

What's Cooking?

Student Objective

The student:

- understands how the Sun's radiation, as heat, can be captured and used
- given a solar oven, can explain what makes it work and how to improve on the design.

Materials (construction)

- file storage box, or other box 12" x 15" x 10" (1 per oven)
- foil backed foam insulation board, approx. ½ sheet per oven
- plexiglass, pre-cut to 12" x 15" (1 per oven)
- aluminum duct tape, 20 feet (per oven)
- black construction paper, 12" x 15" (1 per oven)
- aluminum foil, 18" x 21" (1 per group)
- scissors (1 per group)
- wooden dowel, stick or pencil (1 per oven)
- Science Journal

Materials (cooking)

- oven thermometer, or thermometer that has a range to at least 300°F (1 per group)
- pot holders
- disposable aluminum cooking pans ('brownie' size works well), oven roasting bag, plastic wrap or clear glass covered casseroles

Background Information

1. A solar cooker is a type of solar thermal collector. It 'collects' and traps the sun's thermal (heat) energy. For example, on a sunny day your car with the windows rolled up

Key Words:

conduction
convection
glazing
insulation
radiation
reflector
solar collector
solar thermal
transmission

Time:

1 class period to build oven
1 class for cooking

becomes a collector. The glazing lets in the sun's energy, traps the thermal (heat) energy, and the air inside your car becomes hot. As more light enters the car, the air gets even hotter, until we say that it feels like an oven inside!

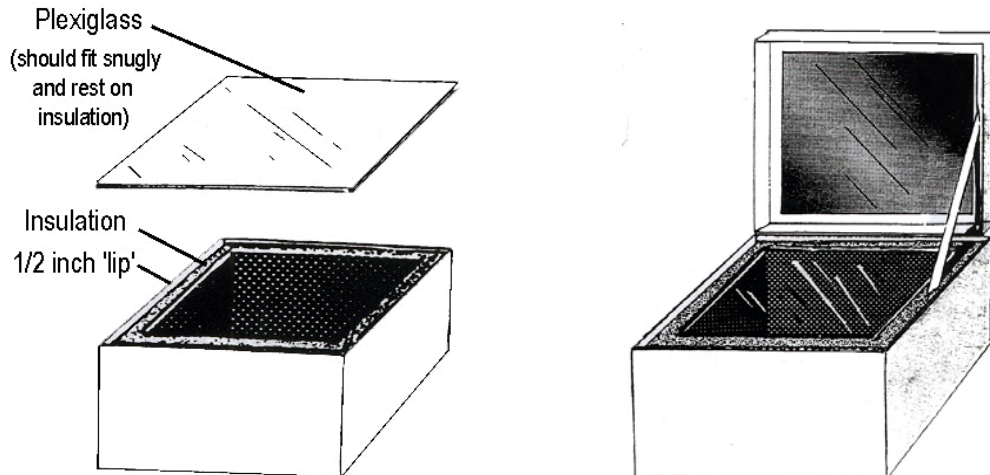
2. Solar ovens are improving the quality of life for many people around the world. Solar ovens have been introduced in parts of South America, Africa and India. In these areas, it is typical for a woman to spend nearly half her workday looking for and collecting firewood. Also, respiratory problems in the children of these areas have been linked to fumes created by the burning of poor quality wood. The use of solar ovens helps to reduce the dependency on firewood. In addition, some women have turned their talents for building cookers into businesses--building and selling cookers for added income.
3. Besides cooking, solar ovens can be used to purify water. This is beneficial for areas where obtaining safe drinking water is a problem.
4. There are many types of cookers, and ways to build them. Cookers generally have 3 elements or components:
 - Glazing that allows heat to enter (glass, clear plastic wrap, etc.)
 - Insulation to retain heat and maintain temperature (styrofoam, feathers, cardboard, paper, etc.)
 - Reflectors to concentrate more sunlight into the cooker (foil, mirrors, etc.).
5. There are three basic types of solar ovens on the market today – box, parabolic reflector and multi-reflector (truncated cone or pyramid). Box ovens produce lower temperatures, but are the least expensive and the most portable. Parabolic reflector ovens produce the highest temperatures but must be constantly adjusted to focus directly on the Sun. Multi-reflector ovens combine a good temperature range and can be designed to have a large cooking capacity.

Procedure (prior to class)

1. Cut insulation material. Each oven requires:
 - (1) 12" x 15"
 - (2) 12" x 9 ½ "
 - (2) 15" x 9 ½ "
2. It would be helpful to construct one oven that can serve as a model for the class to look at during the construction process.

Procedure (during class time)

1. Explain construction procedure (refer to diagram):
 - put insulation inside the box on the bottom
 - put insulation around all the walls of the inside of the box
 - tape all seams: bottom, sides, and around the inside top of the box
 - cover the inside of the box lid with foil for a reflector
 - cover the inside bottom of the oven with black construction paper
 - place the glazing on the top of the oven
 - attach the box lid by one long edge to the oven with an aluminum tape 'hinge'. The rod or stick is used to adjust the tilt of this lid to capture more sunlight.



2. Explain common problems to avoid that can cause the ovens not to seal tightly and therefore not hold in heat:
 - all seams are not sealed tightly with aluminum tape. Make sure that all the seams are covered, both inside and around the inside top opening of the of the oven. The box lid is used as a reflector, so the tape is not critical there.
 - the plexiglass glazing does not sit tightly on the top of the oven. Make sure that the top edges of the insulation are level and flat. Low spots may be filled in with extra pieces of aluminum tape
 - sides of boxes are squeezed in while being taped, thereby making the top opening too small for the plexiglass to fit.
3. Break class into groups of 4 - 5 students per group.
4. Pass out materials.
5. Have students construct ovens referring to the model as necessary.

Procedure (cooking day)

1. Mix or prepare the food to be put in the oven according to the recipe.
2. Put the food in a covered dish, or cover tightly with plastic wrap.
3. Lift glazing, set the dish and an oven thermometer on the bottom of the oven, and replace the glazing.
4. Set the oven facing the Sun.
5. Adjust the tilt of the oven (objects can be placed under one edge), and the tilt of the reflector (with a rod or stick) so that the Sun's rays are directed into the body of the oven.
6. When food is done, be sure to use a pot holder to remove the glazing and also the food.
Solar Cookers can get extremely hot!
7. Students should complete their Science Journal pages.

Related Research

1. Research food preparation in other times and in other places. Was the sun used in food preparation and food storage? How? Where? When? What were the advantages and

- disadvantages to this culture of using the sun's energy for cooking?
2. Biomass (fuel wood) is the world's largest source of cooking fuel. What are some of the social, economic and environmental impacts of the wide spread use of fuel wood for cooking?
 3. Cooking over an open fire is a terrible waste of energy. Several international agencies have developed 'energy efficient' ovens for cooking with wood. What do they look like and what has prevented its widespread introduction and use?

Related Readings

- *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.

Internet Sites

<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.

EnergyWhiz

Submit your cooking tips and favorite recipes to the EnergyWhiz Solar Cookbook on **<http://energywhiz.com/>**.

What's Cooking?

			.1	.2	.3	.4	.5	.6	.7
Nature of Matter	Standard 1	SC.A.1.3-							
	Standard 2	SC.A.2.3-			X				
Energy	Standard 1	SC.B.1.3-	X	X	X		X		
	Standard 2	SC.B.2.3-							

Benchmark SC.A.2.3.3 - The student knows that radiation, light and heat are forms of energy used to cook food, treat diseases, and provide energy.

Grade Level Expectations

The student:

Sixth

- knows forms of radiant energy and their applications to everyday life

Seventh

- knows uses of radiation, light, and thermal energy to improve the quality of life for human beings

Eighth

- extends and refines knowledge of uses of forms of energy to improve the quality of life.

Benchmark SC.B.1.3.1 - The student identifies forms of energy and explains that they can be measure and compared.

Grade Level Expectations

The student:

Sixth

- knows different types of energy and the units used to quantify the energy
- understands that energy can be converted from one form to another (for example solar energy to heat energy)

Eighth

- understands that energy can be transferred by radiation, conduction, and convection
- knows examples of natural and man-made systems in which energy is transferred from one form to another.

Benchmark SC.B.1.3.2 - The student knows that energy cannot be created or destroyed, but only changed from one form to another.

Grade Level Expectations

The student:

Sixth

- understands that energy can be changed in form
- uses examples to demonstrate common energy transformations.

Benchmark SC.B.1.3.3 - The student knows the various forms in which energy comes to Earth from the Sun.

Grade Level Expectations

The student:

Sixth

- knows types of radiant energy that come to Earth from the Sun

Eighth

- knows ways to measure the various forms of energy that come from the Sun.

Benchmark SC.B.1.3.5 - The student knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature.

Grade Level Expectations

The student:

Eighth

- knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature
- knows that the average kinetic energy of the atoms or molecules that make up an object changes when the temperature of the object changes.

What's Cooking?

conduction - the movement of heat or cold through materials that are solid.

convection - the movement of heat through air or in liquids

glazing - the clear material (for example glass or plastic wrap) that lets in light and traps heat

insulation - material used to reduce heat loss or gain

radiation - the way we receive heat from the sun each day. The energy is emitted in the form of waves/particles, and can move from one object to another without heating the area in between.

reflector - shiny device used to alter the path of light

solar collector - a device that collects and traps solar energy

solar thermal - using the Sun's energy to heat something

What's Cooking?

Cooking Tips

- Always use lids on pans, cover tightly with plastic wrap, or use cooking bags to avoid condensation on the oven glass which blocks the solar radiation.
- Temperature:
 - On a clear and sunny day the oven will heat up to 250°F or above. On these days you can cook or bake anything.
 - On a partially cloudy day the oven will heat to 200°F to 250°F. On these days you can easily cook meats, rice, baked potatoes, and frozen vegetables, but baking is not recommended.
- Adjust your cooking time to account for the lower temperature. A rule of thumb is to figure twice the regular cooking time.
- Use a meat thermometer instead of a timer to determine if the food is done.
- Any conventional recipe that would be suitable for your oven will work in a solar oven, also crock pot recipes are suitable for a solar oven.
- Foods generally use less liquids or cook in their own juices. This produces better tasting and more nutritious food.
- Foods never burn and rarely overcook in a solar oven.
- Foods particularly suited for the classroom include: hot dogs, slice and bake cookies, brownies, rice mixes, cocktail sausages in barbeque sauce, nachos, s'mores,
- Some specific food tips:
 - cook (steam) yellow and green vegetable in dark colored casseroles to prevent discoloration
 - reduce liquids in cake recipes by one half
 - cook foods in their natural state (i.e. potatoes in skins and corn in husks)
 - chewy dessert recipes such as brownies come out better than crispy ones
 - meats cook better if cut into small pieces.

Recipes

Solar S'Mores 1

24 squares from chocolate bars
12 graham crackers, halved
6 large marshmallows

Place 4 squares of chocolate on each of 6 graham crackers, top with marshmallows. Cover with remaining graham cracker squares to form sandwiches. Press to seal. Wrap with foil. Place in oven. Bake until heated and chocolate begins to melt. Serve immediately. Makes six servings.

Solar S'Mores 2

½ cup crunchy peanut butter
12 graham crackers, halved
6 large marshmallows

Spread peanut butter on 6 graham crackers, top with marshmallows and place in oven. Cover with remaining graham cracker squares to form sandwiches. Press to seal. Bake until heated. Serve immediately. Makes six servings.

Banana Boats

6 bananas
chocolate bar squares, kisses, or chocolate chips
marshmallows, large or miniatures

Peel one strip of skin from banana. Remove small amount of banana or cut slit into banana. Place chocolate and marshmallows inside banana. Wrap in foil. Heat until chocolate begins to melt. Serve immediately. Makes six servings.

Backyard Baked Beans

2 slices bacon (optional)
16 oz. can (1¾ cups) baked beans
¼ cup firmly packed brown sugar
1 small onion, chopped
1 teaspoon prepared mustard
1/4 cup catsup
2 Tablespoons Worcestershire sauce

Cut bacon into small pieces. Combine chopped onion and bacon in container with lid. Cook covered until bacon is brown and onion is tender. Add remaining ingredients. Bake covered for one hour or until beans are thickened and heated through. Makes four servings.

Florida Solar Cookies

1 cup flour
½ cup blown sugar, packed
1 teaspoon baking powder
1 teaspoon baking soda
1/4 cup butter
3/4 cup granola
1 teaspoon vanilla

Mix butter, sugar and vanilla. Add dry ingredients and mix well. Drop spoonfuls of batter onto a disposable aluminum pan. Cover tightly with plastic wrap (tape on the bottom of pan if necessary). Bake until cookies puff up and appear brown. You can test doneness by inserting a toothpick into the center of a cookie. If it comes out clean, the cookie is done.

Newton's Apples

6 baking apples, cored
3 Tablespoons sugar
6 teaspoons butter
1/4 cup raisins
1/3 cup firmly packed brown sugar
1 Tablespoon flour
½ teaspoon cinnamon
1 Tablespoon water

Place apples in a 12 x 8 inch baking dish. Place ½ Ttablespoon sugar and 1 teaspoon butter in cavity of each apple. Cover tightly with plastic wrap. Bake 1 hour in solar oven or until apples are tender. Combine brown sugar, flour, cinnamon, raisins and water. Spoon mixture in and over apples. Continue baking uncovered until sauce is thick.

