FLORIDA SOLAR ENERGY CENTER®

Energy Research Projects

Author

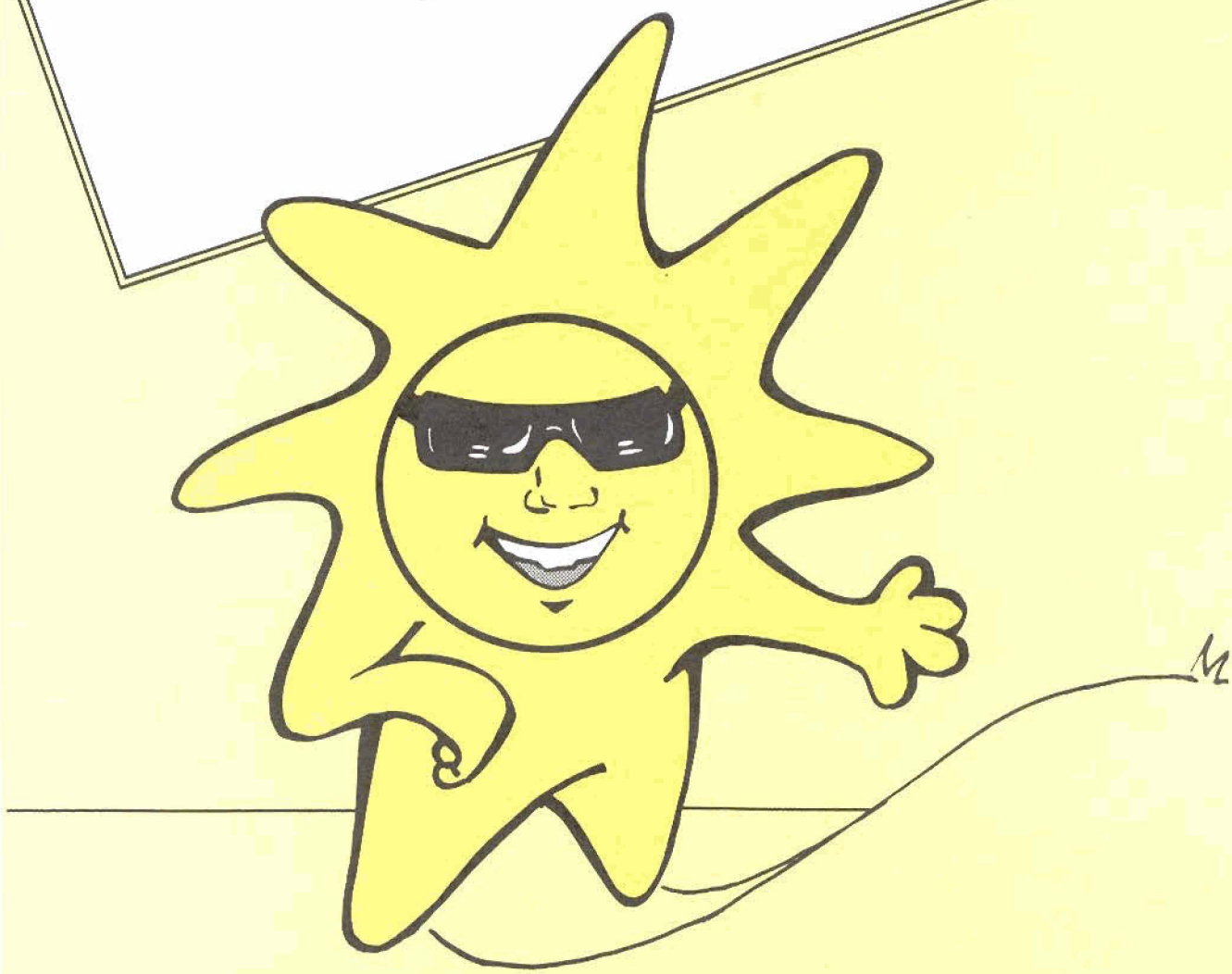
LaHart, David E.

