Graphical Analysis: Plot and Linear Fit

Intro:

Graphical Analysis has a highly intuitive user interface. Many people can learn the program well enough simply by hacking - be brave and inquisitive with mouse clicks. Formal help can be obtained from the on-line HELP (PC version only), or Quick Reference Card (MAC version). All folks can profit from working the following tutorial. You should select options as you work, so your plot looks like the example below. GA is available at all campus computing sites (see notes at end). Menu items below are given for the PC version, and will vary slightly for MAC.

Sample Data Table:

Consider the following sample data set for current vs voltage for a resistor. We will type these data manually into GA, make a plot, then fit the data to a line.

Table 1. Current vs. Voltage for resistor.

Voltage (Volts) $(\pm 0.01)^1$	Current (Amps * 10^{-3}) $(\pm 4\%)^2$
0.10	0.99
0.20	1.85
0.30	2.86
0.40	3.75
0.50	4.48
0.60	4.85
0.70	5.98
0.80	6.26
0.90	7.43
1.00	7.58
1.10	8.39
1.20	9.17
1.30	9.52
1.40	9.89
1.50	10.15

1) least sig. digit of voltmeter.
2) estimate of wandering around of meter reading during measurement.

Note the format features of this table:

1. Descriptive title
2. Variable labels, units, and estimated error.
3. Notes to explain errors. Note that errors may not always be apparent during data collection.
4. Proper use of significant figures, according to precision.
5. Use of multiplier for current units, to supress extra zeros.

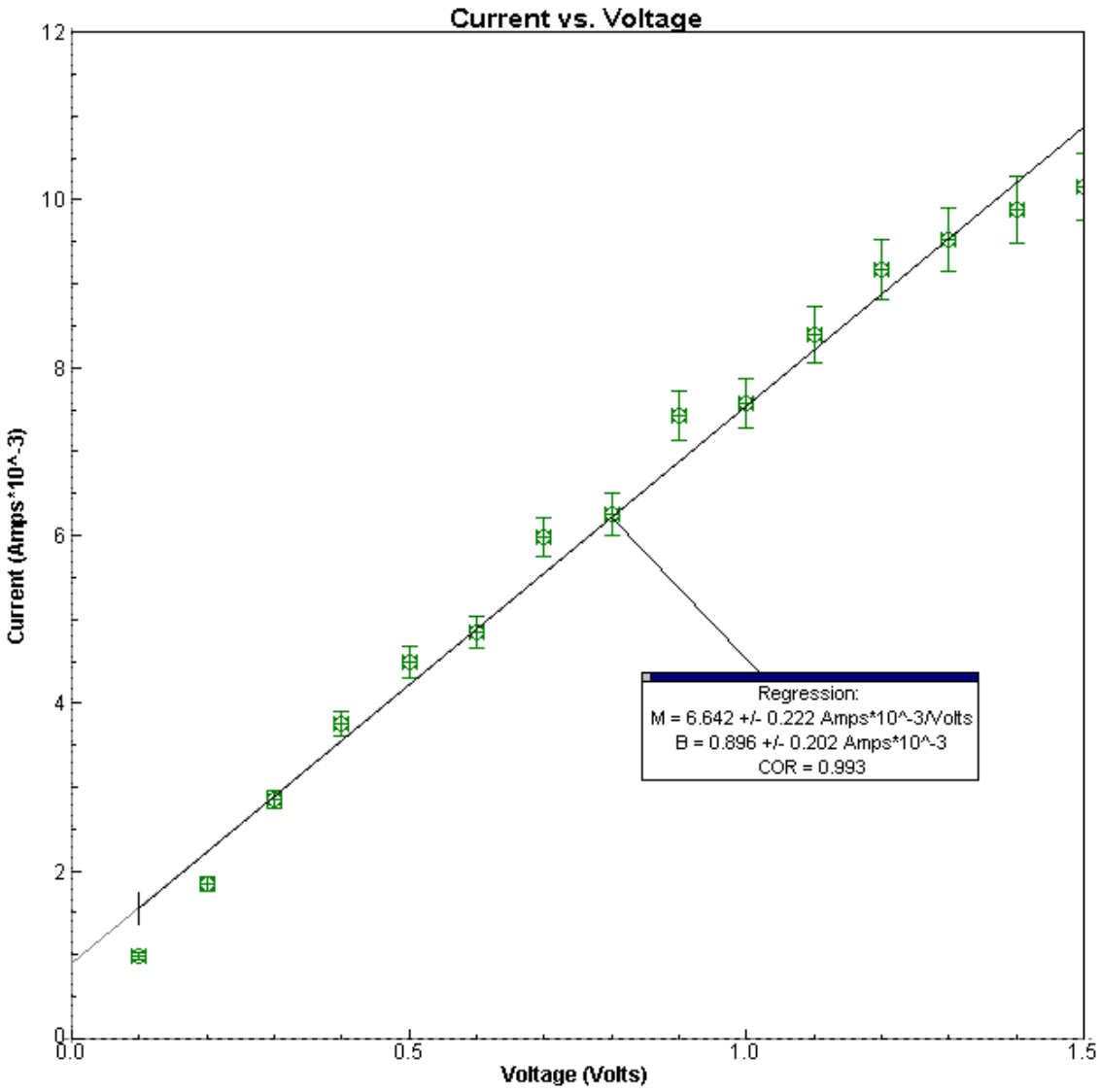
Technical note: These data originate from an EXCEL sheet, where the precision was set (2 digits), and cell borders were drawn. They were then copy/paste special into WORD as formatted text (RTF). A row was added at top to allow labels, with superscripts, etc. Also, individual numbers can be editted to suppress digits, round numbers, etc. This is very awkward in EXCEL.

