Name _____

The College of New Jersey
School of Engineering
ENG142: Introduction to Engineering
Developed by A. Deese

Introduction to Microsoft Excel

Introduction

This exercise introduces students to the use of Microsoft Excel for engineering and technical data analysis. It discusses editing and sorting of data, formatting, use of built-in Excel functions, design and custom functions, conditional statements, error correction and linear interpolation, VLOOKUP's, as well as proper techniques for graphing.

Procedure

1. Open the Microsoft Excel file named "TemperatureData.xlsx". This file should contain two data sets (A, B) that describe the relationship between time and temperature for an experiment we (fictionally) are conducting.

	A	B	C	D	E	F
1		data set A		data set B		
2	label	time	temperature	time	temperature	
3	units	seconds	degrees F	seconds	degrees F	
4		0.2	63.85	0.2	48.92	
5		4.5	58.12	4.1	37.26	
6		4.6	57.37	4.2	37.88	
7		4.7	57.86	4.4	37.80	
8		4.8	56.22	4.5	40.38	
9		4.9	56.19	4.7	39.41	
10		0.8	55.78	4.8	39.35	
11		0.9	54.99	0.3	47.50	
12		1.4	52.69	0.5	47.82	
13		0.1	63.91	1.2	43.43	
14		1.5	52.60	0.6	45.16	
15		1.6	51.93	0.8	44.77	
16		1.7	53.27	0.9	44.45	
17		1.8	52.42	1.1	42.93	
18		1.9	53.23	1.4	42.68	
19		2.0	52.28	1.5	40.73	
20		2.1	52.98	1.7	40.78	

Figure 1: Data Sets A and B Describing Temperature (C) vs. Time (s)

A. Sorting

2. Because of an error in our data collection apparatus, the data is supplied to us in non-chronological order. We will need to sort it. Because data sets A and B have separate time columns, they must be sorted independently. Using the cursor, highlight both columns of data set A (excluding the labels in rows #1 through #3).

	A	B	C	D	E	F
1		data set A		data set B		
2	label	time	temperature	time	temperature	
3	units	seconds	degrees F	seconds	degrees F	
4		0.2	63.85	0.2	48.92	
5		4.5	58.12	4.1	37.26	
6		4.6	57.37	4.2	37.88	
7		4.7	57.86	4.4	37.80	
8		4.8	56.22	4.5	40.38	
9		4.9	56.19	4.7	39.41	
10		0.8	55.78	4.8	39.35	
11		0.9	54.99	0.3	47.50	
12		1.4	52.69	0.5	47.82	
13		0.1	63.91	1.2	43.43	
14		1.5	52.60	0.6	45.16	
15		1.6	51.93	0.8	44.77	
16		1.7	53.27	0.9	44.45	
17		1.8	52.42	1.1	42.93	
18		1.9	53.23	1.4	42.68	
19		2.0	52.28	1.5	40.73	
20		2.1	52.98	1.7	40.78	

29	2.6	54.22	3.0	37.13
30	2.7	55.11	3.2	38.44
31	2.8	55.70	3.3	39.67
32	2.9	57.06	3.5	38.18
33	3.0	57.35	3.6	36.88
34	3.1	57.96	3.8	38.45
35	3.2	57.27	3.9	40.20
36	3.3	57.29	5.0	39.85
37	3.4	57.97	5.1	41.63
38	3.5	57.82		
39	3.6	58.60		
40	3.7	58.39		
41	3.8	58.68		
42	3.9	58.69		
43	4.0	59.27		
44	4.1	58.65		
45	4.2	60.30		
46	4.3	59.20		
47	4.4	58.64		
48			44R x 2C	
49				

Figure 2: Highlighting Data Set A

3. Under the "Data" tab at the top of the screen, click the "Sort" function. This will cause the "Sort" function window to appear.

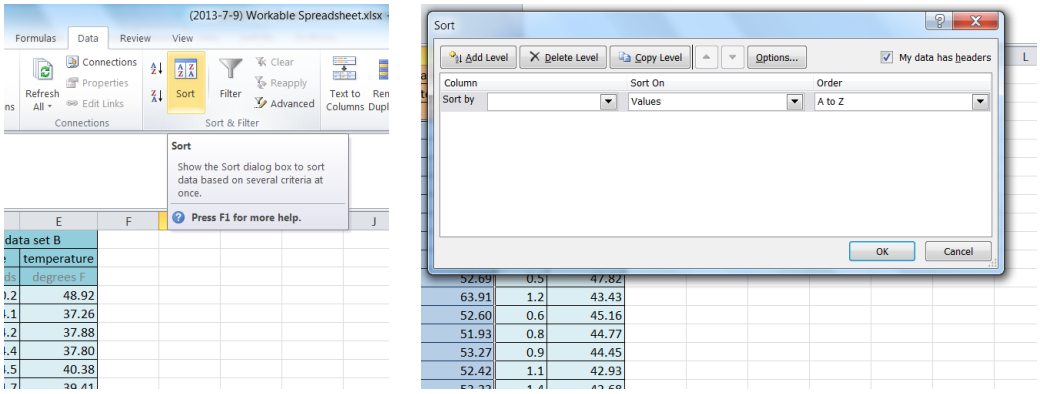


Figure 3: Activating "Sort" Function (Left) and "Sort" Function Window (Right)

4. Normally, one sorts data with respect to the independent variable. In this case, the independent variable is time. The dependent variable is temperature. As such, choose to "sort by" seconds in first box. Also choose to "sort on" values. Lastly, choose to "order" from smallest to largest.

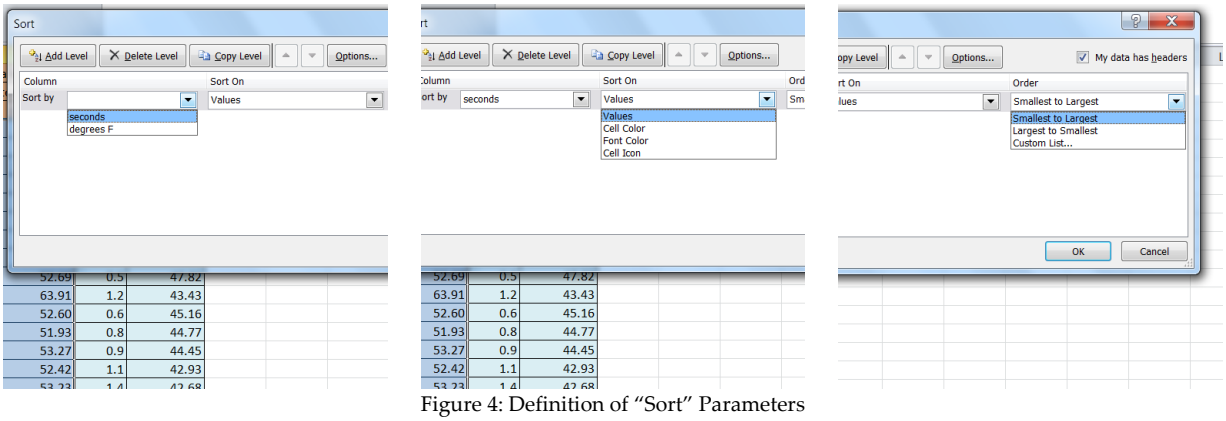


Figure 4: Definition of "Sort" Parameters

5. The result is shown below. Use this same procedure to sort data set B.

	A	B	C	D	E	F
1		data set A		data set B		
2	label	time	temperature	time	temperature	
3	units	seconds	degrees F	seconds	degrees F	
4		0.1	64.48	0.2	49.12	
5		0.2	63.15	4.1	37.57	
6		0.8	55.06	4.2	39.90	
7		0.9	54.78	4.4	38.18	
8		1.0	55.44	4.5	39.48	
9		1.1	53.13	4.7	38.45	
10		1.2	52.65	4.8	39.87	
11		1.3	52.23	0.3	48.61	
12		1.4	53.85	0.5	46.11	
13		1.5	52.54	1.2	41.58	
14		1.6	52.24	0.6	44.99	
15		1.7	51.82	0.8	46.15	
16		1.8	51.88	0.9	43.16	
17		1.9	52.71	1.1	42.64	
18		2.0	54.07	1.4	41.24	
19		2.1	53.75	1.5	43.25	
20		2.2	53.63	1.7	41.47	

Figure 5: Sorted Data Set A

B. Entering Data / Formatting

6. Our client, in Europe, wishes to see this data in terms of ^{O}C. As such, we need to convert it. Click the tab marked "Sheet2" at the bottom of the screen to open a new blank spreadsheet. Right click on "Sheet2" to rename it as "Datasheet2."

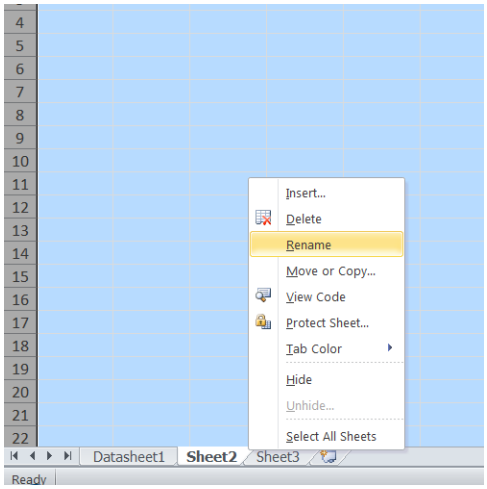


Figure 6: Open "Sheet2" and Rename to "Datasheet2"

7. Format "Datasheet2" to look like "Datasheet1" without copy and paste. To enter data into a cell, simply click on the destination and start typing. Anything we type also shows up in the "Formula" toolbar at the top of the screen. It is marked by label "f_x".
8. Use the "Merge & Center" tool under tab "Home" to create a single cell (like the data set A label) that spans multiple columns or rows.
9. Use the "Paint" tool under tab "Home" to change the background color of a cell

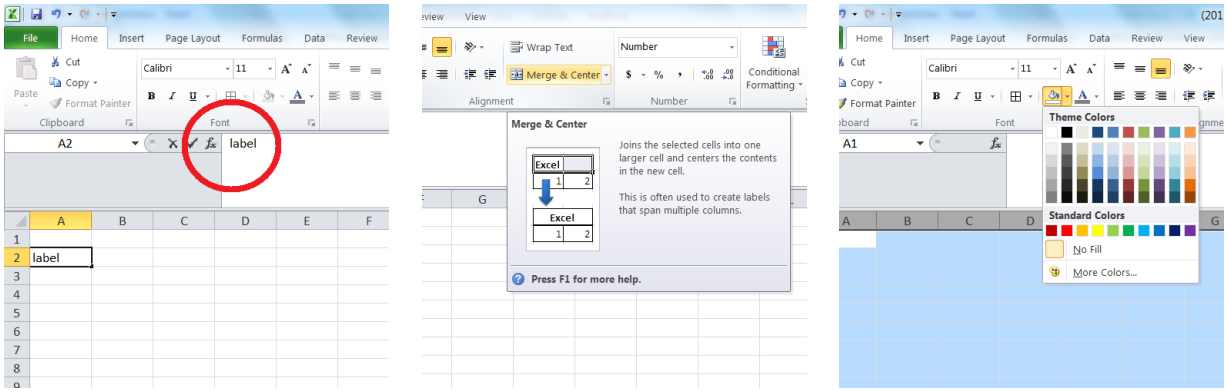


Figure 7: (Left) Entering Data into Cell via Formula Toolbar; (Middle) Using "Merge & Center" Tool; (Right) Using "Paint" Tool

10. Use the "Border" tool under tab "Home" to generate dark cell borders.
11. The text in "Datasheet2" may not fit within cells of default width. To auto-adjust a column's width, highlight it by clicking on the letter header and double-click on either its right or left border.

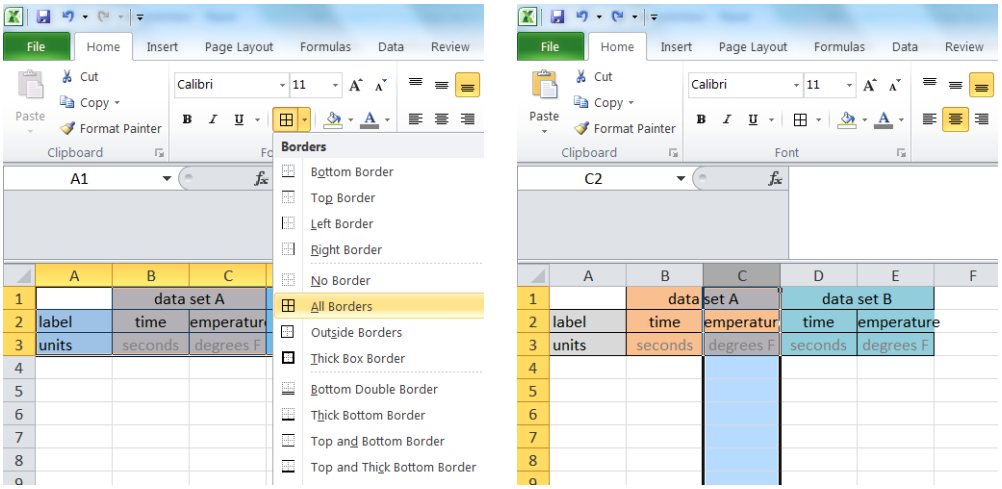


Figure 8: (Left) Formatting Cell Borders via "Border" Tool; (Right) Auto-Adjusting Column C's Width

12. Make sure to change the unit label from "degrees F" to "degrees C."

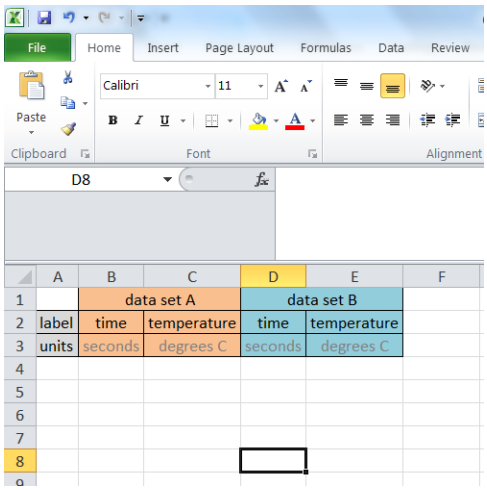


Figure 9: Change Label from "degrees F" to "degrees C"

C. Conversions / Functions

13. Before converting the data, we must transfer it from "Datasheet1" to "Datasheet2." For this purpose, we will use a data reference. Click on cell B4 in "Datasheet2." Enter an equal sign (=). Then, click on cell B1 from "Datasheet1." If done correctly, cell B4 will contain a value of 0.1.
    a. Note that, if we change the value in cell B4 of "Datasheet1," this will be reflected in cell B4 of "Datasheet2."

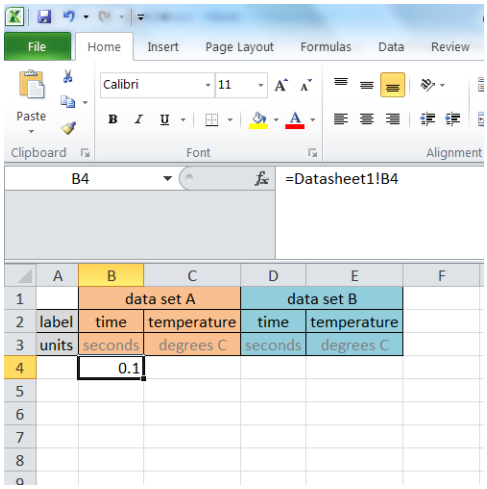


Figure 10: Referring to "Datasheet1" from "Datasheet2

14. We can use the "Fill" tool under tab "Home" to implement B4's reference in the adjacent cells (C4, D4, and E4). Highlight cells B4 to E4. Then, click "Fill Right" tool under tab "Home." If done correctly, the cells will contain values like that shown below.

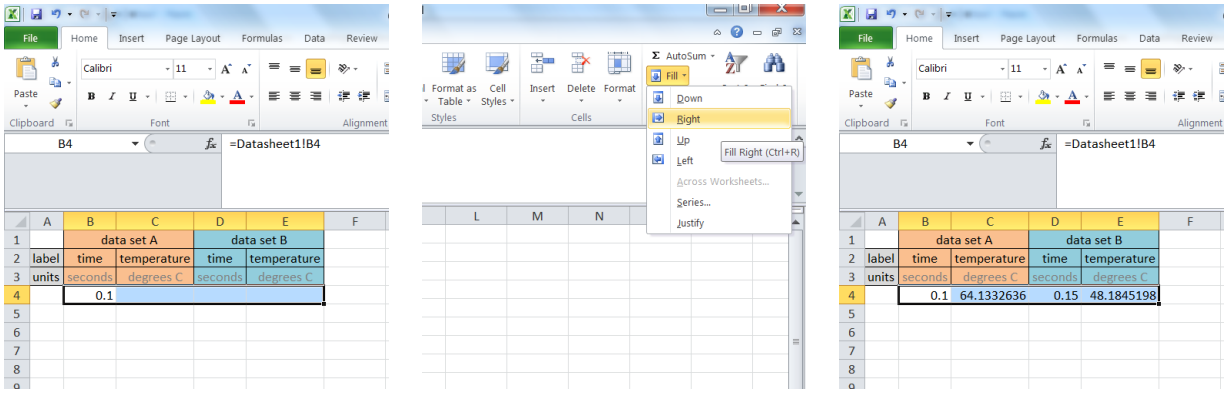


Figure 11: (Left) Highlighting Cells to be Filled; (Middle) Using the "Fill Right" Tool; (Right) Completed Fill

15. The temperature data we have is significant up to two figures (0.01). As such, we want our spreadsheet to display these values rounded to the nearest hundredth's place. Right-click on cell C4 in "Datasheet2." Choose the "Format Cells…" from this menu. A pop-up window, like that shown below, will appear. Choose the category "Number."
16. Set the "Decimal places" parameter to 2. Click "OK" to save this setting.

