STEAM Experiment: Engineering a Solar Oven

Grade Level:	Time Frame:
4th Grade	2 days, 50 minutes each

Standards (ALCOS Science):

4) Design, construct, and test a device that changes energy from one form to another (e.g., electric circuits converting electrical energy into motion, light, or sound energy; a passive solar heater converting light energy into heat energy).*

Objectives:

Students will investigate different types of materials to determine which will best convert solar light energy into heat energy and be most effective in engineering a solar oven.

Students will design a model of a solar oven and test the model by collecting data on its performance and determining methods of improvement.

Background Information:

The sun radiates light and heat, also known as **solar energy**. Solar energy makes it possible for life to exist on Earth and without heat from the sun, Earth would freeze.

Solar energy has existed as long as the sun and while people have not been around that long, they have been using solar energy in a variety of ways for thousands of years. We use solar energy in agriculture to grow plants and we can even use it to cook food.

The first solar box cooker was built in 1767 by Horace de Saussure, a Swiss physicist. It reached temperatures of 190 degrees Fahrenheit and was used to cook fruit. Today, there are many different types of solar cookers being used all around the world in growing numbers.

Made Possible By:

TOYOTA USA FOUNDATION
Investing in a smarter tomorrow.

NEED
National Energy Education Development Project

Because solar ovens do not use fossil fuels, they are safe, do not produce pollution or cause deforestation. The sun is a **renewable energy** source; it is abundant, convenient, nonpolluting, and affordable. It is the ultimate **sustainable** energy source.

Renewable Energy- energy that comes from resources that are naturally replenished on a human timescale; these include wind, solar, geothermal, biofuel, and hydro.
Sustainable-refers to the concept that renewable energy resources will always be around and never be depleted

Materials:

- Use a variety of household items to let students choose from when building their design! Here are some ideas:
  - Shoe boxes
  - Pizza boxes
  - Other cardboard boxes or pieces
  - Aluminum foil
  - Aluminum pans
  - Cellophane
  - Wax paper
  - Wooden dowels or skewers (with removed sharp end)
  - Black construction paper
  - Duct tape
  - Masking tape
  - Scissors
- FOR EACH GROUP OF STUDENTS:
  - Timer (30 minutes/10 minute increments)
    - Teacher could use one timer or give one to each group
  - One flat thermometer (such as a "student thermometer" or aquarium thermometer)
  - "Solar Oven Engineering Design, Data, & Project Rubric" handout packet
- For Class:
  - Access to a sunny day for testing Solar Oven Models
  - Marshmallows, graham crackers, chocolate
    - enough for class s'mores
      *remember to check for any food allergies or restrictions
      *may need access to microwave in case of solar oven technical difficulties

DAY 1 ACTIVITIES

Engage (10 minutes):

1. Brainstorm! Students will list as many words as they can think of to describe the sun. The teacher should list the words on the board.
2. Students will reflect on the following questions and answer out loud.

a. Why do we need the sun?
b. How do we use the sun's energy?
c. What new ways could we use the sun's energy?

Explore (35 minutes):

1. Design it! Students will be divided into groups of 3 or 4 to design and build their own solar oven that will be able to melt a marshmallow and chocolate bar.
    a. Teacher should distribute the "Solar Oven Engineering Design, Data, & Project Rubric" handout packet.
    b. Teacher should discuss the expectations for the goal, design, and expectations for the project.
2. Teacher should show examples of materials that students can use to build their design but not disseminate any material until each group has sketched a design and explained how it works on the design handout.
    a. However, students may want to touch and feel samples of the materials to get an idea of what they want to use.
3. Students will sketch their design on the My Design handout and explain how they expect it will work.
4. When students have finished design, they will build their Solar Cooker Oven using the selected materials provided.
    a. Teacher should remind students that they will be building a model; it doesn't have to be perfect but needs to be able to perform an experimental test!

Evaluate (5 minutes):

1. Share it! Students will choose one group in the classroom to visit and view their model.
    a. Students will ask one question about the other group's model and give one "tip" or advice for the other group's model.

DAY 2 ACTIVITIES

Engage (5 minutes):

1. Discuss it! Students will turn to a neighbor and briefly discuss the following:
    d. What successes do you expect to have when we test our model today?
    e. Do you expect any challenges when we test our model?

Explore (35 minutes):

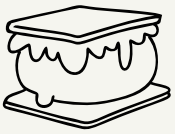
1. Test it! Students will test their Solar Oven Models outside in a safe, sunny area.
    a. Students will set up their model with the appropriate number of bottom graham cracker, chocolate bar, and marshmallow for each group member (or however many can fit).
    b. Teacher should distribute one thermometer and one timer to each group. Students will place their thermometers inside of the solar oven and leave it for a minute or two to register the correct initial temperature.
    c. Students will use the Data Collection handout to record the initial temperature and observations in the "0 minutes" column.
        i. They should describe the state of the marshmallow and chocolate, along with any other observations.
        ii. They should start their timer for 10 minutes OR 30 minutes and watch for each 10 minutes.
    d. Students will record their data each 10 minutes until reaching the total 30 minutes.
    e. Students will determine if there was any change in temperature and if their model heated its contents by answering the Results questions in the data table.

Evaluate (10 minutes):

2. Share it! Each group will list or draw any changes they would make to their model in the space provided on the Data Collection handout.
    a. Each group will share their experiment conclusions with one other group and discuss their successes and challenges with using their model.

References:

https://education.nationalgeographic.org/resource/power-sun



Name of Engineer: _____

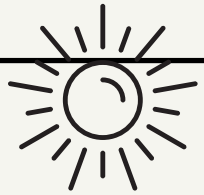
Solar Oven Engineering: Project Rubric

The goal of this project is to use an alternative energy source to cook s'mores. You will design a solar oven using household items that will cook the s'mores using only the sun's heat energy.

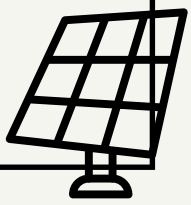
Requirements:	____ points *Above Average*	____ points	____ points *Average*	____points	____points *Needs Work*
Team Work!					
Effort/ Creativity					
Solar Cooker Design					
Presentation					
Data Collection					
Total Points: ____/____					

Teacher Comments:

Name of Engineer: _____



My Design

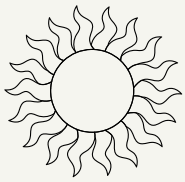


How It Works

_____

_____

Name of Engineer: _____



Solar Oven Engineering: Data Collection

Use the table below to record the temperature in your oven and observations of the marshmallow and chocolate. You should record your data every 10 minutes.

	0 minutes	10 minutes	20 minutes	30 minutes	Results:
Temperature					Was there any temperature change?
Observations					Did the marshmallow or chocolate melt?

After testing your model, would you make any changes to your design to make it work better next time? Write or draw your thoughts below:

Conclusions: