Introduction to Spreadsheets

Spreadsheets are computer programs that were designed for use in business. However, scientists quickly saw how useful they could be for analyzing data. As the programs have become more powerful, scientists have found them to be more useful. They can help relieve the tedium of data analysis and let you quickly manipulate your data. They also have good graphing capabilities.

Here is an introduction to spreadsheets, Excel in particular, that covers their use in graphing data.

If you have not done so already, turn on the computer and the monitor (screen). If the cabinet is locked, ask your instructor or the lab technician to unlock it for you. Leave the cabinet door open whenever the computer is turned on. The computer needs fresh air to keep it cool. The keyboard shelf pulls out. Pull it until it latches in place. Move the mouse to the top of the cabinet.

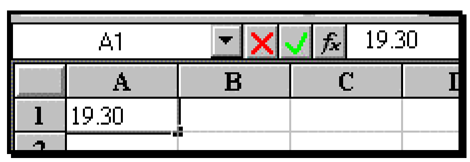
Start Excel

- Click the **Start** button, then **Programs**, then **Microsoft Excel**.

Enter the Data

The first step to use a spreadsheet is to enter the data into the sheet. Spreadsheets are designed so that data are entered in columns, like in Table 1 below. The data for this experiment were the mass of the crucible + lid, the mass of the crucible + lid + hydrate salt, and the mass of crucible + lid + anhydrous salt. We will start by entering the mass of the crucible + lid in the first column. Notice that the first column is labeled "A".

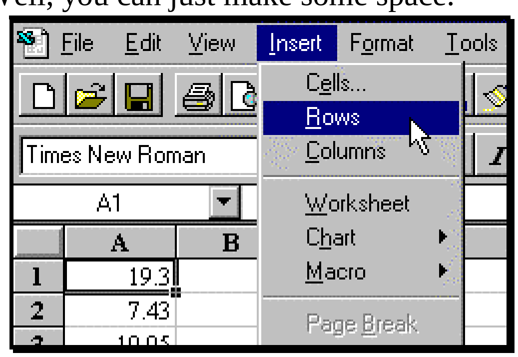
- The first cell in column A is called cell A1. It should be active. If it is not, make it so by pressing the arrow keys until cell A1 is outlined.
- Type **19.30**, the first mass and press the **<Enter>** key.



Notice that A1 is not the active cell any more. A2 is.

- Enter **7.43**
- Finish entering all the crucible + lid masses in Table 1.

Of course, it is always a good idea to label what the contents of a column are. Usually we do this at the top of the column, but you did not leave any space. Well, you can just make some space.



- Move back to cell A1 by clicking on cell A1.

Insert a blank row above the active cell (A1).

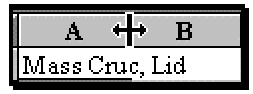
- Click on **Insert**, then **Rows**.

Now there is room for labels. Give the first column a label.

- Enter **Mass Cruc, Lid**.

You may have noticed that your column is too narrow for your heading. You can widen the column.

- Move the mouse cursor to the border between the "A" and "B" column labels so that the cursor changes from an arrow or plus to a two headed arrow.
- Drag the border to the right to make the column is wider.



Now you will enter the next columns of data.

- Label column B **Mass Cr, Lid, Hydr**. It should go in cell B1.
- Enter the masses of crucible + lid + sample in column B.
- Enter the mass of the crucible + lid + anhydrous salt in column C. Do not forget a label.

Your spreadsheet should look almost like Table 1.

Table 1:
Dehydration of Hydrated Cupric Sulfate

Mass Cruc, Lid (g)	Mass Cr, Lid, Hydr (g)	Mass Cr, Lid, Anhydr (g)
19.30	21.60	20.88
7.43	9.99	9.14
19.95	21.85	20.97
9.85	12.01	11.15
20.17	22.65	21.52
19.61	23.61	22.11
10.15	13.45	12.19
11.14	12.87	12.11
20.49	23.82	22.63
21.76	22.76	22.49

Save Your Work

- Click **File**, then **Save**.
- Type a *filename*, but do not press the **<Enter>** key. Your *filename* can be whatever you want the file to be called. The name may include letters, numbers, and spaces. It may include other characters, but some characters like * and \ may not be used.

If you have a diskette, you can save it on there. Click the box labeled **Save in**. Click on **3½ Floppy (A:)**.

- Click **Save**.

Remember, Remember, Remember!!!

Remember to save your work often. You can save it by clicking on the "Save" icon (it looks like a diskette). The old copy will be erased in the process.

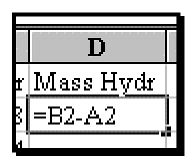
Analyze the Data

All the data have been entered into the spreadsheet (data is the plural of datum). Now you can begin the analysis. You will start by calculating the mass of hydrous salt used. Remember, you calculated this using the equation

(Mass of crucible + lid + sample) - (Mass of crucible + lid).

You will use the computer to do this calculation.

- Label column D **Mass Hydr**.
- Move to cell D2.



Now tell the computer how to calculate the mass of hydrate.

- Enter **=B2 - A2** Do not forget the **=**.

This tells the computer to look at cells B2 and A2 and use the numbers it finds there in the formula. You have calculated the mass of hydrate used in the first experiment.

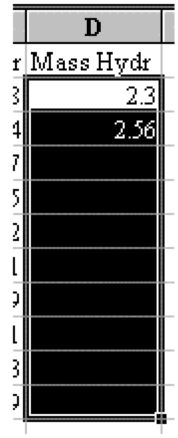
Let's calculate the mass from the second experiment.

- Move to cell D3.

Note that the data for the second experiment are in cells B3 and A3.

- Enter **=B3 - A3**

You could type the formulas into all the cells, but there is an easier way. All spreadsheet programs have the ability to "Fill" columns with patterned data (1, 2, 3, 4, . . . or 2, 4, 6, 8, . . . or 100, 100, 100, 100, . . . or Monday, Tuesday, . . .) or sequential formulas (B2-A2, B3-A3, B4-A4, . . .).



- Select the first cell with the formula in it (should be cell D2).
- Hold down the shift key and press the **<DOWN ARROW>** until you reach the last data row (should be cell D11). Release the shift key.

You have how selected the block of cells D2:D11 (cells D3:D11 should be dark, cell D2 should be outlined). You want to fill the whole block with the formula following the pattern established in the beginning of the block.

- Click **Edit,** then **Fill,** then **Down**.

You have calculated all the hydrated sample masses. Move to cell D4. Look in the edit field at the top of the screen. Notice how the program assumed that the cells it needed to use are in row 4. Move to cell D5. Now the cells in the equation are in row 5. When you entered "=B2 - A2" in cell D2, the computer interpreted "B2" to mean the cell two columns to the left (column B) and in the same row (row 2). It assumed you wanted this same relationship to hold in cell D4. Thus "B2" changed to "B4" - two columns to the left and the same row. "A2" changed to "A4" - three columns to the left and the same row.

In column E, calculate the mass of the anhydrous salts. We calculated this by subtracting the mass of the crucible + lid (in column A) from the mass of the crucible + lid + anhydrous salt (in column C). You could do this by typing in the formulas as before, or you could do it as follows.

- Type **=** (Do not press the <**Enter>** key yet.)
- Click the mass of Crucible, Lid, & Anhydrous salt for the first sample for the first sample. This should be in cell C2.
- Type **-**
- Click the mass of Crucible & Lid for the first sample. This should be in cell A2.
- Press the **<Enter>** key.
- Now fill the column as before. (**Edit/Fill/Down**)

One problem with your table is that there are no units given. Let's correct that problem now.

- Insert a row above the second row as you did earlier.

Now there is room for unit labels.

- Move to cell A2.
- Enter **(g)**
- Add units to the other columns. You can **Fill** these **Right** just like you did with the formulas.

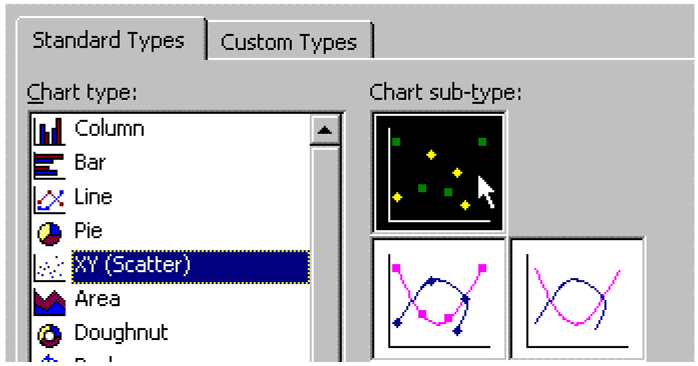
Calculate the mass of water lost in column F.

