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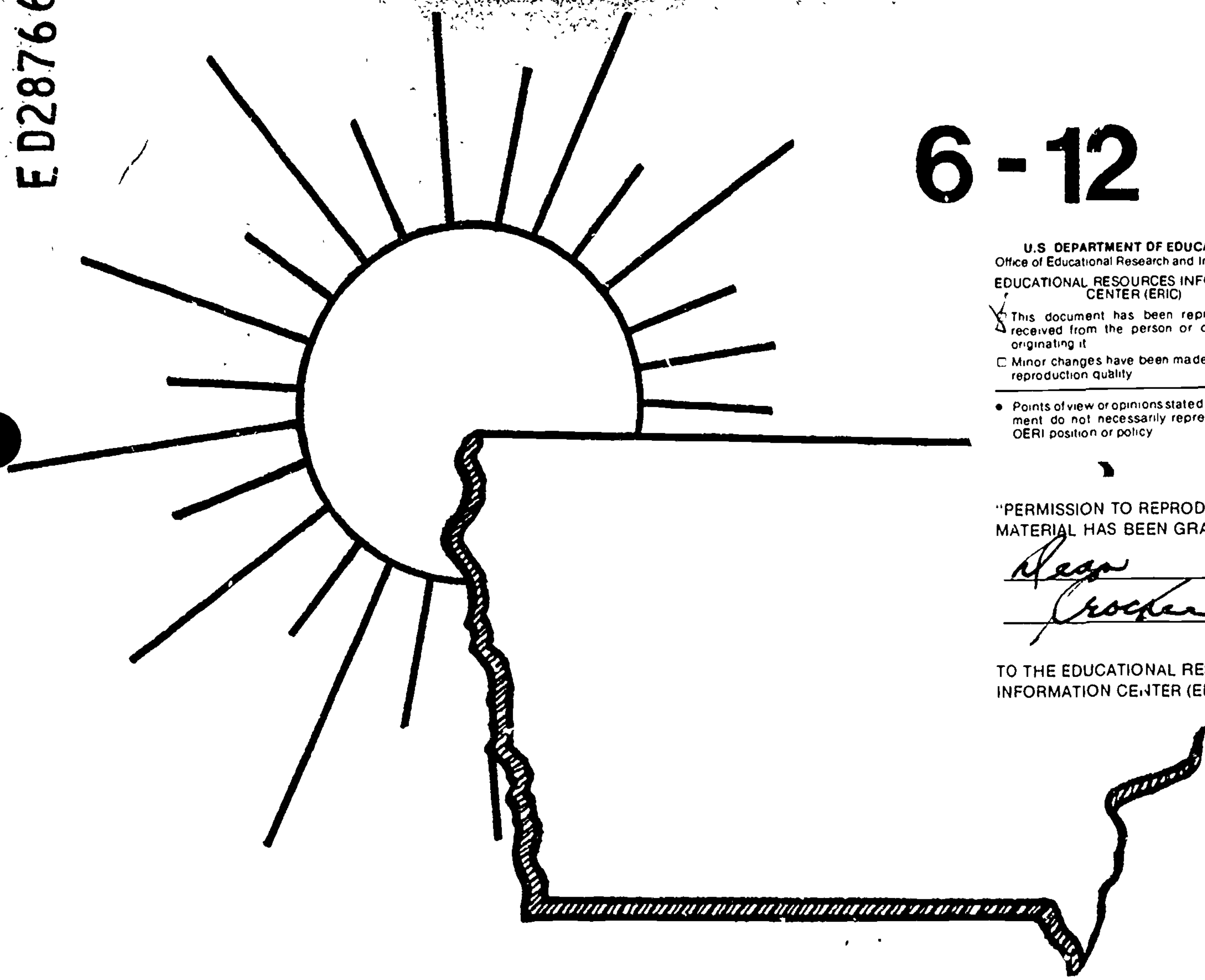
ABSTRACT

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 science. 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 25 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)

IOWA DEVELOPED ENERGY ACTIVITY SAMPLER



6 - 12

SCIENCE

Revised 1987

State of Iowa
DEPARTMENT OF EDUCATION
Grimes State Office Building
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SCIENCE

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-ECAPS Revision Committee

Duane Toomsen, Environmental Education Consultant, Department of Education

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

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Wallace Building, Des Moines, Iowa 50319

Energy Hotline, 800-532-1114 or in Des Moines 281-7017

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

The Energy Education Project, SUNY at Albany, 1400 Washington Avenue
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SCIENCE

INTRODUCTION

The scientific community has always considered the study of energy to be of prime importance, whether it be in the fields of chemistry, astronomy, biology, geology, or physics. Unfortunately, the study of energy in science has frequently not included the issues and impacts of energy use. Those areas have traditionally been concerns of "social scientists." It is clear that we as educators must deal with the application of science principles by focusing on issues that will affect students in the future. Energy literacy is essential for a generation of citizens who will be called upon to make decisions affecting the resources and health of Planet Earth.

The 24 collected activities are designed to:

1. present energy laws and principles in an interesting manner, and
2. develop student skills in acquiring information and making well-informed decisions about energy issues.

They are intended as a starting point or idea bank for the study of energy. You, the teacher, should adapt the activities to suit local needs and equipment. An effort was made to avoid duplicating activities between the six subject areas or the 6-12 IDEAS. You will find many additional activities well suited to the science classroom in other IDEAS packets.

The evaluation of student progress is an important indication that the objectives of a lesson have been met. You may wish to use the stated objectives at the beginning of each activity as a basis for developing test or quiz items. You may also wish to give the students a participation grade for the activities. Credit is appropriate if a student brings in materials. Some activities, which do not have a specific objective easily written as a test item, may be given a completion grade. Although students who follow through with a complex series of decisions have accomplished a task, it is hard to evaluate their decision-making or problem-solving growth with multiple choice tests. A combination of many evaluation methods will encourage the self-esteem and success of every student.

To prevent unnecessary duplication of materials already available, the solar activities of the New York Solar Energy Curriculum were not included. Please write to them at the address provided on the Resource page for a wealth of solar activities.

Finally, it is hoped that you will use the learning cycle strategy and incorporate energy issues into your science courses. It is an important aspect of student learning experiences which will assist students in developing problem-solving and decision-making skills.

Peggy Steffen
Contemporary Science
Ottumwa High School

Educators who assisted in the formation of this section include the following:

Dr. George R. Davis	Emporia State University, Emporia, Kansas
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Renewable vs. Non Renewable Resources

SUBJECT Science LEVEL 6 - 12

ACTIVITY IN BRIEF

Students compare the flow of water through plastic tubing to renewable and non-renewable resources.

OBJECTIVE

At the end of the activity, the student will be able to:

1. Compute rates of flow with simple mathematical procedures.
2. Explain exponential growth.
3. Collect data and graph an exponential growth curve.
4. Identify what factors regulate resource consumption.
5. Distinguish between renewable and non-renewable resources.
6. List ways in which to decrease or minimize fuel consumption.
7. Discuss the locations of and amounts in the reservoirs of non-renewable resources.

MATERIALS

graduated cylinder
2 or 3 pieces of flexible plastic tubing of different diameters each about 3 feet long (1/8, 1/4, 3/8, 1/2" inside diameter recommended)
2 large jars, aquaria, or buckets
stopwatch

TIME

1 class period

LEARNING CYCLE

AWARENESS - This activity is intended to focus attention on the concept of renewable resources and rate of use. It may be expanded to quantitative analysis later.

CONCEPT DEVELOPMENT - The teacher may opt to demonstrate a shortened version of the water activity as the awareness part of the learning cycle and then have the students design an experiment which will test the rate of flow vs. tube diameter. After graphing data from 1/8, 1/4, 3/8, and 1/2" tubing they will have an example of exponential growth. Have students review, read, report and be tested on the concepts of renewables and rate of use. Discuss how the reservoir and flow of water compare to those of fuels.

Example 1.: water or hydropower (and the sun) - reservoir can be refilled by precipitation e.g. the water cycle, if the precipitation comes as expected. What happens in case of drought?

Example 2. Fossil fuels and Uranium - Nature's rate of manufacturing these is so slow that the reservoir is not refilled like water is. Ask students to determine what factors influence rate of flow.

APPLICATION - Have students brainstorm ways in which the American lifestyle could be changed to use energy supplies more slowly. Students should try one of their suggestions for at least one week. Have them reflect on their experiences. Compare lifestyles of cultures with differing amounts of energy consumption.

FOLLOW-UP/BACKGROUND INFORMATION

Small increases in the diameter of the tubing make sizable increases in the rate of flow. To calculate the rate of flow:

$$\text{Rate of Flow} = \frac{\text{volume delivered (ml)}}{\text{time (sec)}}$$

Other variables to be investigated are circumference of the opening, surface area of tube in contact with water, (surface area = circumference x length, or length x diameter pi), frictional forces, and gravity.

"Which Should I Buy?," Project Learning Tree, p. 149-151. "You've Come a Long Way, Maybe," Project Learning Tree, p. 164.

SOURCE OF ACTIVITY

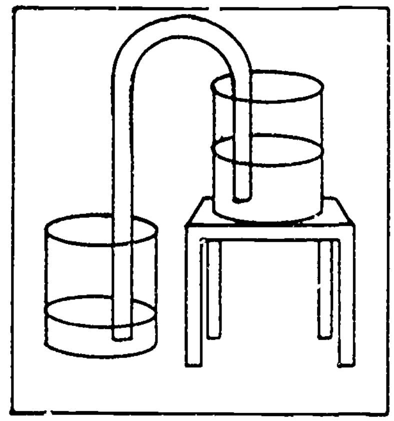
Adapted from I.D.E.A.S. by Nancy Toll.

Renewable vs. Non Renewable Resources

Name___________________

ACTIVITY

Set one container on a desk or table and fill it nearly full of a measured amount of water. Mark it with a sign that says "World Energy Resources". Put another container on the floor nearby. Fill one of the pieces of tubing with water. Put one end under water in the upper container. Hold the other end closed until it is lowered into the floor-level container. Have a student secretary record the time as you release this hose and water begins to flow into the lower container. Instruct the secretary to also record the time when the water stops flowing.



Discussion:

1. Compare the water flow to energy flow.
2. If the water represented "fossil fuels", could the upper reservoir be refilled? Why?
3. If the water represented solar or wind energy, could the reservoir be refilled? Why?
4. How can the flow be slowed or increased? Take data on your idea.
5. Does raising one of the buckets affect the rate of flow?
6. Summarize how the water flow is analogous to energy flow.
7. What factors influence the rate of flow and the rate at which the reservoir is refilled?

Humpty Dumpty's Dilemma

SUBJECT Science **LEVEL** 6-8

ACTIVITY IN BRIEF

The student will look at an example of the Laws of Thermodynamics by comparing the dilemma of Humpty Dumpty to energy.

OBJECTIVE

The student will be able to state the two Laws of Thermodynamics.

First Law of thermodynamics. When heat is converted to another form of energy or when other forms of energy are converted to heat, there is no total loss of energy. In any change of form, energy is lost to us as heat energy, but the <u>total</u> amount of energy remains the same.

Second Law of Thermodynamics. Heat flows from objects with high temperatures to objects with lower temperatures.

The Law of Entropy is the restated Second Law of Thermydynamics. A natural process always takes place in such a direction as to cause an increase in the entropy of the universe. (Entropy describes the disorder of a system.)

MATERIALS

1 raw egg painted with a face
(clothes, arms and legs are optional)
1 trash can liner
stack of books

TIME

1 class period

LEARNING CYCLE

AWARENESS - Students will use the egg analogy to begin their development of the concepts. Before Humpty falls ask them to think about how Humpty and energy are alike. Then complete the rest of the activity.

CONCEPT DEVELOPMENT - Reinforce the concept by discussing several other examples of the Laws of Thermodynamics. For example, show students a large jar of water and a small dropper full of food coloring. Present them as organized, naturally concentrated materials. Add the food coloring to the jar and watch the dispersal until it is evenly distributed. The jar has now gained entropy.

APPLICATION - All forms of energy, when converted create waste heat. When work is done, heat energy is a by-product and is lost to us as usable energy. Since we cannot create more energy in the universe, what we do use becomes more diffuse and unusable. Involve students in an activity designed to make them aware of our throw-away society such as measuring the amount of trash their family produces in one week, or listing things that are routinely thrown away which might be recycled.

FOLLOW-UP/BACKGROUND INFORMATION

See "Paper Consumption," "Would You Like That Wrapped," "And a Side Order of Paper," from Project Learning Tree.

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen.

Humpty Dumpty's Dilemma

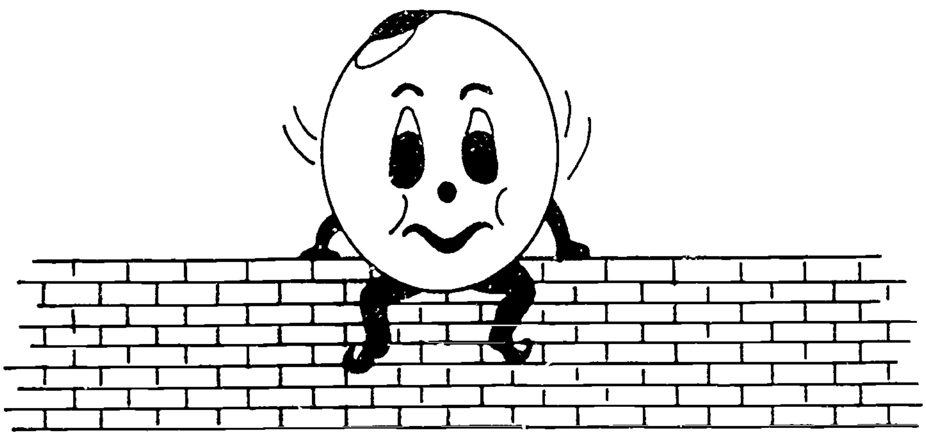
ACTIVITY

Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the King's horses and all the King's men
Couldn't put Humpty together again.

Set a dressed-up raw egg on top of a stack of books covered with a trash can liner. Ask the students to think of Humpty as an energy source. He is a well-organized, neatly packaged arrangement. He also has potential energy because of his height.

After the fall, the arrangement is very disorderly and unrecognizable. Because none of the components were lost, there was conservation of energy (First Law of Thermodynamics: Energy cannot be created or destroyed). Humpty resisted human efforts to restore his original state, in keeping with the Second Law of Thermodynamics (The entropy or disorderliness of the universe is constantly increasing).

If he knew he was going to fall, could Humpty have put his potential energy to use? Students should brainstorm a variety of ways Humpty might have changed his potential energy into useful work. Draw or make models of their ideas for homework. You may wish to use the border on this page to provide a backdrop to their original designs.



Candy Bar Energy Conversions

SUBJECT Science LEVEL 6 - 8

ACTIVITY IN BRIEF

Students analyze an ingredient from a candy bar wrapper to determine how energy is converted during the processing.

OBJECTIVE

Students will explain that forms of energy can be converted and that energy is lost in the form of heat during those conversions.

MATERIALS TIME 1 class period

1 candy bar per group of students
(Make sure ingredients are listed on the wrapper)

LEARNING CYCLE

AWARENESS - Students should be familiar with the forms of energy before starting this activity so a brief discussion of light, heat, chemical, mechanical, electrical energy is in order.

CONCEPT DEVELOPMENT - If the activity is done in class without reference materials encourage students to choose an ingredient they are somewhat familiar with in terms of growing and processing.

If you are lucky enough to have encyclopedias or reference materials at hand, this would be a good library exercise. Another option is to assign the students to look up the processing as homework and bring the information to class to complete the activity. You may also assign the entire activity outside of class.

APPLICATION - Follow-up questions.

1. What has happened to most of the excess heat energy?
2. How has the total supply of energy available in the world been diminished by the production of your candy bar?
3. It is common for manufactured goods to require more energy in than is useable out. Is this true with the candy bar?
4. A typical candy bar has 250 KCal. How might the body use that energy?
5. What might be done to cut down on the amount of energy consumed in the candy bar example?
6. What are some ways we can reduce our energy consumption from manufactured goods? Give specific examples.

FOLLOW-UP/BACKGROUND INFORMATION

Energy in Society, Ontario Ministry of Education, p. 16-23, "Food Processing, Packaging, and Storing." "Biography of a Favorite Thing," Project Learning Tree, p. 152. "Would You Like That Wrapped?," Project Learning Tree, p. 157-160.

SOURCE OF ACTIVITY

Adapted from Energy in Society by Peg Steffen.

Candy Bar Energy Conversions

ACTIVITY

Name________________________

1. Each student group will be given a candy bar. Study the ingredients and pick one to work with today. Put the name of that ingredient on the top of a large piece of butcher paper.
2. List all steps in the production of that ingredient. Indicate what energy conversions happen at each step and how energy is lost. Don't forget to include the distribution of the candy bars after production. A sample is provided below.
3. When finished the class will come together and discuss each flowchart.

SAMPLE FLOW CHART COCOA

CONVERSION	STEP	HOW HEAT IS LOST
	SUN	
L -- C	↓	TO ATMOSPHERE
	COCOA TREE	
	↓	
	WORKERS PICK BEANS AND CARRY TO TRUCK	
C -- H	↓	BODY HEAT TO ATMOSPHERE
	TRUCK CARRIES TO BOAT	
C -- M,H	↓	HEAT FROM ENGINES
	BOAT TO MONTREAL	
C -- M,H	↓	HEAT FROM ENGINES
	TRAIN TO FACTORY	
C -- M,H	↓	HEAT FROM ENGINES
	BEANS ROASTED AT 204°	
H -- C	↓	EXCESS HEAT IS VENTED
	BEANS ARE MILLED, RELEASING COCOA BUTTER	
E -- M	↓	FRICTION HEAT
	CHOCOLATE ADDED TO SUGAR AND MILK; LIQUID IS EVAPORATED	
H -- C	↓	EXCESS HEAT IS VENTED
	CHOCOLATE IS RUBBED ACROSS CORRUGATED GRANITE BASES	
E -- M	↓	FRICTION HEAT
	CHOCOLATE IS MOLDED AND WRAPPED	
E -- M	↓	FRICTION HEAT
	BARS ARE TRUCKED TO STORES	
C -- M, H		WASTE HEAT FROM ENGINES

C = CHEMICAL ENERGY
E = ELECTRICAL ENERGY
L = LIGHT ENERGY
M = MECHANICAL ENERGY
H = HEAT ENERGY (BURNING OF FUEL)

Standing on the Edge

SUBJECT Science LEVEL 6 - 8

ACTIVITY IN BRIEF

Students will build a potential energy device to rescue friends from a dangerous pit.

OBJECTIVE

Each student will be able to:

1. Explain the interrelationship between potential and kinetic energy.
2. State examples of energy conversions.
3. Propose reasons for the conversion of energy in manufacturing, <u>or</u> in farming, <u>or</u> in construction, and justify them.

MATERIALS

lengths of string 1 meter long (1 per student)
scissors (1 per 2 students)
two paper clips per student, tape
timer or watch
pencils or pens as trees (students may provide)

TIME

45 minutes

LEARNING CYCLE

AWARENESS - This activity is exploratory in that students will wrestle with making a device to solve the problem. Resist the temptation to give them hints or helps. After the time limit, have each student share their solution. This allows for everyone to see many ideas and synthesize more. See sample solution on this page.

CONCEPT DEVELOPMENT - Discuss the idea of potential energy (the tree at the top) and its usefulness in the situation. Go on to identify the changing of potential energy into kinetic energy as the tree falls. Explain that energy has been converted. Only when energy is converted is it useful to us.

APPLICATION- Have students think of other situations in which potential energy devices might be useful. Such as, "How might very heavy 'drawbridges' that lay across moats of old castles have been operated by one person using a potential energy device?"

You might have students brainstorm a list of energy sources that contain potential energy (petroleum, wood, hydropower, tides, coal). What must be done to make them convert their potential energy into kinetic energy?

