STEM IN THE LAB

innovate. explore. discover.

Idaho National Laboratory

# OUR MISSION

INL's K-12 STEM Program works to inspire Idaho's future STEM workforce, impact students, teachers and families by integrating best practices in STEM education, and empower employees to become STEM mentors to transform K-12 STEM into a driver for innovation.

# SOLAR OVENS OVERVIEW

*Researchers at the Department of Energy's Idaho National Laboratory have developed an inexpensive way to produce plastic sheets containing billions of nanoantennas that collect heat energy generated by the sun and other sources. Students will create their own solar ovens to bake s'mores on for a STEM project relating to the Idaho National Laboratory's solar project. This is a fun STEM activity for students to use the engineering design process and to give them an idea of what the Department of Energy's researchers do at Idaho's National Laboratory.*

# SCIENCE BEHIND IT

*Several scientific phenomena are involved in making your oven the best heater it can be. Heat is the form of energy (sometimes called thermal energy) that is transferred by a difference in temperature. You want to transfer the sun's heat to your solar over. Reflection is the throwing back of light, heat or sound by a body or surface, like a mirror. The shiny foil you'll use in your oven will reflect the sun's light and heat inside your oven. During absorbtion, energy is taken into a material rather than reflected. You will line the inside of your oven with black paper so it can absorb the light and heat being reflected into it. Another energy process you should be familiar with for this project is convection, which is the transfer of heat by the movement of a gas or liquid. You'll use plastic wrap to make your oven airtight so the air warmed by the sun doesn't leave your oven through convection. One final energy term important to this project is insulation. Insulating materials prevent heat leaving your oven through radiation. That's why you are going to line the inside of your oven with a cheap and effective insulator—newspaper!*

# MATERIALS

- *One pizza box (Per student or group)*
- *Newspaper*
- *Tape*
- *Scissors*
- *Black Construction Paper*
- *Clear Plastic Wrap*
- *Aluminum Foil*
- *One Piece of Notebook Paper*
- *One Pencil or Pen*
- *One Ruler. Wooden Dowel, or Stick*
- *Timer or Phone Timer*

# RESEARCH AND DESIGN PROCESS



**RESEARCH QUESTIONS**

*Like engineers, students will sketch out a design of their solar ovens. While students are planning their design prompt them with questions.*

- *"What materials do you plan on using for your solar oven?"*
- *"How big is your pizza box?"*
- *"What problems could you run into while creating your solar oven?"*
- *"What materials will you use for your solar oven to make it hot enough to bake s'mores in?"*

*If time, allow students to make a few different sketches and allow students to share their design's with the class or review each other's designs.*

**PROCEDURES**

1. *After students have generated a plan for their solar ovens, allow students to begin constructing their designs and prototype.*
2. *Once time is up, allow students to form a line and have a museum walk of their displayed projects.*
3. *If time, give students time to share positive comments and feedback about each other's solar ovens.*
4. *Allow students to take their solar oven outside to test.*
5. *Give each student or group graham crackers, Hershey bars, and marshmallows to construct their s'mores.*
6. *Have students set a timer and see who's s'more bakes the fastest in their solar oven.*

# HELPFUL GUIDELINES, TIPS AND TRICKS

1. *The pizza box needs to be folded into its box shape and closed.*
2. *Place the piece of notebook paper in the center of the lid of the box and trace its outline on the lid. Put the piece of paper aside.*
3. *Carefully cut the two long edges and one of the short edges of the rectangle that you just traced on the lid of the box, forming a flap of cardboard.*
4. *Gently fold the flap back along the uncut edge to form a crease.*
5. *Wrap the underside (inside) face of this flap with aluminum foil. Tape it on the other side so that the foil is held firmly. Try to keep the tape from showing on the foil side of the flap. The foil will help to reflect the sunlight into the box.*
6. *Open the box and place a piece of black construction paper in so it fits the bottom of the box. This will help to absorb the sun's heat.*
7. *Close the box, roll up some newspaper, and fit it around the inside edges of the box. This is the insulation that helps hold in the sun's heat. It should be about 1 to 1 1/2 inches thick. Use tape to hold the newspaper in place, but only tape it to the bottom of the box, not the lid.*
8. *Cut two pieces of plastic wrap an inch larger than the flap opening on the box top. Open the box again and tape one piece of plastic wrap to the underside of the flap opening. After taping one side, BE SURE TO PULL THE PLASTIC WRAP TIGHT, and tape down all four sides so the plastic is sealed against the cardboard. Then close the box and tape the other piece of plastic wrap to the top of the flap opening. Again, be sure the plastic wrap is tight and tape down all four edges to form a seal. This creates a layer of air as insulation that helps keep the sun's heat in the box.*

# EXTENSION ACTIVITIES



- *Students can improve their solar ovens or make changes that they think would help their solar oven bake food items better.*
- *In science journals or on a piece of paper, students can write a list of other items they could bake in their solar ovens. Students may take their solar ovens home to try baking other items. For example, students could bake a mini pizza or cookies in their solar oven at home.*
- *Students can write or experiment what they think would happen if they used a lighter piece of construction paper for their solar oven instead of black.*
- *In science journals or on a piece of paper students could write about what they think would happen if they placed their solar ovens out at night to try and bake food items.*
- *Students can find a way to reduce the amount of sunlight on their solar ovens.*
- *Students can make observations to determine the effect of sunlight on Earth's surface.*

# STANDARDS

### NGSS ENGINEER STANDARDS

- *K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.*
- *K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.*

### KINDERGARTEN

- *K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface.*
- *K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*

### FIRST GRADE

- *1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.*

# RESOURCES


*https://thefutureofthings.com/3736-flexible-nanoantenna-capture-abundant-solar-energy/*
*https://www.nextgenscience.org/sites/default/files/K%20combined%20DCI%20standardsf.pdf*
*https://www.nextgenscience.org/sites/default/files/1%20Combined%20topicsf.pdf*
*https://www.education.com/science-fair/article/design-solar-cooker/?utm_medium=social&utm_source=pinterest&utm_campaign=evergreen&utm_term=02112 019_img+s8_ac_ms_s_&utm_content=solar_oven*