Graph the Data

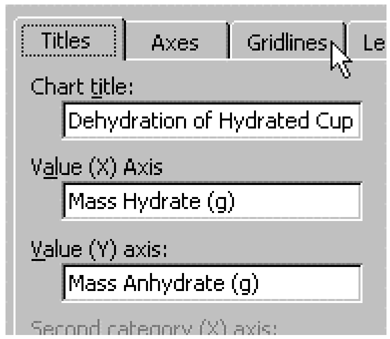
Let's make a graph of your results. Excel calls graphs "Charts."

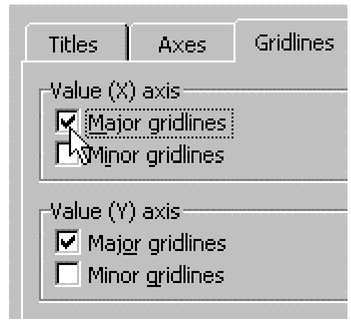
- Select the block with the x-axis data and the y-axis data. These would be the mass of hydrous salt and anhydrous salt in D3:E12. You can do this like before, or you can move the mouse cursor to the first cell (D3), and drag to the last cell (E12).
- Click **Insert,** then **Chart.**

Scientific graphs are often “XY” or “Scatter” graphs. In an XY graph, the scale along the x-axis is linear. **Be very careful to not use the “Line” graph!** The x-axis increments are not uniform in a Line graph.



- Click **XY(Scatter)**.
- You want to plot just the points, so click the first box.
- Click **Next**.
- Click **Next**
- Click the **Chart Title** box and enter a title for your graph.
- Click the **Value (X) Axis** box and enter the x-axis label. Do not forget units.
- Click the **Value (Y) Axis** box and enter the y-axis label.
- Click on the **Gridlines** tab.
- Click on **Value (X) axis Major gridlines** box.
- Click **Next**.
- Click **As new sheet**.
- Click **Finish**.

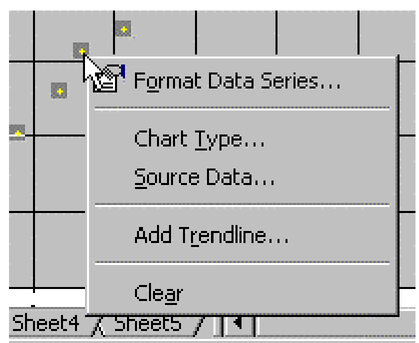




The computer plotted a graph for you.

Add Best Fit Line

You now have a nice looking graph. The only problem is that you do not have your best fit line on it. So, let's find the best fit line.



- Right-Click a data point. In other words, put the cursor point on a data point and press and release the RIGHT mouse button.
- Click **Add Trendline**.
- Click the picture of the function that best describes your data. Then click **OK**.

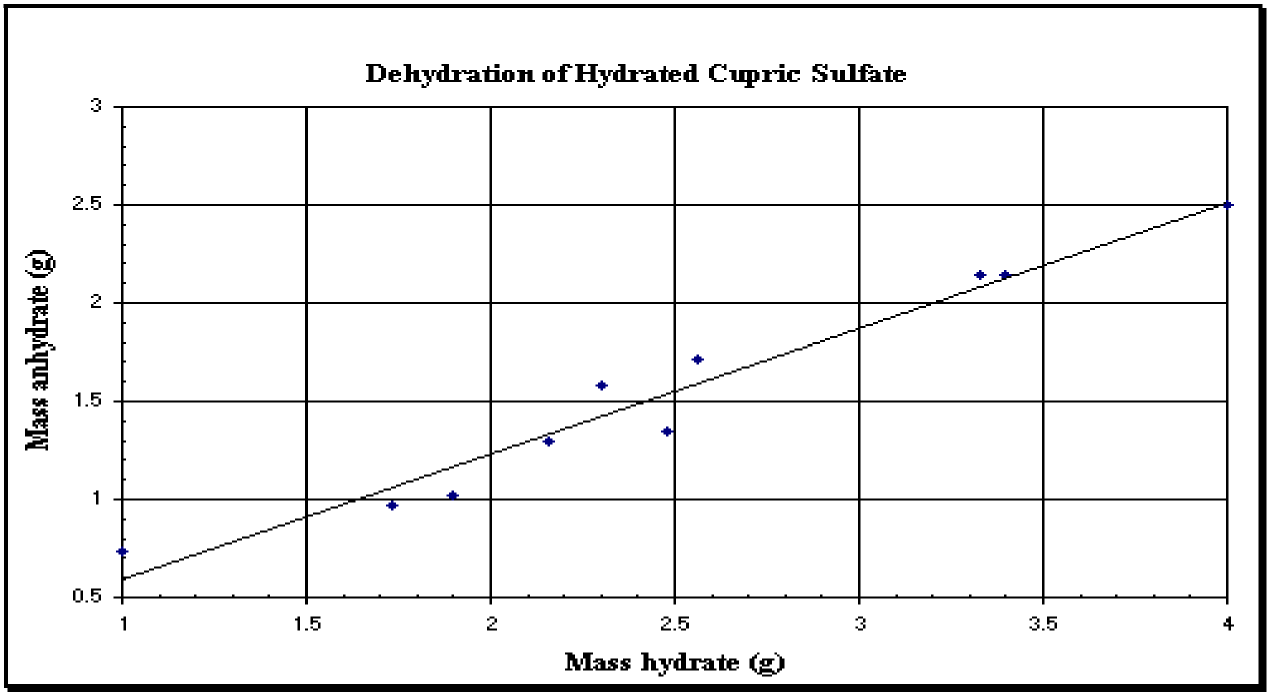
Admire your graph.

