Unit: Cooking with the Sun and Solar Ovens

Lesson #10: Let's Get Cooking!

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DESCRIPTION: The purpose of this lesson is to provide students with a hands-on experience using the sun to cook cornbread or cookies. Students will also learn to use an infrared thermometer. There is also an optional extension for the class or individual students to design and build the ultimate solar oven.

GRADE LEVEL(S): 4-8

SUBJECT AREA(S): Solar energy, energy transformation, solar cooking

ACTIVITY LENGTH: 30 minutes of prep time; 2-3 hours in class

LEARNING GOALS:
At the end of this lesson students will be able to:

- Follow and prepare a recipe for cookies.
- Learn to take and record oven temperature every 30 minutes using an infrared thermometer.
- Evaluate the three ovens with a pros and cons list for each one after cooking.
- Write one or two of their own questions.
- Make suggestions for design changes.

STANDARDS MET:
Next Generation Science Standards:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- 5-PS1-3. Make observations and measurements to identify materials based on their properties.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Educator Background:

- An understanding of the basic components of solar ovens and how solar ovens work
- Solid understanding of energy transformation and heat transfer
- Knowledge of reflection, absorption, and insulation
- Understanding of the engineering design process

Student Background:

- An understanding of the basic components of solar ovens
- Basic knowledge of energy transformations
- Basic understanding of insulation, absorption and reflection (or at least some familiarity with the terms)

Other Materials List:

- Student handout "Solar Oven Comparison Data Sheet"
- Student handout "My Ultimate Solar Oven"
- A sunny day and a quiet, sunny location away from distractions
- A Box Solar Oven (Instructions included in "Let's Build Solar Ovens!")
- An Automobile Shade Solar Oven (Instructions included in "Let's Build Solar Ovens!")
- A Copenhagen Style Solar Oven (Instructions included in "Let's Build Solar Ovens!")
- 3 lightweight black pots with lids. These should be identical for comparison purposes.
- 2 cooking trivets on which to set the pots (the cooling rack will work for the Auto Shade Oven)
- Oven roasting bags for the Auto Shade and Copenhagen ovens
- One infrared thermometer
- One temperature data sheet per student
- Toothpick
- Hot pads

Vocabulary:

- Reflective panel
- Insulation
- Absorption
- Heat
- Temperature
- Energy/Energy transformation

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Lesson Details:

Activity:

1. Prepare the cookie dough either with your class or beforehand.

2. Place the cookies into the pans and set up the sun ovens as described below.

3. Have students use the infrared temperature gun to check the temperature every 30 minutes, record the data on their data sheets and turn the box to face the sun if needed. The food is generally cooked when condensation begins to drip inside the bag or down the Plexiglas of the box cooker.

4. Allow at least 90 minutes before checking the cookies with a toothpick to see if they are done. Baked items do not brown in the sun. Opening the oven or bag allows the heat to escape quickly, so be thoughtful about when you decide to check the food.

5. Important: Always use hot pads when checking food. It will be very hot.

Recipe: "Sunny Doodles"

It will be best to grease the pans and press the dough into the bottom of the pans as one large cookie. Sprinkle cinnamon sugar evenly on top of each large cookie. This will make the finished product consistent between all three ovens for comparison of data and it allows for easier sharing with a classroom of students. Each recipe makes 24 round cookies. You may want to double the recipe for this project.

- 1 cup butter
- 1 1/2 cups sugar
- 2 large eggs
- 2 3/4 cups flour
- 2 teaspoons cream of tartar
- 1 teaspoon baking soda
- 1/4 teaspoon salt

- 3 tablespoons sugar
- 3 teaspoons cinnamon

Directions:

1. Mix butter, 1 1/2 cups sugar and eggs thoroughly in a large bowl.
2. Combine flour, cream of tartar, baking soda and salt in a separate bowl.
3. Blend dry ingredients into butter mixture.
4. Meanwhile, mix 3 tablespoons sugar, and 3 teaspoons cinnamon in a small bowl.
5. Form the cookies in the pans and sprinkle them with the cinnamon-sugar.

File Box Oven

1. Place the covered pan inside the box on top of a cooking rack or trivet that will allow air to circulate under the pot. Set the Plexiglas on top of the small box. Make sure that the box is sealed securely so that no air is escaping. Use tape or string to tilt the reflective panels evenly. Align the box so that there is an even shadow on each side of the box. This will ensure that the sun oven is pointed directly in the sun.

Special note: This file box oven tends to cook unevenly when all four panels are angled out to reflect the sun. Why? Are they not angled correctly? Are they reflecting off each other? It was left in the lesson because this particular oven lends itself well to scientific inquiry and the testing of one variable at a time. For example, a student could suggest that only one panel be used and reflected downward rather than back. The panels could be tilted differently, or maybe the bottom panel could be taken off and the two side panels taped onto each side of the middle panel to provide more reflective area. Let the students redesign this oven and test their own experiments after the first cooking trial.

Auto Shade Oven

1. Place covered pan in an oven proof cooking bag and tie closed.
2. Place cooking pot and bag on the cooking rack. Aim the oven so that the foil on the auto shade is facing the sun.

Copenhagen Oven

1. Place covered pan on a trivet inside an oven proof cooking bag and tie closed.
2. Place bag, trivet and cooking pan in the bottom panel of the cooker and aim it toward the sun so that an even shadow falls on each side of the cooker.

Closure:

Discuss the students' reactions while you enjoy the food that you cooked. Clean up.

Evaluation:

Have students fill out the assessment sheet. Encourage students to think up one or two more of their own evaluative questions to write down.

Extension:

This lesson includes an optional extension for the whole class or individual students or pairs to create their ultimate Solar Oven using materials from school, home and the dollar store.

Lesson Notes:

A suggestion would be to divide the students into three groups and have a volunteer parent work with each group to build one of the ovens. You only need one of each oven for this activity. Or have a volunteer parent come three different days (or once a week for several weeks) to work on the solar ovens over time with different small groups out in the hall. It works out well to spend as much time as needed to build the ovens in the rainy, winter months to have them completed and ready when the sun comes out again. You can keep cookie dough in the freezer if necessary.

Alternatively, you could make nachos or S'mores in these ovens if you do not want to deal with raw eggs or a recipe. If you opt for chips with cheese, or chocolate and marshmallows on graham crackers you should have students check the food every ten minutes, as these items will cook much faster.

- Cooking pots: Any cooking vessel can be used, but lightweight dark pans work best. Any oven safe container can be painted with nontoxic, heat resistant black paint. (B-B-Q paint is a good choice).
- Black enamel cookware is inexpensive and can be found in most stores and online. If you plan to do more solar cooking experiments with students, it might be a good idea to invest in a few identical cooking pots.
- Thermometers: The infrared temperature gun allows students to observe the temperature safely. It is pointed at the oven at close range. It displays the temperature. The student records the time and temperature and hands the device to another student. You can use any standard kind of cooking thermometer that reaches to at least 350 degrees, but you will need to buy a thermometer for each oven. They can be difficult to read during cooking because plastic or glass steams up.