
5. Shred newspaper into strips and wrap it into a piece of aluminum foil. This will serve as insulation for the bottom of the collector.
6. Place the wrapped newspaper in the bottom of the milk carton. Mold it to fit snugly. It should be about 2" to 3" thick.
7. Remove the top and bottom from a large juice can.
8. Cut it in half or flatten it and tape the sharp edges with masking tape.
9. Bend approximately 60 cm of copper tubing into an "S" shape.
10. Make it so that it will fit into the box, using the two holes you have already made. The tubing should stick out of the ends of the box a little (about 1").
11. Make sure the tubing doesn't touch the sides of the box.
12. Try to have the tubing touch the can as much as possible. Punch holes in the can and attach the copper tubing using wire if possible, or drill holes in the flattened can to run the wires through.
13. After the tubing is in place, paint the can and tubing black.
14. Place the tubing and can inside the milk carton on top of the wrapped shredded newspaper.
15. Cut the corners of a plastic report cover.
16. Fold the corners down to fit the top of the box and tape the sides down with masking tape. It should form a cover.
17. The panel is now ready to attach to a water source using the plastic tubing or rubber hose.
18. Tape or cap the outlet end of the hose, turn the water on just long enough to fill the tubes.
19. Set the collector in the sun for about 10-15 minutes.


Bent Copper Tube
Large Juice Can
(Flattened &
Painted Black)
Aluminum Foil
Shredded News-
paper

A SIMPLE SOLAR OVEN

SUBJECT Industrial Technology LEVEL 6 - 8

ACTIVITY IN BRIEF

Cooking with the sun is a way to show that light energy can become useful heat energy. In this activity, students will be constructing a simple solar oven using a styrofoam cooler.

OBJECTIVE

Based upon the results of this activity, each student will be able to: 1) list the advantages of using the sun to cook food, 2) describe the process of solar cooking, and 3) list and explain the purpose of the necessary parts for a solar oven.

MATERIALS

a rectangular styrofoam cooler with a tight fitting lid
an oven thermometer
duct tape
scissors
jigsaw, utility knife, or Exacto knife
aluminum foil
protractor or 45 -45 -90 triangle
rubber cement, or elmers Glue
cardboard, or corrugated boxes (empty boxes)
double-strength glass to fit your cooler opening
(If glass is unavailable, you may substitute plexiglas or a clear plastic sheeting.)

TIME

4 class periods

LEARNING CYCLE

AWARENESS - Discuss solar heating. Show the students examples of solar greenhouses. Explain how a solar oven works and how it is similar to a solar greenhouse. Talk about solar concentration with mirrors. Describe the Solar One* power generating station in California.

CONCEPT DEVELOPMENT - Construct the solar oven and test it by cooking hot dogs or some simple food. Students must also understand how to orient the oven so it receives the most intense sunlight. Have students add extra reflectors if necessary.

APPLICATION - Discuss how solar cooking could be feasible on a large scale basis. What type of ovens would be necessary? What type of materials would be needed? What materials would make this or any solar oven stronger and more efficient?

EVALUATION - 1) Have the students list five advantages of using solar energy for cooking. 2) Have the students describe the process of heating food with the sun.

FOLLOW-UP/BACKGROUND INFORMATION

Cooking with the sun is a way to show that light energy can become useful heat energy. But time, energy, and materials must be properly invested in order to make use of "free" solar energy. This incoming energy is spread out, not concentrated. And its rays seem to change direction as the earth circles the sun. Still, solar energy can be used effectively for many jobs, including slow-cooking of meat and potatoes; heating houses; and heating water. This model oven will give you chances to do some solar heating and solar cooking on the next sunny day.

Cooking with the sun has been one of the more popular projects attempted by solar enthusiasts. Hot dog cookers with a spit and curved reflector are easy to make. Umbrellas lined with mylar have been used to focus solar heat on a tea kettle or rice pot. Curved reflectors made of aluminum also can help concentrate light onto food enclosed in black cans or glass-windowed boxes. Fresnel lenses have been used to produce intense heat, and oven plans using one are available for $.75 from Edmund Scientific Co., 1888 Edscorp Building, Barrington, NJ, 08007.

A durable oven made of sheet aluminum and plywood is described in detail, with construction diagrams, in Practical Sun Power by Rankins & Wilson, from Lorien House (publisher), P.O. Box 1112, Black Mountain, NC, 28711, for approximately $4. This model would be appropriate for industrial arts students to build and would last longer than the model described here. However, it would require a greater initial investment of time and materials to complete it.

There was no noticeable difference in temperatures recorded between bright foil-lined and painted-foil-lined models that this author built. Differences between single and double panes of glass were also small. Double-strength glass is recommended, however, as less likely to crack under heat. When the oven was empty (full of air, as in a house) then a double-paned glass model heated 10-15^{o} F hotter than a single-paned one.

Simple flat aluminum foil reflectors, on the other hand, improved performance considerably, raising the interior temperature of a double-glazed model by 40^{o} F in 15 minutes on a September afternoon. Mirrors or curved aluminum reflectors may improve performance even more.

The main problem with the reflectors as described is wind. Unless reflectors are weighty, every breeze can change their position and reduce their effectiveness. Wind chills the oven, too, suggesting the need for careful sealing and more insulation if the oven is to be used often.

*Solar One is a solar powered electrical generating station located in southern California.

SOURCE OF ACTIVITY

Iowa Developed Energy Activity Sampler. Adapted by Alan Glass.

ACTIVITY

Set the cooler upside down on its lid. Using a protractor or a 45 degree triangle, mark the diagonal from the bottom "lid" edge upward, as shown in diagram 1.

Cut as indicated by the dotted line, leaving a slot for the glass window to set in. Line the inside of the box with aluminum foil. Paint the inside of the oven with flat black paint.

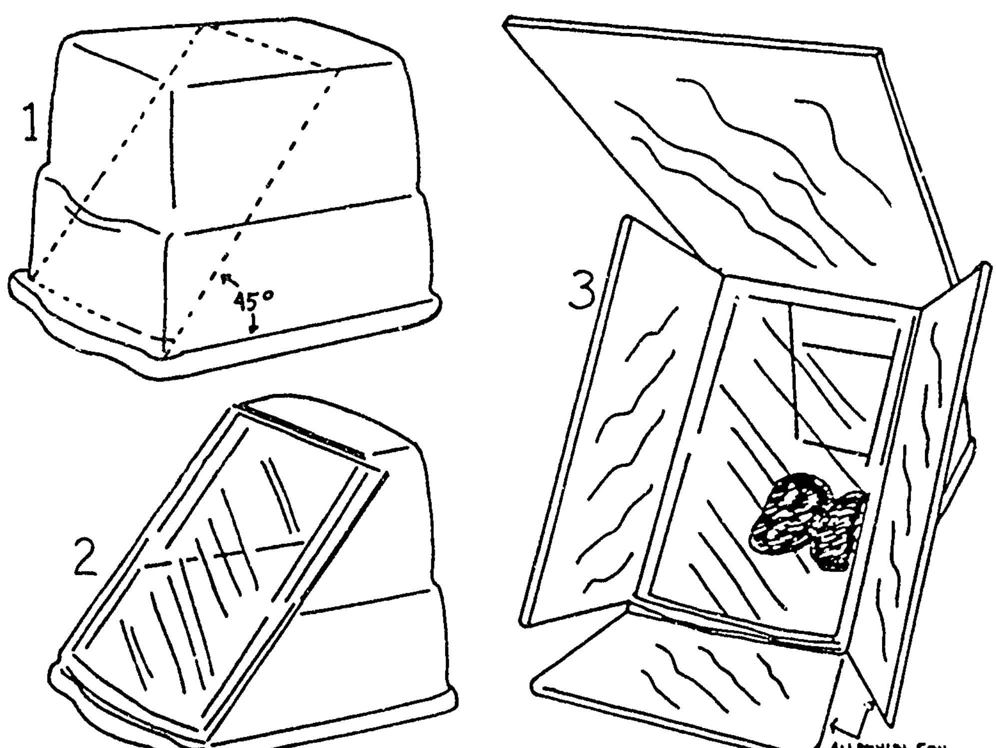
Measure the opening for glass and buy a piece that will cover it and the styrofoam edges completely (diagram 2). Tape the glass securely in place and cover all edges with aluminized duct tape.

If a glass panel is unavailable or too expensive for your students, you may substitute clear plastic sheeting, film, or plexiglas.

Make reflectors from cardboard or pieces or corrugated boxes covered with aluminum foil. Hinge two of them and attach with duct tape to the sides of the oven. Support the backs with hanger wire if necessary. Lay one reflector on the ground in front of the oven and angle another one over the top. (See diagram 3). You can see spots of light on the glass when the foiled panels are positioned most effectively.

Position your solar oven outdoors with the glass directly facing the sun. You have the correct position when the shadow of the oven lies directly behind it, not more to one side than the other. Every 15-20 minutes you will have to move the oven slightly to keep it oriented to the sun.

Lift your oven off its base (formerly the lid of the cooler) to put in an oven thermometer and whatever food you want to bake slowly. Potatoes are shown in the diagram. Cookies can be baked on a cookie sheet or pie tin. Hot dogs are probably the easiest food to cook, the least expensive, and the fastest. On a bright sunny day, hot dogs will take 15-30 minutes to cook.



SOLAR WATER HEATER IN A TOTE TRAY

SUBJECT Industrial Technology LEVEL 6 - 12

ACTIVITY IN BRIEF

In this activity, you will build a model of a typical solar collector (hot water system). It contains the same parts as a large-scale collector, but scaled down to model size.

OBJECTIVES

At the end of this activity, each student will be able to: 1) name and describe the function of each part of a solar collector, 2) measure the amount of heat absorbed from the sun per square foot of collector. 3) list and describe the combination of collector materials which produces the most heat per sq. ft. of area.

MATERIALS

plastic storage tote tray
glazing cover (glass, plexiglas, clear plastic film, etc.)
different kinds of insulation, such as fiberglass or styrofoam
sheet steel or other metal to use as an absorber plate, approx. 24 - 28 gauge. Size: about 24" x 24"
scrap copper tubing, 1/4" O.D. about 3-4 ft. long
2 pieces of rubber hose, 1/4" I.D. to fit the copper tubing approx. 24" long each
a 1 gallon thinner or ditto fluid container (empty can)
acid core solder
flat black spray paint
support post 1 x 2" pine or scrap wood, approx. 16" long
wood for base - scrap wood or plywood approx. 12" x 16"
wood glue, No. 4 finish nails (about 4)
thermometer in a one-hole rubber stopper
propane torch
sheet metal cutting equipment

TIME

approx. 2 class periods

LEARNING CYCLE

AWARENESS - Introduce to students information on various types of flat plate collectors. Discuss the operation of a flat plate collector and its five main parts (glazing, collector plate, box, insulation, and air or liquid).

CONCEPT DEVELOPMENT - Have students construct the flat plate collector and test the operation of the collector by placing it in the sun. Record all data on the chart provided. Have students identify each part of the basic collector as they construct it.

APPLICATION - Discuss several uses for the model solar collector built in this activity. What is the difference between this model and a commercially manufactured collector? What materials could be used to make the collector more efficient?

EVALUATION - 1) Have the students draw a diagram of a flat plate collector and label each part. 2) Have the students describe the function of each part of the solar collecter built in this activity.

FOLLOW-UP/BACKGROUND INFORMATION

Plastic tote trays commonly found in industrial arts storage cabinets can be used as collector boxes. If they are unavailable, you may substitute a box made from scrap plywood with 1" x 4" sides.
The glazing can be made from any of a variety of materials:
Plexiglas, plastic sheets, Saran Wrap*, or even glass (requires extra care). A frame should be made for the glazing out of scrap 1"x2" or wood lattice.

SOURCE OF ACTIVITY

"Solar Energy Education - Industrial Arts." Solar Energy Project, New York State Education Department, Albany, New York 1981.

Adapted by Alan Glass

FOR THE STUDENT:

Activity:

1. Ask your instructor for a plastic tote tray and a glazing cover.
2. Place one kind of insulating material in the bottom of the tray.
3. Cut a piece of sheet steel to fit into the tray.
4. Bend the copper tubing into an "S" shape. This can be done by hand or the tubing can be bent around a pattern made from scrap wood. (Diagram 2.)
5. Solder or glue the copper tubing to the sheet steel absorber plate as shown in diagram 3. If the tubing is soldered, clean any excess flux from the plate after soldering.
6. Spray the absorber plate with flat black paint. Let dry.
7. Line the inside of the tote tray with styrofoam or fiberglass insulation.
8. Place the absorber plate in the plastic tray. Determine the location of and drill two holes in the side of the tray through which the rubber hoses will be connected to the copper tubing.
9. Connect the rubber hoses to the ends of the copper tubing.
10. Cut two short lengths of copper tubing. Drill a hole in the lower right side and in the upper left side of the 1 gallon can. (See diagram 1.) The holes should be sized so that the copper tubing fits snugly into them. Solder the tubing pieces to the holes. These will act as hose connectors.
11. Attach the lower hose of the collector to the lower connection on the gallon can and the upper hose to the upper connection.

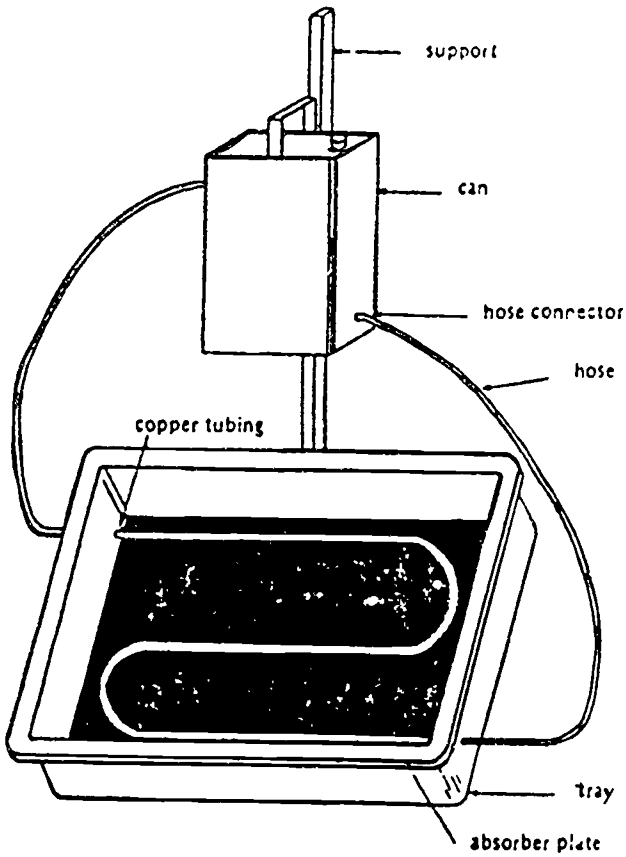


Diagram 1

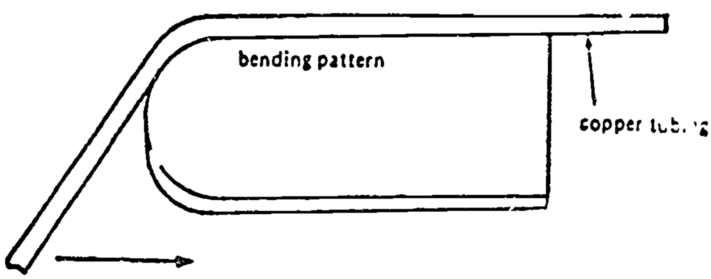


Diagram 2

12. Glue and nail the support piece to the base wood.
13. Put the glazing cover on the collector and take the entire apparatus outside. Make sure glazing is sealed tight against the tray. Aim your solar collector at the sun by leaning it against a support post driven into the ground.
14. Attach the gallon can storage tank to the support post above the collector. (See diagram 1.)
15. Fill the storage tank with exactly one gallon of water. Place the rubber stopper containing the thermometer into the opening of the can. Make sure the thermometer bulb is in the water. Read and then record in the data table the beginning temperature of the water.

