SCIENCE FAIR CENTRAL

Maker Corner Activity

THE POWER OF THE SUN

Grade Level: Middle School

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THE HOME DEPOT

Discovery EDUCATION

Solar power is Earth's most abundant energy source!

Overview

Take a guess: What is Earth's most abundant energy source? If you guessed the sun, then you're correct! Solar power provided by the sun by far exceeds any other kind of energy—renewable or non-renewable—on Planet Earth.[1] In this activity, students will learn about thermal energy and heat transfer. They will work together as they try to harness the energy of the sun by designing, creating, and testing a solar cooker. After considering how their solar cooker could help developing countries around the world, they will then be challenged to refine their designs in a way that could benefit people in these areas.

This activity focuses on **Designing Solutions**, **Creating or Prototyping**, **Refine or Improve**, and **Communicating Results** stages of the Engineering Design Cycle.

Engineering Design Cycle

- Defining the Problem
- **Designing Solutions**
- **Creating or Prototyping**
- **Refining or Improving**
- **Communicating Results**

Objectives

Students will be able to:

Design, build and **test** a solar ovenz
Analyze how to **modify** and **improve** its design
Evaluate how the improved designed could be used to help people in developing countries

Heat always moves from a warmer object to a cooler one.

Materials

For teacher use:

- Computer or other technology with the ability to project
- Utility Knife

For students to share:

- Masking tape
- Black duct tape
- Aluminum tape
- Insulation tape
- Glue
- Plastic wrap
- Reflective insulation
- Scissors
- Bag of large marshmallows, enough for every student to have at least one
- Paper plates
- Black construction paper

Enough for every four students:

- One cardboard box (empty pizza boxes can also work)
- One aluminum tray
- Ruler
- Solar Oven Design Handout
- Solar Oven Design 2.0 Handout

Have you ever wondered . . .

What is heat transfer?

Heat energy and thermal energy are two terms often used interchangeably. Thermal energy exists within the molecules of an object. When an object has heat energy, its molecules move very quickly. Colder objects have molecules with less energy that move more slowly. Heat transfer occurs when thermal energy moves from one object (or surrounding) to another. Heat always moves from a warmer object to a cooler one, and never the reverse. This is because objects naturally work towards having the same amount of heat energy.[2]

What does heat transfer have to do with a solar oven?

The rays emitted by the sun have a lot of thermal energy. When they strike an object on earth, they automatically move to this cooler object, which makes this object warmer and creates heat! A solar cooker is a closed, sealed box that gets hotter and hotter from the sun's rays. Different features (reflectors to collect and redirect sunlight, insulation, and/or a black-colored inside) help turn this closed box into an oven that is truly powered by the sun. [2]

What are the benefits of a solar oven?

Though solar ovens are undoubtedly slower than electric ovens, they also come with considerable benefits. Around the world,

Solar ovens reduce negative environmental impacts.

approximately three billion people cook over fires that burn fuels like kerosene, charcoal, wood, and animal dung. Cooking this way is one of the leading causes of air pollution and contributes to over 2.5 million deaths each year. In addition, people in developing countries (mostly women and girls) often have to spend hours each day gathering enough fuel to prepare for cooking. Solar ovens could benefit these communities by minimizing the negative health effects of cooking, as well as reducing its environmental impacts.

In addition, females would be able to apply the time they used to spend collecting fuel materials to other important activities, like education or economic opportunities.[3]

Make connections!

How does this connect to students?

As issues of pollution, global warming and climate change are becoming more and more prevalent, it grows increasingly important for students to be aware of clean energy sources. Solar ovens are just one of the many ways that the sun's energy can be harnessed for power. Exploring this concept will give students a greater understanding of Earth's most abundant clean power source.

How does this connect to careers?

Renewable Energy Engineer—A renewable energy engineer researches and develops new forms of renewable energy, as well as seeks to further designs of solar cells, wind turbines and hydroelectric dams.

Mechanical Engineer—Mechanical engineers research, design, develop and test mechanical devices related to all aspects of renewable energy, such as wind turbines and the solar panels, electric generators and pumps that are used in solar power plants.[4]

International Aid Worker—International aid workers help distribute and dispense humanitarian aid to people and regions affected by disaster. The skills needed can vary immensely and may range from knowledge of nutrition to nursing, engineering, or finance.[5]

How does this connect to our world?

When you live in a developed country, it can be easy to forget that others around the world do not have stovetops, ovens or microwaves readily available. As a result, people in these countries (mostly women and girls) have to resort to cooking methods that often produce fumes that are harmful to the environment and their own health. This activity will help make students aware of these challenges, while also probing them to think of innovative clean energy solutions that could possibly be used in countries around the world.

Blueprint for Discovery

Prior to class arriving:

- Arrange the solar oven materials in a visible part of the classroom and create a list of the available materials on the board or a piece of chart paper.
- Write the Quick Write question on the board.
- Photocopy the *Solar Oven Design* and *Solar Oven Design 2.0* handouts

During class:

Part 1

1. Begin class with a two-minute Quick Write: What comes to mind when you think of the sun? Once two minutes are up, encourage students to share their response with a partner.

2. Ask students to raise their hands if they wrote down something related to heat. Can anyone explain why things get hot from the sun?

