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Name: _____
Date: ____ / ____ / ____ Class Hour: ____

SOLAR LOCATION ANALYSIS: THE PV WATTS® CALCULATOR

Student Response Guide

Place written responses and graphs into this document where you see the asterisk, *. Your written answers should appear in bold-face type. If they don't, bold them yourself.

After you complete this document, but before you submit it, go through it to organize it for easy reading by your teacher.

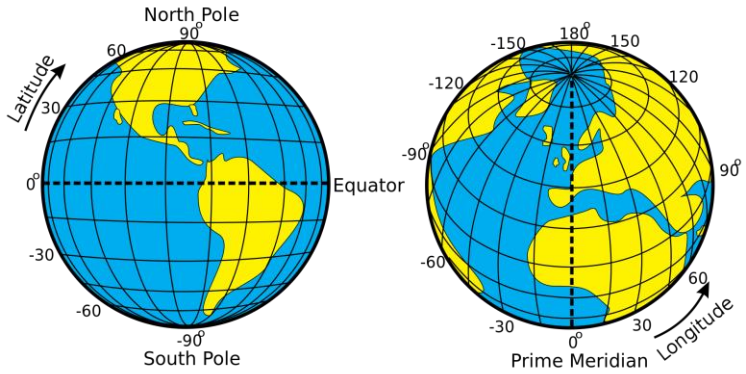
Activity, Part 1

Definitions for:

Latitude (below)

Longitude (below)

Figure 1.



Latitude:

***Definition**

Longitude:

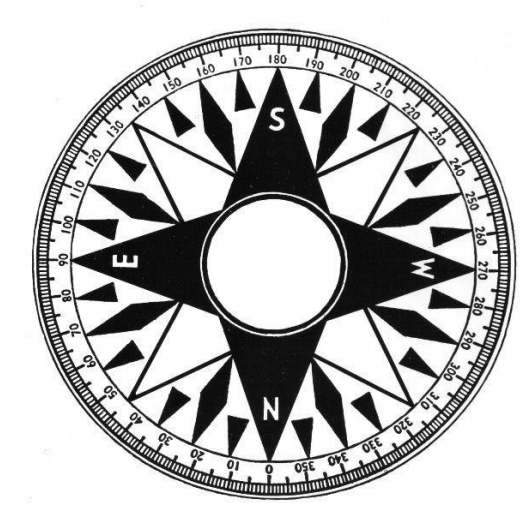
***Definition**

Definitions for:

Solar azimuth

Solar altitude or solar elevation

Figure 2.



Solar azimuth:

***Definition**

Solar altitude or solar elevation:

***Definition**

Definition for:

Solar tilt angle

Figure 3.

Solar tilt angle:

***Definition**

Show What You Know

Place graphs and written responses into this document where you see the asterisk, *****. Your written answers should appear in bold-face type. If they don't, bold them yourself.

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1. Produce two graphs. Use the graphing function within your **Student Spreadsheet** to produce three plots on the following two graphs:

- Annual Energy Production as a function of solar Tilt Angle (refer to this as **Graph 1**)
- Annual Energy Production as a function of solar Azimuth Angle (refer to this as **Graph 2**)

On each graph include:

1. a plot for your location (**Location 1**)
2. a plot for Quito (**Location 2**)
3. a plot for the location you chose (**Location 3**)

Include a legend on each graph that identifies each plot. Paste the two graphs into this document, below.

Graph 1:

*****

Graph 2:

*****

Write full and complete answers in paragraph form to each of the six questions that follow. Make regular and appropriate references to one or both of your graphs to support your answers . It is recommended that you use words in your writing that read something like this: "As you can see in Graph 2..."

2. Compare the effect of tilt angle among the three locations Explain similarities, differences, connections, or relationships that you observe.

***Answer**

3. In general, what is the effect of tilt angle on the energy production of a solar PV system? Is there a generalization or “rule of thumb,” that you can apply for the best tilt angle selection for any location?

***Answer**

4. Compare the effect of azimuth among the three locations. Explain similarities, differences, connections, or relationships that you observe.

*****

5. What combination of azimuth and tilt angle would seem to be the best for each of your 3 locations? Explain how you determined the best combination for each.

***Answer**

6. Consider your ideal tilt angle and azimuth selections for each of the three locations. How does the annual energy production value differ for the three locations? Explain the differences you observe. Which location would seem to be the best for producing solar photovoltaic electricity?

*** Answer**

7. In which of your three locations would it be easiest to live “off the grid,” using a solar PV system to supply your electricity? In answering, assume the PV systems at all three locations are installed at their ideal azimuth and tilt angle. Further, assume you need to use the same amount of electricty at all three locations. All other considerations for your decision are the same except for geographic location and the size of the solar PV system you need to install to meet your electricity needs.

*** Answer**

8. You want to install a solar PV system at your location. Assume you will be able to install it at the best combination of tilt angle and azimuth for maximum performance. What other things--site specific variables--usually have to be taken into account in order to get the best performance from a solar PV array? Describe at least three, and explain how each one can negatively affect the performance of a solar PV system.

*** Answer**

9a. Determine and comment on the long-run significance of installing a well-placed,residential-size solar PV system at your location.

Choose the ideal azimuth and tilt angle for your location from previous PVWatts calculations. Then return to the PVWatts Calculator. Enter information for your location. In the **System Info** page, leave the System Size at 4kW, which is about average for a residential installation. Enter the combination of Tilt Angle and Azimuth you chose. Keep all other input information the same as your first inquiry. Then record the **Annual AC Energy (kWh)** produced and the **Annual Energy Value ($)** into from the **Results** page into the data table, below.

Time Period	AC Energy Produced (kWh):	Energy Value ($):	Pounds of CO_2 pollution given off to the air for each kWh of electricity produced by the electric utility in your region:	Lbs. of CO_2 saved from entering the atmosphere:	Tons of CO_2 saved from entering the atmosphere:
Annual:					
After 10 years:					
After 20 years:					
After 30 years:					

Working with a calculator and the information you recorded, determine the **AC Energy produced (kWh)** and the **Energy Value ($)** after 10, 20, and 30 years. Enter this information into your data table.

Now navigate to the United States Environmental Protection Agency power Profiler webpage using this link: https://www.epa.gov/energy/power-profiler

Enter information as appropriate to view a report on the air emissions impact from utility-generated electricity in your region. Specifically locate the strip chart showing the average carbon dioxide emissions rate (lbs/MWh) in your geographical region. Convert this number, given in lbs/MWh, to lbs/kWh, and enter it into the middle of the data table. The value you enter is the number of **pounds of carbon dioxide pollution given off to the air for each kWh of electricity produced by the electric utility in your region**.

From this, calculate how much carbon dioxide would be saved from going into the air annually, and after 10, 20, and 30 years from the system you designed in PVWatts at your location. Enter these values into your table. Convert each of these numbers to tons carbon dioxide savings in the last column of the table.

9b. Consider the data you've entered into your data table. Comment on the long-run financial significance of installing a well-placed,residential-size solar PV system at your location.

*

9c. Again, consider the data you've entered into your data table. Comment on the long-run environmental significance of installing a well-placed,residential-size solar PV system at your location.

*