Publication Number

FSEC-EP-1-89

A Research Institute of the University of Central Florida
1679 Clearlake Road, Cocoa, FL 32922-5703 • Phone: 321-638-1000 • Fax: 321-638-1010
www.fsec.ucf.edu

Energy Research Projects



Florida Solar Energy Center
Dr. David LaHart

Introduction

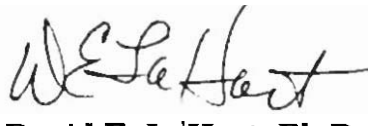
The Florida Solar Energy Center (FSEC) is a research and education arm of the State University System hosted by the University of Central Florida. The Florida legislature established FSEC in 1974 to conduct research in alternative energy technologies, to ensure the quality of solar energy equipment sold in Florida, and to educate people about renewable energy technology.

One method of disseminating research results has been through teacher education programs and the development of instructional materials. FSEC-developed materials are designed to teach science and social studies research methods and/or process skills. All units are field-tested and correlated with student performance standards and state curriculum frameworks.

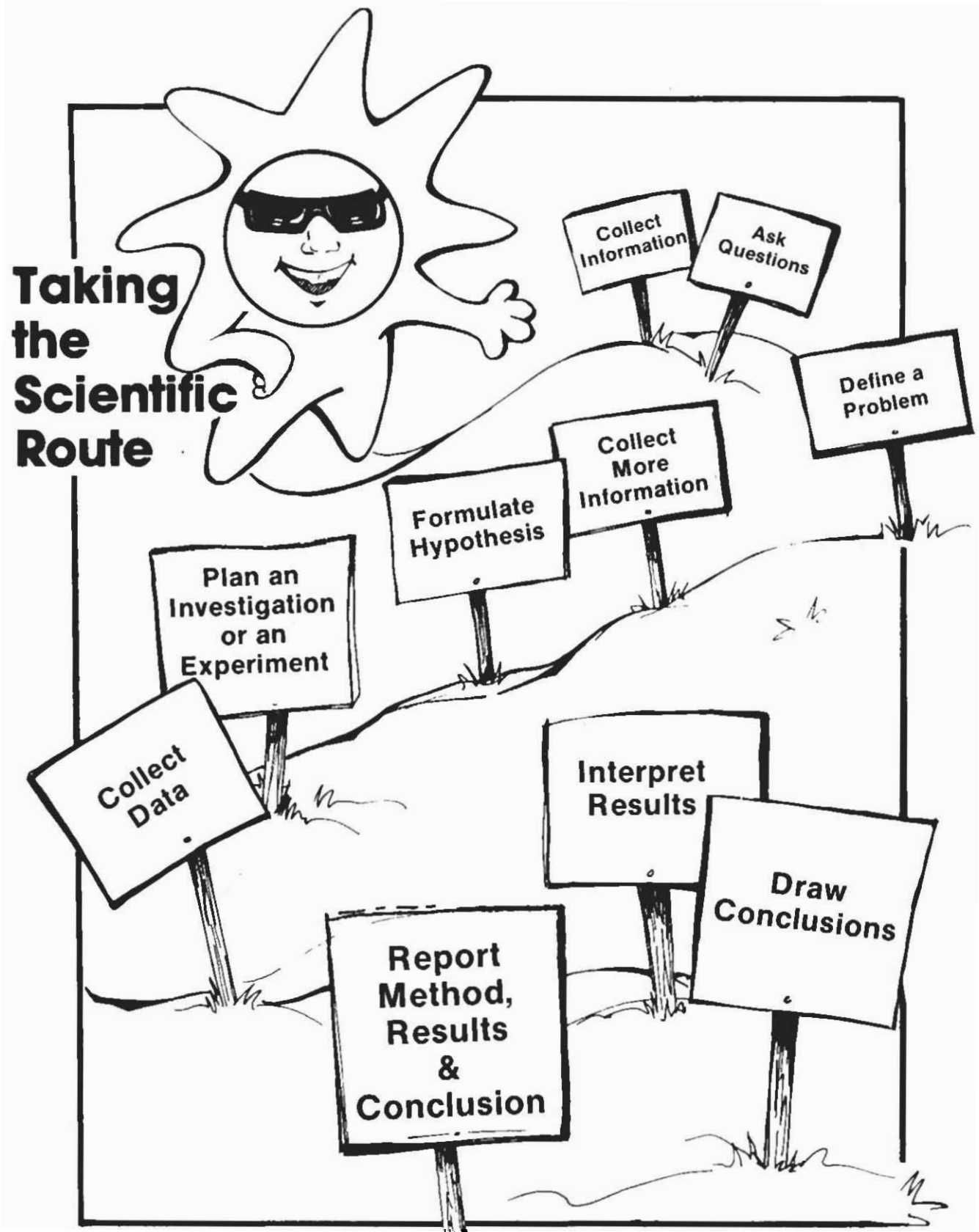
This **Energy Research Projects** guide has been taken from the **Florida Middle School Energy Education Project** (FMSEEP). FMSEEP was developed for the Governor's Energy Office with the active involvement of teachers, supervisors and utilities. Copies of all the FMSEEP units are available from FSEC's Public Information Office. In addition, FSEC publishes an **Energy Note** series that provides detailed information about renewable energy technologies and energy conservation strategies. Contact us for a publications list.

