EXCEL Intermediate Tutorial

Summary of important mathematical operations and formulas (from first tutorial):

Operation	Key
Addition	+
Subtraction	-
Multiplication	*
Division	/
Exponential	^
To enter a formula	Type "=" before the formula
Example: $X^{-5} + Y^3$	=((X)^-5+(Y)^3)
Example: 3.2×10^{-6}	3.2E-6 or 3.2*10^-6
Solve the equation: $750 \div 760 \times 22.4$	=((750/760)*22.4)

Example 1:
Solve the expression $(8.314) \times (0.000901)^2$

Using a standard Excel spreadsheet you would enter the number 1.5 in cell A1, 0.00902 in cell B1 and the formula =(A1*(B1^2.0)) in C1. The answer of 0.000122 would then appear in C1.

You would enter

	A	B	C
1	8.314	0.00901	=(A1*(B1^2.0))
2			
3			

and get

	A	B	C
1	8.314	0.00901	0.000675
2			
3			

Exercise 1: Solve the expression $((2.3026) \times (1.249)^{1/2})/49.32$ **Answer**: 0.05218 (sig figs!)

Example 2:
Suppose you needed to calculate the above expression $X \times (0.00901)^2$ for X = 1.5 to 3.2 by increments of 0.1. This is really easy to do using an Excel spreadsheet. First you need to enter the values of X into the spreadsheet (using column A for example). You can either type these in directly, or use a formula (X = X + 0.1) to calculate these values.
 Either type in the values yourself (see next table) or type in the first value, and then type the formula =(A1+0.1) into A2. If you do the latter, you can then copy this formula (using Ctrl-c) and then paste it into all other cells (A3:A18). You can also use the drag feature of Excel to fill these cells. Eventually, you should end up with 18 values, ranging from 1.5 to 3.2.
 For column B, you always have the same value of 0.009010. To do this easily, type this value into B1, then copy it and paste it into B2:B18. To get the right number of decimal places, highlight the column and use the Format function to set 6 decimal places for these numbers.

1

To obtain the answers, you need to type in the formula =(A1*(B1^2.0)) into C1, copy this formula and paste it into cells C2:C18.   This will give you the final Table seen below.

Directly typing in the values for A and B

	A	B	C
1	1.5	0.009010	=(A1*(B1^2.0))
2	1.6	0.009010	
3	1.7	0.009010	
4	1.8	0.009010	
5	1.9	0.009010	
6	2.0	0.009010	
7	etc.	etc.	
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

Using a formula to increment A values

	A	B	C
1	1.5	0.009010	=(A1*(B1^2.0))
2	=(A1+0.1)		
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

Final Excel Table:

	A	B	C
1	1.5	0.009010	0.000122
2	1.6	0.009010	0.000130
3	1.7	0.009010	0.000138
4	1.8	0.009010	0.000146
5	1.9	0.009010	0.000154
6	2.0	0.009010	0.000162
7	2.1	0.009010	0.000170
8	2.2	0.009010	0.000179
9	2.3	0.009010	0.000187
10	2.4	0.009010	0.000195
11	2.5	0.009010	0.000203
12	2.6	0.009010	0.000211
13	2.7	0.009010	0.000219
14	2.8	0.009010	0.000227
15	2.9	0.009010	0.000235
16	3.0	0.009010	0.000244
17	3.1	0.009010	0.000252
18	3.2	0.009010	0.000260

Exercise 2: Create a table of data that solves for the formula X*(8.314)/(101,325 x 1.50) where X ranges from 20 to 40 by increments of 2

Final answer should look like:

A	B	C	D	Answer
20	8.314	101,325	1.50	0.001094
22	8.314	101,325	1.50	0.001203
24	8.314	101,325	1.50	0.001313
26	8.314	101,325	1.50	0.001422
28	8.314	101,325	1.50	0.001532
30	8.314	101,325	1.50	0.001641
32	8.314	101,325	1.50	0.00175
34	8.314	101,325	1.50	0.00186
36	8.314	101,325	1.50	0.001969
38	8.314	101,325	1.50	0.002079
40	8.314	101,325	1.50	0.002188

Graphing Experimental Data

Suppose you perform an experiment in which you change the pressure of an ideal gas in a fixed volume, and measure the corresponding temperature change. You might get data like the following:

Pressure (atm)	Temperature Change (^{o}C)
2.0	0.0361
2.1	0.0398
2.2	0.0437
2.3	0.0477
2.4	0.0520
2.5	0.0564
2.6	0.0610
2.7	0.0658
2.8	0.0707
2.9	0.0759
3.0	0.0812
3.1	0.0867
3.2	0.0924
3.3	0.0982
3.4	0.1043
3.5	0.1105
3.6	0.1169

To create a standard graph, you can do the following:

1. Type/generate these values into an Excel spreadsheet. For this example I have started in cell A1, and used columns A and B.
2. Highlight all the values in these two columns
3. Click on Insert, and click on Chart (alternatively click on the Charts Icon on your toolbar)
4. Once the Charts Wizard is loaded it will give you various options for your graph (Step 1). Typically we select the X-Y scatter option, and the first sub-type of just data points
5. Click "Next" once you have decided what sort of graph to generate.
6. The wizard will generate a small graph (Step 2) with your data labeled as Series 1. If this looks right to you (make sure that the data is OK, and that you have all of it), click "Next"
7. At this point you can label your graph. With the Titles button on the top row selected, type in your X-axis legend (Pressure), your Y-axis legend (Temperature) and the heading (What this graph really is – I used "Measured temperature change with pressure for system" but you should decide on a suitable title depending on the experiment).
8. When you have done this, you can check some other options, such as Gridlines (decide what you want) and Legend (do you need this – not if only one set of data).   When happy, Click "Next"
9. At this point (Step 4) you are asked where you want the generated graph to be placed. Make sure that the option "As object in" is selected and Click "Finish".
10. You should end up with a graph that looks like:
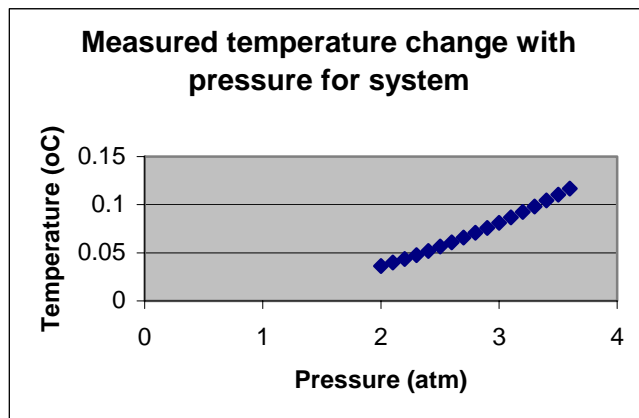
You can move your graph around your spreadsheet by selecting the graph (left-click), holding down the left mouse button and dragging it.

Now that you have generated the graph, you will need to format it. The automatic Chart wizard automatically starts at zero for both the x and y axes, and this is not what we want here.

To change scales on the axes, simply double left-click on the axis itself. For the x-axis, we would like the scale to start at 2.0, go to 4.0, in increments of 0.5. When we double-click on the x-axis in the plot itself, we get a box with various options. Click on the "Scale" option, and

then type 2.0 in the "Minimum" box. Leave the "Maximum" value as 4.0, and the major unit value as 0.5. Your graph should know look like:
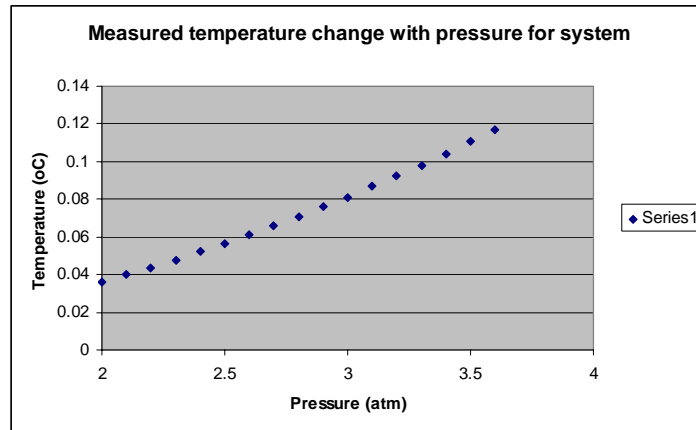

