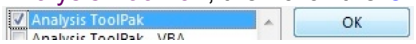
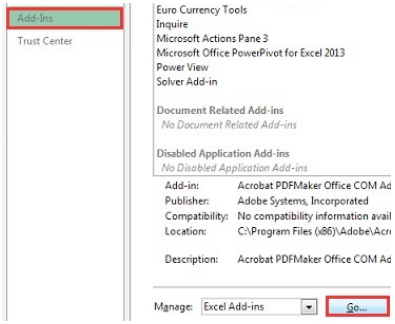
Select File, followed by Options (which can be found towards the bottom of the list).

- Click on Add-ins (on the left of the pop-up box); then click the Go button (center bottom of pop-up box).
- On the new pop-up box, tick the box next to Analysis ToolPak; then click the OK button.



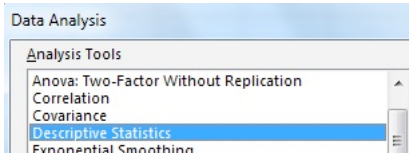

The Data Analysis option should now be present under the Data tab.

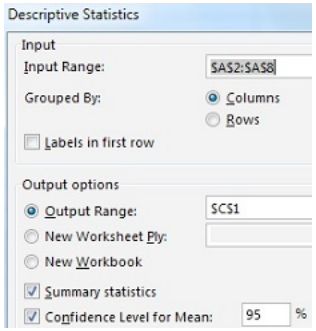
## Error Treatment - Data Analysis: Descriptive Statistics

http://www.l4labs.soton.ac.uk/tutorials/excel/16e7.htm

Used to calculate the mean (with associated error) on a set of multiple readings.


- Select Data Analysis under the Data tab.
- Select Descriptive Statistics then click OK.
- Make sure the cursor is in the window to the right of Input Range, then highlight the relevant cells by clicking and dragging the mouse from the start to the end of your data.
- Click on the circle to the left of Output Range, then (after making sure the cursor is in the window to the right) click on the cell where you wish the results to appear.
- Finally, tick the Summary statistics and Confidence Level for Mean options, before clicking OK.



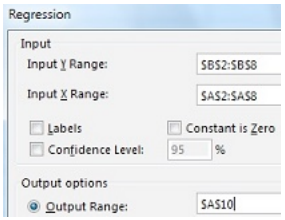

*See the "Error" Quick Guide or the online tutorial for details on how to interpret the Output Table.*

## Error Treatment - Data Analysis: Regression

http://www.l4labs.soton.ac.uk/tutorials/excel/16e8.htm

Used to perform a linear regression on a set of x-y data.

- Select Data Analysis under the Data tab.
- Select Regression then click OK.
- Click in the window to the right of Input Y Range, then highlight the cells containing your y-data. Similarly click in the window to the right of Input X Range, then highlight the cells containing your x-data.
- Finally click on the circle to the left of Output Range, then (after making sure the cursor is in the window to the right) click on the cell where you wish the results to appear, before clicking OK.




*See the "Error" Quick Guide or the online tutorial for details on how to interpret the Output Table that will be produced.*

# USING *EXCEL* 2016 – QUICK GUIDE

(*See www.l4labs.soton.ac.uk/main/menu1.htm for web and video tutorials*)

**IMPORTANT: Always save your work (as different versions) frequently so it is possible to recover an earlier version of your work if needed.**

## Performing (Repetitive) Calculations

www.l4labs.soton.ac.uk/tutorials/excel/16e1.htm
www.l4labs.soton.ac.uk/tutorials/excel/16e2.htm
www.l4labs.soton.ac.uk/tutorials/excel/16e13.htm

See "Review of Error Estimation & Treatment" Quick Guide - Example 1'. In this example the calculations to determine the concentrations (with associated errors) could be performed by hand, but it is better to use *Excel* since this will make it easier to fix mistakes (and update the calculation answers) if needed.

First enter the column headings and values as shown below. Note: The subscript represents the solution number (N) and σ the associated error.

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Soln {N} | $C_{N-1}$/M | $C_{N-1,Max}$/M | $C_{N-1,Min}$/M | $V_{N-1}$/ml | σ{$V_{N-1}$}/ml | $V_{Tot}$/ml | σ{$V_{Tot}$}/ml | $C_N$/M | $C_{N,Max}$/M | $C_{N,Min}$/M |
| 2 | A | 1.500 | 1.510 | 1.490 | 5.00 | 0.03 | 25.0 | 0.2 | | | |
| 3 | B | | | | | | | | | | |

To get Excel to determine the values for the calculations for Solution A (shown in the "Errors" Quick Guide – Example 1):

