Solar Cooker

Create a solar cooker to make S'mores and in the process learn about solar energy and its use as a fuel source.

Engineering Design Process Outline

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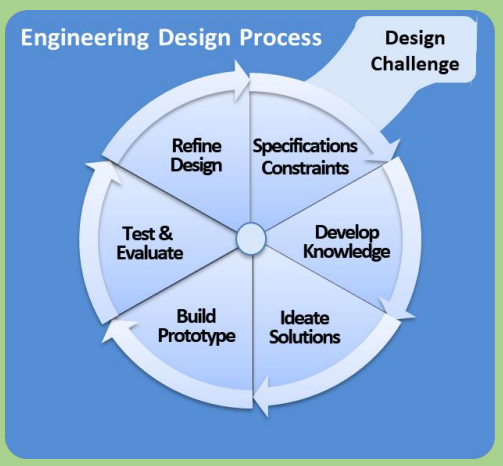


Step 1: Design Solar Cookers

Do you love cooking using your stovetop, oven or microwave? Better yet, do you simply enjoy good home cookin' while spending time with your family?

Around the world, many families are trying different ways to:

- cook nutritious meals with little money
- pasteurize water (kill disease-causing organisms)
- lower energy costs

Solar cookers use solar energy — the energy from direct sunlight — to heat, cook or pasteurize food and beverages. As an alternative to gas, wood, or electric stoves, solar ovens are a low-cost, eco-friendly technology that can improve the lives of families who have little money.

In this project, you will work as a **solar design engineer*** to design a solar cooker to make S'mores.

Before you enjoy your tasty treat, let's learn more about your design challenge.

*To view a short career video on solar design engineering hold Ctrl and click to follow this link or copy and paste this link into your browser: https://www.youtube.com/watch?v=wnTUvWjNTMM

Step 2: Your Challenge - Design a Solar Cooker!

Your challenge is to work as a solar engineer to build a solar cooker that cooks four S'mores in 30 minutes. You will build a solar cooker and design the best angle to cook your S'mores.

You will have **limited time and materials** for your solar cooker.

Materials

- One 14-inch pizza box
- Aluminum Foil
- Plastic Wrap
- Black construction paper
- Tape
- Glue
- Popsicle Sticks
- Energy from the Sun

S'Mores

- Marshmallows
- Chocolate bar
- Graham crackers

Step 3: Specifications and Constraints

To design a solution to this challenge, first identify the specifications and constraints.

Specifications are what your solution must do. They are the requirements. For example, specifications for solar engineers might be that they design a structure that collects solar energy to help to grow plants during the winter.

Constraints are things that limit your solution. A constraint may be how much you can spend or how much time you have to complete the challenge. For example, a constraint for a solar engineer might be that they design a solar panel system for a school that costs less than $25,000.

What are the specifications and constraints for this challenge? Check off the correct choices below.

	SPECIFICATION	CONSTRAINT
Limited materials	☐	☐
Limited time	☐	☐
Design a solar cooker that cooks four S'mores in 30 minutes	☐	☐
Design a cooker that uses energy from the sun	☐	☐

Step 4: Design Criteria

Good job identifying the specifications and constraints! Now that you know what you are supposed to do, here are some criteria that you will use to evaluate your solar cooker.

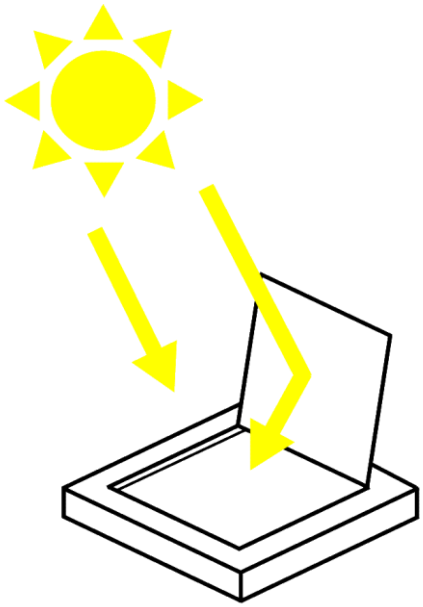
Specifically, you want your solar cooker to fully cook four S'mores (melted chocolate and gooey marshmallows) so that they are ready to eat in 30 minutes.

