"So Much Snow…So Little Light!"

Hannah and Eldred were skiing on a beautiful day in early January. The skiing was better than ever and they felt they could easily ski for another 4 hours. However, Hannah noticed that the sun was very low in the sky. It was 3:30 pm and daylight was about to end! "If only it snowed in June or July when the sun is higher in the sky and the days are longer," Hannah remarked. When she got home, Hannah got on her computer to find out about the seasons, sun, and earth. She found that the earth had a tilt that changed the angle of sunlight hitting the earth as the earth revolved around the sun. She told Eldred about this and he said, "Let's set up an experiment to see if the **angle of tilt** is important in heating up the earth."

They decided to investigate this question**: What effect does the angle of sunlight hitting a surface have on the energy received by that surface?**

You are going to investigate **angle of light hitting a solar cell** and the **effect this has on energy transfer** measured in milliamps of electricity.

Hypothesis and Prediction

1a. Make a hypothesis that answers the question, **What effect does the angle of sunlight hitting a surface have on the energy received by that surface?** Justify your hypothesis by using your knowledge of earth movements and seasons.

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1b. If your hypothesis is correct, make a prediction as to how changes in the angle of the light hitting the solar cell will affect the amount of energy (milliamps) produced by the solar cell.

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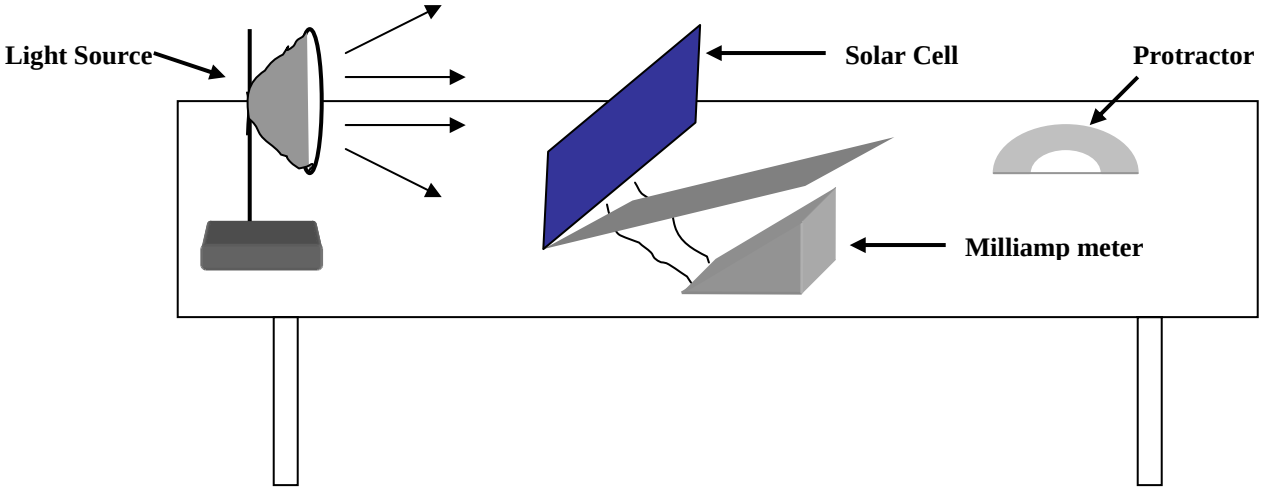
Setting up and conducting the experiment
Directions: In order to test your prediction, you will use the following materials.

Materials

- natural (Sun) or artificial (lamp) light source
- ring stand or other means of supporting the lamp
- protractor
- 1 solar cell with connecting wires
- 1 milliamp meter.

In this experiment, you will use the protractor to adjust the angle that the light rays hit the solar cell. The diagram below shows one possible configuration of the equipment. Your teacher will give you additional directions if different equipment is used.



- Adjust the distance between the light source and the solar cell so that you get a measurement between 0 milliamps and the maximum value on the milliamp meter for any angle between 0° (horizontal) and 90° (vertical).
- Make sure you control all variables and adjust the independent variable carefully.