- $c_A$: In Cell I2 enter =B2*E2/G2
- $c_{A,Max}$: In Cell J2 enter =C2*(E2+F2)/(G2-H2)
- $c_{A,Max}$: In Cell K2 enter =D2*(E2-F2)/(G2+H2)

*The formulae in the I column corresponds to $C_{N-1}V_{N-1}/V_{Tot}$ whilst that in column J corresponds to $C_{N-1,Max}V_{N-1,Max}/V_{Tot,Min}$*

We can now extend the calculation for the remaining solution (B):

- For Row 3 we are calculating the concentration and associated error of Solution B (made by diluting Solution A). Therefore, the value in Cell B3 needs to be the concentration of Solution A (shown in Cell I2). We can get Excel to copy the exact value across by entering in Cell B2 =I2
- Similarly, the maximum and minimum concentrations of A are entered as follows: In Cell C3 enter =J2 and in Cell D3 enter =K2
- The values in the E3 to H3 cells will be the same as before, so highlight E2 to H2, and copy them down (by dragging down from the bottom right of the highlighted cells) to Row 3.
- The calculations in the I3 to K3 cells will be the same as before (except using the Row 3 values), so also highlight I2 to K2, and copy them down to Row 3.

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Soln {N} | $C_{N-1}$/M | $C_{N-1,Max}$/M | $C_{N-1,Min}$/M | $V_{N-1}$/ml | σ{$V_{N-1}$}/ml | $V_{Tot}$/ml | σ{$V_{Tot}$}/ml | $C_N$/M | $C_{N,Max}$/M | $C_{N,Min}$/M |
| 2 | A | 1.500 | 1.510 | 1.490 | 5.00 | 0.03 | 25.0 | 0.2 | 0.300 | 0.30626 | 0.29386 |
| 3 | B | 0.300 | 0.306 | 0.294 | 5.00 | 0.03 | 25.0 | 0.2 | 0.060 | 0.06212 | 0.05796 |

Click on Cell I3: Note that the cell indexes in the formula have been automatically updated (to =B**3***E**3**/G**3**) when it was copied from I2.

Assuming the sequential dilution was continued in the same way to make a third solution (C), the calculation for this could then be set up by highlighting B3 to K3, and drag-copying them to B4 to K4.

Note: If you later found you had made a mistake, e.g. the error in $V_{Tot}$ was actually ±0.25ml, simply changing the values in H2 and H3 to 0.25 will automatically update the calculation (- Not something that would happen if you had done this by hand!)

If the calculated values have to be cited (in the report) as *Value* ± *Error*, we need to determine the larger of $C_{Max}$-C and C-$C_{Min}$ (to cite as the ±*Error*) for each solution.

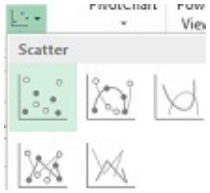
| | I | J | K | L |
|---|---|---|---|---|
| 1 | $C_N/M$ | $C_{N,Max}/M$ | $C_{N,Min}/M$ | $\sigma\{C_N\}/M$ |
| 2 | 0.300 | 0.30626 | 0.29386 | 0.0063 |
| 3 | 0.060 | 0.06212 | 0.05796 | 0.0021 |

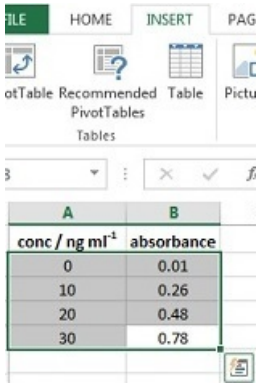
This can be done in the Excel example by entering in Cell L2 =IF((J2-I2)>(I2-K2),J2-I2,I2-K2) and copying down. Note that what this formula does is: If $C_{Max}$-C is bigger than C-$C_{Min}$, show value of $C_{Max}$-C, otherwise show value of C-$C_{Min}$.

## Graphing

http://www.l4labs.soton.ac.uk/tutorials/excel/16e3.htm

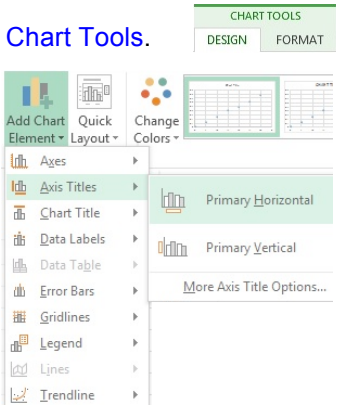
- Highlight the data you want to plot; then click on the Insert tab.
- Click on the Scatter Chart icon, followed by the icon for scatter chart with markers but no lines. The graph will appear on the page. IMPORTANT: If the plot contains so many data points that the individual markers cannot be told apart (e.g. spectra) – The selected plot type must instead be scatter chart with lines but no markers.