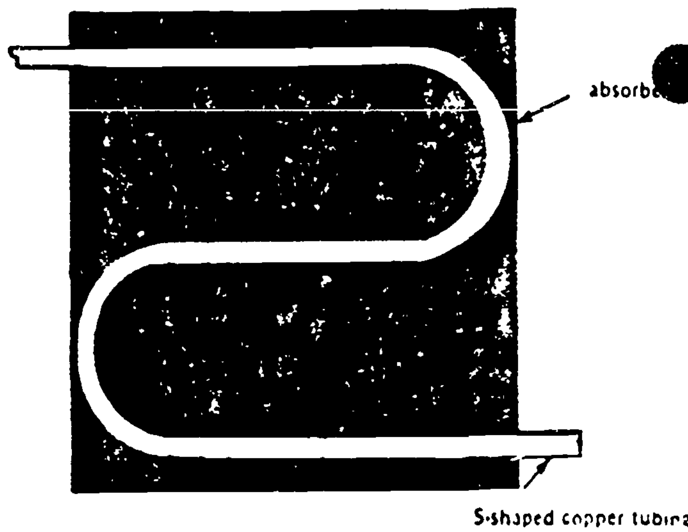


Diagram 3 Completed Absorber Plate

16. Continue to record the temperature every 15 minutes over the course of the test period or until the temperature stops rising.
17. Plot the data, temperature vs. time, on the graph. Compare your results to the results of students who used other materials in their collectors.
18. Determine the increase in the temperature of the water ((T) from the beginning until the end of the test.

T (end) - T (beginning) = T

19. Calculate the total amount of heat collected in Btu. Multiply the mass of the water by the temperature change. The mass of 1 gallon of water equals 8.3 lbs.

Heat (Btu) = 8.3 x T

20. Determine the surface area of your absorber plate by multiplying its length in feet by its width in feet.

Area (sq.ft.) - length x width

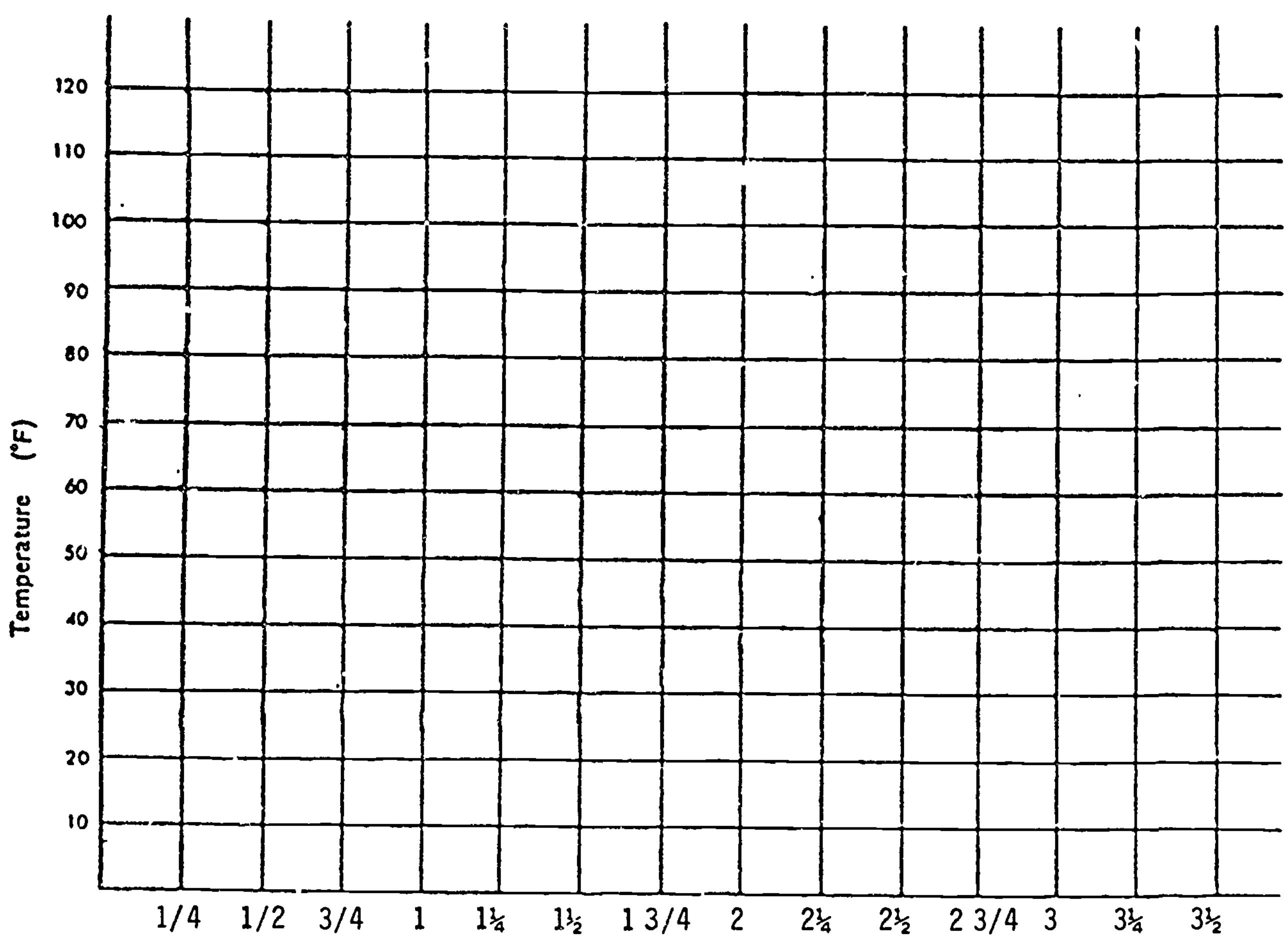
21. Determine the relative efficiency of the heat collected in Btu per square foot of absorber plate. To do this, divide the Btu collected by the number of square feet of absorber plate.

$$\text{Efficiency (Btu/sq. ft.)} = \frac{\text{Btu collected}}{\text{sq. ft. of absorber plate}}$$

Data Table

Time (hr.)	Temperature °F	Time (hr.)	Temperature °F
Beginning		2	
1/4		2 1/4	
1/2		2 1/2	
3/4		2 3/4	
1		3	
1 1/4		3 1/4	
1 1/2		3 1/2	
1 3/4			

Graph



A SOLAR STILL

SUBJECT Industrial Technology LEVEL 6 - 12

ACTIVITY IN BRIEF

In this activity, you will be constructing a solar still which is used for desalination of salt contaminated water.

OBJECTIVE

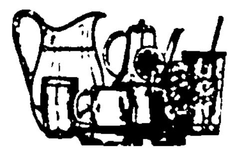
Each student will be able to define desalinization and will describe the concept of solar distillation.

MATERIALS

glass bowl, large beaker, or glass jar
(1 quart size)
table salt
plastic wrap (Saran Wrap)
drinking glass or small beaker
marbles
newspapers

TIME

1 - 2 class periods



LEARNING CYCLE

AWARENESS - Introduce students to other ways of using solar energy. Discuss photovoltaics and distillation of water. Discuss how the sun is used by campers and explorers to get the energy needed for survival.

CONCEPT DEVELOPMENT - Construct the solar still. Place the still in the sun and observe what happens to the water after a long period of time. Remove the cover and examine the underside. What is left on the underside?

APPLICATION - What type of energy conversions are taking place? What are some possible large scale uses of a solar still such as this?

EVALUATION - 1) Have students define desalinization in a paragraph. 2) Have students describe the process of desalinization and give one example of how it could be used to enhance the world's supply of fresh water.

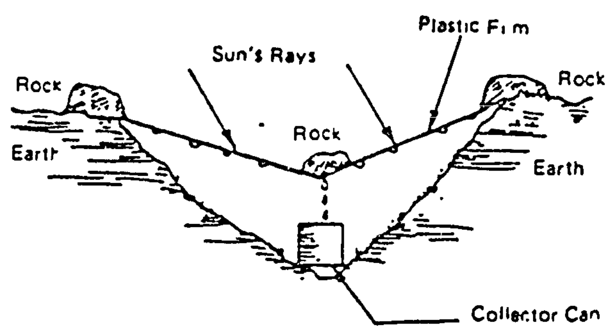
FOLLOW-UP/BACKGROUND INFORMATION

Evaporation of the salt water doesn't happen in a few minutes, so it is not reasonable to expect results in a single class period. Try to find a warm and sunny location where the still may sit for at least 24 hours. Eventually a mist of fresh water will collect on the surface of the plastic and some will drip into the glass.

An industrial arts class or senior high science students may like to make a more functional and durable still. Measurements and diagrams for construction of one are included in Practical Sun Power by Rankins and Wilson, Lorien House, P.O. Box 1112, Black Mountain, NC 28711, $4.

If area of the schoolyard is available for digging a shallow pit 30 to 40 cm deep, students may construct a basic survival still using a clean jar, beaker, or can for the collector and a piece of plastic storm window sheeting for a cover. Use rocks, bricks, or scrap lumber to hold down the perimeter of the plastic film. Put another small rock on the film over the collector, depressing the center of the film about 30-35mm from ground level. Water tends to cling to plastic (more readily than to glass) so a relatively steep incline is important to get droplets rolling.

Mark the hole so no one will accidently step into it. Let the still sit undisturbed for two to 24 hours, then remove the can and refill the hole. Take the fluid collected to the classroom for identification. Students may want to make a slide with a drop of distillate and check for presence of bacteria, or try to start a bacterial colony with it.



Survival Still

SOURCE OF ACTIVITY

Iowa Developed Energy Activity Sampler. Adapted by Alan Glass.

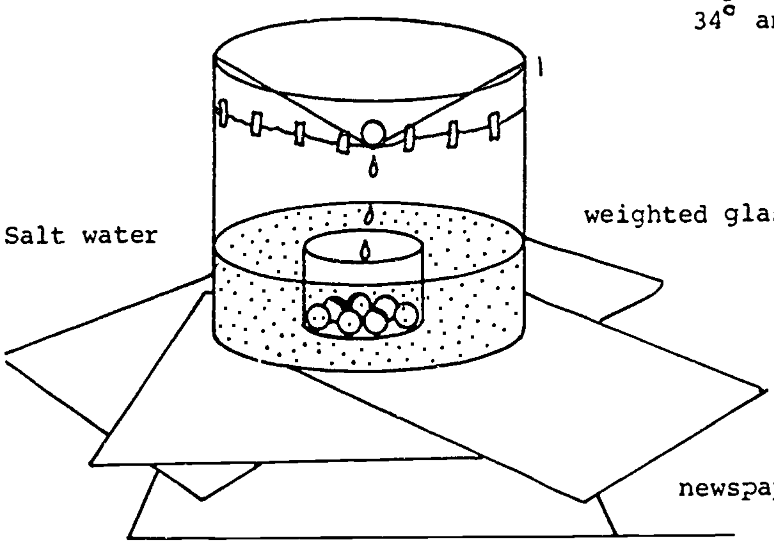
ACTIVITY

1. Prepare salt water using 3.5 g table salt for every liter of water.

2. Wash and dry marbles so they are clean.

3. Organize the materials as shown in the diagram. Put some marbles in the beaker to keep it from turning over. Put the plastic food wrap loosely around the top. Secure the edges with tape or a rubber band. Then put one marble on the wrap so that it dips significantly over the small beaker.

4. Put the still on newspapers (for insulation) on the ground in direct sunlight. Leave it undisturbed for an hour or more. You can leave it overnight and reclaim it 24 hours later if you have a quiet location for it.



5. Questions:
   a. Notice the appearance of the plastic cover. What has happened?
   b. Remove the cover and examine its underside. Put some of the drops on your finger and taste it. It tastes like ________________.
   c. Remove the glass. Carefully take out the marbles (if you used them). Examine the remaining contents.
      1. What is it?
      2. What evidence identifies it?
   d. How did the "new" material get into the glass? Was work done?
   e. What does <u>distillation</u> mean?

6. Extended Activity: Using library resources, find out about water desalinization (taking salt out) projects around the world. Do any of them use the sun? Where in the world are people most interested in getting fresh water from salt water? Why?

SUPER SOLAR OVENS

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

In this activity, students will be constructing a simple solar oven which can be used to cook easy meals.

OBJECTIVE

Each student will be able to explain: 1) how solar energy can be used to heat air in an oven used for food preparation, and 2) how solar energy is converted to thermal energy

MATERIALS

3/4" fir plywood, as needed according to oven size chosen
18" of 1" x 4" pine wood
8 ft of 1" x 2" pine wood
1 1/2" extruded styrofoam insulation (approx 2ft x 4ft)
28 gauge sheet metal (for lining the inside of the oven). You may substitute aluminum foil for the sheet metal
approximately 24" x 24" of double strength glass, plexiglas, or clear plastic sheeting.
two 3/4" x 2" box-hinges
1/4" plywood or cardboard for reflector panels
aluminum foil
wooden door knob
#4 finish nails
wood glue
latex caulk
flat black enamel paint (spray or brush)
duct tape
thermometer

TIME

7 - 14 class periods

LEARNING CYCLE

AWARENESS - Discuss solar heating. Show the students examples of solar greenhouses. Explain how a solar oven works and how it is similar to a solar greenhouse. Talk about solar concentration with mirrors. Describe the Solar One* power generating station in California.

CONCEPT DEVELOPMENT - Construct the solar oven and test it by cooking hot dogs or some simple food. Students must also understand how to orient the oven so it receives the most intense sunlight. Have students add extra reflectors if necessary.

APPLICATION - Discuss how solar cooking could be feasible on a large scale basis. What type of ovens would be necessary? What type of materials would be needed? What materials would make this or any solar oven stronger and more efficient?

EVALUATION - 1) Have students describe in a paragraph how solar energy can be used to heat food. 2) Have the students explain how the energy conversions (from solar energy to heat energy) take place. 3) Have the students record the rise in temperature inside the oven for each 15 minutes the oven is in the sun. Make a chart of the temperature rise over 1 or 2 hours.

FOLLOW-UP/BACKGROUND INFORMATION

Cooking with the Sun is a way to show that light energy can become useful heat energy. But time, energy, and materials must be properly invested in order to make use of "free" solar energy. This incoming energy is spread out, not concentrated. Still, solar can be used effectively for many jobs, including slow-cooking of meat and potatoes; heating houses; and heating water. This model oven will give you chances to do some solar heating and solar cooking on the next sunny day.

Cooking with the Sun has been one of the more popular projects attempted by solar enthusiasts. Hot dog cookers with a spit and curved reflector are easy to make. Umbrellas lined with mylar have been used to focus solar heat on a teakettle or rice pot. Curved reflectors made of aluminum also can help concentrate light onto food enclosed in black cans or glass-windowed boxes. Fresnel lenses have been used to produce intense heat, and oven plans using one are available for 75 cents from Edmund Scientific Co., 1888 Edscorp Building, Barrington, NJ, 08007.

A durable oven made of sheet aluminum and plywood is described in detail, with construction diagrams, in Practical Sun Power by Rankins & Wilson, from Lorien House (publisher), P.O. Box 1112, Black Mountain, NC, 28711, for approximately $4. This model would be appropriate for industrial arts students to build and would last longer than the model described here. However, it would require a greater initial investment of time and materials to complete it.

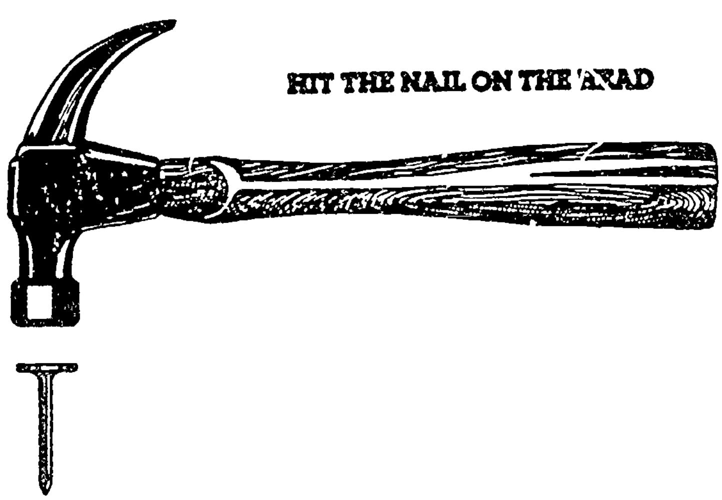
*Solar One is a solar powered electrical generating station located in southern California.