Funding for the distribution of **Energy Research Projects** is provided by the Florida Office of Environmental Education through the East Central Florida Environmental Education Service Project.

Your comments and suggestions are always welcome.



David E. LaHart, Ph.D.
Cape Canaveral, FL
May 1990



Put some energy in your research project!

Contents:

1. Parent letter
This letter may be sent home to help parents define their roles in the students' project.

2. Basic science project information
This section includes a description of each of the components of a good investigative science project, from selecting a research topic to displaying the completed project. If the project will be entered in the Florida State Science and Engineering Fair or a district science fair, request more information from the fair director or the Florida Foundation for Future Scientists, 111 Norman Hall, Univ. of Florida, Gainesville, FL 32611.

3. Worksheet: questions and hypotheses
This worksheet provides an opportunity for students to practice formulating research questions and hypotheses.

4. Examples of researchable energy questions
Students may use this list to decide upon an appropriate energy topic for investigation. For many students, these examples will be the springboard to creating new questions.

5. Sample abstracts
Two sample abstracts are provided. Each models the format and content of a good project abstract.

6. List of energy resources
The names and addresses for additional information on energy related topics is also included.

7. Information request letter
Students can use this sample letter as a model when writing to request information.

8. Energy related science fair project titles

1. Parent letter

Dear Parents,

Your child is working to develop a science project. This project will provide an opportunity for your child to use many academic abilities: researching, measuring, calculating, organizing, writing, and presenting. The amount of knowledge gained by your child will depend on the amount of work that he or she does.

There are several ways you can be involved in your child's science project:

Be a good listener. Your child will need to discuss topic ideas in order to decide on a specific question to investigate. Listen and ask questions that will encourage your child to focus his or her ideas.

- ***Provide materials.*** Some supplies may be needed in order for your child to conduct the necessary tests or to construct equipment and models for the investigation. A simple back-board or display surface may be needed to show the work. Providing a project log book to record data is a good idea.
- ***Provide transportation.*** Your child may need to go to the library, museum, university, or other places to obtain information for the project. It may be necessary to transport the finished project and your child to and from the display site. (The student should be able to set up and take down the display.)
- ***Monitor safety.*** Be sure any potential hazards are avoided. Extreme caution should be exercised when using chemicals, power tools, fire, or electricity. Storage space for materials and work in progress is important. Provide technical assistance as needed.

Remember, the project is to be the work of the individual student. Whether or not the project wins any awards, your child will gain knowledge, confidence, and self-esteem by completing the project independently.

The resources listed below will provide more specific "how-to" information about science projects.

Beller, Joel. ***So You Want To Do A Science Project.*** New York: Arco, 1982.

