Outline for Weather Station

I. **Assembly Instructions (Before and After configuration)**

Materials Needed:

- Screwdriver with a hexagonal head (2.5 mm), you may also use an allen wrench.
- An SD card reader. This may be a multi card reader or an SD card adapter.

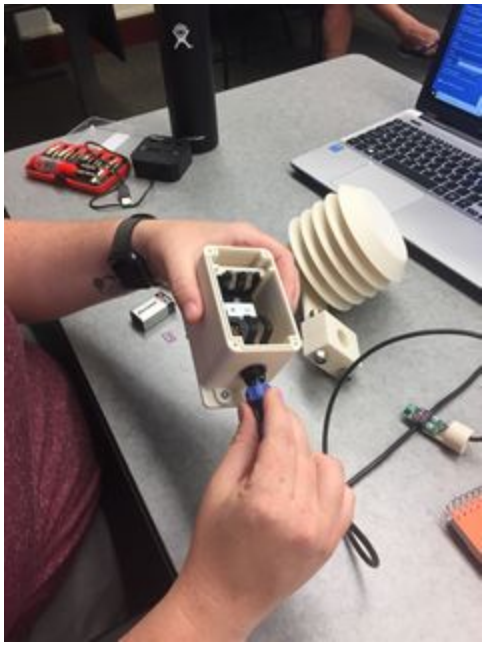
INSTRUCTIONS FOR ASSEMBLY BEFORE CONFIGURATION OF SD CARD

1. Open up the power box. (This requires your screwdriver)

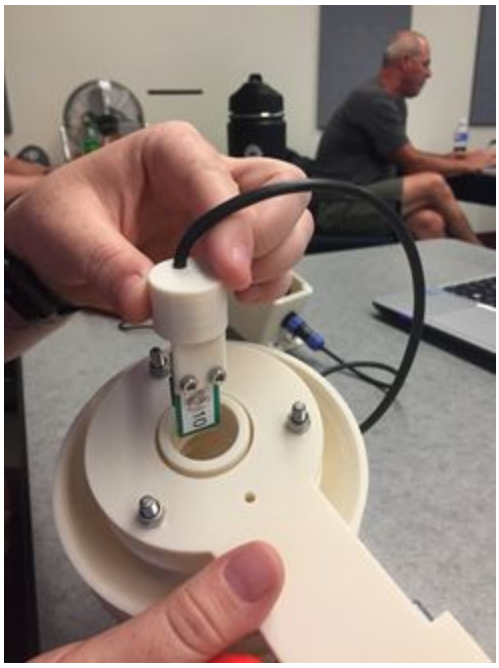
2. Take the micro SD card out of its slot.

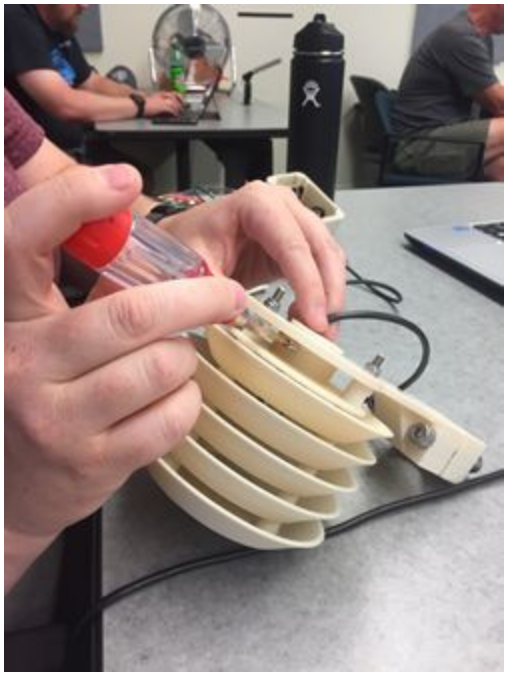
3. You now have all of the following parts.

4. Attach the cable to the bottom part of the power box. Make sure you line up the white circles and screw the blue cap on.



5. Next peel the white sticker off of the sensor on the other end of the cable. Now take the sensor end of the cable and slide it into the bottom circular part of your shield. Tighten each screw on either side equally to stabilize the sensor. Make sure you do NOT tighten these screws too much otherwise the 3D printed body will crack.



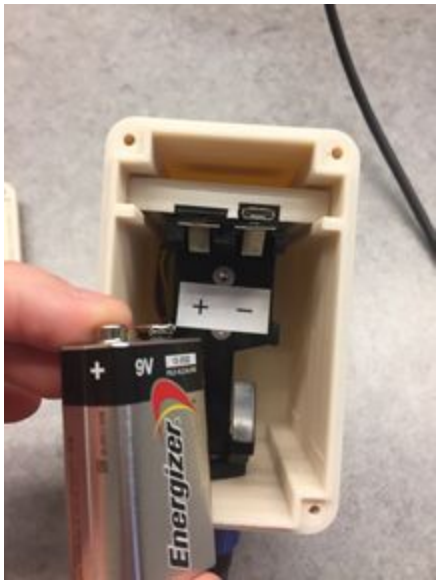


AT THIS POINT YOU WILL NEED TO CONFIGURE YOUR MICRO SD CARD! (See instructions for this)

INSTRUCTIONS FOR ASSEMBLY AFTER CONFIGURATION OF SD CARD

1. Insert your micro SD card back into it's correct slot. Make sure the print on the card faced toward the battery slot.

2. Place the battery into its correct position by placing the positive side matched up with the positive side. When you do this and the battery is working you will see a VERY QUICK green flash.



3. Place the lid back onto the power box in correct position according to the indentations on the lid. Then tighten screws. Make sure not to tighten the screws too tight. They should be flush with the top but not warping the top.

NOW YOU ARE READY TO COLLECT DATA!!!

