Unit 1 Uncertainties

There are always uncertainties involved in measurements and in calculations that involve measurements with uncertainties. There are also methods that can help reduce uncertainties of measure quantities.

One of these methods is to make multiply measurements of a quantity. From these measurements a standard deviation can be calculated. In appendix II of the lab manual this method is discussed and an example is shown. Many of the calculators can also perform a standard deviation. Break out the manual for the calculator and practice with the example in the back of the book there will be other labs where you will use the standard deviation and the calculator is a time saving device. Standard Deviation is a statistical function.
Below are a few examples for a few different calculators. In our example we will use the data from the manual on page 159.

TI-30 For most TI 30 models. Enter each data point by entering the number then pressing the Σ+ key. Once all the data points has been enter select 2^{nd} x^2 (i.e. $\bar{x}$) this is the average of the data. For the standard deviation (i.e.the σn-1 key) is 2^{nd} $\sqrt{x}$.

TI-82 .

TI-83 Begin by choosing the STAT button, then edit. Enter the data into one of the list L1-L6. Once the data is entered select STAT again then curso key this is the average of the data r over to CALC. and hit enter. Select OneVar and hit enter. Next select the list that you put the data into(2^{nd} 1-6 for L1-L6).The display should show OneVar L#. Hit enter again and the next display will show the calculations $\bar{x}$ is the average and Sx is the Standard Deviation.

TI-85 Begin by pressing the STAT button then F2(EDIT). Then enter twice to select xStat, yStat. To start everything fresh press F5(CLRxy) to clear out the information if any contained in these variables. Enter the data as the x variable for each data point leaving the y variable as 1. Once the last data point is enter press 2^{nd} M1 (CALC). Then enter twice to select xStat and yStat. We are interested in the 1-var calculation therefore enter F1. The value $\bar{x}$ is the average and Sx the standard deviation.

TI-86 Select OneVar from the Catalog menu. Then 2^{nd} List and F1 to get the symbol {. Enter the data follow each data point with a comma then 2^{nd} List F2 to get close the bracket. The display should look like OneVar {#,#,#,…#}. Hit Enter and the display will show the calculated values where $\bar{x}$ is the average and Sx is the standard deviation.

TI-89 You must first create a list by {#, #, #, # ….}STO→list name(for example L1). Looks like the following on the input line {#,#,#,#}→L1. Type in or choose from the Catalog, OneVar followed by the list name in our case OneVar L1 then enter. The display will show done when the calculation is complete To View the results type in or select from the catalog menu ShowStat then press enter. The average of the data is $\bar{x}$ and the standard deviation is Sx. The Operating System of the 89 has recently been upgraded and a new statistical package has been added free of charge access to the web page is at www.ti.com/calc/doc/ 89.htm a Graphlink cable(calculator to PC) with a current version of the graphlink software is required.

HP49G Press┌→5(STAT) .Single –var. F1 (Edit). Enter the data downward then to return to the previous screen press enter when in an empty cell. To display the results use the arrow buttons to cursor to _mean then select F3(√) and cursor over to _Std Dev. and select F3(√). Then F6 to display the selected results

This lab also deals with the propagation of errors during calculations. When calculating the Volume of a block V we multiply width x length x height. Each measurement has an uncertainty such that width is $w \pm \delta w$ where δw is the uncertainty in the width w. We also have measurements $h \pm \delta h$ for height and $l \pm \delta l$ for length. To calculate the uncertainty in the volume, δV, you would use Rule 2 as outlined on page 160 of the lab manual and shown below for this example

$$\delta V = V\left(\frac{\delta h}{h} + \frac{\delta w}{w} + \frac{\delta l}{l}\right)$$

Use the same principles from above to determine the uncertainty in density if D =mass/volume. Keep in mind the rule 2 applies for multiplication and division of measurements with uncertainties. Use $m \pm \delta m$ and $V \pm \delta V$ to determine δD

$\delta D =$