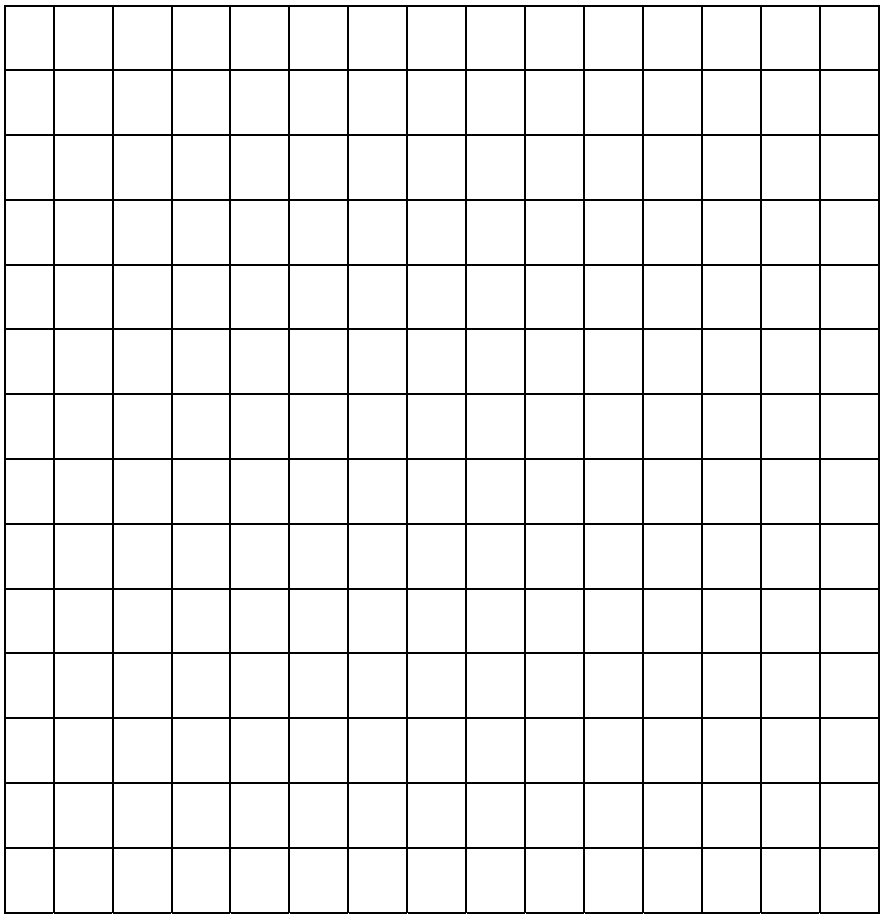
2. Record the results of your experiment in the table below.

Effect of Angle Tilt on Energy Produced

Trial	Angle: 0°	Angle: 10°	Angle: 20°	Angle: 30°	Angle: 40°	Angle: 50°	Angle: 60°	Angle: 70°	Angle: 80°	Angle: 90°
1										
2										
3										
AVERAGE										

3. Use the data from your table to graph the angle tilt vs. electrical energy produced and draw a best-fit curve.

The Effect of Angle of Light on Energy Produced



4. Use your graph to explain the relationship between the angle of light tilt and the electricity produced

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5. Examine your experimental set up and data collection carefully. Name at least 3 possible errors an experimenter could make and explain how these errors could change the data.

a. _____

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b. _____

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c. _____

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6. Do the results of your experiment provide evidence that supports your hypothesis?

☐ **Evidence <u>Does</u> Support Hypothesis** ☐ **Evidence <u>Does Not</u> Support Hypothesis**

Explain how you know

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7. Why are milliamps an appropriate unit to use in this investigation?

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This experiment uses a model of the earth-sun system.
8a. Draw a labeled diagram of your setup, explaining all parts and what they represent in the earth-sun system.

8b. Draw a labeled diagram of the earth-sun system including the equator and axis of rotation, and all four seasons for northern and southern hemispheres.

9. Compare your experiments with the earth-sun system system. Fill out the following chart with similarities and differences between the two systems.

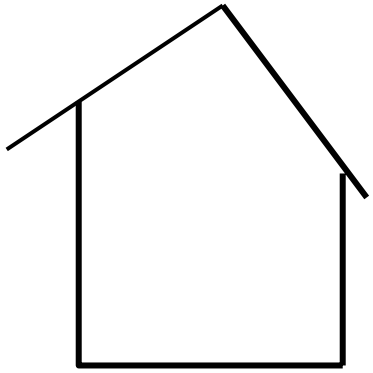
	SIMILARITIES	**DIFFERENCES**
LIGHT COMPARED TO SUN		
SOLAR CELLS COMPARED TO EARTH SYSTEM		

10. At 45 degrees north latitude, compare the length of daylight and angle of the sun on Dec 21 to the length of daylight and angle of the sun on Jun 21st

11 a. Which direction does the house below need to face in order to get the maximum amount of light in the winter and the minimum amount of light in the summer?

☐ **North** ☐ **South** ☐ **East** ☐ **West**

11 b. Draw and label the sun's rays hitting or entering the house on June 21st and December 21st.



12. How can house designs that make use of the sun and are well insulated conserve natural resources and improve the environment?

13. Use your understanding of the earth-sun system to explain why Hannah and Eldred will never be able to ski in Vermont at 9 pm in July