ATSC 201 Fall 2017b Excel Tutorial

Tutorial Outline:

-Basic Introduction to Excel Terminology and Functions

-Example problems using equations and variables

-Format of Homework

Excel Terminology:

-Worksheet (spreadsheet): Your default display within excel containing a bunch of grid boxes called 'cells.'

-Cell: An individual box on a worksheet. A cell can contain text characters (ie words or sentences) as well as numerical values and formulas. Each cell is identified by a column letter and row number. For example, the cell in the top left of the worksheet is called cell 'A1.' The cell immediately to the right is 'B1.' Underneath A1 is A2.

Using Cells:

Click on the cell and start typing words or formula. Let's start with text (no numbers). Click on cell 'A1' and type in your name. When your are done typing, hit enter. Note that your name may appear to also show up under column B if it is long enough but that the contents are still all contained within cell A1. Numerical values can be entered in the same manner (type in a value and hit enter).

Using cells as a means of calculation (inputing a formula):

Let's say we want to calculate the expression 579 + 621. Excel can do all this for you when the expression is entered correctly within one individual cell. Click on cell 'B3,' it is where we will do this calculation. We cannot just type in '579+621' and hit enter and expect Excel to solve the problem. Instead, for excel to know that this is a calculation, we must start with an '=', so within B3 should be typed '=579+621', then hit enter. Note that what we have entered has disappeared and what is left is the result, the answer!

Excel can handle more complex calculations as well involving sines, cosines, absolute values and exponents just to name a few. Note, however that angles must be given in **Radians, not Degrees**. If we wanted to find the cosine of an angle, say π, we would type '=cos(pi())'. Try it in an available cell. You should obtain the answer '-1.'

The table on the back of this sheet provides a basic list of Excel mathematical functions.

Mathematical expression	In Excel	Notes
+	+	
-	-	
x	*	
÷	/	
| a |	abs(a)	Absolute value
a^b	a^b	
sin(a)	sin(a)	Argument in radians
cos(a)	cos(a)	
tan(a)	tan(a)	
arcsin(a)	asin(a)	Returns in radians
arccos(a)	acos(a)	
arctan(a)	atan(a)	
π	pi()	No argument needed
e^b	exp(b)	To get value of e, use exp(1).
ln(b)	ln(b)	Natural log
log(b)	log(b)	Base 10
$\log_2(b)$	log(b,2)	Base 2 (2 can be replaced by other bases)
1×10^{-3}	1E-3	E means "times ten to the power of"
$(a)^{1/2}$	sqrt(a)	square root

Defining and using variables:
To learn how to define variables we will set up a sample problem. Our problem is:

"Plot the change in density of dry air with height in an isothermal (constant temperature) atmosphere. Assume a temperature of 25°C and use pressure coordinates as a surrogate for height in the atmosphere. Plot for 100 kPa up to 0 kPa at 10 kPa increments. Plot the y-axis (pressure) on a logarithmic axis."

First, we need to set up the spreadsheet into an ideal printing format. Select Layout > Page Layout. This way, you can see how many columns will fit in one page.

When you have created all your answers, check all your pages to ensure that no lines extend into adjacent pages. Wrap your text or move your graphs as needed to avoid splitting the graph once you are ready to print the worksheet.

After you finished creating all your answers, save the excel spreadsheet as a pdf file. Print the pdf, not the xls.

Now back to our exercise…

The equation we will use to solve this problem is the so-called Ideal Gas Law (eqn 1.18)

$$P = \rho * R_d * T$$

Where P is the total atmospheric pressure, ρ the dry air density, R_d the gas constant and T the temperature of the air in Kelvin.

The first thing we must do when starting a HW exercise (besides putting our name on it in the upper left) is to copy the problem statement into the excel worksheet. This can be done with a simple text box (click insert menu, then text box).

Now, underneath our problem statement, we define our known and unknown variables as well as define any equations we will use. Your excel worksheet should look like:

Plot the change in density of dry air with height in an isothermal (constant temperature) atmosphere. Assume a temperature of 25°C and use pressure coordinates as a surrogate for height in the atmosphere. Plot for 100 kPa up to 0 kPA at 10 kPa increments Plot the y-axis (pressure) on a logarithmic axis."

