What Can I Cook?

A Lesson Plan Solar Cooking Temperatures and Solar Cookers

Grade Level: K-5

Lesson Overview: Students will become familiar with solar cooking and investigate what items can be cooked in which kind of solar ovens based on temperatures.

TEKS:

Math: K.11(B), K.13(A,B,C), K.14(A), K.15, 1.8(B), 1.9(A), 1.11(A,B,C,D), 1.12(A), 1.13, 2.10(B), 2.12(A,B,C,D), 2.13(A,B), 2.14

Science: K.1(A,B), K.2(A,B,C,D,E), K.3(A,B,C), K.4(A), K.5(A), K.6(D,E), 1.1(A,B), 1.2(A,B,C,D,E), 1.3(A,B), 1.4(B), 1.6(C,D), 1.7(A), 2.1(A,B), 2.2(A,B,C,D,E), 2.3(A,B,C), 2.4(A), 2.6(A,B), 2.7(A), 2.10(B)

Social Studies: K.13(A,B), K.14(A,B), K.16(A), K.17(A), 1.6(B), 1.8(A,B,C), 1.16(A,B,C), 1.18(A), 1.19(A), 2.8(A,D), 2.16(A,B), 2.18(A), 2.19(A)

ELA: K.1(A,B,C,D), K.2(A), K.3(C), K.4(B), 1.1(A,B,C,D), 1.2(A), 1.3(C), 1.4(B), 2.1(A,B,C,D), 2.2(A), 2.3(C), 2.4(A)

Time: Activity 1: 20 minutes, Activity 2: 30minutes to preheat ovens, 3 hours of observations (every 30 minutes for 5 minutes) or watch all day and record temps at 30 minute intervals, Activity 3: 30 minutes for research plus cooking time.

Materials: completely built solar ovens, oven thermometers, solar cookbooks, science notebooks or sheets of paper

Vocabulary: temperature, Celsius, Fahrenheit, radiation, conduction, convection, absorption, insulation

Tips to help the Solar Chef

SAFETY TIPS:

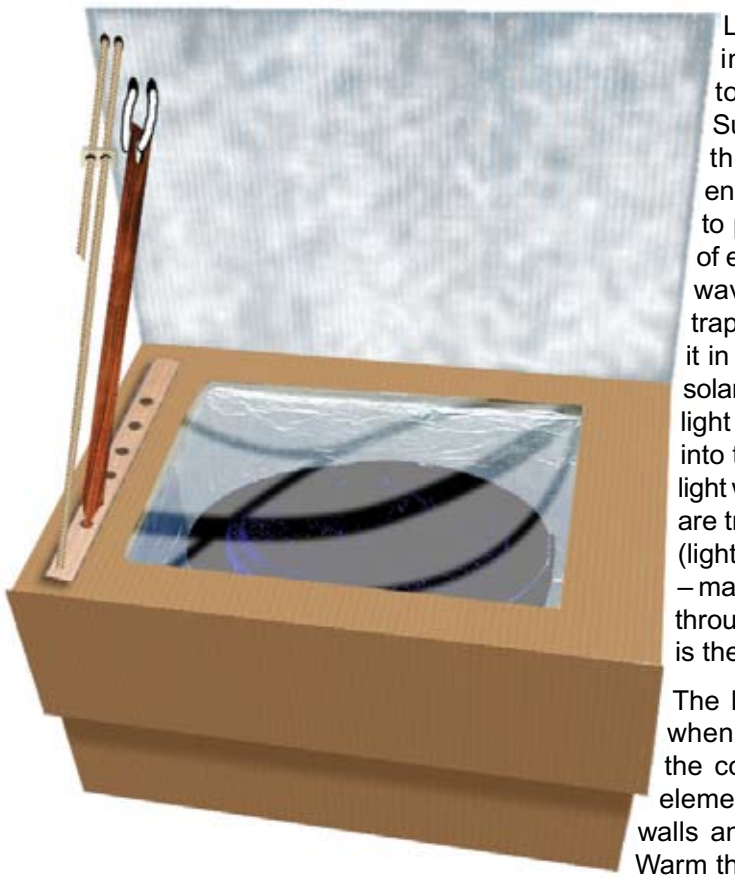
- The oven can reach temperatures of 275 degrees, hot enough to cook food and kill germs in water. Be careful not to allow students to burn fingers.
- Do not use any materials that could give off toxic fumes when heated, such as duct tape or styrofoam pellets.
- Expect cooking time to take about twice as long as conventional methods and allow about half an hour to preheat.
- Always use lids on pans, cover tightly with plastic wrap, or use baking bags to avoid condensation on the oven glass which blocks the solar radiation.