 For the y-axis, we can do the same, and make the changes we want. Suppose we wanted to run this axis scale from 0.02 to 0.12, using units of 0.02. If we do this, our graph looks like:
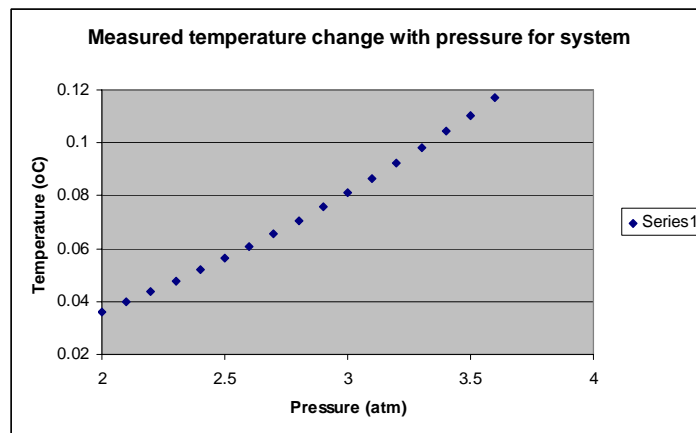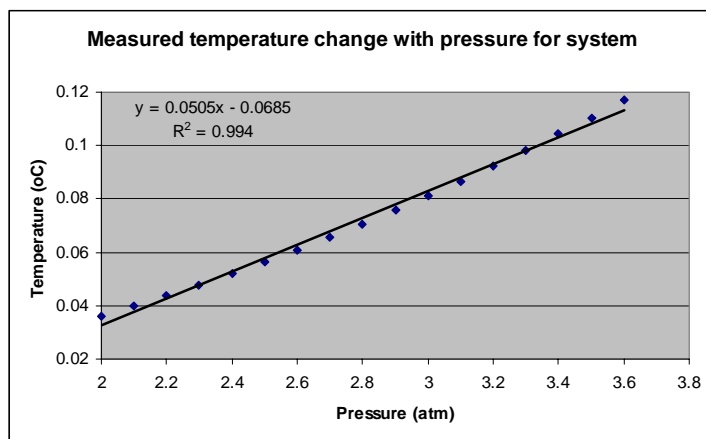

To remove the Series 1 label (no need to have this, as we have only one series plotted) we can just select it (left click in this small box) and hit the "Delete" key. The graph now looks like:
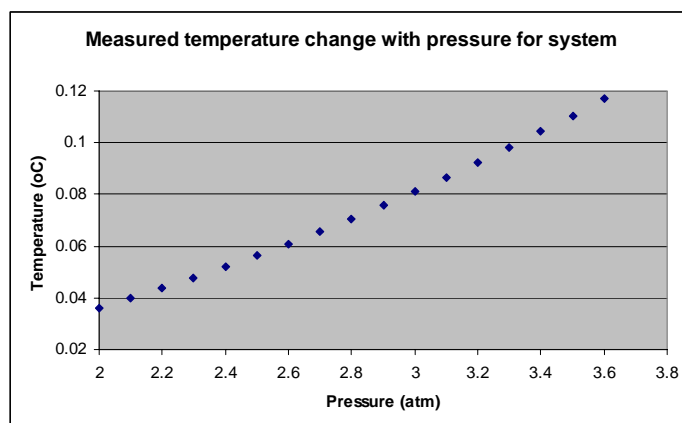
Now, once we have made the graph full-scale on the axes, we probably want to fit a line through the data. In Excel, this is called adding a "Trendline". You can add a trendline by RIGHT-clicking once on any data point. When you do this, a menu pops up, and one of the options is to "Add Trendline". By clicking on this option you get another menu of options. To fit a straight line to the data, make sure the Type tab is selected, and then click in the Linear Trend/Regression box. It will go black to show it is selected. If you have more than one series of data in your graph, you will have to select which dataset you want a trendline fitted to (see later). Once this is done, you can click on "OK" at this point, and you will see a straight line through your data points, like:

Measured temperature change with pressure for system

Temperature (oC) vs Pressure (atm)
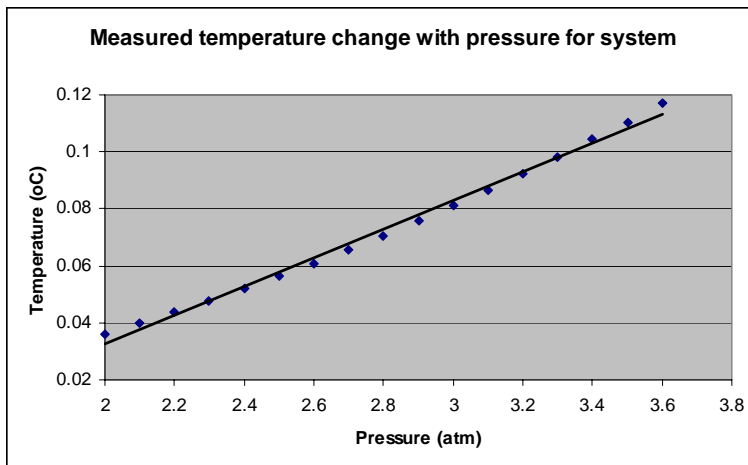
If you want to know what your fitted values are, you can get these by displaying the parameters of the Trendline fit. To get these, double left-click again on the line, and another menu will pop up. The first tab will allow you to change the format of the trendline, the second one is the menu you've seen previously saying what type of line you want to fit to your data, and the third tab (Options) allows you to put the fitted parameters onto the graph itself. Select the Options tab, and check the "Display equation on chart" and "Display R-squared value on chart" options. When you click on OK your graph will now look like:

Measured temperature change with pressure for system

$y = 0.0505x - 0.0685$
$R^2 = 0.994$

Temperature (oC) vs Pressure (atm)

It is important to remember that not all data conform to a straight line. If you look closely at the data you have used, it is really not a good straight line (the R^2 value is not that bad, but could be better). Given the curve seen in the data, it looks more like a quadratic equation would fit this data better. You can also fit quadratics in Excel (or any order polynomial) by using the menu that is obtained by right-clicking any data point.

First of all, you have to remove the straight trendline and the box of parameters. You can do this by simply right-clicking on the line itself and clicking on the "Clear" option. Once this is done, you can now right-click on any data point again, select "Add Trendline" and now select the "Polynomial" option. You will be asked for the order of the polynomial you wish to fit, 2 corresponds to a quadratic. Remember to check the Display options under the "Options" tab, and then your graph should look like:
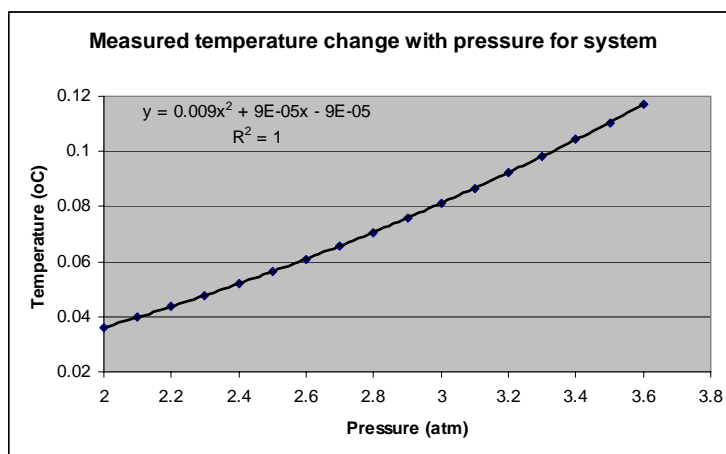
This is clearly a much better fit! Now the only thing that you might want to do is to increase the significant figures of the fit values. Double-click on the displayed parameters, to generate another menu. Select the "Number" option, and now you can display the values using any format you like. If you want Scientific notation, click on "Scientific" and select the number of decimal places (suggest 3). Your graph will now look like:
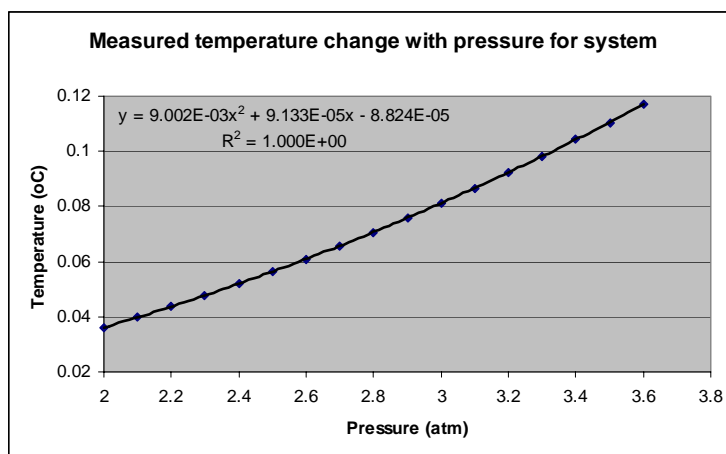

