Activity Title: Powered by the Sun!

Activity Objective(s): In this activity, teams will use data and graphs to determine the best components to use for a solar box cooker. They will design and build a box cooker, and test it out to see if it works well enough to make S'mores!

Grade Levels: 3 - 5

Process Skills: Experimental design, measuring, graphing, and data analysis.

Lesson Duration: One 60 min session

A solar cooker heats up in the Sun!

Materials and Tools (per group of three students):

- Thermometer
- Timers
- Cardboard box
- Aluminum pans
- Aluminum foil
- Black construction paper
- One piece of plexiglass big enough to cover the box
- Sunshine, OR gooseneck lamp with 100 W bulb
- S'mores fixin's (graham crackers, marsh mellows and chocolate)

Club Worksheets: (Make copies for each student to put in binder)

1. Design Challenge
2. Imagine and Plan
3. Experiment: Data Table
4. Summary
5. Fun With Engineering at Home

Club Facilitator or Teacher Notes by Stage:

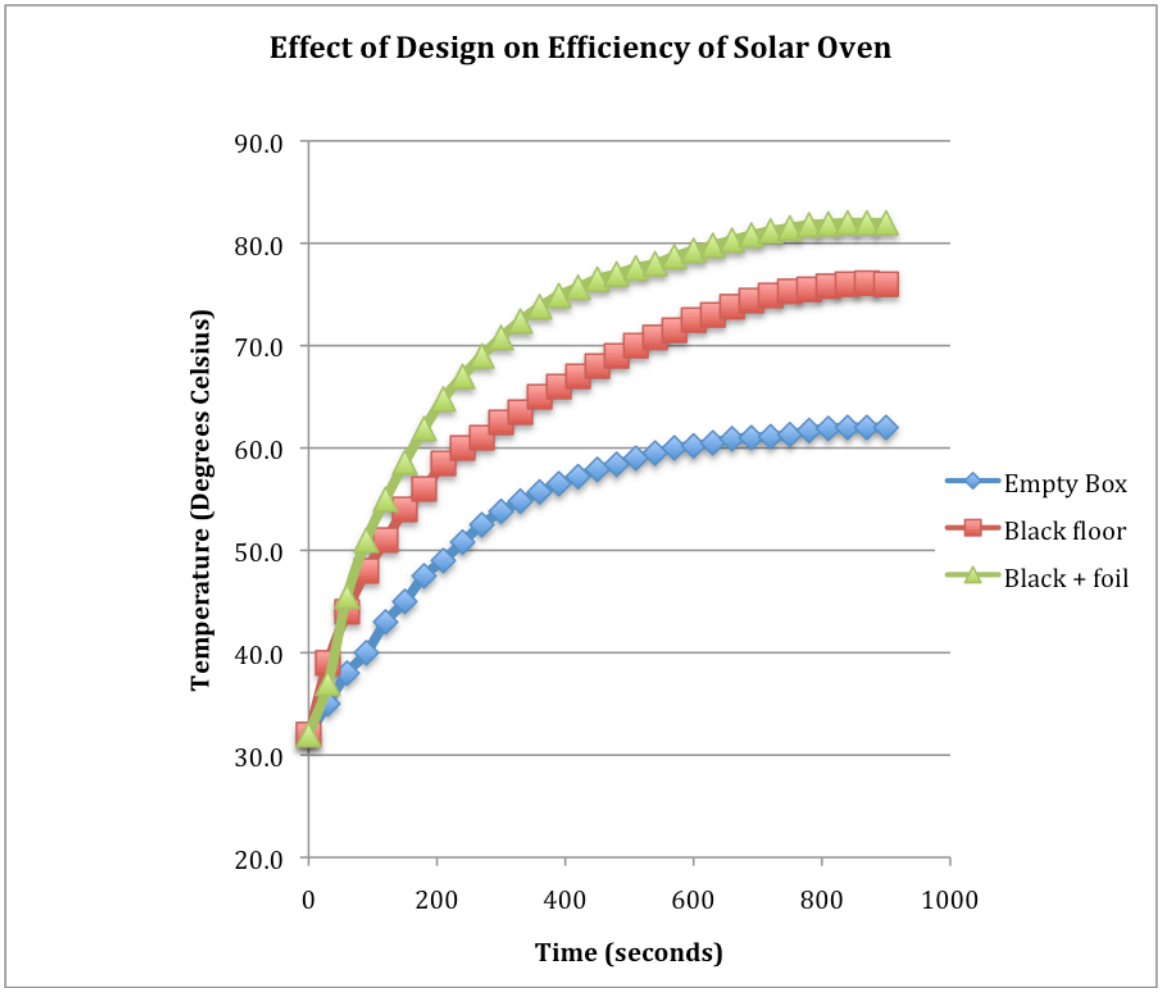
Stage 1: Set the Stage (Approx 10 minutes): Ask!

Explain to the students that there is no atmosphere on the Moon, so temperatures fluctuate through a wide range. In the shadowed areas the temperature is –180 °C (or – 300 °F), and in the sunlit areas it is about 100 °C (or 212 °F), which is the boiling point for water! These are serious extremes for human beings!