Schlichting, Sandi. ***You, the Investigator: A Science Project Guide for Kids.*** Florida: Idea Factory, Inc., 1986.

VanDeman, Barry A., and Ed McDonald. ***Nuts and Bolts: A Matter of Fact Guide to Science Fair Projects.*** Illinois: The Science Man Press, 1980.

2. Basic science project information

Select a Research Question

A good question:

- is based on a topic in which you are interested
- can be answered by experimentation
- leads to an investigation that yields measurable data.

Read the list of energy research questions for ideas.

State the Purpose of the Project

The purpose should be worded in a concise manner, stating exactly what you want to find out through the project. A good format is to start out with "The purpose of my project is to . . ."

Research the Topic

Collect all the information available on the topic. Use reference books, scientific magazines, textbooks, and personal interviews with experts. Keep notes in a log or journal.

Formulate the Hypothesis

The hypothesis is a statement of the expected outcomes of the experimentation. It should be based on research of the topic and any prior knowledge or experience.

Examples:

Question: How is cooking time affected by using a lid on the pot?
Hypothesis: Using a lid on the pot shortens cooking time.

Question: How is velocity of moving water related to the energy produced by a waterwheel?
Hypothesis: The greater the velocity of the water, the greater the amount of energy produced by a waterwheel.

Design and Conduct the Experiments

Design an experiment to test the hypothesis.

Identify variables in the experiment:

1. Manipulated variable: variable to be changed to determine what effect it will have on another variable
2. Responding variable: variable which changes in response to the manipulated variable
3. Variables held constant: all variables that are kept constant to ensure validity of the results.

Conduct the tests: be sure to conduct multiple trials or use a large test sample.

Systematically record all data in a log or journal.

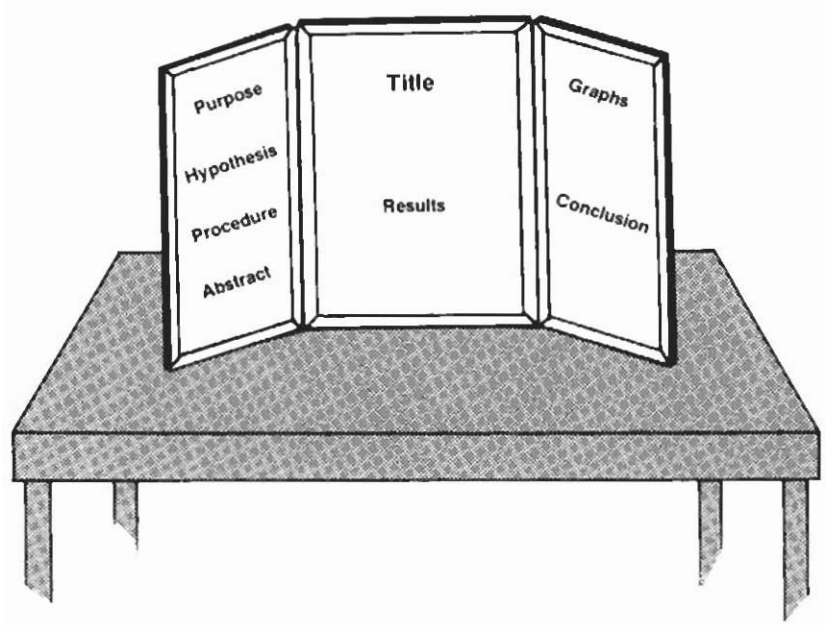
Determine the Results
Compile or average your data to determine if the data support or fail to support the hypothesis. This should be written in discussion form. Notations, graphs, charts, pictures, and tapes may be used to illustrate and supplement data.

Draw Conclusions
State outcomes of the experiment and tell what you learned. Describe how this knowledge might be applied in the future. If further investigations seem appropriate, describe them. Did you accept or reject the hypothesis?

Write an Abstract
An abstract is a brief summary or overview of the project. The abstract should be about 250 words. It should include the purpose, the hypothesis, a summary of the research and experimental design, a brief description of the results, and the conclusions. It should be displayed with the project. Look over the examples provided.