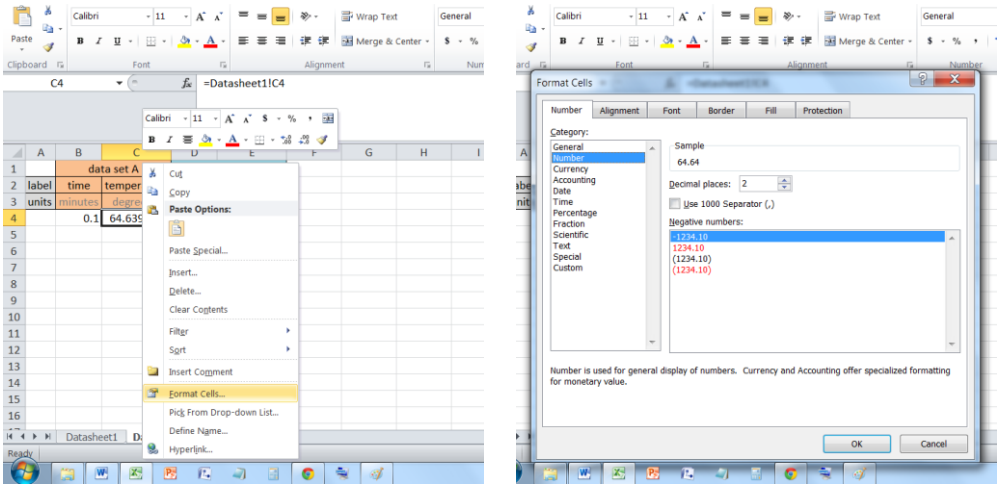


Figure 12: (Left) Right-Click to Allow Cell Formatting; (Right) Setting "Decimal places" Parameter to Two

17. Repeat this process for cell E4.

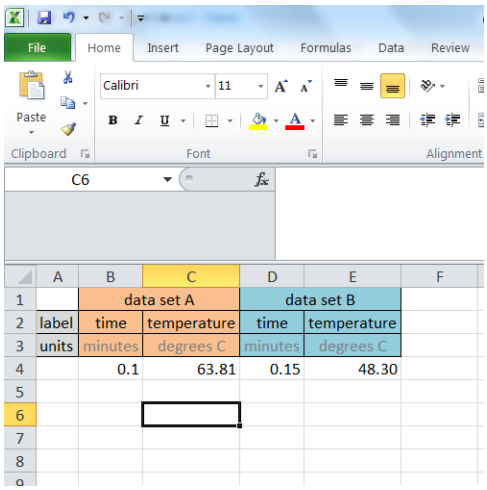


Figure 13: Properly Formatted Cells C4 and E4 (Two Significant Digits Only)

18. Use the "Fill Down" tool under tab "Home" to recreate the entire data set in "Datasheet2." Remember that columns B and C end at row 48; columns D and E end at row 37. Fill accordingly.

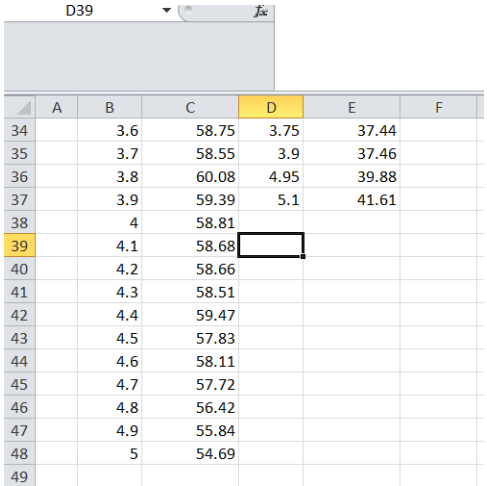


Figure 14: Properly Filled Spreadsheet (Columns B Through E)

19. Use the "Format Painter" tool under tab "Home" to format data cells on "Datasheet2" as done in "Datasheet1." Highlight the cells with format you want first. Then, click the "Format Painter" tool. Then, highlight the cells you want to format on "Datasheet2."

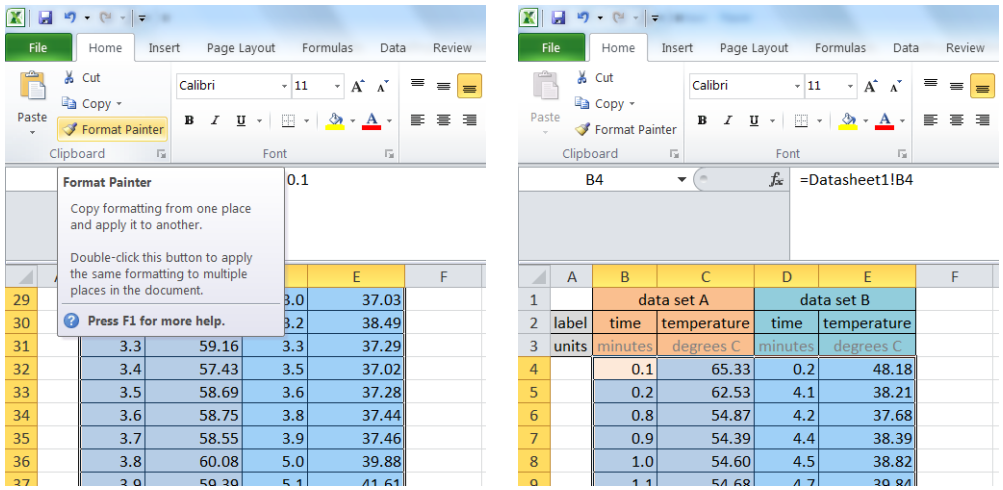


Figure 15: (Left) Highlighting Cells and Using "Format Painter" tool; (Right) Applying format to "Datasheet2"

20. The equation for conversion from Fahrenheit to Celsius is shown below. Use this equation to convert all data in columns C and E to Celsius. An example for cell C4 is as follows: = (5/9)*(Datasheet1!C4-32).

