

What's Cooking 3

Student Objective

The student:

- will design and construct a solar cooker
- will research, analyze and critique solar cooker designs
- will work with a group to develop a plan, list materials, and delegate tasks
- will demonstrate originality and inventiveness using low cost and recycled materials

Materials:

- photos (or slides) of several different cookers including some made from recycled materials
- materials (either purchased or recycled) that students can use to construct their cookers (i.e. glass, plexiglass, mirror, corrugated plastic, windshield reflectors, foil, mylar 'space' blankets, sheet cardboard, insulation, etc)
- hand tools (i.e. razor knives and other cutters for various materials)
- glue in various forms
- tape - aluminum and clear
- black 'stove' paint
- ruler and tape measure
- protractor, t-square
- table protection
- cutting boards
- thermometers, oven thermometers, digital infrared thermometer (if available)

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| Key Words: |
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|-----------------------------------|
| fresnel parabolic reflector |
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Time:

- 1 class period for research (could be homework)
- 1 class period to brainstorm and begin plan
- 1 class periods for construction

Background Information

Solar cookers come in various sizes and shapes. The three most common types of solar cookers are box cookers, parabolics and panel cookers. Many variations on these basic types exist.

Box cookers - Box cookers are the most common cookers. They cook at moderate temperatures.

Advantages:

- can cook in multiple pots simultaneously
- can be built from many different materials
- can be built any size to cook large quantities of food
- doesn't need to be repositioned as frequently as other designs
- keeps food moist

Disadvantages:

- can't fry foods - box cookers bake or slow cook
- glass or other glazing is required
- walls can shade interior if not angled properly

Parabolic cookers - Parabolic or curved cookers cook fast at high temperatures.

Advantages:

- cooks as fast as a conventional electric burner
- can fry foods

Disadvantages:

- may need materials that are harder to obtain or more expensive
- requires periodic realignment to the Sun
- can damage eyes

Panel cookers - Panel cookers combine elements of box and parabolic cookers. They cook at moderate temperatures.

Advantages:

- inexpensive to make
- may be made collapsible

Disadvantages:

- can't fry foods
- some designs do not work well when the Sun is directly overhead

Solar cookers can be made from a wide variety of materials—both purchased (wood, sheet aluminum, flexible sheet plastic, glass, mirror, plexiglass, etc) and recycled (cardboard, mirror, umbrellas, coolers, cds, car windshield shades, etc). Garages (and garage sales) are great sources of materials for solar cooker construction. A cooker can easily be made for under \$10. in materials

Procedure – Cooker Research & Design Planning

1. **Engage:** Lead a classroom discussion on what they have learned so far about solar cookers.
2. Show the students some cooker photos. Include parabolic and panel cookers in the presentation. Let the students make comments and discuss the designs. Discuss the three main types of cookers and what distinguishes each type of cooker.
3. **Explore:** Tell the students they will be researching solar cookers—both commercially

available designs and those that can be handmade, and then making a cooker of their own design and testing it. During their research into different cookers they will be evaluating the materials, shape and size, ability to reflect, cost and portability of each design. They can then use this information to help in constructing their own cooker.

4. Divide the students into groups. Within the groups, each member should research a different cooker, however, the groups should research at least one cooker from each of the three main types.
5. Inform students to use caution and ethics when accessing and viewing web sites to use as research sources. Their searches should conform to the standards of scientific investigations.
6. Students should complete the Research section of their Laboratory Manuals. Research can be conducted during class hours or assigned as homework.
7. On the following day, instruct the students to discuss their findings (advantages and disadvantages of the different cookers and different building materials) within their group.
8. Based on their research and brainstorming the students will determine a solar cooker design that they can construct using low cost and/or available (recycled) materials. You may provide some materials or have students create a class-wide list of available items they can purchase, recycle or donate from home.
9. Observe the groups during the planning stage. Remind the students that their goal is to maintain high standards and produce a quality product. Pass out (or post) the rubric to show the students the criteria you desire.
10. Encourage students to work out a rough draft before completing drawing their final plan in their Laboratory Manuals. Students need to develop a scale for their drawing and label all measurements. (This should not be a trial and error activity—students need to have a plan!) Assist the students as needed in completing their Laboratory Manuals.
11. Students need to generate a list of all construction materials including amounts and cost. Partial product cost must also be calculated. For example, 2.5 rolls of aluminum foil at \$3.99, recycled packing styrofoam peanuts at \$0.
12. Students must generate the instructions for constructing their cooker based on the specifications of their design and materials needed.
13. Have students develop a company name and logo to complete this planning phase of the activity. Note: Assigning a company cover page for the activity packet will integrate an ‘art in science’ concept and showcase your artistically talented students.