Display the Results
Sometimes projects are displayed in order to share the results with other people. Although there is not just one correct way to display a project, the components should be exhibited in a logical sequence. (The components include the purpose, hypothesis, procedure, abstract, results, and conclusions).

If you plan to enter your project in the State Science and Engineering Fair, remember exhibit size is limited: 76 cm (30 in.) deep, front to back; 122 cm (48 in.) wide, side to side; and 274 cm (108 in.) high, floor to top. (Display tables are 76 cm high.) Any exhibit exceeding these dimensions will be disqualified at a science fair that uses the rules developed for international competition. Here is one good example of a display.



Reminder
If your research project is intended for entry in a science fair, be sure to check with your district science fair coordinator or the Florida Foundation for Future Scientists for detailed rules and regulations.

3. Worksheet: questions and hypotheses

Asking questions is how science begins. Possible answers or explanations for the questions are expressed as testable hypotheses. Sometimes the formulation of a hypothesis leads to new questions to investigate.

Complete this practice exercise. If a question has been stated, formulate a testable hypothesis. If the hypothesis has been stated, formulate a question related to it.

Example topic	Question	Hypothesis
Solar energy	How is solar energy absorption related to surface area?	The larger the surface area, the greater the amount of solar energy that will be absorbed.
Freezers		The amount of food put into a freezer determines the amount of energy used.
Hot water costs	How much does a dripping hot-water faucet cost you?	
Batteries		The longer a battery is recharged, the longer it will provide energy afterwards.
Home heating	How does the color of a roof affect interior building temperature?	
Insulation		One thick layer of insulation is as effective as several thin layers with the same total R-value.

4. Examples of researchable energy questions

Questions represent the most exciting aspect of science. Most advances in science begin with curiosity, expressed as a question. Each of these energy research questions can be a beginning. Experimentation may even lead to new questions and further research.

How much difference is there in the amount of heat produced by "cool white" light bulbs in contrast to regular light bulbs?

Where should trees be planted to help reduce the energy used to cool a building?

How much hot water is saved by showering instead of bathing?

How is the interior temperature of a refrigerator affected by frequent opening and closing?

How does the amount of light affect the amount of biomass?

What growing medium produces more biomass: regular soil or a hydroponic solution?

What has more heat energy: edible oil or petroleum oil?

Which produces more heat energy when burned: green wood or dry wood?

How fast do you have to turn a bicycle wheel to generate enough electricity to light a small lamp?

How does the interior temperature of a compost pile change over time?

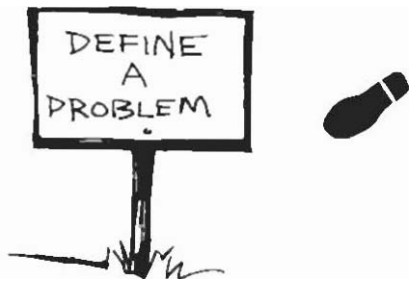
Which type of container allows water to heat in the least amount of time in a microwave?

Which type of bulb produces more light: an incandescent bulb or a fluorescent bulb?

In which situation would a battery last longer: frequent on and off use or continuous use?

Which kind of nut produces the most heat energy when burned?

What kind of wood produces the most heat energy when burned?



Which kind of window tinting is most effective at reducing the interior temperatures in cars?

Where should ventilation openings be placed to better reduce the temperature in your attic: on the peak (ridge vents) or on the gable ends?

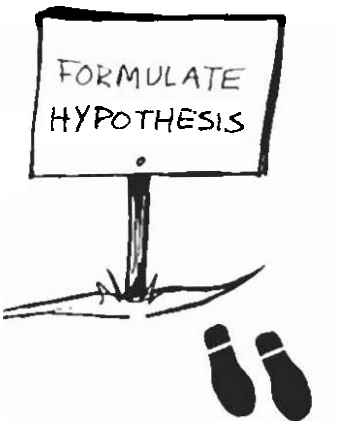
How does changing the number of blades on a windmill affect the amount of energy it can produce?