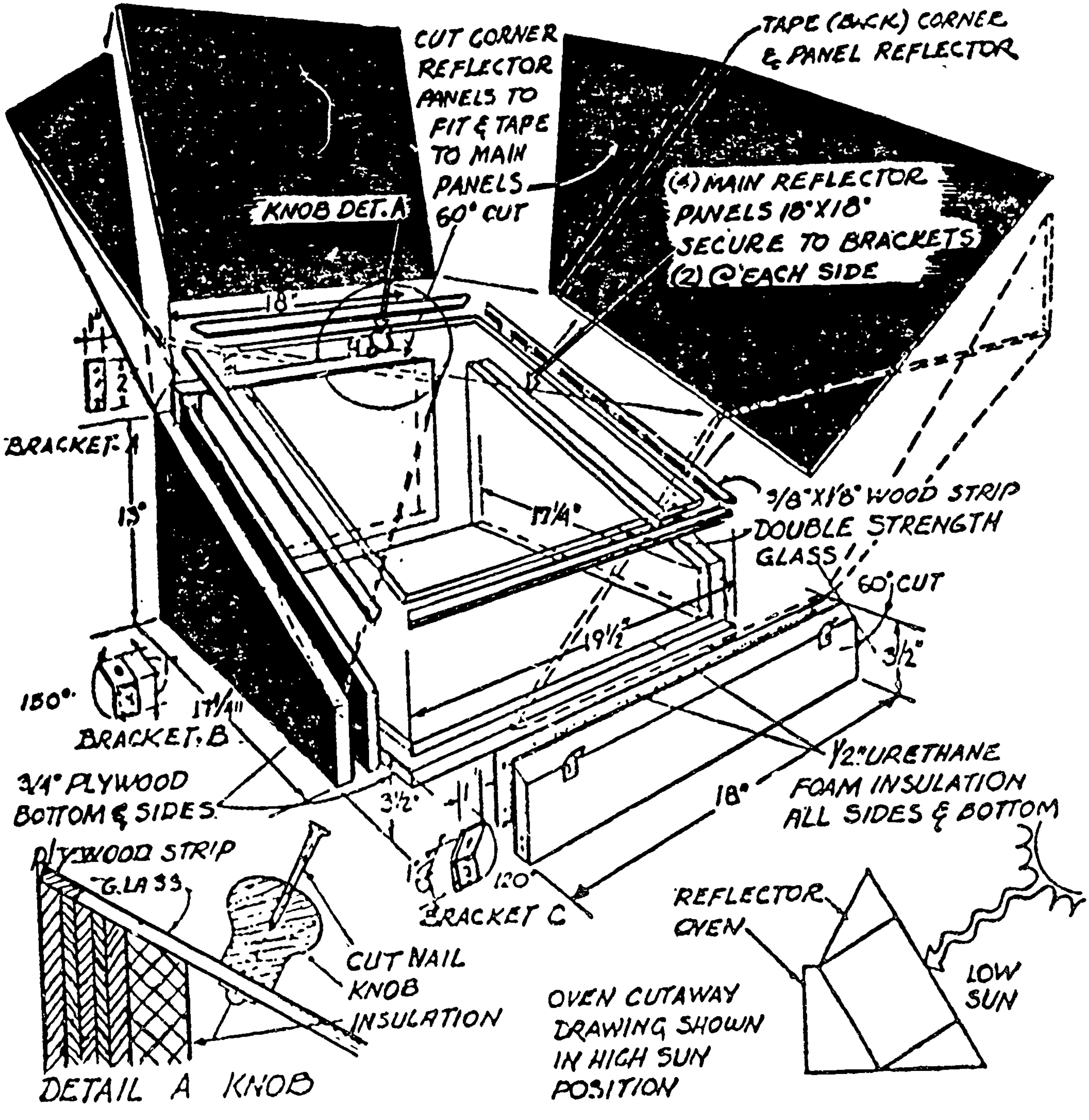
SOURCE OF ACTIVITY

Adapted by Alan Glass, "Practical Sun Power," by Rankins and Wilson, Lorien House. Popular Mechanics Magazine, May 24, 1982.

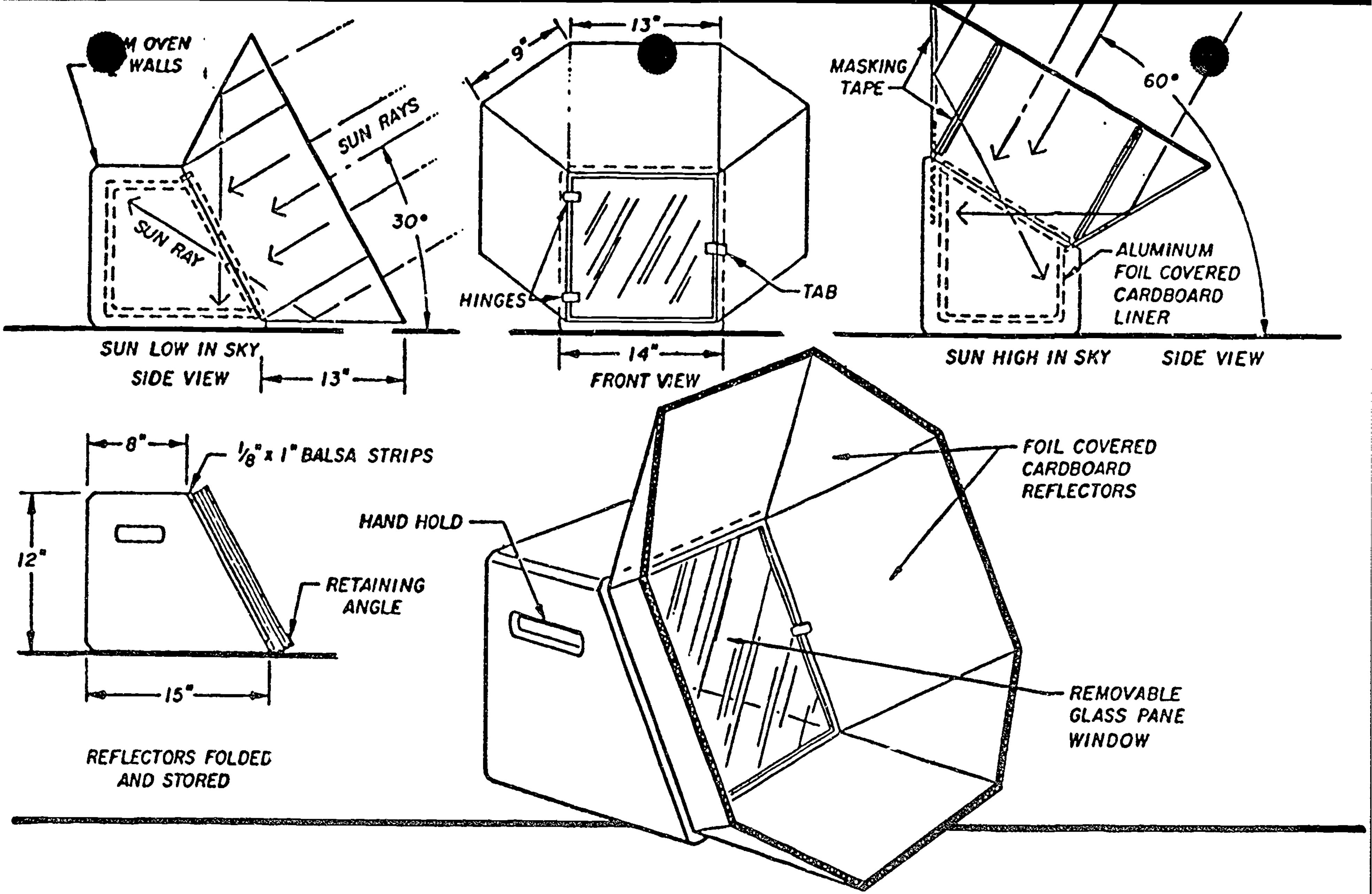
ACTIVITY

1. Choose one of the diagrams for solar ovens provided in this activity.
2. Measure and lay out 3/4" plywood pieces to form the oven box according to the dimensions on the diagram. Cut as specified.
3. Assemble the pieces to form the box with wood glue and #4 finish nails. Set all nail heads.
4. Measure oven box opening for door frame.
5. Cut 1" x 2" pine for door frame. Miter all corners.
6. Cut a groove 1/8" wide x 1/2" deep down the center of each of the door frame pieces for the glass. This may be done on the table saw if one is available.
7. Cut the glass to fit inside the frame.
8. Insert the glass in the frame, glue and clamp the mitered corners.
9. Cut styrofoam to line the inside of the box. Cut all pieces to fit snugly. Glue styrofoan to the box with wood glue.
10. Cut 28 gauge sheet metal to fit inside the box. Line the inside of the box with the sheet metal. Use latex caulk or epoxy glue to secure the metal pieces in the box.
11. Caulk all corners inside the oven to seal all seams.
12. If you choose not to use sheet metal, you may line the inside of the box with aluminum foil.
13. Paint the inside of the oven with flat black paint.
14. Attach oven door to the box with two 3/4" x 2" hinges.
15. Attach wooden door knob to the door.
16. Cut reflector panels to fit the oven door. Cover reflector panels with aluminum foil and tape reflectors to the box with duct tape.
17. Place finished oven in the sun, put food on an aluminum pie tin or aluminum foil and pop it into the oven. Hot dogs take about 15 to 30 minutes, hamburgers take about 30 minutes. You can moniter the temperature rise by placing a thermometer inside the oven while the food is being heated.





ALTERNATIVE OVEN



SOLAR OVEN

IT33

THE SUN'S POSITION IN THE SKY

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

Students will be constructing a device which will measure the sun's position in the sky.

OBJECTIVE

At the end of this activity, each student will be able to measure the angle of the sun's rays and determine the altitude and azimuth of the sun. This information is important when placing collectors to ensure that the collector receives the greatest possible amount of sunlight.

MATERIALS

a small peg board, 3/8" wood dowels, a magnetic compass, a bubble level, a clock or watch, paper, pencil, straight edge, and a protractor

TIME

4 - 6 class periods

LEARNING CYCLE

AWARENESS - Explain altitude, azimuth, and zenith of the sun. Introduce the ideas of solar orientation and discuss why it is important.

CONCEPT DEVELOPMENT - Have the student construct some sun position devices such as the one found in this activity. Collect and record all data accurately in the charts provided.

APPLICATION - Discuss the importance for knowing the sun's position in the sky. How does this affect the design of flat plate collectors. How is this data helpful in the placement of solar collectors.

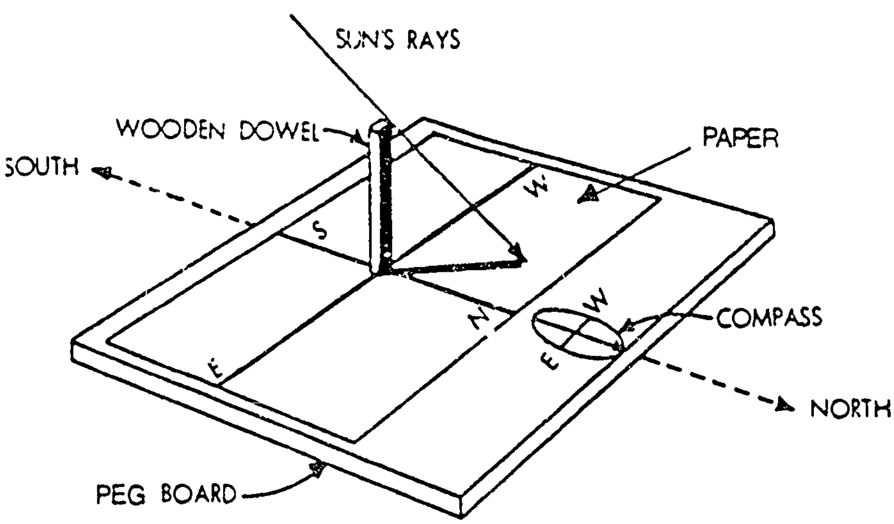
EVALUATION - 1) Have the students describe in a paragraph why it is necessary to determine the altitude and azimuth of the sun. 2) Have the students complete a data table similar to the example given on the last page of the activity. Record information for at least 3 hours.

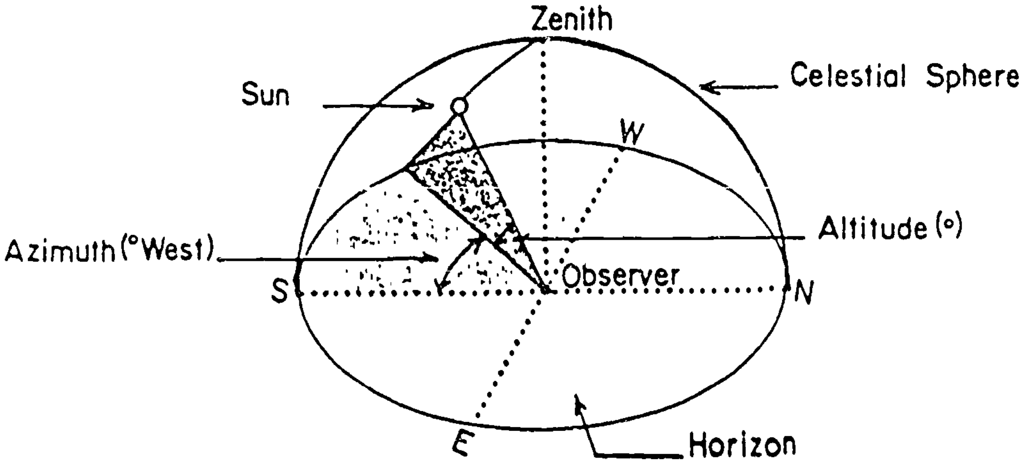
FOLLOW-UP/BACKGROUND INFORMATION

Perhaps the most fundamental information needed by the solar energy experimenter is solar position and intensity data. The apparent position of the sun changes throughout the day as a result of the earth's rotation about its axis. The sun appears to rise each day in a generally eastern direction and sets in a generally western direction. As the earth revolves about the sun during the course of the year, the exact path that the sun appears to take changes. This is a result of the fact that the earth's rotational axis is titled 23 1/2° with respect to a line drawn perpendicular to the plane of the earth's orbit about the sun. Only twice a year the, around March 21 (the vernal equinox) and September 23 (the autumnal equinox), does the sun appear to rise directly at the east point and set directly at the west point. The sun reaches the lowest point (at noon) in the southern sky December 22 (winter solstice) and the highest point June 21 (summer solstice).

Several systems of coordinates are used to describe the position of celestial bodies. One, which is quite similar to the equatorial system of longitude and latitude on Earth, makes use of the "celestial sphere" with star position measured in terms of "right ascension" and declination. Generally, however, the more straightforward horizon system, similar to that used by navigators or surveyors, is used by those working in the solar energy field. The position of the sun is described in terms of its altitude (angle) and its azimuth (angle).

The altitude of the sun is determined by measuring the angle between the observer's line of sight to the sun and the horizon (the horizontal plane of the observer). The azimuth measurement used by solar energy workers is slightly different than that used by surveyors. The azimuth is the angle measured between the N-S line and the projection of the line of sight onto the horizontal plane. The angle is measured between the S horizon point and the projection on the horizontal plane of the line of sight to the sun. The azimuth will therefore be a measurement in degrees E (in the morning) or of degrees W (in the afternoon). (In the surveyor's system, all measurements of azimuth are made by measuring the angle clockwise from the N horizon point and can have values of 0° to 360°.





In this discussion, the directions referred to are the geographical rather than the magnetic compass directions. Since the north magnetic pole does not correspond with the true or geographical pole, corrections to compass readings must be made to correct for the magnetic declination at any given locality. The magnetic declination is the angle between the direction the compass needle points and true north; values for magnetic declination can be found on local topographical maps or in tables in most physics reference books.

At 12 o'clock noon, sun time, the sun would be located somewhere along the imaginary line that passes through the N-S points and your zenith. However, 12 o'clock solar time does not correspond to 12 o'clock standard time. For this reason, the sun's shadow does not fall exactly along a line running north and south at 12:00 noon (clock time). Correction can be made for local time as follows:

> There are 24 time zones extending around the earth, these extend over 360°. Each time zone covers approximately 15° of longitude (360° divided by 24). This means that 1° of longitude corresponds to a time difference of 4 minutes.
>
> $15° = 1$ hour $= 60$ minutes, therefore, $1° = \frac{60 \text{ minutes}}{15 \text{ degrees}} = 4$ min/degrees

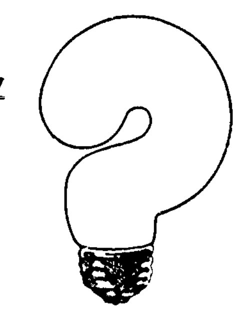
Longitude is measured westward from the prime meridian at Greenwich, England. Therefore, longitudes of 0°, 15°, 30°, 45°, 60°, 75°, etc., correspond to the center of each time zone. The center of the Eastern Time Zone is the meridian with a longitude of 75°. Add or subtract 4 minutes to the time for every degree of longitude that you are east or west of the center of your time zone.

