GET COOKING (2 HOUR)

In this activity, students will build a simple solar cooker. They will make observations and qualitatively describe the melting rate of a piece of chocolate in the cooker.

OVERVIEW

Topic: Solar power

Real World Science Topics

- An exploration of engineering design
- An exploration of solar energy

Objective

Students will gain an understanding of how different materials respond to solar energy, and they will use engineering design principles to plan, construct, test, and modify a solar cooker.

Materials Needed for Teacher Demonstration

- pizza box
- plastic wrap
- aluminum foil

Materials Needed for Student Teams

- two pizza boxes
- aluminum foil (about 3 meters per team)
- plastic wrap (about 0.5 meter per team)
- invisible adhesive tape
- duct tape
- scissors
- insulating material (foam, shredded paper, etc.)
- matte black paint or black construction paper
- chocolate bars (two)
- stopwatch or clock

Teacher Preparation

Depending on student ability, you may wish to construct a model solar cooker prior to the activity. If you choose to do this, follow the directions in the steps described in the activity. Alternatively, you may opt to challenge your students to design the solar cooker without teacher assistance; in this case, no teacher preparation is needed.

GET COOKING (1 HOUR)

Standards Met

NATIONAL SCIENCE STANDARDS ADDRESSED

CONTENT STANDARD A:

As a result of activities in grades 5–8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD B:

As a result of their activities in grades 5–8, all students should develop an understanding of

- Properties and changes of properties in matter
- Transfer of energy

CONTENT STANDARD E:

As a result of activities in grades 5–8, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F:

As a result of activities in grades 5–8, all students should develop an understanding of

- Personal health
- Populations, resources, and environments
- Science and technology in society

NATIONAL MATH STANDARDS ADDRESSED

- Investigate how a change in one variable relates to a change in a second variable.
- Recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom or in everyday life.
- Build and draw geometric objects.
- Design investigations to address a question and consider how data-collection methods affect the nature of the data set.
- Propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.
- Solve problems that arise in mathematics and in other contexts.

GET COOKING (1 HOUR)

NATIONAL TECHNOLOGY STANDARDS ADDRESSED

CREATIVITY AND INNOVATION

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

- Apply existing knowledge to generate new ideas, products, or processes
- Create original works as a means of personal or group expression
- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

TECHNOLOGY OPERATIONS AND CONCEPTS

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:

- Understand and use technology systems
- Select and use applications effectively and productively
- Troubleshoot systems and applications
- Transfer current knowledge to learning of new technologies

Sources

National Science Teachers Association

http://books.nap.edu/html/nses/overview.html - content

National Council of Teachers of Mathematics

http://standards.nctm.org/document

National Educational Technology Standard

http://cnets.iste.org/currstands/cstads-netss.html

1. **Warm-Up Activity:** Introduce the activity by displaying the pizza box, aluminum foil, and plastic wrap to the students. Have students identify the typical uses for each of these materials. Then ask students to think about how these materials could be used to cook dinner. Prompt students by having them think about what happens when they cover food with plastic wrap and place the food in the microwave. Also ask: What happens when you wrap hot things with aluminum foil? Why might hot pizzas be delivered in cardboard pizza boxes? Students should think about how all of these materials relate to keeping things hot. Allow students to brainstorm for several minutes, and then tell them that in this activity they will use these materials to design and build a solar cooker. If students need clarification about the term solar cooker, tell them that a solar cooker is a simple oven that uses the radiant energy of the sun to heat food or water. Tell students that it's important that the solar cooker collects and traps the sun's energy.

2. Break the class into small teams of three to five students. Pass out the materials to each team as well as the Student Handouts. The materials for this activity are shown in the photo below.