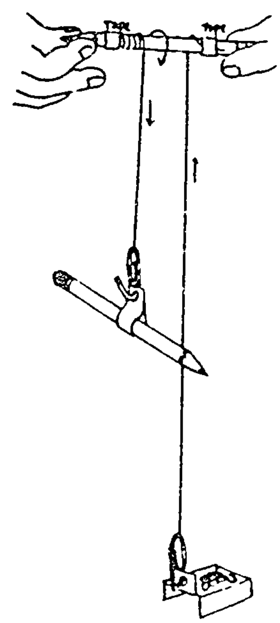
Cut out pictures of machines from newspapers and magazines. How do they turn potential energy into kinetic energy?

FOLLOW-UP/BACKGROUND INFORMATION

Engineering in the Ancient World Landels, J.G. University of California Press, Berkeley. 1978

SOURCE OF ACTIVITY

Engineering in the Ancient World Landels, J.G. University of California Press, Berkeley. 1978
Activity adapted from Activity Set 8: Potential Energy, What Is Energy?, Ministry of Education, Ontario, by Joseph Riesselman.



Name________________

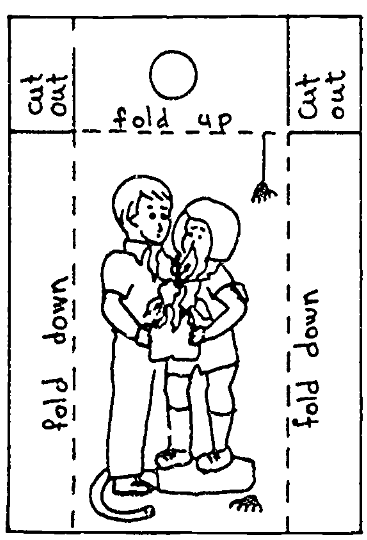
Standing on the Edge

You and two other scientists (Sam and Sally) are traveling alone in one of the most remote jungles of the world searching for a rare black and white orchid plant. Sally spots the plant and just as she reaches down to examine it, the ground gives way under both Sam and Sally. They fall into an underground cave many feet deep. They call up that there are many snakes, spiders, and creepy crawlers down there and would you please get them out as soon as possible? A shout from them alerts you to the fact that there is a gas seeping around your friends. No Time To Lose!!

The only equipment you have is a long rope, two hooks, and an axe. Your partners are too heavy for you to lift out directly just using the rope.

Your problem is to lift them without going into the cave. You need to plan a potential energy device using the equipment you have and rescue the expedition from disaster. Can You Do It?

Your teacher will give you a rope (string), 2 hooks (paper clips), and an axe (scissors). Use the floor as the bottom of the pit, and the top of the desk as the top. Cut out the figure on this page and put it in the pit. This is your objective. You will have 15 minutes. Good Luck!!



More for Less

SUBJECT Science LEVEL 6-8

ACTIVITY IN BRIEF

Students will use food chains from their school lunch menu to understand energy flow and to begin activities that emphasize wise use of energy in food preparation.

OBJECTIVE

Each student will describe the concepts of food chains, energy consumption, and conservation measures in food preparation.

MATERIALS None TIME 1-4 class periods

LEARNING CYCLE

AWARENESS - Phase 1 and 2 are an introduction to the food chain concept and the principle that energy is lost during each energy conversion on the food chain. It is also a chance for students to look at how their food is prepared and the energy consumed along the way.

CONCEPT DEVELOPMENT - In Phase 3, the students are asked to compare energy requirements in terms of cooking. For ease of calculations, a typical conventional oven requires 3.8 kilowatts during 60 minutes of operation while a microwave uses 1.5 during the same time. On a low setting a crock-pot uses .075 kilowatts per hour. On high it uses 1.5 kilowatts. If you do not wish to take the time to have the students cook and time, these figures may be helpful in calculating relative energy consumption.

APPLICATION - Ask the students to brainstorm conservation ideas about food in Phase 4. (A list of brainstorm ideas is below)

1. Plant your own fruits and vegetables.
2. Collect plant refuse as compost which can be used as fertilizer.
3. Feed your pets from leftover food.
4. Eat less candy and processed food and more fruits and vegetables. Buy fewer convenience foods. (TV dinners, pre-cooked foods, etc.)
5. Purchase items in bulk.
6. Find a way to re-use food containers.
7. Use food-preservation techniques such as canning and drying.
8. Cut down on the use of meat.

Once a list has been generated the students need to put the list to use. It is suggested that students make posters or produce a pamphlet. You might have them write a story about a family that uses the ideas, or have the students try one of the ideas for a time at home. Whatever you decide, make sure that the students do more than brainstorm and list. You will ensure that the information will be remembered for a much longer time.

FOLLOW-UP/BACKGROUND INFORMATION

The Iowa State Extension Service will have information for this activity. Magazines such as Organic Gardening and Mother Earth News are also good sources.

Diet for a Small Planet by Francis Lappe (from Ballantine Books) includes information and recipes for saving energy by eating lower on the food chain.

Some other ideas you might explore are:
1. Identify ways in which energy is wasted at fast food outlets.
2. What other methods of food purchasing and packaging would result in energy savings?
3. Do a controlled experiment on cooking in covered vs. uncovered containers.
4. Investigate the energy requirements needed to produce ready to eat products versus meals made from "scratch."

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen.

More for Less

Name ______________________

FOR THE STUDENT

Energy conservation is not limited to using less electricity, or buying less fuel for your family car. You will investigate the energy requirements of the food you eat.

Phase 1:

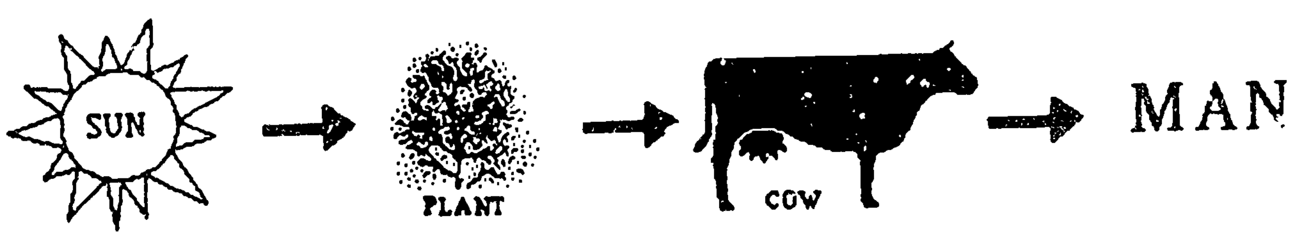
Trace the energy route of today's school lunch from the sun to the student consumer. Since this may get complicated with too many food items, limit your diagram to four elements of the lunch, such as vegetable soup, bread, cake, milk. Someone in the class may have to inquire about whether the items were furnished in cans or whether they were made "on site".

After you have finished the diagram, circle some areas that could be changed to use less energy.
What food items seemed to take the most energy to eventually serve to students?

Make a menu for 3 days' time that include items with low energy needs.
Would these menus be acceptable to other students?

Phase 2:

In the exercise above, you made a simple food chain that might have been from the first energy source, the sun, to vegetation, to cattle, and finally to man. There were many other steps as well.



A general principle to remember about food chains is that with every conversion of energy from one step to another there is a loss of energy. The shorter the food chain, the greater the percentage of solar energy that is available to the human consumer. Plant protein requires less energy input than does animal protein. That means that whole grains and legumes (beans, lentils, peas), when substituted for meat or used as meat extenders, conserve energy. Milk, cheese, eggs, fish and poultry require less than 20% of the energy input required for beef cattle and produce the same amount of protein. So more "efficient" eating would usually mean menus low in grain-fed beef, high in vegetable and animal produce substitutes.

List some ways in which Americans might reduce the amount of animal protein consumed.

Phase 3:

There are a variety of ways in which food can be prepared or cooked. Choose a simple one-pot meal and compare the cost of cooking it in a conventional oven, a microwave, and a crock-pot. You will find the number of watts consumed per hour on the appliances. In order to have adequate comparisons, you might try cooking the meal at home or in the home economics lab to obtain accurate times. Which method used the least amount of energy?

Phase 4:

In addition to the conservation measures mentioned above, there are many things that can be done to reduce both the cost of food and the energy required to produce and prepare food. Brainstorm a list of ideas and prepare a series of posters or a pamphlet on energy conservation ideas to publish for your school. You might also wish to expand your publication to include non-food related conservation techniques that you have learned.

Water and Energy, a Drippy Business

SUBJECT Science LEVEL 6-8

ACTIVITY IN BRIEF

Calculating the amount of water wasted from a leaky faucet is the start of a study on hydropower generation.

OBJECTIVE

The student will explain how energy is lost from leaking faucets and how electricity is generated from hydrcelectric power plants.

MATERIALS	TIME
per group or students - 1 graduated cylinder, pail, timer or stopwatch	1 - 2 class periods

LEARNING CYCLE

AWARENESS - Part A is an exercise in calculating volumes and time, but is an eye opener for students when the calculations are complete. During the 10 minute wait, you might discuss world-wide uses of water, sources of freshwater, and the body's need for water. After the calculations are complete, follow up with a discussion about how energy is wasted from other water misuse. Have them consider such appliances as dishwashers, clothes washers, baths versus showers, etc. Discuss measures that might be taken to conserve both water and energy.

If you use a metric measuring device, have students use the conversion of 3.78 l/gal. to compare volume.

CONCEPT DEVELOPMENT - Part B is an introduction to hydroelectric power. Try to emphasize the fact that a lot of water is required to produce electricity although the numbers will speak for themselves. As an additional note, you might find out how many liters are in a neighboring pond or lake and compare the numbers with the students' figures.

APPLICATION - While hydrcelectric power is an energy alternative, its use is limited and there are some environmental impacts to its use. These are listed below.

Limits and Impacts:

1) Rely on rain and snow melt to feed the system.
2) High cost of construction.
3) Hinders the movement of fish.

4) Increases the siltation of river beds.
5) Requires proper terrain.

Have the students list benefits and consequences for hydroelectric power. Does one side outweigh the other?

FOLLOW-UP/BACKGROUND INFORMATION

Find out if there is a hydroelectric dam in your area. How much does it contribute to the area's electricity needs?

SOURCE OF ACTIVITY

Adapted from Water and Energy, Ministry of Education, Ontario, by Peg Steffen.

Water and Energy, a Drippy Business

FOR THE STUDENT Name______________

You will investigate the amount of water wasted from a dripping faucet. You will also be introduced to hydroelectric power generation.

Materials you will need include a container to catch the drips, a graduated cylinder, and a timer or stopwatch to measure the number of drips per minute.

PROCEDURE: PART A

1. Place your container in the sink to catch the drips from the faucet. Set the faucet to allow water to drip at the rate of about one drop per second.
2. Time the drips for one minute and take an accurate count of the number of drips.

Number of Drips per minute ______________

3. Allow the faucet to drip for 10 minutes. Measure the number of milliliters in your collecting container.

Number of milliliters ______________

4. From your findings, calculate how much water would be collected in :

an hour ______________
1 day ______________
1 week ______________
1 month ______________
1 year ______________

Convert the "month" number to liters for future use.
__________gallons equals__________liters. (1 gal =3.78 liters)

Assignment for tomorrow:

Find out how much water your family uses in one month.

PROCEDURE PART B.

1. Assume that the amount of electricity to operate a hot water heater for one month is 500 kilowatt hours.

2. Assume that your family had a drip of hot water each month equal to what you calculated in Part A. Use the "month" drip number in liters and find its percentage of your family's total water use by dividing the amount of "drip" water by the total water used.

$$\frac{\text{Amount of "Drip" water in liters}}{\text{Total water use for one month in liters}}$$

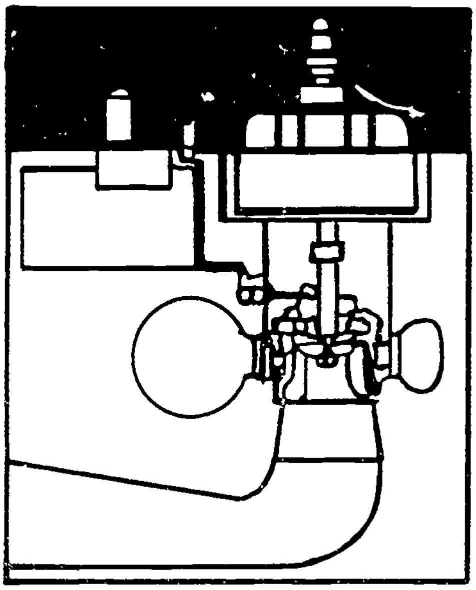
Multiply this number by 500 to find the number of kilowatt hours needed to heat the "drip" water.

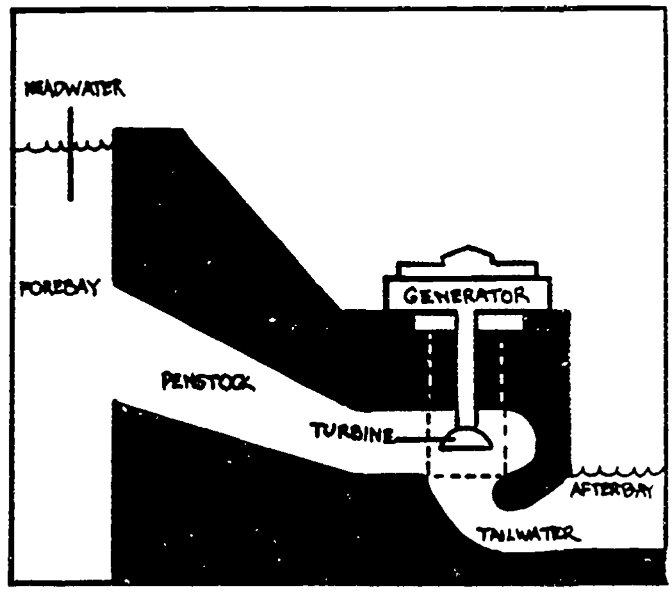
Number of kilowatt hours______________

Determine the cost of heating the wasted hot water by multiplying by \$.073 per kilowatt hour. Cost______________

PROCEDURE: PART C

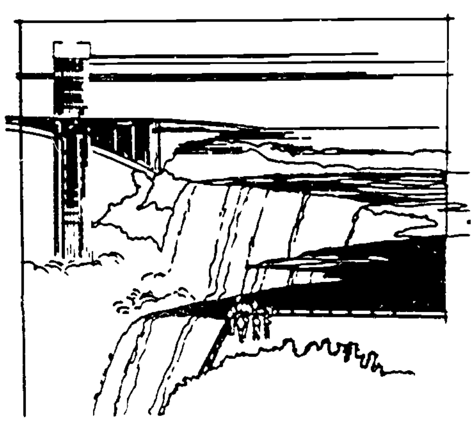
Let's imagine that your electricity is produced by a hydroelectric dam in which falling water turns the wheel of turbines to produce electricity.

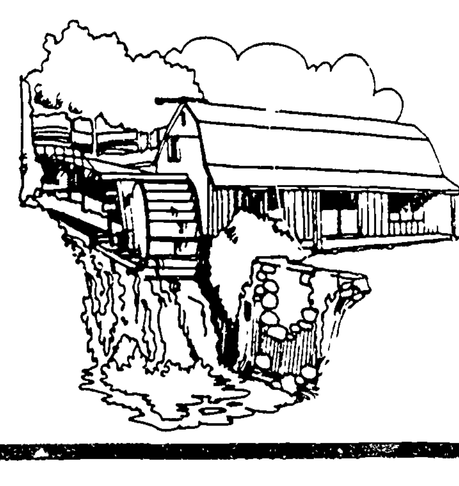




It takes 12,000 liters of water falling 30 meters to produce 1 kilowatt-hour of electricity. Determine how much water would have to fall to produce the electricity required to heat the "drip" water.

Number of kilowatt hours X 12,000 = ____________liters of falling water.





Insulation: Hot Box!!

SUBJECT Science **LEVEL** 6 - 8

ACTIVITY IN BRIEF

Students will choose 3 insulating materials to test for insulating ability using a cardboard box and a lightbulb.

OBJECTIVE

Each student will be able to:

1. List the essential elements of scientific experimentation.
2. Will identify insulating and non-insulating materials.

MATERIALS

1 cardboard box per group
ceramic sockets with 100 watt bulbs
(1 per group)
4 thermometers per group
insulating materials such as wool, aluminum foil, fiber glass, metal, newspaper, home insulation, etc.
scissors or knives, masking tape

TIME

2 class periods

LEARNING CYCLE

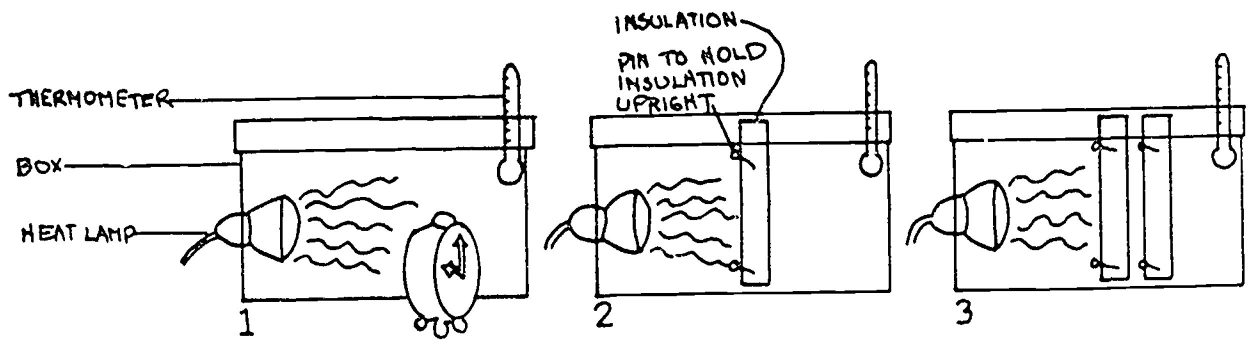
AWARENESS - Before seeing this activity, explain to the students that they are going to build a new home. Ask them, "What insulation will you use in your home to make it most energy efficient?" Visit the local lumberyard and find out what is available. They might also wish to find out what is present in their own home. In small groups (3-4) have the students discuss the insulations and pick three insulations they would like to test.

CONCEPT DEVELOPMENT - You may have students follow the directions on the front of this activity, or have the students write their own experimental design. (See also the alternative diagram below for the box set-up.) Review the essential elements of good design before they start, but resist the temptation to direct their every move. Much is learned from mistakes! Students may wish to alter the design such as testing more than three materials. Students should share responsibilities so that all temperature readings are taken during one trial. After they have gathered data, have them identify areas which might be improved if this was done again.

APPLICATION - 1. Have a resource person from a building industry or from a power company visit and explain R value to students. Have students compare their findings with the information presented. The power companies or the Iowa Energy Policy Council can furnish R value information.

2. Have students build or draw the models of homes. What other techniques can be used to make a house more energy efficient?

3. Have students build cardboard houses complete with insulation and test them using a bulb inside the house for winter and a bulb outside the house for summer. Prepare a summary on the findings.



FOLLOW-UP/BACKGROUND INFORMATION

Many activities about insulation can be found in the New York Solar Energy Project. The address can be found on the page "Resource Organizations". See also "A Comparison of Insulation Efficiencies" from Project Learning Tree, p. 179-180

SOURCE OF ACTIVITY

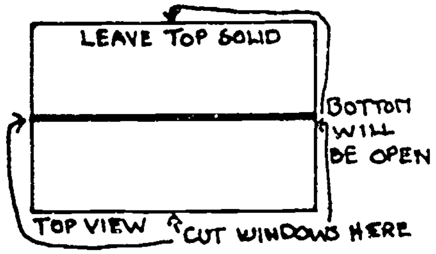
Adapted from Department of Energy's "Science Activities in Energy" by Myrna Moore and Peg Steffen

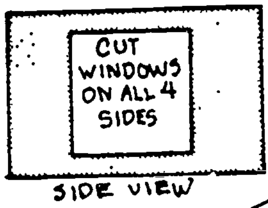
Insulation: Hot Box!!