Given:	T=		25 degs c
	Rd=		0.287 kPa K^{-1} m^3 kg^{-1}
	P=	100-0	kPa
Find	ρ=	?	kg m^{-3}
Using eqn 1.18			
	ρ=P/(Rd * T)		

Now, let's use variables to start solving the problem. The first thing we must do is change the temperature into the correct units (from Celsius to Kelvin). To convert from Celsius to Kelvin we add 273.15 to the Celsius temperature. Underneath our equation, let's show this conversion. Click on the cell in which you want to perform the calculation (I kept mine consistent in the same column that I am specifying all my other values). In this cell, begin to type in the formula "=(cell ID for temperature in Celsius)+273.15". Your sheet should look like:

Given:	T=	25	degs c
	Rd=	0.287	kPa K^{-1} m^3 kg^{-1}
	P=	100-0	kPa
Find	ρ=	?	kg m^{-3}
Using eqn 1.18			
	ρ=P/(Rd * T)		
	T=	=D12+273.15	

Note that excel highlights any cells you are using in your calculation. The cell D12 is where the temperature is stored in Celsius. When you hit enter, this will go away and the correct temperature (298.15K) will be provided.

We have just performed a calculation in excel using a variable (cell D12 in my image). However, we have not used absolute referencing. What this means is if we were to move our calculation (copy and paste or drag and drop for example) the correct calculation would no longer be performed. The variable specified within the calculation is relative to the location of the cell containing the typed equation. Excel thinks the variable is always 9 cells above my equation in this case. Go ahead and highlight and copy your converted temperature cell and paste it anywhere in your sheet. You should get an error and when you double click on the newly pasted cell to edit the equation, you will see that the variable location has moved, most likely to a cell that has no value at all.

To get around this, excel has a system known as 'absolute referencing.' That is, a variable location can be specified absolutely and it will not change even when an equation is copied and pasted. To do this, $ notation is used. If we wanted to absolutely reference cell D12 in an equation, we would type D12. The $D locks in the values within column D and $12 the values within row 12. Together, they represent only the value in D12. Note that two $'s are not always needed (we can only absolutely reference a column or a row if wanted).

Let's redo the conversion correctly this time using absolute referencing. You calculation should look similar to:

| T= | =D12+273.15 |

 Now if you were to copy and paste this equation anywhere, you will always get the correct answer. Absolute and relative referencing are useful in different situations and with practice you will know which to use and when.

The only thing that is needed in order to begin solving the rest of the problem is our values of pressure. We want to solve for the density at a given value of pressure ranging from 100 kPa to

0 kPa. The best way to go about this is to set up a column containing pressures and next to that a blank column that will contain density values solved by using eqn 1.18.

| P (kPa)	Density (kg m^{-3})
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

Next, we need to calculate the density values. We will use both absolute and relative referencing to streamline our calculation, so that we can just type in the equation one time and subsequently drag and drop to obtain all our density values. Go ahead, type in your calculation following eqn 1.18. Absolutely reference the values for temperature (K) and the dry gas constant, but relatively reference the value for pressure. This will hold the variable values for the gas constant and temperature to those specified above in your worksheet but will allow the pressure variables to change once we drag and drop our equation. My equation looks like:

Given:	T=		25	degs c
	Rd=		0.287	kPa K^{-1} m^3 kg^{-1}
	P=	100-0		kPa
Find	ρ=	?		kg m^{-3}
Using eqn 1.18				
	ρ=P/(Rd * T)			
	T=		298.15	K

| P (kPa)	Density (kg m^{-3})	
0	=B24/(D13*D21)	
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		

Now we "fill down" the equation into the other cells below it by clicking and holding on to the "handle" (small black square) at the lower right of the cell (I'll show this). Thus, we have all our values of dry air density in the atmosphere.

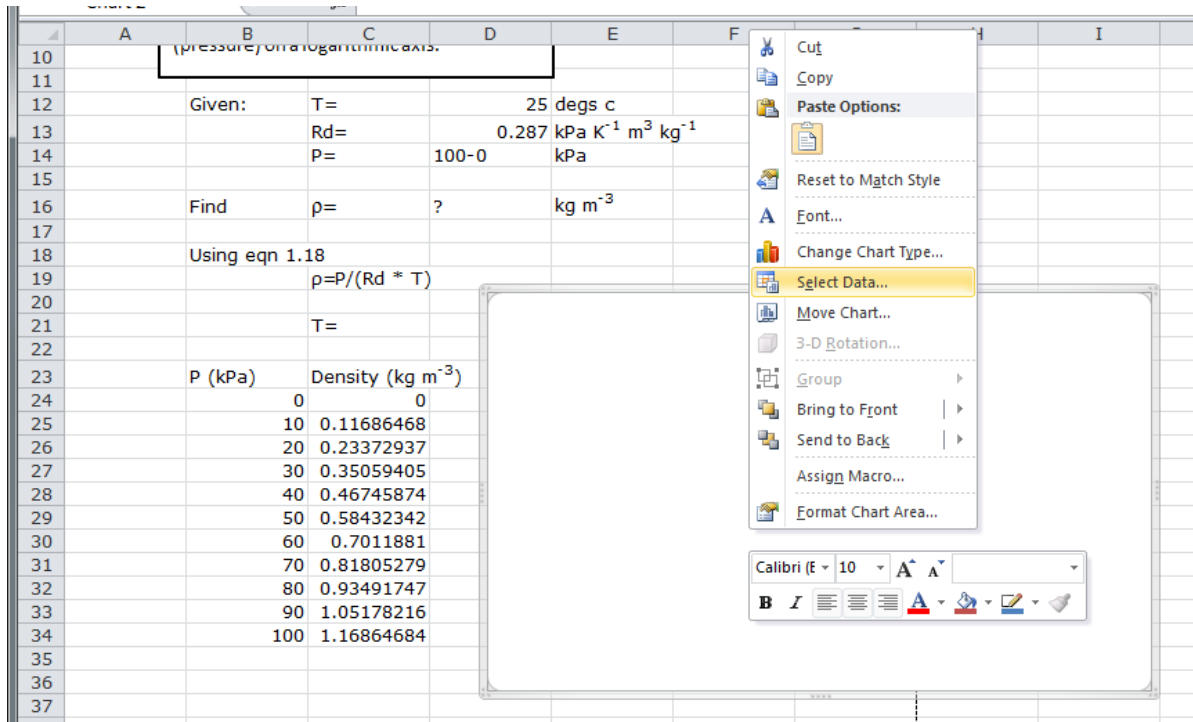| P (kPa)	Density (kg m^{-3})
0	0
10	0.11686468
20	0.23372937
30	0.35059405
40	0.46745874
50	0.58432342
60	0.7011881
70	0.81805279
80	0.93491747
90	1.05178216
100	1.16864684

Ok, now we are ready to plot the data. Click on blank cell to the right of your column data. Now go up to the insert tab and select 'scatter' then 'scatter with straight lines and markers'
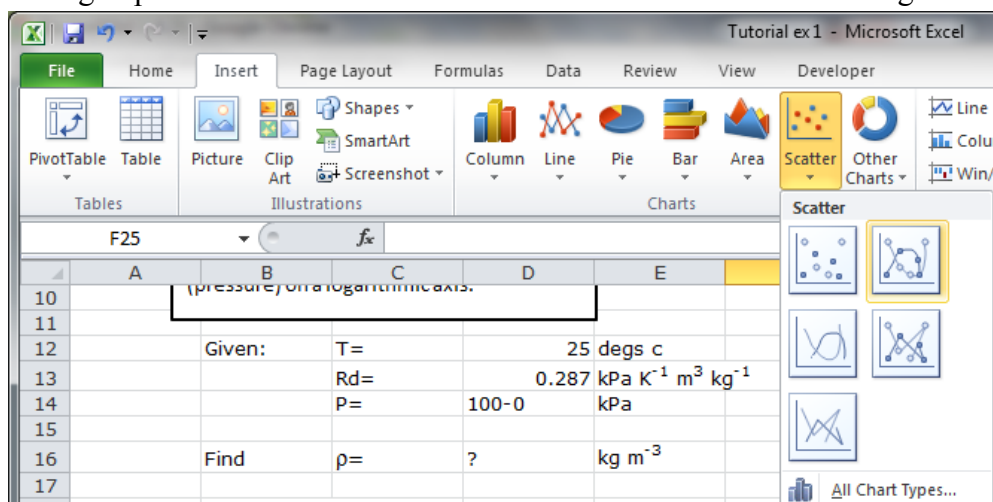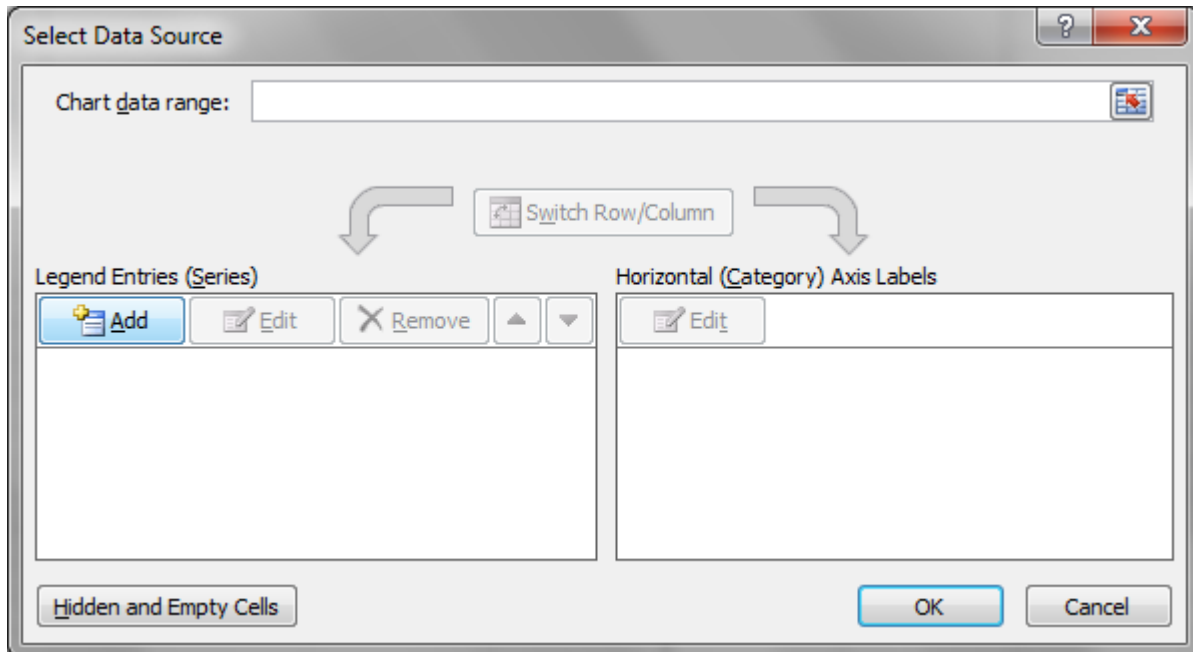