Plot data:

There are many types of plot that can be used to present data sets, such as pie chart, polar plot, contour plot, etc. The most common is the "XY Scatter" plot, This suffices for all the experiments in this lab. It is the default type for GA.

Steps for plotting the data from Table 1. Choose options so your plot looks like the example below.

1. Open the GA program.
2. Enter the data values manually. They will appear in the plot window, too, for instant gratification and checking values.
3. Title: Click the title and give a more informative name.
4. Format columns: 2-click each column at its top to bring up options to: assign variable name, units, set rounding and error bars (absolute or percent). Note that you must tell GA what the error bars are, based on your experiment.
5. Format Symbols & Error bars: 2-click in the plot to bring up options: Normally, we will check (use) point protectors (symbols) and error bars and legend (if more than 1 data set), others are normally off. If error bars are very small, you might turn them off, but state clearly that the errors are smaller than the symbol or implied by multiple points. NEVER use connecting lines to join the dots!
6. Format Axes: Click the name of either axis to: choose which data to plot and to set scale limits. Autoscale works fine in this case.



Fit Line:

Theory suggests that these data should be describable by a linear function. Namely, Ohm's law states that the voltage drop V (volts) across a resistor R (ohms) is proportional to the current flow I (amps). Thus we have

$$V = IR \qquad \text{eq. 1}$$

Steps to do a linear fit with GA:

1. Select region of data to be fit – best done by dragging through points on the plot (only the X coordinate is sensed).
2. MENU \ ANALYZE \ REGRESSION. This will add the line to the plot, and show the statistics for the line including mean ± SD for slope (M) and

intercept (B), with units for each, if set already. You can position the dialog box or remove this fit using the drag bar (top) or close box (upper LHS).

3. Print a hardcopy by: FILE \ PRINT \ Chart, Table, All. Often the Plot only is the best option, since it gives a full page output, and the data table should be presented elsewhere, with proper formatting.

Data Analysis Programs:

We use 3 specialty programs for data analysis in PHY122 and PHY132:

1. Graphical Analysis (GA) – frequently
2. Science Workshop (SW) – sometimes
3. Data Studio (DS) – rarely.
4. EXCEL (XL) – optional.

Instructions for accessing them follow. In all cases, be sure to save your work to floppy or AFS space, and logoff properly! Students from either course (phy122 or phy132) can use either platform (MAC or Windows), in principle.

MAC

1. Logon with your asurite id and pw.
2. Open Desktop | Applications | Instructor Volumes | phy122
3. You may need to logon using user = phy122, pw = phy122.
4. Graphical Analysis is an icon you can open.
5. Data Studio is an icon inside the folder Data Studio. Ignore the "run me first" – it sets preferences.
6. Science Workshop ...

Windows

1. Logon with your asurite id and pw.
2. Open Desktop | Applications | Instructor Volumes | phy132pb.
3. Open phy132pb. It will mount "phy132" to the desktop (may be behind the window).
4. Graphical Analysis: click the icon for Gax.exe. Its ready.
5. Click Data Studio Setup (MSDOS). It is an autologon with pw. It mounts an icon on the desktop for Data Studio.
6. Open Data Studio icon. This may take 30 sec to produce the "Welcome" window.
7. Science Workshop ....