What size blades are needed on a ceiling fan for the best cooling?

How much hot water is saved by using a flow restrictor on your shower head?

How can solar energy be used to desalinize salt water?

How is cooking time affected by the size of the pan used?



How does the number of blades on a wind charger affect the number of RPMs?

How is the velocity of moving water related to the energy production of a waterwheel?

Which keeps a room coolest: drapes, window shades, or blinds?

How does the addition of aluminum siding affect the interior temperature of a building?

What type of greenhouse glazing retains heat best?

What common materials absorb the most energy from the sun?

How does magnification of a light source affect the electrical output of a solar cell?

How does the diameter of a rod affect its heat-conducting ability?

How is a family's energy use affected by switching to daylight savings time?

Which stove's heating efficiency is least sensitive to the type of pan being used: a gas stove or an electric stove?

How does the size of a temperature difference affect the rate of heat flow from one substance to another?

How does thermal mass affect the internal temperature of a building?

What type of container maintains food temperatures longest?

How energy-efficient are battery-powered appliances?

What kinds of energy changes occur when substances are dissolved in water?

Which fabrics biodegrade faster: natural or synthetic fabrics?

How does the height from which an object is dropped affect the energy transferred to the surface on which it lands?

Should your home's doors open inward or outward to conserve the energy used for heating and cooling?

How is viscosity of motor oils affected by temperature changes?

How does a swimming pool cover affect water temperature?

What type of water pipes do the best job of slowing down heat loss during water flow?

Do all batteries marked 1.5 volts produce the same amount of energy?

How effective are windshield sun screens at reducing the interior temperature of a closed automobile?

How much energy is saved if an air-conditioner unit is shaded from direct sunlight?

At what angle (relative to the ground) should a stationary solar collector be placed for maximum efficiency?

If air conditioning is not used, when should windows be opened and closed for the lowest interior temperatures?

What type of window provides the most efficient temperature maintenance of a building?

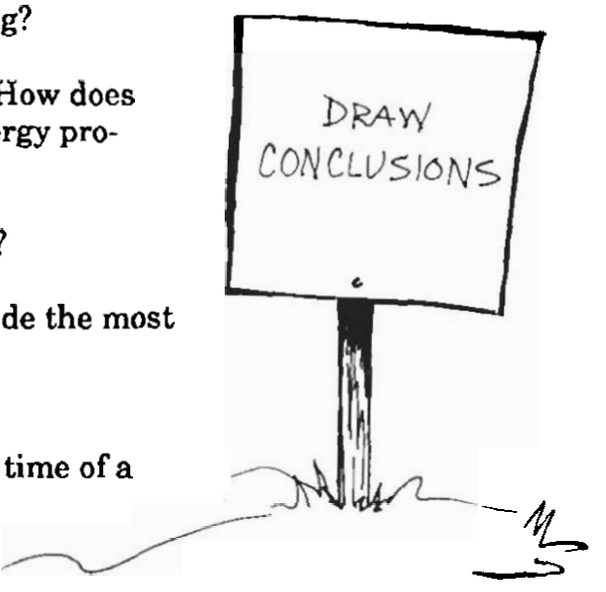
How does window size affect heat flow in a building?

How energy-efficient are rechargeable batteries? (How does the cost of recharging compare with the cost of energy produced?)

How much energy is released by burning a candle?

What is the best orientation for a building to provide the most efficient heating and cooling?

How much does a dirty lint filter affect the drying time of a clothes dryer?



Which uses less energy to light a given area: one large-watt bulb or two smaller-watt bulbs?

How does the shape of an enclosed area affect the efficiency of its energy use? (Is a square room more efficient that an L-shaped room of the same square footage?)

Are rooms easier to heat and cool with or without carpet on the floors?

How is the amount of energy needed to boil water affected by the presence of salt in the water?

How long does it take to transfer heat through different substances?

How much energy is saved by insulating a water heater?

Where is the best place in a home to install a water heater to prevent the most heat loss through the pipes?

How does the shape of the blades on a windmill affect the energy it produces?