Since there is no atmosphere and thus no clouds on the Moon, there are no cloudy days! During the daytime, it is always sunny! So why not take advantage of all that sunshine, and put the Sun to work? Ask the students to come up with some ideas of how they could use solar energy to do some work for them.

Today we'll build an oven that uses energy from the Sun to cook food. Let's make S'mores! It's easy!

Stage 2: Imagine and Plan (Approx 10 min)



- Break the students into teams of three and distribute the **Design Challenge** worksheet.
- Ask the students to look at the graph on the worksheet (see above). Three different scenarios are depicted on the graph:
    1. A plain cardboard box, covered with plexiglass
    2. A cardboard box with black construction paper on the bottom
    3. A cardboard box with black construction paper on the bottom and aluminum foil on the sides
- Ask the students to discuss among themselves which materials seem to make a better solar cooker.
- Hand out the **Imagine and Plan** worksheet, and ask them to list the materials they want to use for their solar cooker, and to draw a picture of their design.
- Note: Remember, the thermometers are glass. They have a small rubber "keeper" on them so that they will not roll on a table when laid down. Tell them to be careful when handling the thermometer.

Stage 3: Create (Approx 10 minutes)

- Build the solar cooker!

Stage 4: Experiment (10 minutes)

- Now that the students have their solar oven, hand out the **Experiment: Data Table** worksheet.
- Students should record the temperature on the thermometer before placing it in the box.
- Students should place a S'more and the thermometer in the box and close the plexiglass lid.
- Place the box in direct sunlight (they may have to tilt the box so that there are no shadows inside). If it is a cloudy day, use the goose neck lamp with the 100W bulb.
- Students should record the temperature on the thermometer every 30 seconds for 10 minutes. At the end of 10 minutes, ask them to report out around the room. Whose cooker got to the highest temperature? Whose cooker melted the marsh mellows and the chocolate?
- If there is time, the students should graph their data. From the graph in the handout, which design does their data most closely resemble?

Stage 5: Challenge Closure

- Hand out the Challenge Closure / Summary Sheets (please collect one per team and save in a folder for NASA).

1. Design Challenge

During the lunar day, the sun shines very brightly and it gets very hot. Why not put the Sun to work? Today, we will design and build a solar oven. To test the oven, we will try to make S'mores!

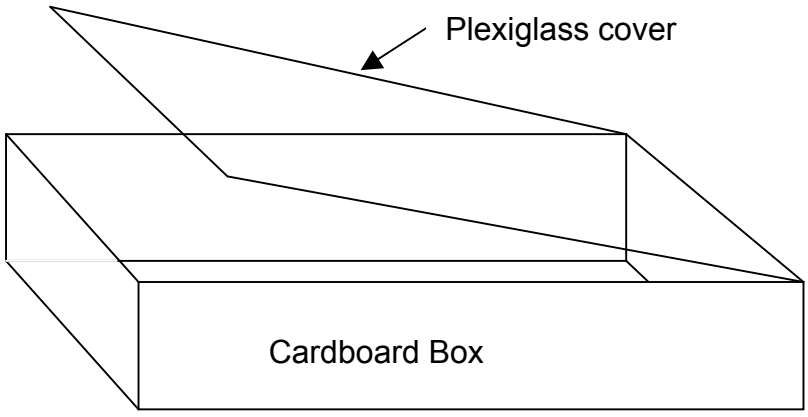
Materials:

- Thermometer
- Timers
- Cardboard box
- Aluminum pans
- Aluminum foil
- Black construction paper
- One piece of plexiglass big enough to cover the box
- Sunshine, OR gooseneck lamp with 100 W bulb
- S'mores fixin's (graham crackers, marsh mellows and chocolate)