Don't forget when you decide to collect it, make sure you take the battery out BEFORE the SD card.

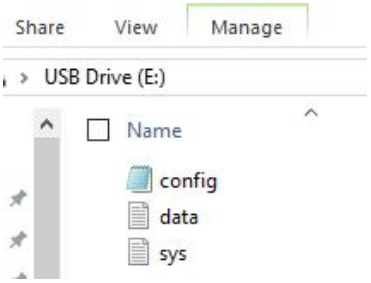
II. Configuration of data.

The SD card can be found under the (+) side of the battery, in the power box. It should be label side toward the battery.

**Never remove the card when a battery is inserted.

**Never plug anything into the USB port to the left of the MicroSD card slot.

1. Remove the card and place it in a micro SD card reader attached to your computer.
2. Open the card in file explorer and look for a file named Config.

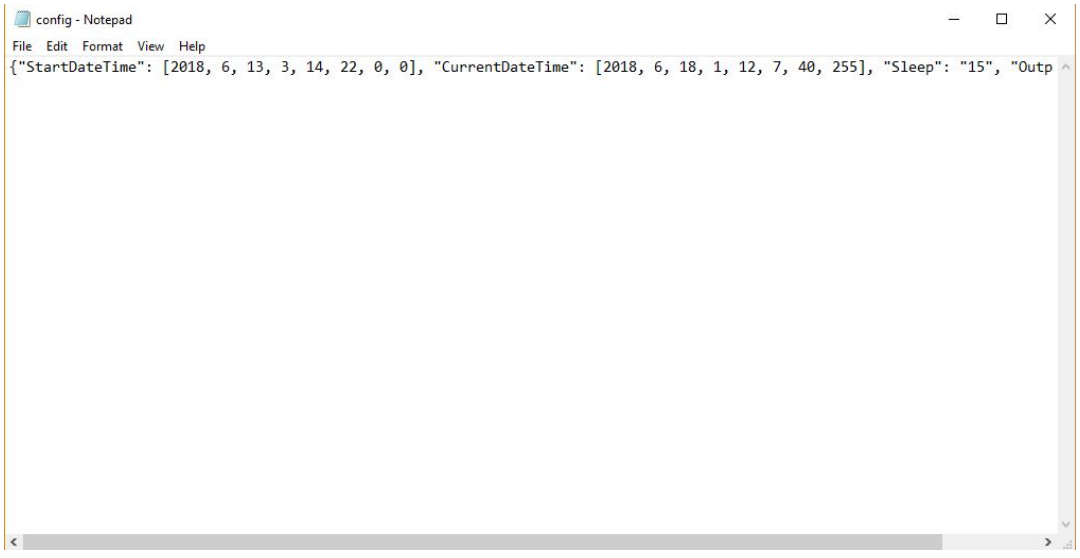


3. Open this file in notepad or other word processing program.
4. You will see the following lines of code.

{"StartDateTime": [2018, 6, 13, 3, 14, 22, 0, 0], "CurrentDateTime": [2018, 6, 19, 2, 9, 25, 30, 255], "Sleep": "15", "OutputType": "1"}

{"StartDateTime": [YYYY, MM, DD, W, HH, MM, SS, SubSS], "CurrentDateTime": [YYYY, MM, DD, W, HH, MM, SS, Sub Sec], "Sleep": "MM", "OutputType": "1"}

EXAMPLE:



1. {"StartDateTime": [YYYY, MM, DD, W, HH, mm, SS, SubSS], in this section you will input start time you want the unit to begin taking data. It will begin once a battery is inserted so you want to move your minutes ahead of current time by approximately 5 min.
2. YYYY= 4 digit year i.e. 2018
3. MM= 2 digit month i.e. 06
4. DD= 2 digit day i.e. 23
5. W= day of the week Mon=1, Tue=2, Wed=3, Thur=4, Fri=5, Sat=6, Sun=7
6. HH= Hour in 24 clock time i.e. 14 would be 2PM
7. mm= minute i.e. 47
8. SS= seconds i.e. 35
9. Sub SS= Sub seconds (likely 00 due to nonuse.)
10. "CurrentDateTime": [YYYY, MM, DD, W, HH, MM, SS, Sub Sec], in this section you will delete code and replace with "". When complete it will read
11. "CurrentDateTime": "",
12. "Sleep": "MM", this section tells your device how long to sleep, in minutes, between each data point. Entering "01" would take a data point every 1 minute. Entering ".01" would take a data point every 6 seconds. Entering "15" would take a data point every 15 minutes. Using a longer sleep period increases battery life.
13. "OutputType": "1"} in this section you are telling the station where to save data points. Entering "1" tells the station to save to the MicroSD card.
14. **Always enter "1" here.
15. Save the configure file.
16. Properly eject the card by clicking the "safely remove hardware or eject media" 

button on the taskbar of your computer.
17. Remove MicroSD card.
18. Replace MicroSD card in weather station power box label side facing the battery.
19. At this point you need to begin logging observations of weather conditions and locations of weather station. Pictures are great for this step. Continue using 24 hr. time.

II. Downloading data (Chris)

A. Remove the SD card from the unit. **MAKE SURE TO REMOVE THE BATTERY FIRST!!**

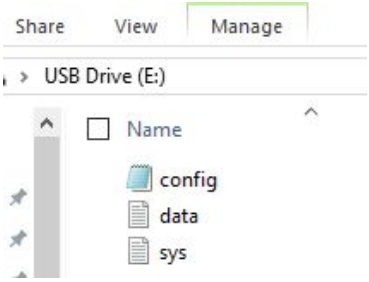
B. Place the SD into a Micro SD slot in a computer.

