

Name: \_\_\_\_\_

Date: \_\_\_\_\_ Class: \_\_\_\_\_

# Experimenting with Solar Heaters: Part 1

## Worksheet

### Solar Heaters

Solar heaters are used to concentrate radiant solar energy that travels from the Sun to the Earth. Solar heaters use reflectors to concentrate sunlight on one point where the radiant solar energy can be transformed into thermal energy. In this activity, you will use homemade solar heaters to measure the solar energy transferred to a vial of water and to design a more effective solar heater.

1. How might you set up a controlled experiment to determine the effectiveness of solar heater?

2. Record your temperature data for the solar heater activity in the table below.

Vial #	Location	Mass (grams)	$T_i$ (Celsius)	$T_f$ (Celsius)	$\Delta T$ (Celsius)
1	Direct Sunlight	30			
2	Solar heater in direct sunlight	30			

3. Which vial of water experienced the most temperature change? \_\_\_\_\_

4. Energy flowing into or out of a system can be calculated using the equation:

$$q = mc\Delta T$$

q = the quantity of heat (in Joules) flowing into or out of the system

m = the mass of the substance

c = the specific heat capacity of the substance, the amount of energy (in Joules) needed to raise the temperature of one gram of a substance one degree Celsius

$\Delta T$  = the change in temperature

In the chart below, calculate the amount of heat energy transferred to each of your vials of water using the equation  $q = mc\Delta T$ .

Vial #	Location	Mass (m) grams	Specific Heat (c) J/g•C°	Change in Temp. ( $\Delta T$ ) Celsius	Heat energy transferred (q) Joules
1	Shade	30	4.18		
2	Direct Sunlight	30	4.18		
3	Solar heater in direct sunlight	30	4.18		

5. Which vial had the largest increase in heat energy? \_\_\_\_\_

6. Vial 2 was the control in this experiment. What is the purpose of a control in an experiment like this?

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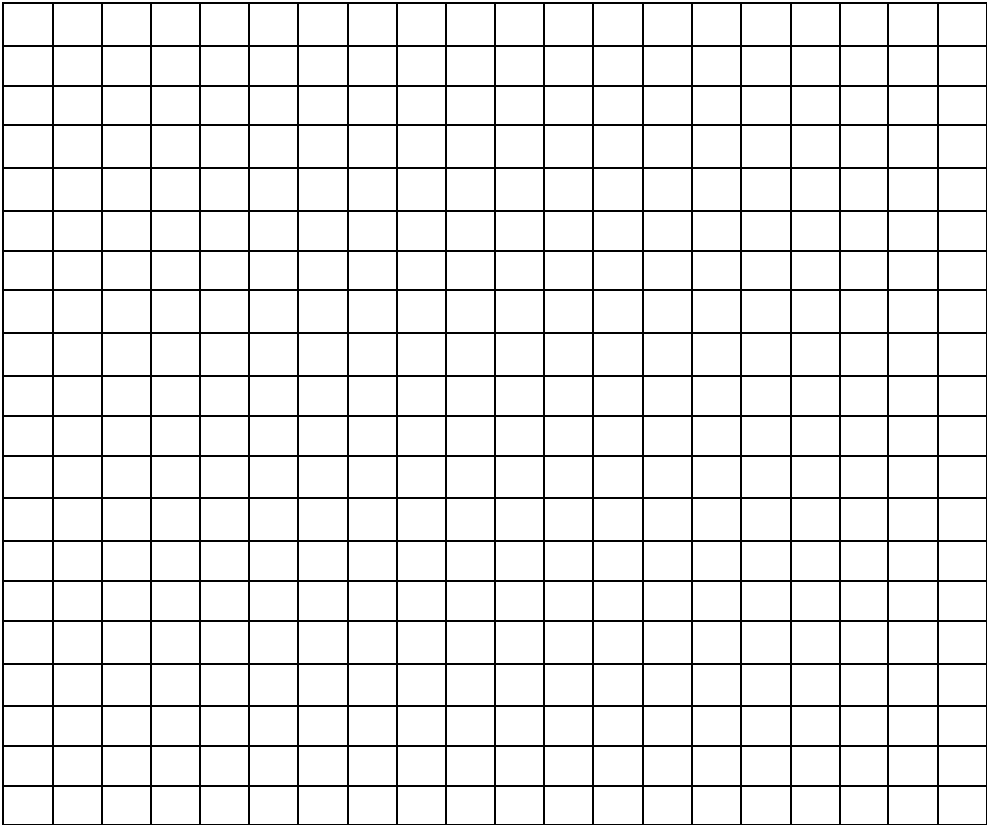
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7. In the space below, create a bar graph showing the amount of heat energy transferred to the vials. Don't forget to label the x-axis and y-axis, and include your scale.

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8. What does this graph show? Briefly describe the graph and complete the following sentence: This graph shows...

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9. Was the solar heater more effective than a vial in direct sunlight with no solar heater? To calculate effectiveness you must figure out how much more the solar heater was able to heat water. For example, if the  $\Delta T$  for the direct sunlight vial was  $5^{\circ}\text{C}$  and the  $\Delta T$  for the solar heater vial was  $20^{\circ}\text{C}$ , then the efficiency of the solar heater would be  $20^{\circ}\text{C} \div 5^{\circ}\text{C} = 4$ . This would mean that four times the solar energy was transferred to the vial with the solar heater than without the solar heater.

Vial	Design	$\Delta T$ (Celsius)	$\Delta T$ of Vial 2 (Celsius)	Effectiveness
2	Vial, direct sunlight, no solar heater		$\div$	= 1
3	Solar heater in direct sunlight		$\div$	=

10. How does the effectiveness of the two designs above compare? Explain why you think this is.

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11. Extension Question: Were there differences in the effectiveness of different students' solar heaters? Explain possible reasons for these differences.

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