



# SCIENCE OF ENERGY

JILL WILLIAMS

## SOLAR CONCENTRATION

<b>Time Frame:</b>	<b>Standards:</b>
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).1.6.2 Utilize the components of scientific problem solving to design, conduct, and communicate results of investigations. 8-9.PS(ES).1.6.3 Use appropriate technology and mathematics to make investigations. 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. 7.S.1.6.4 Use evidence and critical thinking to accept or reject a hypothesis.
<b>Objectives:</b>	
To learn that radiant energy can be concentrated on an object with a concave mirror.	
<b>Background Information:</b>	
<b>What is energy?</b> Energy is the ability to do work, the ability to make a change. Everything that happens in the world involves a change of some kind, the exchange of energy in some way. The total amount of energy in the universe remains the same. When we use energy, we do not “use it up”; we convert one form of energy into other forms. Usually the conversion of energy produces some heat, which is considered the lowest form of energy, since it dissipates into the surroundings and is difficult to capture and use again. Energy is categorized in many ways-by the forms it takes and by what it does-the changes it makes-the effects we can see or feel or measure.  When radiant 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.	

# SCIENCE OF ENERGY

## SOLAR CONCENTRATION

### 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 get 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 just 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.

## SOLAR CONCENTRATION

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 or 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 get 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 using both Celsius and Fahrenheit scales. Predict what will happen.

**Step 5:** Record the temperature of the water in all the cans in both scales after 5 minutes.

**Step 6:** Record the temperature of the water in all the cans in both scales 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?

### 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. 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 Exploring Solar Energy Activity 3

<http://www.need.org/>

Adapted by Jill Williams as part of the INL Educational Science writing team.