1. If your computer does not have a Micro SD slot then you will need to get a Micro SD card reader.
2. 

3. Make sure that you then plug that into your computer using a USB slot.
4. 

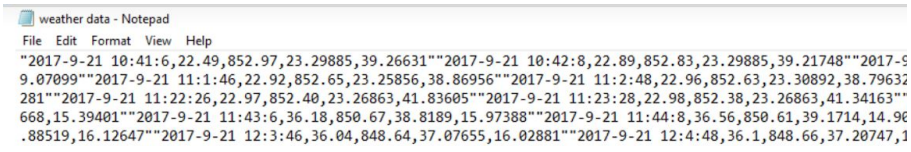
C. Open the SD card on your computer.

1. Open file manager
   a) This should open up automatically when you insert the Micro SD card into the Micro SD card reader.
2. There will be a new USB Drive in your file manager. In the picture this one is labeled as F:
3. 

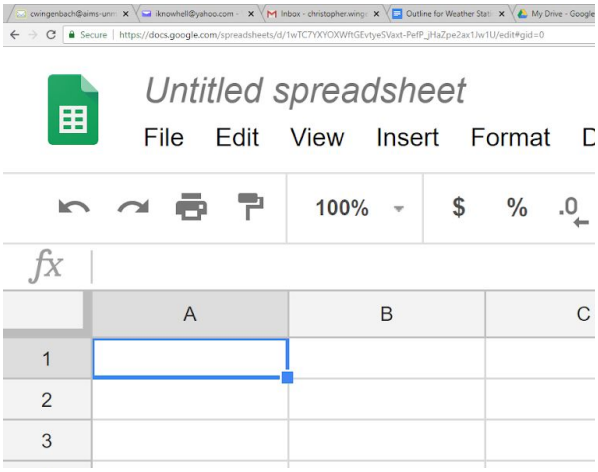
4. Double click that link and you will see a screen like this picture.
5. 

6. Double click the data file.

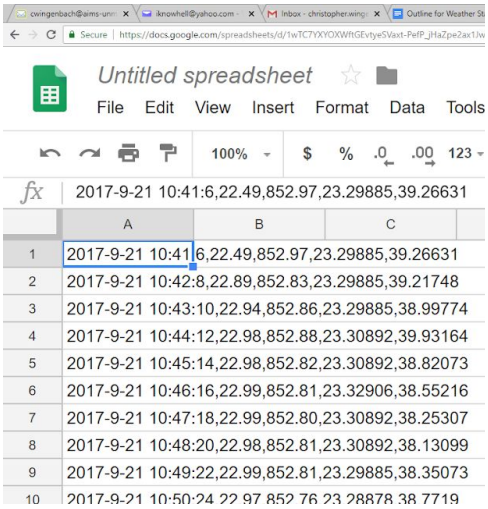
D. A new window should open with the data file contained within, that file will look like this.

1. 

E. Use Ctrl+A to select all then Ctrl+C to copy the information.
F. Open a spreadsheet of your choice. I will be using Google Sheets for the images used in this manual. Then paste the information into A1 of Sheet 1.

1. 

G. You will notice that all of the information is in that first column.

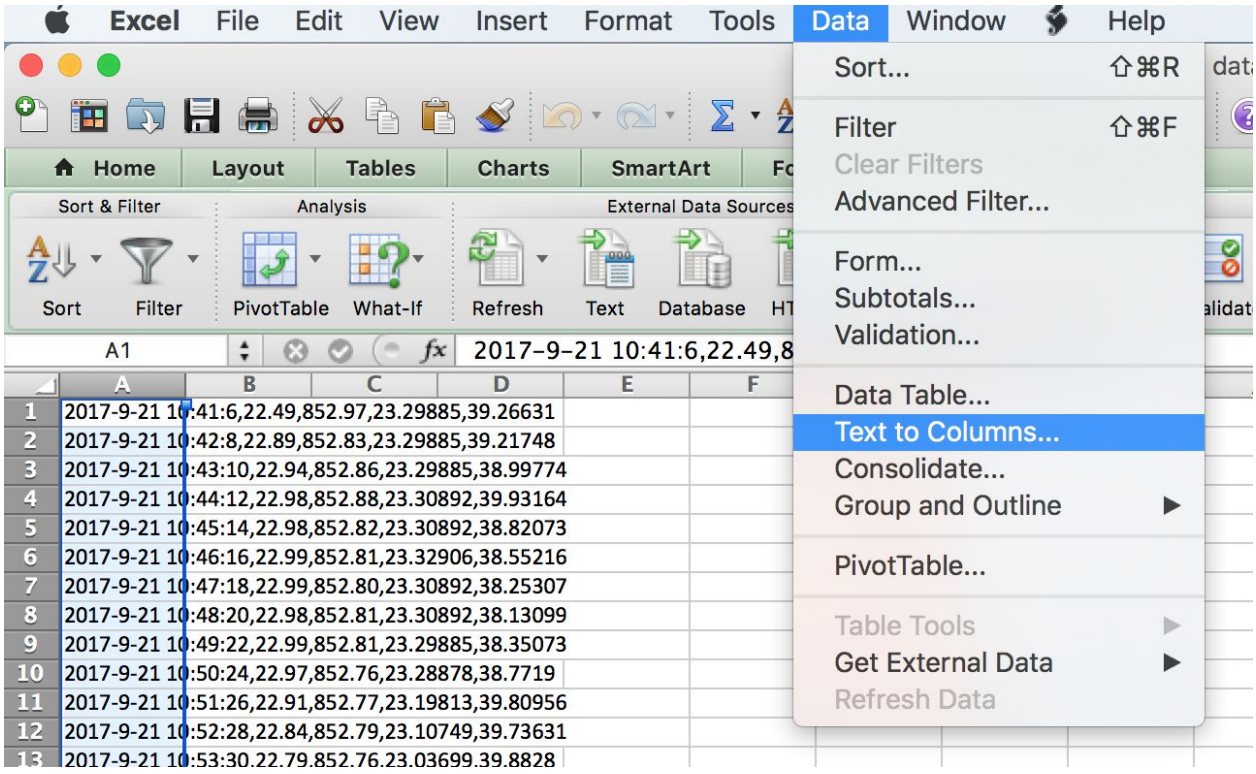
1. 