## Graphs - Titles

- Click on the plot; then select the Design tab under Chart Tools.
- Click on Add Chart Element; then select Axis Titles followed by Primary Horizontal. The text *Axis Title* will appear at the bottom of the graph. Highlight the text on the plot and enter your desired x-axis title.
- To add a y-axis title: Repeat the process, but select Primary Vertical.
- Click on the text *Chart Title* that appears on the plot and replace it with an "informative title", i.e. the title should not just restate the axis titles but should supply additional pertinent information and/or explain the purpose of the plot.

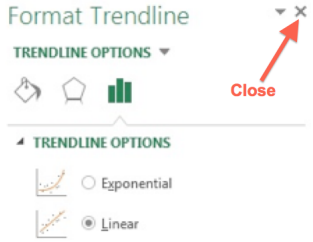



## Graphs – Adding Trendlines

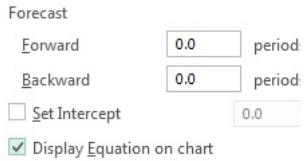
http://www.l4labs.soton.ac.uk/tutorials/excel/16e4.htm

To add a trendline to a set of data:

- Click on one of your data points in the plot; then select the Design tab under Chart Tools.
- Click on Add Chart Element; then select the Trendline section followed by More Trendline Options. The Format Trendline window will appear.




- Under Trendline Options, select Linear.
- At the bottom of the Display equation on

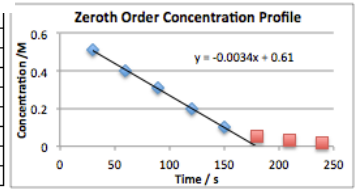



window, tick the box next to chart, then click Close.

To add a trendline to part of a set of data:

- Separate your y-data into two columns (one with the data you wish to add the trendline to and the other with the remaining data).
- Plot both sets of data and then add the trendline (to the linear portion of the data) as detailed previously.

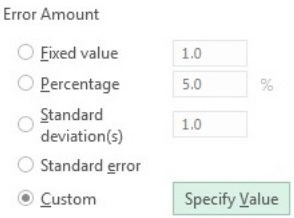
| Time / s | Concn / M | |
|---|---|---|
| 30 | 0.51 | |
| 60 | 0.4 | |
| 90 | 0.31 | |
| 120 | 0.2 | |
| 150 | 0.1 | |
| 180 | | 0.05 |
| 210 | | 0.03 |
| 240 | | 0.02 |

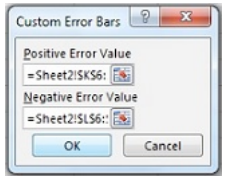



## Error Treatment – Graph Error Bars

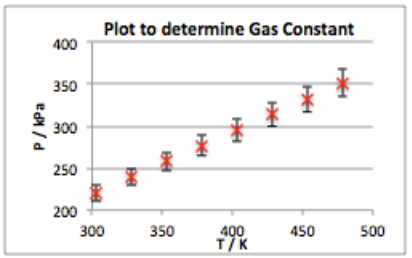
http://www.l4labs.soton.ac.uk/tutorials/excel/16e10.htm

- Add two additional columns of data (next to the plot data), titled Positive Error and Negative Error. Note: Often you will first need to calculate the minimum ($Y_{Min}$) and maximum ($Y_{Max}$) values; the Positive Error would then be $Y_{Max}$-Y and the Negative Error would be Y-$Y_{Min}$.
- Click on the Design tab under Chart Tools.
- Click on Add Chart element, then select Error Bars followed by More Error Bars Options. The Format Error Bars window will appear on the right.
- Click on the circle to the left of Custom, then click Specify Value.
- For the Positive Error Value: Click in the box and then highlight the cells containing the Positive Error values. Similarly define for the Negative Error Value. The graph will now include the error bars - Example shown below.




| TEMP | PRESSURE | | |
|---|---|---|---|
| T / K | P / kPa | +ve Error | -ve Error |
| 303 | 220 | 10 | 9 |
| 328 | 240 | 10 | 10 |
| 353 | 258 | 11 | 11 |
| 378 | 277 | 12 | 12 |
| 403 | 295 | 13 | 13 |
| 428 | 314 | 14 | 14 |
| 453 | 332 | 15 | 15 |
| 478 | 351 | 17 | 16 |




*See the "Error" Quick Guide or the online tutorial for details on how to use error bars to determine gradient errors (by adding Min/Max lines).*

## Error Treatment - Data Analysis

http://www.l4labs.soton.ac.uk/tutorials/excel/16e6.htm

*Excel* is able to perform a number of statistical analyses/procedures for you. However these need the Data Analysis Tool to have been added to *Excel*.

If Data Analysis is not present under the Data tab: