

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 to 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 2013 which is installed on campus computers. Many other spreadsheets are logically very similar.

STARTING THE PROGRAM

On a Windows computer, go to the **Start** button, select **All Programs**, go to **Microsoft Office 2013**, and select **Excel 2013**. 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 million¹, 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**. (Lowercase letters also work; Excel converts them to uppercase letters. An 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. The formula still appears in the space between the tool bar and the body of the spreadsheet when cell C1 is selected, while the numerical result of that formula is displayed in the cell. You can 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). Then right click somewhere in the highlighted area and 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, but this is inefficient. Instead, place the cursor on cell **B1**. 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 or Ctrl-V to paste the formula. 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. Clear the contents of the cells used so far.*

GRAPHING EXERCISE # 1

Do not clear the contents of the cells used in this section.

The following data will be used to illustrate the ability of spreadsheets to make graphs.

Time, 10^3 s	[N ₂ O 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 table into Excel using cells A1 through B6. To get a superscript “3” type “Time, 103 s” and highlight the “3”. Then click on the arrow in the lower right corner of the Font box (on the HOME tab) on the menu bar, check the Superscript box, and click OK. Obtain subscripts in a similar manner. After you have entered both column headings, select both and click on Format (in the Cells group) and then select Auto Fit Column Width. Enter 2.57E-3 and the other concentrations exactly as written. How does Excel rewrite 0.87E-3 ? Note how Excel expects values written in scientific notation.

Highlight the block of data (0 to 0.30E-3) and go to the **INSERT** tab in the menu bar, and then find the **Charts** box. Select **Scatter (X,Y)** and choose 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. You should be at the **Design** tab of the menu bar. Move the chart to a new sheet by clicking on **Move Chart Location** and 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.

Label your chart: Click the “plus” button in the upper right corner of the graph/chart. Check the box for Axis Titles. Move the cursor to the x-axis title and type “Time, 103 s”. Press Enter and then select the “3” and go to the HOME tab, and in the lower right corner of the Font block, click Superscript. Enter the other axis title, remembering that axis titles are usually somewhat short. Enter a chart title which is not redundant. For this chart, “Check if Zero Order” would work; this will make more sense after we study chemical kinetics later in the semester. In most cases, you must 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. If “Series 1” appears on the graph as a legend, click on it to select it. Delete it by either right clicking and choosing delete or by simply hitting the “Delete” or “Backspace” key. Also delete the gridlines. 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.

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 N₂O₅ 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 Sheet1 and enter a column heading in cell C1. In cell C2 enter the formula =**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**. Copy the formula down column C. To make your new graph of natural log of the concentration vs. time, 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). A nonredundant title would be “Check if First Order.”

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** and change the Maximum to -5.5 or something reasonable. In some programs you may need to first choose Fixed or Manual instead of Auto. Make the minimum a reasonable value such as -8.5 or -9. Click **close**, if an option, or just click on the chart. Add a trendline with equation and R-squared displayed on the chart by doing the following. Click on Add Chart Element in the upper left corner of the screen. Move to Trendline and then More Trendline Options which you click. Check both Display Equation and Display R-squared. Save your file to the Y: drive. Show this graph to your instructor, and he may want to see all three graphs immediately before you leave.

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:

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

Start these manipulations on a new sheet, such as Sheet2.

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**. Use * to multiply. Remember how to enter numbers in scientific notation for Excel. Copy cell B2 down column B as far as you have values in column A.

Make a graph with density on the y axis. Show vertical gridlines every 1°C from 0°C to 20°C. Show horizontal gridlines also. Show your instructor the graph.

At what temperature is the density of liquid water a maximum?

LAST EXERCISE

Make the Excel tables (Figures 3 and 4) for the Determination of Density experiment found at

http://vpultz.sites.truman.edu/files/2017/09/Determination_of_Density_2017.pdf

You may wish to do this in a new file. Store this file on the Y: drive or your personal computer.

You can find more 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