After clicking the graph type, a blank graph window will appear on your worksheet. This is what we wanted to happen, as we have not yet selected the data!
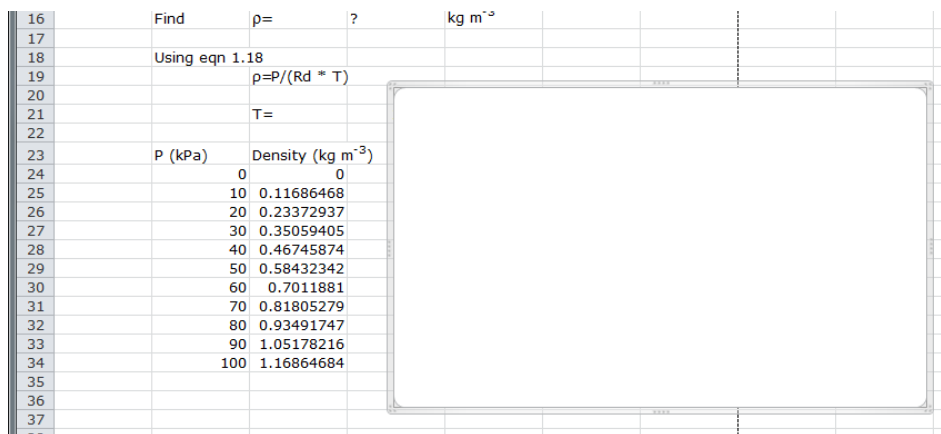

The next step is to select our data to plot. We start by right clicking on the blank graphing window and clicking on 'select data.'

|	A	B	C	D	E	F			H	I
10			(pressure) on a logarithmic axis.				Cut			
11							Copy			
12		Given:	T=		25	degs c	Paste Options:			
13			Rd=		0.287	kPa K^{-1} m^3 kg^{-1}				
14			P=	100-0	kPa					
15							Reset to Match Style			
16		Find	ρ=	?	kg m^{-3}		Font...			
17										
18		Using eqn 1.18					Change Chart Type...			
19			ρ=P/(Rd * T)				Select Data...			
20							Move Chart...			
21			T=				3-D Rotation...			
22										
23		P (kPa)	Density (kg m^{-3})				Group			
24		0	0				Bring to Front			
25		10	0.11686468				Send to Back			
26		20	0.23372937							
27		30	0.35059405				Assign Macro...			
28		40	0.46745874							
29		50	0.58432342				Format Chart Area...			
30		60	0.7011881							
31		70	0.81805279							
32		80	0.93491747				Calibri (E ▾ 10 ▾ A A			
33		90	1.05178216				B I ≡ ≡ ≡ A ▾ ...			
34		100	1.16864684							
35										
36										
37										