III. Formatting Data in Excel

After downloading the data into Excel, the data will be all in one column separated by a comma.

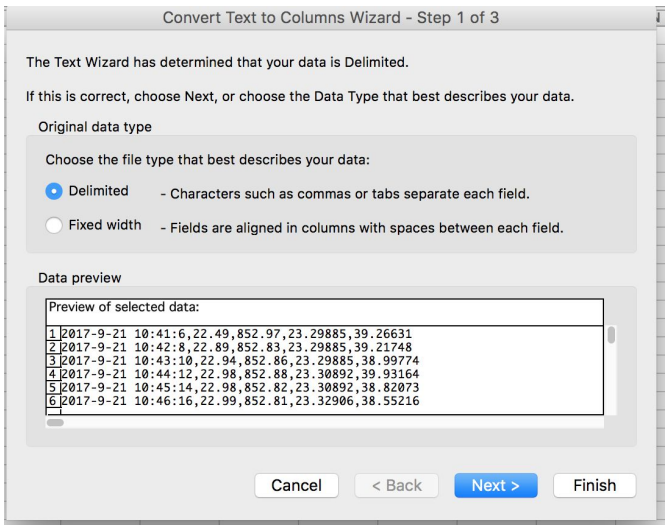
	A	B	C	D
1	2017-9-21 10:41:6,22.49,852.97,23.29885,39.26631			
2	2017-9-21 10:42:8,22.89,852.83,23.29885,39.21748			
3	2017-9-21 10:43:10,22.94,852.86,23.29885,38.99774			
4	2017-9-21 10:44:12,22.98,852.88,23.30892,39.93164			
5	2017-9-21 10:45:14,22.98,852.82,23.30892,38.82073			
6	2017-9-21 10:46:16,22.99,852.81,23.32906,38.55216			
7	2017-9-21 10:47:18,22.99,852.80,23.30892,38.25307			
8	2017-9-21 10:48:20,22.98,852.81,23.30892,38.13099			
9	2017-9-21 10:49:22,22.99,852.81,23.29885,38.35073			
10	2017-9-21 10:50:24,22.97,852.76,23.28878,38.7719			
11	2017-9-21 10:51:26,22.91,852.77,23.19813,39.80956			
12	2017-9-21 10:52:28,22.84,852.79,23.10749,39.73631			
13	2017-9-21 10:53:30,22.79,852.76,23.03699,39.8828			
14	2017-9-21 10:54:32,22.78,852.74,23.02692,39.68748			
15	2017-9-21 10:55:34,22.77,852.76,23.03699,39.54099			
16	2017-9-21 10:56:36,22.78,852.76,23.04706,39.51657			

In order get the data into separate columns you will need to select column “A”. Click on “Data” on the toolbar and select “text to columns”

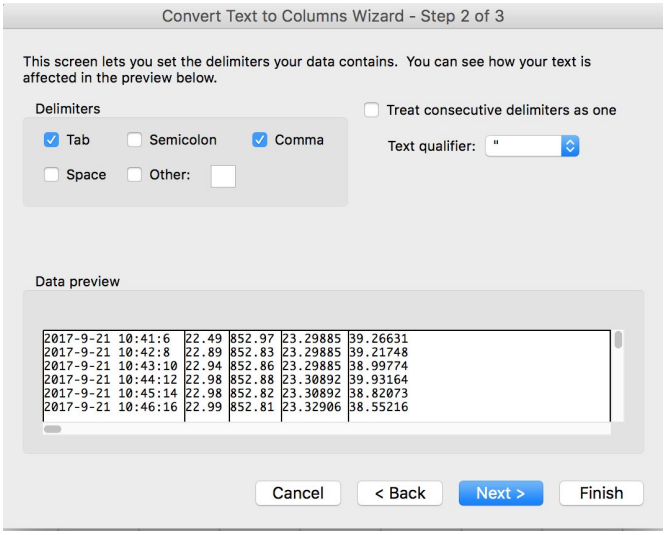


Choose “Delimited” and go to “Next”. Then select “comma” and go to “Next”. Finally select “General” and select “Finish”

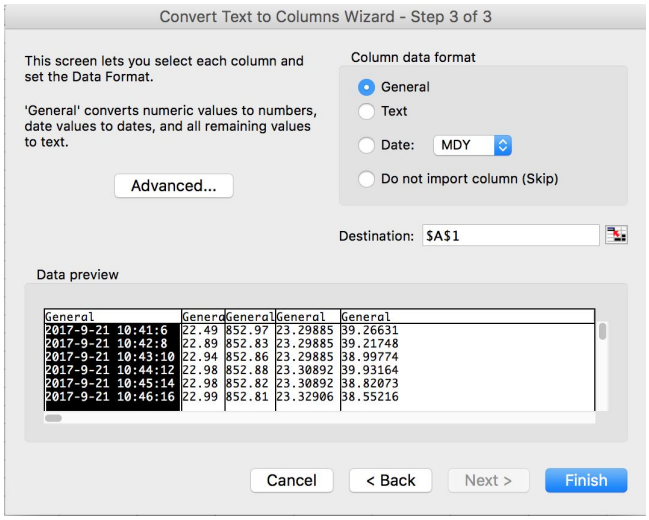
Step 1



Step 2



Step 3

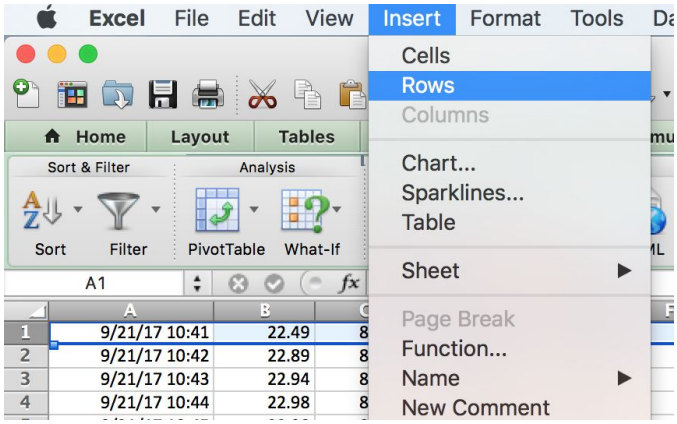


Now your data should be in columns and ready to be used. You may need to expand column "A" in order to read all of the dates and time if your data shows up as "#######".