3. On the board, write: "Heat = Thermal Energy." Explain that heat energy and thermal energy are the same thing. When an object has thermal energy, its molecules are energized and move very quickly—much more quickly than if they were cold. Heat always wants to move from a hotter object or surrounding to a cooler object or surrounding. The sun is hotter than anything on Earth, which is why thermal energy is always transferred from the sun's rays to whatever it touches.

4. Move on to explain that students will be working in groups to experiment with thermal energy and heat transfer as they build their own solar oven. In other words, they will be creating an oven that uses the sun as power...not electricity or gas! Hold up one of the empty boxes and explain that it will be their job to experiment with the materials available so they can capture and trap the sun's thermal energy in this box so a marshmallow can be cooked.

5. Direct students' attention to the materials that will be available to them as they create their design. Hold up a few of the key materials, such as the aluminum foil tape, black construction paper and plastic wrap, and have students discuss how they may be used to harness, capture or trap the sun's rays. Tell students that they may use any of the materials available to create their solar oven.

6. Divide students into groups of four and pass out one Solar Oven Design handout to each group. Review the directions included in Step #1, and then allow student groups about 40 minutes to complete this step and build their ovens.

Part 2

1. On a sunny day, place the ovens in a safe place outdoors that receives direct sunlight. Insert a few marshmallows (enough for each group member) inside each oven.

2. As students wait for their ovens to heat, instruct them to complete the first two columns of Step #2 on their Solar Oven Design handout.

3. fter 30 minutes, students may open their ovens and see how the cooking is coming along. If the marshmallows all need more time, allow 10-15 additional minutes. If certain ovens have already cooked their marshmallows, bring students' attention to these ovens so they can consider how they were constructed differently.

4. As students enjoy their (hopefully gooey) marshmallows, instruct them to complete the third column of Step #2 with their group members.

Part 3

1. Engage students in a full-class discussion about what seemed to work well in their designs and what could be improved upon. Encourage students to listen to the ideas of others, as they will all be expected to refine their designs.

2. Explain that ovens that use clean energy like theirs are in need around the world. There are many organizations that work to help people in developing countries gain access to different clean cooking sources. Show students this video and explain that the video was created by an organization who gets support from the United Nations Foundation. Like the clean cook stoves seen in the video, solar ovens could also have the ability to change people's lives.

3. Instruct students to Think/Pair/Share about how a solar oven could benefit those without access to a safe cooking source.

4. Pass out the Solar Oven Design 2.0 handout and challenge students to consider how they would change the design of their oven to be used in a developing country. Instruct students to consider parts of their original design that would need tweaking to function optimally, as well as aspects of their design that may need to be changed entirely. Encourage collaboration between groups and the sharing of ideas as students modify and refine their designs.

Take Action

Possible Extension Activities:

1. Students can conduct additional research on the cooking problems experienced in developing countries, as well as organizations that are working to create change. Guide students in organizing an event where they can educate others about this global issue, share the solar cookers they created, and raise money for an organization that helps promote solar cooking around the world.

2. Besides cooking, how else might solar energy be used to solve problems? Encourage students to choose a problem at home or globally that could be solved through harnessing the power of the sun. Students can then share their problems and solutions with each other...and maybe even give one of the solutions a try!

National Standards

Science

Next Generation Science Standards

MS-PS3-3
Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-ETS1-1
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-3
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Technology Education

Next Generation Science Standards and **International Technology and Engineering Educators Association**

Students will develop an understanding of Design. This includes knowing about:

- Attributes of design.
- Engineering design.
- The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Mathematical Practice

Common Core

CCSS.Math.Practice.MP1
Make sense of problems and persevere in solving them.

CCSS.Math.Practice.MP5
Use appropriate tools strategically.

English Language Arts

Common Core

CCSS.ELA-LITERACY.CCRA.W.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.SL.4
Present information, findings, and supporting zzzzvvv such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Sources

1. Perez, Richard. “A Way to the Most Abundant Energy.” Scientific American. https://www.scientificamerican.com/article/a-way-to-the-most-abundant-energy/

2. Layton, Julia. “How Solar Cooking Works.” How Stuff Works. https://science.howstuffworks.com/environmental/green-science/solar-cooking1.htm

3. Global Alliance for Clean Cookstoves. United Nations Foundation. http://cleancookstoves.org/home/index.html

4. Layton, Julia. “Top 5 Renewable Energy Careers.” How Stuff Works. https://money.howstuffworks.com/5-renewable-energy-careers.htm

5. Talty, Alexandra. “Seven Tips for Becoming an International Aid Worker.” Forbes. https://www.forbes.com/sites/alexandratalty/2013/10/10/millenial-thursdays-the-down-and-dirty-of-international-aid-work/#66852ed31d70

Solar Oven Design

Step 1: Brainstorm and Build

With your group, take a few minutes to discuss, brainstorm, and sketch your initial design idea for your solar cooker below. Once you have a design sketched, collect your materials and get started building. Remember: It's okay to make changes to your design as you begin to build!

Step 2: Design Justification

Material	Why did we choose this material?	Did this material function the way we anticipated? *Why or why not?*

Solar Oven Design 2.0

Step 1: Discuss how your original oven could be improved so that it...

1. Works better than it did before
2. Could be used to cook in a developing country

Step 2: Create a diagram of a modified solar oven below, being sure to label the new materials you would use. *(Note: If you would like to use materials that aren't currently available in the classroom, that's okay!)*

Step 3: Explain

Develop a paragraph that explains your group changed your oven in the way(s) that you did. How will this help improve its functioning? How could this be used to help cook in developing countries around the world?