TEMPERATURE TIPS:

- 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 200oF 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.

Background: ***This activity needs to have several hours of occasional observation. If your students move from class to class, you can have the students collaborate on one large observation chart that all can have access to.***

The purpose of a solar box cooker is the same as a regular oven – to heat things up and cook food. It can also be used to purify water. The energy from regular ovens may be electricity or natural gas; the energy for a solar box cooker is the sun.



Light from the sun must be trapped in the solar oven and changed to heat energy to cook the food. Sunlight radiates light energy across the vacuum of space. Radiation energy does not need air or a force to push it; it is the natural movement of energy by waves – like light or heat waves. Some of that light can be trapped in a solar cooker by putting it in the sun. Sunlight then enters the solar cooker through the window. Some light enters directly; some is reflected into the box by a reflector. Most of the light waves traveling through the window are transformed from short wavelength (light) to long wavelength energy (heat) – making it more difficult to escape back through the window – it is trapped. This is the greenhouse effect.

The light energy turns to heat energy when absorbed by whatever is inside the cooker. A dark floor pan (heating element), dark cooking pots, food, the walls and even the window absorb light. Warm things give off waves of heat. Heat energy moves by radiation, conduction and convection. It is a law of nature that heat always travels from hot to cold. Radiation is energy in the form of waves, rays or particles. Conduction is the transfer of heat from molecule to molecule. Anything that touches a hot object will receive some of the heat; some materials are better conductors than others. Metal is a good conductor, cardboard is not. Convection is the movement of air molecules (we say, "heat rises"). The heated air inside the cooker will find "cracks" between the walls, around the top, anywhere a tiny space exists, and move outside.

TIPS FOR SUCCESS USING THE SOLAR BOX COOKER

A solar oven should take advantage of the natural forces of light and heat, and prevent the natural sources from defeating the process of cooking:

1 Reflection – add a reflector outside, and use a reflecting surface on the inside walls

2 Absorption – use dark colors where you want the light to transform to heat; use lighter colors where you do not want heat.

3 Conduction – use good conductors as cooking utensils where you want heat to go; use poor conductors for walls where you do not want heat to go

4 Convection – the hot air is trying to move to the cooler air – keep inside with a tight fitting lid and make sure walls are tight

5 Insulation – insulate to halt conduction and convection

6 Maximum use of solar energy – the solar oven window must always be facing the sun – place the cooker to catch the most sun – think about clouds and shade.

SOLAR COOKING DAYS

1 Type 1 day – clear and sunny – ovens will heat 275^{0}F to 325^{0}F and readily stay above 250^{0}F. Try cooking anything.

2 Type 2 day – hazy or partly cloudy – ovens heat to 200^{0}F to 225^{0}F – as little as 15 minutes of sun every hour will allow cooking to continue. Try meats, rice, baked potatoes, vegetables, but not breads or cakes.

3 Type 3 day – overcast – if clouds completely block the sun, one cannot cook.

BASIC SAFETY

1 The solar box cooker is a real working oven, not a toy.

2 Keep your face away from the lid when opening the oven.

3 Use pot holders to handle cooking pans.

4 Do not worry —solar cookers are capable of cooking many kinds of food. They often get 100_F hotter than crock pots. Pathogenic bacteria die at temperatures greater than 165^{0}F. As with conventional ovens, it is up to the chef to ensure that all food is fully cooked, so use a thermometer. For demonstrations, consider using pre-cooked items such as hotdogs or prepared cookie dough.

1 Point the oven toward the sun until the shadow made by the prop stick lines up directly behind the prop stick itself.

2 Adjust the reflector so that the brightest spot of sunlight reflects on the inside front wall of the cooker. This gives the interior its fullest illumination.

3 Tie the prop stick in the position to hold the reflector at the proper angle.

4 You may refocus the oven during the cooking period to keep the sun angle at the optimum position.

5 You may also position the oven "ahead" of the sun, so that the optimum sun angle will occur at a later time.

a. For long cooking dishes – focus in the morning and early afternoon.

b. To keep the oven at its hottest for steaks, chops and soufflés – refocus every 15 minutes.

c. For most casseroles, roasts, chicken – set the reflector toward or ahead of the sun to suit you schedule; over cooking is almost impossible.

d. For absentee cooking, set the oven at the mid point of focus for your time away so that the temperature will peak about an hour before you return.

e. Outside temperatures aren't critical to success, but watch out for cold wind which can increase convection though the window and lower temperatures.