Example: Your clock reads 10:00 Eastern Standard Time. Your longitude is 80°. This is 5° west of the 75th meridian where it is actually 10:00. Subtract 5 degrees x 4 minutes/degree = 20 minutes. It is 9:40 solar time at your locality. The sun will not be on your meridian until 10:20 (clock time).

SOURCE OF ACTIVITY

This activity is one included in the Department of Energy's <u>Solar Energy Project: Activities in Earth Science, 1979.</u>

Adapted by Alan Glass.



ACTIVITY

Directions:

1. Locate the mid-point of one long edge of the pegboard and place the dowel into the hole 6 rows in from the mid-point.

2. Place a piece of paper on the board by pushing it down over the dowel.

3. Remove the paper from the board. Draw two lines on the paper, each passing through the center of the hole. One line should be parallel to the long side of the paper; the other should be parallel to the short side of the paper. In other words, these two lines are perpendicular (at right angles or 90° to each other. Mark the ends N-S, E-W (as shown on the sketch) to show the compass directions to use in lining the board.

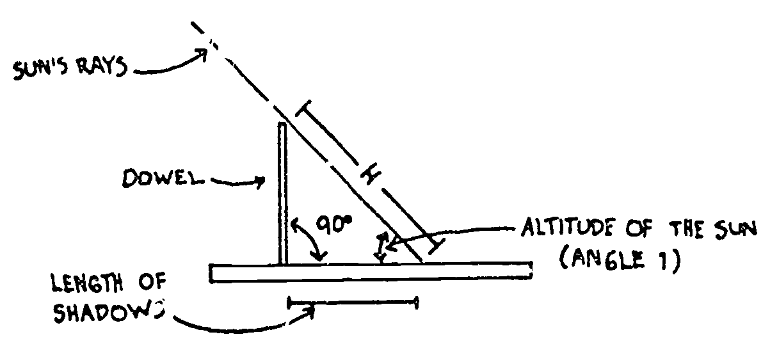
4. Set the board in a horizontal position where it will receive the direct rays of the sun most of the day. Align the board with the compass as shown in Figure 1. Use the bubble level to check that the board is level. Level it if needed. (Note: your instructor may suggest aligning the board in a different way.)

5. Measure and record the height of the dowel above the top surface of the board.

6. Each 15 minutes, draw a line on the paper showing the position of the shadow. Be careful to mark the end of the shadow accurately. Since the positions of the shadows are needed throughout the day, students in all classes will have to make use of each other's data. Record the time and data for each shadow drawn.

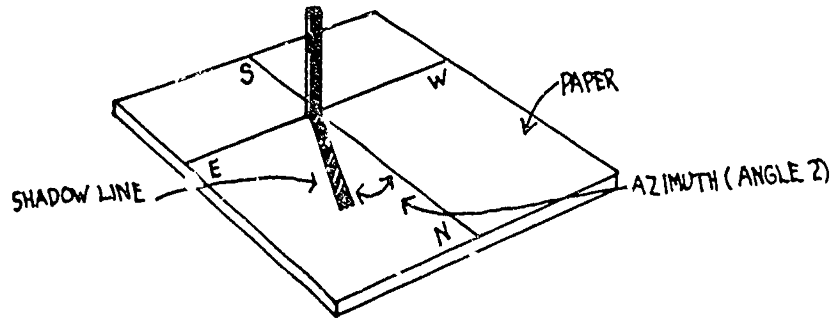
7. For each position of the shadow you will want to measure two angles:

   a. The first is the angle between the shadow(s) on the paper and the slanting side (H) of the triangle as shown in the sketch below. This angle is called the altitude of the sun.



   On a separate sheet of paper draw a right angle triangle such that the vertical side is equal to the dowel height and the horizontal side is equal to the shadow length. Draw line (H) and measure angle 1. Record: date, time, and altitude of the sun in degrees on the diagram.

b. The second angle tells us how much east or west of the N-S line the sun is. This angle is called the azimuth.



c. Measure angle 2, and record it directly on the apparatus. If the actual position of the sun is west of the N-S line (in other words, the shadow falls to the east of the N-S line), then the azimuth angle is recorded as so many degrees west. If the sun is east of the N-S line, then the azimuth is recorded as a certain number of degrees east. Example: In the sketch on the previous page, the azimuth might be approximately 30°W.

8. Prepare a data table for the sun's position. Include the following information:

Date:		
Time	Sun's Altitude in degrees	Sun's Azimuth in degrees

9. Since the solar energy designer needs this kind of information for the whole year, tables have been carefully prepared by scientists. Compare your data with that in published tables available from the weather bureau. Why are the tables arranged by latitude? What is the approximate latitude where you live?

A PHOTOVOLTAIC DEMONSTRATOR

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

This activity involves constructing a photovoltaic demonstrator to determine the angle at which the sun's rays are most intense. The demonstrator can also be used to set and orient rooftop solar panels. This demonstrator will consist basically of a photovoltaic (solar) cell connected to a milliammeter.

OBJECTIVE

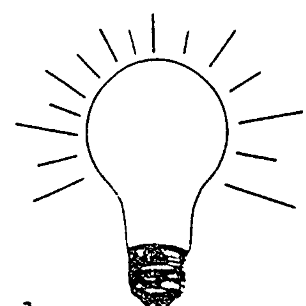
Each student will be able to measure the output of the demonstrator as a function of the sun's azimuth, altitude, and intensity, and of the demonstrator's angle of inclination.

MATERIALS

3/4" plywood
photovoltaic cell
hinges (two)
clips (two) -optional
milliammeter
wire for electrical connections
screw type electrical connectors
screws
plexiglass sheet, about 4"x4"x1/8" thick
compass
several solar collector glazings, such as glass, plastic, acrylic, and various commercial products
1/2" band iron, 1/16" to 1/8" thick, about 10" long
epoxy
variable resistor (5K)
SPST switch
protractor

TIME

5 - 6 class periods



LEARNING CYCLE

AWARENESS - The students are given information on solar intensity and solar orientation. The students discuss terms such as azimuth, zenith, and solar altitude. Solar panels are discussed.

CONCEPT DEVELOPMENT - The students construct the photovoltaic demonstrator and test it when completed. Determine the principle behind photovoltaics.

APPLICATION - Discuss solar orientation. How is it important to a contractor, or someone who is placing a solar panel on his/her own house or building. What are other applications for the demonstrator?

EVALUATION - 1) Have students take readings and fill out the graphs provided on the last page of this activity. 2) Have students describe in a paragraph the purpose for the demonstrator and the process of measuring the angle of inclination.

FOLLOW-UP/BACKGROUND INFORMATION

Take a trip to a house which is equipped with solar panels. Use the demonstrator to check the azimuth of the sun for that location. Determine the correct angle for that particular solar installation.

SOURCE OF ACTIVITY

"Solar Energy Education-Industrial Arts", Solar Energy Project, New York State Education Department, Albany, New York 1981. Adapted by Alan Glass.

ACTIVITY

1. Cut out, sand, and finish wood parts to the specifications shown in Diagram 1. Cut 6" of band iron and sharpen one end as shown in the diagram.

2. With a router, rout out a depression slightly larger than the solar cell and 1/16" deep. Also rout spaces for the wires and a space for the SPST switch. (If router is not available, skip this step.)

3. Drill holes for the solar cell wires, milliammeter, and the variable resistor.

4. If the solar cell does not have presoldered wire leads, a lead must be carefully soldered to either side. Use extra care to make sure no solder leaks over edge.

5. Assemble the wooden sections as shown in Diagram 1. Attach band iron support.

6. Insert the solar cell into its depression. Feed wires through the drilled hole. If you did not rout a depression in the wood, you may glue the cell on the wood.

(CAUTION: Solar cells are very expensive and very fragile. Mount the cell very carefully.)

7. Cut the plexiglas sheet to cover the solar cell and screw it into place. It may also be glued into place.

8. Attach the milliammeter, variable resistor, electrical connectors, switch, and remaining wiring.

9. Wire the circuit as shown in Diagram 2. Be sure to wire the variable resistor in parallel with the meter.

10. Attach the two clips to hold glazings.

11. Align a protractor with the hinges of the demonstrator. Lift the top section of the demonstrator, stopping at 5 degree intervals. At each stop, carefully mark the position of the sharpened end of the band iron.

PART II. USING THE PHOTOVOLTAIC DEMONSTRATOR:

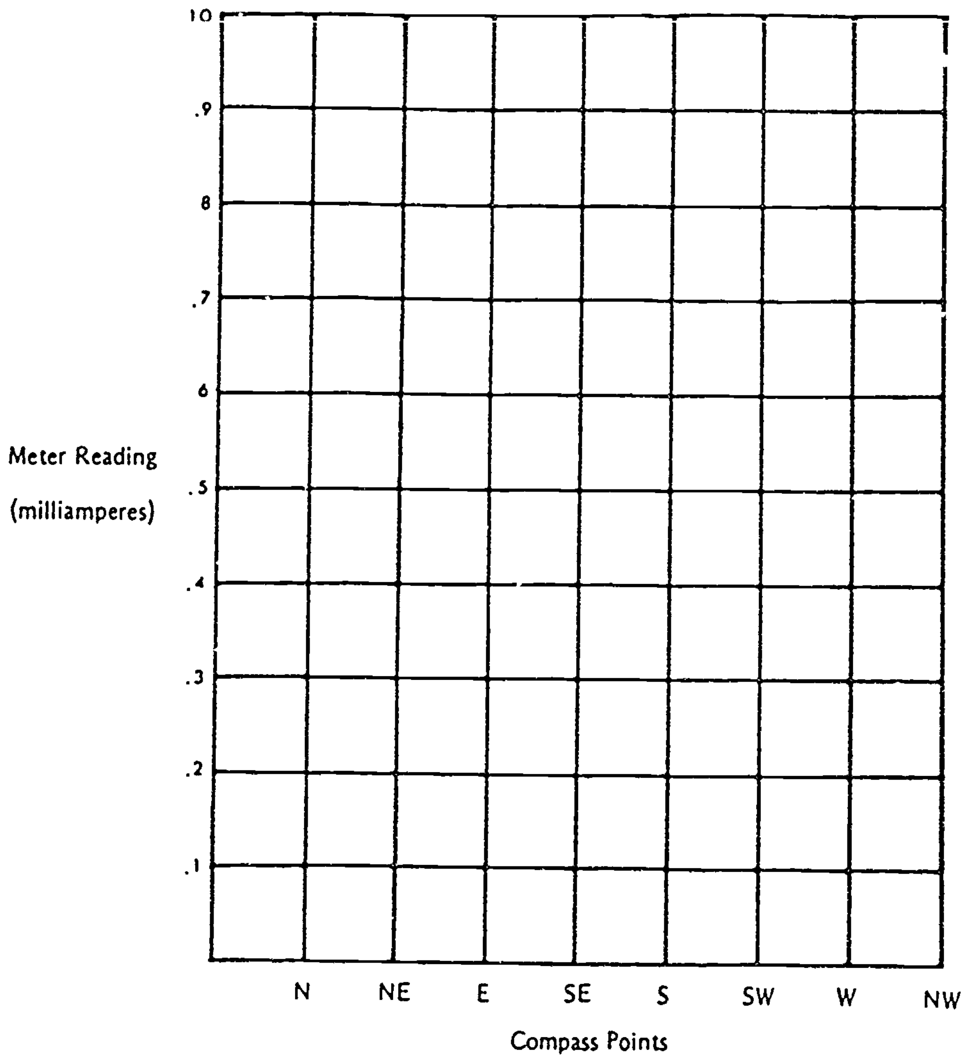
1. Determining the angle of azimuth of the sun (the distance of the sun from true south)
   a. Set the demonstrator at 45 degrees outside; free of shadows, buildings, or trees. Note the time of day.
   b. Sight the demonstrator along the following compass points: N, NE, E, SE, S, SW, W, and NW, and take a meter reading at each point.
   c. Plot readings on Graph 1.
   d. Select the compass point with the highest reading. Sight the demonstrator at 5 degree intervals around this compass point. The highest reading will give you the approximate angle of azimuth of the sun from true south.
   e. Repeat Step 1 for another time of day.

2. Determining the best angle of inclination for the demonstrator by finding the altitude of the sun (the height of the sun in the sky)
   a. Set the demonstrator at the angle of azimuth you found in Step 1.
   b. Position the top section of the demonstrator at 5 inclination intervals and take a meter reading at each interval. Start with 0 and end with 90 .
   c. On Graph 2 plot meter readings vs. degrees of inclination.
   d. Select the inclination with the highest meter reading. Subtract from 90 to obtain the solar altitude for the time of day you noted. Solar altitude tells you the height of the sun in the sky.
   e. Repeat Step 2 for another time of day.

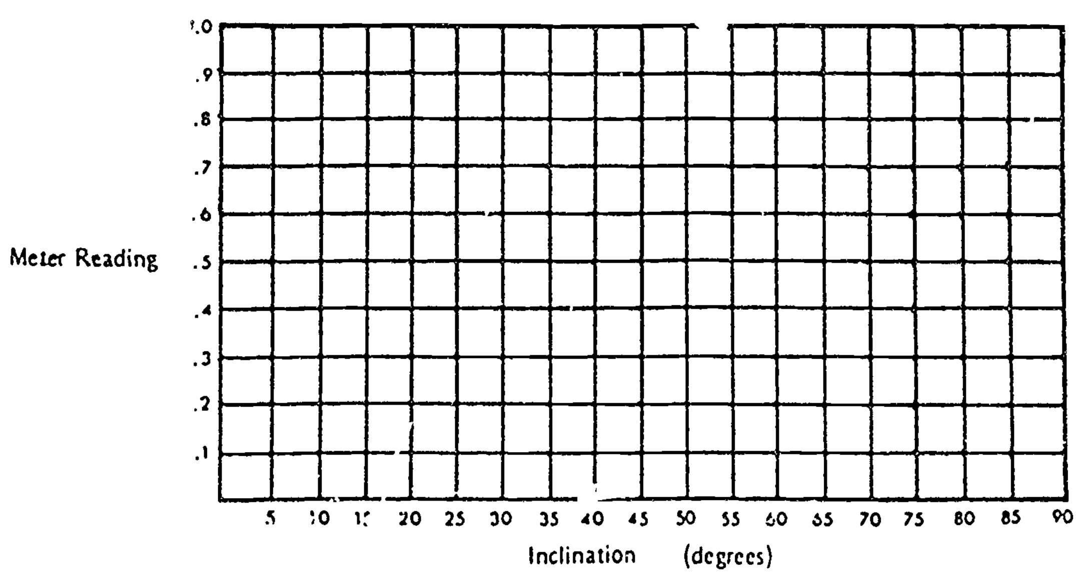
3. Determining solar intensity
   a. Keeping the same angle of azimuth, set the solar demonstrator at the angle of inclination which yielded the highest reading in Step 2.
   b. Take meter readings several times a day over several days, (may be hard to do as class is not in session all day) carefully noting time, day, meter reading, and especially sky and weather conditions.

4. Determining the transmittance of glazing
   a. Set the demonstrator at the angles of azimuth and inclination found in Steps 1 and 2.
   b. Use the variable resistor to set the meter to 1.
   c. Insert test glazings between the clips and record the meter readings.
   d. Construct a bar graph representing types of glazings and the percent of light transmitted.