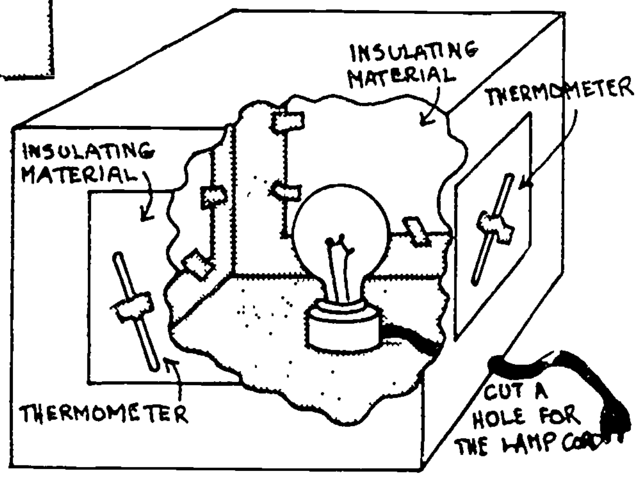
Name______________

You will be doing an experiment that will answer the following problem: What materials are most effective in preventing heat loss (insulating)?

The Experimental variable is the different materials you will have to choose from. All other conditions of the experiment must remain the same. You need some way to determine whether a material is more effective than another and so we will measure the temperatures before and after applying heat. Temperature change is the dependent variable. Cut up your box like the one diagrammed here.







Next cover three windows with insulating materials. Why is one left open? Tape a thermometer to the outside of each insulating material. Hang one into the center of the open window.

Make a data table to record the rise in temperature for the different materials. A sample is shown.

Record the starting temperatures of all windows. Place a light in the center of the box and turn it on for 5 minutes. Record the rise in temperature for all insulations. What do you conclude about the effectiveness of the insulation types you used?

TYPE OF MATERIAL	MINUTE	TEMPERATURE
	Start	Start
A.	1.	1.
	2.	2.
	3.	3.
	4.	4.
	5.	5.
	Start	Start
B.	1.	1.
	2.	2.
	3.	3.
	4.	4.
	5.	5.
	Start	Start
C.	1.	1.
	2.	2.
	3.	3.
	4.	4.
	5.	5.
	Start	Start
D. CONTROL	1.	1.
	2.	2.
	3.	3.
	4.	4.
	5.	5.

Electric Luxuries/Necessities

SUBJECT Science **LEVEL** 6 - 8

ACTIVITY IN BRIEF

Students will survey their home for electrical items and then discuss why some might be considered luxuries and some necessities.

OBJECTIVE

During the activity, the student will examine his/her dependence on electricity. At the end of the activity each student will be able to 1) describe what electrical items constitute a necessity, and 2) will explain a lifestyle which uses less electricity.

MATERIALS

None

TIME

1 class period

LEARNING CYCLE

AWARENESS - Students should list all electrical items in the initial survey of their house.

CONCEPT DEVELOPMENT - During the discussion, students should explain why they consider some electrical items to be luxuries and others necessities. In question 4, have students consider handicapped persons whose lives are made easier by electrical appliances, and how people depend on electrical life support systems.

APPLICATION - Examining lifestyles from other countries is a good way to complete this activity. You might simply finish with the last discussion questions or you might assign the students to investigate a lifestyle of their choice and report on how energy is used.

FOLLOW-UP/BACKGROUND INFORMATION

"The 'Good' Old Days," and "A Voyage Back in Time," OUTLOOK, Deptment of Public Instruction. "A Simpler Life," Project Learning Tree, p. 173.

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Marjorie Gowdy and Peg Steffen.

Electric Luxuries/Necessities

ACTIVITY: **Name**________________

1. Make a list of all electrical items in your home. Where possible, list the number of watts that each item consumes. Indicate how many hours per day an item is used.

Sample data Table:

Electrical Item	Number of Watts	Hours used/day

2. As a class you will fill out two columns, one for luxuries and one for necessitites. Give the teacher electrical items from your list for the columns.

3. As a class, vote on the five items from the necessities column that would make your life difficult if you had to do without them. Vote on five items from the luxuries column that would be easy to live without.

Discussion questions:

1. Were you surprised at the list you generated from home?

2. How are these items a help to us?

3. How did you decide that some items were a necessity?

4. What people might find some items that we consider a luxury to be a necessity?

5. What alternatives can be used in place of some the luxury items?

6. Describe the lifestyle of a family who uses no electricity?

7. What things can we do to cut down on the amount of electricity we use?

8. What lifestyle changes would we have to make in order to drastically cut down on the amount of electricity consumption?

Solar Potpourri

SUBJECT Science LEVEL 6-8

ACTIVITY IN BRIEF

The students will have a variety of solar experiences to prepare them for the final activity, designing a solar cooker.

OBJECTIVE

Each student will be able to illustrate the elements of solar design and will describe practical uses of solar energy.

MATERIALS

Indicated on each activity

TIME

1 - 2 weeks

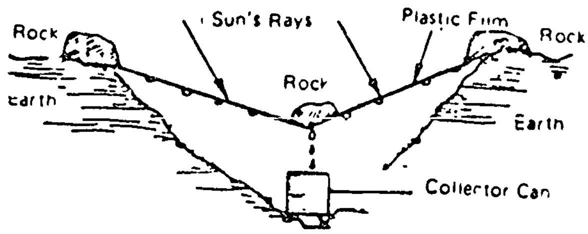
LEARNING CYCLE

AWARENESS - Activity 1 is intended to spark student interest and to involve them in simple solar design. This should be limited to one or two class periods. Then move on to other activities that will reinforce what they have discovered.

CONCEPT DEVELOPMENT - Activities 2, 3, and 4 are exercises to show students ways in which solar energy is used and elements of solar design. You may do any number of these depending on your time frame. An idea to save time and yet expose students to all activities, is to split the class into groups, each of which is assigned a different activity. At the conclusion, each group reports their findings to the class.

Special notes about Activity 4: A Solar Still (Solar Desalinizer): You may substitute a plastic shoe box in place of the large glass jar. Do not expect results in a single class period. Try to find a warm and sunny location where the still may sit for a least 24 hours. Eventually a mist of fresh water will collect on the surface of the plastic and some will drip into the glass. Should cloudy weather prevail, a sun lamp will get results more quickly. This is not recommended because students get a false impression of easy, instant results.

If an area of the schoolyard is available for digging a shallow pit 30-40 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. Set up as illustrated. Water tends to cling to plastic 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 set undisturbed for 2 to 24 hours.



APPLICATION - Activity 5 is included to give students a chance to design and test a solar device using the principles they have been exposed to. As an option, you may have students design a passive solar house and construct a simple model. For additional free information, contact the Iowa State Extension Service in your county, or the Iowa Extension Service, Iowa State University, 110 Marston Hall, Ames, Iowa 50011. Iowa Energy Hotline: 800-532-1114.

EVALUATION - 1) What are three ways in which passive solar energy might be used by individuals? 2) What is the effect of overhang on the amount of sun that strikes a window? 3) What components are used in the design and construction of solar cookers?

FOLLOW-UP/BACKGROUND INFORMATION

You will find many excellent solar activities and information from:

Solar 80's, Florida Solar Energy Center, 300 State Rd. 401, Cape Canaveral, FL 32920

National Solar Heating and Cooling Center, P.O. Box 1607, Rockville, MD 20850

"Solar Energy II," from Science Activities in Energy, American Museum of Science and Energy, P.O. Box 117, Oak Ridge, TN 37830

Secondary Solar Energy Education Curriculum, Solar Energy Project, SUNY at Albany, 1400 Washington Avenue, P.O. Box 22100, Albany, NY 12222

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Fred Worrell, Bernard Hermanson, and Peg Steffen.

Solar Potpourri

Name_______________________

Experiment 1: Solar Egg Cookery

Materi: s you will need; square metal plates large enough to hold a frying egg, eggs, styrofoam pieces, cardboard, aluminum, glass panes, plastic wrap.

A. Place the plates in the sun. Allow time for the plates to heat up. Try to fry an egg on the plate. Take note of cooking time.

B. If your egg did not cook or took too long to fry, brainstorm ways to increase the speed of the solar plate. Improve your plate and make a drawing of your final design.

C. Cook another egg and compare the time with your first attempt. Are there any improvements that would increase the cooking time even yet?

Experiment 2: Solar "Shades"

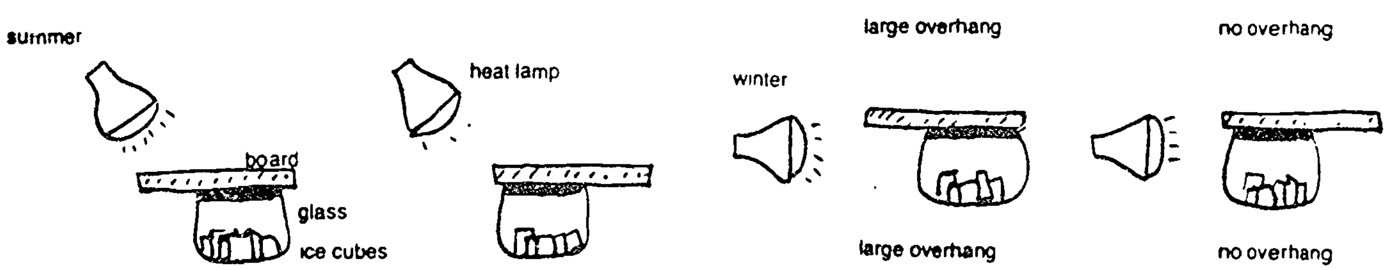
Materials you will need; several cups of ice cubes, a wooden board 18" x 12", glass bottle with lid, heat lamp or sunlight.

A. Put one cup of ice cubes inside the glass bottle. Place the wooden board over the bottle to simulate different overhangs as shown below.

B. Place a small heat lamp high over the bottle to simulte the summer sun. Record the time to melt the ice cubes for each of the two summer overhangs. (Move the piece of board to simulate first a large overhang and then a small overhang.)

C. Do the same for the winter sun, only reduce the angle of the light rays to the horizontal plane.

D. What is the effect of an overhang on protection from the sun?



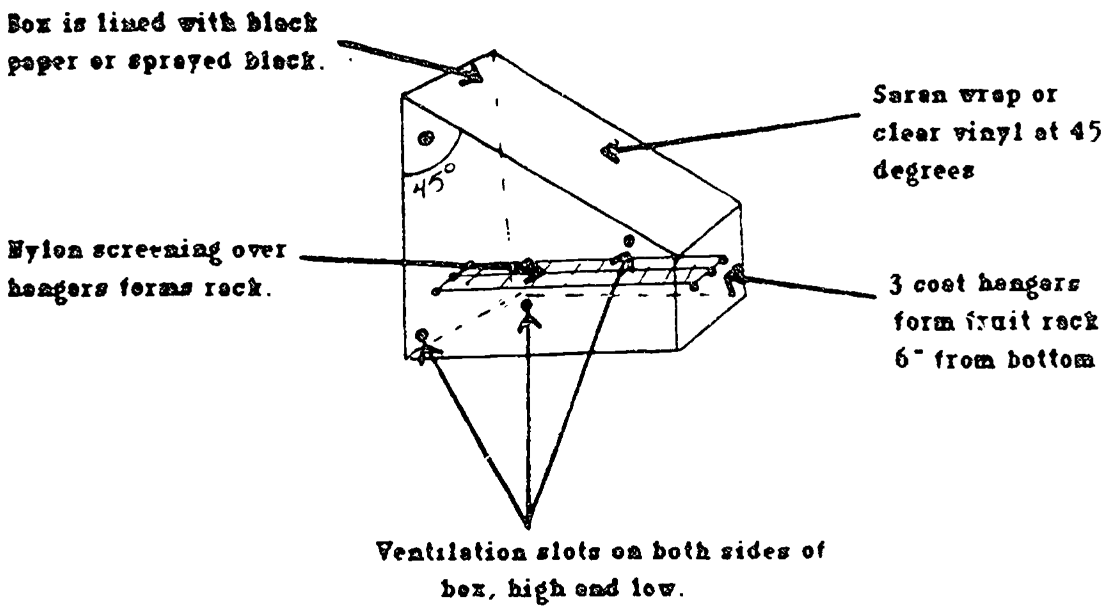
Experiment 3: Solar Fruit Dryer

Materials you will need; a large cardboard box, 3 metal coat hangars, wire screening, plastic wrap, black spray paint.

A. The design is pictured below. Make improvements as you see fit.

B. After completion, test your dryer out with a variety of foods.

C. Calculate the energy saved by solar drying foods as compared to storing in the freezer or canning.



Experiment 4: Solar Still

Materials you will need; a glass bowl or large beaker, table salt, plastic wrap, drinking glass or small beaker, marbles, newspapers, rubber band.

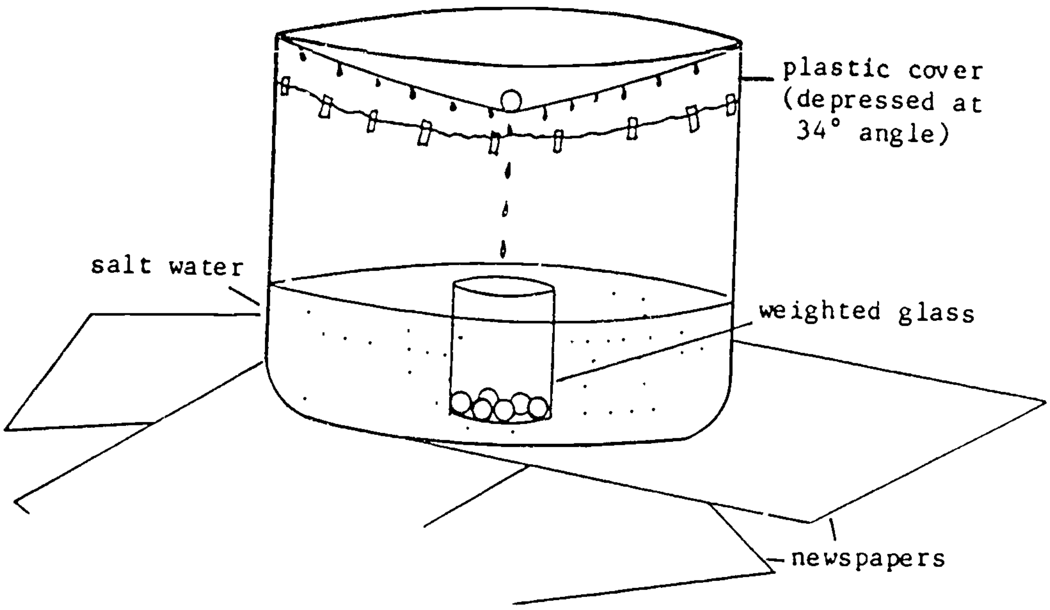
A. Prepare salt water using 3.5 g table salt for every liter of water.

B. Wash and dry marbles so that they are clean.

C. 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.

D. 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 24 hours later if you have a quiet location.

Solar Still



Questions:

1. Notice the appearance of the plastic cover. What has happened?

2. Remove the cover and examine its underside. Put some drops on your finger and taste it. It tastes like_______________.

3. Remove the glass. Carefully take out the marbles. Examine the remaining contents. What is it?

4. How did the "new" material get into the glass? Was work done?

5. What does "distillation" mean?

6. Find out how this "desalinization" is done around the world. Where are people most interested in getting fresh water from salt water?

Experiment 5: Solar Cooker Design

Your assignment is to design, construct, and test a solar device to perform a specific function useful in the preparation of food or drink. You can use elements of activities we have done, but you must make improvements and redesign where necessary. Your teacher will tell you whether to work in groups or individually. Construction will take place outside of school so that your design is secret until the day of final unveiling. You will be responsible for finding the following before you turn in your project:

1. Food or drink intended for use in cooker.
2. Maximum temperature achieved.
3. Time for cooking under optimum conditions.
4. Cost of the device.
5. Improvements you would make next time.

Hidden Helpers

SUBJECT Science LEVEL 6 - 8

ACTIVITY IN BRIEF

Students create a visual representation of the energy consumption of the U.S. compared to other countries of the world.

OBJECTIVE

Each student will 1) compare the U.S. consumption of energy to that of the rest of the world. Students will 2) at the end of the activity, examine their lifestyle to determine ways in which to cut down on the number of "hidden helpers".

MATERIALS

Poster board, white butcher paper, magic markers, crayons, rulers, old magazines, glue, tape, scissors, paint, graph paper, construction paper

TIME

1 - 2 class periods

LEARNING CYCLE

AWARENESS - This activity is an awareness activity for the students to examine the data and draw conclusions. After the construction of the pictures, have the students explain their creations to the class. This will help them to verbalize their thoughts and to hear what the others thought about the data.

CONCEPT DEVELOPMENT - Class Discussion:

1. In many ways our energy helpers have served us well, carrying us rapidly around the world; bringing delicacies from long distances, like coffee from Africa and pineapples from Mexico; producing durable goods, plowing fields, carrying messages, and resculpturing the earth. What changes in our lifestyle will have to happen in order to cut our number of energy helpers in half?

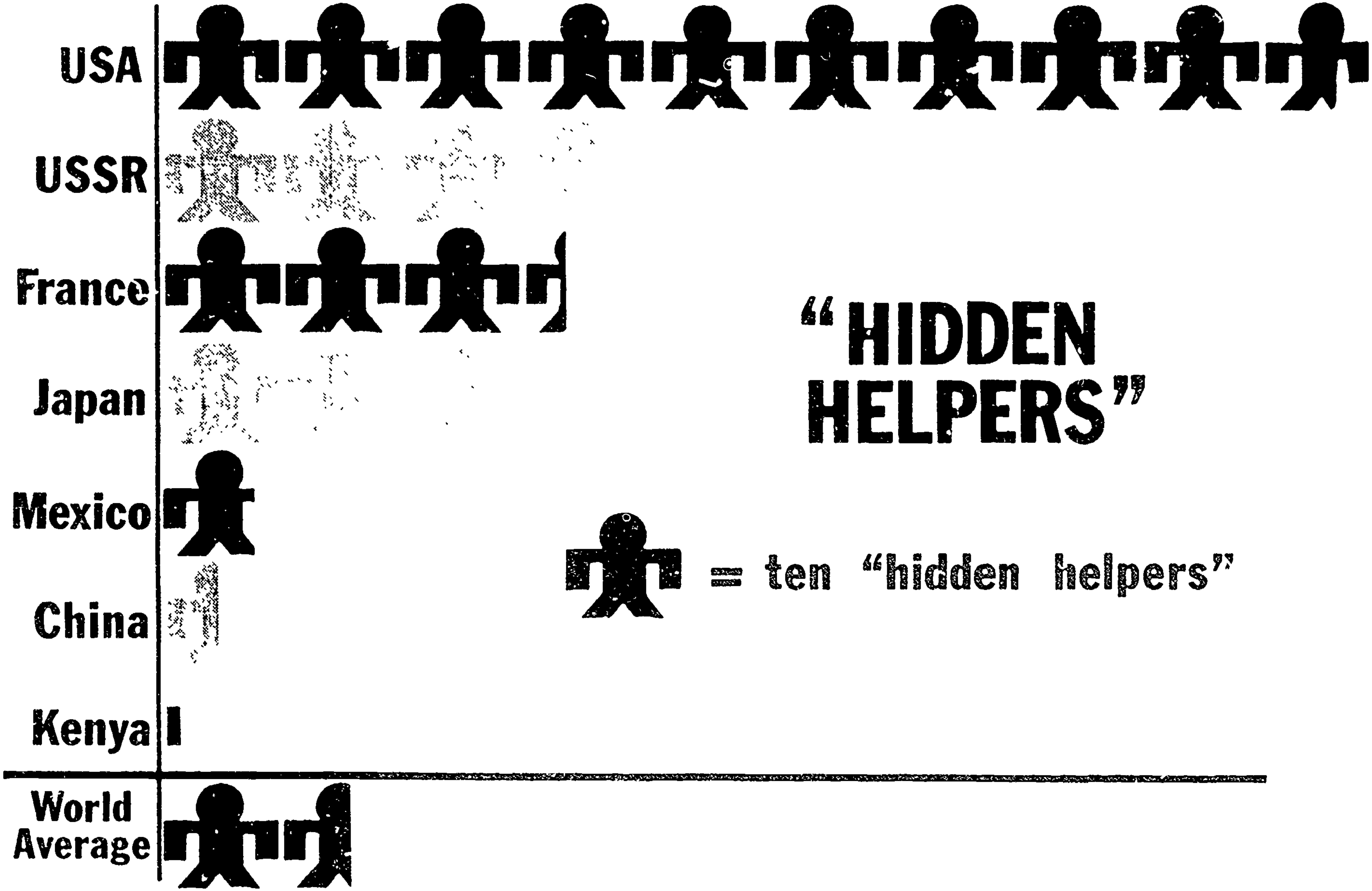
2. What do you think will happen to the number of hidden helpers if scarcity makes them more and more expensive? Who will have the most energy helpers?

