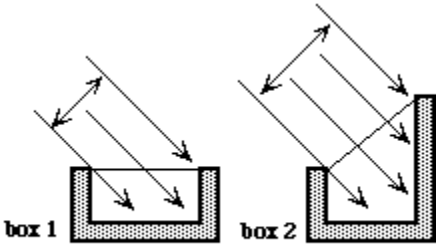
Malcolm X
Lesson Plan: **SOLAR COOKERS**

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 travels from the oven to the food and that is how the food can cook.
- **Heat gain.** The heat gain inside a solar box cooker is due to "the greenhouse effect." To describe the greenhouse effect, first, sunlight must be able to pass easily into an enclosure. Glass is often used because light can travel through glass with relative ease. Once light is absorbed by materials within the enclosure, the light is transformed into longer wavelength heat energy. **Dark colored materials** placed in the bottom of the oven will absorb more sunlight and generate more heat, while light colored materials will take longer to heat up. 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 materials to allow for adequate heat gain and retention.



The orientation of the apparatus to the sun also affects the heat gain. The picture to the left shows that the greatest amount of sunlight passes through the glass when it is perpendicular to the sun's rays. The most effective shape that a solar cooker can be made into is a parabolic shape because it reflects the light in the most efficient manner.

- **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 objects to cold objects. 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 because

hot air radiates through the glass lid. The tin foil used throughout the construction slow the heat loss due to conduction and radiation.

- **Manufacturing process:** Who makes them and when are they used?
    - Solar cookers are often used by people in third world countries due to the lack of technology. They can also be used in the event of a natural disaster.
- **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 be used during the hot parts 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 (aluminum foil, in this case) to use and where to place it

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

*Note: If there is no sunshine during the day of the demo, a heating light bulb may be used to simulate the sun's radiation.

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
- Graham crackers, Marshmallows, and chocolate
- Sunny day with minimal wind
- Lamp with heating light bulb

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/