

Physics 26/27 Computer Lab

Introduction

You have at least two software options for analyzing your lab data and generating graphs with the help of a computer. This lab manual assumes the use of a graphical analysis program called *KaleidaGraph*, but you may choose to use *Excel* or some other similar program to achieve the same results. If you decide to use Excel, you may use the FitHaven templates from the *Data Analysis* book by William Lichten (this book can be purchased in the campus bookstore, but is not required for this lab). A special license agreement has been obtained from the publisher for UNC-CH physics students to use these templates, which can be downloaded free of charge from the introductory physics lab website:

<http://www.physics.unc.edu/labs>

Instructions for using the FitHaven templates are provided with the software, and therefore will not be discussed here. Consult your TA if you have specific questions about analyzing your data using Excel.

The computer lab for Physics 26 and Physics 27 is located in Phillips 245. (The graphical analysis program *KaleidaGraph* discussed here is also available on the Macintosh computers in the public student labs throughout campus). Room 245 is secured by a combination lock, for which your TA will give you the combination.

If you use the Macintosh computers in room 245, you will need a 3.5-inch floppy disk on which to store your work. The disk should be PC-formatted unless you plan to use it in another Macintosh computer. Items that you have stored on the computer's internal hard-drive are automatically erased when the computer is turned off.

Write it here so that you'll have it when you need it:

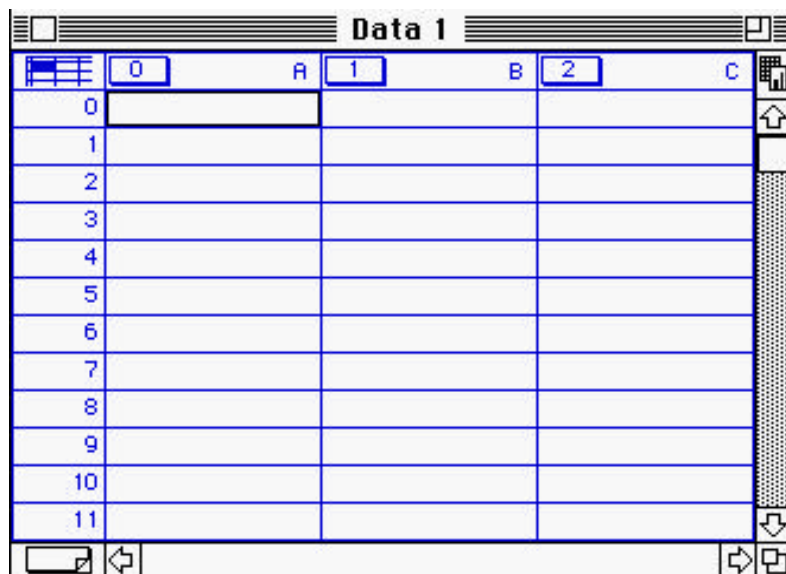
This computer facility is solely for use by students currently registered in a lab section for Physics 26 or Physics 27. Do not give the combination to anyone not registered for the course.

When you use the computer lab, you will need a 3.5-inch floppy disk on which to store your work. Items that you have stored on the computer's internal hard-drive are automatically erased when the computer is turned off.

Kaleidagraph Basics

When you start the KaleidaGraph program, two windows will appear on the screen: the formula entry window (which you can ignore for now) and a data window, shown below.

The data window consists of cells arranged in rows and columns. The rows and columns are numbered consecutively starting from zero. The first data cell, for instance, is located in Row Zero, Column Zero. Columns also have a title. By default, the column titles are A, B, C, D... for a new data window. Later we'll describe how to change the column title to something more related to your data.



Data Window

Entering Data

As an example of how to enter data and make a plot, here is a table of distance vs. time data for a moving object:

Time (seconds)	Distance (meters)
0.65	1.15
1.10	2.35
1.95	3.35
2.45	4.45
2.85	5.65