3. What do you think will happen to the number of helpers we have if the rest of the world starts consuming energy as fast as we do?

APPLICATION - Have the students use the accompanying "Lifestyle Survey" to determine where much of the energy is used. Have them list suggestions for changes that would have a significant effect on the amount of energy consumed. Have them choose one suggestion and try it for a week What is their reaction?

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen


USA
USSR
France
Japan
Mexico
China
Kenya
World Average
"HIDDEN HELPERS"
= ten "hidden helpers"

42

Hidden Helpers

Name________________

ACTIVITY:

Visualize a ration of 2500 calories/day as equivalent to the average well-fed person's consumption in food. Call this one human "person power". Then the average daily energy consumption of people in various countries can be compared to having armies of hidden helpers moving and shaping the environment.

In many countries there is little commercial energy available and the main sources of power are people and firewood. The People's Republic of China is an example of a country that relies heavily on people-power for agriculture and major construction projects.

Use the following chart as background information to develop a visual image of how Americans consume energy in relation to the rest of the world. You may make a poster, collage, cartoon, graph, storybook, etc.

Energy Helpers Per Person/Day*	Country	Region
99	U. S.	North America
51	Australia	Oceania
46	Sweden	W. Europe
45	W. Germany	W. Europe
40	Britain	W. Europe
40	U.S.S.R.	E. Europe
33	France	W. Europe
28	Japan	Asia
27	New Zealand	Oceania
[illegible]5	Italy	W. Europe
	Israel	Middle East
16	WORLD AVERAGE	
14	Argentina	S. America
12	Iran	Middle East
9	Mexico	C. America
8	Korea	Asia
6	Brazil	S. America
5	China	Asia
4	Egypt	Africa
2	India	Asia
1	Viet Nam	Asia
0.2	Kenya	Africa
0.1	Nepal	Asia

* U.S. ratio is based on statistics for energy consumption released by DOE. Other countries' ratios are based on energy consumption statistics from the United Nations.

S42

SOURCES: LIFESTYLE SURVEY

Compare the amount of energy used for your standard of living with that of someone in a developing nation such as Mexico or China. In each category give an example of how energy is used. Indicate whether there is M = much energy used, L = little energy used or N=no energy used. The first category has been done for you.

USE OF ENERGY	U.S.	UNDEVELOPED NATION
Transportation	Plane, car, train or bus M	Walk, bicycle, bus L
Initial Cost of House construction		
House Upkeep (lawn, paint, repairs)		
Consumer Goods (records, make-up, hobbies, toys, TV, magazines, etc.)		
Electricity Use (Give Minutes/day) *Radio - TV *Air Conditioning *Heating *Power tools *Clock, iron *Dishwasher *Clothes washer *Clothes dryer *Lights *Sewing machine *Telephone *Misc. Appliances		
Clothing		
Food (processing, transportation, prep.)		
Recreation		

Energy and Attitudes

SUBJECT Science LEVEL 6 - 8

ACTIVITY IN BRIEF

Students will collect samples of media which represent energy attitudes in America. They will develop a plan of action to alter one energy attitude.

OBJECTIVE

Each student will examine public attitudes towards energy.

MATERIALS

None

TIME

1 - 2 class periods

LEARNING CYCLE

AWARENESS - This is an awareness activity designed to have students examine the public's beliefs and attitudes about energy. They should also understand that attitudes affect actions.

CONCEPT DEVELOPMENT - Students might be asked to write a short paper about their present attitudes about energy and how those attitudes affect their lifestyle and energy use. Or, they might be assigned to develop a survey tool and sample the community or school population about energy attitudes.

APPLICATION - After the students have developed a plan of action for the activity (question 5), they should put part of it into effect, such as produce a poster, commercial, song, photo essay, etc. These should be shared with the class and/or with the school and community. You might even plan to do a media blitz or put the students' plans into action during Energy Education Week, held in March each year. Students should critique the results of their plan of action. Was it effective? How could it be improved?

Use an attitude or belief as the hub of a futures wheel (see Trends and Consequences). Assume that this belief is the basis for everyday choices and actions by the majority of Americans.

Research American Indian beliefs about the use of natural resources and compare them to widespread attitudes held today.

FOLLOW-UP/BACKGROUND INFORMATION

Discarded copies of Forbes, Fortune, New Yorker, Business Week, Time, Newsweek, and Wall Street Journal are especially good resources for this activity if you wish to provide some for the students.

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peggy Steffen

Energy and Attitudes

Name________________

ACTIVITY

Collect ads and articles from magazines, newspapers, and reports from television for 1 or 2 weeks that express values about the use of energy materials. For each item turned in, write a sentence or two about:

a. the attitude or beliefs of the advertiser or writer as stated or implied in the ad, and,

b. the effect of the picture or text on the reader

You will report your findings to the class and/or turn in the articles that have been found.

The class will then produce a large chart of the attitudes found.

DISCUSSION QUESTIONS

1. What are the prevailing beliefs and attitudes of the American public today about energy?

2. Are these beliefs and attitudes consistent with what you believe? Explain.

3. How are the attitudes affecting our energy use?

4. What steps might be taken to influence the public about the need to conserve energy resources?

5. Develop a plan of action to change one attitude presently held by the public.

Go With the Flow: Thermometers and Heat

SUBJECT Science **LEVEL** 6-12

ACTIVITY IN BRIEF

Water and Air thermometers are used to introduce the concept of heat and temperature. Students are then asked to investigate heat storage and specific heat.

OBJECTIVE

Each student will be able to list methods for measuring the heat of their surroundings and define the concept of heat and storage ability (specific heat).

MATERIALS

Listed for the student in each activity. Activity 3 also requires styrofoam cups, a thermometer in each, ethyl alcohol, 7% salt water (70 g salt in one liter water). All jars that are used should be the same size (peanut butter or mayo jars). The lids can be fitted with a styrofoam lining.

TIME

1-2 class periods

Advance preparation: Freeze a thermometer in the center of each styrofoam cup. These are the "popsicles." You will need 1/student or group. Allow tap water, salt solution, and alcohol to reach room temperature before the activity. Assign each group to do one of 4 tests with the "popsicle."
Group A. Control uses no solution in jar.
Group B. 100 ml of alcohol in jar.
Group C. 100 ml of tap water in jar.
Group D. 100 ml of salt solution in jar.

LEARNING CYCLE

AWARENESS - Activity 1 and 2 are designed to give a quick introduction to the limitations encountered in measuring temperature or the average level of heat in a local environment. The amount of heat a material absorbs before it changes a volume significantly varies with the material. Fluids generally respond more rapidly than solids.

Expected results for Activity 1 and 2:
Water thermometer - The water will readily rise or fall by heating or cooling. On refrigeration the water level may go down so far as to empty the glass tube making calibration impossible. You might note that air pressure also affects the water thermometer as constructed because it is not evacuated and sealed as commercial ones are and so are more sensitive to air pressure changes.

Air thermometer - The balloon's change may be hard to measure. If the balloon was slightly inflated and attached in the coldest expected environment, and if markings were inked in carefully spaced intervals on the skin, the degree of expansion on warming could be measured or quantified as a function of the increased distance between those markings.

CONCEPT DEVELOPMENT - Activity 3 is an introduction to the concept of "specific heat." You will want to reinforce the concept after conclusions have been drawn from the activity.

Expected results:
The air temperature inside the jars will drop rapidly during the first two to four minutes and then level off. The "popsicle" temperature remains near 0° C. It appears that some heat is "lost" from the fluids without any noticeable gain by the popsicle or by the outside thermometer either. Students will probably not notice any change in the "air" jar. The question is, "Where did the extra heat come from in the other jars to start melting the ice?" The ability of materials to absorb heat is an individual characteristic of each. The amount of heat necessary to raise one gram of a material 1° C is called "specific heat." For liquid water, that unit is one calorie. For most other substances, that unit is some fraction of a calorie. So a group of materials at the same temperature does NOT contain the same amount of heat, gram per gram. This concept is important in choosing materials for heat storage systems.

APPLICATION - Materials which are condensed or frozen release stored heat to the environment without changing temperature themselves. Water, the most widely available "heat sponge," absorbs or releases 80 cal/gram as it melts or freezes. Water exchanges heat at a rate of 540 cal/gram at its boiling point. These phase changes are very important when heat storage is desired, as in solar heating systems. Eutectic salts and paraffin are sometimes used because their melting/freezing temperatures and accompanying peak of heat storage and release lie in the 29°-49° C range which is easily obtained by solar collection, even on cold winter days.

Activities that you might do at this point are:
1. An investigation of thermal expansion of building materials.
2. An investigation of active solar systems in homes and businesses.
3. The heat storage capacity of salts. (See "Storing Solar Energy in Salts and Paraffin" in the New York Solar Energy Curriculum.

Available from: Solar Energy Project, SUNY at Albany,
1400 Washington Avenue, P.O. Box 22100
Albany, N.Y. 12222

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen

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Go With the Flow: Thermometers and Heat

Name_______________

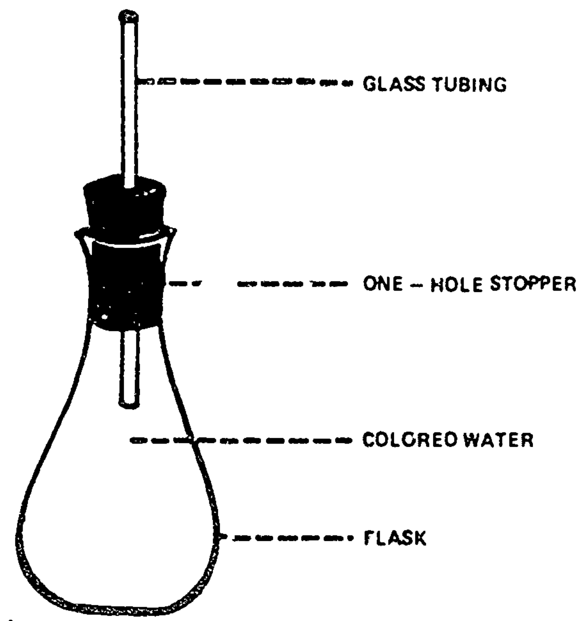
ACTIVITY:

You will investigate temperature and heat with several types of materials.

ACTIVITY 1: Water Thermometer

Materials include an Erlenmeyer flask or bottle with a neck that can accept a one-hole rubber stopper, rubber stopper with one hole, 6" glass tubing, food coloring, thermometer

Procedure:
Fill the flask with water. Add food coloring to make the water easier to see. Using liquid soap or glyceri e as a lubricant, fit the glass tubing into the rubber stopper so that the lower end barely extends beyond the stopper bottom. Put the stopper into the flask as shown in the sketch, forcing out any extra water. Mark the water level in the glass tube with a grease pencil or magic marker and note the temperature on a standard thermometer. Compare your device with those of classmates.



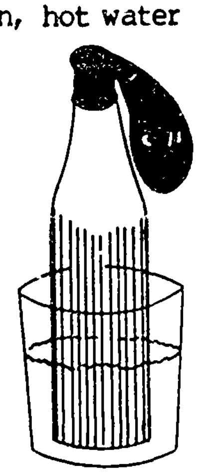
WATER THERMOMETER

Is the water level the same in all? Expose the water thermometer to as many different conditions as you can...and mark the water level for each of these conditions. Why would this thermometer not be used in outdoor conditions?

ACTIVITY 2: Air Thermometer

Materials you will need include a pop bottle or flask, a balloon, hot water and ice, and a small pail.

Procedure:
Stretch the balloon opening over the mouth of the bottle. Set the bottle in a pail or beaker of boiling hot water. Either describe or make a picture of any changes in the balloon. Next put your air thermometer into a beaker or pail of ice water. (You may also use a refrigerator). Describe what happens to the balloon.
How could you calibrate an air thermometer?
How could you make an air thermometer that would be more sensitive to temperature changes than the one you have?



ACTIVITY 3: Heat Flow and Heat Storage

Materials: Each student or group of students will need a "popsicle", two small thermometers, a glass jar in which the "popsicle" will fit, an insulated jar lid or a book wrapped in plastic, and a solution assigned by the teacher to test.

Procedure:

Lay one thermometer on the desk where you are working and record the "room temperature". Tape a small thermometer to the inside of the glass jar with its bulb just touching the bottom of the jar. Read the temperature and record it. Then put a "popsicle" without its styrofoam jacket into the jar, keeping it from touching the thermometer or the jar wall. Your teacher will tell you if you are to add anything to the jar before you put on the insulated lid. If you are adding a liquid, record the temperature of the liquid before you add it to the glass jar.

You will record the temperature of the thermometer in the "popsicle" and in the jar every minute for 15 minutes. You will read the room thermometer at the same time. Record any observations and share class results. Make graphs of the results to show the change in temperature over time of the jar thermometers.

1. Which jar had the lowest temperature after 15 minutes?

2. What factors were kept the same (controlled) in the four different set-ups? What was the experimental variable?

3. Try to give some explanation for the temperature readings of the popsicle thermometer.

4. Which fluid is the best heat storage medium?

Hot Cars and the Steamy Earth

SUBJECT Science **LEVEL** 9 - 12

ACTIVITY IN BRIEF

The effect of the sun's energy on the temperature of car interiors is an example of the Greenhouse Effect. Students investigate variables with automobiles and plastic boxes before discussing the earth and it's temperature.

OBJECTIVE

Each student will investigate the phenomenon of the greenhouse effect and compare the findings to the effect of CO_2 on the earth's temperature.

MATERIALS

Thermometers, tape measures, graph paper
Invention activity: Plastic shoe boxes, wax paper, white paper, black construction paper

TIME

1 - 3 class periods

LEARNING CYCLE

AWARENESS - For the activity, use as many different types of automobiles as possible, especially newer compact hatchbacks and pre-1978 domestic sedans. Due to several variables (such as color) student data will be contradictory.

CONCEPT DEVELOPMENT - At this point, the class can go in one or more of several directions.

1. Try to isolate the variables of area/volume ratio as a factor that influences the temperature of the closed up automobiles. Using plastic shoe boxes, each group covers up a different percent of the box with heavy paper (all the same color). Expose to the bright sun and record the maximum temperature.
2. Investigate whether color influences the temperature inside the shoe boxes.
3. Investigate the effect of coverings on temperature. (cloth aluminum, foil, wax paper, black paper).

Using plastic shoe boxes the students will find they can more easily control the variables. The same calculations as were done with the automobiles can be done with the boxes. By doing a series of experiments with the box, the student should get a better idea of what variables are important to the temperature increase. The sun works best as a light source, but incandescent lamps will also work.

At the conclusion of the experimentation, introduce to students the idea that the earth acts like an automobile or shoe box in that CO^2 traps the sun's heat energy. This is the greenhouse effect.

APPLICATION -
1. Have the students investigate the problem of air pollution and the greenhouse effect. What possible solutions might limit the amount of CO_2 in the atmosphere? What might happen if the greenhouse continues to heat up the earth's climate?
2. Arrange a field trip to a local greenhouse. How is the greenhouse able to manage the sun's light in maintaining growing temperatures?

FOLLOW-UP/BACKGROUND INFORMATION

A Guide to the Study of Environmental Pollution. Prentice-Hall, 1972

SOURCE OF ACTIVITY

Written by Dr. George R. Davis

Hot Cars and the Steamy Earth

Name__________________

ACTIVITY

You will be placed in a group of 3 or 4. Each group will need a thermometer and a tape measure. You will record the following data from an automobile that has been sitting in the sun.

1. Air temperature outside of the automobile (celsius). ______________
2. Maximum air temperature inside of the automobile with windows rolled up.

   ____
3. Maximum air temperature inside of the automobile with windows rolled down.

   ____
4. Determine by measurement the total area of glass on the automobile. (in square meters)

   ____
5. Determine by measurement the volume of passenger compartment. (in cubic meters)

   ____
6. Calculate the glass surface area to volume of passenger compartment
7. Make, Model and color of automobile. __________________________

   ____

The class will organize the data and graph the maximum temperature inside the automobiles with the windows rolled up and its glass surface area to passenger compartment ratio.

Were any of the windows tinted?
Did it make any difference in the temperature?
Discuss your findings.

Suggested table for class data:
(C.W.=closed window, O.W.=open window)

Car Type	Car Color	Area of Glass	Volume	A/V Ratio	C.W. Temp.	O.W. Temp.	Air Temp.

Trends and Consequences

SUBJECT Science **LEVEL** 9-12

ACTIVITY IN BRIEF

A future's wheel is designed to examine consequences from the use of technology. The students will use either an energy trend or an energy consuming device in constructing a sample wheel.

OBJECTIVE

The student will explain the consequences of an energy trend or innovation.

MATERIALS	**TIME**
Large pieces of paper, magic markers	1 class period

LEARNING CYCLE

AWARENESS - Students are frequently made aware of energy alternatives and choices, but seldom are required to think about the consequences of those choices. The futures wheel is a good introduction to futuristic thinking in that students must project their thinking into future possibilities. This activity is best done the first time with the teacher and then as a group or individual project. After having done one, you can assign one as a homework assignment. Some examples are listed below:

Television
Telephone
Automobile
Computer
An oil embargo
Increased use of coal, nuclear, hydropower, etc.

CONCEPT DEVELOPMENT - After having done the wheel, have students categorize the nature of the various consequences. Are they social, economic, technological, environmental, or related to politics? Also categorize the consequences by whether they affect people individually, whether they affect American society, or whether the consequences have world-wide impact.

APPLICATION - You might consider using the relevance tree shown on the next page to diagram energy possibilities for the future. Start with the top two levels filled out and have the students complete the rest of the tree. This activity is best done after students have been exposed to many different energy alternatives and understand the pro and con sides to their use.

FOLLOW-UP/BACKGROUND INFORMATION

Reference: J.A. Barker, "Future Study in Curriculum Planning," pp. 55-61 in The Role of Future Studies in Public Education. Misc., Publ. of the Science Museum of Minnesota, No. 4., St. Paul, MN 55101

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen.

Trends and Consequences

Name ______________

FOR THE STUDENT

A futures wheel is a tool to help you examine possibilities and consequences of following trends or using innovations. It is a graphic way to emphasize complex interrelationships.