$$T_{Cel} = \frac{5}{9}(T_{Fah} - 32) \tag{1}$$

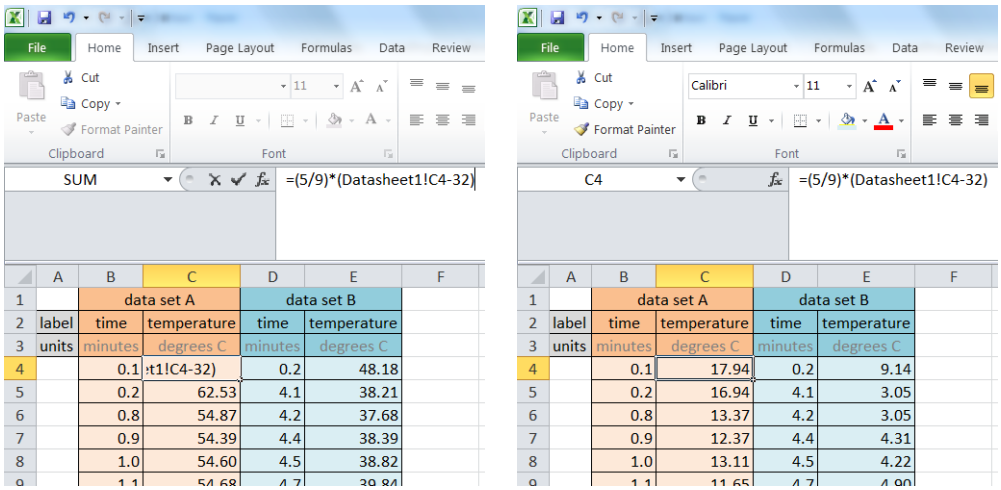
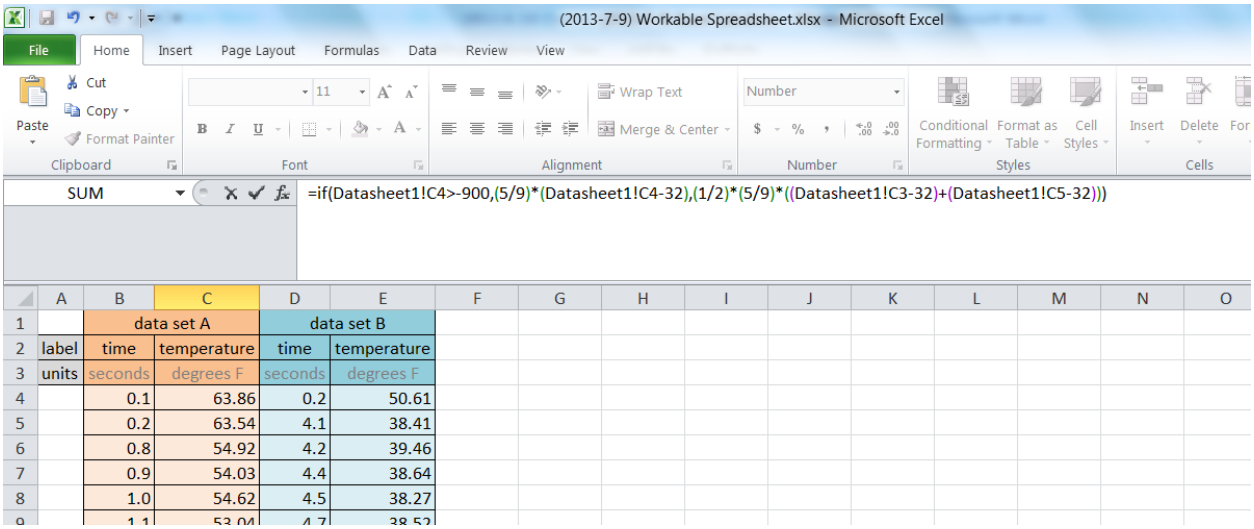


Figure 16: (Left) Implementing Conversion Formula with Reference to "Datasheet1"; (Right) Using "Fill Down" Tool to Implement this for All Cells in Columns C and E

D. Conditional Statements

21. We notice that there is a problem with some of the data. Some of the temperatures were accidentally read as -999.00, due to measurement error. We want to eliminate these temperature data points and redefine them as average of the previous and next measurements. This process is known as linear interpolation. We will use a statement like that below where k represents the k^{th} data point.

$$T_{Cel}[k] = \begin{cases} \frac{5}{9}(T_{Fah}[k] - 32) & if\ T_{Fah}[k] > -900 \\ \underbrace{\frac{1}{2} \times \frac{5}{9} \times [(T_{Fah}[k-1] - 32) + (T_{Fah}[k+1] - 32)]}_{average\ of\ previous\ and\ next\ data\ points} & else \end{cases} \quad (2)$$



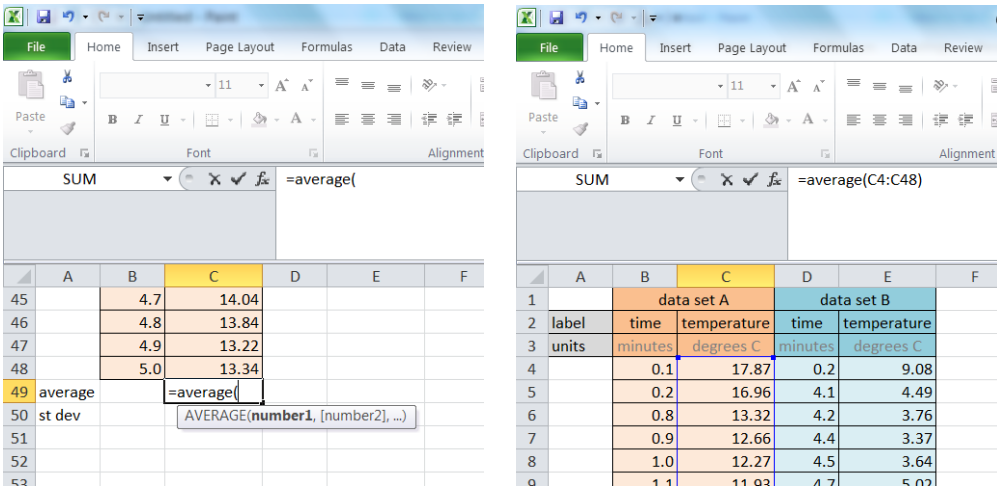
	A	B	C	D	E
1		data set A		data set B	
2	label	time	temperature	time	temperature
3	units	seconds	degrees F	seconds	degrees F
4		0.1	63.86	0.2	50.61
5		0.2	63.54	4.1	38.41
6		0.8	54.92	4.2	39.46
7		0.9	54.03	4.4	38.64
8		1.0	54.62	4.5	38.27

Figure 17: Implementing an IF Statement to Eliminate Bad Temperature Data (< -900)

Note: The IF function in Excel works as follows: IF(condition, output if true, output if false). You will note that (for cell C4) we put "Datasheet1!C4>-900" in the first field. This is the condition we want to test. We put "(5/9)*(Datasheet1!C4-32)" in the second field because this is the output we want if the data is "ok." We put "(1/2)*(5/9)*((Datasheet1!C3-32)+(Datasheet1!C5-32))" in the third field because this is the output we want if the data is "bad."

E. Built-In Excel Functions

22. The client wants us to define, for each data set, the average and standard deviation of the temperature data in "Datasheet2." For this, we use the "AVERAGE" function in Excel. To calculate the average of the temperature data in cell directly below it, enter "=AVERAGE(". Without hitting the "ENTER" button, then highlight the data we want to take average of. Here, this is cells C4 through C48 and E4 through E37. After we hit "ENTER" button, the average value will be displayed in cell C49.



	A	B	C	D	E
45		4.7	14.04		
46		4.8	13.84		
47		4.9	13.22		
48		5.0	13.34		
49	average		=average(		
50	st dev				
51					
52					

	A	B	C	D	E
1		data set A		data set B	
2	label	time	temperature	time	temperature
3	units	minutes	degrees C	minutes	degrees C
4		0.1	17.87	0.2	9.08
5		0.2	16.96	4.1	4.49
6		0.8	13.32	4.2	3.76
7		0.9	12.66	4.4	3.37
8		1.0	12.27	4.5	3.64

Figure 18: (Left) Entering "AVERAGE" Function; (Right) Highlighting Appropriate Cells

23. To calculate the standard deviation of data, use the "STDEV" function in a similar manner. Simply highlight those cells we want to find standard deviation for.

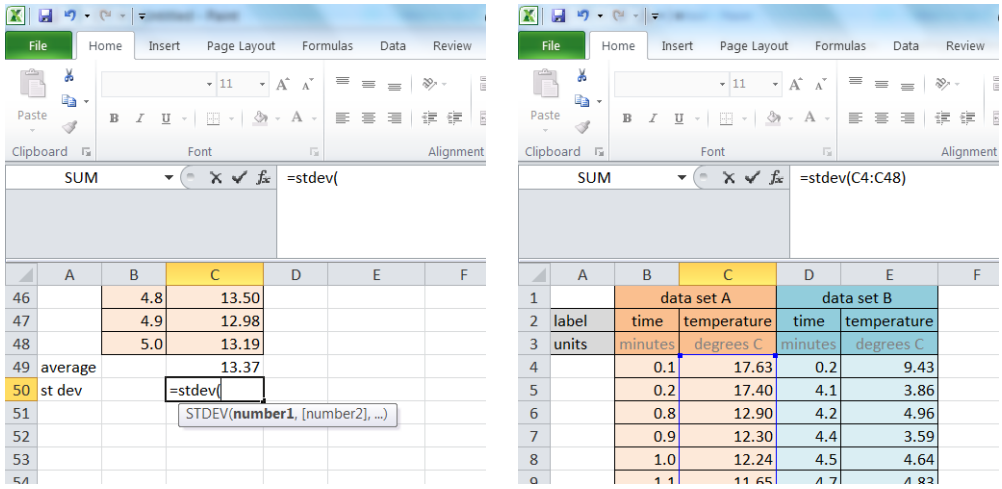


Figure 19: (Left) Entering "STDEV" Function; (Right) Highlighting Appropriate Cells

F. VLOOKUP Function

24. The client also wants us to display, under the standard deviation value, the temperature data point closest to time = 3.0 seconds. Obviously, we could look for the data point and copy / paste. However, let's try using a "VLOOKUP" function. In cell C51, enter "=VLOOKUP(3.0," to tell Excel that we are looking for datapoint associated with time = 3.0 seconds. DO NOT hit "ENTER" button.