Procedure - Construction & Testing Day

1. Have an outside area available for students to use for painting, glueing and testing of their cookers.
2. Assist students as needed during construction of their cookers.
3. If students vary their designs during the construction (or testing) process—and they probably will—have them note their changes in their Laboratory Manuals.
4. As the groups finish their cookers, have them clean up their area then take their cooker outside to test and modify slightly, if necessary.
5. There are several methods that can be used to test cookers. At your discretion, testing can

be done by the groups individually as they finish their cooker construction, or a class wide criterium can be set up to be done during the following class period. Some tests that can be done are:

- put a small container with 100 ml of water and a thermometer inside the cooker and measure the temperature increase in the water during a set amount of time
- test the ability of the cooker to boil water. Place a specific amount of water in a container covered with Saran wrap in the cooker.
- test the speed of heating in their cookers by taking temperature readings at intervals and graphing the results.
- cook a specific item (i.e. boil/fry an egg)

6. **Explain and Elaborate:** After completing the activity, lead a discussion of what designs performed the best having the groups share their experiences, lessons learned and thoughts for further solar cooker designs.

Evaluation and Student Assessment

Using the rubric below, assess each student/group performance during the activity. Point assessment to be determined by instructor.

| | Exemplary (all skills mastered) | Average (Most skills mastered) | Novice (Needs Improvement) |
|---|--|---|---------------------------------------|
| Team productivity - completed on time in a professional manner | | | |
| Diagram and scale - neat and easy to read | | | |
| Material list - neat and matches the procedure list | | | |
| Procedure list - logical with key terms and concepts included correctly | | | |
| Analysis is complete, correct, and written using proper terms and/or concepts | | | |
| Team’s collaboration and effectiveness in achieving a common goal | | | |
| Cooker construction - overall appearance and the quality of the work | | | |

Related Research

1. Have students select various types of foods to cook to see what food type works best in their solar cooker.
2. Enter the best designs in the Solar Energy Cook-off at the Florida Solar Energy Center

- held as part of the Energy Whiz Olympics each May.
3. Have student's present and critique each solar oven design, cost, and productivity (cooking) results.
 4. Research where each type of design is used the most, and why this type of cooker is preferred. Do large companies produce these cookers, or are they made by individuals.
 5. Have groups of students research and report on international solar cooker initiatives. Examples include: the Barli Development Institute for Rural Women, Federal Intertrade Haiyuan Solar Cooker Project, TNO Solar Socket, Cameroon Sustainability Sun Bakeries Programme, Solar Liberty Foundation - Empower Haiti Project.
 6. Identify a charitable organization that assists with disaster relief and donate the most effective cookers, or several that are built specifically for this purpose.

Related Reading

- ***Cooking With the Sun: How to Build and Use Solar Cookers*** by Beth Halacy & Dan Halacy (Morning Sun Press, 1992)
Cooking With the Sun gives simple directions for solar cookers and solar hot plates along with a host of recipes including pizza, chicken and pecan pie.
- ***Cooking With Sunshine: The Complete Guide to Solar Cuisine with 150 Easy Sun-Cooked Recipes*** by Lorraine Anerson and Rick Palkovic
Whether you're new to solar cooking or have been doing it for years, Cooking with Sunshine is your definitive guide to making a variety of tasty sun-cooked meals. The book includes instructions on building and buying cookers, recipes for main dishes, accompaniments and desserts and ideas for special occasions

Internet Sites

- http://www.fsec.ucf.edu/en/education/k-12/energywhiz_olympics/solar_cookoff/index.htm**
Florida Solar Energy Center's annual solar cooking competition, the Solar Energy Cook-off for grades 4 through 12. Includes rules and information on how to enter a team.
- http://www.fsec.ucf.edu/en/education/k-12/energywhiz_olympics/solar_cookoff/cookbooks.pdf**
Cookbook of winning recipes from the Brighthouse Solar Energy Cook-off at the Florida Solar Energy Center
- <http://solarcooking.org/>**
Solar Cooking International, solar cooking archive includes solar cooking plans, documents and a list of resources and manufacturers.
- <http://www.sunoven.com/>**
Sun Ovens International. Includes solar oven history, recipes, and photos.