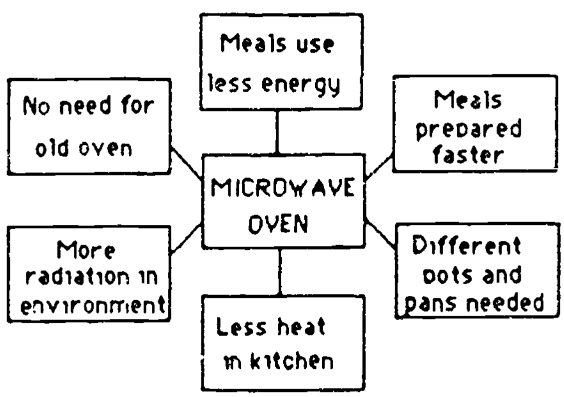
Procedure:

1. Near the center of a large piece of paper, write the name of an energy innovation or trend.

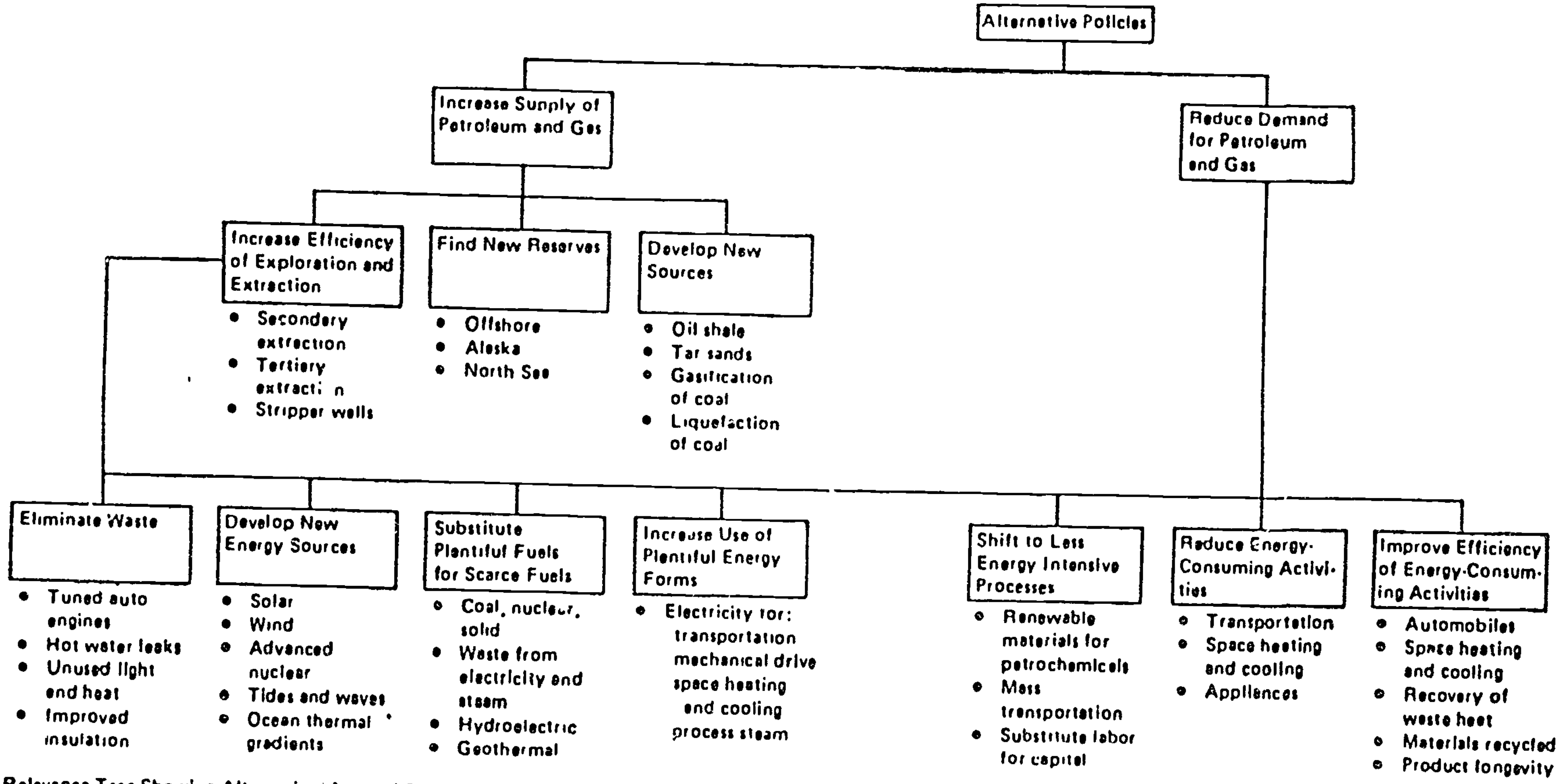
   Here are some possible ones for you to use
   - -gasoline prices at $3.00 per gallon
   - -sales of wood burning stoves are up 500%
   - -solar heating systems are mass produced cheaply
   - -fusion succeeds
   - -electric cars are widely used.

   Draw a circle or box around the item chosen.

2. Then decide on the probable consequences of this innovation or trend. (What might happen (good or bad) if this were to actually take place? Write each of these effects outside and around the circled energy trend. An example for "microwave oven" is shown. The initial reactions are called first order consequences. They are indicated by the single lines connecting the energy innovations with its possible consequences.



3. Now what are the possible effects of each of the first order consequences? Draw and connect each secondary effect proposed by students with two lines between it and the first order to which it relates. Continue this process for about four orders of consequences, using three lines for connecting third order ones and four lines for the fourth order.



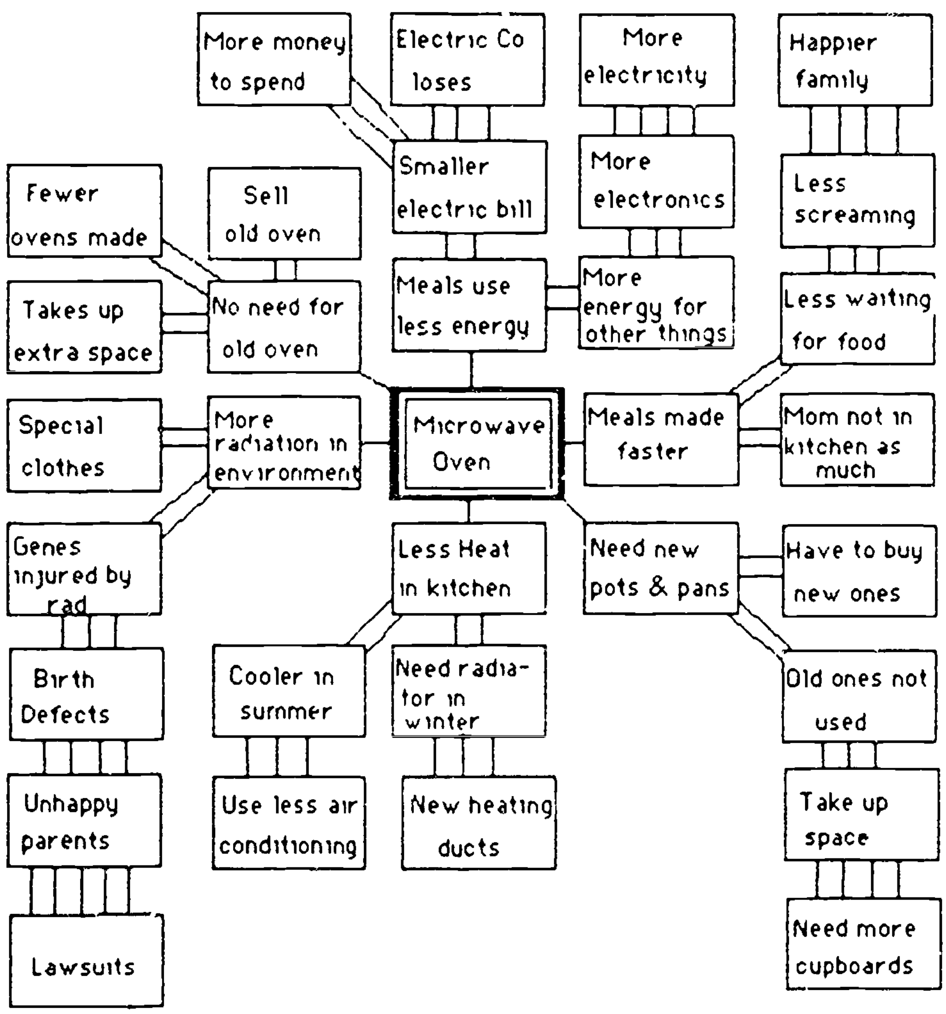
Relevance Tree Showing Alternative Means of Providing an Adequate Energy Supply by 1995

The relevance tree, like a futures wheel, diagrams some energy possibilities for the near-term future. Reprinted by permission of the MIT Press from Energy and Social Change, edited by James O'Toole, copyright 1976 by the Massachusetts Institute of Technology.

S59

Sample Future's Wheel:

Microwave Oven



Reference J A Barker "Futures study in Curriculum Planning," pp 56-61 in The Role of Future Studies in Public Education Misc Publ of the Science Museum of Minnesota, No 4 St Paul, MN, 55101

Energy Hide and Seek

SUBJECT Science **LEVEL** 6 - 12

ACTIVITY IN BRIEF

Students attempt to pick up and thread colored beads (energy resources) to determine the energy profit.

OBJECTIVE

Student will be able to identify the limitations and consequences of obtaining energy resources.

MATERIALS

A supply of colored plastic or ceramic beads of five different colors (preferable black, red, white, blue, yellow)
needles and thread

TIME

1 class period

LEARNING CYCLE

AWARENESS - Prior to class place the beads in the following proportions into a small container.

Black (coal)	50% (5.0 grams)
Red (Uranium)	3% (.20 grams)
White (Natural Gas)	10% (1.0 grams)
Blue (Oil)	37% (3.7 grams)
Yellow (solar)	a quantity exceeding coal

Match the size of all bead colors (except most yellow) to needles so that all beads can be threaded. Threading represents the fact that current technology is available to use the energy resource. Match the holes in the yellow beads to a large needle so that most yellow beads cannot be threaded. This represents the lack of technology to use solar energy. At the start of the search, heave the canister contents forcefully towards the ceiling so that the beads spread out over a wide area. Prepare a table on the board to collect the number of beads for each color in 3 trials. In order to make the search difficult, you may wish to hide the beads in an area outside with grass.

CONCEPT DEVELOPMENT - In most cases the number of beads collected in round three will be less than round two and perhaps one, even though more time was given. Discuss the diminishing amount of traditional energy resources and why prices will rise as a result of availability. The Law of Diminishing Returns fits in well. The companies invested twice the labor and perhaps the capital yet did not do better.

Net energy profit is what is left after one takes out what energy was required in gathering from the total. If the energy required to gather exceeds the amount gathered then there is no net energy profit.

Companies which divert capital to develop new resource technologies are foregoing current income or profit. Thus, perhaps the incentives must be great to forego current opportunities.

The moving of furniture, leaves, etc. represents changes in the environment. If students did not replace items moved, they did not restore the environment to its original condition.

Threaded yellow beads represent the use of available technology to use solar energy (passive solar collector). The fact that most yellow beads could not be threaded represents the fact that much technology is not now available.

APPLICATION - Have each student research the energy resource they were assigned. Is it found in your state? What resources will be most available in 50 years? In 100 years? How does price affect energy consumption?

SOURCE OF ACTIVITY

Written by Dr. George R. Davis
Energy Tradeoffs in the Marketplace, a project of the Washington State Council on Economic Education. Superintendent of Public Instruction, State of Washington. 1980 Edition

Energy Hide and Seek

Name________________

ACTIVITY:

The class will be divided into 5 companies whose job it is to recover as many beads of one color as possible in the time allowed.

A. Each company will receive a needle with 30 cm. of thread already attached. You will be assigned a color. Each company can collect only the bead color assigned.

B. You will pick up as many beads as possible in two minutes and thread them on the string.

C. At the end of the search, each company will record the number of beads threaded on the data table drawn on the chalkboard.

D. You will be allowed to search for an additional two minutes. Record the additional beads threaded.

E. Now you may search for four minutes. Record this last count. Sum all counts for each color bead.

Follow-up Questions.

1. Think of the beads as energy sources. Discuss which color bead represents which energy resource.

2. What was the problem with the company assigned to collect the yellow beads? What does this represent in the real world?

3. If any company had to move furniture, rugs, leaves, twigs, etc. did they put them back in their original location? What does this represent in the real world?

4. Did any company disregard the rules and collect an unassigned color?

5. Were some energy resources (beads) harder to find than other? Is this true today?

6. Which resources are used in our community?

7. Which resource is most available now? In the future?

Black Tuesday

SUBJECT Science **LEVEL** 9-12

ACTIVITY IN BRIEF

The Northeast blackout of 1965 is a dramatic example of how vulnerable we are to breakdowns in the technology network. Through a film and magazine article, students are given a basis to understand our dependency on energy. Finally, they evaluate an invention for benefits and problems.

OBJECTIVE

Student will be able to cite evidence for their dependency on energy and technology.

MATERIALS

Movie: "Trigger Effect", Episode 1 of Time/Life series called "Connections". Produced by BBC and written by James Burke. It is available at most AEA's.

TIME

2 - 3 class periods

LEARNING CYCLE

AWARENESS - The film serves as the awareness portion of this activity.

CONCEPT DEVELOPMENT - The discussion questions and interaction will help students to understand the relationship between energy and technology.

APPLICATION - The assignment will focus attention on one innovation. Students should work in small groups and report their findings to the class. See "A Simpler Life" from Project Learning Tree, p. 173.

SOURCE OF ACTIVITY

Adapted from teacher materials from the "Connections" series (Time-Life) by Peg Steffen.

BLACK TUESDAY

The northeastern U.S. is the Megalopolis - a vast intermeshing of cities, towns, and suburbs. It is urban America of the twentieth century brought to its fullest flower - and its fullest fragility. It is utterly dependent on turbine technology - a world that runs on electricity and on the faith that one has only to push a button, flick a switch or throw a lever to make electricity work. Electricity is its pulse, its power. And then one night the electricity stopped.

At 5:17 p.m. in Buffalo, 5:17 in Rochester, 5:18 in Boston, 5:28 in New York the clocks in the Megalopolis sputtered to a standstill. Lights blinked and dimmed and went out. Skyscrapers towered black against a cold November sky. Elevators hung immobile in their shafts. Subways ground dead in their tunnels. Streetcars froze in their tracks. Street lights and traffic signals went out - and with them the best-laid plans of the traffic engineers. Airports shut down. Mail stacked up in blacked-out post offices. Computers lost their memories. TV pictures darkened and died. Business stopped. Food started to sour in refrigerators. Telephones functioned but dial tones turned to shrill whines under a record overload. Nothing else seemed to work except transistor radios - and radios could only share the puzzlement and finally deliver the comforting news that the world had not come to an end, but that almost the entire Northeast had fallen victim to its very dependence on The System.

The System was the sprawling, interconnected grid of power networks that girdled the region - and when The System mysteriously broke down, the result was the most colossal power failure in history. It was a breakdown that wasn't supposed to have happened. Only a year before a Federal Power Commission report had pronounced that such grids were relatively invulnerable to even nuclear attacks. Like a string of Christmas tree lights, one power system after another blinked out in a wave of failures cascading down from the upper reaches of the grid. The big blackout engulfed 80,000 square miles across parts of eight U.S. states and Canada's Ontario province and left 30 million people in the dark.

New York's blackout was the longest - more than thirteen hours in some parts. It affected the most people; 600,000 trapped in stalled subways; nearly 100,000 stranded waiting for commuter trains that never ran; hundreds caged in elevators and thousands penned in skyscrapers. Incredibly, the blackout stopped short of catastrophe. There were no plane crashes, no train wrecks, no disastrous fires, no crime waves or looting sprees. And there was no panic. There were scores of auto accidents, most of them no more than minor bumps in the snail-paced traffic.

And crime rates in the region fell well below normal. Hospitals switched to emergency generators when they could, flashlights and candles when they could not. At St. Luke's in New York after a blackout delivery, an official confessed: "I can't tell you if it's a girl or a boy."

Transistors drew little knots of people everywhere; only radio mastered the communications collapse that blacked out TV and knocked out all morning papers except the Times.

The experience was sobering for the Megalopolitans - a rather unsettling lesson in how totally their lives are wired to electricity. The blackout stopped not only factories, but dentists' drills; not only subways, but Mixmasters; not only lights, but clocks and cash registers, x-rays and milking machines, water pumps and hair dryers, stock tickers and stereo sets and doorbells. Electricity had become to a stunning extent the main current of American civilization.

The prevailing view among utility men was that the blackout was a fluke that simply shouldn't have happened. And yet, regional failures had happened before - notably a five-state Midwest blackout that blanketed four times as much territory though it affected only a tenth as many people. Some thought it could happen again - that the day might come when a failure in an interwoven nationwide grid could black out the entire U.S. within moments. The problem was that the grid system is efficient and economical when it works, however disastrous results when it doesn't. "Power interconnections are a wonderful thing," said one utility man, "but the more we get, the more exposure we have to a major failure."

It was later determined that the power failure was caused by an improperly set shoebox-size protective relay at the Sir Adam Back No. 2 plant operated by the Hydroelectric Power Commission of Ontario on the Niagara River.

The experience brings up important questions about our dependency on technology and the electrical network. Have we allowed ourselves to become slaves to the System? Is there such a thing as too much technology? Are you prepared for such an event in your life? Is your life dependent on technology? If so, do you know how that technology works? Could you cope if the technology was no longer available to you on a short term basis? on a long term basis?

Black Tuesday

ACTIVITY

Name_______________

Students should either view the film "Trigger Effect" from the Connections series or read the essay "Black Tuesday".

DISCUSSION QUESTIONS

1. What was the cause of the Blackout of 1965?
2. Why did the blackout affect such a large area of the U.S. and Canada?
3. What were some of the problems that developed for the cities and their citizens as a result?
4. How might an individual prepare for the possibilities of a shutdown in our technological network?
5. Kuwait has made the leap from a very old style of life into modern technology in a matter of a few years. How might these rapid changes affect the people?
6. List 6 technologies that you depend on every day. Indicate what you would substitute if these were unavailable tomorrow.
7. Explain the importance of energy in our technological worl·.
8. What do you think would happen to our dependence on technology if energy in fossil fuel form were to disappear?

The assignment: Choose some technological innovation such as the television, car, telephone, etc. What are the benefits and problems associated with its use? List them in a form similar to the one shown.

Innovation________________________________

Benefits associated with its use.

1.
2.
3.
4.
5.
etc.

Problems associated with its use.
1.
2.
3.
4.
5.
etc.

Do the benefits of this innovation outweigh the problems? Explain.

A Smorgasboard of Energy Alternatives

SUBJECT Science LEVEL 9-12

ACTIVITY IN BRIEF

A variety of activities are suggested for the student in order to focus attention on alternate energy sources.

OBJECTIVE

Each student will be able to describe alternate energy sources.

MATERIALS

Resource materials

TIME

1 - 3 class periods

LEARNING CYCLE

AWARENESS - The students may not be familiar with some of the energy sources mentioned, so allow for some exploration time until they find an idea that fits their learning style and interests. Have them do this on an individual basis at the start.

CONCEPT DEVELOPMENT - You may wish to assign the students to groups or allow them to work in pairs, especially for such things as plays and skits. The list provided is by no means complete. Ask that the group or student turn in a description of what they are going to do at the end of the first day of exploration and brainstorming. Set a time limit during which all will be able to complete the project. Set aside one day to share results. All other work can be done outside of class or in class as time allows. Indicate to the students that you will grade this assignment on completeness and accurateness of information about alternative energy resources. Additional points can be given for originality, neatness, and time required for completion.

APPLICATION - Students have been exposed to many possible energy sources for the future. Have the students debate the pros and cons of the following statement: "It is the responsibility of the U.S. Government to make research and development of alternative energy sources a priority item of our national budget."

Divide the students into teams and set up a shortened debate format in which each team is allowed 2 minutes for opening remarks, and then a question and answer period is allowed and regulated strictly by the teacher. Be careful not to allow the more vocal students to monopolize the discussion. Set up rules as you see fit with the group you are working with.

FOLLOW-UP/BACKGROUND INFORMATION

Contact the Resource organizations listed at the front of the packet for information about energy alternatives. Have a student lab assistant write letters for you on official school stationery for best results. See also the resources listed in the activity "Energy 2000."

SOURCE OF ACTIVITY

Written by Peg Steffen.

A Smorgasboard of Energy Alternatives

Name____________________

FOR THE STUDENT

This is a smorgasboard of ideas to choose from. Your teacher will explain how many are due and when.

1. Find out about wind power generation and draw a scale picture or build a model of one that can be built and used at home or school.

2. Compare wind machines for cost and efficiency.

3. Plan a low net-energy farm operation and identify areas that can be improved by more efficient use of energy resources. How can alternative energy sources be put to work, such as wind or solar power?

4. Design a community-agricultural complex that utilizes waste heat from an electrical or industrial complex.

5. Build a series of solar heaters for standard size aquariums. Compare the efficiency of the designs.

6. Create a photo essay of energy alternates.

7. Make a poster of the different types of geothermal energy. Include the positive and negatives aspects.

8. Design a passive solar home for the Iowa climate.

9. Find out about recycling in your community and report about it in an article or by using photos.

10. Diagram the process of using Ocean Thermal Energy Conversion (OTEC).

11. Write a story from the perspective of river life that has been affected by a hydropower facility.

12. Build and test a simple solar panel.

13. Test different heat storage materials. Make sure you control all variables except one.

14. Calculate the cost of outfitting a home with enough solar cells to take care of electrical needs.

15. Produce a play about energy alternatives that are available. The cast of characters are the different kinds of energy sources.