Clicking on select data will bring up the 'Select Data Source' window shown below. This window controls what series (lines) are plotted on your graph. Clicking the 'Add' button will allow us to add a line to our plot (in this case the dependence of density on pressure). Click Add.
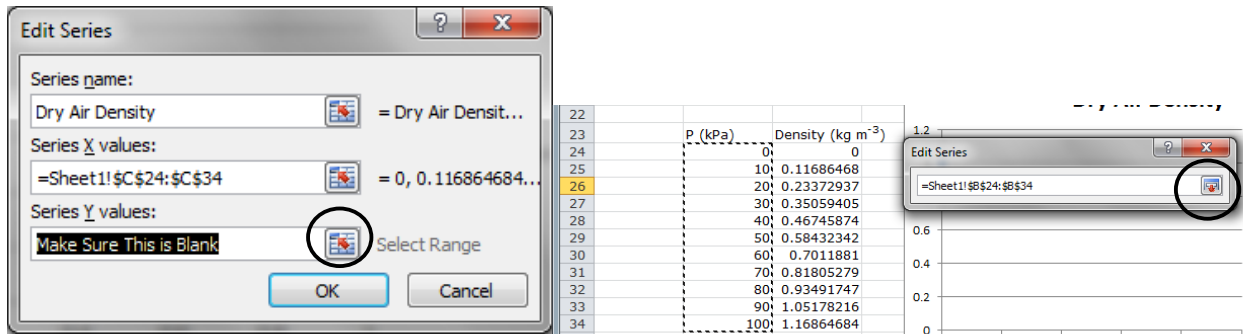

Select Data Source

Chart data range:

Switch Row/Column

Legend Entries (Series)   Horizontal (Category) Axis Labels

Add   Edit   Remove   Edit

Hidden and Empty Cells   OK   Cancel

After you click add, the 'Edit Series' box will appear. This box allows us to title our line as well as select our x-axis and y-axis values. Enter the series name as shown below.
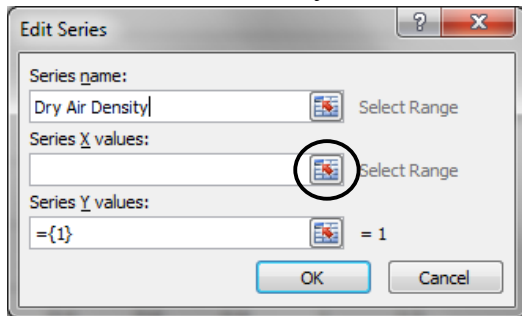

Now we want to select the X values. Do this by clicking the small button the right of the blank field where the window says 'Select Range.' I have circled this in the image above. Clicking this button brings up a smaller 'Edit Series' box (shown below). Excel wants us to highlight our x-value data. For this problem, we want to highlight all the density values, as shown in the dashed line. Note excel, automatically inserts our range of values in the Edit Series box after they are selected. Once the values are selected, click the circled button below.
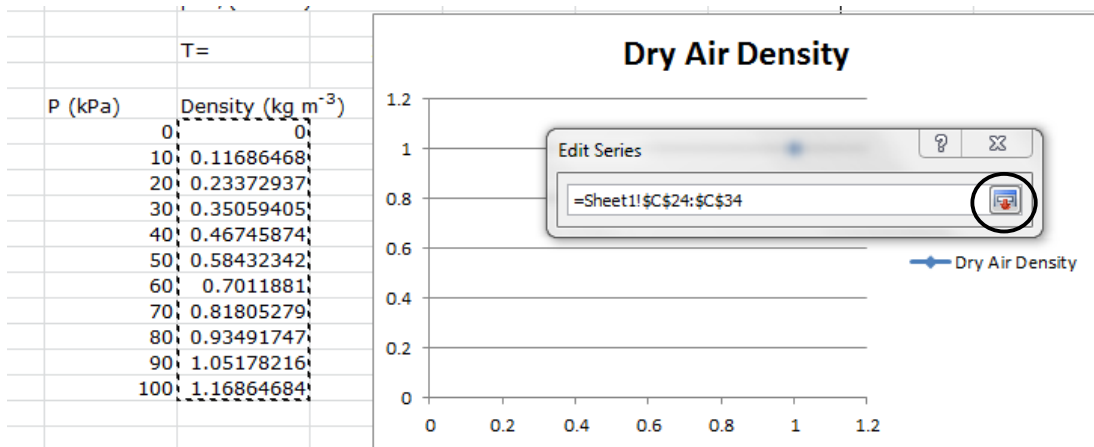
The larger Edit Series box has reappeared. We will now follow the same procedure but this time for the Y values. Before clicking the small button, delete any entries in the 'Series Y values' box, which has been highlighted below. Click again on the circled button and follow the same instructions as above, except this time for the Pressure values.