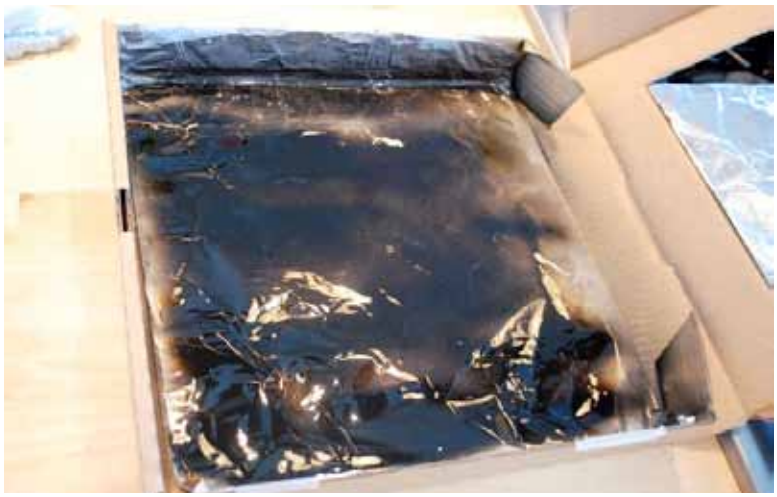
3. At this point in the activity, decide if your students will be designing the solar cooker with their teams or if they will be following a set of procedures (detailed below). If they will be designing the solar cookers independently, instruct students to work together to create a sketch of their solar cooker as well as brainstorm a list of steps to build the solar cooker. Allow them several minutes to brainstorm steps and write them out in list form. Each group should have their sketches and steps approved by you before proceeding with construction of the solar cooker. Encourage students to explain their reasoning for different features of their solar-cooker design. Offer the groups feedback to help improve their design, pointing out any parts of the list that may be incomplete or problematic. Make sure that students have utilized all of the materials in their lists of steps.

4. Once students have received teacher approval for their designs, allow them time to construct their solar cookers. In most cases, students will need approximately one hour to construct their solar cookers. Circulate as they work and answer any questions they may have during their design and construction. Once all groups have constructed their solar cookers, resume the activity at Step 13.

5. If your students will need more involved instruction to build a solar cooker, instruct them to carefully cut three sides out of the top of one pizza box to create a flap, as shown in the image below. Assist any students who may have trouble cutting through the cardboard box.

6. Now, students should line the inside of the pizza box with aluminum foil. Instruct groups to make sure the shiny (reflective) side of the foil is facing outward. Students should glue or tape the foil to the inside of the box, covering all of the interior surfaces and minimizing wrinkles in the foil.

7. Once the inside of the box is lined with foil, instruct students to paint it with matte black paint. (Alternatively, students can tape black construction paper onto the foil lining.) Instruct students to answer Question 2 on the Student Handout at this point; this question will get them thinking about the reason for the black paint. In the photo below, spray paint was used to paint the box black, but you can substitute any matte black paint.

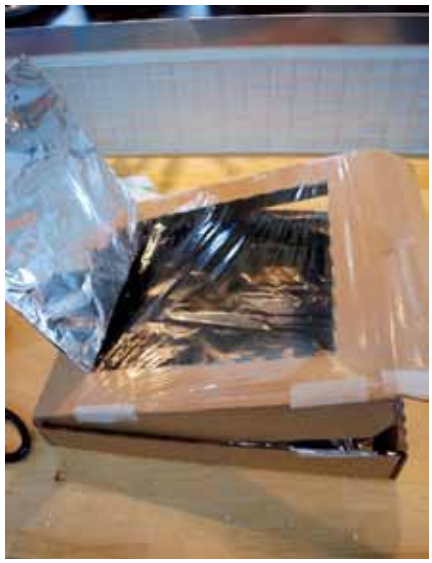


8. At this point, you may wish to have students construct an insulating layer in the bottom of their solar cooker. This step is optional, but it will help the cooker retain heat. To do this, place insulating material on top of the layer of black aluminum foil. Insulating material can be shredded paper, wadded cotton balls, or pieces of rigid foam. Then repeat Step 7 so that the insulating material is covered with another layer of aluminum foil and painted black.

9. Instruct students to wrap the cutout flap from the pizza box with foil. Again, the reflective side of the tinfoil should face outward. Students can secure their foil with tape or glue.