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| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | |
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| Nature of Science | | | | | | | | | | | | | | | | | | | | | | |
| Standard 1 | SC.912.N.1. | | | | X | | | | | | | | | | | | | | | | | |
| Standard 4 | SC.912.N.4 | X | | | | | | | | | | | | | | | | | | | | |
| Physical Science | | | | | | | | | | | | | | | | | | | | | | |
| Standard 10 | SC.912.P.10. | | | | | | | X | | | | | | | | | | | | | X | |
| Mathematics Standards | MA.912.A.10.1 | | | | | | | | | | | | | | | | | | | | | |
| Language Arts Standards | LA.910.2.2.2, LA.1112.2.2.2, LA910.4.2.1 | | | | | | | | | | | | | | | | | | | | | |

Science Standards

Standard 2: The Practice of Science

- SC.912.N.1.4 - Identify sources of information and assess their reliability according to the strict standards of scientific investigation.
- SC.912.N.4.1 - Explain how scientific knowledge and reasoning provide an empirically based perspective to inform society's decision making.

Standard 10: Energy

- SC.912.P.10.7 - Distinguish between endothermic and exothermic chemical processes.
- SC.912.P.10.19 - Explain that all objects emit and absorb electromagnetic radiation and distinguish between objects that are blackbody radiators and those that are not.

Language Arts Standards

Literary Analysis - Standard 2: Nonfiction

- LA.910.2.2.2 - The student will use information from the text to answer questions or to state the main ideal or provide relevant details.
- LA1112.2.2.2 - The student will use information from the text to answer questions or to state the main ideal or provide relevant details.

Writing Applications - Standard 2: Informative

- LA.910.4.2.1 - The student will write in a variety of informational/expository forms, including a variety of technical documents
- LA.1112.4.2.1 - The student will write in a variety of information/expository forms, including documents using precise technical and scientific vocabulary.

Mathematics Standards

Algebra - Standard 10: Mathematical Reasoning and Problem Solving

- MA.912.A.10.1 - Use a variety of problem-solving strategies, such as drawing a diagram, making a chart, guess-and-check, solving a simpler problem, writing an equation, working backwards, and creating a table.

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fresnel - a thin optical lens consisting of a number of small lenses arranged to make a lightweight lens of large diameter and short focal length

parabolic - the set of all points whose distance from a fixed point, the focus, is equal to its distance from a fixed line, the directrix. The algebraic graph of a quadratic equation is a parabola. A satellite dish is an example of a parabola.

reflector - a surface that reflects (bounces) light in a desired direction

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Cooker Design Research

1. Create a table or chart for the designs your group researched using the items below:
 - Category of design (i.e. box cooker, parabolic)
 - Manufacturing company or website where design was found
 - Advantages of design
 - Disadvantages of design
 - Materials used in construction of this cooker
 - Advantages of these materials
 - Disadvantages of these materials
 - Type of cooking that can be done in this type of cooker

2. For each design your group researched, the group should decide what part of the design you like the best, and whether it is something that can be incorporated into your own cooker design. List below the different parts that you will incorporate in your design.

3. Determine the tasks that need to be accomplished in the construction of your cooker. Assign tasks (and job titles) among your group. List everyone's contribution below.

Cooker Construction

4. Diagram and label your solar cooker

Scale: _____

5. List below all your construction materials and the costs. Use additional pages if necessary.

| <u>Material</u> | <u>Amount</u> | <u>Cost (each)</u> | <u>Total Cost</u> |
|-----------------|---------------|--------------------|-------------------|
|-----------------|---------------|--------------------|-------------------|

6. List the construction directions for your cooker below. These should be complete enough that someone who did not see your cooker would be able to construct one.

7. On the following page, create the cover artwork for your cooker design and construction pamphlet. Include your company name, company logo, and team member names.

Analysis of Design and Construction

8. Explain what previous solar cooking experiences influenced you in developing your oven design.

9. What constructing materials did you use as absorbers or emitters, conductors or insulators of the infrared waves from the Sun? Organize your answer in a data table with your columns labeled.

10. What issues or tasks challenged the group?

11. What went well during the design and building of your cooker?