Electronics Challenge #3

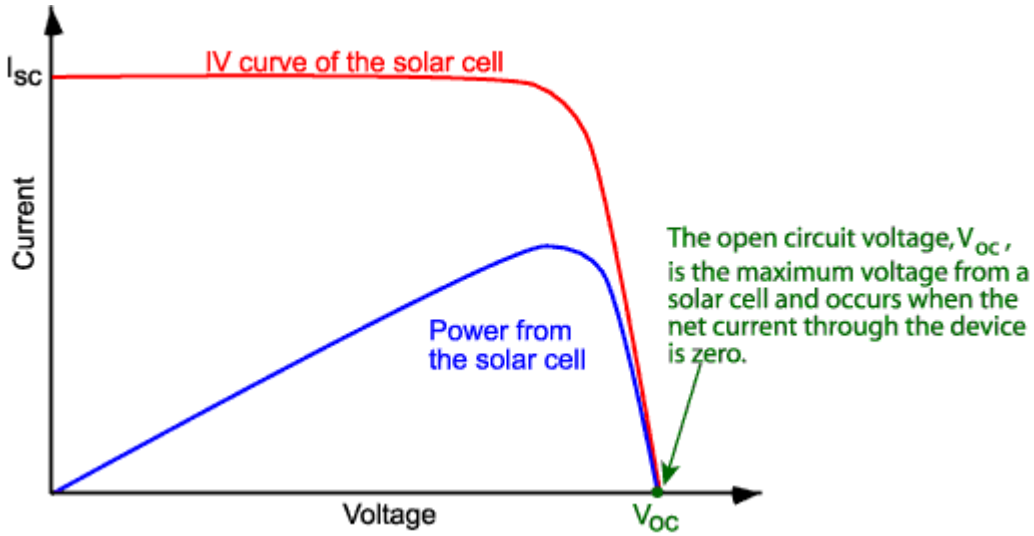
Solar Panel Challenge

Due Date: May 12, 2021

Challenge Overview

In this Challenge, we will measure the output of a solar cell, sometimes call a PV or photovoltaic panel, and plot the voltage vs current curve which represents the power output of the panel. You will use the solar cell in your lab kit, along with the multimeter that came in your Electrical kit. In addition, you will use some of the resistors also supplied in your kit.

The objective of this Challenge is to get a plot which looks somewhat like the red curve in the picture below. This is a classic IV curve for a PV panel and shows how the current (I) and voltage(V) coming from the panel change as the load changes. If you are interested in leaning more about the IV curve, here is a good tutorial. Watch at least the first 5 minutes or so. [NABCEP - MUST Know - IV Curve* - YouTube]



The graph above shows the output of the solar panel is not linear across the range. As the resistance changes, the voltage holds almost the same until the voltage reaches a critical level. The current then starts to decrease at a high rate, until it is 0 at the Open Circuit

Voltage. The maximum output of the panel is right at the knee of the curve, where the slope of the blue power curve reaches 0.

In the Challenge described below, you will generate a very similar curve using parts from our Electronics kit and as bright a light source as you can find. The brighter the light the better the experiment will work. Try moving your experiment by the window if you can catch the direct rays from the sun. In a pinch, your cell phone can be used, but a regular desk lamp will work much better.

Challenge Requirements and Scoring

- Students will use the materials from the Electronics Kit to:
  - Build a circuit
  - Gather data from the circuit
  - Plot data in Excel or similar program to create a graph
- Students will email the finished graph to Julie Miller Kalbacher at jamiller@mwdh2o.com
  - Make sure to title the document correctly.
  - The document should have the student name on it, school name on it and "Solar Panel Challenge Graph" as the title.
  - All submissions will be evaluated. The team will be awarded the highest scoring student's score as the team score.
  - Graph is worth up to 100 points

Both Divisions, the Greater Time Commitment and the Lesser Time Commitment, are following same steps for this Challenge

1. **Please watch the "Resistors" tutorial video on the MWD Solar cup web site for an example of how to hook up the resistors in your kit while measuring the voltage and current in these circuits.**

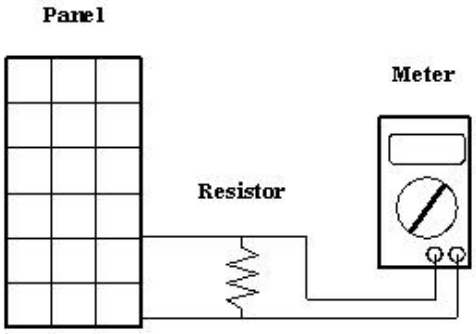
   a. If you don't recall how to hook up the meters to measure voltage and current, please refer to the Basics of Electronics Challenge.

   b. We are going to measure voltages first.

2. **The procedure to take the necessary voltage data is as follows:**

   a. Attach ten different values of the resistors in your kit to the breadboard as demonstrated in the **"Resistors and Light Bulb"** tutorial video on the Solar Cup webpage. **Note that** your kit has multiple resistors of each value, just select one of each value.

   b. Hook up the circuit as shown below using the breadboard and one of the resistors. Note that the meter leads are hooked up to measure ACROSS the first resistor.