	A	B	C	D	E
1	9/21/17 10:41	22.49	852.97	23.29885	39.26631
2	9/21/17 10:42	22.89	852.83	23.29885	39.21748
3	9/21/17 10:43	22.94	852.86	23.29885	38.99774
4	9/21/17 10:44	22.98	852.88	23.30892	39.93164
5	9/21/17 10:45	22.98	852.82	23.30892	38.82073
6	9/21/17 10:46	22.99	852.81	23.32906	38.55216
7	9/21/17 10:47	22.99	852.8	23.30892	38.25307
8	9/21/17 10:48	22.98	852.81	23.30892	38.13099

Column Headers:

In order to label each column of data you will need to create a new row above the data sets. Select Row 1 and click “Insert” on the toolbar. Select “Row” and a new row will appear above the data.



	A	B	C	D	E
1					
2	9/21/17 10:41	22.49	852.97	23.29885	39.26631
3	9/21/17 10:42	22.89	852.83	23.29885	39.21748
4	9/21/17 10:43	22.94	852.86	23.29885	38.99774
5	9/21/17 10:44	22.98	852.88	23.30892	39.93164
6	9/21/17 10:45	22.98	852.82	23.30892	38.82073

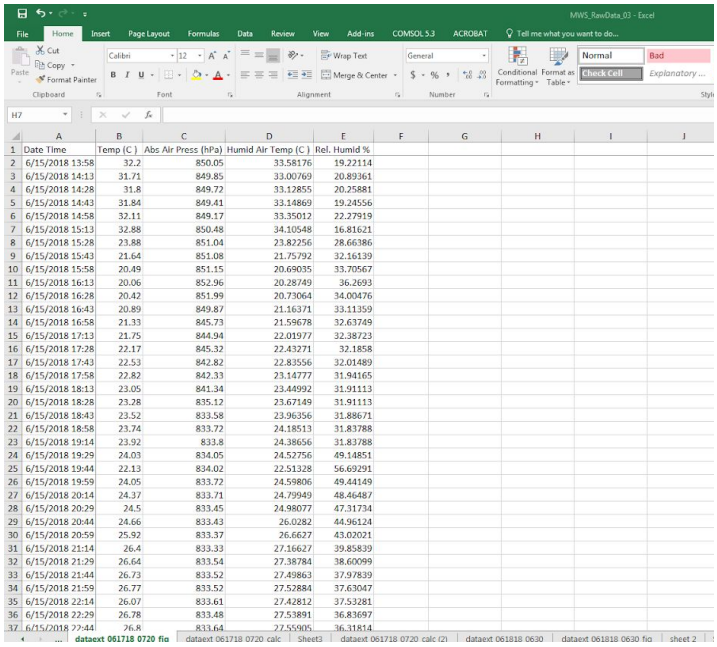
Label the columns as follows. Column “A” Date and Time, Column “B” Temp Co, Column “C” Pressure, Column “D” Temp C∘, Column “E” Humidity.

	A	B	C	D	E
1	Date and Time	Temp Deg C	Pressure	Temp Deg C	Humidity
2	9/21/17 10:41	22.49	852.97	23.29885	39.26631
3	9/21/17 10:42	22.89	852.83	23.29885	39.21748
4	9/21/17 10:43	22.94	852.86	23.29885	38.99774
5	9/21/17 10:44	22.98	852.88	23.30892	39.93164

IV. Graphing and interpreting data (Kyle)

A. Using the excel graphing tools, create a X,Y Scatter Plot to represent the change in temperature (T), air pressure (P), and relative humidity (RH) over time.

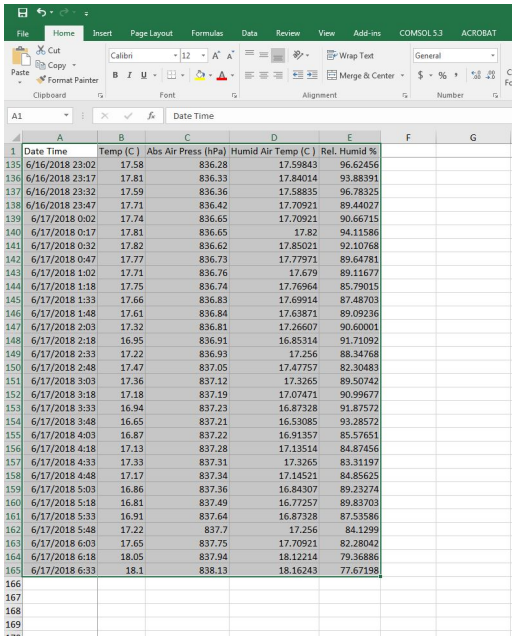
B. Make sure the data used for the X axis is is in the first column (Date and time). The following data points will be in the columns to the left.