Once you have selected the Y values, hit ok on the 'Edit Series' box, which will bring you back to the 'Select Data Source' window. Note we now see our density entry in the 'Legend Entries.' Click ok on the Select Data Source window. You should now have the plot shown below:
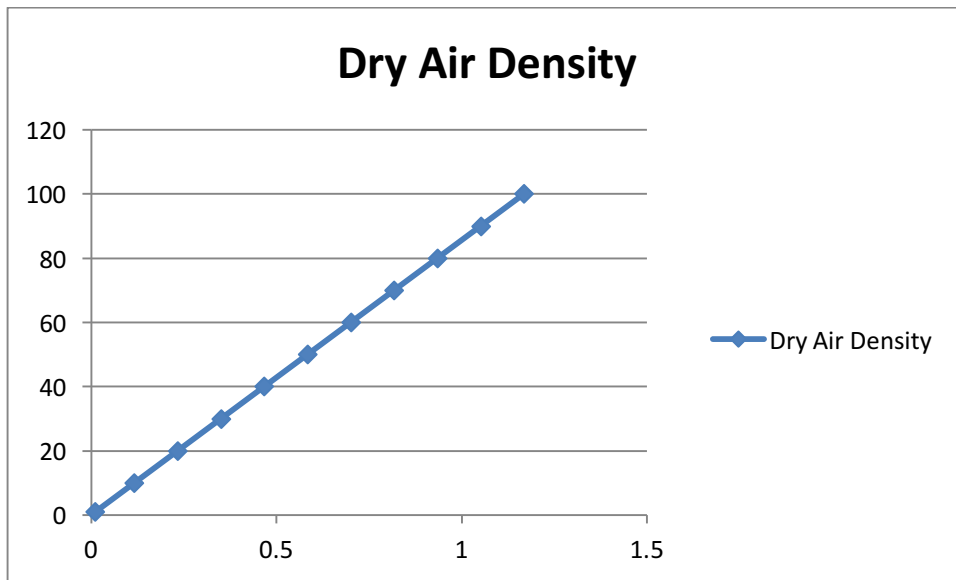

Quick inspection tells us this is not what we were hoping for. Remember atmospheric pressure decreases with height, so we want the higher values on the bottom of our plot to get a real sense of how the atmosphere is built. What we need to do is reverse the y-axis. On your plot, double click on the y-axis to bring up the 'Format Axis' window, shown below. Under axis options, click the box for 'Values in reverse order.' Also, remember the problem statement asked for logarithmic scaling on the y-axis. Also check the 'Logarithmic scale' box to obtain the correct y-axis scaling. Both boxes have been circled in the image below. You should receive an error about not being able to calculate a log of zero. We will fix this later, hit ok for now.

The Format Axis box is extremely handy. For example, it allows you to change where your tick marks are located, axis minimum and maximum values, as well as major and minor unit lengths Let's change these to make our graph look nice. Enter the options as shown below (I changed

the minimum axis value, maximum axis value, major unit, minor tick mark type, and the location where the horizontal axis crosses the vertical). Click close when done.

Note there is one point that is not connected to the rest. This is because of our logarithm error. Simply replace the 0 in the Pressure column with a 1 and we should be ok.
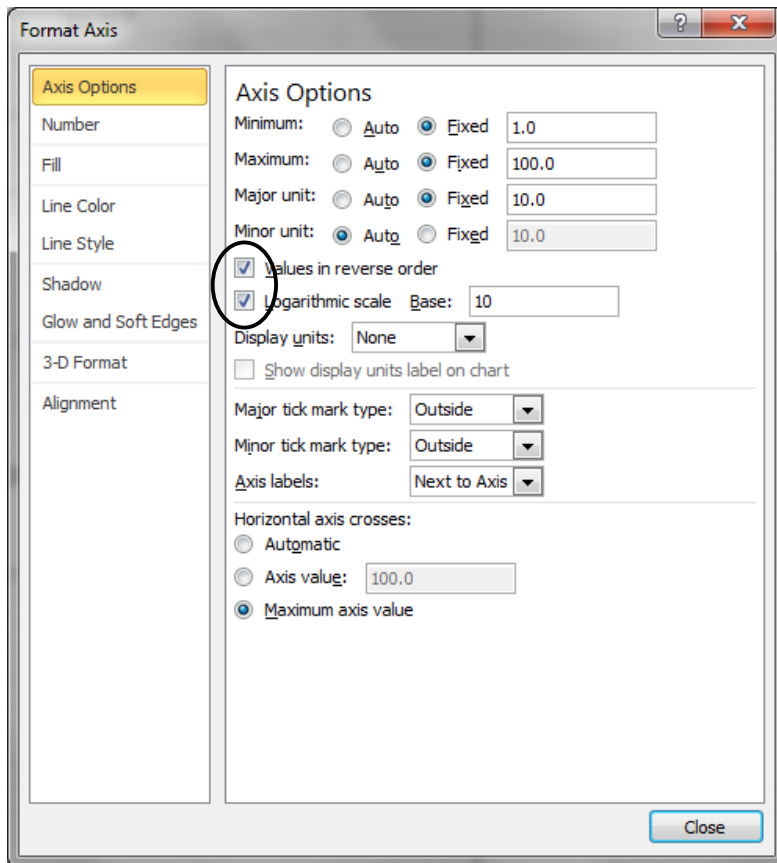