Voltage Circuit

c. Set your meter to the 20V voltage position. (3 clicks counterclockwise from off)

d. If the value is negative, simply swap the input leads to the meter.

e. Make sure you have a very bright light source. The solar panels are very small and will not put out much current if the light is dim. Put the light source as close as possible to the PV panel. Do not move the panel or light source during your measurements or you will have to start over.

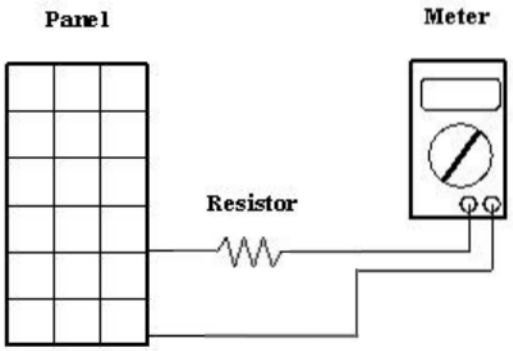
f. Record the data and move alligator clips to the next resistor in line.

g. Repeat the procedure for all ten resistors and record the voltage reading of each resistor.

h. When you are finished, disconnect all the alligator clips and meter leads, but leave the resistors in the same position on the breadboard**.**

i. Do not be tempted to leave some of the wires connect and merely re-arrange them to make the next circuit. Doing so will greatly increase your chances of making a wiring error and may damage your meter.

3. The procedure to take the necessary current data is similar:



Current Circuit

a. Hook up the circuit as shown above using the breadboard and one of the resistors.

   Note that the meter leads are hooked up so that the current goes THROUGH the meter and back out.

b. Set your meter to the 20ma voltage position. (4 clicks clockwise from off)

c. Do not measure current when the meter is set to a voltage range. You will damage the meter and will be unable to finish the measurements.

d. If the value is negative, simply swap the inputs to the meter.

e. Record the data and move alligator clips to the next resistor in line.

   i. Make sure you step through the resistors in the same order you used when taking the voltage readings.

f. Repeat the procedure for all ten resistors and record the current reading of each.

4. Now plot your data in Excel (or whatever graphing program you have.)

   i. It should look something like the graph below.

   ii. If you don't know how to make a scatter plot in Excel, here is a good tutorial**:** Creating a Scatter Plot in Excel 2016 - YouTube

b. Now take a screen shot and email it to Julie Miller Kalbacher jamiller@mwdh2o.com

   i. Use the correct format when emailing the document
      1. Your name
      2. The name of your school
      3. Title the document: Solar Challenge Graph

   ii. You can also include your response to the extra credit question at the end of this Challenge.

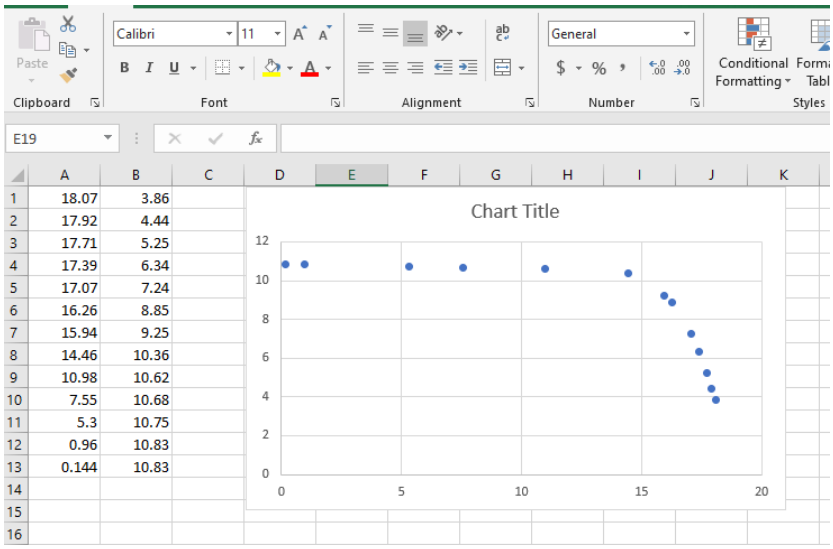
5. Sample graph results to self-check your results

a. Here is the Excel graph I got when I plotted the data shown in the table at the left side of the figure.

b. I had a few extra resistors, but your plot should have the same basic shape as mine.

c. To collect this data, I used the same solar panel, resistors and meter you received in your kit. Your data will differ from mine because your light source will be different, but the shape of the graph should be mostly the same.

d. If you are not getting a similar graph, please reach out to Julie Miller Kalbacher at jamiller@mwdh2o.com



	A	B	C	D	E	F	G	H	I	J	K
1	18.07	3.86									
2	17.92	4.44									
3	17.71	5.25									
4	17.39	6.34									
5	17.07	7.24									
6	16.26	8.85									
7	15.94	9.25									
8	14.46	10.36									
9	10.98	10.62									
10	7.55	10.68									
11	5.3	10.75									
12	0.96	10.83									
13	0.144	10.83									
14											
15											
16											

****10 bonus points if you can tell me why the graph does not go all the way to 0 at the maximum voltage. Hint: Review Ohms law in the Circuits Challenge.**