	A	B	C	D	E
1	Date Time	Temp (C)	Abs Air Press (hPa)	Humid Air Temp (C)	Rel. Humid %
2	6/15/2018 13:58	32.2	850.05	33.58176	19.22114
3	6/15/2018 14:13	31.71	849.85	33.00769	20.89361
4	6/15/2018 14:28	31.8	849.72	33.12855	20.25881
5	6/15/2018 14:43	31.84	849.41	33.14869	19.24556
6	6/15/2018 14:58	32.11	849.17	33.35012	22.27919
7	6/15/2018 15:13	32.88	850.48	34.10548	16.81621
8	6/15/2018 15:28	23.88	851.04	23.82256	28.66386
9	6/15/2018 15:43	21.64	851.08	21.75792	32.16139
10	6/15/2018 15:58	20.49	851.15	20.69035	33.70567
11	6/15/2018 16:13	20.06	852.96	20.28749	36.2693
12	6/15/2018 16:28	20.42	851.99	20.73064	34.00476
13	6/15/2018 16:43	20.89	849.87	21.16371	33.11359
14	6/15/2018 16:58	21.33	845.73	21.59678	32.63749
15	6/15/2018 17:13	21.75	844.94	22.01977	32.38723
16	6/15/2018 17:28	22.17	845.32	22.43271	32.1858
17	6/15/2018 17:43	22.53	842.82	22.83556	32.01489
18	6/15/2018 17:58	22.82	842.33	23.14777	31.94165
19	6/15/2018 18:13	23.05	841.34	23.44992	31.91113
20	6/15/2018 18:28	23.28	835.12	23.67149	31.91113
21	6/15/2018 18:43	23.52	833.58	23.96356	31.88671
22	6/15/2018 18:58	23.74	833.72	24.18513	31.83788
23	6/15/2018 19:14	23.92	833.8	24.38656	31.83788
24	6/15/2018 19:29	24.03	834.05	24.52756	49.14851
25	6/15/2018 19:44	22.13	834.02	22.51328	56.69291
26	6/15/2018 19:59	24.05	833.72	24.59806	49.44149
27	6/15/2018 20:14	24.37	833.71	24.79949	48.46487
28	6/15/2018 20:29	24.5	833.45	24.98077	47.31734
29	6/15/2018 20:44	24.66	833.43	26.0282	44.96124
30	6/15/2018 20:59	25.92	833.37	26.6627	43.02021
31	6/15/2018 21:14	26.4	833.33	27.16627	39.85839
32	6/15/2018 21:29	26.64	833.54	27.38784	38.60099
33	6/15/2018 21:44	26.73	833.52	27.49863	37.97839
34	6/15/2018 21:59	26.77	833.52	27.52884	37.63047
35	6/15/2018 22:14	26.07	833.61	27.42812	37.53281
36	6/15/2018 22:29	26.78	833.48	27.53891	36.83697
37	6/15/2018 22:44	26.8	833.64	27.55905	36.31814

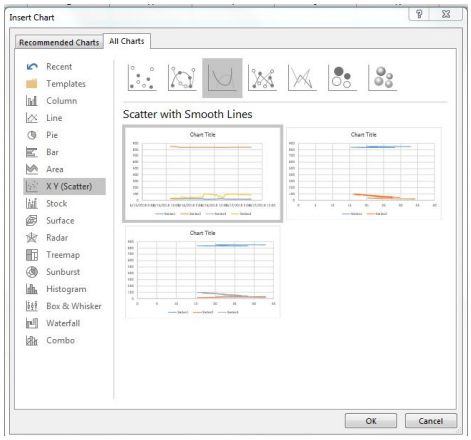
C. There are two measurements for temperature, one associated with the pressure sensor and one associated with the humidity sensor. You are welcome to keep both, delete one, or find the average between the two; whichever you decide.

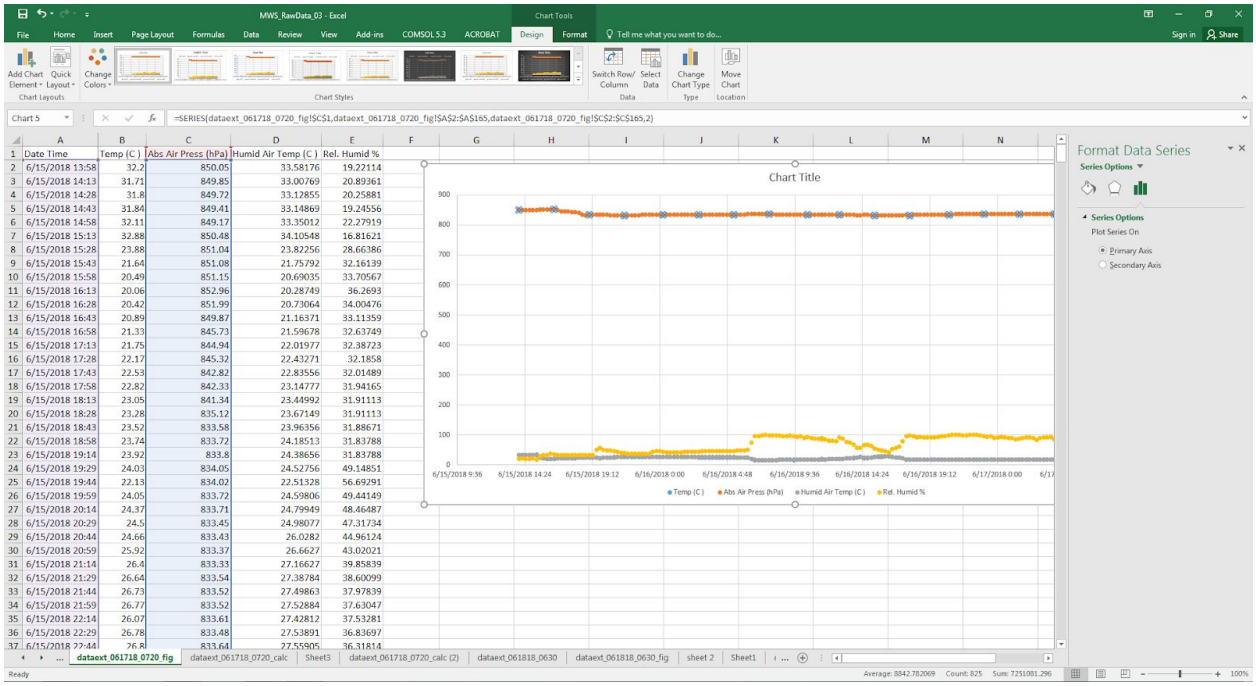
D. Left click on the first cell in the first column and select the data you would like to graph.