The Conserver Society

SUBJECT Science | LEVEL 9-12

ACTIVITY IN BRIEF

Students are exposed to a life without electricity through a Peace Corps letter from Kenya. They are asked to consider alternate lifestyles and the idea of a conserver society.

OBJECTIVE

The student will be able to list the four elements of a conserver society.

MATERIALS

none

TIME

1 - 2 class periods

LEARNING CYCLE

AWARENESS - Students will have a chance to discuss a lifestyle in which no electricity is available. Some of the students may have been in situations without electricity for a short term such as camping or summer camps. Ask them to contribute ideas that were used to cope without electricity. Students may be familiar with pioneer life as another example. Electricity has not been on the human scene for very long. Many advanced civilizations functioned without electricity. What other energy sources did they use?

This is a good time to reinforce the idea of renewable and non-renewable resources. In the reading renewables include firewood, charcoal, and sun and the non-renewables include candles (made from petroleum), kerosene and batteries.

CONCEPT DEVELOPMENT - After the students have had a chance to develop their picture or diagram, have them explain it to either a small group or to the class. You might share the picture that follows at the conclusion of your sharing session. It is a Self-Reliant Homestead adapted from Mother Earth News. They may find aspects useful when considering a plan in Part 3.

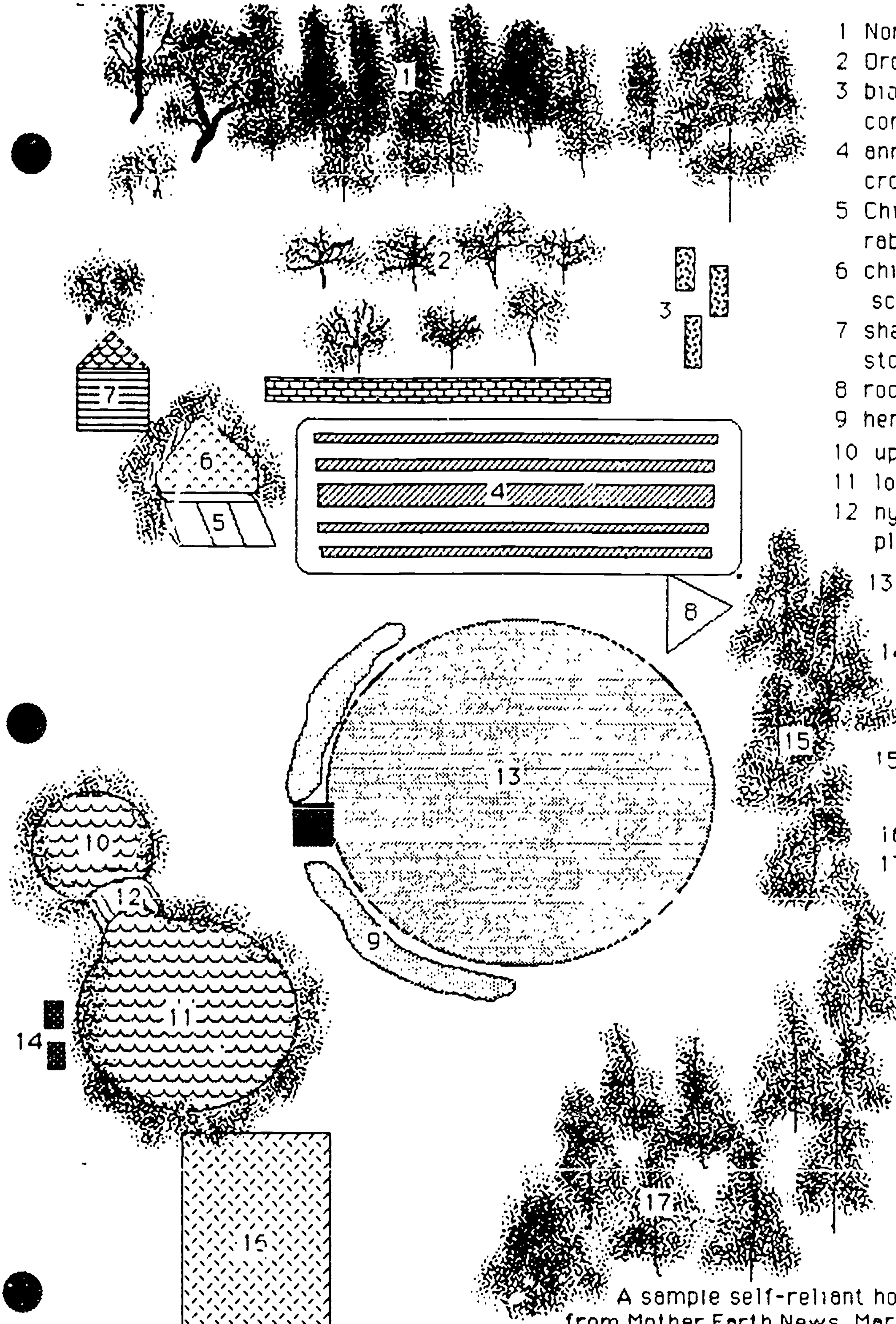
APPLICATION - The hardest part of any new idea is to sell it to someone else. While conservation is not a new idea, it is frequently overlooked because it is inconvenient, or requires more time. Have the students limit their plans to 5 or 6 ideas that can be explained. After they have made a plan, have them list consequences to the ideas. (What would be the effects on individuals and society if these plans really were put into effect in the near future?) List 2 consequences for each item on the plan.

FOLLOW-UP/BACKGROUND INFORMATION

Energy and Society from the Ontario Ministry of Education, p. 18 for information about the conserver society.
"MOM's Self-Reliant Homestead," March/April 1985, The Mother Earth News.
"A Look at Lifestyles," p. 184 Project Learning Tree.

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. and Energy and Society by Peg Steffen



1 North sun trap
2 Orchard
3 biodynamic composting area
4 annual food crops
5 Chicken coop rabbit house
6 chicken scratching yard
7 shed with grain storage aloft
8 root cellar
9 herbs, greens
10 upper pond
11 lower pond
12 hydroelectric plant
13 passive solar house
14 beehives
15 east wind break
16 parking
17 south sun trap

A sample self-reliant home adapted from Mother Earth News March/April 1985

The Conserver Society

Name____________

Part 1.

The following is a letter from a Peace Corps worker in Kenya, East Africa to a friend in Iowa. She is working at a school in a mountainous rural village. Daytime temperatures do not change much throughout the year, but nights can become chilly.

Dear Mary,

I'll try to describe some of the energy uses here. Of course, there is no electricity. Everyone lives in small mud and thatched huts. The only permanent buildings around are the school and my house. Firewood is commonly used if the dead wood can be found. They cook in their huts on the floor or in small round metal containers call chiko. December is charcoal-making month. A large burlap bag of charcoal is sold for about $2.80 in U.S. dollars. This is what is used in the chiko cookers. They use kerosene to light them. It is also used in their lanterns. Candles are used for light, but not often because they are expensive here. After awhile, all this becomes a way of life. Life is very simple without electricity. People usually go to bed early too.

Kenyans depend on the sun for so much—time, drying clothes, and crops. Of course there is no running water either. I'm the only one within several miles who has a rain tank. It leaks and so I am dependent on the river for my daily water needs. Most people bathe in the river or out of a bucket.

Flashlights are a part of every household. Batteries are very expensive and I have gone through so many. Everyone does laundry by hand then lays it on the grass to dry. I've learned to fold mine so they don't have too many wrinkles. There are charcoal irons though.

Of course, with no electricity there is no refrigeration. Many foods simply don't need it. My eggs last about three weeks and up on my hill, my fresh butter will stay hard for two weeks. There is milk in cartons I buy called UHT—it's ultraheated. Also margarine comes in a can and dried milk is popular. Cold sodas are unheard of as is beer.

As Always,
Jensy

Discussion questions:

1. What renewable and non-renewable sources of energy are mentioned in the letter?

2. What do you think Jensy liked best about her low-energy situation?

3. How has a lack of electricity changed her living habits?

4. What aspect of Jensy's life would present the greatest challenge to you if you were in her place?

Part 2.

Assume you want to live in an uncomplicated and less energy-expensive lifestyle. Draw a picture or describe how you would live. Consider such things as where you would live, how you would support yourself, what type of house you would buy or build, and how you would use less energy than you do now.

Part 3.

The concept of a "conserver society" was put forward by the Science Council of Canada and is a term we hope to see more of in the future. What does this concept mean? We have looked at a society that uses no electricity, but few of us are willing to make the sacrifice to live without electricity and some comforts in our daily life. The elements of a conserver society are listed below. Look at them and see if the lifestyle you envisioned in Part 2 fits into the pattern of a conserver society.

A. Promotes economy of design, that is doing with less.

B. Favors re-use or recycling.

C. Questions the ever-growing demand for consumer goods.

D. Recognizes that diversity in many systems such as energy and transportation, might increase their economy and stability. (in other words, don't put all of your eggs in one basket.)

What would you have to change in order to fit the scenario you designed to a conserver pattern?

As a class or in a small group, develop a plan to steer the American lifestyle toward a conserver society. Try to use a "carrot" approach rather than a "stick" approach in offering incentives for change. Can you think of some future political or economic incidents that might push us to the conserver society more quickly?

Energy 2000

SUBJECT Science LEVEL 6-8

ACTIVITY IN BRIEF

Students are provided with information about many forms of energy alternatives. They will evaluate 5 of the sources and write a story or design a city which uses alternate energy forms in the year 2000.

OBJECTIVE

The student will contrast alternate energy sources and will evaluate them using the criteria of pollution, technology, quantity, and other considerations.

MATERIALS	TIME
resource materials, large drawing paper red and blue pencils or pens	1 - 3 class periods

LEARNING CYCLE

AWARENESS - Students may not have been introduced to some of these energy resources, so you may want to provide more explanation or additional information. You might also provide time in or outside of class to research the five energy sources they are focusing on.

CONCEPT DEVELOPMENT - The evaluation of energy sources will enable the students to make decisions based on data and information. They should be careful about biased statements and opinions if they are required to collect additional information. Encourage the students to consider other energy sources if they find them in the literature. The list provided does not include new technologies that may be emerging.

APPLICATION - Question three is designed to have the students use the information they have gathered to envision energy sources for the future. The assignment may be done outside of class, but provide adequate time for creativeness. One week is not too long. Encourage students, who prefer, to work with their hands to build a model of the future city. Set aside some class time for sharing the stories, drawings, and models. After the sharing session, have students write a short paragraph about actions that need to be taken in order for their future city to be reality. Is it feasible by the year 2000? You might wish to have students read science fiction stories and determine what energy sources are used.

FOLLOW-UP/BACKGROUND INFORMATION

Contact the Resource Organizations listed at the front of this packet for free or inexpensive information about many of the energy sources. Also see "Design With Nature," p. 183 from Project Learning Tree. Encourage students to use Reader's Guide for current articles.

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen

Energy 2000

Name____________________

FOR THE STUDENT

You have been introduced to a variety of energy resources such as coal, oil, solar, and hydropower. Below you will find a short description of possible sources of energy, their positive points and shortcomings. Some are traditional and others are still in development stages. Read these carefully as you will need this information later.

SOURCE	QUANTITY	CONSIDERATIONS
GEOTHERMAL		
a) hot water	Limited sites near earthquake faults or Volcanic activity	In wide use in New Zealand, Iceland, Japan. May cause local fog or put toxic elements and excess heat into environment.
b) dry steam	Limited sites	Low production costs, Used in Italy and California. Noise of steam is ear splitting.
c) hot, dry rock	Potential is great, but actual number of sites may be small.	Hot rock 1-6 miles underground is estimated to match the energy of Alaskan North Slope. Minimum pollution.
HYDROGEN	Produced by electrolysis (Splitting water molecules)	Developing slowly. Requires sizeable power input. May not be efficient unless produced with solar or hydropower. Burns clean.
HYDROPOWER	Provides 15% of electrical power	23% of world electrical capacity depends on falling water. Inexpensive and relatively clean, but produces ecological disturbances when dams are built across rivers.
TIDAL POWER	Enough for 40-50% of needs if captured but efficient sites are scarce.	Primitive, inefficient machinery. A plant in France runs cheaper than fossil fuels or nuclear. Little environmental impact. Peak power demand and peak power output seldom match.

WAVES	Unknown	Many experimental devices. Varies with the wind. Hostile ocean environment hamper development. Limited sites.
OCEAN THERMAL ENERGY CONVERSION (OTEC)	Gulf stream could supply 100 times the current U.S. demand.	Could be commercially available before year 2000. Operates on difference in water temperature. Little environmental impact. Artificial upwelling may benefit fishing industry. May be cost-competitive with nuclear. Florida waters have potential.
NATURAL GAS	Limited and non-renewable.	Well developed technology. Clean burning. Efficient transport system.
NUCLEAR		
a) Standard Light water reactor (LWR)	The uranium fuel is in limited supply, may last less than 30 years. (Uses U^{235})	Requires highly skilled staff, produces waste heat that might be used for heating buildings. Fuel may be in short supply. Storage of wastes is a problem and controversial.
b) Breeder (liquid sodium cooled)	Uranium supply is unknown. (Uses U^{238})	Technology is present, but the plant produces plutonium which is used in nuclear weapons. Poses security risk. More efficient than LWR.
c) Fusion	Abundant fuel material in ocean water	Complex technology not yet developed for commercial use. Efficiency and safety unknown.
OIL	Limited, and production will become expensive in the future.	Developed but poses pollution problems with oil spills, burning causes air pollution. U.S. must import about 50% of needs. Used in many non-fuel uses such as plastics, rubber, and fibers.

SOLAR		
a) space heating and cooling	Abundant but scattered energy	Cheap to operate but equipment is expensive. Little pollution. Easy to design into new homes. Storage necessary in colder climates.
b) solar cells	Abundant	Technology is expensive and storage is needed. Provides electrical power directly from sun's rays so they only work when the sun shines.
c) Solar thermal	Must be concentrated by reflectors.	Still developing. Used in France to a small degree. Solar satellites may prove to be more efficient.
WASTES		
a) biomass	Limited but renewable	Uses digesters to convert crop surpluses or wastes into methane gas which can be used in cooking, lighting, heating, and small engines. Also includes the production of alcohol.
b) refuse burning	Could provide 1-2% of energy demand in 5 years.	Developed but not widely applied. Collection and separation can be expensive. Reduces the number of landfills needed.
WIND	Production estimate is 1 to 15% of consumption.	Advanced but not widely used. Simpler than solar-electric. Visual pollution? High-wind areas are not near high population areas. Transmission of electricity may be a problem.
WOOD	High potential because it is renewable	Could replace 21% of fossil fuels in U.S. and 50% of industrial fuel needs. Major source of global carbon monoxide pollution. Half of the earth's forests have disappeared since 1950.

ENERGY 2000:

You now have a starting point in understanding what energy sources are available now and some that might be useful in the future. Pick at least five sources and fill out the following chart to compare the negative and positive aspects. If possible, collect some additional information about the energy sources so that you have more data.

Energy Source	Environmental Pollution					Technology	Quantity	Other
	Air	Water	Noise	Thermal	Land			

Label the negative aspects with a red check and the positive aspects with a blue check. Compare the number of red and blue checks.

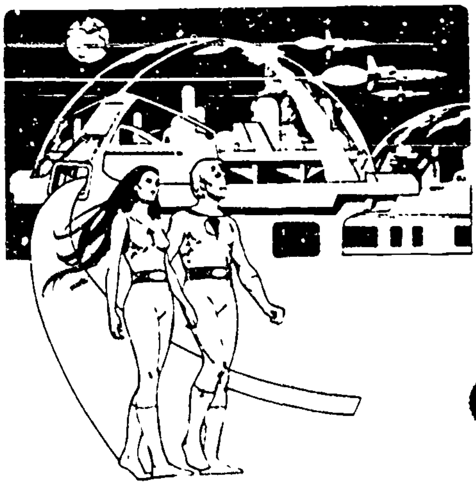
1. Which of the five sources looks most promising to you? Why?

2. Since it is unlikely that we will depend on only one energy source in the future, what combination of ideas do you favor and why?

3. You may a) write a science fiction story in which you set up a city in the year 2000 using any energy sources above, or b) design and draw a city showing how the above energy sources are used to provide heat, cooling, electricity, and transportation. Assume you are in Iowa for both.

Some excellent articles you might wish to use are found in Social Issues Resources Series, (SIRS) on Energy. Individual Articles in 1984 include:

1. "Fundy's Thundering Tide: Can We Harness Its Power?" International Wildlife, Nov./Dec. 1984, pp. 34+
2. "The Realities of a Fusion Future," Science Digest, Nov. 1984 pp. 71+
3. "Nuclear Undertakers," Science 84, Sept. 1984, pp. 50-59
4. "Solar Power," Progressive, Sept. 1984, pp. 32-35



5. "The Demise of Nuclear Power: What Comes Next?", Challenge, July/Aug. 1984, pp. 38-45

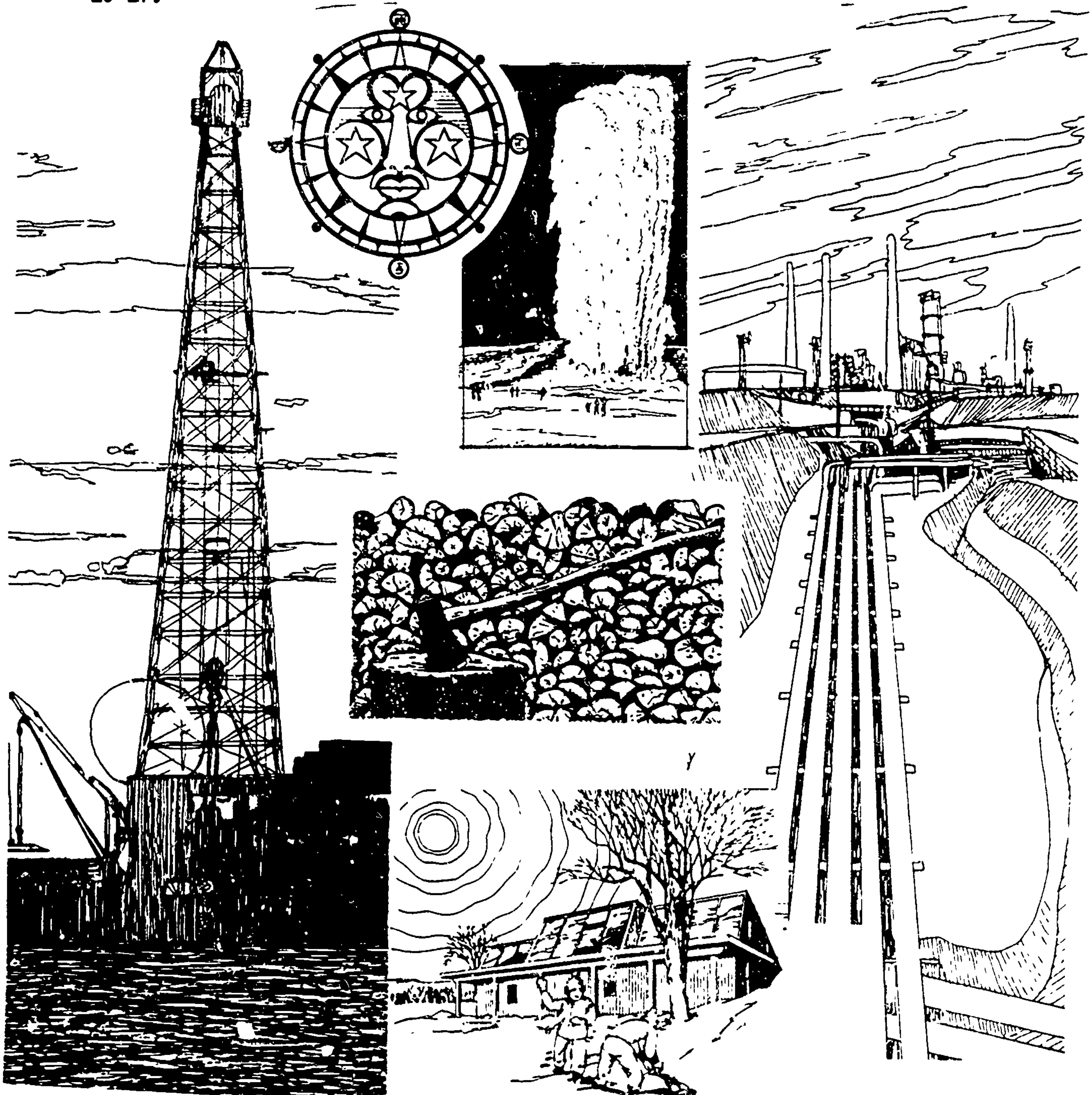
6. "Learning to Live with Plutonium," Science Digest, July 1984, pp. 49+

7. "America's Energy Dilemma," American Legion, July 1984, pp. 18+

8. "The Solar Travelers," Environmental Action, June 1984, pp. 23-26

9. "Damming the World," Not Man Apart, Oct. 1983

10. Energy's Uncertain Future," Christian Science Monitor, March 2, 1984, pp. 16-17.



The Energy Debate

SUBJECT Science LEVEL 9-12

ACTIVITY IN BRIEF

Opinions and biases abound for energy issues. Students are asked to respond to quotations in the "energy debate". Finally, the students choose an issue about which to have their own debate.