Next double click on the x-axis. Let's leave the axis range as the default. The only two options we will change here are the 'Major tick mark type' (set to inside) and the 'Axis Labels' (set to High). Click close and your graph should now look like:
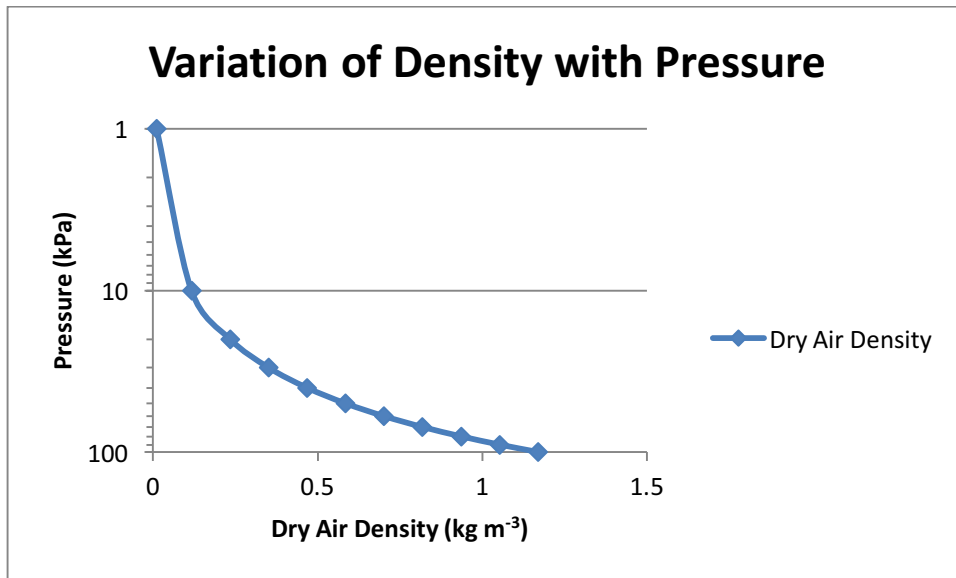
Dry Air Density
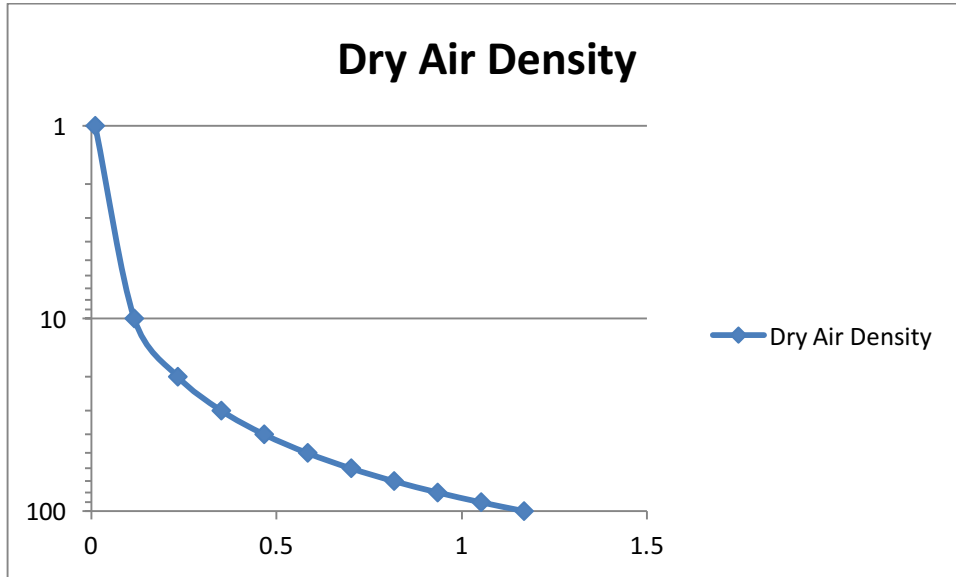
The last thing to do before we are done is to label axes correctly and with units as well as put an appropriate title on the chart. All these will be worth points in the homework. It is hard to tell the meaning of a plot without the proper units!!

