



SOLAR POWER

SOLAR HOT DOG COOKER

JILL WILLIAMS

Time Frame:	Standards:
45-60 minutes	8-9.PS(ES).1.2.1 Use observations and data as evidence on which to base scientific explanations 8-9.PS(ES).1.6.3 Use appropriate technology and mathematics to make investigations. 8-9.PS.2.3.2 Classify energy as potential and/or kinetic and as energy contained in a field 7.S.1.2.2 Use observations to make defensible inferences 7.S.1.6.2 Use appropriate tools and techniques to gather and display data 7.S.1.6.3 Evaluate data in order to form conclusions
Objectives:	
To explore the conversion of radiant (electromagnetic) energy to thermal energy and how it can be used.	
Background Information:	
<p>Radiant energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Solar energy is an example of radiant energy.</p> <p>Thermal energy is heat. It is the internal energy of substances. It is caused by the vibration and movement of atoms and molecules within substances. The faster the molecules in a substance move or vibrate, the more thermal energy is in that substance.</p> <p>In this experiment we will be taking solar energy (radiant energy) and converting it into thermal energy to cook the hot dog. With our solar cooker, the sunlight (solar or radiant energy) will enter the can through the opening we cut and become trapped by the transparency film. It will be absorbed by the hot dog and changed into heat. The transparency film will allow the sunlight in but it won't allow the thermal (heat) energy out. This trapped thermal energy cooks the hot dog.</p> <p>Information taken from Intermediate Energy Infobook produced by the NEED Project.</p>	

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Background Information:

Safety precautions:

1. Remind the students that the cookers and the hot dogs will get hot. Remind them to use caution around them.
2. Wooden skewers have a pointy end. Remind the students to take care not to wave them around or poke other students with them.
3. Depending on your students use the scissors or the exacto knife. If using the exacto knife, remind the students not to leave them laying around and to watch how they move with them so as to not poke or cut another student.

Materials:

- ◆ 1 Pringles Potato Chip can for each student plus one to model
- ◆ Scissors or Exacto knives
- ◆ 1 wooden skewer for each student 35 cm (14 in) or 30 cm (12 in) long
- ◆ 1 piece of transparency film 20 cm x 10 cm (8 in x 4 in)
- ◆ 1 hot dog for each student.
- ◆ Tape
- ◆ Timers (optional) used for timing how long the hot dogs cooked for.
- ◆ Template for making a line for the cuts (optional) 17.5 cm x 3.75 cm (7 in x 1.5 in)

Procedure:

Teacher Preparation:

1. Make sure you have a set of the student materials for each of the students. One option is to have the students supply the Pringles cans for the experiment and keep only a few on hand in case a student doesn't bring one. Also make one ahead of time as a model for the students. An alternative to hot dogs would be biscuit or bread dough wrapped around the skewer.
2. Make a copy of the instructions for the students. (Student handout below)

Procedures:

1. Model for the students how to make the hot dog cooker by following the instructions below.
2. Cut the Pringles can as shown in Diagram 1. Bend back the flaps but do not remove from the can. They will be used to reflect radiant energy onto the hot dog.
3. Cover the opening on the inside of the can with the transparency film and tape the film into place.
4. Make small holes in the metal end of the can and in the plastic lid. Remove the plastic lid from the can.
5. Put a hot dog onto the skewer, slide the skewer into the can, and place the end of the skewer through the hole in the metal end. Put the plastic lid back on the can,

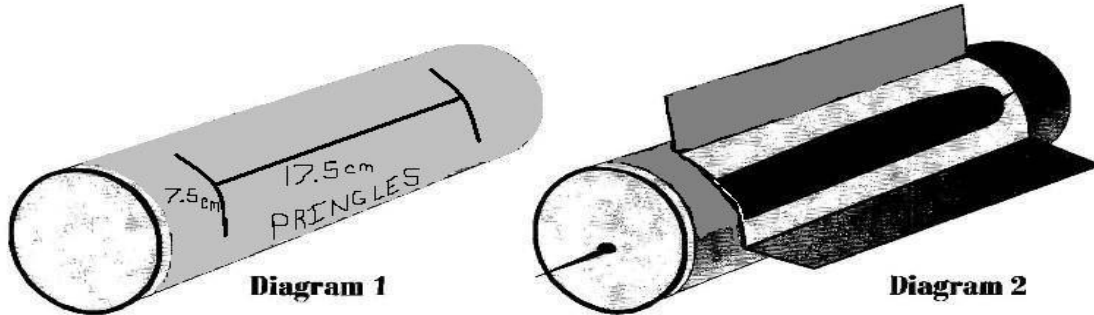
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fitting the other end of the skewer through the hole. The hot dog should be suspended in the can as shown in Diagram 2.

6. Then have the students start making their own solar hot dog cooker.



7. After the students have cooked their hot dogs. Have them complete the assignment by answering the questions at the bottom of the page. As an extension to the lesson have the students come up with ways that they could improve the cooker or create a design for a larger solar cooker.

Optional Extension Lesson:

Objective:

To plot and graph the change in temperature over time that occurs in the solar oven (Pringles Chip Can).

Materials:

- 6-10 Pringles Potato Chip cans (This depends on how many groups you want and the size of the group. Suggested size is 3 students to a group.)
- 6-10 thermometers that read up to about 200 degrees Celsius (One thermometer for each group) (Digital cooking thermometers would work well for the activity.)
- 1 scissors or Exacto knife
- 1 piece of transparency film
- tape
- Ruler
- Timers (optional)

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Teacher Preparation:

1. Cut each of the 6-10 pringles cans as shown in diagram 1 above. Bend back the flaps but do not remove from the can.
2. Cover the opening on the inside of the can with the transparency film and tape the film into place.
3. Make a small hole in the plastic lid of the cooker.
4. Slide a thermometer into the hole in the lid. Make sure that the end of the thermometer doesn't touch the bottom of the can and that the thermometer can be read through the opening in the can.
5. Anchor the thermometer at the top of the can so that it doesn't slide through the hole and touch the bottom of the can. (This will most likely not be necessary if you are using cooking thermometers.)

This activity can be done before, during or after the students cook their hot dogs.

Procedure:

1. Divide the students into groups.
2. Give each group a Pringles solar cooker with a thermometer inside and experiment instructions. Create a data table for the data collected during the experiment.
3. Record the temperature of the cooker and place the cooker in direct sunlight. Predict what the temperature the cooker will reach.
4. After five minutes record the temperature. Calculate and record the changes in temperature.
5. After 10 minutes record the temperature. Calculate and record the changes in temperature.
6. After 15 minutes record the temperature. Calculate and record the changes in temperature.
7. After 20 minutes record the temperature. Calculate and record the changes in temperature.
8. Have the students look at the data and come up with a conclusion. What overall temperature change was there? Was it bigger than you expected? Was it smaller than you expected? What could you cook in the cooker?
9. Discuss their conclusions. What could you do with this cooker? Where would solar cookers work well? Where wouldn't they work very well? Could you do something with them to make them work better?

Assessment:

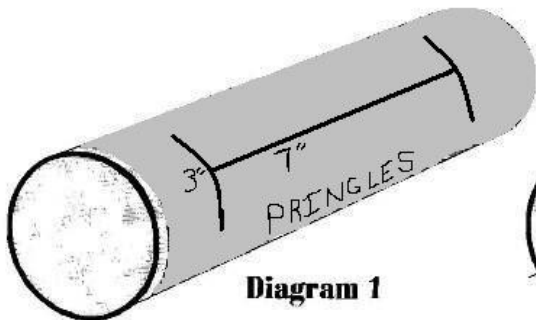
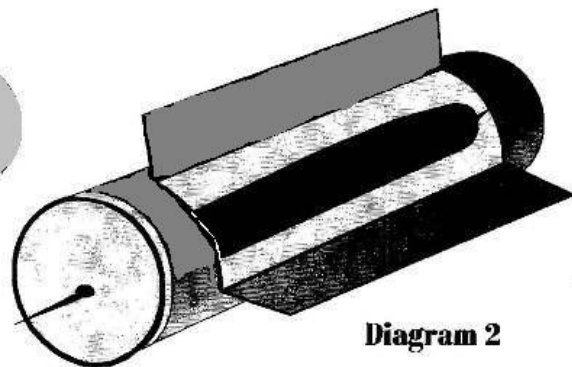
Assessment would be the written conclusions and answers to the questions. The end result could be an assessment as well. Did they follow the instructions and have a cooked hot dog in the end?

Additional Content:

SOLAR COOKING

Procedures:

1. Cut the Pringles can as shown in Diagram 1. Bend back the flaps but do not remove from the can. They will be used to reflect radiant energy onto the hot dog.
2. Cover the opening on the inside of the can with the transparency film and tape the film into place.
3. Make small holes in the metal end of the can and in the plastic lid. Remove the plastic lid from the can.
4. Put a hot dog onto the skewer, slide the skewer into the can, and place the end of the skewer through the hole in the metal end. Put the plastic lid back on the can, fitting the other end of the skewer through the hole. The hot dog should be suspended in the can as shown in Diagram 2.
5. Place the Solar Hot Dog Cooker into direct sunlight, positioning the flaps so that they will reflect sunlight (radiant energy) onto the hot dog.
6. Time how long it takes for your hot dog to cook. If it is a very cold day, consider how you might insulate your cooker to improve energy efficiency.
7. Will your cooker work in artificial light? Experiment with a powerful artificial light such as an overhead projector.

**Diagram 1****Diagram 2**

SOLAR COOKING TEMPERATURES

Procedures:

1. Have one person from your group get a Pringles solar cooker with a thermometer inside. Create a data table for the data collected during the experiment.
2. Record the temperature of the cooker and then place the cooker in direct sunlight. Predict what the temperature the cooker will reach.
3. After five minutes record the temperature. Calculate and record the changes in temperature.
4. After ten minutes record the temperature. Calculate and record the changes in temperature.
5. After 15 minutes record the temperature. Calculate and record the changes in temperature.
6. After 20 minutes record the temperature. Calculate and record the changes in temperature.

These are examples for the lab sheets for the students.



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References:

Adapted from the NEED Project's Intermediate activity: Solar cooking (2001) and Intermediate Energy Infobook. (2008) <http://www.need.org/>
Adapted by Jill Williams as part of the INL Educational Science writing lab.

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