Design Specifications

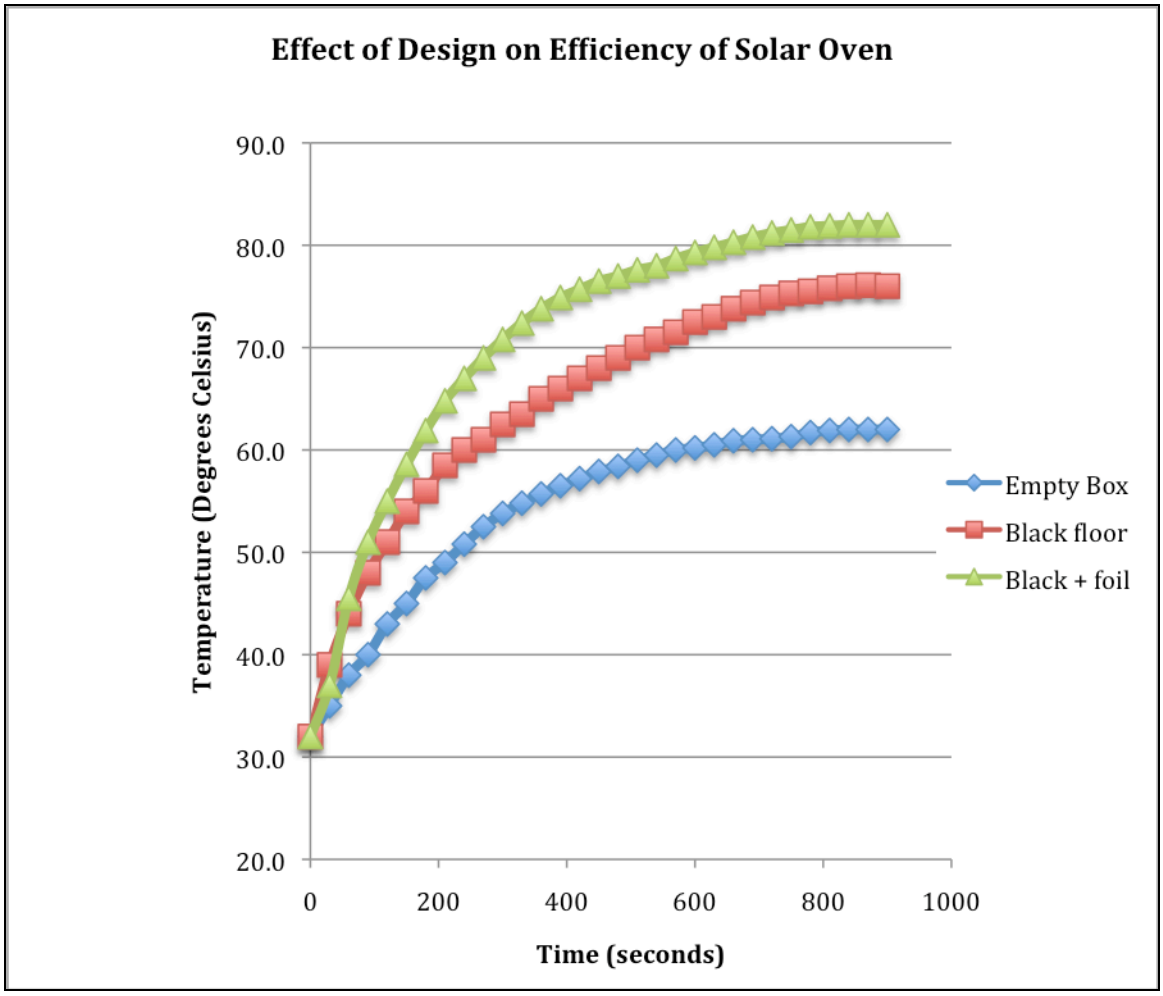
Your solar oven must meet the following specifications:

1. It must have a "footprint" of no more than 40 cm x 40 cm.
2. In 10 minutes, the temperature inside the box must increase by 10 degrees Celsius.
3. You may use any available materials to line the bottom and inside of box.



2. IMAGINE and PLAN

Here is some information on solar ovens that other people have made. Use this information to help you design your solar oven.



All of these solar ovens were made of a cardboard box covered with a clear, plexiglass lid. For the most part, plexiglass allows sunlight to pass through, but it will not let the heat back out.

The curve labeled "Empty Box" represents the data from an empty cardboard box with no changes made to it.

The curve labeled "Black floor" was for the same box, but with black construction paper placed on the floor of the box.

The curve labeled "Black + foil" was still the same box with the black construction paper on the floor, but also with aluminum foil lining the sides of the box.

What difference do the different materials make in the design of the solar over?

How do you think the black construction paper affects how well the solar oven works?

What purpose do you think the aluminum foil might serve?

Sketch your plans for your solar oven:

3. Experiment: Data Table

Now that you have built your solar oven, let's see if we can make S'mores! Follow these steps:

1. Record the temperature in the room in the chart below.
2. Place the thermometer and the uncooked S'more in the solar oven.
3. Record the temperature in the chart below every 30 seconds.

Room Temperature: _____ ^{o}C

Time	Temperature
0 seconds	
30 seconds	
60 seconds	
90 seconds	
120 seconds	
150 seconds	
180 seconds	
210 seconds	
240 seconds	
270 seconds	
300 seconds	
330 seconds	
360 seconds	
390 seconds	
420 seconds	
450 seconds	
480 seconds	
510 seconds	
540 seconds	
570 seconds	
600 seconds	

4. Summary

1. Did your S'mores melt? What was the maximum temperature reached by your solar oven?

2. What could you have done to make your solar oven work better?

3. Do you think it would make a difference to use actual sunlight compared to light from a lamp? Why or why not?

4. What other things could you use a solar oven for other than making S'mores?

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Team Name:_____

Fun with Engineering at Home

Activity 11: *Powered by the Sun!*

Today we designed and built an oven that uses solar energy (or the light from a lamp) to heat things up.

- **Home Challenge**: During this week talk with your parents and friends about all the ways we could use solar energy here on Earth.
- List four uses for solar energy that you have heard about:
    - _____
    - _____
    - _____
    - _____

Look up "the greenhouse effect." Can you explain what "the greenhouse effect" has to do with your solar oven?

What else does the greenhouse effect have to do with?

HAVE FUN!!