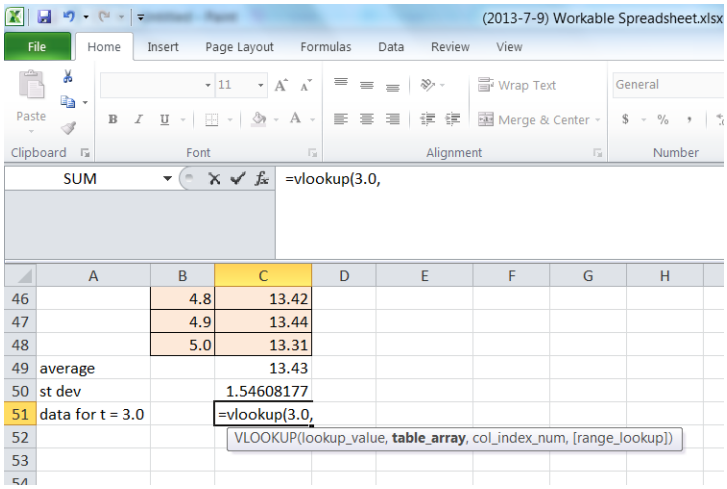


Figure 20: First Step in Using "VLOOKUP" Function

25. Then, highlight the block of cells that contain the data. For this, the index values (time in this example) must be the first column. As such, we will highlight columns B and C from row 4 to row 48. One highlighting is complete, press "," but do not press "ENTER" button. We're not done yet.

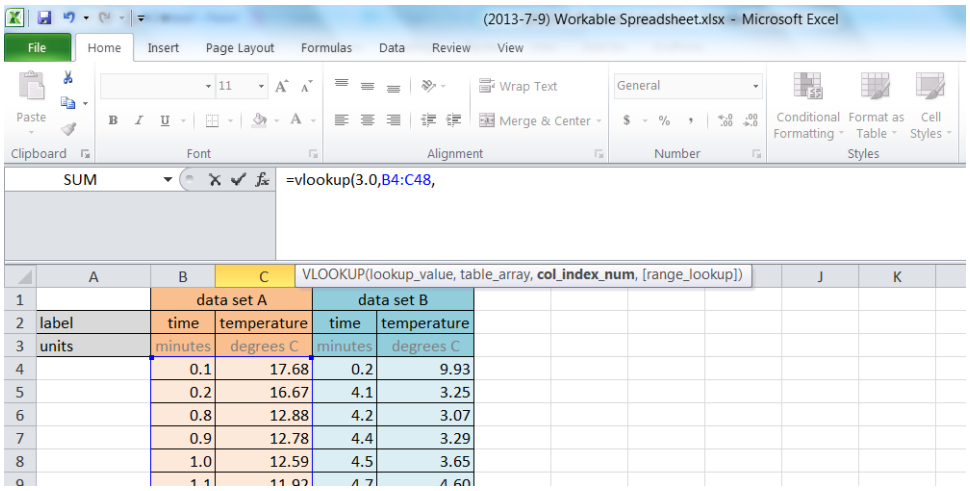


Figure 21: Second Step in Using "VLOOKUP" Function

26. Then, enter the number corresponding to the column containing output we want. In our case, we want the function to return temperature data which is the 2nd column from our highlighted data set. Enter the number 2 followed by "," but do not hit "ENTER" button.

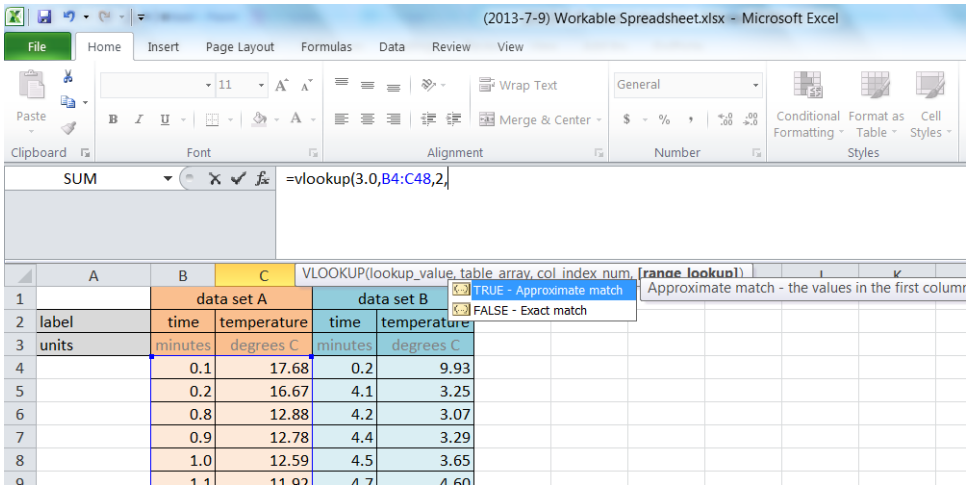
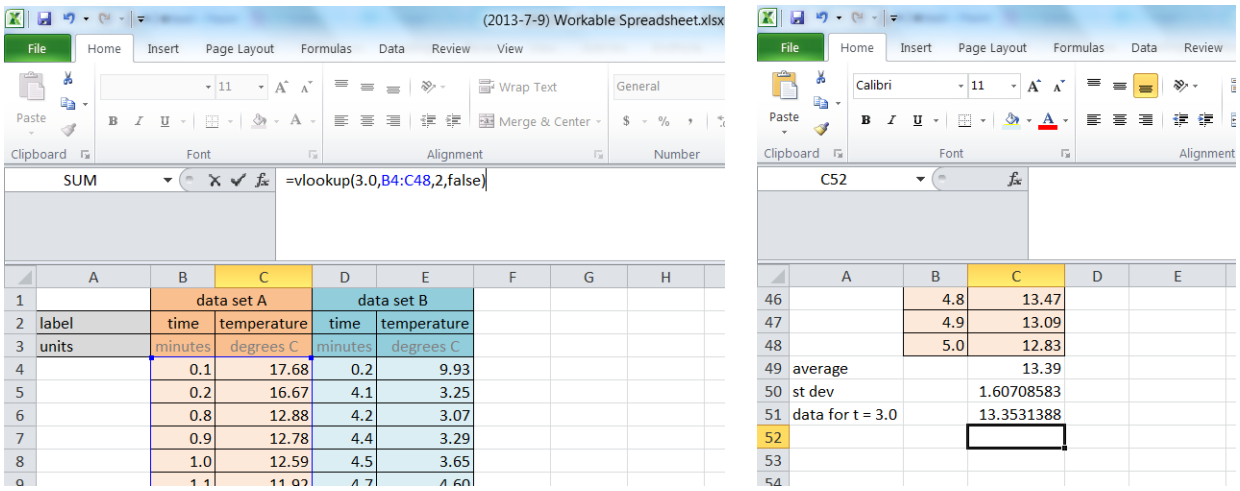


Figure 22: Third Step in Using "VLOOKUP" Function

27. Last, we must enter a "TRUE" or "FALSE" value. "TRUE" tells Excel to find the data point closest to 3.0 even if an exact match does not exist. "FALSE" tells Excel to return only an exact match. We will enter "FALSE" followed by ")" and hit "ENTER" button. The appropriate value will then be returned.

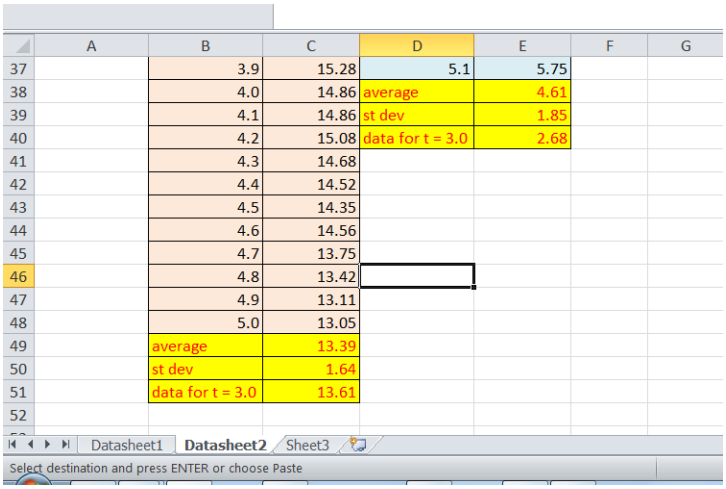


	A	B	C	D	E
1		data set A		data set B	
2	label	time	temperature	time	temperature
3	units	minutes	degrees C	minutes	degrees C
4		0.1	17.68	0.2	9.93
5		0.2	16.67	4.1	3.25
6		0.8	12.88	4.2	3.07
7		0.9	12.78	4.4	3.29
8		1.0	12.59	4.5	3.65

	A	B	C
46		4.8	13.47
47		4.9	13.09
48		5.0	12.83
49	average		13.39
50	st dev		1.60708583
51	data for t = 3.0		13.3531388
52			
53			

Figure 23: (Left) Last Step in Using "VLOOKUP" Function; (Right) Result

28. Repeat this process for data set B.
29. Format the summary values as shown below. Remember, only two significant digits should be used.



