

Appendix: Plotting Data on Microsoft Excel 2003

Plotting Data sets on Excel is very easy and occurs in several simple steps. The basics of each step will be explained, but remember that you can always dig in deeper and become more proficient if you wish.

Part I: Enter Data and set up Graph

- a) Bring up Microsoft Excel and start a new spreadsheet.
- b) Type in your x – axis values (the independent variable concentration) in Column A.
- c) Type in your y – axis values (the dependent variable, absorbance) in Column B.
- d) Place the title of the data set (e.g., absorbance in column B) in the first cell of the column.
- e) If you have multiple data sets (series) to be plotted on the same graph, enter the data in Column C, D, etc.
- f) Highlight the data sets to be plotted (left click and hold).
- g) In the tool bar, click on “Chart Wizard” (looks like a colored bar graph).

Part II: Chart Wizard

This program sets up plots in detail and occurs in 4 basic steps.

Step 1: Choose Chart type

- a) Under “Standard Types” (don’t need custom plots yet!) choose: “XY (Scatter)
- b) Under chart sub – type, choose the one without lines (we will add lines later).
- c) Click Next

Step 2: Set Data Range and Series Labels

- a) The data range should already be entered, since we highlighted it on the Excel spreadsheet earlier.
- b) Click on the “Series” tab for labeling separate series (data sets), but only if more than one set has been plotted on the same graph.
- c) Choose which series to label (series 1 is column B, series 2 is column C, etc.) and type in the appropriate label for it.
- d) Click Next

Step 3: Set up and Label the Title, Axes, Gridlines and Series Legend:

- a) Under **Titles**: Type in the name of your Graph (include parameters plotted and the system being studied).
For example: “Intoxication Level vs. Weight for Males Between age 20 and 35”.
- b) Under **Axes**: Label the x and y – axes (ie: Weight (lbs) or Temperature (K)). Always include the units used on the graph in parentheses after the variable. The axes values are already set and the number range should always be included (computers automatically set the range, whereas by hand you have to figure out the proper data set range yourself).
- c) Under **Gridlines**: Add or remove lines on the graph, like on graphing paper. It is usually best to include the Major X and Y gridlines only to avoid clutter.

- d) Under **Legend**: The series legend is the box showing your data sets plotted. Only include this Legend if you are plotting more than one data set (series). You can place this Legend wherever you want, but on the right normally looks best.
- e) Under **Data Labels**: Make sure “none” is chosen. On scientific plots, showing the data values next to their points on the graph is redundant and messy.
- f) Click Next when finished.

Step 4: Setting Chart Location

- a) You can set the graph up as a new sheet or have it inserted onto the Excel spreadsheet sowing your Data Table. In reports and labs, it is best to set up the Graph as a new sheet, and include the Data Table on a separate sheet of paper, or in the Data portion of a lab report.
- b) Click Finish when done.

Part III: Adding Best-Fit Lines

In science, plots are designed to find and show the relationship between two variables. Many times a linear relationship is desired, but non – linear relationships (exponential, curved, etc) can often be expected.

Since the data points are somewhat scattered due to experimental uncertainty, many scientists add “error bars” to their data points to show the spread of uncertainty. We won’t be doing error bars in any of these labs. What is done is finding a “best – fit” line that represents all the data points, but does not necessarily touch all of them. This “**Trendline**” shows the general relationship between the variables plotted on the Graph.

To add a trendline, follow these steps:

- a) Right click on a data point on the Graph from the series you are interested in.
- b) Choose “Add Trendline”.
- c) Choose a type of trendline: Several are available, but if the relationship looks somewhat liner, choose “Linear Plot”. If the data looks curved, choose “Polynomial at level 2, 3 or 4”. You may need to try several different lines before finding the “best – fit” line.
- d) General Rule: Never ever just “connect the dots” on a scientific plot!
- e) Under trendline options, select "display equation on chart" so that you can see the mathematical result of the least-square fit.
- f) To format the Trendlines, right click on the line. Under **Pattern**, you can choose a color, line thickness or specific style (dashed, dotted, etc.).

Appendix: Plotting Data on Microsoft Excel 2007

Plotting Data sets on Excel is very easy and occurs in several simple steps. The basics of each step will be explained, but remember that you can always dig in deeper and become more proficient if you wish.