Graph 1



Graph 2



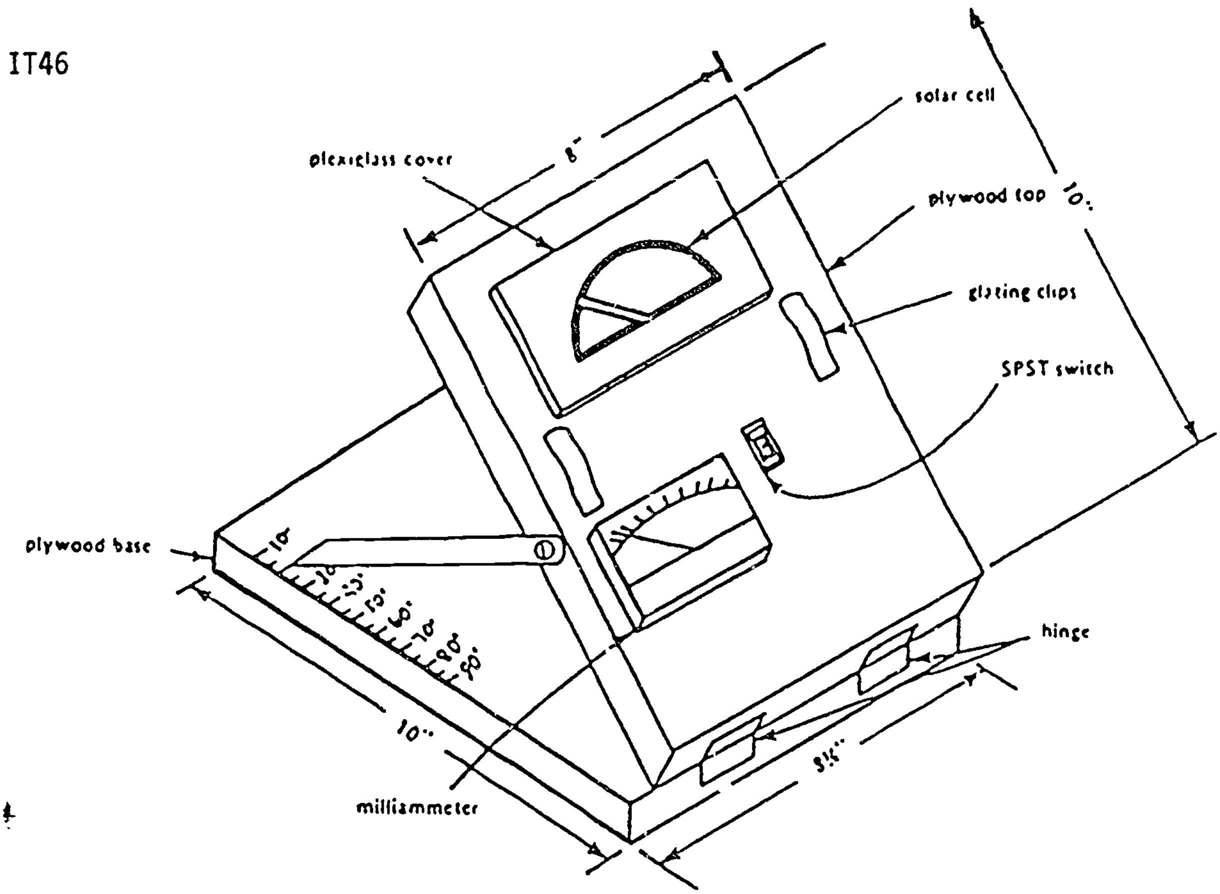


DIAGRAM 1

PHOTOVOLTAIC DEMONSTRATOR DIMENSIONS

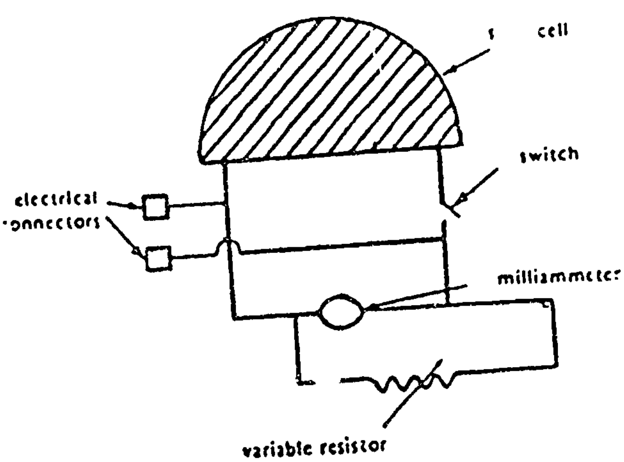


DIAGRAM 2

WIRING DIAGRAM

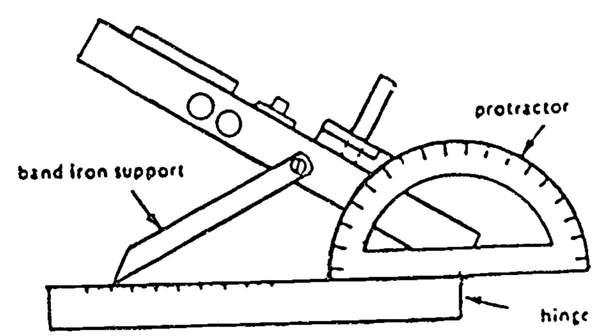


DIAGRAM 3

CALIBRATING THE DEMONSTRATOR

ENERGY WORD GAMES

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

In this activity, students will play word games with energy the theme. Students will also be asked to create their own game.

OBJECTIVE

At the completion of this activity. each student will be able to state concepts, define keywords and recognize forms of energy.

MATERIALS	TIME
paper and pencil	3 - 5 class periods

LEARNING CYCLE

AWARENESS - Review major energy terms and their definitions. Review the basics of each of the energy forms you have studied.

CONCEPT DEVELOPMENT - Play Energy Bingo. Have students make up an energy crossword puzzle. Play the password energy game.

APPLICATION - Have each student make up his or her own energy game. It may be a crossword puzzle, or an energy game patterned after a television game show. Example: Wheel of Energy Fortune or Family Oil Rights Feud.

EVALUATION - Ask each student to state or list on paper five major forms of energy and define each form.

SOURCE OF ACTIVITY

Miriam Colvin, Dorothy Kruse, Ada Narem, Directed by Ella Jedicka, University of Northern Iowa. Adapted by Alan Glass.

ACTIVITY

1. ENERGY Bingo: Ordinary bingo requires only the ability to hear numbers called, to recognize them on a card, to cover them on the card when called, and to say "Bingo!" when five adjacent numbers are covered in a row, column, or diagonal. ENERGY requires additional skill: Knowledge of some energy-related terms. The objective is to enhance retention of what the student has learned about energy, to motivate learning additional facts, and to point out gaps in knowledge.

   a. Advance preparation: Cards must be developed like the following example. No two should be exactly alike. Words from the accompanying list are suggested. Add others that are appropriate for your classes.

      Also, prepare in advance a short descriptive sentence for each energy-related word used on your game cards. Put each sentence on a separate slip.

   b. Play: To begin play, the caller will shake up the word slips in a 3 lb. coffee can or other suitable container. Then he will draw and read one slip at a time. Players must decide which term is being described and, if they have that word on their cards, cover it. From then on, it is played just like conventional bingo.

E	N	R	G	Y
evaporate	entropy	R-factor	geothermal	hydro-power
conduct	nuclear	recycle	gas	bicycle
convect	fusion	FREE	coal	flywheel
electric	fission	retrofit	petroleum	Calorie
EER	insulate	radiation	quad	fuel

2. Crossword puzzles and word-maze games: Provide graph paper with 1/2" or cm squares. Encourage students to make word puzzles using;

   a. as many "energy words" as possible; or

   b. as compact a format as possible (measured in ratio of squares used/squares available); or

   c a graphic energy-related design within which selected words will "fit;" or

   d a special theme, like travel, houses, electricity, conservation, alternative sources, etc.

3. Charades:
   a. Advance preparation: Have energy vocabulary written onto separate slips of paper or file cards and placed in a shoe box or a 3 lb. coffee can.

   b. Play: A student will draw out one of the energy terms. This student must pantomime or find a way to describe his energy-related feature without saying anything. Some fingerspelling may be allowed. The student who first guesses the term ir question will then get the privilege of drawing out another slip of paper and repeating the process for a different energy word.

4. Password: Energy Style

   a. Advance preparation: Make 3 clue cards, one large one to show the audience and 2 small ones, one for each team. (The card goes only to the contestant giving the clue.) Use heavy paper so writing will not show through. Use the ENERGY WORDS FOR GAMES or any others of your choice.

   b. Play: Bring four students to the front of the classroom and have the alternate giving clues and receiving clues (two teams). Give points according to how many clues have been given--10 for the first clue, 9 for the second clue, and so on down to 1 point before you reveal the word to the guessing partner. Game is 21 points.

A CLASSROOM SAVONIUS WINDMILL

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

The Savonius rotor windmill is one type of windmill widely in use which produces electric current for homes. This activity involves constructing a simple model of a Savonius rotor windmill out of tin cans and inexpensive spare wood.

OBJECTIVE

Each student will demonstrate how wind energy is converted into mechanical, then electrical energy by windmill devices. Each student will be able to identify different windmill designs.

MATERIALS

three two pound or one gallon cans (empty coffee cans work well)
1/4" Diameter all-thread (threaded rod) three feet long
six 1/4" nuts
two roller skate wheels with 1/4" inside diameter (or 1/4" bearings)
one 18" x 18" piece of 3/4" plywood for base
approx. 8 foot of 1" x 2" pine (or equivalent)
glue, nails, rubber band
epoxy cement
a 1.5 volt D.C. electric motor, small flashlight bulb
3/4" scrap wood - to make a pulley for the threaded rod

TIME

10 - 14 class periods

LEARNING CYCLE

AWARENESS - Discuss various types of windmills, including horizontal and vertical axis machines. Show the students pictures of various types of windmills and explain the operation of each type. Describe how windmills are used to convert the power of the wind into electricity

CONCEPT DEVELOPMENT - Construct the model Savonius rotor windmill. Connect a generator to a pulley on the rotor. Measure the current output with a milliammeter.

APPLICATION - Discuss how this basic design could be changed to produce more electricity. What modifications would have to be made to construct a windmill that would produce larger amounts of electricy?

EVALUATION - 1) Have students draw a diagram of 4 different types of windmills. Label each windmill. 2) Have students write a paragraph describing the energy conversions that take place when a windmill produces electricity.

FOLLOW-UP/BACKGROUND INFORMATION

Try making a Savonius rotor windmill with 5 gallon buckets or 30 or 50 gallon barrels. Hook up a 12 volt D.C. generator from a car to your large windmill. How much electricity can you produce?

Further information on the Savonius windmill may be obtained by referring to the Mother Earth News magazine and other periodicals, such as Popular Science, Popular Mechanics, and Mechanix Illustrated. Wind and Windspinners, by Michael A. Hackleman and David W. House, published by Peace Press, Culver City, CA, is a very comprehensive source of information on the Savonius type windmill.

SOURCE OF ACTIVITY

Model directions provided by William G. Hoffman, Capt. Nathan Hale School, Coventry, CT, 06238. Reprinted from Connecticut Journal of Science Education, Vol. 14 (2). Iowa Developed Energy Activity Sampler. Adapted by Alan Glass.

ACTIVITY

1. Cut both ends out of three coffee cans. Carefully cut the cans in half lengthwise so that you end up with two equal sized trough-shaped pieces from each can. Cover the sharp edges with adhesive tape to lessen the possibility of a cut.

2. Fabricate the four end caps of thin plywood or masonite, 1/8" or 1/4" thick will be adequate. The diameter of the end caps should be twice the diameter of the cans you used plus 1". These end caps should be round and must have a 1/4" diameter hole drilled in the exact center. Draw a straight line through the center of each end cap with a pencil to assist you in positioning the rotor blades on the end caps.

3. Assemble two can halves to an end cap in the following manner to form a rotor subassembly. Use epoxy cement mixed in accordance with the package instructions to glue the rotor blades in place (Fig. 1).

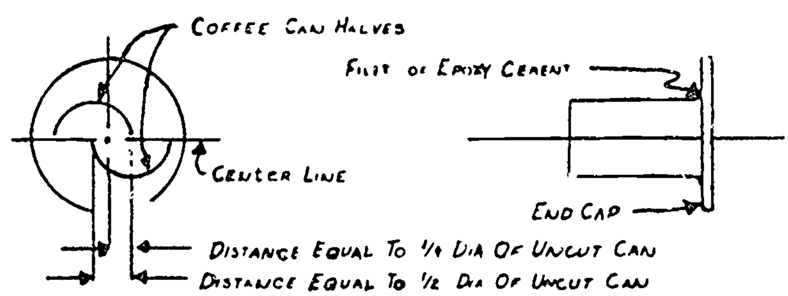


Fig. 1

4. Make a total of three rotor subassemblies as shown in step 3.

5. Join the three rotor subassemblies and the fourth end cap as shown in Fig. 2 by passing the three foot threaded rod through the center hole of each end cap. Make sure that the center line of each end cap is oriented 60 degrees away from the one below it. Epoxy each rotor subassembly and the fourth end cap to the one next to it and tighten the 1/4" nuts to hold everything together until the epoxy cement dries.

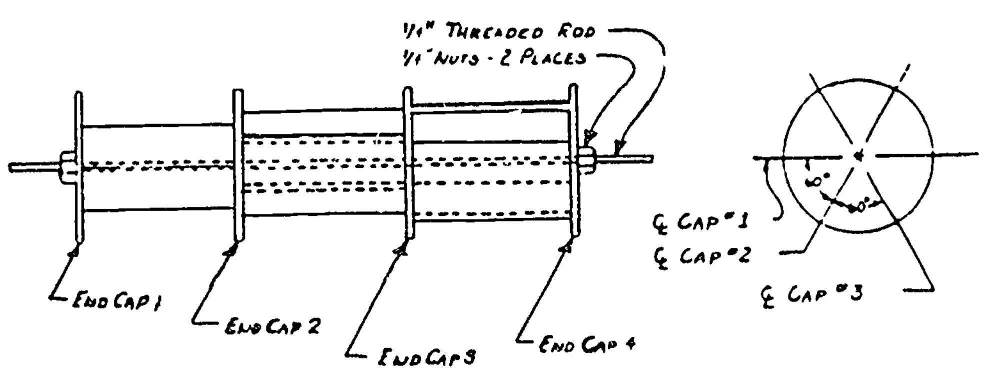


Fig. 2.

6. Install the bearings (roller skate wheels) as shown. Use a 1/4" nut at each end of the bearing to hold it in place and lock it to the rotor shaft. Tighten the nuts snugly (Fig. 3).

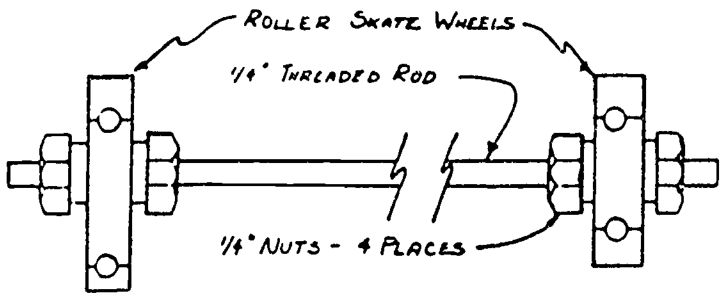
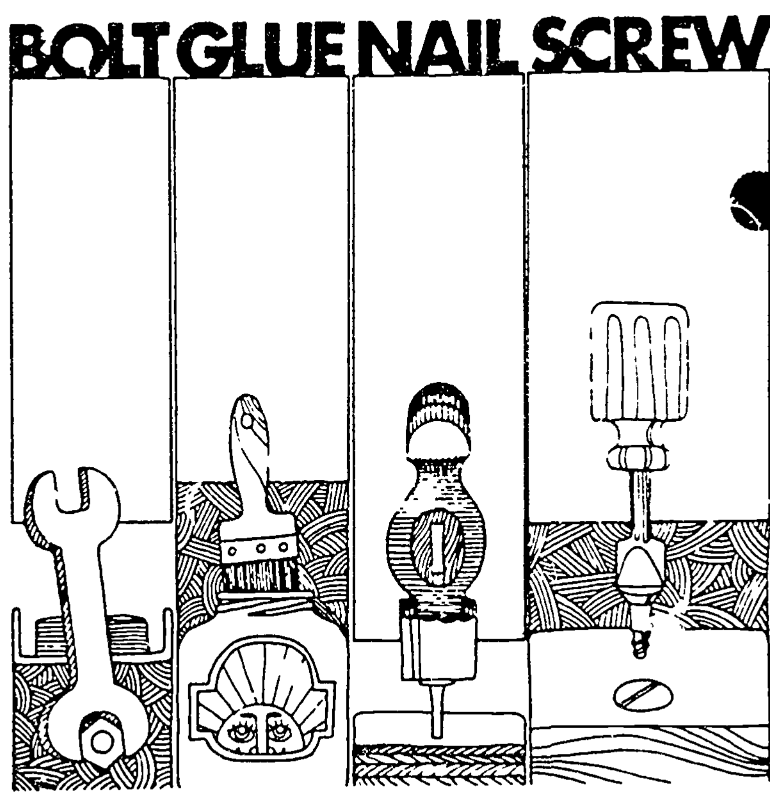


Fig. 3.