To change how something looks, right-click the thing you want to change. Many options are presented.

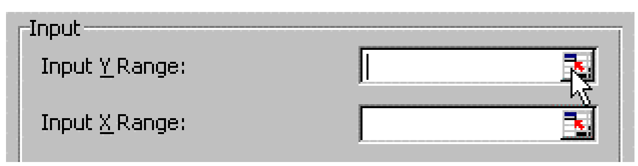
Find the Slope and Y-Intercept

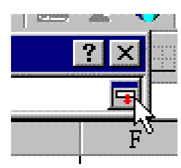
- Click the **Sheet1** tab near the bottom of the page to return to the data sheet.

Most spreadsheet programs can calculate the "best" straight line to fit data. They do this by calculating the linear least squares fit to the data. Any good statistics book can tell you about least squares fitting. The program also calculates some statistical values about the fit. This is called “regression analysis”. Spreadsheets usually bury the regression analysis commands under several menus. The software companies must think that they are very advanced. Here we go....



- Click **Tools**, then **Data Analysis**.
- {If **Data Analysis** is not an option under **Tools**, then it has not been installed. You may be able install it by clicking on the **Add-ins** option under **Tools**. Then click so there is a check mark next to **Analysis ToolPak**. Click **OK**. Now try clicking on **Tools**, then **Data Analysis**.}
- Click **Regression**.
- Click **OK**.
- Input the location of the y-axis data in the **Input Y Range** box. Since you probably do not remember where the y-axis data is, click on the go-to-spreadsheet icon in the **Input Y Range** window. Select the y-axis data from the spreadsheet, then click on the return icon.





- Input the location of the x-axis data in the **Input X Range** box.
- Tell the program to do the regression analysis by clicking **OK**.

The program has made a new sheet on which to record the analysis. Your data are still on Sheet1.

You can see the output of the regression analysis. To see some of the information you may need to use the <**Down Arrow**> to move lower on the sheet. Also, some of the columns are too narrow to read. The two numbers you are most interested in are the "Intercept Coefficient" which is the y-intercept, and the "X Variable 1 Coefficient" which is the slope. So, for this data the slope is 0.63 and the y-intercept is -0.03 g.

16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
17	Intercept	-0.033236558	0.125498989	-0.26484	0.797832	-0.32263793	0.256164817
18	X Variable 1	0.632971146	0.048041467	13.17552	1.05E-06	0.52218725	0.74375504

Regression Analysis

Let me briefly describe some of the other numbers that are listed. R Square (r^2) is the coefficient of determination. Multiple R is R Square's square root (r), and is the correlation coefficient. When r^2 is 1, then all the data points fall exactly on the best fit line. When r^2 is 0, then there is no correlation between the dependent and independent variables. In this case, if r^2 were 0, then there would be no relationship between the mass of anhydrous salt produced and the amount of hydrated cupric sulfate heated. R square gives the fraction of the variation in the mass of anhydrous salt that is due to the variation in the mass of the hydrated salt. Since r^2 is .956, this means that 95.6% of the change in the mass of anhydrate is due to the change in the mass of hydrate that was heated. 4.4% is due to something else (random errors perhaps?).

