BUILD A SOLAR OVEN

OBJECTIVE

To demonstrate an understanding of Engineering Design Process while utilizing each stage to successfully complete a team challenge.

CHALLENGE

The team mission is to design and build a solar box cooker, and test it out to see if it works well enough to make S'mores!

PROCESS SKILLS

Experimental design, measuring, graphing and data analysis

MATERIALS

General building supplies

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, marshmallows and chocolate)

Oven mitts

WORKSHEETS

Imagine and Plan

Experiment and Record

Quality Assurance

Fun with Engineering at Home

MOTIVATE

- Have students watch the video "Living on the Moon":

  http://svs.gsfc.nasa.gov/goto?10515

SET THE STAGE: *ASK, IMAGINE, PLAN*

- Share the *Design Challenge* with the students
- Tell students that if they succeed in their design, a tasty treat will be had!

CREATE

- Hand out the materials to the students and challenge them to build their own solar ovens.

EXPERIMENT

- Have students follow the directions on the *Experiment and Record* worksheet to complete their experiment.
- Once the oven is built, 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 a goose neck lamp with the 100W bulb.
- Ensure students use oven mitts when moving the plexiglass lid or removing items from the solar oven once exposed to the sun.

IMPROVE

- If there is time, have students inspect their designs and the experiment results. Allow teams to rework their design if needed.

CHALLENGE CLOSURE

- Engage the students in a discussion with the following questions:
  - *Whose oven got to the highest temperature?*
  - *Whose oven melted the marshmallows and the chocolate?*
  - *What could you have done to make your solar oven work better?*
  - *Does it make a difference to use actual sunlight compared to light from a lamp? Why or why not?*
  - *What else could you cook using a solar oven?*
  - *How did the distances from the bottom reflective surface affect the cooking of the food in your oven?*

END OF PROGRAM

This session concludes the NASA Beginning, Engineering, Science and Technology series. Students now should have a firm grasp of the Engineering Design Process and how it is applied in real applications of our quest to travel to the Moon, Mars and beyond. Print out a certificate for each student for all the steps to becoming a NASA BEST student (p.?).

DESIGN CHALLENGE

Can we cook while on the Moon?

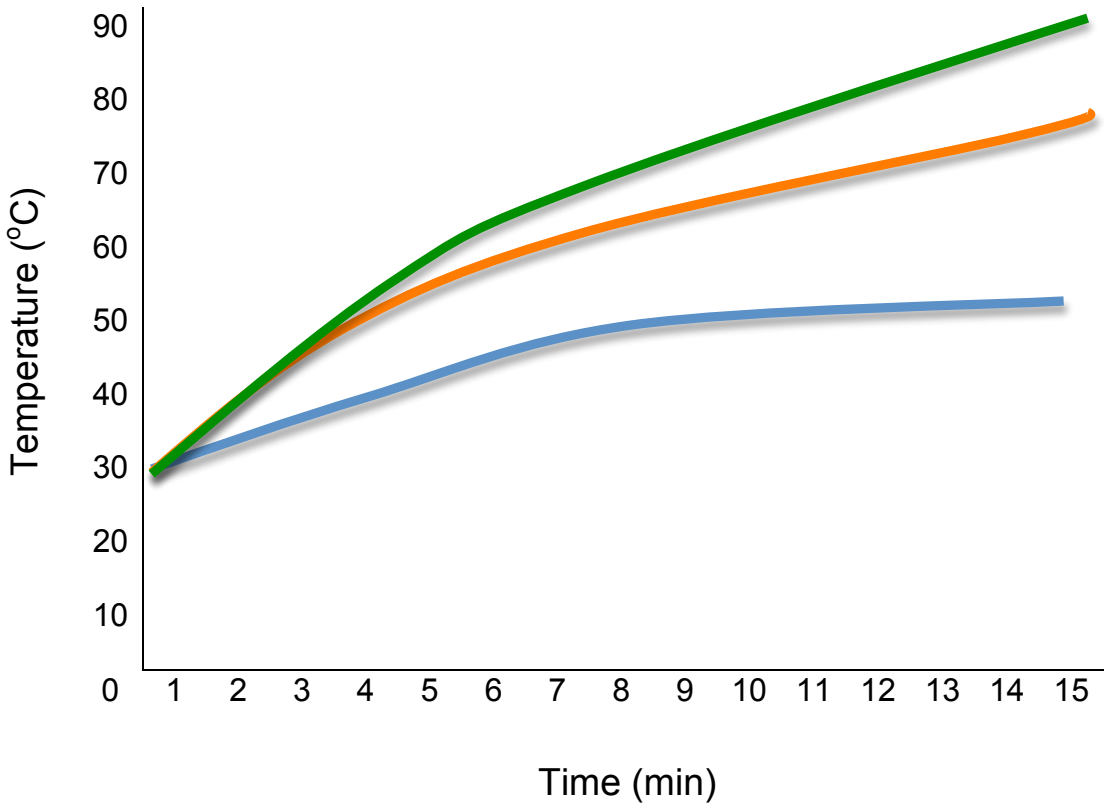
While we might have to bring just about everything with us when we establish a habitat on the Moon, one thing we won't need is solar energy. There may be no atmosphere, no climate nor weather on the Moon, but that all means it DOES make it an ideal place to collect solar energy. The majority of the Moon is exposed to sunlight constantly, except briefly during a rare lunar eclipse. If that energy could be harnessed, we could use it to power most everything in our habitat…including that most important device that helps us cook our food – an oven!