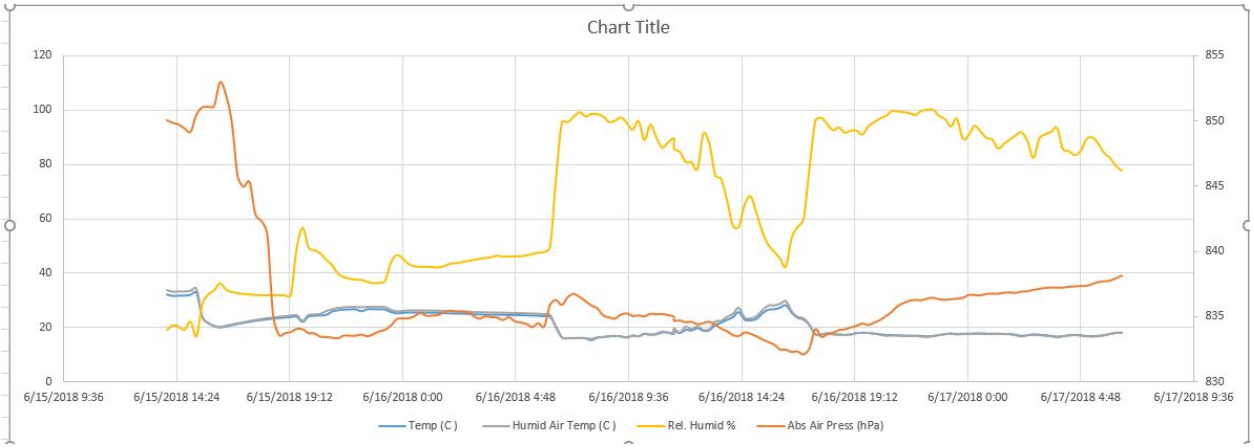
	A	B	C	D	E
1	Date Time	Temp (C)	Abs Air Press (hPa)	Humid Air Temp (C)	Rel. Humid %
135	6/16/2018 23:02	17.58	836.28	17.59843	96.62456
136	6/16/2018 23:17	17.81	836.33	17.84014	93.88391
137	6/16/2018 23:32	17.59	836.36	17.58835	96.78325
138	6/16/2018 23:47	17.71	836.42	17.70921	89.44027
139	6/17/2018 0:02	17.74	836.65	17.70921	90.66715
140	6/17/2018 0:17	17.81	836.65	17.82	94.11586
141	6/17/2018 0:32	17.82	836.62	17.85021	92.10768
142	6/17/2018 0:47	17.77	836.73	17.77971	89.64781
143	6/17/2018 1:02	17.71	836.76	17.679	89.11677
144	6/17/2018 1:18	17.75	836.74	17.76964	85.79015
145	6/17/2018 1:33	17.66	836.83	17.69914	87.48703
146	6/17/2018 1:48	17.61	836.84	17.63871	89.09236
147	6/17/2018 2:03	17.32	836.81	17.26607	90.60001
148	6/17/2018 2:18	16.95	836.91	16.85314	91.71092
149	6/17/2018 2:33	17.22	836.93	17.256	88.34768
150	6/17/2018 2:48	17.47	837.05	17.47757	82.30483
151	6/17/2018 3:03	17.36	837.12	17.3265	89.50742
152	6/17/2018 3:18	17.18	837.19	17.07471	90.99677
153	6/17/2018 3:33	16.94	837.23	16.87328	91.87572
154	6/17/2018 3:48	16.65	837.21	16.53085	93.28572
155	6/17/2018 4:03	16.87	837.22	16.91357	85.57651
156	6/17/2018 4:18	17.13	837.28	17.13514	84.87456
157	6/17/2018 4:33	17.33	837.31	17.3265	83.31197
158	6/17/2018 4:48	17.17	837.34	17.14521	84.85625
159	6/17/2018 5:03	16.86	837.36	16.84307	89.23274
160	6/17/2018 5:18	16.81	837.49	16.77257	89.83703
161	6/17/2018 5:33	16.91	837.64	16.87328	87.53586
162	6/17/2018 5:48	17.22	837.7	17.256	84.1299
163	6/17/2018 6:03	17.65	837.75	17.70921	82.28042
164	6/17/2018 6:18	18.05	837.94	18.12214	79.36886
165	6/17/2018 6:33	18.1	838.13	18.16243	77.67198
166					
167					
168					
169					

E. Left click on “Insert” > “Charts” > “X,Y Scatter Plot”
    1. Choose a plot with connected points on a curve, there are usually a few options to choose from.