10. Tell students to use the second pizza box to cut out three squares, similar in size to the cutout flap on the first pizza box. Instruct students to wrap each flap in aluminum foil (again, the reflective side should face outward).

11. Next, students should place a layer of plastic wrap across the cutout hole in the first pizza box This step will allow sunlight to enter the box, but will prevent much of the heat from leaving the box. Question 4 on the Student Handout addresses this concept; you may wish to have students pause and answer this question now.



12. Next, have students use the duct tape to secure all of the foil-wrapped flaps together around the perimeter of the cut-out square on top of the box. Each flap should be tilted at an angle so it works to direct the sunlight toward the oven. Have students think about the purpose of these shiny flaps. Prompt students by having them think about what sunlight does when it strikes the shin flaps. (It bounces off.) Then have them think about what happens when sunlight is directed onto an object. (It heats up.)

13. Lead the class outside (ideally on a sunny, warm day). Have students bring their solar cookers, two chocolate bars, their Student Handouts, and a pencil to record their observations. Be sure to bring a stopwatch or clock outside. Instruct each group to place a square of chocolate inside of the box. They should use care when opening the box so that the flaps all stay in place. You may want to have students place the chocolate on a small piece of paper towel or plastic wrap so any mess from melting chocolate is contained. The final setup is shown below:

Students should place their boxes in a sunny location. They should then place the second bar of chocolate next to the solar box. Have students draw sketches and make observations of the two chocolate bars the instant they are placed in the sun. Begin the stopwatch and instruct students to make observations of the chocolate bars every five minutes. (Announce the time intervals as they pass.)

14. **Wrap-up Activity:** Bring the class back inside and spend a few minutes discussing the activity with your students. Have students share their observations. Poll the class to find out whose chocolate bars melted the fastest and have students discuss why this might be the case. Ask students about the purpose of observing a chocolate bar outside of the solar cooker. (Students should note that the chocolate bar outside of the cooker helps us to compare how well the solar cooker worked. If the chocolate bar inside the solar cooker and outside the solar cooker melt at the same rate, then the solar cooker is just as good as leaving food out in the sun!) Sample questions include the following:

- What could be some other possible designs for a solar cooker?
- Why are panels of aluminum foil important to the design?
- What changed occurred to the chocolate and why?
- What challenges did you face and how did you overcome them?
- How could you improve your design and why?
- If multiple designs were used in this activity, which ones were most successful and why?

Get Cooking Extension Activities

1. After students have answered the questions on the Student Handout, challenge them to use their solar cooker for one of the uses brainstormed in Question 8 on the Handout. Allow them to make modifications to the cooker before beginning.

2. Have students conduct additional research on solar cookers to learn more about how they can help people in developing countries. You may even wish to have students write a short report, detailing the engineering technology, to summarize what they have learned.

GET COOKING BACKGROUND INFORMATION

What is a solar cooker?

A solar cooker is a simple device used to harness the energy from the sun. It is designed so that sunlight is redirected into the interior of a closed box. The top of the box is a clear material, either glass or plastic. This clear top allows sunlight to enter the box and then stay trapped inside. The black interior of the box absorbs the sunlight energy, allowing the box to heat up. The box is usually lined with insulated material to keep heat inside.

What are some different designs of a solar cooker?

The design taught in this activity is one of the most common solar-cooker designs, known as a panel cooker. The panels are the key feature; they direct the sunlight toward the closed box at the center of the device. There are two other types of solar cookers. The first is similar to a panel cooker; it's called a box cooker. The box cooker resembles a large box with a clear glass or plastic lid. Box cookers often have one panel that can be adjusted to maximize the amount of sunlight that enters the box. The third type is known as a parabolic cooker. They have a round reflective surface with a dark box at the center. Parabolic cookers can reach high temperatures, but they require more supervision and adjustments than the other types of cookers.

What are the uses for a solar cooker?