	A	B	C	D	E	F	G
37		3.9	15.28	5.1	5.75		
38		4.0	14.86	average	4.61		
39		4.1	14.86	st dev	1.85		
40		4.2	15.08	data for t = 3.0	2.68		
41		4.3	14.68				
42		4.4	14.52				
43		4.5	14.35				
44		4.6	14.56				
45		4.7	13.75				
46		4.8	13.42				
47		4.9	13.11				
48		5.0	13.05				
49		average	13.39				
50		st dev	1.64				
51		data for t = 3.0	13.61				
52							

Figure 24: Formatted Results

G. Graphing

30. We need to create a single graph that displays the results of our work. Select the “Scatter” plot under “Inset” Tab as shown below. DO NOT highlight any data.

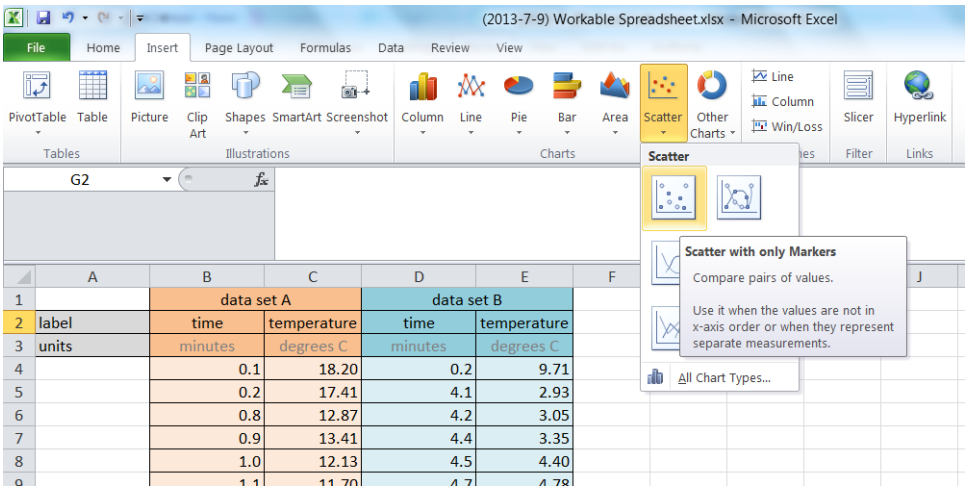


Figure 25: Bringing Up Blank Scatter Graph

31. This will bring up an empty plot window like that shown below.

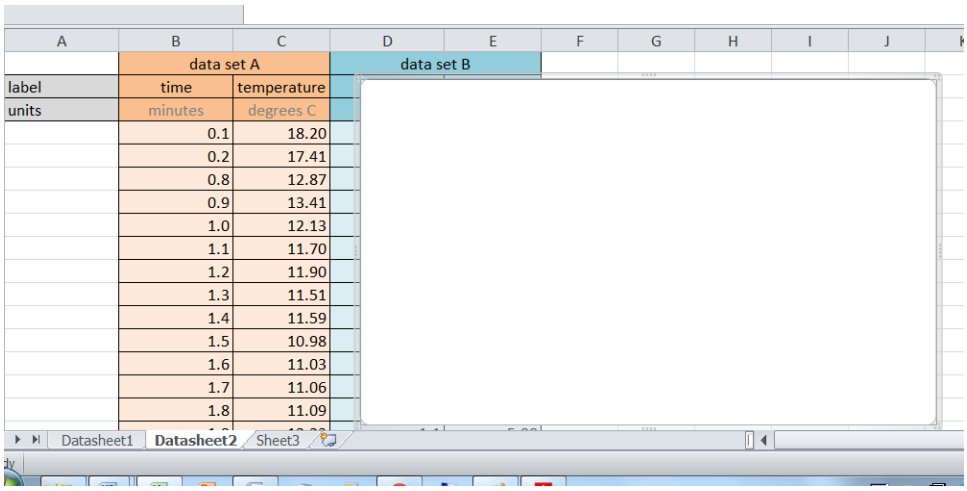


Figure 26: Blank Scatter Graph

32. Remember that, for our data, time is the independent variable and should be placed on the x-axis. Temperature is the dependent variable and should be placed on the y-axis.
33. Right-click on the graph and choose "Select Data…"

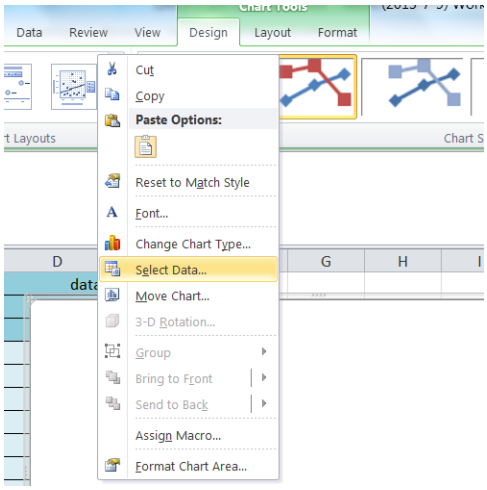


Figure 27: First Step in Entering Data

34. This will bring up a window like that below.

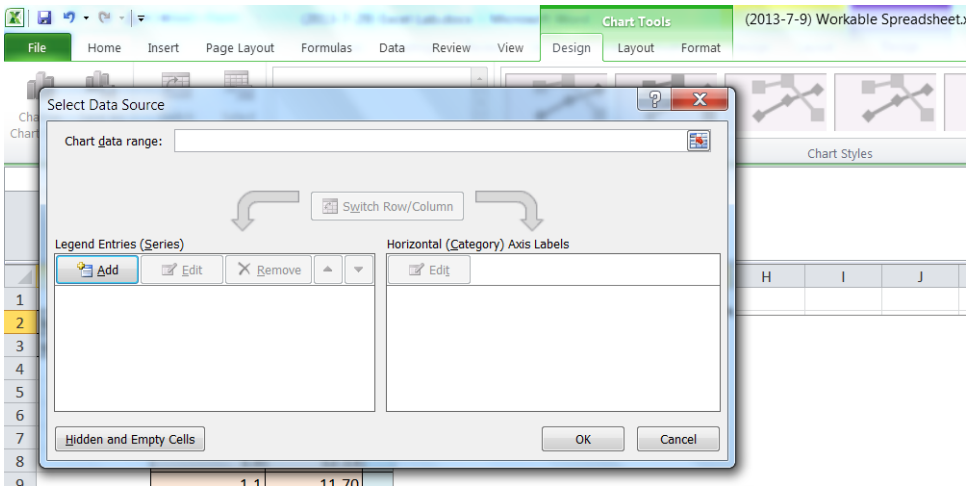


Figure 28: Select Data Window

35. Click "Add" to enter new data. This will bring up a window like that below. Enter a series name of "Data Set A."

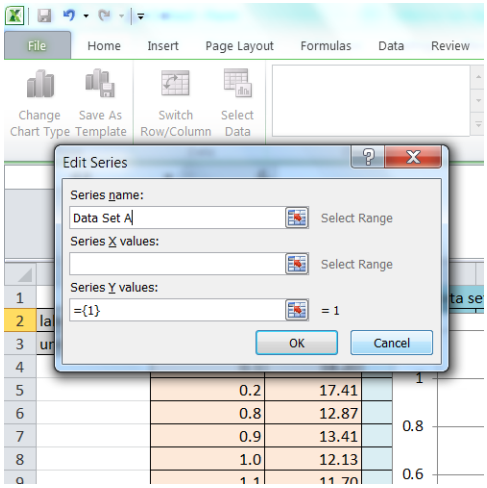


Figure 29: Entering Series Name

36. Next, click the box next to "Series X Values" box. This will allow us to choose the independent variable data set (aka. time). Once this box is clicked, use the cursor to highlight cells B4 through B48. Hit "ENTER" button to finalize your selection.