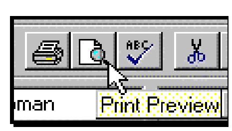
3	*Regression Statistics*	
4	Multiple R	0.977724776
5	R Square	0.955945738
6	Adjusted R Square	0.950438956
7	Standard Error	0.126520102
8	Observations	10

"Observations" is the number of observations. It is simply how many data sets you have. The "Standard Error" is not very useful to us. Its square is the sum of the squares of the vertical distances from the data points to the line. Least squares analysis involves finding the line that gives the smallest possible value for this number.

The "Intercept Standard Error" and "X Variable 1 Standard Error" (see above) are the standard deviations of the y-intercept and the slope respectively. They are a measure of how well you know that the slope calculated is the actual slope of the data. The "Lower 95%" and "Upper 95%" give the range of the y-intercept and slope in which it is 95% confident the actual y-intercept and slope of the data fall. So, in this case we can be 95% sure that the slope is between 0.52 and 0.74, assuming that there is nothing wrong with the data and that there is a linear relationship.

If you want more information about these values, you can find them all in a good statistics book. Your chemistry, biology, or math instructor may be able to help you understand them also. One thing to keep in mind is that none of these numbers tells you if the data really is in a straight line. You must always look at the graph yourself to decide this.

Print the Table



- To print a table of data, select the sheet the table is on by clicking on **Sheet1** tab.
- Click the **Print Preview** icon. It is near the top of the screen, the fifth from the left. The icon has a picture of a magnifying lens and paper. When the cursor is over the icon, a description of what the icon does will appear.

If it looks OK, click **Print**. If it is not right, then you can change it. For example, let's add solid column and row lines to our table.

- Get back to the spreadsheet by clicking **Close**.
- Select all the data including the labels.
- Right-Click the selected block.
- Click **Format Cells**.

You now have many, many options for changing how that block looks. You might want to come back here sometime and see what some of those options are. For now, let's get back to lines.

- Click the **Border** tab.
- Click **Outline** and **Inside**.
- Click **OK**.

You have added solid lines to your table. When you print your table, it will have those lines.

- Click the **Print Preview** icon.
- {You can change the header or footer by clicking **Setup**, then **Header/Footer**. You can change the orientation of the paper from portrait to landscape in **Setup** too.} If your table looks OK, click **Print**.
- Click **OK**.

Print the Graph

To print a graph, bring the graph back onto the screen.

- Click on the **Chart1** tab near the bottom of the screen.
- Click the **Print Preview** icon.
- When it looks right, click **Print**.
- Click **OK**.

Remember, Remember, Remember!!!

Remember to save your work often.

Download Lab Data

When data are already entered into a computer, it is usually not necessary to retype it. For example, the pooled lab data for this course is available online. It can be copied directly into a spreadsheet for analysis.

Start the browser.

- Click on the **Start** button in the bottom left corner of your screen.
- Click **Programs**.
- Click **Internet**.
- Click **Netscape Navigator**.

Go to the Lab Data Homepage

- Near the top of the page is a window labeled **Location:** with something like *http://www.tacoma.ctc.edu/inst_dept/science* in it. Click on the text in the window and type

http://www.tacoma.ctc.edu/home/phunter/labdata. Then press the **Enter** key.

or

- Click on **Bookmarks**, then **Lab Data Homepage**.

Call up the lab data.

- Click **View Data in Class Pool**.
- Select the experiment and section. There should be a table of data on the screen.

Save the data to disk.

- Click **File**, then **Save As**.
- Enter a filename. It is best if the filename ends with the extension ".htm".
- Click **Save**.

Close the browser.

- Click **File,** then **Exit**, then **Yes**.

In Excel, open the file you just saved.

- Click **File**, then **Open**.
- In the **Files of type:** window, select **All Files (*.*)**.
- Click on the file you just saved, then click **Open**.

All the data is now in your spreadsheet, ready for analysis. Don't forget to save your new spreadsheet.

- Click **File**, then **Save As**.
- Type a new filename, but do not hit the **Enter** key.
- In the **Save as type** window, select **Microsoft Excel Workbook (*.xls)**.
- Click **Save**.

Create a graph of mass of precipitate as a function of mass of sodium phosphate. To select the data for the graph

- Select the Mass of Na_3PO_4 data.
- Hold down the control key (<Ctrl>) and use the mouse to select the Mass of Ppt data by clicking on the first value and dragging to the last.
- Now release the control key.

Exit the program.

- Click **File,** then **Exit**.

To shut down the computer:

- Remove your diskette.
- Click **Start**, then **Shut Down**.
- Click **Yes**.

Remember to turn off the monitor (screen) and the computer. Tell the instructor or the lab technician that you are finished with the computer.