7. Balance the rotor assembly by placing it horizontally supported on its bearings (for instance, between two desks) and spin it by hand. When it stops spinning, mark the very bottom of one of the end caps with chalk. Repeat this procedure several times. If you find that one side always ends up on the bottom, you will have to lighten this side by removing material from the end caps. Do this gradually by filing, sanding, or scraping away the excess, carefully checking to assure that not too much material has been removed. When the rotor is correctly balanced it will stop in random positions when spun. This completes the rotor assembly.



8. Make a suitable framework that will allow you to mount the rotor in a vertical position supported by its bearings and free to turn in the wind. This framework may be constructed of scrap plywood or 3/4" lumber. A suggested configuration is shown in Fig. 4.

9. Epoxy the outer races (surfaces) of the bearings to the base and upper support. Make sure that the rotor is free to turn. You may have to remove some material from the base and upper support by drilling to allow clearance for the inner race of the bearing and 1/4" nuts on the end of the threaded rod.

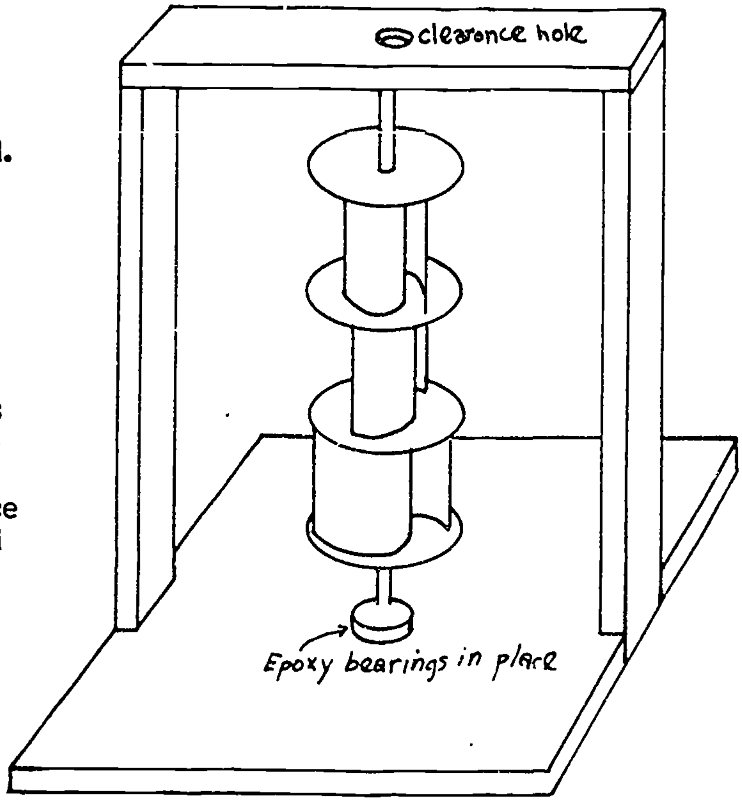
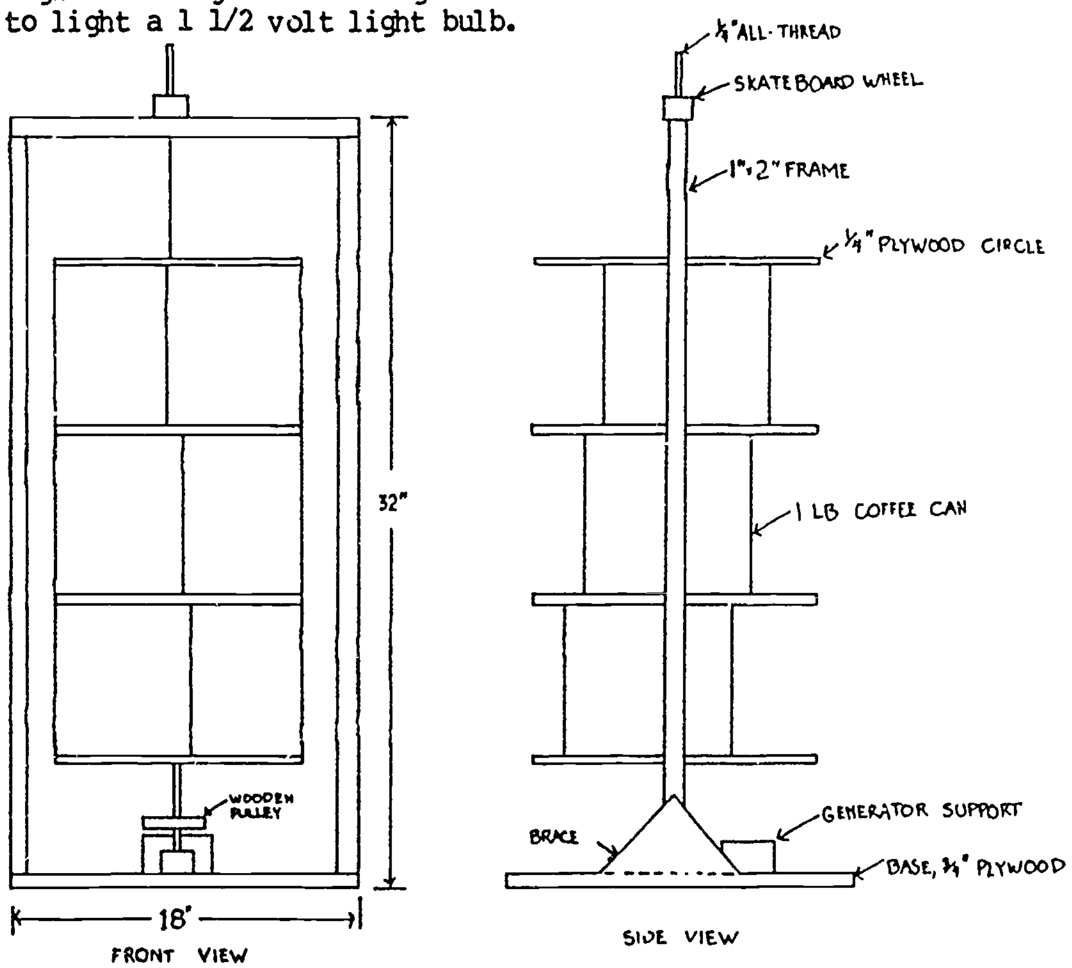


Fig. 4

Conclusion:

Take your masterpiece outside on a breezy day and see how well it works. If you are satisfied with its performance, you may attach a small 1 1/2 volt D.C. permanent magnet motor to the shaft by using pulleys and elastic band belts. When the motor is spun fast enough it will generate enough electricity to light a 1 1/2 volt light bulb.



AN INSULATING WINDOW COVER

SUBJECT Industrial Technology LEVEL 6 - 8

ACTIVITY IN BRIEF

In this activity, students will be constructing a styrofoam window cover panel which can be inserted in household windows during winter nights when heat escapes out of the house through window panes.

OBJECTIVE

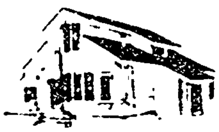
Each student will be able to explain the value of insulation and how insulation can be used to help stop heat loss in the winter.

MATERIALS

one 4' x 8' sheet of 1" rigid styrofoam insulation
30 lineal feet of wood lattice, 1 1/8" x 1/4"
2 plain cabinet knobs with screws or 2 screw eyes
Elmer's glue
one of the following: decorative fabric, wallpaper, foil, cork, 1/4" plywood, or latex paint
30 lineal feet of weatherstripping

TIME

2 class periods



LEARNING CYCLE

AWARENESS - The students will be shown examples of different types of insulating materials. Tell students to find where insulation is located in the house they live in.

CONCEPT DEVELOPMENT - The students will construct the window cover, and test it in a window in their own house.

APPLICATION - Discuss other places where insulation could be applied to the house to save energy. Why is one type of insulating material better than another?

EVALUATION - 1) Have the students brainstorm and verbally list all the different types of materials used to make commercial insulation. 2) Have students make a list of any other materials which could be used for insulation. 3) Have the students write a paragraph describing how insulation keeps a house warm in the winter and cool in the summer. What would a house with no insulation be like? Why?

FOLLOW-UP/BACKGROUND INFORMATION

Talk to a contractor (ask a contractor to come into your classroom) to discuss the value of insulating in conserving energy. Additional information may be obtained from the Owens-Corning Corporation on insulation and R values of insulating materials.

SOURCE OF ACTIVITY

Iowa Developed Energy Activity Sampler. Adapted by Alan Glass.

ACTIVITY

1. Carefully measure the inside casing of the window to be fitted with an insulating cover. Record the height, the top width, and the bottom width. If the width measurements differ by greater than 1/8", you should make a paper or cardboard pattern of this non-standard opening before proceeding.

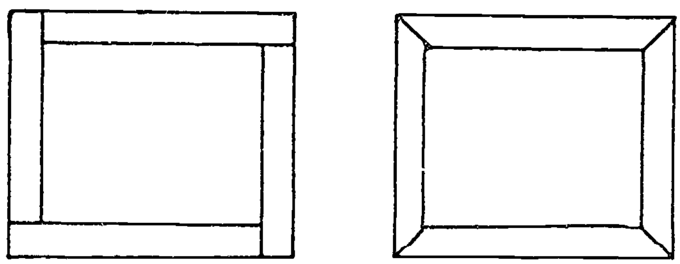
2. Substract 1/8" from both the width and the height.

3. Using the adjusted width and height measurements, mark off in pencil the panel to be cut from the styrofoam sheet. Or, if you have made and trimmed a pattern, pin it to the styrofoam as a guide.

4. Hold the styrofoam sheet steady while you carefully cut out the panel with the utility knife. Score the styrofoam lightly in the first cut. Increase pressure on succeeding cuts until you cut all the way through.

5. Check your panel against the window for closeness of fit. Trim only if necessary because a tight fit is essential. You will find slight "give" in the material that will compensate for slight imperfections.

6. Cut the lattice strips with a hand saw to make a wooden frame for the panel. Start with exact dimensions of your cut piece and then make <u>one</u> of the following:
   a. Box frame - Each piece is the width or length of the panel less the 1 1/8" of the lattice. Glue the frame to the panel first, then staple each joint twice.
   b. Mitered frame - Each piece is the width or length of the panel. Ends are cut 45 with a mitre box. Glue frame to the panel, then staple each corner twice.



a. b.

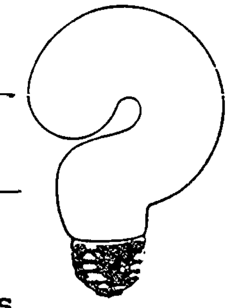
7. Consider the framed side of your panel the "outside": it will face the window. Now decorate at least the "inside" or room-facing area of your window cover. You may glue foil or cork to the room-face side. Or you may choose fabric or wallpaper to cover your panel. If so, allow a 5" margin over both length and width dimensions. Cover edges of your panel and staple the material to the wooden frame in back. You can also paint your window cover by brushing on latex paint. Or you may prefer to cover the panel with a plywood face. If so, frame both sides and then glue the plywood to the room-side face.

8. Add knobs or screw-eyes (for pulls) last. Put one on opposite ends of the room-facing side, in a convenient position for pushing on and pulling off the panel. If your window is small (about four square feet or less in area), one center knob is probably enough.

9. Apply weatherstripping around the window casing. This will help prevent infiltration.

10. Install the window cover. It should press tightly against the weather stripping when in place, yet it is lightweight and easy to remove whenever desired.

CHECKING WALL INSULATION



SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

In this activity, students will be measuring the temperature differences between walls and interior rooms to determine the adequacy of insulation in the walls and floors.

OBJECTIVE

Each student will be able to list the various types of insulating materials and explain the best applications for each type. Each student will define the concept of the "R" and "U" value as it relates to insulation.

MATERIALS

a thermometer
home insulation check sheet

TIME

2 - 3 class periods

LEARNING CYCLE

AWARENESS - Discuss basic concepts of insulation. Explain the "R" factor and the "U" factor and why they are important. Discuss and give examples of each of the various types and forms of insulation.

CONCEPT DEVELOPMENT - Check the wall temperature and the room temperature of your class room. Calculate the difference. Is the insulation adequate? Complete the home insulation check exercise. Check the type and amount of insulation in the walls, the attic, and the basement.

APPLICATION - Which materials are the best insulators? Why? What makes up a good insulator? How can you tell if a house or other building is underinsulated?

EVALUATION - 1) On a short answer quiz, have the students define "R" value, "U" value and the word "insulation." 2) On a short essay test, have the students list five different types of insulating materials, the advantages and disadvantages of each, and what type of applications each insulation material is best suited for.

FOLLOW-UP/BACKGROUND INFORMATION

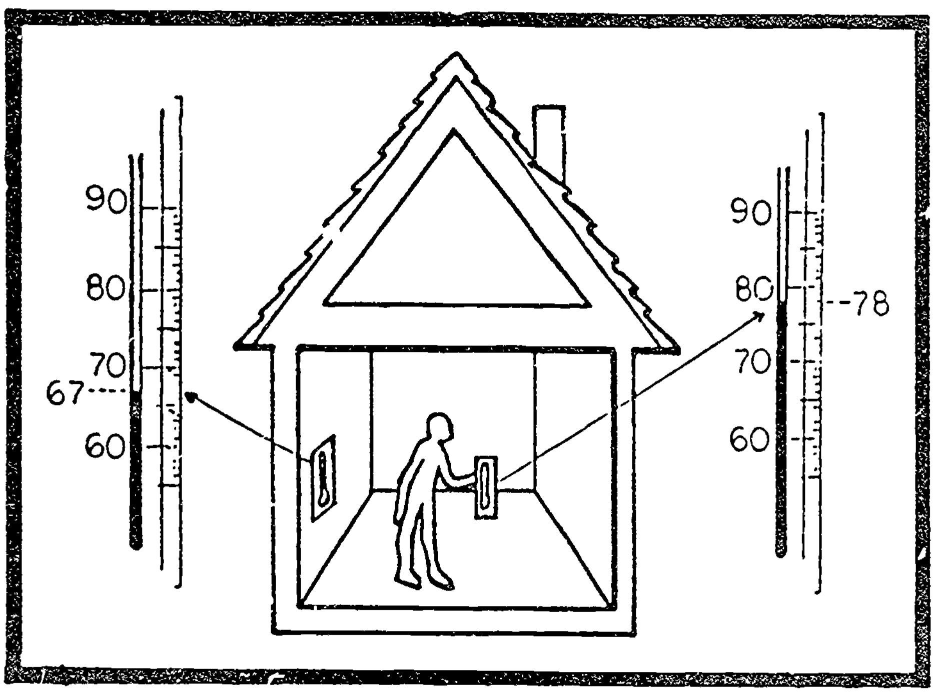
Talk to a local contractor or insulation dealer for latest facts on various types of insulation and the proper use for each.

SOURCE OF ACTIVITY

Activity adapted from Energy Conservation in the Home, An Energy Education/Conservation Curriculum Guide for Home Economics Teachers, U.S. Department of Energy. Prepared by University of Tennessee Environment Center and College of Home Economics, Knoxville, TN, October, 1977. Adapted by Alan Glass.

ACTIVITY

During the heating or cooling season when the heating or cooling equipment is operating, place a thermometer firmly against the inside surface of an exterior wall and another in the center of the room. It's easiest to hang the thermometer on a picture nail or hook on the wall. Place one thermometer on a chair in the middle of the room. Allow sufficient time for the temperatures to register and then record the two readings. If the difference between the two readings is greater than 5° F, the wall is probably not adequately insulated. The example illustrated below shows an exterior wall temperature of 67° F and a center of the room temperature of 78° F.



The next step is to determine the difference in the two readings: 78° F-67° F = 11° F. The difference is greater than 5° F; therefore, for this example, we would draw the conclusion that the wall may be inadequately insulated.

READING ELECTRIC METERS

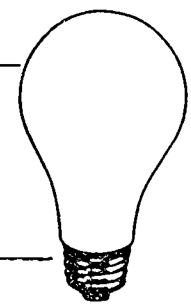
SUBJECT Industrial Technology LEVEL 6 - 12

ACTIVITY IN BRIEF

Most people pay little attention to the meter attached to their house or business, but this device is what determines what your electric bill will be each month. This activity will teach you how an electric meter works and how to read a meter.

OBJECTIVE

Each student will be able to accurately read a house or business electric meter. Each student will be able to describe the basic operation of the electric meter.



MATERIALS

student activity sheet
pencil or pen

TIME

2 - 4 class periods

LEARNING CYCLE

AWARENESS - Explain the purpose of electric meters and their importance to society. Explain the operation of an electric meter. Define and discuss kilowatt and kilowatt hours as a measure of energy.