At what angle should windmill blades be set for maximum efficiency?

How is the power of a windmill affected by changing the diameter of the wheel?

What shape reflector best concentrates the sun's energy?

Students may wish to choose 6-8 questions from this list or write some of their own. After a few hours in the library or talking to people, students should narrow the questions to three very specific ones. Writing a testable hypothesis is the next step!

	Research Question	Hypothesis
1.		
2.		
3.		

5. Sample abstracts

Writing an abstract: sample 1

An abstract is a summary of your research project. It should include the purpose, hypothesis, procedure, results, and conclusions of your research. A partial bibliography of major resources should be presented on the same page. The abstract below is an example of how it's done.

ABSTRACT

WHAT MATERIAL IS EFFECTIVE AS A SOLAR BLANKET? — Title of project
Smith, Susan B. — Personal information
111 Green Street, Anytown, FL 35000
Anytown Middle School, 555 Main St., Anytown, FL 35000 — School association
Mr. David Johns, Anytown Middle School — Sponsoring teacher

This research was done to determine the effectiveness of different pool cover materials in raising and maintaining water temperature, thus extending the swimming season. — Purpose

As solar energy can best penetrate clear materials, it was hypothesized that clear covers would produce the greatest increase in water temperatures. — Hypothesis

Three model above-ground pools were constructed, utilizing aluminum and vinyl from a dismantled pool. Each pool was filled with the same amount of water. One pool was covered with clear vinyl, and second pool was covered with black opaque vinyl, and the third pool was left uncovered to serve as a control. — Procedure (what you did)

Both daytime and nighttime water temperatures were recorded over a one-month period.

The following conclusions were formulated from the test results. Clear vinyl cover material produces the most significant increase in daytime water temperature. Both clear vinyl and black opaque vinyl covers were effective in significantly reducing nighttime heat losses. — Results / Conclusions

Bibliography

Cromer, Charles, J., P.E. Solar Heating of Swimming Pools. FSEC-EN-6. Cape Canaveral, Florida: Florida Solar Energy Center, 1981.

Ramsey, Dan. Trouble-Free Swimming Pools. Pennsylvania: Tab Books, Inc., 1985, pp.103-105.

"Solar Energy." McGraw-Hill Encyclopedia of Science and Technology. New York: McGraw-Hill Book Co., 1987.

Three or four major sources of information

(The space allowed for an abstract and bibliography is larger than shown; the sample abstract and bibliography were reduced in size).

Writing an abstract: sample 2

ABSTRACT

WHAT GLAZING MATERIAL RETAINS GREENHOUSE HEAT BEST? — Title of project

Jones, Kenneth J. — Personal information
111 First Street, Anytown, FL 35000
Anytown Middle School, 555 Main St., Anytown, FL 35000 — School association
Mrs. Janice Smith, Anytown Middle School — Sponsoring teacher

This research was conducted to determine which available greenhouse glazing should be used to retain heat as long as possible. — Purpose

Only one available glazing material had insulating channels inside the material. It was hypothesized that this glazing would provide the greatest heat retention. — Hypothesis

A chamber was constructed by placing one box inside another box with blanket fiberglass insulation filling the space between them. A 200-watt bulb inserted through the side of the chamber provided a source of heat. Three tests were conducted with each type of glazing. The chamber was closed by placing the glazing material over the remaining open side. The light was turned on and left on until an interior thermometer registered 50°C. The light was turned off and temperatures recorded every three minutes until the thermometer registered 30°C. — Procedure (what you did)

The results of the tests were very similar for three of the glazing materials: Lexan, Lexan with reflective film, and L Cast Acrylic. Each maintained interior temperatures of 30°C or higher for less than 40 minutes. Exolite maintained the temperature for 56 minutes. — Results

These results were the basis for the conclusion that the insulating channels in Exolite provided the best material for heat retention. — Conclusions

Bibliography — Three or four major sources of information

Jones, Robert W. The Sunspace Primer. New York: Van Nostrand Reinhold Co. Inc., 1984, pp. 51-68.

