

## How to Extract Data for the Millikan Experiment

If you copy the double-entry list of mass/voltage data provided by Mr. White into a spread sheet, you are going to have to split the entry into two columns and do some other manipulations. Below is brief outline of how to do everything you need to do for a Google Sheet. The approach is similar for an Excel spread sheet.

- 1.) Paste double-entry data into Google Sheet, then go to Data and select “split text to columns” (I would put the first entry in the second row so you can use the first row later to label the columns)
- 2.) With all of the data highlighted, go to Format, then Number, and select “Scientific Notation”
- 3.) Create a column in which you determine “q” (put the equation into the top cell, then when it has done the calculation, put the arrow over the bottom right-hand area of the cell and a tiny downward triangle will show up. Clicking on the triangle and pulling it down will make each included cell do the same calculation)
- 4.) With the calculated-q column highlighted, go to Format, then Number, and select “Scientific Notation”
- 5.) As this column has calculated value in it, we have to detach the numbers from the equation that generated them (which is to say, we need to make those numbers into “values only” information). To do this, highlight the column (or, at least, the numbers in the columns), copy, then in a different column control-click on page (this is right-click) and select the “paste values only” option for the pasting
- 6.) If need be, select this new column, go to Format, then Number, and select “Scientific Notation”
- 7.) To see what your charge data looks like, select the “values only” column, go to Insert and select Chart (use the Column graph option). You should see a random arrangement of charge values
- 8.) To make sense of the randomness, highlight the charge (q) column, go to Data and select Sort Range. The window should identify the column you have highlighted. You want to order the data “from A to Z” (this should sort your numbers from lowest to highest—if it doesn’t, try the other option for sorting . . . “Z to A”)
- 9.) Make another Column chart. You should see very definite steps (if the chart is so spread out, select the first twenty entries in your sorted column and do a Column chart for that data—that should get rid of the higher order values, which you don’t really need in any case.
- 10.) You should now have four or five groupings on your chart. You have no idea how many charges are on the oildrops that are in the first grouping, but you know there is one elementary-charge-unit difference between that group and the next. So count the number of oildrops there are in the first group (actually count them off the graph) and in a new column, determine the average charge for the group (write “=average()”, with the column/row identifier for each of the charges you want summed inside the ()). Find the average q for the first four groups.
- 11.) Create a column in which the difference between each successive average is taken. You should find the values are very close to  $1.6 \times 10^{-19}$  coulombs.