

## BAR Experiment Lab Report Tips

1. When graphing you must use a computer to do the graphs. Excel can be used to make the tables, do the calculations and make the graphs. It will do regression analysis or “trend lines” (least squares fitting) you can use this to plot your lines. Excel can also do smooth nonlinear curves. There are other programs which will work but Excel is preferred since you have free access. You should include the trend line produced by Excel, both on the graph and in your report. You should also report the correlation coefficient (usually signified as R or  $R^2$ ) which gives you some idea how good the fit is. The closer R is to  $\pm 1$  ( $R^2 = 1$ ) the better your fit is to a trend line, i.e. the closer your points are to falling on trend line ( $R = \pm 1$  means all your points should fall exactly on the chosen trend line). Some programs report an  $X^2$  or variance of the fit,  $s^2$  which tell you how good the fit is. Excel report  $R^2$ .

A graph should occupy essentially the whole page (margins of 0 inches), one graph per page. Generally, they should be in Landscape mode (unless told otherwise). Spread out your axes so your data occupies as much of the graph area and page as possible. It does not have to start at the origin, (0,0). You want to minimize the empty space.

2. For the Beer’s Law Graph, you will have 4 experimentally determined data points and the (0,0) point (5 data points in all). Fit the points to a best-fit straight line (linear) while forcing the line through the origin, the (0,0) point.. Excel allows this in the same window in which you set the type of fit and tell Excel to include the equation for the line and  $R^2$  on the graph. You can tell if it’s been forced through the origin since the intercept in the equation for the line from Excel should be zero ( $y = m \cdot x$ ).
3. Use Excel for the calculations for the zero, first and second-order tables and graphs. You have free access to it. It doesn’t work well on an iPad or the on-line version. The computers in 170 CE have Excel on them as do most of those around campus. If you use Excel (any spreadsheet program) you can program the columns to do the calculations for you (there’s a minimum of 170 calculations) and then use the spreadsheet (with the appropriate titles, column headings and units) in your report. In your spreadsheet make time (elapsed time) and absorbance columns and then program the spreadsheet do the appropriate calculations for you. You should have a separate spreadsheet (worksheet) for each solution, just like the report form. Don’t have the tables span more than one page (i.e. don’t break it across pages unless you have to because it’s too big to fit on a single page). I’ve listed below what should go in the columns of your spreadsheet. You also need to show an example of each of these calculations for one of the solutions in your report (see the rubric).

Column 1: elapsed time (report in either minutes or seconds, do not use “wall-clock” time, such as 1:20)

Column 2: Absorbance (A)

Column 3:  $[\text{Dye}]_t = A/m$   
where, A = absorbance  
m = slope of the Beer’s Law Graph.

Column 4:  $\ln [\text{Dye}]_t$   
Just take the natural log of each cell in Column 3.

Column 5:  $1/[\text{Dye}]_t$   
Just take the reciprocal of Column 3.

4. Excel can do regression fits (linear, exponential, polynomial, etc.). In Excel highlight the columns you want to plot and then click “Insert” (this may be different depending on your version of Excel or spreadsheet, in older versions you click on the chart wizard icon). A chart dialogue box pops up. Choose a “scatter” plot with no lines (points only). Once you have the graph, right click on a data point and choose “trendline”. Follow the directions in the dialogue box. You can do linear or curved trend lines. In the options box choose to have it print the equation for the line and the  $R^2$  value. I have an example using Excel for the CrY exp. on the class web page. What ever you do, don’t tell it to connect the points so you get a jagged line. It’s not hard to figure it out and there are tutorials on-line or get help from a TA or myself. It’s a good thing to learn so you can use it in the future.

For the zero-order graph do NOT use a linear fit. Use an exponential or power series (parabolic works well). The reaction is NOT zero order with respect to the Dye. Print the equations and  $R^2$  values and put them near the name for each solution in the legend (pull everything inside the graph so it has room to spread out).

For the first-order and second-order graphs use linear fits for both even though technically only one of the graphs should have straight (linear) lines and the other should be curved. Print the equations and  $R^2$  values and put them near the name for each solution in the legend (pull everything inside the graph so it has room to spread out). One of these graphs should have parallel straight lines. The other will have lines which diverge and the points don’t fit the linear trend line well (they’ll look parabolic in relation to the straight lines). The correct order is determined from the graph with the most parallel straight lines. You need to discuss why they should be parallel.