Solar Collector

CONTEXT

There are numerous sources of renewable energy available that are inexpensive and non-polluting. A good example of a renewable resource is solar energy, which is continually provided by the sun. Solar Energy can be collected as thermal energy, and then can be converted into electricity, or used to warm a building or provide hot water for such processes as cooking or bathing.

Experience has shown that solar Energy can be used to improve living conditions in many parts of the world. In countries like Haiti, throughout Africa, many parts of Asia, and in the Middle East, traditional fuels - including firewood and fossil fuels - are scarce. Sunlight, rather than being scarce, is abundant. Solar energy is also used throughout the world to augment more traditional home heating fuels such as oil or natural gas.

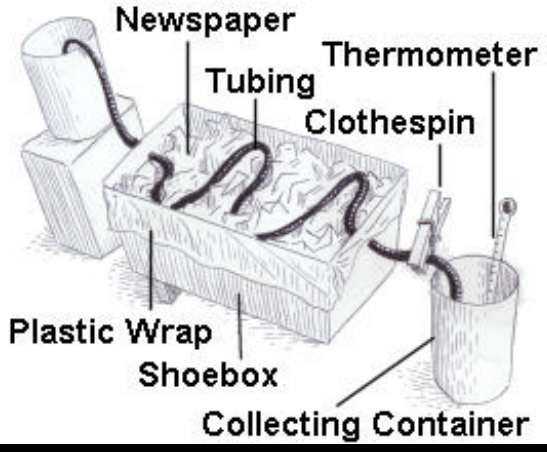
It is important to find the most effective means of converting energy from the sun into other, more convenient and usable forms of energy. A step toward finding the most efficient way to collect and use the sun's energy can be taken by making small models of solar collectors and finding ways to improve their performance.

CHALLENGE

EXPLORATORY

Work in groups (2-3) to research and then brainstorm for 10 practical uses for solar energy. List 10 recycled materials that could be used to build a model of a solar collector in class. Develop a drawing of a solar collector you could develop from the materials that you identified.

INTERMEDIATE



Conduct a brainstorming session to generate a list of 10 recycled materials that could be used to build a model of a solar collector. Design, sketch, and build a solar collector that improves upon the one illustrated here. Use the recycled materials and the tools your teacher provides for the class. Once the model is operational your team should develop and implement a plan to collect and record data on the performance of your solar collector.

ADVANCED

Design, and build a model house or other building that utilizes a solar collector that is a significant improvement of the one illustrated above. Use the recycled materials and the tools your teacher provides for the class. Collect and record data on the performance of your solar collector. Include a 150-200 word report on your ideas, the problems or difficulties overcome in building your design, and the efficiency achieved by your design.

MATERIALS

Exploratory (none)

Intermediate

- Shoe Box or other box similar in size
- Newspaper
- 2 containers (buckets, plastic cartons, etc.)
- Water and 1 liter container
- Paper and pencil
- Metric ruler (supplied)
- Plastic tubing (1.5 meters supplied)
- Black spray Paint (2 cans supplied to each class)
- Celsius thermometer (supplied)
- Plastic Wrap (supplied)
- 1 wooden spring type clothes pin (supplied)

Advanced

- Shoe Box or other box similar in size
- Newspaper
- 2 containers (buckets, plastic cartons, etc.)
- Water and 1 liter container
- Paper and pencil
- Metric ruler (supplied)
- Plastic tubing (1.5 meters supplied)
- Black spray Paint (2 cans supplied to each class)
- Celsius thermometer (supplied)
- Plastic Wrap (supplied)
- 1 wooden spring type clothes pin (supplied)

CRITERIA

Your success on this Challenge will be based on your completion of the activities below. Three general criteria for your performance will be: **participation** in the activity; the **accuracy** of your measurement and model construction; and the **performance** of your design. Your teacher will help you understand how your performance will be graded.

EXPLORATORY

- List of 10 uses of solar energy
- List of 10 materials that could be used in building a model solar collector
- Determine if your plan for the solar unit could work

INTERMEDIATE

- Design sketch(s)
- Model construction
- Gather and record data
- Interpret the data and determine how well your solar collector performs

ADVANCED

- Design sketch
- Model construction
- Gather and record data
- Interpret the data and determine how well your solar collector performs
- Designate how you would improve your solar collector
- Present your final report

INTEGRATED SCIENCE MATH AND TECHNOLOGY ACTIVITIES

The following example of an integrated S/M/T Activity is provided to show possible Science/Math/Technology connections to the challenges introduced earlier.

Heat (calories) = Mass (weight of water) x Specific Heat x Change in Temperature
Define new vocabulary.
Research solar powered cars, electric battery recharging, using solar energy in space exploration.

By removing the tubing the collector can be used as a solar cooker. Use aluminum foil to hold foods with a low melting point such as cheese or chocolate. Some groups could melt cheese for nacho dip and others chocolate to dip marshmallows in for a class picnic.

PROBLEM SOLVING PROCESS

These steps may be helpful to students in constructing a model:

1. Put one hole in each end of box.
2. Paint inside of box black.
3. Fill box with crumpled black construction paper or newspaper. If newspaper is used, paint it black.
4. Insert tubing through box with 60 cm sticking out from each end. Coil the remaining tubing on top of the newspaper in the box.
5. Cover box with clear plastic wrap.
6. Place collector in direct sunlight with one end sitting 5 cm higher than the other.
7. Position one container at the low end of the box as a collection container.
8. Fill the other container with water and measure and record the temperature in degrees Celsius.
9. Put tubing from the higher end of the box into the container with the water. Elevate the container to a level higher then the box.
10. Allow the water to flow through the tube to the lower end of the box. Use the clothespin to partially limit the flow of water into the second container.
11. Record the temperature of the water in the collector.
12. Chart the temperature change. Run the warmer water through your model again and chart this change. Plot data from each trial for time and temperature change on a x-y graph.

NOTES TO TEACHERS

The intended challenges were designed to be open-ended and flexible to accommodate all learning levels. Please feel free to incorporate additional material(s) to enhance the activity. There are various science and math competencies you can incorporate into the activity to meet your needs. Students should be given the freedom to try to improve upon the design of the solar collector described in this activity. You could challenge them to compete with other groups to devise the most efficient collector of solar energy.

RESOURCES

The categories of Exploratory, Intermediate, and Advanced provide a context to help students understand the social and personal meaning of each challenge. Additional materials may be found at the following locations:

- Encyclopedia/CD ROM or Book form
- Rodale Press, 33 East Minor Street, Emmaus, PA 18049: *Solar Food Dryer*, by Ray Wolf, (ed.), (1981) ISBN 0-87857-333-X
- Van Nostrand Reinhold Company, 135 West 50th Street, New York, NY 10020: *Successful Solar Energy Solutions*, By S. Braden, et. al. (1980) ISBN 0-442-20738-7
- Solar Cookers International, 1724 11th Street, Sacramento, CA 95814, www.accessone.com/~sbcn

PROPOSED CURRICULUM / STANDARDS CONNECTIONS

The following Curriculum/Standards Connections for grades 5-8 have been included to aid in the use and assessment of the design challenge projects. NOTE: These connections have been extracted from the National Standards. You will need to check their correlation with your own State Curriculum Standards to ensure consistency with your curriculum goals.

Note on Assessment: We strongly recommend using the Student Reflection Sheet and the Rubric provided in the Appendix to enhance the learning process, by encouraging student awareness and participation in the assessment of their work. These tools can help students to understand the context, meaning, and value of undertaking these challenges.

Science Content Standards	Standards for School Mathematics	Standards for Design and Technology
Science as Inquiry • inquiry into the principles and concepts of solar energy **Physical Science** Properties and changes of properties in matter • properties and changing of materials for energy storage and release Transfer of Energy • heat collection and transfer **Life Science** Populations and ecosystems • use of alternative energy to reduce drain on the ecosystem **Earth and Space Science** Earth in the solar system • Earth's rotation, tilt, and the effects on solar energy • latitude and weather; effects on solar energy **Science and Technology** • design and modeling of a solar collection system **Science in Personal and Social Perspectives** • effects of using alternative energy on individuals and society **History and Nature of Science** • development of the science of alternative energy	**Mathematics as problem solving** **Mathematics as communication** **Mathematics as reasoning** **Mathematical connections** • applying math to real problems in science and technology **Number and number relationships** **Number systems and number theory** **Computation and estimation** **Patterns and functions** **Algebra** • application of formulae to determine energy gain and the orientation of solar collectors **Statistics** **Probability** **Geometry** • use of geometry in the design of solar collectors **Measurement** • use of trigonometry to determine the orientation of the solar collectors	**Design** • design and development of solar collectors and other alternative energy devices **Develop and produce products and systems** • building of solar collector models **Use and manage technology** • research and inquiry via the internet and other sources • use of tools and machines in the building of collectors **Assess the impacts and consequences of technology** • assess impact of using vs. not using solar energy on the greenhouse effect **Nature and history of technology** • history of the technology of alternative energy materials, devices, and systems • evolution of alternative energy and the ability to replace fossil fuels **Connections** • integration of science, math and technology in the design and development of solar collectors and other alternative energy devices