CONCEPT DEVELOPMENT - Have students record meter readings as described in the activity. Locate the meters on local industrial establishments. Record the rate of electricity used and compare it to the students' home reading.

APPLICATION - Have students draw and design a new computerized meter. What would be changed on a new design of meter to make it easier to use and read?

EVALUATION - 1) Have the students keep a record of the electricity used in their house for one month. Record the meter reading daily, and at the end of the month compare it to the reading taken by the power company as noted on the electricity bill. Did the student take an accurate reading from the meter? 2) Have the students write a paragraph describing the basic operation of an electric meter. 3) Have the students fill out the meter worksheet included in this activity.

FOLLOW-UP/BACKGROUND INFORMATION

Refer to the activity in this booklet, entitled "An Electric Appliance Meter." Talk to a representative from your local power company.

SOURCE OF ACTIVITY

This student activity was taken from Environmental Education Strategies for Wise Use of Energy, Division of Science Education, North Carolina Department of Public Instruction, February, 1974. Adapted by Alan Glass.

ACTIVITY

On some wall of your home—basement, garage, or most often outside—you will find an intricate glass-enclosed device. If you are like most people, you seldom pay any attention to it. Nor do you need to, for modern electric meters perform their job so accurately and reliably that you need never be troubled. But, every month or so, a person from your electric utility company comes to see it, and later you are billed for the exact amount of electricity used.

Meters Measure Electricity. Through your meter's glass enclosure, you can see a revolving aluminum disk and a series of dials and pointers, or digital numbers. Without explanation, they don't make much sense, but they are really quite simple.

The amount of electricity you use determines the speed at which the disk moves. The more electricity you use, the faster it turns. Each revolution represents a portion of an electric energy unit called watt-hour. This watt-hour measurement is transferred from the disk through a series of gears to the digital numbers or pointers on the dials.

Just What Is A Watt-hour? Every hour a 100-watt light bulb burns, it uses 100 watt-hours of electric energy. Since a watt-hour is such a small unit of energy, your electric utility company uses a unit equal to 1,000 watt-hours—a kilowatt-hour—to measure the amount of electricity used.

What Makes Your Meter Disk Turn? There are two sets of connections which cause your meter to register: (1) the amount of current flowing into your house, and (2) the pressure or voltage at which the current is flowing.

Electric current is like water flowing through a pipe. The rate of flow of electrons through a line is measured in amperes. Pressure is the force that pushes electric current through the lines, measured in volts. To determine the electrical power (watts) used, multiply amperes of current by volts of pressure. Your electric bill is stated in kilowatt-hours.

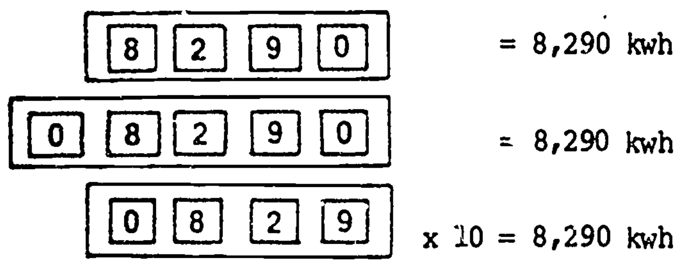
Clock-Like Meter Accuracy. Friction inside the meter is all but eliminated with the use of a magnetic-suspension system which uses a magnetic field to float the disk and its shaft in air. To help maintain accuracy provided by magnetic suspension and other design features, the meter is sealed with filters which keep its interior free of dust and other contaminants which can cause inaccurate meter registration.

Your Meter—A Small Motor. Your meter is basically a small induction motor run by magnetic forces created by electricity in a set of coils. The voltage coil is a winding of wire connected to the power supply lines. The current coil is a winding of wire connected with the household wiring. When current passes through these coils, the disk is forced to turn at a speed exactly proportional to the number of watts (amps x volts) of electrical power being used.

Meter Progress To Meet Your Needs. Meters have changed a great deal in the last 20 years. They have had to. Television, electric heating, more lights, freezers, air conditioners, water heaters, and other new appliances have more than quadrupled the average family's consumption of electric power. Twenty years ago a meter rated at 600 watts was enough to meet average household requirements. Today's meters are capable of handling up to 48,000 watts.

<u>How To Read Your Kilowatt-Hour Meter</u>. The kilowatt-hour meter is an instrument used to measure electrical energy consumed by a customer.

Two types of meters used by the power companies are the digital and dial type meters. The digital meter is read directly from left to right as shown in Figure 1. Readings on some digital meters are obtained by multiplying by ten.



[8290]   = 8,290 kwh
[08290]   = 8,290 kwh
[0829] x 10 = 8,290 kwh

Figure 1 - Digital Kilowatt-Hour Meters

Most meters have four or five dials (see Figure 2). The figure above each of the dials indicate the number of kilowatt-hours (kwh) registered by the meter during the time that the hand on that dial makes one complete revolution. So, when the hand on the right-hand dial has passed from one figure to the next, 1/10 of 10 kwh, or 1 kwh, has been used.

Be sure to read the meter "backwards"—from right to left—and remember to read the smaller of the two numbers between which the pointer on the dial is standing. <u>This is very important</u>.

Note that the pointers of the 10 and 1,000 dials rotate clockwise and counterclockwise on the 100 and 10,000 dials. During the time that the pointer on any one dial is making a complete revolution from 0 to 0, the pointer on the next dial to the left will pass from one figure to the next. Therefore, although a pointer on one dial may appear to have arrived on a given figure, that figure should not be read unless the pointer on the dial to the right has reached or passed 0.

For example, in Figure 2, the pointer on the 1,000 dial looks as if it is on the 5, but you should read that dial "4" because the pointer on the 100 dial, to the right, has not made a complete revolution to 9. The correct reading is shown under the dials.

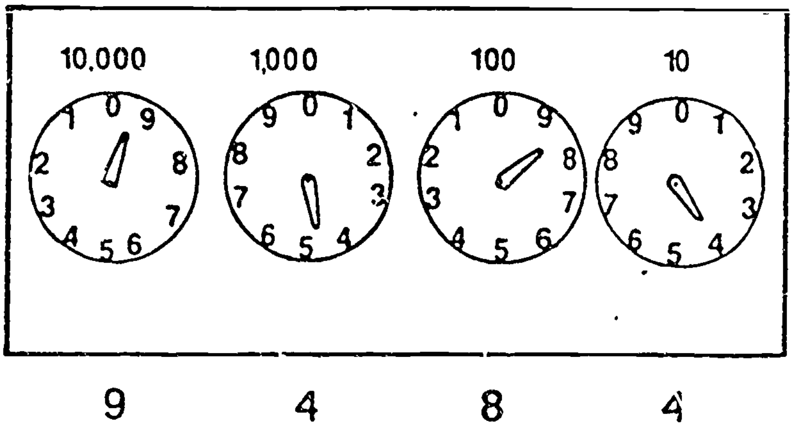
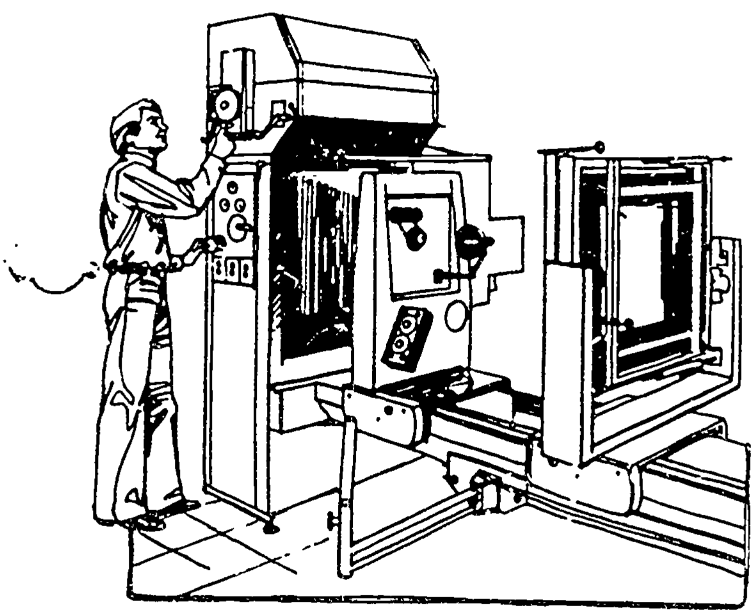
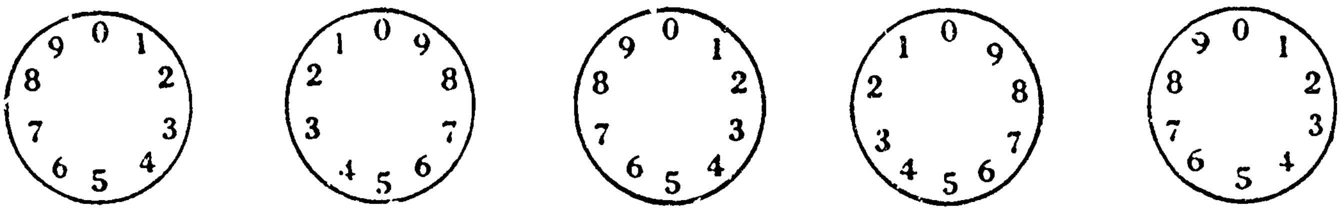


Figure II - Dial Kilowatt-Hour Meter

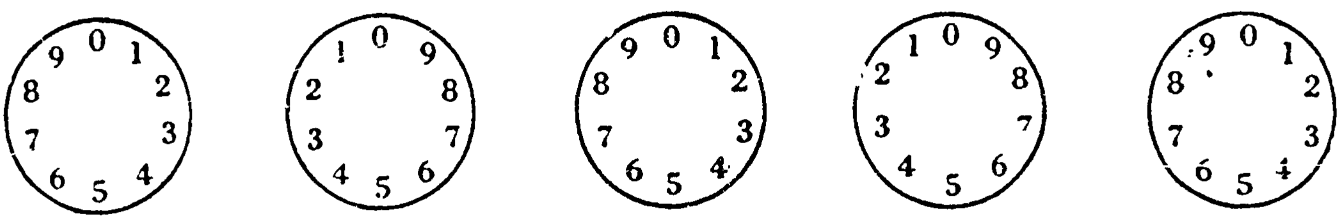


HOW MUCH GAS OR ELECTRICITY DO WE USE?

Name ______________________ ____________

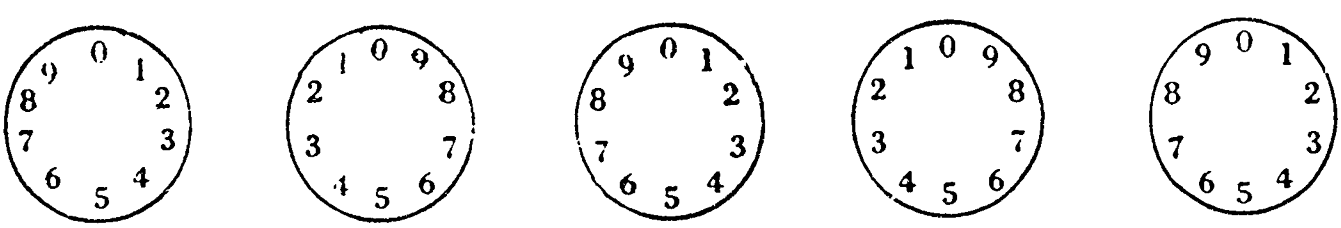


Date __________ Time __________ READING ____________________

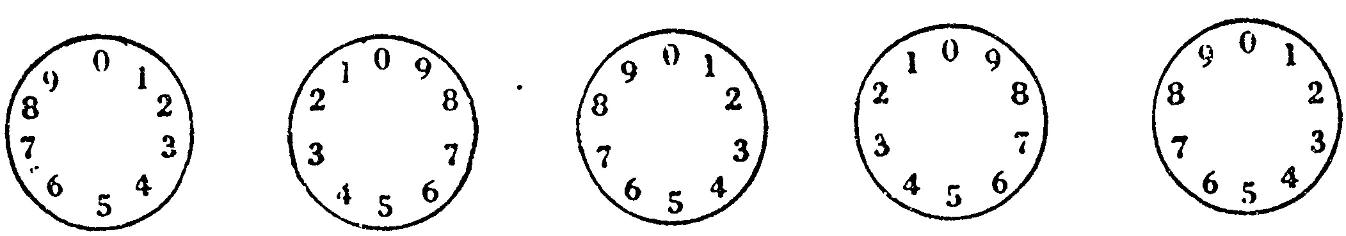


Date __________ Time __________ READING ____________________

TRY TO SAVE ENERGY!



Date __________ Time __________ READING ____________________



Date __________ Time __________ READING ____________________

AN ELECTRIC APPLIANCE METER

SUBJECT Industrial Technology **LEVEL** 9 - 12

ACTIVITY IN BRIEF

In this activity, students will build a device which will measure how much electricity is used by different tools or appliances. A utility company electric meter is adapted to measure the amount of electricity which is used.

OBJECTIVE

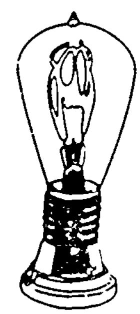
Each student will be able to demonstrate how an electric meter is used to measure electricity used in a home or business. Each student will be able to measure the electrical consumption of various tools and appliances.

MATERIALS

one 1" x 8" x 12" #2 pine board
(or available type of wood)
one 1" x 8" x 9" #2 pine board
one 2" x 2" x 8" #2 pine board
four #10 - 1 1/2" Flat head wood screws
four #10 - 2 1/2" Flat head wood screws
four feet of #12 - 3 electric wire
one grounded plug
one surface-mounted grounded outlet
one screen door pull
one A-Base 120 volt electric meter
(contact your local power company, you should be able to get a meter at little or no cost if you tell them it is for instructional purposes)

TIME

6 - 8 class periods



LEARNING CYCLE

AWARENESS - Introduce to the students the basics of reading an electric meter. (See "Reading Electric Meters.") Discuss kilowatts and kilowatt hours and how they are calculated to determine a household's monthly electric bill.

CONCEPT DEVELOPMENT - Construct the electric appliance meter. Identify the proper electrical hookup from the plug to the meter to the outlet. What type of circuit is used? Test the meter using various tools or appliances. Which appliance uses the most electricity of those tested?

APPLICATION - Discuss how this meter could be used by homeowners or business people when buying equipment or appliances. How could the design be improved to make it more usable?

EVALUATION - 1) Have the students record the amount of electricity used to run various tools, machines and appliances for 2 minutes. Plot this information on a graph. 2) Have the students write a paragraph describing how a device like the one built in this activity could be useful to any consumer.

FOLLOW-UP/BACKGROUND INFORMATION

Contact your local power company for meters and information on how your particular meter measures electricity used. Different companies' meters operate using different means. Some meters are now digital, making them easier to read.

SOURCE OF ACTIVITY

Cedar Falls Utilities Power Company, Cedar Falls, Iowa. Adapted by Alan Glass.

ACTIVITY

1. Cut wood (pine or any type of wood which is avaiable) for base. 1" x 8" x 9"
2. Cut wood for upright where meter will be mounted. 1" x 8" x 12"
3. Cut wood for corner support block. 2" x 2" x 8"
4. Optional: (If table saw is available) Cut a dado in the base piece for the upright 5 1/2" back from the front of the base piece. Check that the upright piece fits snugly in the dado slot. (cut the dado to a depth of half the thickness of the base piece)
5. Assemble the base. Use glue and four #10 - 1 1/2" flathead wood screws to attach upright to base. Glue and attach corner support block to upright and base piece with #10 - 2 1/4" flathead wood screws. Countersink all screw heads. (Pilot and shank holes must be drilled prior to installation of the screws).
6. Center the electric house meter on the front of the upright piece and mount using wood screws. Different models of meters require different mounting techniques according to the bracket on the back of the meter. Be sure to mount the meter securely to prevent the possibility of it falling off the base.
7. Wire the outlet to the meter as shown in the wiring diagram. (If the meter you use has different connections than the meter shown here, please consult your power company on the proper method of connection).
8. Mount the outlet onto the base board with the screws provided in the outlet.
9. Attach the door pull with wood screws (this provides a carrying handle for your finished appliance meter).
10. Test your meter. Plug it into a wall outlet, plug a radio or appliance into your meter and record how much electricity is used by that appliance.