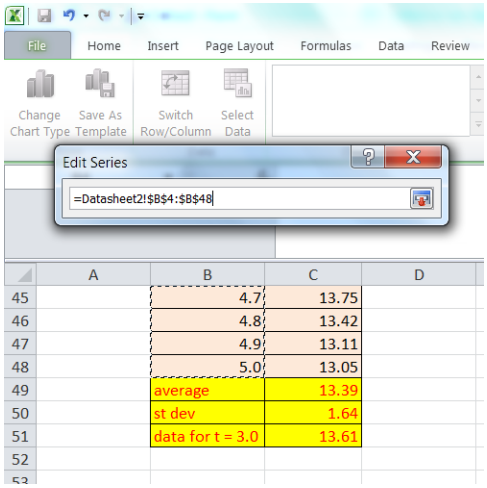


Figure 30: Selecting Independent Variable Data Set

37. Click the box next to “Series Y Values” box. This will allow us to choose the dependent variable data set (aka. temperature). Once this box is clicked, highlight cells C4 through C48. Hit “ENTER” button to finalize your selection.

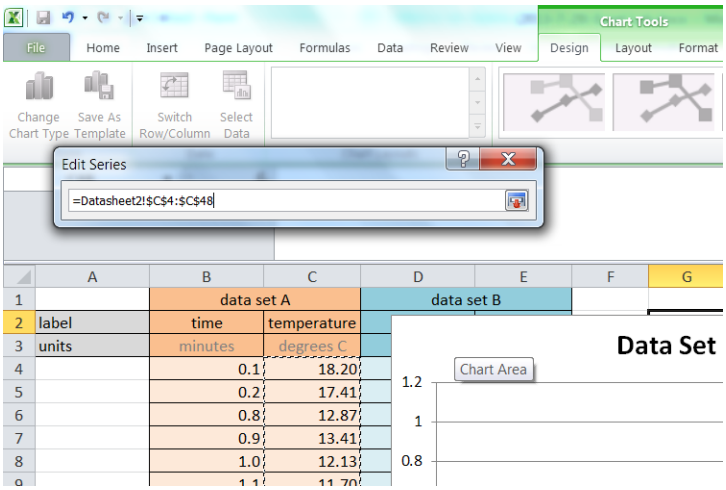


Figure 31: Selecting Dependent Variable Data Set

38. Hit “OK” to go back to previous screen.

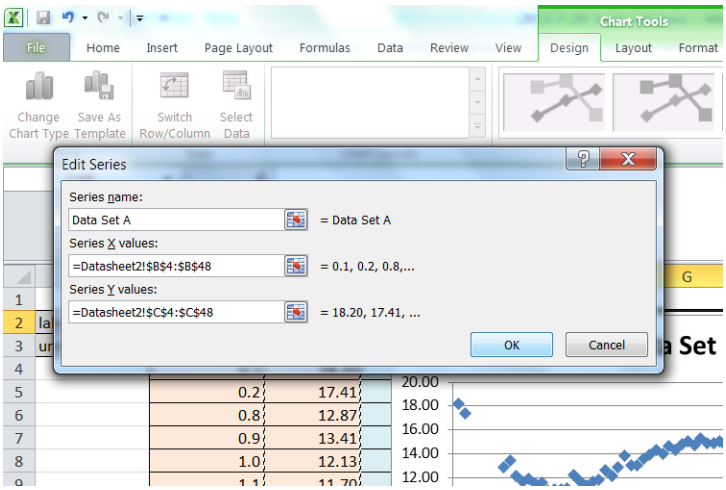


Figure 32: Hitting OK to Go Back

39. Use the “Add” button again, as shown in Figure 28, to include Data Set B in graph. Remember to name the data set properly. Hit “Ok” several times to exit windows and return to graph. The result is shown below, one graph with two clearly-labeled data sets.

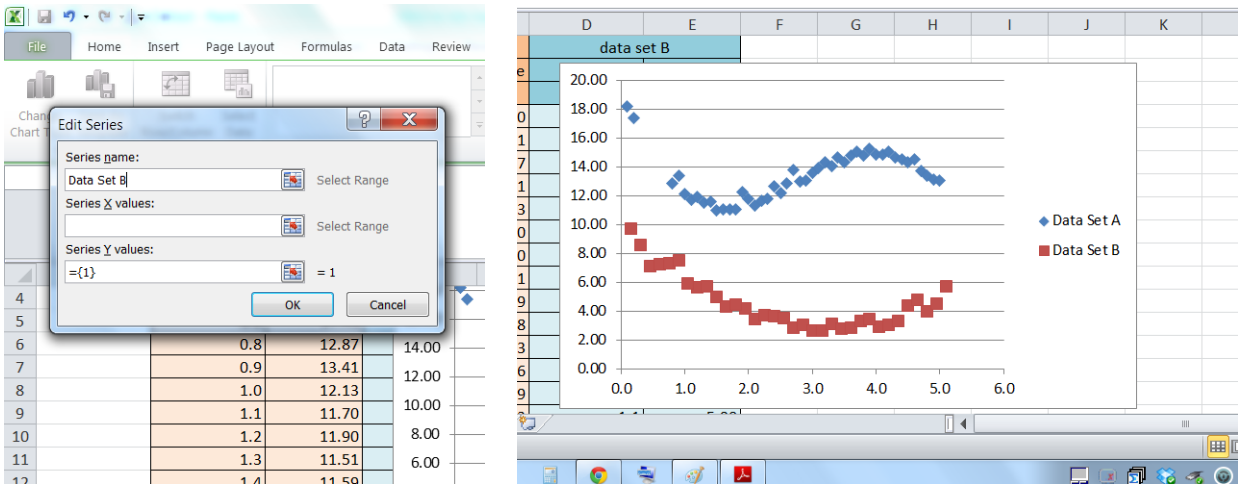


Figure 33: (Left) Include Data Set B in Graph; (Right) Completed Graph

40. We are not done yet. We need to clearly label both the x and y axes. For the x-axis label, we will use the menu function shown below under "Chart Tools / Layout" tab. Note that this tab will not be visible unless you click the graph first.

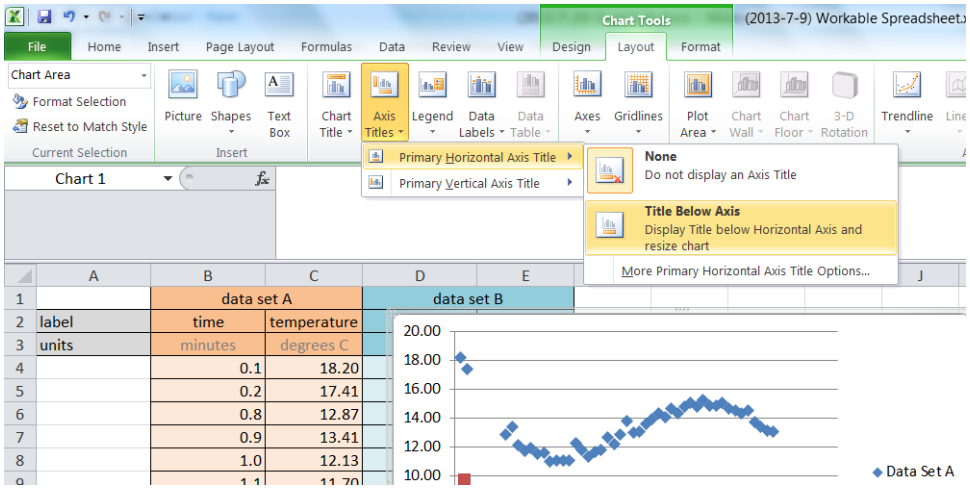


Figure 34: Defining X-Axis Label

41. Define the x-axis label in appropriate text box, as shown below. Remember that it is ESSENTIAL to always include units (seconds in this case).

