

## Solar Energy Answer Key

*Angle and Output Prediction: How does the angle of illumination affect the solar panel output?*

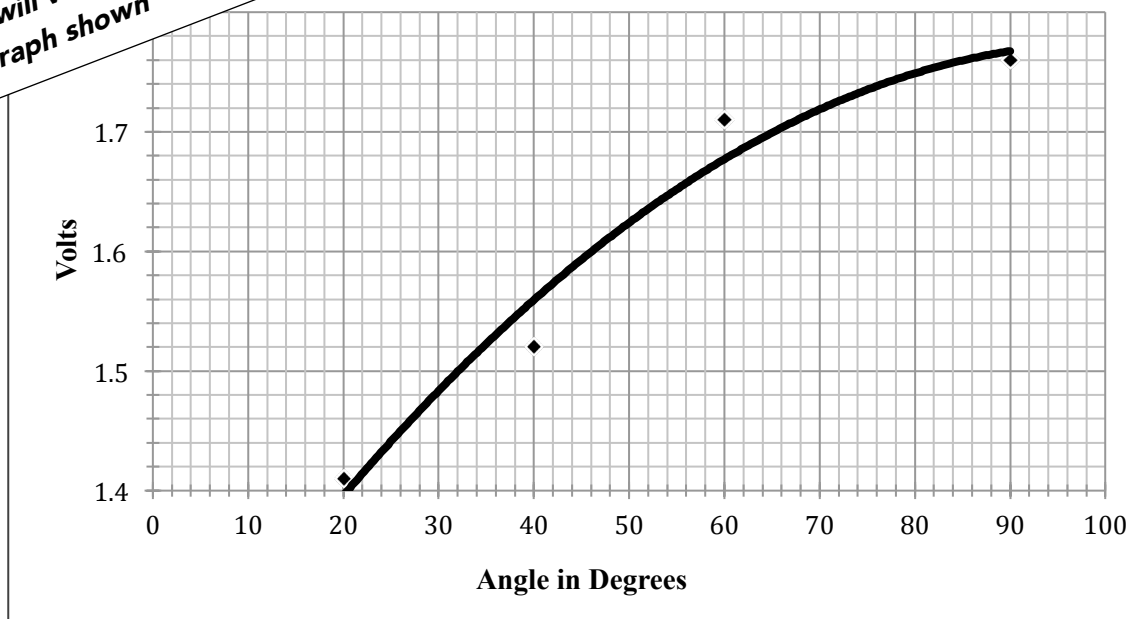
I think the solar panel output will **Student answers will vary** as the angle of illumination decreases.  
(increase / decrease)

*Angle and Output Data*

Angle and Output	
Angle (°)	Voltage (Volts)
90	1.76
60	1.71
40	1.52
20	1.41

**Student answers will vary,  
sample data shown**

**Graph: Angle and Output**



**Graphs will vary, sample  
graph shown**

*Angle and Output Explanation*

1. Based on what you know about photovoltaic cells, why do you think you got these results?

**The voltage is lower at angles less than 90° because the light is more spread out and fewer photons hit the solar panel directly.**

Temperature and Output Prediction: How does increasing temperature affect solar panel output?

I think the output will Student answers will vary as the temperature increases.  
(increase / decrease)

Temperature and Output Data

Student answers will vary, sample data shown

Temperature and Output		
	Temperature (°C)	Voltage (Volts)
	Room Temp.: 23.7°C (H)	1.71
0:30	24.5°C	1.68
1:00	25.6°C	1.65
1:30	26.2°C	1.60
2:00	28.1°C	1.54
2:30	30.3°C	1.49
3:00	31.5°C	1.44
3:30	32.1°C	1.42
4:00	32.4°C (L)	1.42

Whole Class Data

Student answers will vary, sample data shown

Angle and Output: Whole Class	
	Angle – Max Voltage (°)
1	90°
2	90°
3	90°
4	90°
5	90°
6	90°

Student answers will vary, sample data shown

Temperature and Output: Whole Class		
	Temp. - Max Voltage (°C)	Temp. - Min Voltage (°C)
1	23.7°C	32.4°C
2	26.6°C	37.1°C
3	26.4°C	32.9°C
4	25.1°C	37.8°C
5	24.2°C	33.3°C
6	27.0°C	34.5°C

## Results

1. Based on the class data, what is the ideal angle for sunlight to hit a solar panel and have the maximum output? (circle one)

20 °

40 °

60 °

90 °

*This is usually the case*

2. Based on your graph, at what angle do you begin to see a significant drop in voltage?

***The voltage drops significantly at 40°. Both 60° and 90° have the highest outputs.***

*This is usually the case*

3. Based on your data, what is the best temperature in degrees Celsius for voltage output?

***Based on my data, the best temperature for voltage from a solar panel was room temperature (23.7°C).***

## Conclusion

1. As a solar engineer, your company needs to write a user guide to inform customers about the conditions in which their solar panels will work best. You are responsible for writing the section on solar panel output as it relates to temperature and angle. Use evidence from your experiments to write 1 – 2 paragraphs that could be included in the user guide. Include information about what time of day and in which seasons their solar panels will produce the most output.

***Congratulations on the purchase of your new solar panels! To be sure that you get the maximum efficiency from your solar panels, we have a few tips for you to consider. To start, your solar panels will generate the highest voltage when the sun hits the panels at a 90° angle. This means the angle is best for your solar panels in the middle of the day when the sun is the highest in the sky. It also helps if your solar panels are angled towards the south, so they can get the best angle from the sun in the southern sky.***

***In regards to temperature, your solar panels will produce less electricity as it gets hotter outside. At room temperature, approximately 23°C, your solar panels will produce the most volts. As it gets hotter, they become less efficient. In New Mexico, this means that solar panels are the least efficient in the summer and more efficient in the spring and fall.***