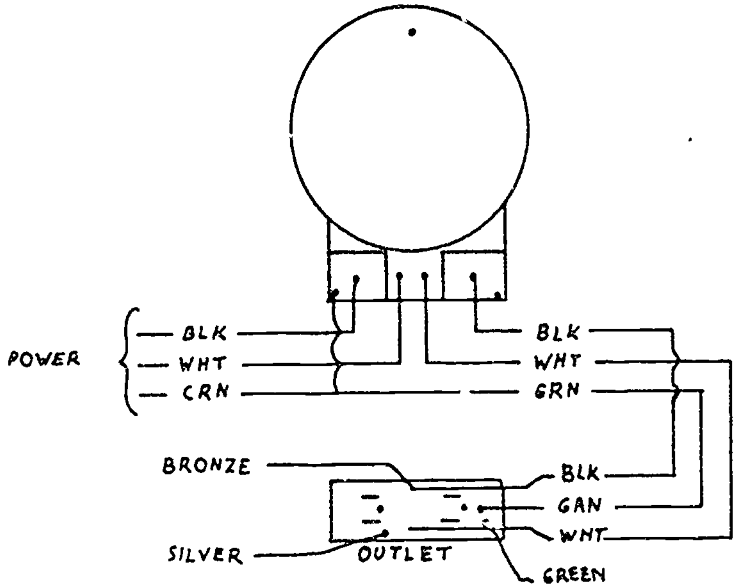


Figure 1: WIRING DIAGRAM

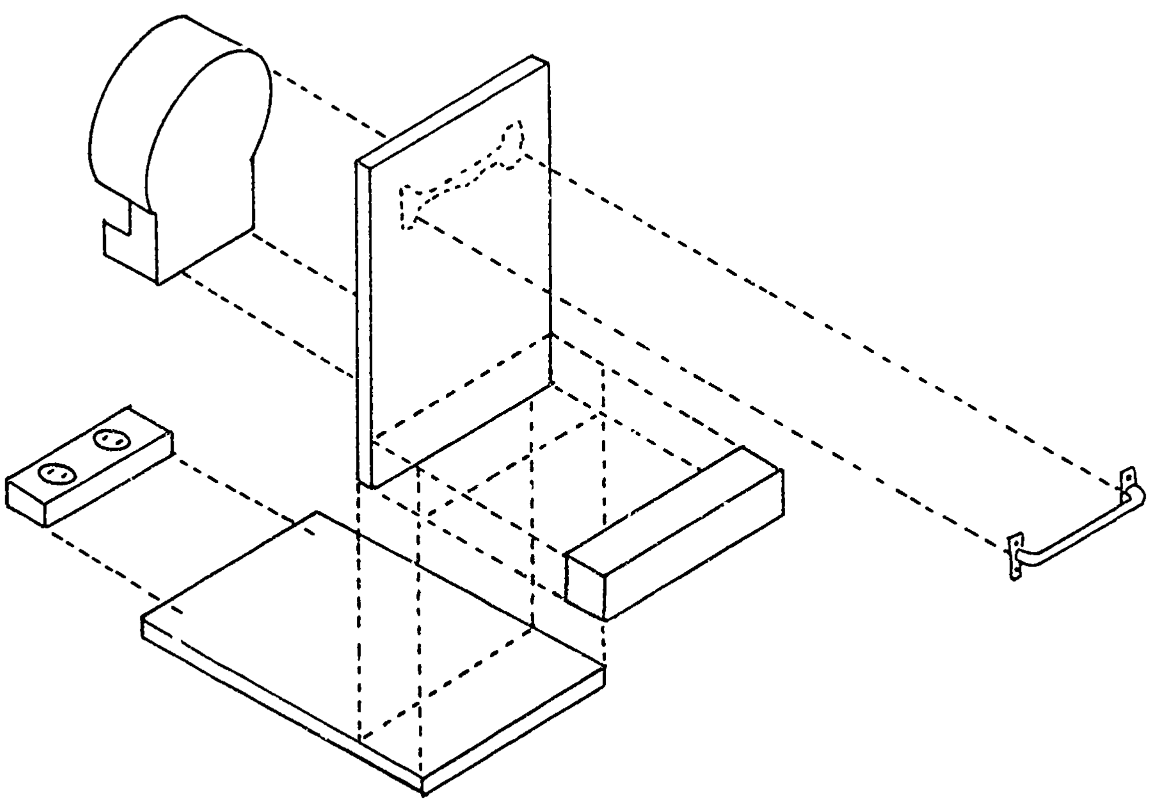


Figure 2: ASSEMBLY OF ELECTRIC APPLIANCE METER

FUEL STICKS FROM SAWDUST

SUBJECT Industrial Technology **LEVEL** 9 - 12

ACTIVITY IN BRIEF

This project will help students see how a material which might otherwise be wasted, can be reused. In this activity, useful products (fireplace starters) are made from recycled sawdust. This activity involves recycling, as well as using biomass and converting it directly into fuel.

OBJECTIVE

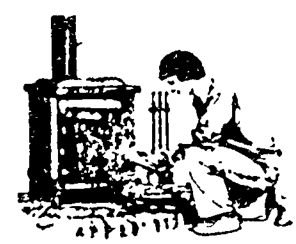
Each student will be able to describe the process of recycling, and demonstrate one method of using discarded materials (biomass) as a useful fuel. Each student will be able to identify types and uses of biomass materials as energy sources.

MATERIALS

paraffin - old candles or slabs of paraffin.
double boiler - a low temperature crock pot will work. Never heat paraffin directly in a pan. It may ignite.
hot plate with adjustable heat control or cooking stove
soup ladle or metal spoon
sawdust
tape - cellophane
paper - 8 1/2 x 11" ditto paper in various colors or
empty paper towel or bathroom tissue holders
candy thermometer - For safety, use the all metal type with the bimetal sensing element and dial at the top. Candy thermometers are usually better than meat thermometers because they have a lower temperature range.
three-pound coffee can
wood stir stick
funnel - optional
dowel rods - 1/4" x 15" - optional
- 1" x 25"
scrap boards - optional

TIME

1 or 2 class periods



LEARNING CYCLE

AWARENESS - Introduce the area of recycling to the students. Discuss what types of items can be recycled. Discuss biomass enery. What makes up biomass? (sources of energy which were once living)

CONCEPT DEVELOPMENT - Students will mix up and form the fuel sticks from the sawdust and parafin. Test the fuel sticks by igniting and timing how long each fuel stick will burn.

APPLICATION - Discuss what changes could be made to the shape of the fuel stick to make it burn hotter or longer. What other ways can biomass material be recycled?

EVALUATION - 1) Have the students define "Biomass" energy. 2) Have the students list other biomass materials used as energy sources. 3) Have the students describe the term "recycling."

FOLLOW-UP/BACKGROUND INFORMATION

The city of Pella, Iowa is burning sawdust acquired from the Rollscreen Corporation to supplement the city's production of electricity. The Rollscreen plant produces 190,000 lbs of sawdust per day.

SOURCE OF ACTIVITY

"Energy Activities For Industrial Arts," Minnesota Department of Education. "Iowa Energy Bulletin" March/April 1979. Adapted by Alan Glass.

ACTIVITY

1. Construct a support base to hold the paper tube while it is being filled with the sawdust/paraffin mixture. These blocks can be made by gluing a 1" long piece of 1" diameter dowel rod to a piece of scrap board. Two dozen or more are required.

2. Roll sheets of 8 1/2" x 11" paper into tubes and adjust to fit the support bases. The paper should be rolled so that the finished tube is 8 1/2" long. Tape the paper tubes on the outside. NOTE: Colored ditto paper may be used to brighten up the project. Also, before rolling the paper into tubes, you may wish to ditto or print the name of your school, instructions for using the starters, etc., on the paper. Empty bath tissue or paper towel rolls work extremely well. This is easier than trying to roll your own tubes.

3. Set the paper tubes in an upright position on the support bases. They are now ready to be filled with the paraffin/sawdust mixture.

4. Melt the paraffin in a double boiler. Keep the thermometer in the melted paraffin at all times and NEVER let the temperature exceed 125-150° F. Observe the following safety rules:

   a. Use a double boiler or a wax melting pot. Don't, for example, heat wax in a kettle over an open flame.

   b. Always keep a thermometer in the melted paraffin and keep the temperature as low as possible. Unlike water, which boils, paraffin looks the same at a safe temperature (125-150° F) as it does at an unsafe temperature. When paraffin is overheated it can reach its flash point and start to burn.

   c. Use a metal thermometer rather than a glass thermometer.

   d. Do not overfill the container. A container filled to 1/3 of its capacity is satisfactory.

   e. Always use an electric heating element. It is safer than an open flame.

   f. Use a metal double boiler rather than a glass double boiler.

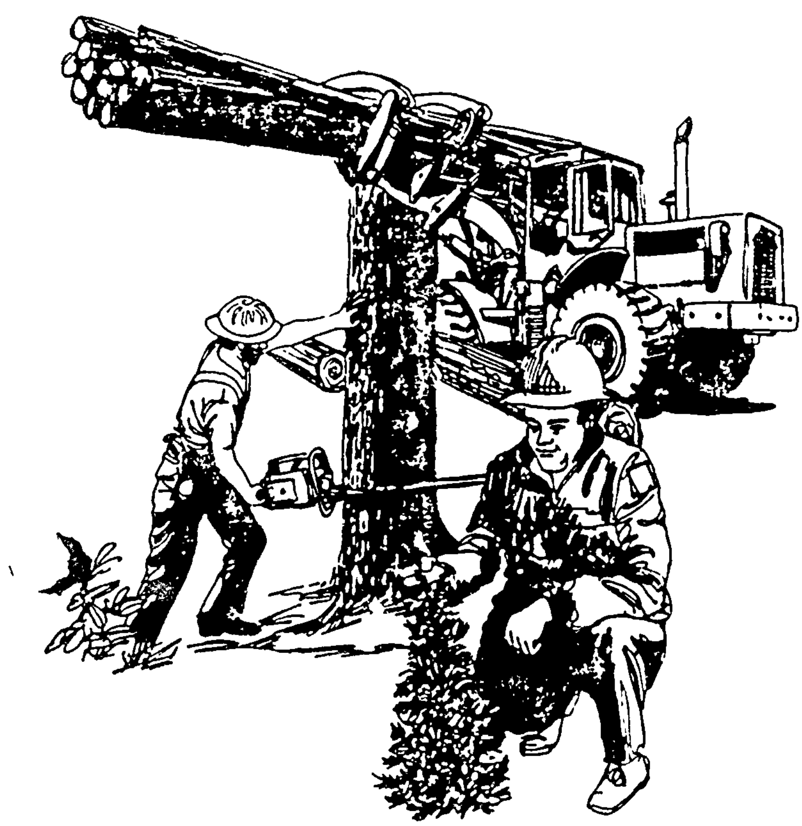
5. Mix several different formulas of paraffin and sawdust together in a three-pound coffee can. Keep notes on the details of the mixtures. Stir with a long wooden spoon or a wood stick until the sawdust is coated with the paraffin.

6. While the mixture is still hot and pliable, carefully spoon the mixture into the paper tubes or into a funnel and then ram the mixture into the tube with a 1/4" dowel.

7. Allow the mixture to cool and then remove the paper tube assembly from the support bases.

8. To use the fireplace starter, light the paper tube. The fireplace starter may be used for campfires, fireplaces, or for starting charcoal grills.

9. Test some of the "formulas". Which were most successful?
   a. Who can make a formula that burns the longest?
   b. How does changing the amount of wood affect burning characteristics?
   c. Is there a better paper?



FORMING A RADIOACTIVE CLOUD

SUBJECT Industrial Technology LEVEL 9 - 12

ACTIVITY IN BRIEF

This activity will produce a source of alpha particles to use in a cloud chamber or a Geiger counter for detecting radiation. This activity will provide students with a source for detecting radiation. Students will be given the opportunity to observe radiation being given off.

OBJECTIVE

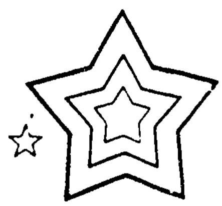
Each student will be able to define radioactivity, alpha radiation, nuclear reactor and radioactive waste. Each student will be able to explain several positive and negative aspects of nuclear power production.

MATERIALS

crucible or fire-proof container
gas light mantle, pin, rubber cement,
glass or plastic cylindrical container with cover (approx. 8cm. in diameter and 4cm. high)
a flashlight, methyl alcohol, eye dropper,
black paper, glue, black felt (1cm x 25 cm)
small wood cube, dry ice (available from ice cream stores or packing plants)
a Geiger counter (may be leased from the Federal Emergency Management Agency - Civil Defense Agency, if your school science department does not have one.)

TIME

1 - 2 class periods



LEARNING CYCLE

AWARENESS - Present to the students information on nuclear power plants and nuclear energy. Discuss benefits of nuclear energy (clean, inexpensive) as well as environmental drawbacks of nuclear energy (radioactivity, wastes).

CONCEPT DEVELOPMENT - Conduct the radioactivity experiment as directed. Observe the traces of radiation given off by the radioactive substance in the container.

APPLICATION - What causes the visible radiation given off in the container? Use a Geiger counter to measure the amount of radiation being emitted. Have students research to find out what the safe levels are for radiation in our environment.

EVALUATION - 1) Have the students define the following: a) radioactivity, b) alpha radiation, c) fusion, d) fission, e) nuclear reactor, and f) radioactive waste. 2) Have the students make a list of all positive aspects of nuclear energy. 3) Have the students make a list of all the negative aspects of nuclear energy. 4) Hold a nuclear energy pro-con debate. Which side has a better argument?

FOLLOW-UP/BACKGROUND INFORMATION

When heat is applied to a material, a chemical change occurs. Combustion is an example of such a change. The mantle used in this activity contains thorium, which gives off alpha radiation particles as it burns. The remaining ash also contains alpha particles.

The alpha radiation causes ions to form along its path. The ions serve as condensation centers for the alcohol vapors. Alpha particles are relatively large and cause considerable ionization even though they do not move very far.

Radioactivity is the release of particles and/or energy from the nucleus of an atom. This release of energy takes the form of a mysterious type of radiation. Radiation can be identified as being Alpha (positive charge), Beta (negative charge) and Gamma (no charge). Each varies in their amount of potential energy.

Radioactive sources are becoming common in the production of energy and medical technology. This activity provides a safe level of radiation to be utilized in the technology laboratory.

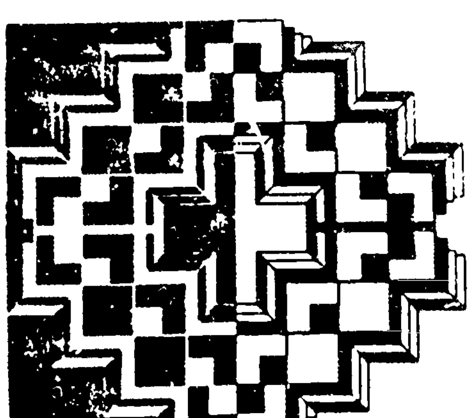
An alternative to making your own radioactive material is to buy a small amount of alpha radiation material from a scientific supply house (Edmunds Scientific, Frey Scientific).

Try using a Geiger counter to measure the radioactivity of the substance. You should not expect more than low levels of radiation from the substance.

Geiger counters may be leased from the Federal Emergency Management Agency (Civil Defense Agency).

SOURCE OF ACTIVITY

Physical Science, by Johnson, Barr, and Leyden. Addison-Wesley Publishing Company. Physical Science, A Search for Understanding, by Brown and Anderson, Lippincott Company. Sci-Tech Activities for Technology Education, by Tim Street and Bill Tracey. Adapted by Alan Glass.



ACTIVITY

PART I: Making a Radioactive Mass

1. Using a match, burn the gas light mantle in the crucible or fire proof container.

2. Let the mantle burn until ashes remain.

3. Coat the head of the pin with rubber cement.

4. Dip it in the ashes of the mantle and let it dry.

5. Repeat coating the head of the pin until the ball of cement and ash is the size of a large match head.

Result:

The ball of ash can be used in experiments with radiation. Alpha radiation is present in everyday substances such as cigarettes. It is safe to dispose of in the trash.

PART II: Detecting Radiation in a Substance

1. Cover the inside bottom of the container with the piece of black paper.

2. Glue the black felt strip to the inside upper portion of the container.

3. Using the eye dropper, saturate the felt strip with alcohol. The alcohol vapors should fill the container.

4. Place a radioactive source on the wood cube near the center of the container.

5. Cover the container and place it on top of the dry ice.

6. Direct a beam of light from the flashlight through the side of the container.

7. Move the beam slightly and look for the radiation given off.

Results:

Students will see the radiation in the form of white trails left by the alpha particles.