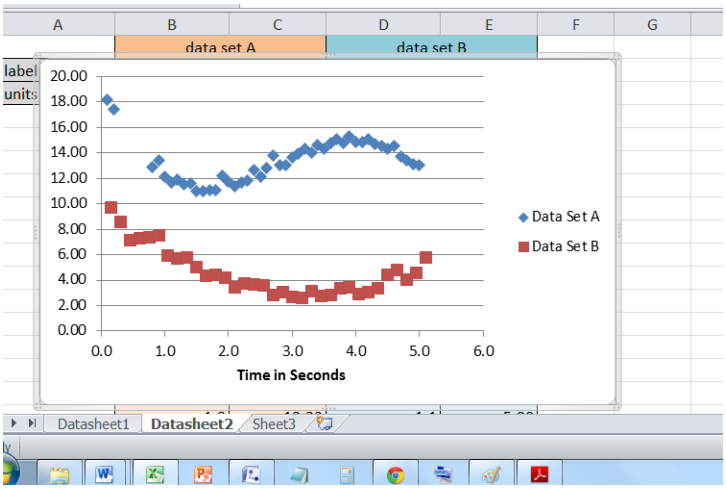


Figure 35: Defining X-Axis Label via Text Box

42. Define a y-axis label of "Temperature in Degrees Celsius" using similar tool.

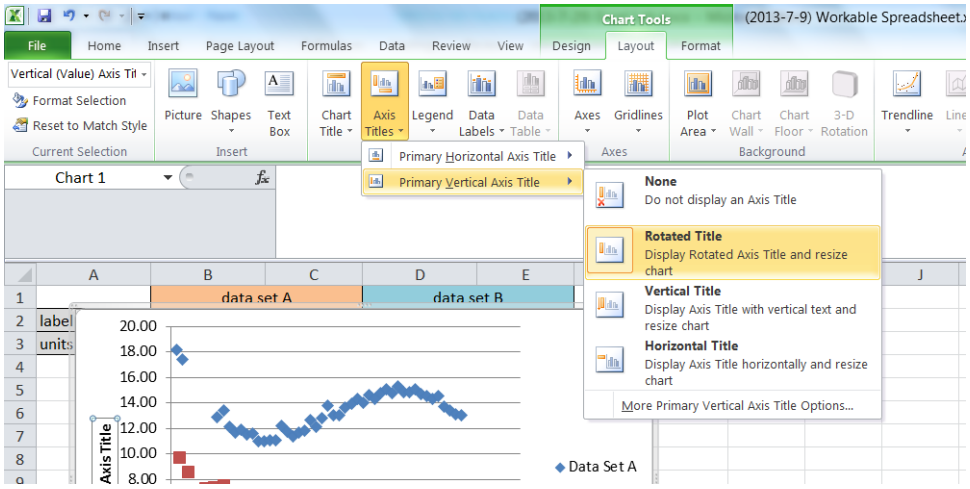


Figure 36: Entering Y-Axis Label

43. Next, we will define a title for our graph. We will use the following form: "Dependent Variable Vs. Independent Variable for System X with Constants Y and Z". For example, we will title this graph as "Air Temperature vs. Time for Room Heated by GE HVAC System with Nominal Power = 10,000BTU."

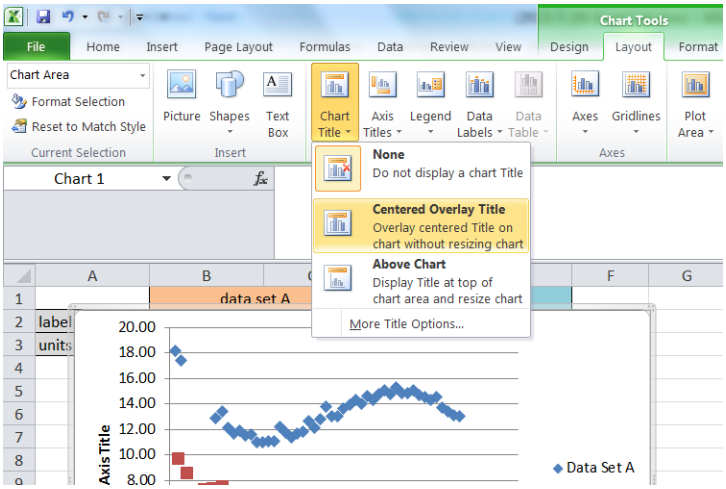


Figure 37: Entering Graph Title

44. We may move certain parts of the graph around to make the result more aesthetically pleasing. Also, we can right click on certain parts of the graph to "format" them. How closely can you make your graph resemble that below?

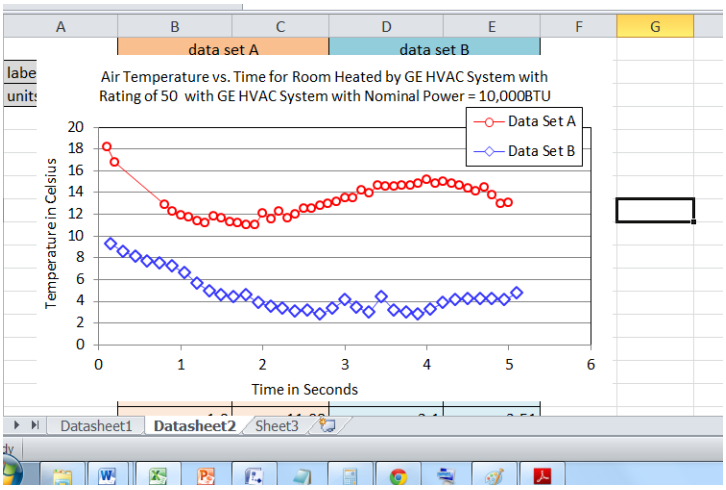


Figure 38: Completed Graph with Proper Formatting

45. This graph may be copy and pasted into Microsoft Word. This is shown below.

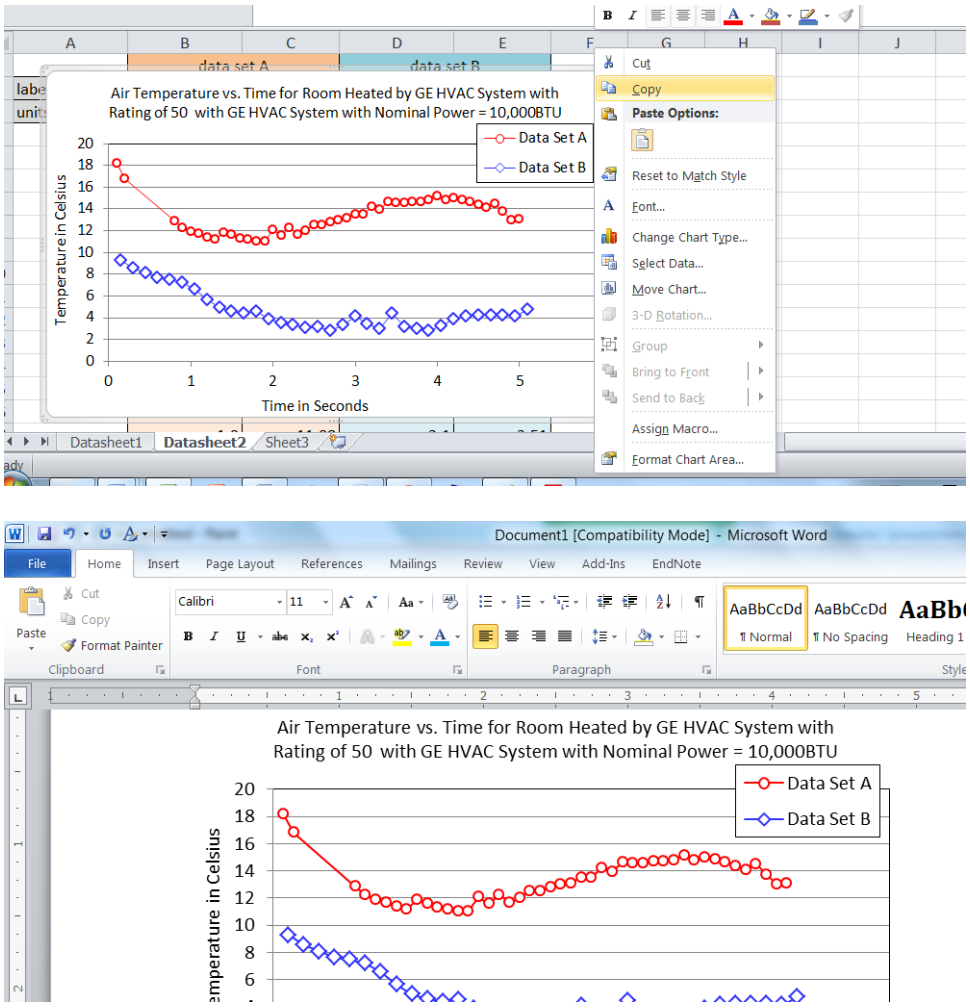


Figure 39: Copying and Pasting Graph into Microsoft Word

H. Deliverables

Students should provide the instructor with two items. First, an electronic copy of the completed excel file. Second, an electronic copy of the completed word file with graph inserted.