Below is what you will use to rate your solar cooker. Use it to think about how you will build your solar cooker!

Solar Cooker Rating	1	2	3
Angle Design	The sunlight reflects outside of the solar cooker.	The sunlight reflects inside the box, but is NOT centered.	The sunlight reflects inside the box AND is centered.
Ready to Eat	The chocolate did not melt AND the marshmallows did not become gooey.	The chocolate melted OR the marshmallows became gooey.	The chocolate melted AND the marshmallows became gooey.
Time	2 or less S'mores are ready to eat after 30 minutes	3-4 S'mores are ready to eat after 30 minutes	4 S'mores are ready to eat in less than 30 minutes.

Step 5: Develop Knowledge

What is a Solar Cooker?



Solar cookers capture solar energy to warm food. They work by reflecting sunlight off the open lid onto the bottom of the box. The bottom is covered with clear plastic wrap to trap the heat. The reflecting surface needs to be angled to direct the maximum amount of sunlight. The box receives sunlight both **directly** from the Sun as well as **reflected** off the lid of the box.

Step 6: Build a Prototype - Part I

Engineers build **prototypes**, or a first version of a product, to test their design ideas.

Follow the instructions below and use the materials given to you to build you solar cooker.

Remember the design criteria that you will be using to evaluate your solar cooker!

PART I INSTRUCTIONS:

1. Cut the edges off the top cover of the pizza box so that it becomes just one flat surface.

2. Attach a single piece of aluminum foil to the inside of the cover using tape. Keep the foil smooth to reflect the most sunlight!

3. Place the black construction paper in the bottom of the box; black absorbs the most light and captures the most energy from the Sun.

Step 7: Build a Prototype - Part II

Engineers build **prototypes**, or a first version of a product, to test their design ideas.

Follow the instructions below to **determine the optimum box-lid position for your solar cooker**.

Remember the design criteria that you will be using to evaluate your solar cooker!

PART II INSTRUCTIONS:

1. Go outside and place the pizza box in full direct sunlight.

2. Position the lid so that the bottom and foil covered lid face the sun.

3. Move the foil covered lid up and down and look for the reflection of the sun from the foil onto the black paper bottom. Adjust the solar cooker so that the reflected sunlight is centered on the bottom of the box. To be effective the lid needs to reflect as much sunlight as possible towards the bottom where the S'mores will be located.

4. Secure the lid's position at that angle using two Popsicle sticks and tape.

Step 8: Test Your Design

Ok, now comes the final decision you must make as an Engineer on this project.

Do you want to place just the marshmallow or the chocolate on graham cracker in the cooker?

Or do you want to place the entire constructed S'more in there?

Put your 4 S'mores into the solar cooker. Cover the box opening with plastic wrap. Make sure the box is positioned facing the sun and monitor your S'mores to see if the chocolate and marshmallows are melting.

After 30 minutes, evaluate your design using the design criteria on the following page.

Step 9: Evaluate Your Design

Now that you have designed and tested your solar cooker, evaluate your solar cooker using the rubric below.

Solar Cooker Rating	1	2	3
Angle Design	The sunlight reflects outside of the solar cooker.	The sunlight reflects inside the box, but is NOT centered.	The sunlight reflects inside the box AND is centered.
Ready to Eat	The chocolate did not melt AND the marshmallows did not become gooey.	The chocolate melted OR the marshmallows became gooey.	The chocolate melted AND the marshmallows became gooey.
Time	2 or less S'mores are ready to eat after 30 minutes	3-4 S'mores are ready to eat after 30 minutes	4 S'mores are ready to eat in less than 30 minutes.

1. How would you rate your solar cooker for angle design?

   We give it a (1, 2, 3):

2. How would you rate your solar cooker for ready to eat?

   We give it a (1, 2, 3):

3. How would you rate your solar cooker for time?

   We give it a (1, 2 or 3):

Step 10: Refine Design

Engineers use test results to refine their designs.

Based on your evaluation of your solar cooker, how would you refine your design?

1. Where did you score the lowest?

2. What could you do to improve those areas of your design?

Step 11: Design Solution

Congratulations! You have successfully used engineering design to make a solar cooker! You have just done what solar engineers do every day - design and construct devices that use energy from the sun.

If you didn't have a chance to view the video at the beginning click here to explore a career as a Solar Design Engineer*.

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