

Lesson Plan: SOLAR COOKERS

Project: Heating smores with solar cookers

Example images at <http://solarcooking.org/plans/>

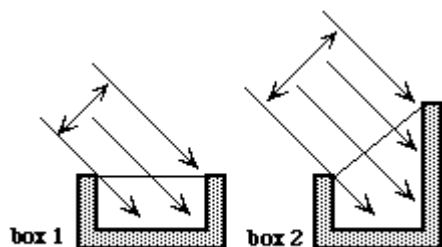


Teaching Plan:

Introduction:

Discuss the science of a solar cooker, its worth and environmental effects (5-10 minutes)

- **Newton's Law of Heating.** Food placed in a 250 degree oven will take longer to cook than the same food placed in a 350 degree oven. Newton's Law of Heating provides a more precise description of how the rate at which items cook is affected by the starting temperature of the food and the temperature of the oven.
- **Heat gain.** The heat gain inside a solar box cooker is due to "the greenhouse effect." Sunlight passes easily into glass covered enclosures. Once light is absorbed by materials within the enclosure, it is transformed into longer wavelength heat energy. **Dark materials** placed in the bottom of the oven will absorb more sunlight and generate more heat. If the heat energy builds up faster than it is lost, the oven will become hotter. *A poorly insulated oven will lose heat too fast to attain temperatures hot enough to cook.* The solar box cooker has a dark cookie sheet in the bottom and is wrapped with good quality insulation to allow for adequate heat gain and retention.



The orientation of the apparatus to the sun also affects the heat gain. The picture shows that the greatest amount of sunlight passes through the glass when it is perpendicular to the sun's rays.

- **Heat loss.** The loss of heat from a solar oven is described by the Second Law of Thermodynamics, which explains how heat travels from hot to cold. Heat loss is a combination of **conduction, radiation, and convection**. Heat is lost from the solar oven by conduction, when the heat travels through the molecules of the physical box to the outside air. Radiation is also a factor in heat loss, when hot air radiates through the glass lid. The aluminum foil and foil tape used throughout the construction slow the heat loss due to conduction and radiation.
- **Manufacturing process:** Who makes them? Who uses them? When? How?
 - Third world countries use them, as well as in the event of a natural disaster, solar cookers are useful to making food when no technology is available.

-
- **Advantages?**
 - Convenient
 - Reduce deforestation
 - Does not use wood-fire which creates carbon monoxide (health-damaging pollutants)
 - Uses no fuel, Alternative energies
- **Disadvantages?**
 - Can succumb to wind, or bad weather (in which case, would not work)
 - Only can use during hot part of the day
 - Must have a decent design to collect sunlight
 - Takes longer to cook things
 - Can lose heat much more quickly than pans, and cannot store heat to warm food
- **What things should you focus on designing your solar cooker?**
 - Shape and size of the solar cooker
 - The amount of reflecting material (tin foil, in this case) to use and where

Build Solar Cooker (20 minutes)

Test cook smores (30 minutes)

Test temperatures (2 minutes)

Conclusion (1-2 minutes)

Mentors scientific background:

- Engineering process → Ask, Imagine, Plan, Create, Improve
- Heat and solar energy, photovoltaics
- Alternative energy resources
- Reliability



Modules/Demos or Project

Building the Cookers (Designs may vary):

1. Fold/design cardboard into desired outline/frame as to collect the optimal amount of sunlight
2. Reserve a spot for food/liquids to be put in
3. Attach tin foil to the insides of the apparatus (using tape or glue) to reflect sunlight onto food/liquid

Testing the cookers:

1. Place food (smore) in spot reserved for food
2. Place in sunlight at optimal angle (perpendicular to sun's rays) to collect sunlight

Analyzing:

1. This experiment will be tested solely based on the feel of the smore; others, such as the temperature of liquids, would be measured with a thermometer

Closing Activities/Discussion:

- What were some problems that you encountered while designing your cooker?
- Did your cooker heat the smore to a fairly noticeable degree?
- What other factors would you need in order for your cooker to work even better?
- How did each team member contribute to the project?
- How did you manage your time?

Materials:

- Cardboard
- Tape & glue
- Tin foil
- Marshmallows
- Sunny day with minimal wind
- Plastic wrap

**References/Citations:**

- 1) Science of Solar Cooking: http://www.tamaradwyer.com/solcook/phys_sci.html
- 2) Advantages/Disadvantages: http://en.wikipedia.org/wiki/Solar_cooker#Advantages
- 3) Roger Wilpitz Encinal High School Solar Cooker project
- 4) Example images for solar cookers: <http://solarcooking.org/plans/>