The Challenge: Your mission is to design and build a solar oven to cook your own S'mores simply using a cardboard box and a few extra materials. 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 15°C.*
3. *You may use any available materials to line the bottom and inside of box.*
4. *Your food may not touch the bottom of the oven directly. You must design a way to best cook 2 S'mores off of the bottom surface.*
5. *You must cook the two S'mores at two different heights. You will also test which height allows food to cook at a faster rate.*

IMAGINE AND PLAN

Below is a graph showing data that demonstrates the efficiency of three different solar oven designs: (1) plain box, (2) box with a black bottom and (3) a box with aluminum foil and a black bottom.



Which line (blue, orange or green) do you think represents the solar oven that is just an empty box?

_____

Which of line do you think represents the solar oven with aluminum foil and a black bottom?

_____

What purpose do you think aluminum foil might serve?

_____

_____

IMAGINE AND PLAN

How will you meet the design constraint of the food not being allowed to touch the bottom surface of the solar oven?

_____

_____

_____

Predict how the height of your food from the bottom surface will affect how quickly it is cooked.

_____

_____

Draw and label your solar oven:

EXPERIMENT AND RECORD

1. Using the materials provided, build you solar oven based on your design. Remember the goal is to capture heat in your oven to cook S'mores.
2. Record the starting temperature of the oven: _____ °C
3. Record the heights of the food from the oven floor: _____ cm _____ cm
4. Place the S'mores in the oven. Close the lid and begin cooking.
5. Record the temperature change in the table below. Make sure to use oven mitts when lifting the lid or manipulating anything inside the oven!

Time Min:sec	Oven Temperature °C	Time Min:sec	Oven Temperature °C
0:00		5:30	
0:30		6:00	
1:00		6:30	
1:30		7:00	
2:00		7:30	
2:30		8:00	
3:00		8:30	
3:30		9:00	
4:00		9:30	
4:30		10:00	
5:00		10:30	

EXPERIMENT AND RECORD (continued)

Record any observations of your food while it is cooking. These observations will help to determine which food placement height allows for quicker cooking.

Time Min:sec	S'more 1 _____ cm	S'more 2 _____ cm
1:00		
2:00		
3:00		
4:00		
5:00		
6:00		
7:00		
8:00		
9:00		
10:00		

QUALITY ASSURANCE FORM

TEAM NAME:

NAMES OF ENGINEERS:

	YES	NO
Did the solar oven increase in temperature by more than 10°C?		
Did this team's design differ from your team's design?		
Did both S'mores melt?		

Which height position worked best in this solar oven? _____

List the specific strengths of the design:

List the specific weakness of the design:

How would you improve the design?

Inspected by: _____

Signatures: _____

_____

_____

FUN WITH ENGINEERING AT HOME

Today we learned a fun way to harness the Sun's energy, trapping the radiant heat from the Sun to cook food. With your family members, look up the meaning of "the greenhouse effect". Can you explain what "the greenhouse effect" has to do with the solar oven your team designed and built?

Discuss with your family members the following question:

Why do we use the term "the greenhouse effect" when talking about global warming?

YOU BE THE TEACHER!

Show your family how to build a solar oven. Test it out by cooking something new. How about baking a pizza in your solar oven? Grab a frozen pizza from the store or make one from scratch. Use the results of your experiment to determine at what height to place your pizza in the oven.

This marks the end to the NASA Beginning, Engineering, Science and Technology series. We encourage you to continue to look for more activities, articles and podcasts about NASA any day and every day!

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