Solar cookers are most effective in areas with already-warm temperatures. They can be used to cook foods, such as breads and beans, that would otherwise require a wood-fueled oven or fire. Solar cookers can also be used to pasteurize water. This involves heating water to 65°C (150°F) for a short time. This is a lower temperature required to boil water, but it can kill microbes such as hepatitis A and E. coli. Solar cookers can also be used to sterilize dry medical equipment, including bandages and medical instruments.

How can solar cookers be used to help people in developing countries?

Solar cookers are useful because they offer people a cost-effective way to heat food and water without consuming natural resources. They are useful for preparing food that can take long amounts of time, such as beans. These foods, without a solar cooker, would require a cooking fire for several hours. This is an investment of time and resources that many people in developing countries do not have. It is estimated that some people in developing countries spend approximately 25 percent of their incomes on fuel. Solar cookers can help reduce these costs while also reducing fuel consumption. Solar pasteurization of water can prevent illnesses and increase availability to clean water. Solar cookers help people meet their needs for clean water and cooked food for a minimum investment of time, money, and natural resources.

Key Vocabulary

radiant energy: light energy from the sun in the form of visible light and heat energy

reflection: when something bounces back off of a surface

solar energy: energy from the sun's rays that can be used to heat and power things in our lives

GET COOKING TEACHER HANDOUT

1. What is a solar cooker and what are some of its uses?

   [Sample answer: A solar cooker is a simple oven that heats food using energy from the sun. It can cook food or purify water.]

2. Why is important to make the inside of your solar cooker black?

   [Sample answer: The paint is important because the color black absorbs heat. It is important that it is matte so that more heat is absorbed instead of reflected.]

3. What is the role of the aluminum foil in the solar cooker?

   [Sample answer: The foil helps reflect the sun's rays into the cooker. The flaps are pointed at an angle to direct the light that bounces off the aluminum into the solar cooker.]

4. Why is the plastic wrap important to the design of your solar cooker?

   [Sample answer: The plastic wrap lets light in, but keeps the heat trapped inside the cooker. Without the plastic wrap, it would take a really long time for the chocolate to melt.]

5. Write a prediction about what you think will happen to the chocolate inside the solar cooker when you place it in the sun. What will happen to the chocolate bar outside of the solar cooker? Which one will melt faster and why?

   [Sample answer: I predict that the chocolate inside of the solar cooker will melt faster because more sunlight will be directed onto it.]

6. Draw a sketch of the chocolate bars in the following table. Be sure to include descriptions of how the chocolate bars look.

   [Images and descriptions will vary, but the chocolate bar inside of the solar cooker should melt much more quickly than the bar outside of the cooker.]

Time of observation	Sketch and observations of chocolate in the solar cooker	Sketch and observations of chocolate outside of the solar cooker
0 minutes		
5 minutes		
10 minutes		
15 minutes		
20 minutes		

7. What is the purpose of observing a chocolate bar outside of the solar cooker?

[Sample answer: So that you can compare how much faster the solar cooker heats things up than the sun by itself.]

8. What are some other possible uses for a solar cooker?

[Sample answer: I think it could be used to cook entire meals or to bake bread. I also think it could be used to purify water if it can heat the water enough.]

GET COOKING STUDENT HANDOUT

1. What is a solar cooker and what are some of its uses?

2. Why is important to make the inside of your solar cooker black?

3. What is the role of the aluminum foil in the solar cooker?

4. Why is the plastic wrap important to the design of your solar cooker?

5. Write a prediction about what you think will happen to the chocolate inside the solar cooker when you place it in the sun. What will happen to the chocolate bar outside of the solar cooker? Which one will melt faster and why?

6. Draw a sketch of the chocolate bars in the following table. Be sure to include descriptions of how the chocolate bars look.

Time of observation	**Sketch and observations of chocolate in the solar cooker**	**Sketch and observations of chocolate outside of the solar cooker**
0 minutes		
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7. What is the purpose of observing a chocolate bar outside of the solar cooker?

8. What are some other possible uses for a solar cooker?