OBJECTIVE

Each student will be able to list different opinions about energy resources and their uses.

MATERIALS

Resource materials that are helpful to students preparing statements and position papers.

TIME

1 - 3 class periods

LEARNING CYCLE

AWARENESS - Have students read the quotations and fill out a chart similar to the one below.

Name of Author	Energy Source(s) referred to if any	Point of view	Agree or Disagree

Review with the students the completed chart.
Have the students indicate whether they agree or disagree with the person's point of view. Simply marking with an "A" for agree or "D" for disagree is enough at this point in time.

CONCEPT DEVELOPMENT - Activity suggestions:

1. Choose a favorite quotation and write a paragraph explaining its key idea or a paragraph stating reasons for your choice of this particular statement.
2. Develop a short essay or speech including one of the quotations in it.
3. Write a brief rebuttal statement to several of the quotations provided.
4. Draw a pictoral representation of one of the quotations.
5. Develop a cartoon or poster about one of the statements.

APPLICATION - Set up a shortened form of a debate for the class in which one of several quotations is the focus. Allow students to research their position out of class, prepare statements of one minute per student, and allow for controlled discussion in which all students are allowed to speak for a limited amount of time. Be careful not to let a handful of outspoken students monopolize the debate, although some will be well suited to this type of learning activity. Have each student summarize the arguments given on paper to turn in for credit and to indicate where they agree and where they disagree.

SOURCE OF ACTIVITY

Adapted from I.D.E.A.S. by Peg Steffen

The Energy Debate

Name_______________

Seldom have people li.ing in a democratic society had so much conflicting information and so many opinions showered on them as have been spawned by the great energy debates. Some facts seem certain. Energy availability affects everyone. Data is missing or is interpreted differently by various interested groups. Opinion and priorities differ widely even among "experts". Examples of fact, opinion, prediction, and persuasions are included in the following selected quotations. Your teacher will explain to you the activity expectations.

The United States puts 45% of its total energy into vehicles. To make them, run them, and clear a right of way for them when they roll, when they fly, and when they park. Most of this energy is to move people who have been strapped into place.
For the sole purpose of transporting people, 215 million Americans allocate more fuel than is used by 1300 million Chinese and Indians for all purposes. Almost all of this fuel is burnt in a rain dance of time-consuming acceleration.

Ivan Illich

China's several hundred million (people) use less electricity for all purposes than the United States uses for air-conditioning alone, and the U.S. is two hundred fifty times more demanding of energy for its wet-rice culture than in China.

David F-ower

Material thrift has become almost impossible; the system conspires against it. As a society, we assign the highest value to our le sure and therefore a lower value to all things that might demand our time and attention. Disposable, self-cleaning, self-defrosting, easy-to-use, ready-to-wear, ready-to-eat, all-purpose—these are the adjectives that get our consumerist juices churning. No matter that the time most of us save we then fritter away in front of the garrulous TV.

Caril Tucker

As a social creature man will not accept any warnings that interfere with daily business.

Donald Carr

We should build the south side (of the house) loftier, to get the winter sun, and the north side lower to keep out the cold winds.

Xenophon

Our most optimistic estimates indicate that solar electric generating capacity might represent about 1% of the total installed capacity by the year 2000. Despite accelerated research and development efforts in alternative energy form, sources other than fossil and nuclear fuels, will be supplying only about 10% of electric generation by the year 2000—and more than half will be hydroelectric.

H.V. Young

Real wealth is knowing what to do with energy.

R. Buckminster Fuller

The time has come to inquire seriously what will happen when our forests are gone, when the coal, oil, and the gas are exhausted.

Theodore Roosevelt

A man who cannot fill his bathtub because the water keeps running out does not need a bigger water heater, he needs a plug.

Malcolm McEwen

We envision a new society, less despoiling, more conserving of the biosphere and the planet's resources. It would be one in which biological systems, driven by renewable energy sources like the wind and the sun, would provide the food and other vital imputs for human communities.

John Todd

There are some smart people who think that nuclear power will make a comeback. They point out that the U.S. cannot go on running up ever-higher oil import bills. They argue that a widespread return to coal, as might seem logical, would involve a cost in environmental hazards and labor problems that the country cannot pay. When these facts are recognized, the argument goes, the country will look at Chicago—where Commonwealth Edison efficiently, cleanly, and economically gets 45% of its power from nuclear plants—and say: "Nuclear is the best bet".

Jean Bridges

It is pointless to talk of tightening the safety systems or the licensing procedures; they are already so tight that it has been almost impossible to get approval for building nuclear plants in the U.S. However carefully it is designed, a piece of mechanical engineering can and will fail; however "foolproof' the safety system, it cannot be made proof, as the nuclear industry itself says, against bloody fools. The question is not whether accidents can be prevented; they cannot. It is whether the public is prepared to live with accidents like Three Mile Island. It is perfectly prepared to live with air crashes, in which hundreds die, in exchange for mobility.

Nigel Hawkes

Another effective energy-conserving measure is recycling. Every household throws out an average of 250 glass bottles a year (a pint of oil is needed to make one bottle) and 350 pounds of paper (three pounds represent a quart of oil). Much waste can be salvaged or recycled. The Scandinavians have receptables in each building for this purpose.

Michel Bosquet

The Big Pay-Back

SUBJECT Science **LEVEL** 9 - 12

ACTIVITY

Students will research solar collector designs and construct a working model to be tested for efficiency and pay-back time.

OBJECTIVE

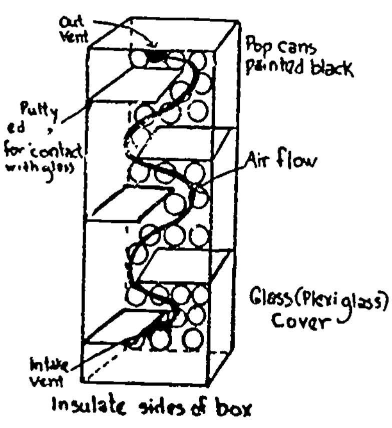
The student will be able to identify the elements of solar collector design and use.

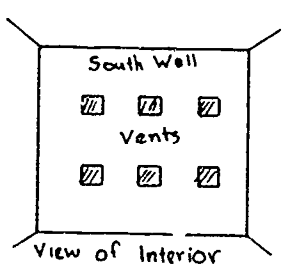
MATERIALS	**TIME**
to be determined by student design (You might ask for school help on costs if the units will be used later by the school.)	1 - 3 weeks

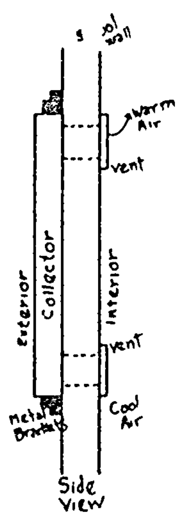
LEARNING CYCLE

AWARENESS - This project can be as large or small as you wish. Students may work individually or in groups. Your time frame will dictate how large to make the collectors. Units designed to heat entire rooms will require more time, money and effort than demonstration units. You may give them limits on collector size. Research might be assigned out of class. If you wish to provide materials, the Iowa State Extension Service and Iowa Energy Policy Council are good sources of free material. There are also many fine books available through the library system. Allow for students to test materials or design elements on a small scale to incorporate later.

CONCEPT DEVELOPMENT - Students should be allowed to design with a minimum of teacher interference. The design and testing procedure is excellent in developing thinking skills. (They will also learn from mistakes.) Students may find one or more flaws in the unit during the testing. Allow them to make corrections and retest. In order to save class time, you might assign the research and construction outside of class and set aside several testing days at school to compare units and performance. A sample solar collector is pictured below.







APPLICATION - Assign students to continue monitoring the units over an extended time period. Have them investigate other uses of solar energy such as industry, farming, greenhouses, and water heating. Careers that should be mentioned include architecture, building trades, engineering, chemistry, and physics.

FOLLOW-UP/BACKGROUND INFORMATION

Many excellent solar experiments can be found from the Department of Energy's Science Experiments in Energy, Solar Energy Packet. Also see the New York Solar Energy Packet from Solar Energy Project, SUNY at Albany, 1400 Washington Avenue, P.O. Box 22100, Albany, NY, 12222.

SOURCE OF ACTIVITY

By John Stiles and Peg Steffen

The Big Pay-Back

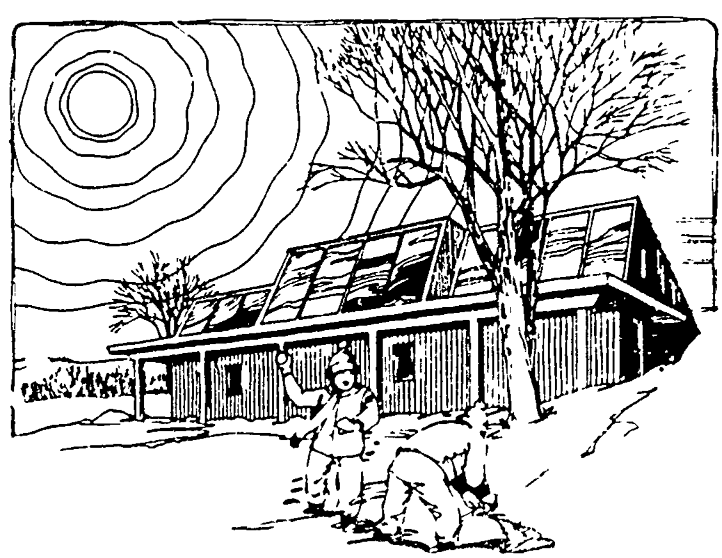
Name ______________

FOR THE STUDENT:

You will design and test a solar collector to be used in your school or home. You should plan to use air as the heat transfer mechanism and the unit should have few or no moving parts.

1. Research design elements of solar collectors and list those aspects you might plan to incorporate into your unit. Visit homes or businesses with solar systems at work.
2. Research materials commonly used in solar collectors. List those items that are inexpensive and available locally. Find out the cost of each item. Perform any preliminary tests to determine the best materials for your locality and weather situations.
3. Complete your design and cost estimates and clear the unit design with your teacher before beginning construction.
4. During the construction, keep track of actual expenses incurred. This will be used in your analysis of pay-back time.
5. Perform the following analyses on your unit.

   a. Maximum temperature achieved by the unit.
   b. Best working angle.
   c. Best building site for installation
   d. Estimated length of time for heat collection during winter months.
   e. Size of room which the unit can comfortably heat.
   f. Cost of installation to heat entire home.
   g. Pay-back time (energy savings minus material and energy cost)



World Energy Simulation

SUBJECT Science **LEVEL** 9-12

OBJECTIVE

Each student will be able to compare population and energy use between developed and undeveloped countries.

MATERIALS

6 clear plastic or glass containers
80 M & Ms per class

TIME

20 minutes

LEARNING CYCLE

AWARENESS - Before class, set up the "world energy supply" in clear plastic or glass cups (beakers will do also). Each cup should be labeled with one continent, the percentage of the world's population, and the percentage of its world energy use. (NOTE: The world consumes eighty quads of energy annually.)

	Population	Energy Use
Africa	10.5%	8%
North America	8 %	39%
Asia	61 %	18%
Australia-New Zealand	.5%	3%
South America	6 %	8%
Europe	14 %	24%

M & Ms or other small candy should be placed in clear glasses. Each piece represents 1 quad (quadrillion btu's)

Africa = 6
North America = 32
Asia = 14
Australia = 3
South America = 6
Europe = 19

Divide the class into groups to represent the continents above.
For example, if you have a class of 25, 14 students will be Asia
3 will be Africa
2 will be North America
1 will be Australia
2 will be South America
4 will be Europe
remainder in Asia

1. Direct each "continent" to areas around the room.
2. Give each group the cup that contains their energy allocation.
3. Ask a spokesperson from each group to read the information on each cup. As they do, ask them if there are enough M & Ms for the population. Allow for comments at this time.
4. After all groups have read the cups, ask the whole class how they feel about the energy wealth of North America.
5. Give the class 5 minutes to negotiate with each other about energy resources. Is North America willing to redistribute?
6. At the end of the time limit, ask students what methods were used in their negotiation. What was the result?
7. Allow the students to eat the energy resources.

CONCEPT DEVELOPMENT - Discussion questions:

1. How is this exercise similar to the present world situation?
2. The U.S. must import much of the energy it uses. What are the resulting problems for us in terms of economic and political well-being?
3. What might happen to change this world energy picture?
4. If an energy shortage develops, who will be the first to feel the effects and why?

APPLICATION - Students might be assigned to report or debate on one of the following topics:

Oil Embargo of 1973
U.S. dependency on oil
Oil production of the Middle East
Oil production in the U.S.
Energy reserves of the world and the U.S.
Expected time of energy resource depletion
Effects of energy dependency on coal
Energy alternatives
Lifestyles of continents who use less energy per population.

Another application is a debate and group decision about the formation of an energy plan to move the U.S. away from dependency on imported energy resources.

FOLLOW-UP/BACKGROUND INFORMATION

See Activity "Hidden Helpers" in this packet.

SOURCE OF ACTIVITY

Adapted from an activity originally from Duane Toomsen by Peg Steffen.

ENERGY CONVERTERS AND POWER

SUBJECT Science, Mathematics **LEVEL** 9-12

ACTIVITY IN BRIEF

Students will discuss and observe their ideas of power by performing simple exercises and then expand this knowledge of power to different energy converting machines.

OBJECTIVE

1. Define power.
2. List 5 energy converters and order them as to how much power output they supply.
3. Graph typical power outputs in order.
4. Compare energy converting machines.
5. Express a number as a power of ten.
6. Describe changes in the power of machines, if any, which have occurred.

MATERIALS

Universal Weight Machine or something to act as a weight to lift such as a large book or block stopwatch or timing device with second hand , various graphing materials: graph paper, compass, ruler

TIME

2 class periods

LEARNING CYCLE

AWARENESS- After performing the activity on the other side of this page, the teacher should ask if students think there are differences between individual's physical power. The students can then calculate a simple example of power using their data and the following formula:

$$\text{power} \quad \frac{\text{pounds * distance moved * \# of repetitions}}{\text{time (seconds)}}$$

133 w = 100lbs * 2ft
.13 kw * 20 reps div.by
30 secs.

CONCEPT DEVELOPMENT - Students should then, as a class, make a list of energy converting "machines" they feel would be powerful. See "For the Teacher" In the end, the teacher may supply the given list found in this section.

APPLICATION - The teacher should supply the students with the "Energy Calendar" and instruct the students to find out how the historical progression in energy use correlates with the escalation in power outputs. When did waterwheels come into use, for example - before or after windmills? Which turbine is the newest attempt to date and put in chronological order all of the basic converters listed on the chart.

FOLLOW-UP/BACKGROUND INFORMATION

Follow-Up - Many different activities can be set up with the data given in the tables. Two that might be worthwhile are as follows:

1. Using a compass and protractor, make a circular pictograph of the representative fractions of "energy output." Each named component would represent a segment of the total energy outputs mentioned in the original data chart. Based on the sum of 17,192,315.8 kw or 17.2 * 10^6.kw in a 360° circle, each degree would be represented by 360 divided by 17.2 million kw = 20.9°. The result is the graph included in "For the Teacher."
2. In mathematics you could have all the students convert the power ratings into powers of ten as indicated in the chart under "For the Teacher."
3. Each "power of ten" is often called "one order of magnitude" in scientific literature. How many orders of magnitude are there from man"s power output to the rocket blast?
4. Make a histogram, pictograph, or other scalar method of the comparisons listed on the Energy Converter table.
5. Use an adding machine tape to block out proportional areas related to power. One full tape may be used for cooperative effort or give each student a piece of adding machine paper about 4 yds. or 4m long or make your own long sheets of paper by taping pieces together or use discarded runs of computer paper.
6. Make a historical power grid, using the same orders of magnitude on the vertical scale, but putting historical time (perhaps also expressed in powers of 10 as "years ago"?) on the horizontal scale.

SOURCE OF ACTIVITY

Energy Packet and Nancy Toll

ENERGY CONVERTERS AND POWER

Name________________

ACTIVITY

The teacher should ask the students who they think is the most "powerful" person in class and discuss what power means to them. Then, have the students go to the weight room and have volunteers see how many bench presses they can do, on the Universal Weight Machine, in a given amount of time - say 30 seconds. (Be sure to use students who have worked with the Universal before and who won't stress their muscles too much. Avoid using large weights. This activity could also be done in the classroom using a known weight such as a large book or brick.) Students should record the number of lifts, the amount of weight lifted, and the time for each volunteer.

Power Cutput of Selected Energy-Converters

Basic Converter	Typical Power Output (in Kilowatts)
Man	.1
Ox	.2
Horse	.5
Windmill	15
Waterwheel	300
Steam Engine	2000
Internal combustion engine	10,000
Gas turbine	80,000
Water turbine	100,000
Steam turbine	1,000,000
Liquid fuel rocket	16,000,000

*The watt is a unit of energy per unit of time.

S102 Birthday of planet Earth was 4.5 billion years ago.

Oldest known rocks are 3.3 billion years old.
First plants (algae) appeared 3.2 billion years ago.

First known animals (jellyfish) died 1.2 billion years ago.
Fossils first became abundant 600 million years ago.

Age of fishes began 400 million years ago.
Fern-like plants grew densely, became basis of COAL, 300 million years ago.

First dinosaurs thrived 225 million years ago.
First mammals appeared 200 million years ago.

Decline of dinosaurs occurred about 135 million years ago. Along with fossil plants, some became fossil soup (PETROLEUM).
First primates trapped in a fossil record lived 70 million years ago.

Man-like creatures appeared about 3 million years ago.
Ice Ages began 1.7 million (1,700,000 years ago.

Man began to use fire, 500,000 B.C.
Last glaciers retreated, 8000 B.C.

Man learned to smelt metal and make bronze, 3000 B.C.
Iron technology was begun, 1000 B.C.

Water wheels were used in Greece, 300 B.C.
Book by Vitruvius describes watermills, steam jets, and other machines, 27 B.C.

Mt. Vesuvius destroys Pompeii, 79 A.D.
Waterwheels come to Europe, 500 A.D.

First windmills were used 650 A.D.
Coal was burned in an English monastery, 852 A.D.

Whale oil came into use for lighting, 900 A.D.
Coal was regularly used for home heating in Newcastle, England, 1300 A.D.

Windmills started to drain the Netherlands, 1500 A.D.
Modern steam engine was conceived by Watt, 1765.

First oil well was drilled in Pennsylvania, 1857.
Otto designed the 4-stroke internal combustion engine, 1876.

First incandescent lighting was provided to a small area of New York City, 1882
Becquerel discovered radioactivity, 1896.

