The Basics of Spreadsheets

Spreadsheets are computer programs that allow the user to enter and manipulate numbers. They are capable of performing a wide variety of calculations and can be programmed to perform any calculation for which the mathematical formula may be represented. One advantage of spreadsheets over calculators is that the data is stored in an easily readable form. This makes it possible to double check entries and replace mistyped numbers. More importantly, spreadsheets allow you to automate repeated tasks. You could also write a computer program in BASIC or some other language to perform such repetitive tasks, but it is quicker to learn and use a spreadsheet. Spreadsheets also allow you to make graphs of experimental data and to plot functions. We will continue to use spreadsheets in CHEM 131 and other chemistry courses.

The particular program that we will use is Excel 2010 which is installed on campus computers. Many other spreadsheets are logically very similar.

STARTING THE PROGRAM

Go to the **start** button, select **All Programs**, go to **Microsoft Office**, and select **Microsoft Excel 2010**. If at any time during this lab the computer does not respond as the instructions indicate it should, ask a computer-comfortable neighbor or your instructor for help.

SPREADSHEET CELLS

The core of a spreadsheet is a two-dimensional array of cells. Each of these cells has a name based upon the row and column in which it lies. The rows are numbered from 1 to over one million[1], and the columns are labeled alphabetically, starting with A. With this system the upper left-hand cell is named **A1**. Likewise, the cell two columns to the right is named **C1** and the cell five rows down from that is named **C6**. One of the reasons why spreadsheets are so flexible is that you can use the names to represent the contents of the cell. For example, enter the number 5 in cell **A1** and the number 2 in cell **B1**. To move from one cell to another you may use the cursor keys (arrows). This is one way to *select* a cell. Now select any open cell (**C1** would be fine) and enter the formula =A1/B1 or +A1/B1. The equal or plus sign tells the program that you are entering a formula and not a label such as "Time" which identifies the entries in a column or row or cell. When you press Enter, the number 2.5 appears in the cell. Notice that the formula still appears in the space between the tool bar and the body of the spreadsheet, while the numerical result of that formula is displayed in the cell. You can now go back and change any of your entries. For example, change the contents of **A1** to 12, and the spreadsheet automatically recalculates the values of any other cells that depend on **A1**. *Stop and verify that the other students in your row have gotten through these steps successfully and help them if necessary.*

ENTERING DATA

Clear the contents of the cells you have used so far. First, highlight the cell(s) you wish to clear using click and drag (with your left mouse button). Next, make sure you are in the **Home** tab, find the **Editing** box, click on the eraser icon, and select Clear All. Another way of doing this is to right click somewhere in the highlighted area then select **Clear Contents**.

For the sake of argument assume that you need to calculate the squares of the first six multiples of five. Starting with cell **A1**, enter the following numbers in column A: 0, 5, 10, 15, 20, 25, 30. In cell **B1** enter the formula =A1*A1. After entering this formula the result should be 0. You could then enter the formula =A2*A2 in cell **B2**, and so on. Instead, place the cursor on cell **B1**. Click on the icon of two pages in the **Clipboard** box of the **Home** tab in the menu bar (or right click on the cell and select copy). A flashing symbol will appear on the spreadsheet. Highlight cells **B2** through **B7** with the mouse. If you are using Windows, press enter. If you are using a Macintosh you must go to edit and click on paste. The formula should have been copied into the cells with changes made so that each formula refers to the correct piece of data. *Stop and verify that the other students in your row have gotten through these steps successfully and*

help them if necessary.

GRAPHING EXERCISE # 1
Clear the contents of the cells used in the previous section.
The following data will be used to illustrate the ability of spreadsheets to make graphs.

Time, 10^3 s	$[N_2O_5]$, mol/L
0	2.57E-3
4	1.50E-3
8	0.87E-3
12	0.51E-3
16	0.30E-3

Enter the time data in one column and the concentration data in the adjacent column. To get a superscript "3" type "Time, 103 s" and highlight the "3". Then click on the arrow in the right corner of the Font box in the menu bar, check the Superscript box, and click OK. Obtain subscripts in a similar manner. Enter 2.57E-3 and the other concentrations exactly as written. How does Excel rewrite 0.87E-3 ?

