SOLAR ENERGY

SOLAR CONCENTRATION

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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. 7.S.1.2.2 Use observations to make defendable 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 7.S.1.6.4 Use evidence and critical thinking to accept or reject a hypothesis

Objectives:

To learn that radiant energy can be concentrated on an object with a concave mirror.

Background Information:

When energy hits objects, it can be reflected or absorbed. The absorbed radiant energy can be converted into heat (thermal energy). Black objects tend to absorb radiant energy. Shiny objects tend to reflect radiant energy. Radiant energy can be by the sun or by an artificial source. A mirror reflects radiant energy. A concave mirror can concentrate solar radiation onto an object.

Solar Energy

Solar energy is energy from the sun. The sun is a giant ball of hydrogen and helium gas. The enormous heat and pressure in the interior of the sun cause the nuclei of the two hydrogen atoms to fuse, producing one helium atom in a process called fusion. During fusion, nuclear energy is converted into thermal (heat) energy and radiant energy. The radiant energy is emitted from the sun in all directions and some of it reaches Earth. Radiant energy is energy that travels in electromagnetic waves or rays. Radiant energy includes visible light, x-rays, infrared rays, microwaves, gamma rays, and others. These rays have different amounts of energy depending upon their wavelength. The shorter the wavelength, the more energy they contain.

Information is from The NEED Project in the Exploring Solar Energy Teacher guide
http://www.need.org/

Materials:

- 10 cans – 5 painted black, 5 regular metal. Soup size is about right or pint size paint cans. Talk to your cafeteria about soup cans that they throw away.

- 10 lids with holes for the rubber stoppers. If you buy pint sized paint cans they come with lids. You can drill a hole in the lid the right size for the stoppers.
- 10 rubber stoppers. The kind with the hole in the middle to put the thermometer through.
- 10 thermometers
- 12 concave mirrors
- Pitcher of cold water
- 5 beakers (For measuring the hot and cold water into the cans.)
- Clay (To hold the concave mirrors in place.)
- Metric rulers
- Classroom set of lab sheets or individual lab sheets (examples you can use below)

Procedure:

Preparation: Paint 5 cans and lids black. Drill holes in center just smaller than the size of the stopper. Your wood shop or tech teacher may be able to help with this. Prepare a pitcher(s) of cold water, enough to fill 10 cans with 200 ml of cold water. Set up 5 centers lettered A-E. At Center A have 2 cans (1 black and 1 silver) and lids, two thermometers and a beaker. At Centers B and C have the 2 cans (1 black and 1 silver) and lids, two thermometers, a beaker, clay and 2 mirrors. At Centers D and E, have the have 2 cans (1 black and 1 silver) and lids, two thermometers, a beaker, clay and 4 mirrors.

1. Introduce the concept of radiant energy and that radiant energy can be collected and concentrated on an object. One way of doing this is using concave mirrors. The students will be exploring the concept of concentration of solar radiation.
2. Divide the students into 5 groups lettered A-E. Explain the procedure and have the students complete the activity (outlined below). They must get data from the other groups to complete the activity.
3. **(Steps for activity)** Fill the silver and black cans with 200 ml of cold water.
4. Put the thermometers into the cans and position the stoppers so that the thermometers are not touching the bottom of the cans. Place the cans in a sunny place. This may be outside or a sunny place within your classroom.
5. Position the mirrors:

   Group A: The control without mirrors.

   Groups B & C: Position one concave mirror behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about seven centimeters (7 cm) from the cans. Use pieces of clay to hold the mirrors in the correct position.

   Groups D & E: Position two concave mirrors behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about seven centimeters (7 cm) from the cans. Use pieces of clay to hold the mirrors in the correct position.
6. Record the temperature of the water in all the cans. Predict what will happen.
7. Record the temperature of the water in all the cans after 5 minutes.
8. Record the temperature of the water in all the cans after 10 minutes.

9. Return to the classroom (if outside) and have the students collect the data from the rest of the groups. You can have the students walk around and do this on their own or you can do this as a class and put it into a data table on the board. The students will then copy down the information onto their own paper.
10. Have the students draw their conclusions about what happened. Did solar concentration heat up the water faster or slower? Compare between one mirror and two mirrors. What was the same? What was different?
11. After they have drawn their conclusions discuss what they found out. Discuss what this means to them in their lives. Could this help to produce more power using solar panels or other solar heating methods?

This experiment is based on the NEED Project's Exploring Solar Energy Activity 3
http://www.need.org/

Assessment:

Observe how the students work in groups and the group interactions to obtain the additional information they need to complete the activity.
Use the students' written data and conclusions from the activity to assess if they understood the concept.

Additional Content:

1. Have the students create graphs from their data and from the compiled data of the other groups. After a class discussion, assign students a written paper researching what uses solar concentration has in commercial or residential buildings.
2. Have the students design a way to use solar concentration in homes and buildings. Have them create a model of their design.

Examples of lab sheets follow. You may print them and use them if you would like.

SOLAR CONCENTRATION

Concave mirrors can be used to collect solar radiation and concentrate it on an object.

PURPOSE: To explore the concentration of solar radiation.
Hypothesis: Read the procedures. Predict what you think will happen
PROCEDURE:
Step 1: Fill the silver and black radiation cans with 200 ml of cold water.
Step 2: Put thermometers into the cans and position the stoppers so that the thermometers are not touching the bottoms of the cans. Place the cans in a sunny place.
Step 3: Position the mirrors:

Group A: The control without mirrors.
Groups B & C: Position one concave mirror behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about seven centimeters (7 cm) from the cans. Use pieces of clay to hold the mirrors in the correct position.
Groups D & E: Position two concave mirrors behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about seven centimeters (7 cm) from the cans. Use pieces of clay to hold the mirrors in the correct position.

Step 4: Record the temperature of the water in all the cans. Predict what will happen.
Step 5: Record the temperature of the water in all the cans after 5 minutes.
Step 6: Record the temperature of the water in all the cans after 10 minutes.
Step 7: Collect and record the data from the other groups onto the data table.

RECORD THE DATA

	WITHOUT MIRRORS						With 1 Mirror						With 2 Mirror					
	ORIGINAL		5 MIN		10 MIN		ORIGINAL		5 MIN		10 MIN		ORIGINAL		5 MIN		10 MIN	
	C	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**
BLACK CAN																		
SILVER CAN																		

CONCLUSIONS: Look at your data. What have you learned about concentrating solar energy? What uses could this have?

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PROCEDURE:
Step 1: Fill the silver and black radiation cans with 200 ml of cold water.
Step 2: Put thermometers into the cans and position the stoppers so that the thermometers are not touching the bottoms of the cans. Create a data table. Place the cans in a sunny place.
Step 3: Position the mirrors:

Group A: The control without mirrors.

Groups B & C: Position one concave mirror behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about seven centimeters (7 cm) from the cans. Use pieces of clay to hold the mirrors in the correct position.

Groups D & E: Position two concave mirrors behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about seven centimeters (7 cm) from the cans. Use pieces of clay to hold the mirrors in the correct position.

Step 4: Record the temperature of the water in all the cans on the data table you created. Predict what will happen.
Step 5: Record the temperature of the water in all the cans after 5 minutes.
Step 6: Record the temperature of the water in all the cans after 10 minutes.
Step 7: Collect and record the data from the other groups onto the data table.

CONCLUSIONS: Look at your data. What have you learned about concentrating solar energy? What uses could this have?

References:

Adapted from The NEED Project's 2008 Exploring Solar Energy Activity 3
http://www.need.org/
Adapted by Jill Williams as part of the INL Educational Science writing team.