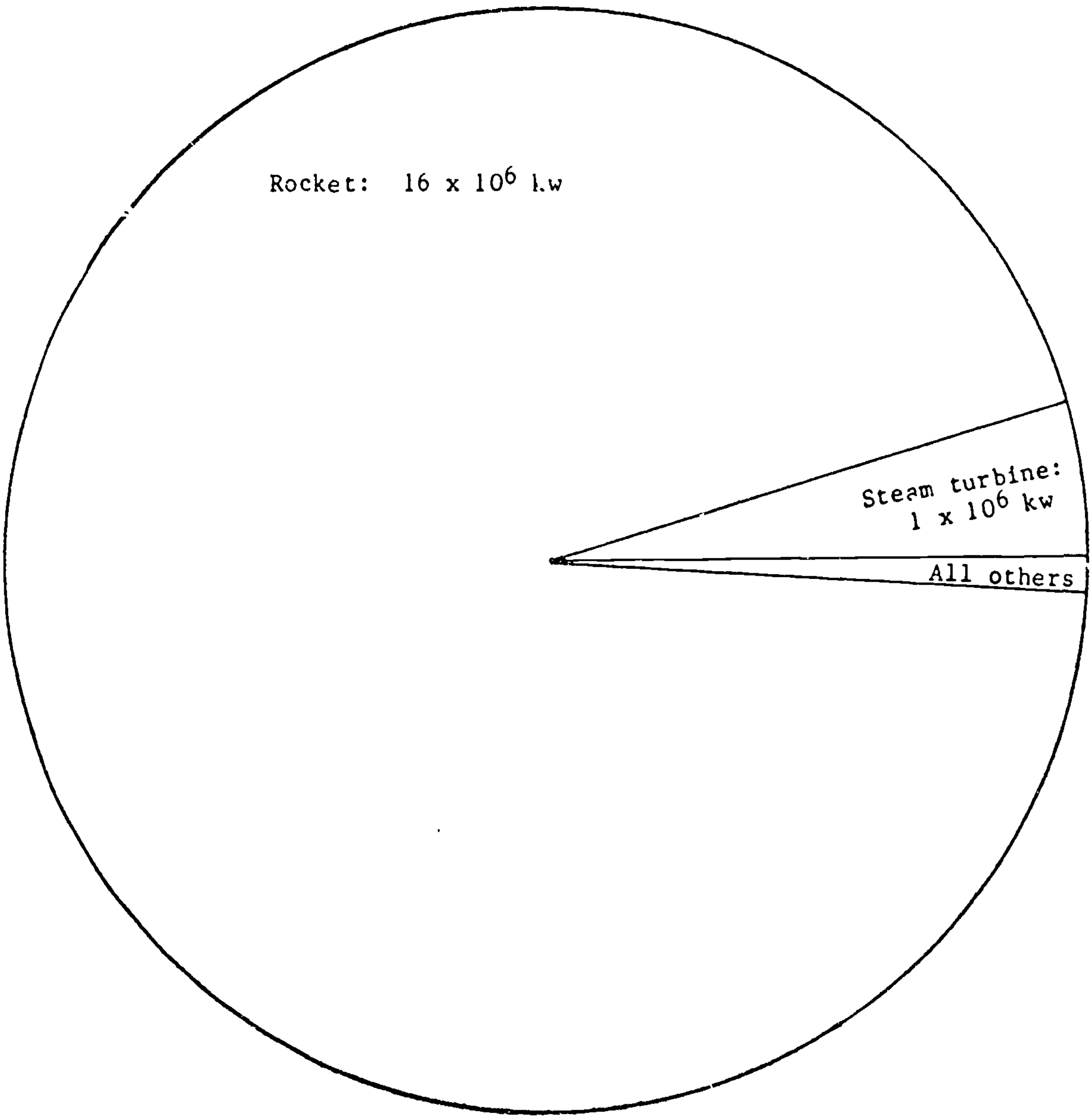
Wright brothers flew the first successful airplane, 1903.
First jet plane flew, 1942.

First nuclear explosions were detonated in 1945.
First nuclear electric power plant in the U.S. was completed, 1958.

Man first walked on the moon in 1969.
"Energy Crisis" of limited supplies and higher fuel prices became a public concern in the winter of 1973-74.

ONE-SECOND TIME MACHINE

(model of energy output in kilowatts)



Non-exact model for possible graphic presentation of Table on "Power Output of Selected Energy Converters"

Poisons From the Skies

SUBJECT Science **LEVEL** Grades 9-12

ACTIVITY IN BRIEF

The student will investigate the effects of acid water on Daphnia before debating possible solutions to the problem of acid rain.

OBJECTIVE

The student will be able to 1) identify causes and effects of acid rain, and 2) list alternate solutions.

MATERIALS

4 glass containers of equal size per group, narrow range pH paper, approximately 3-6 pH
10 % solution H_2SO_4, sulfuric acid, shallow glass dishes such as petri dishes spring or boiled pond water, masking tape, grease or wax pencil, eye droppers, hand lens, Daphnia from a biological supply company.

TIME

1 - 3 class periods for experimentation
1 period for application

LEARNING CYCLE

AWARENESS - The students will test different concentrations of acid on microscopic organisms such as Daphnia. In order to cut down on equipment needs, you may wish to set up small groups of 2-4 students. Daphnia are large and easy to see for counting purposes, but you may use another fresh water organism. You may require that the students design their own experiment using the acid concentrations as the experimental variable and the mortality of the daphnia as the dependent variable (the variable that changes as a result of the experimental variable.) A plan has been provided if you feel the students need more direction. Have the students provide their own container. Baby food jars, small beakers, pickle jars or even culture dishes will be sufficient. Have the students make daily observations after the pH has been adjusted and a measured amount of daphnia put in. As an alternative to having students prepare their own acid mixtures, you may want to prepare these yourself to known levels in order to save class time. They should make a sample count of surviving organisms each day. Have students graph days versus number of organisms for each pH level.

CONCEPT DEVELOPMENT - Have each group share the results with the class. Encourage discussion about why the results occurred. List on the board possible sources of error. Identify experimental and dependent variables and whether a sufficient control was use.

Students should read and develop background information about the causes of acid rain and where it has become a problem. (See sources listed below).

APPLICATION - Students will form a position statement about possible solutions to the problem of acid rain and will provide background data to support their position. You may have them work individually, or in pairs. Indicate to students that you will grade on accuracy and completeness.

FOLLOWUP/BACKGROUND INFORMATION

"Acid Precipitation Awareness Curriculum Materials in the Life Sciences" by Harriet Stubbs, The American Biology Teacher. Vol. 45, No. 3, April 1983. The following organizations have many fine articles and pamphlets, some of which are free:

The Acid Rain Foundation
1630 Blackhawk Hills
St. Paul, MN 55122

Publication Information Officer
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, MN 55113

SOURCE OF ACTIVITY

Adapted from "Acid Precipitation Awareness," Harriet Stubbs, The American Biology Teacher, by Peg Steffen.

Poisons From the Skies

Name________________

ACTIVITY 1

You will test the effects of acid water concentrations on a microscopic organism. You will need to collect the following materials.

4 glass jars or containers of equal size.
masking tape, pH paper provided by your instructor
spring water or pond water that has been boiled
organisms such as Daphnia
sulfuric acid

Problem statement:
What is the effect of pH on microscopic pond organisms?

Procedure:

You will make 3 different solutions of acid water, pH of about 3, 4, and 5. Use the spring water to fill all 4 containers to the same level. Test the pH of the spring water. Record this. One container with pure spring water will be the control (does not receive any acid). You will add sulfuric acid drop by drop to the other three jars if you are using a small container such as a baby food jar. Test the pH after each additional drop. Record the final pH in each container and mark the jars with masking tape. If you are using a container such as pickle jar or pint mason jar, you may add up to 5 drops before testing for the pH. Once the jars have been adjusted, add a measured amount of organisms, such as 2 milliliters, to each of the 4 containers. Observe the movement of the organisms. After a few minutes, take an eye dropper and mark it about half way up the glass tube with a grease pencil. Fill the dropper to the line with water from the control jar and empty it into a shallow dish. Using the hand lens, count the number of organisms you find that appear to be alive. If you have a lab partner, have them make a count also and average the two findings. Make a data table similar to the one shown. Place the jars in an undisturbed place and make observations and sample counts each day for 3 days.

Number of Surviving Organisms

Day	Control	Jar 1	Jar 2	Jar 3

After you have collected the data, graph the number of organisms versus the day for each pH. Share your findings with the class.

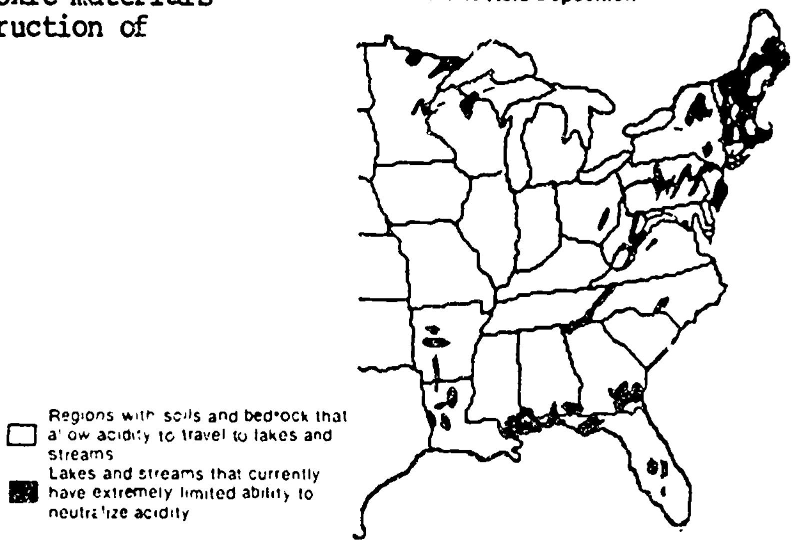
What was the experimental variable in this experiment?

What was the dependent variable?

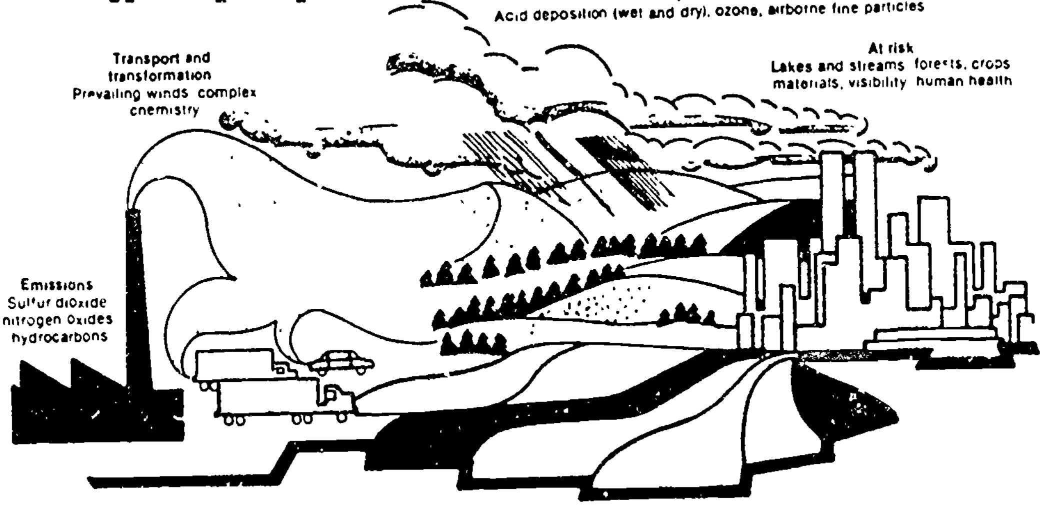
Did you have an adequate control?

Acid Rain describes any form of precipitation that contairs a greater than normal amount of acid. Pure water would have a pH of 7; any reading lower than than would indicate a higher acid content. The combination of rain and oxides are part of nature's balance to nourish plants and water life. When the oxides are increased as a result of the burning of fossil fuels such as coal and oil, the delicate balance becomes upset as the amount of acid in the rain rises. The map below shows where acid rain has become a threat to the soil and water resources in addition to erosion of buildings, leaching of toxic materials from the soil, and the destruction of plant and animal life.

Regions of the Eastern United States With Surface Waters Sensitive to Acid Deposition



Application Assignment: Research the causes of acid rain and list the contributors to acid rain in order of the amount of air pollution produced. Write a position paper about what you believe is a good solution to the problem. Include possible effects economically and politically that might occur if your solution was to take place. Provide data that supports your position.



Farmer, Farmer, How Does Your Garden Grow?

SUBJECT Science LEVEL 9-12

ACTIVITY

Students are given a short history lesson about agriculture and compare three modern methods of farming for energy consumption.

OBJECTIVE

Each student will be able to explain the changes in agriculture that have taken place over time and will compare the energy costs of producing food between traditional, minimum tillage, and organic methods.

MATERIALS

none

TIME

1 - 2 class periods

LEARNING CYCLE

AWARENESS - A diagram is provided below that shows an energy history of food production. You might use this in addition to the initial background information given.

CONCEPT DEVELOPMENT - The initial research for the assignment can be done outside of class, or you might provide the information to the students from the library or from the Iowa State County Extension Service in your county. See also, article "Fuel Required for Field Operations," Mathematics I.D.E.A.S. There may be someone in your area who uses the methods described. If possible, ask them to come to class and discuss their farming techniques with the students. With traditional methods, about nine calories of energy resources have been invested for each calorie available in the food. In primitive cultures, 5 - 50 calories were obtained for each calorie invested. You might mention this during the discussion.

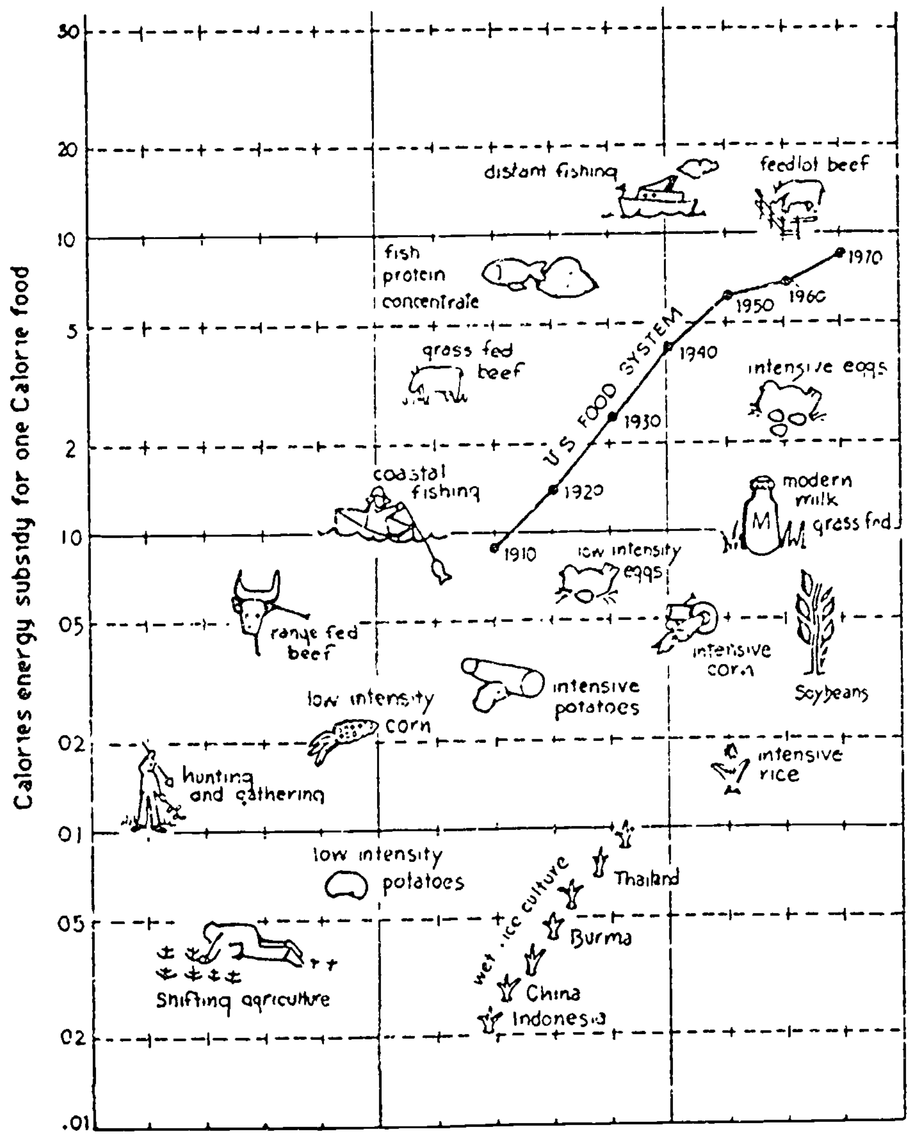
APPLICATION - Much of the grain that we produce is used in the feeding of livestock. There is always loss of energy during transformations between sun and grass and between grass and livestock. Only 10% of the energy in plants is available to the animals that eat the plants. In turn, only 10% of the energy in herbivores (cattle and hogs) is available to meat eaters (us). One reason that the U.S. consumes such large amounts of energy is that we eat much more meat than the rest of the world. Discuss ways in which we can cut down on the amount of energy we consume in food products. Have the students investigate the diets of people in other developed and undeveloped nations.

FOLLOW-UP/BACKGROUND INFORMATION

Contact your county extension service and the Iowa Energy Extension Service, Iowa State University, 110 Marston Hall, Ames, IA 50011 for information bout energy and agricultuie.

SOURCE OF ACTIVITY

Adapted from IDEAS and Energy and Society, Ministry of Education, by Peg Steffen.



Energy subsidies for various food crops The energy history of the United States' food system is shown for comparison Diagram from Energy, Sources, Use and Role in Human Affairs by C and J Steinhart, Duxbury Press, 1974 Used with permission

Farmer, Farmer, How Does Your Garden Grow?

Name______________

A Short History Lesson:

The method of obtaining food for survival has changed much over the ages. Primitive man hunted for meat and gathered fruits and berries. Even today, some peoples still use this method. Tilling the soil with pointed sticks and later primitive tools and planting seeds saved from the previous year made harvests more predictable and helped to spark the development of civilization. Pioneers in North America used hunting, fishing, gathering, and finally a type of agriculture called slash-and-burn. Clearing land by chopping the trees and burning the remains was responsible for large areas being put to agricultural use in the eastern United States. Unfortunately, the soil of wooded areas is not suited to tilling year after year.

Questions:

1. Why is this method not in use now?

2. What might happen to the soil if exposed to environmental conditions after clearing the covering crop of trees?

3. Corn and tobacco were the principle crops on this cleared ground. Farmers frequently used the ground for several years and would then move on. Why was this so?

In modern times, the mouldboard plough has been used to break and prepare a seedbed for planting. After plowing, traditionally discing is done before planting and then several cultivations are done to control weeds. After the harvest, fall plowing buries the crop residue and weeds and speeds the spring planting the following year. Unfortunately, the soil is open to wind and water erosion during the winter months.

Most recently, minimum tillage has been proposed as a way to conserve both soil and energy. In this method, smaller machinery is used with a system that allows for the soil to be broken, fertilizer added, and the seed planted all in one operation. Instead of cultivation, herbicides are applied to control weeds. Plant residue from the previous year is left and provides a mulch while cutting down on exposure to wind and water erosion. Another method of farming is organic, in which animal wastes are used exclusively instead of commercial fertilizers. Herbicides are not used so there is some loss of crop yield.

Time for some super sleuthing!!

You will compare the energy requirements for the traditional method, the minimum tillage method, and organic farming. You will need to find out the following things: (Assume you are farming a 240 acre farm. Do all calculations using this figure.)

1. Initial cost of the machinery.

2. Operating costs of the machinery.

3. Fuel needs of the tractors over a year's time.

4. Herbicide and fertilizer needs in terms of cost and amount.

5. Other costs.

Split the above among the group to which you have been assigned. If there is someone from a farm family, you may be able to interview the operator, otherwise contact local implement and coop people who might have information. Another excellent source of current information is the county extension service.

Fill out the chart below to compare farming methods.

FARMING METHOD	MACHINERY NEEDS	FUEL NEEDS	CHEMICALS (relative amt.)

From what you have been able to discover about the various farming methods, which type of farming is able to produce the highest yield? Which type of farming uses the least amount of energy?

Decision time: The question really becomes one of food production and economics versus energy consumption.

1. What do you suggest as the best course of action at the present?

2. What actions might be taken to ensure that the supply of fossil fuels will last longer?

3. Envision what farming will be like in the future when fossil fuels are no longer available. Create a scenario with pictures and with a written explanation. Remember, you are supplying grain and meat.