This can be done by clicking on the chart once, then be going up to the menu bar and selecting 'Layout' under the 'Chart Tools' menu options.
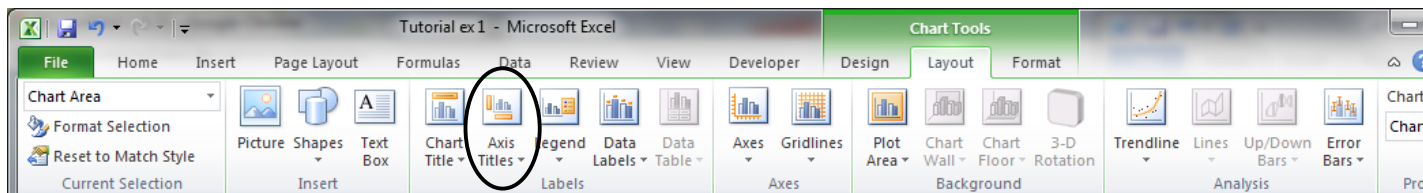
This provides us with another set of useful tools to make our plots look nice. To add axis titles, click on the circled button above, select the correct axis and enter your title. See if you can replicate:

Variation of Density with Pressure

Y-axis: Pressure (kPa)
X-axis: Dry Air Density (kg m^{-3})

Legend: ◆ Dry Air Density

Homework 3 Example from Chapter 2 on Radiation, involving plotting (this problem will be assigned later):

A5___) "Plot the local solar elevation angle vs. local time for 22 December, 23 March, and 22 June for the following city: _____ (use the actual one assigned this term).

Hint, lets first do this for Vancouver, Canada, because the textbook already shows the answer at the bottom of page 32. Once we get our spreadsheet to agree with the Sample Application, then we need change only a few things in the spreadsheet to have it instantly give us the answer for the assigned city.

Follow along as we set this problem up in excel. Tips for plotting multiple curves on the same graph are given on the next page.

Plotting instructions using MS Excel (XY Scatter):

Many HW assignments ask for plots to support your answer and most all of them are referring to an XY Scatter type plot within Excel. Use these directions to guide your current and future work.

These directions assume you already have plotable data sorted into columns.

Step 1: Click on a blank cell on your worksheet.

Step 2: At the top of the program click on the insert tab, then on the 'scatter' button and select the appropriate type of scatter plot. I suggest 'scatter with straight lines and markers.'. A blank frame should appear so don't worry, you are doing this correctly!

Step 3: Right-click on this blank frame and click on 'select data.'

Step 4: A box titled 'Select Data Source should appear with two columns: Legend Entries (Series) and Horizontal (Category) Axis Labels. Under 'Legend Entries' click on the 'Add' button.

Step 5: A new box titled 'Edit Series' should pop up. It is from this dialogue where the data is selected to place on your set of axes. We will do this step 3 times to produce 3 lines on one plot (Solar elevation angles for 22-Dec, 23-Mar and 21-Jun).

Step 6: In the 'series name' box type in 22-Dec.

Step 7: In the 'series X values' box, click in the white area, then push the little button with the red, upward pointing arrow immediately to the right.

Step 8: A new 'edit series' box will appear. It is here that we will select our x-coordinate data: the local time of day. Highlight all of the local time data, not including the column title. Note Excel has inputted a formula into the Edit series box for you. All that you need to do once this data is selected is push the button in 'edit series' box with the downward red arrow. You should be brought back to the original 'edit series' box.

Step 9: Repeat steps 7 and 8, except for the 'Series Y values' this time. You should delete the ={1} before proceeding with selecting the data.

Step 10: Hit the 'OK' button on the main 'edit series' box and a graph will be generated. Note this is for only the 22 December data. Start again with the 'Add' button from the Select Data Source box, which should still be open, and follow steps 4-10 again for the other two cases. Then hit 'OK' on the Select Data Source box and you will see your whole plot.

All plots should be edited to have appropriate axis labels, units and legend. We will go over this once everyone has reproduced the raw figure.