Highlight the block of data (0 to 0.30E-3) and go to the **Insert** tab in the menu bar, then then find the **Charts** box. Select **Scatter** then **Scatter with only Markers** (the top left option with only dots on the chart icon) as the chart type since you have xy data points. Any time that you have experimental data points, as in this example, the data points must show on the chart. There are options available to insert a chart title, axis labels, legends, and gridlines. These are all found in the **Layout** tab of the menu bar. For the Layout tab to be displayed, the chart must be selected. Enter a chart title and label the axes. Gridlines and Legend give you additional formatting options which you might wish to explore. In most cases, you will want to delete the gridlines. If there is only one series, delete the legend. If there are more than one series', keep the legend. For this exercise, delete the gridlines and legend now. To delete the series, click where it says "Series 1" on the graph. The legend is now selected. You can delete it by either right clicking and choosing delete or by simply hitting the "Delete" or "Backspace" key. Delete the gridlines in the same way. Click anywhere on a gridline (not the axes) to select them, then delete them. Your graph should now just contain the axes and the data points. Now switch to the **Design** tab of the menu bar. You are going to move the chart to a new sheet because a graph must cover at least half a page if your instructor requires you to print graphs. Click on the **Move Chart** icon in the **Location** box, then select **New sheet**. To keep your sheets well organized, you may wish to give the sheet a name indicating what information is on it. At the bottom of the screen, there are tabs currently named "Sheet 1", etc. When a chart is moved to a new sheet, it will appear as "Chart 1" unless you rename it. To switch between different sheets and charts, click on the desired tab at the bottom.
Show your instructor your graph on the computer monitor. *Make sure that the other students in your row have gotten through these steps successfully.*

As you shall see later, it is possible to determine the relationship between reaction rate and reactant concentration by plotting various functions of the concentration vs. time. For example, if the rate of reaction of N_2O_5 is linearly related to concentration then a plot of the natural log of the concentration vs. time should lead to a straight line. Return to the spreadsheet and build a column (in column C) with formulas such as **=ln(B2)** where **ln** refers to the natural log. **B2** refers to a cell, and I assume that your concentration data starts in cell **B2**. To make your new graph of natural log of the concentration vs. time, you again need to highlight the appropriate block of data. The x-values are still in column A, but now the y-values are in column C. Highlight the data in column A, then hold down the control key (or "open Apple" on a Mac computer) and highlight the data in column C. Follow the same directions as in the last exercise to create the graph (or chart).

At this point your graph violates a guideline on graphing. The y-axis goes from 0 down to -10, but the data only covers part of that range, from -5.96 to -8.11 Change the default y-axis scale by right-clicking

on a y-axis value, such as -4. Left-click on **Format Axis**, select **Fixed** in the Maximum: option, and change the maximum to -5 or -5.5 or something reasonable. While you are here you might as well change the minimum to a more reasonable value such as -8.5 or -9. Click **close**. Show this graph to your instructor. *Help your fellow students to complete these steps.*

Note that when we make graphs (or charts, as Excel calls them), we plot y versus x. Excel assumes that the data for the x-axis is in the first column that you highlight, and data for the y-axis will be in column(s) to the right.

GRAPHING EXERCISE # 2
Petrucci/Harwood/Herring/Madura, *General Chemistry* 9th ed., Problem 1.83 gives an equation which can be used to relate the density of liquid water to Celsius temperature in the range from 0 °C to about 20 °C:

$$d(g/cm^3) = \frac{0.99984 + (1.6945 \times 10^{-2} t) - (7.987 \times 10^{-6} t^2)}{1 + (1.6880 \times 10^{-2} t)}$$

In cell A1 enter "Temperature (°C)" and in cell B1 enter "Calculated density of water (g/cm3)"
To get the degree sign, select where you want the symbol to go, then in the **Insert** tab of the menu bar, find the **Symbols** box, and click on the **Omega** symbol. Scroll through the rows of symbols until you find the degree symbol and select it. Click **Insert** then **Cancel**.
In cell B1 highlight the "3" and format it as a superscript.
In cell A2 enter "0" and in cell A3 enter **=a2+1** or **=a2+.1**
Excel will convert the lowercase letters to uppercase. Copy the formula in cell A3 down the column until you calculate a value of 20.
In cell B2 enter the equation given in the textbook, replacing the variable *t* by **A2**, and remember to use *
when you wish to multiply. Copy cell B2 down column B as far as you have values in column A.
Make a graph with density on the y axis and show your instructor.
At what temperature is the density of liquid water a maximum? Hint: For this graph show both vertical and horizontal gridlines.

LAST EXERCISE
Make the Excel tables for the Determination of Density experiment found at
http://chemlab.truman.edu/CHEM130Labs/Density.asp

You can find a more complete set of directions for using Excel 2010 at
http://vpultz.sites.truman.edu/
The webpage shows how could calculate an average, and you could sum over multiple cells with a formula such as **=SUM(A2:B2)**.

References:
1. http://msdn.microsoft.com/en-us/library/ff700514.aspx accessed 12/27/2011;
http://news.office-watch.com/t/n.aspx?articleid=1408&zoneid=9 accessed 12/27/2011