TIPS FROM SOLAR COOKS

1 Always use lids on pans to avoid condensation on the oven glass that would block incoming solar radiation.

2 Preheating the oven takes about thirty minutes.

3 Dark colored cooking pans work best; if they aren't available, spray foil or disposable aluminum pans with flat black, heat resistant paint (like that for barbecue grills) – instant solar cookware. Really, any oven ware can be used.

4 Almost any conventional recipe that does not require extremely high heat can be adapted to the solar oven. Adjust the time to compensate for lower temperatures. A rule of thumb is to double regular cooking times.

5 Crock pot recipes and vegetables generally require less liquid or no liquid, and cook in their own juices.

6 Solar ovens are great for bread – put in a frozen loaf early; it will rise and then begin baking in about three hours. In the winter, solar ovens are great for raising yeast dough. Put bread in a loaf pan and invert another loaf pan over it for a lid.

7 If cooking is finished, but its too early for dinner, just close the lid; the warmth will remain in a good tight oven.

8 Cooking times in good sun – Easy to cook foods (white rice, chicken, fish, most fresh vegetables, millet quinoa, barley, cakes) 2 hours. Medium to cook foods (maize, brown rice, potatoes, lentils, black eyed peas, apples, baking bread) 3 hours; hard to cook foods (dried beans, split peas, large meat roasts) 4-5 hours.

9 Use pot holders, and be careful of steam when lifting lid.

For more information on the History of Solar Energy and its uses read the Solar Cooking Educator's Guide at http://www.wattwatchers.org/pages/solarcooking.htm

Setting the Stage: Write the following list on the board or overhead: lasagna, cake, nachos, s'mores, carrots, rice, and hotdog. Ask the students about the time and temperature (and method) needed to cook each one of these things. Investigate as to if any have ever made these items. Ask if any of these can be made using a solar oven. Keep a list of their responses for comparing to later.

Activity One: Observations

Set out and label all the solar ovens you have. In their science notebooks or on paper, each student should rotate through the ovens and write observations about each oven on a separate sheet of paper or page in the notebook. After looking at each oven, students should record similarities and differences between them. Have the students make predictions based on look of the ovens as to which items from your original list can be cooked in each oven. Some things they may notice are size of oven, design, window shape or size, reflectors, insulation methods, and material the oven is made of.

Activity Two: Heat 'em Up (can be done on a separate day)

Take the ovens outside to a sunny place and place one oven thermometer in each oven. Make sure you can read the oven thermometer without opening the oven. Opening the oven will release the heat. Allow the ovens to pre heat for 30 minutes. Record the temperature for each oven every 30 minutes for 3 hours. If you have different students throughout the day, you could have a class wide observation list and have the students you have at the time of the reading record the data to share with all. Have the students record the temperatures onto the correct pages in their notebooks. Do they see any differences in how fast the ovens heated up or the final temperature?

Activity Three: What can I cook?

Have the students look through the solar cookbooks for things that are cooked at the optimal temperature for each oven. Revisit the list from the starter activity and decide which ovens could be used to cook each of the items on the list. (There may be more than one). Now have the students gather the foods needed to cook their recipes and prepare your solar cooked meal.

Discussion:

Go through some of the following questions with your students to reinforce the concepts.

1 What happens inside the oven to create the heat?

2 What kind of energy does it use?

3 Who pays for that energy?

4 What happens if you open the lid while you are cooking?

5 Why do the different size ovens cook at different temperatures?

Extension:

Have the students plan a healthy meal using all the ovens. Choose one item to cook in each oven and serve a healthy, solar oven cooked lunch. Don't forget the desert!

Resources:

http://solarcooking.org
http://www.wattwatchers.org/pages/solarcooking.htm
http://www.solarovens.org/recipes/
http://www.cookwiththesun.com/

OTHER HELPFUL TIPS:

- Any conventional recipe that would be suitable for your oven will work in a solar oven, also crock pot recipes are particularly suitable for using in the 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.

IDEAS FOR USING YOUR SOLAR COOKER AND TASTY RECIPES

Simple Heat-n-eat Ideas

- Hot dogs
- Nacho cheese sauce (can be heated in the jar with the lid removed)
- Baked beans (add hot dog pieces for beanie weenies)

Easy to Bake Oven Ideas

- Slice and bake cookies
- Frozen bread dough (let rise in pan then bake)
- Frozen pizza (french bread pizza fits well)
- Packaged rice mixes

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.

Florida Solar Cookies

1 cup flour

½ cup brown 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 tablespoon 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.

Party Franks

1 pkg mini cocktail frankfurters

2 cups barbeque sauce

Place cocktail frankfurters and barbeque sauce in a covered glass dish or a dish inside a baking bag. Place in oven until heated through—approx. 20 minutes in a hot (350°) oven, 45 minutes in a cool (250°) oven.