There are a lot more “options” with the Excel 2007 version and the set up is quite different from the 2003 version if you are used to that one.

Part I: Enter the Data

- h) Click on Microsoft Excel 2007 to start a new spreadsheet.
- i) Label each column with the parameters to be plotted. The independent variable goes in Column A (x-axis) and the dependent variable goes in column B (y-axis).
For example, if we are plotting how the absorbance of NO₂ depends on its concentration, the concentration is the *independent* variable and the absorbance is the *dependent* variable (it depends on the set concentration).
- j) Type in your x-axis (column A) values and y-axis (column B) values under the appropriate column labels.
- k) If you have multiple data sets (series) to be plotted on the same graph, enter the extra dependent variable data sets in columns C, D, etc. (like multiple species concentrations, O₃, NO and NO₂ or a known data set and an unknown data set).

Part II: Set Up the Plot

- d) Highlight the data sets to be plotted (not the column labels!).
- e) Under the “**Insert**” tab, find the Chart types and click on “Scatter” (without any lines).
- f) This should place you under “Chart Tools” and “Design” now.
- g) Under “**Chart Styles**” click on the type preferred (scroll down for options).
- h) Under “**Chart Layouts**” click on the 1st plot that gives Chart and Axis titles.
- i) Click and drag your plot to expand it to fill up the entire page (easier to see data trends).
- j) Left click on the **Chart Title** to name your plot (i.e.: Absorption of NO₂ vs. Concentration) as well as on your **Axis Labels** which need units (i.e.: [NO₂] (μg/mL) for the x-axis and A_{NO₂} for the y-axis).
- k) **Format Labels** (optional): Right click on the chart and axis labels to make them bold or to adjust the font type and size. Click on “Format Title” or “Format Axis” to add colors (fun stuff!) or rotate the label.
- l) **Format Axis**: Right click on the x and y axis values and choose “Format Axis”. Use this to add minor and/or major tick marks on the plot (for easier estimation of values). These can be placed inside or outside the axis line. You can also alter the color, font style and size of the values. Adjust the minimum and maximum values on the axis in order to maximize the plot size (you do NOT have to start at zero!).
- m) **Format Legend**: Right click on the legend on the right, commonly to delete it. You can click on “Format Legend” to move it around the plot, change font type, color and size, box it and fill in colors, etc. If there are multiple data series, label these with the legend

by clicking on “Select Data”. Choose the series you want and click on “Edit”. You can now name the series whatever you wish (i.e.: O₃, NO or NO₂, etc.) and click on “OK”. Do this for each data series.

- n) **Format Plot or Chart Area:** You can fill in colors within the plot or outside of it by right clicking and choosing “Format Chart Area” or “Format Plot Area”, respectively.

Part III: Adding Best-Fit Lines

In science, plots are designed to find and show the relationship between two variables. Many times a linear relationship is desired, but non-linear relationships (exponential, curved, etc.) can often be found.

Since the data points are somewhat scattered due to experimental uncertainty, many scientists add “error bars” to their data points to show the spread of uncertainty. We won’t be doing error bars in any of these labs. What is done is finding a “best-fit” line (Least squares analysis) that represents all the data points, but does not necessarily touch all of them. This “trendline” shows the general relationship between the variables plotted on the Graph, in the common “ $y = mx + b$ ” format if a linear relationship exists.

To add a trendline, follow these steps:

- g) Right click on any data point on the plot from the series you are interested in.
- h) Choose “**Add Trendline**”.
- i) Choose a type of trendline: Several are available, but if the relationship looks somewhat linear, choose the “Linear” Trend/Regression type. If the data looks curved, choose “Polynomial at level 2, 3 or 4”. You may need to try several different lines before finding the “best-fit” line if not linear.
- j) General Rule: Never ever just “connect the dots” on a scientific plot!
- k) Click on “**Display Equation on Chart**” near the bottom so that you display the mathematical result of the least-squares fit (“ $y = mx + b$ ” form for a linear fit).
- l) **Format Trendlines:** Right click again on a data point and click on Add Trendline. You can choose a color, line thickness or specific style of line if desired (dashed, dotted, etc.).

Part IV: Print Plot

- a) Left click on the “**Office**” button on the upper left of the page. Scroll down to “Print” and follow the instructions. You can preview the page to be printed, adjust orientation, size, etc.

Part: Example Plot