Obviously there are many more options available – which I encourage you to play with.

Now, suppose you wanted to plot more than one set of data on a single graph.   For the data:

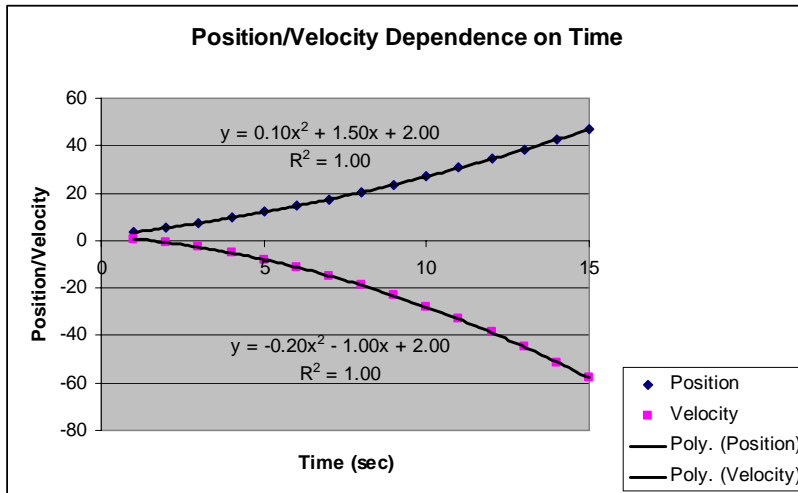| Time	Position (cm)	Velocity (cm/s)
1	3.6	0.8
2	5.4	-0.8
3	7.4	-2.8
4	9.6	-5.2
5	12	-8
6	14.6	-11.2
7	17.4	-14.8
8	20.4	-18.8
9	23.6	-23.2
10	27	-28
11	30.6	-33.2
12	34.4	-38.8
13	38.4	-44.8
14	42.6	-51.2
15	47	-58

where you have the same x-values for two different y-value sets, you can simply select all three columns of data in the spreadsheet, and then click on the Charts Icon. Following the wizard prompting, you can create a scatter graph with just points like previously. However, when you get to Step 2, you will need to identify which data points belong to Position, and which to Velocity. You can do this here by selecting the Series tab. In the "Series" box, you will see two labels – Series 1 and Series 2. If you click on Series 1, you will see on the right that this series corresponds to y-values in column b. As this is the Position data, you can type the word "Position" into the empty Name box. If you then select Series 2, you can type "Velocity" into this empty name box. You will see that the legend at the side of the graph now has the proper labels. Click on the next box, and type in the appropriate legends and title. When you click Finish, you should have a graph that looks like:
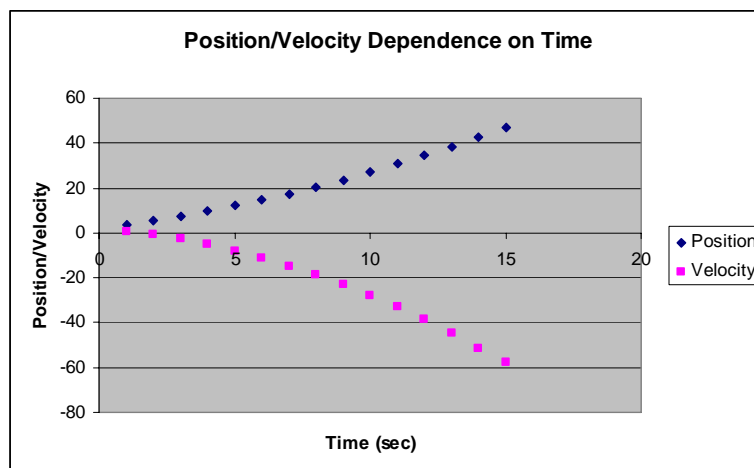
Using the default settings, you can see that the x-axis appears in the middle of the graph. The automatic scaling parameters are fine for the y-axis, but could be changed for the x-axis.
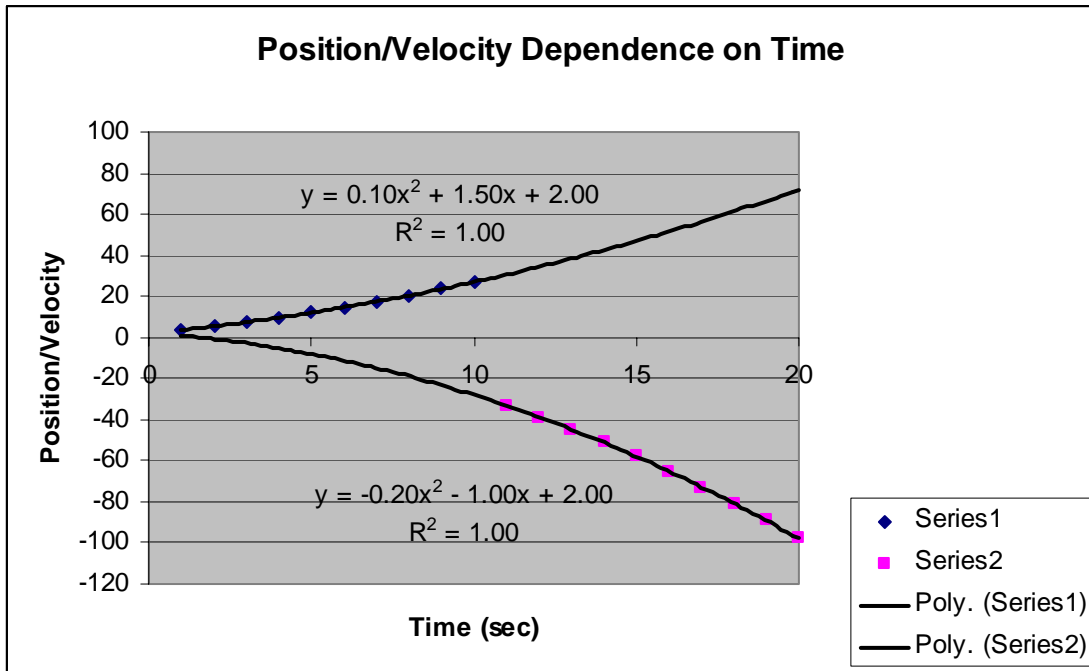
Now we can also fit Trendlines to each separate set of data. Use the above method, right-click on one of the Position data points (diamonds) and fit a quadratic line. Remember to plot the parameters on the graph as well. Repeat this for the Velocity data (squares). Move the legend box onto the graph, and you should get a graph like:

Lastly, if you have different x-values for two different data sets, you can still follow the above procedure. If you had a dataset like

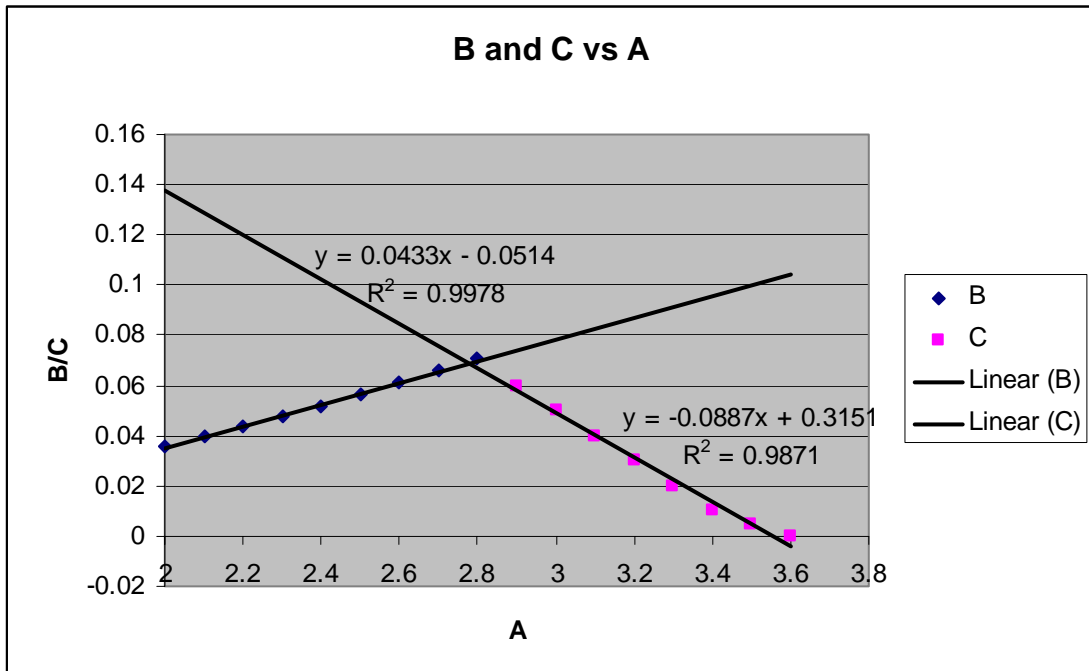| Time (sec)	Position (cm)	Velocity (cm/s)
1	3.6	
2	5.4	
3	7.4	
4	9.6	
5	12	
6	14.6	
7	17.4	
8	20.4	
9	23.6	
10	27	
11		-33.2
12		-38.8
13		-44.8
14		-51.2
15		-58
16		-65.2
17		-72.8
18		-80.8
19		-89.2
20		-98

To plot both these graphs, you have to select ALL of these data (including the blanks of b11:b20 and c1:c10) before clicking on the Charts icon. Following the above procedure, you should get a graph like:

Position/Velocity Dependence on Time

$y = 0.10x^2 + 1.50x + 2.00$
$R^2 = 1.00$

$y = -0.20x^2 - 1.00x + 2.00$
$R^2 = 1.00$

Series1
Series2
— Poly. (Series1)
— Poly. (Series2)

Position/Velocity
Time (sec)

Exercise: Plot the following data together on a single graph, and fit each data set to a straight line.

A	B	C
X	Y1	Y2
2.0	0.03608	
2.1	0.03978	
2.2	0.04366	
2.3	0.04772	
2.4	0.05196	
2.5	0.05638	
2.6	0.06098	
2.7	0.06576	
2.8	0.07072	
2.9		0.060
3.0		0.050
3.1		0.040
3.2		0.030
3.3		0.020
3.4		0.010
3.5		0.005
3.6		0.000

Your graph should eventually look like:

B and C vs A

$y = 0.0433x - 0.0514$
$R^2 = 0.9978$

$y = -0.0887x + 0.3151$
$R^2 = 0.9871$

Legend:
- B
- C
- Linear (B)
- Linear (C)

Y-axis: B/C
X-axis: A

Once you have generated your graph it can be selected, copied, and then pasted into another document.