"Self-sufficient Sun Room." Popular Science February 1988: pp. 80-82.

"Solar Power." New Book of Popular Science. Connecticut: Grolier, Inc., 1987.

(The space allowed for an abstract and bibliography is larger than shown; the sample abstract and bibliography were reduced in size).

6. List of energy resources

The following companies can send you information to help with energy-related science projects. When you request information, try to make your request as specific as possible. For example, if you want information on petroleum production in Florida's Everglades, don't ask for information on "oil in Florida."

Use the phone book. Your local electric utility, gas company and petroleum distributors may have exactly the kind of information you need or may be able to obtain it for you.

Florida Sources

Florida Petroleum Council
Bldg. F-#210
325 John Knox Rd.
Tallahassee, FL 32303

Florida Propane Assoc.
P.O. Box 11026
Tallahassee, FL 32302-3026

Florida Solar Energy Industries Assoc.
1732 County Road 427 No.
Longwood, FL 32750

Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920

Governor's Energy Office
The Capitol
Tallahassee, FL 32399

National Sources

American Gas Association
1515 Wilson Blvd.
Arlington, VA 22209

Solar Energy Industries Assoc.
1730 N. Lynn Street, Suite 610
Arlington, VA 22209

Edison Electrical Institute (EEI)
1111 19th St., N.W.
Washington, DC 20036

Electricity Consumer's Resource Council
1707 H. St., N.W., 10th Floor
Washington, DC 20006

American Petroleum Institute
2101 L Street, NW
Washington, DC 20037

National Coal Association (NCA)
1130 17th St., N.W.
Washington, DC 20036

7. Information request letter

Sometimes you will need to request written information from a museum, university, government office or industry. The best way to ensure a response to your request is to send a brief, well-written letter asking for specific information. The letter below is an example of such a request.

111 Green Street
Anytown, FL 35000
September 1, 1992

Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920

Dear Sirs:

I am doing an energy research project regarding the effectiveness of swimming pool covers. I am interested in determining which cover material increases and maintains water temperatures best.

Please send me a copy of brochure FSEC-EN-6, Solar Heating of Swimming Pools. I would appreciate any additional information available on this topic.

Sincerely,

Susan B. Smith

8. Energy related science fair project titles

A good project title is short and succinct and uses key words. Introductory phrases such as "a study of" or "the reasons for" should be avoided. Here are some project titles that were actually used in science fairs. Try to develop research questions from the titles and then write a testable hypothesis!

Can Petroleum Be Obtained From Weeds?
Enhancement of Methane Production from Aquatic Biomass
Solar Energy Conversion Using Hydrogen-Producing Algae
Water Hyacinths: An Alternate Energy Source
Fuel Content of Native Woods of North Florida
Methane — Garbage to Gas
Production of Electrical Current From Animal Waste
Design for a More Efficient Solar Heater
Effects of Materials and Colors on Solar Heating
Can Radiant Energy be Changed to Mechanical Energy?
Comparing Flat-plate Solar Collectors
Does Temperature Affect the Life of a Dry Cell Battery?
Efficiency of Tracking and Tilted Solar Cells
Improved Electric Car
"Insulation" — A Thermal Barrier
Methane Gas Production with Anaerobic Respiration
Saving Energy — Does Insulation Really Help?
Testing Some Ways to Improve Solar Collectors
Alternate Fuel: Solar Distillation of Alcohol
High Density Pine Planting for Biomass Energy
Solar Oven Efficiency
What Type of Roofing is Best for Florida Homes?
Comparing Thermal Insulations
Controlled Heat in a Solar Oven
Design and Production of Solar Cells
How Does Temperature Affect the Conductivity of Copper Wire?
Effect of Wind Resistance on Vehicles
How Different Storage Temperatures Affect Battery Life
Insulating Properties of Common Household Materials
Nuclear Physics: The Chain Reaction
One Approach to Thermonuclear Fusion
Possibilities of Fusion Power
Comparing Insulation for Hot Water Pipes
Which Battery is Most Cost Efficient?