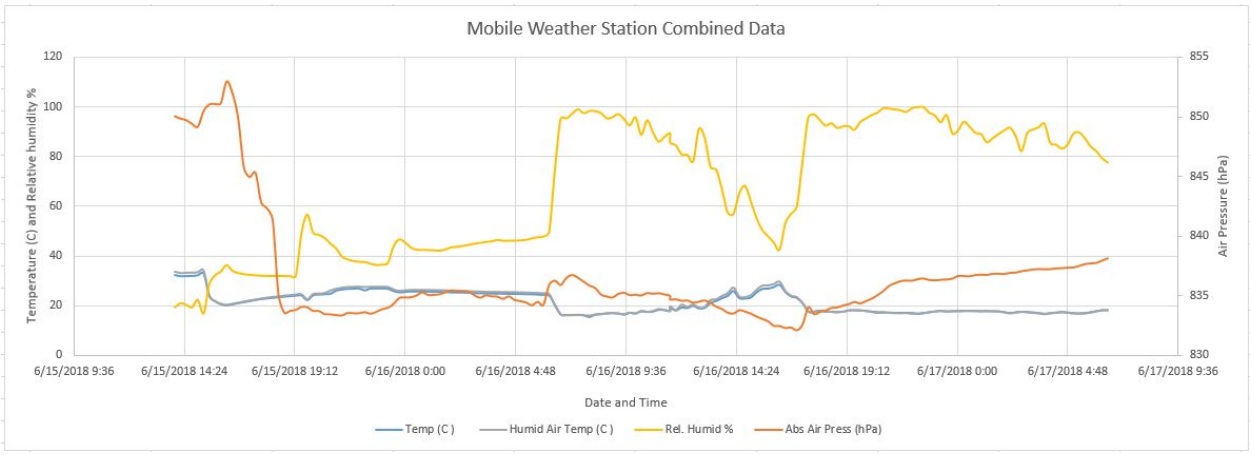




F. A plot should appear in your workbook. Right click on the air pressure data. Select “Format Data Series” > Axis > <u>Secondary Axis</u>.
    1. Using the same steps, make sure the temperature and humidity are on the “Primary Axis.”

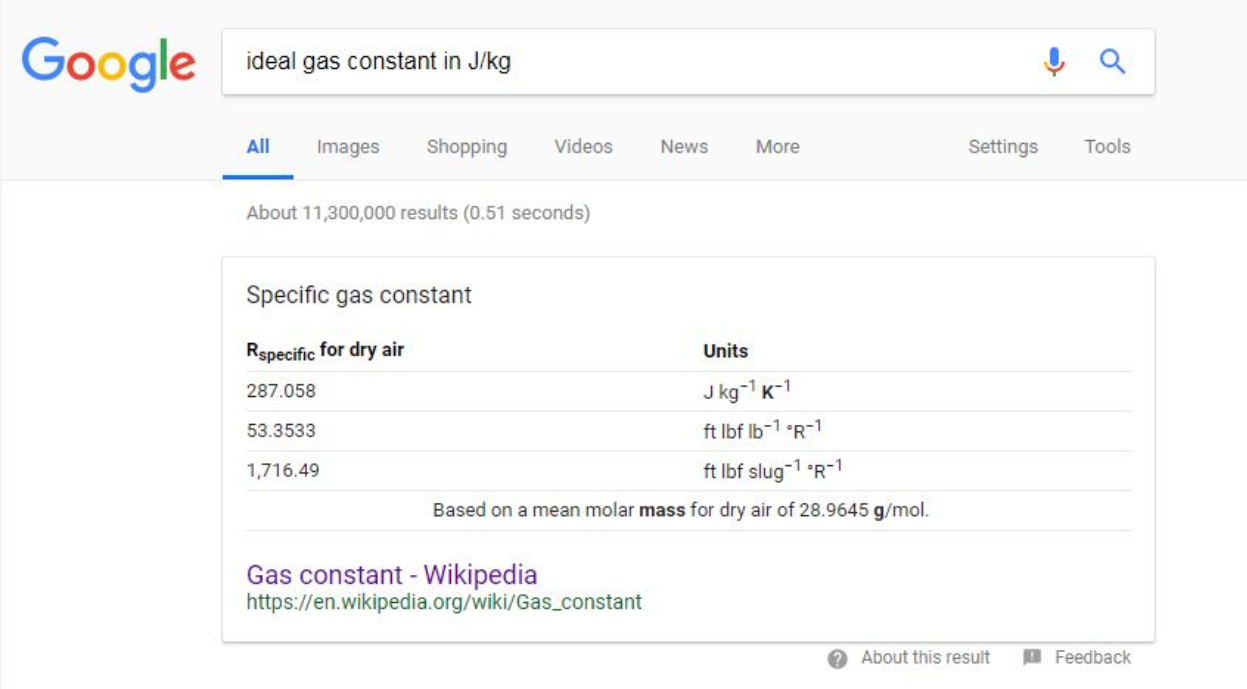


G. Change the design of the Chart Elements and add a Chart Title, Axis Labels, and a Legend.



H. This is the Combined Data figure for your mobile weather station. You can repeat the procedure and create figures for individual measurements i.e. Air Pressure (hPa) vs Time (min).

I. Calculating air density using the Ideal Gas Law (P= ρRT)
    1. Ideal gas constant is 287.058 J/Kg*K. Therefore we need to convert the air pressure to Pa and the Temperature to K.



2. Insert and title new columns next to temperature column (B) and the Air Pressure column (D)..
    a) Insert the formula “=273.15+(B2)”

Date Time	Temp (C)	Temp (K)
6/15/2018 13:58	32.2	=273.15+(B2)

    b) Insert the formula “=100*(D2)”

D	E
Abs Air Press (hPa)	Abs Air Press (Pa)
850.05	=100*D2

    c) Copy and paste these formulas for the rest of the columns.
3. Using the Ideal Gas Law, calculate the air density as shown below.

	A	B	C	D	E	F	G	H
1	Date Time	Temp (C)	Temp (K)	Abs Air Press (hPa)	Abs Air Press (Pa)	Humid Air Temp (C)	Rel. Humid %	Air Density (ρ)
2	6/15/2018 13:58	32.2	305.35	850.05	85005	33.58176	19.22114	=E2/(287.058*C2)

*Make sure to use the Pascal and Kelvin measurements. Copy and paste this formula for the rest of the Air Density column.