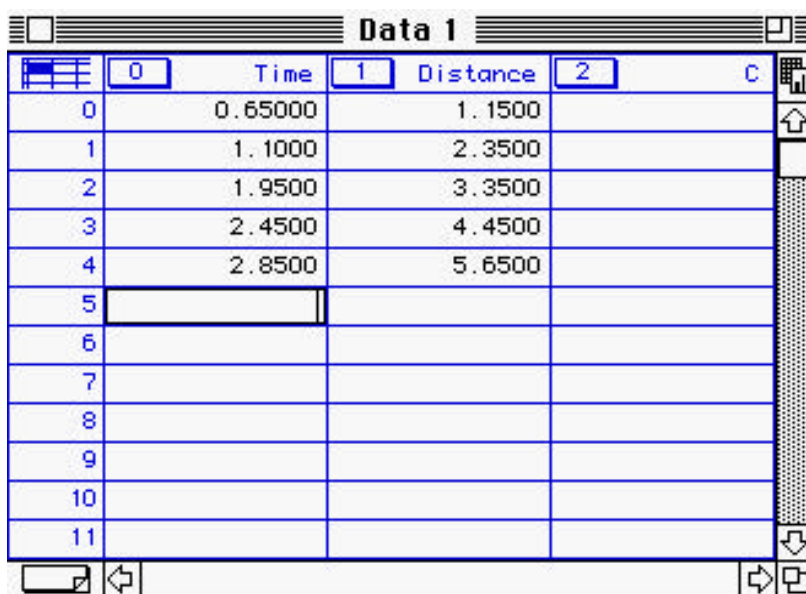
Enter the data in the KaleidaGraph data window, following a similar table format. All the values for a given parameter (time, for example) are entered in the same column.

1. Select the first data cell by clicking in the box in Row Zero, Column Zero.
2. Enter the first time value (0.65). Don't include units.

3. Move to the adjacent box in Row #0, Column #1 (use the mouse and click or simply use the → key) and enter the corresponding distance value (1.15).
4. Enter the next pair of time and distance values in row 1.
5. Repeat this procedure until you have entered all of your data.

Changing Column Titles

You can change the *text* titles of the columns from their default letters (A, B, etc.) to something more descriptive (e.g. Time, Distance). Do this by double-clicking in the topmost box of each column whose title you want to change. A dialog box will appear; simply type in the new title and click **Done**. Repeat this procedure for each of your data columns.



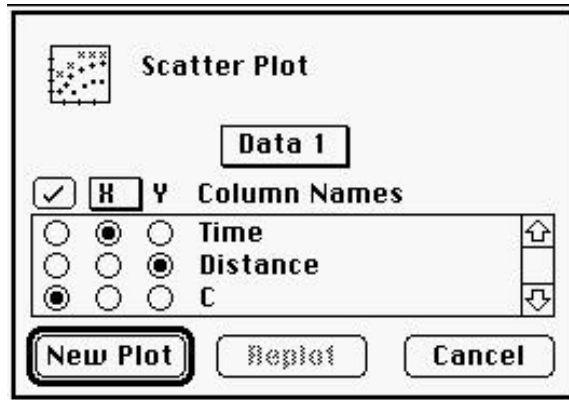
0	Time	1	Distance	2	C
0	0.65000	1.1500			
1	1.1000	2.3500			
2	1.9500	3.3500			
3	2.4500	4.4500			
4	2.8500	5.6500			
5					
6					
7					
8					
9					
10					
11					

Plotting Your Data

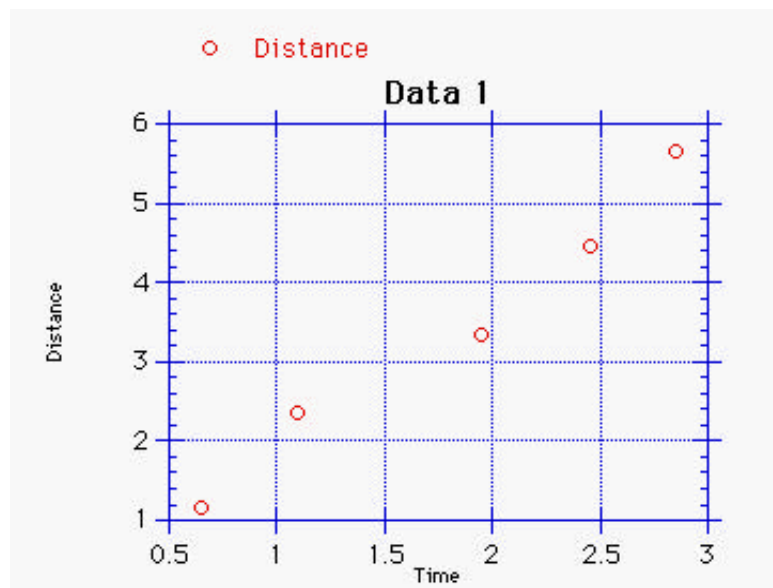
To plot this data, go to the **Gallery** menu and select **Scatter** from the **Linear** sub-menu, as shown below:



A Plot Variable Selection window will open, listing the column titles. Select X and Y variables for the plot by clicking in the appropriate buttons with the mouse.



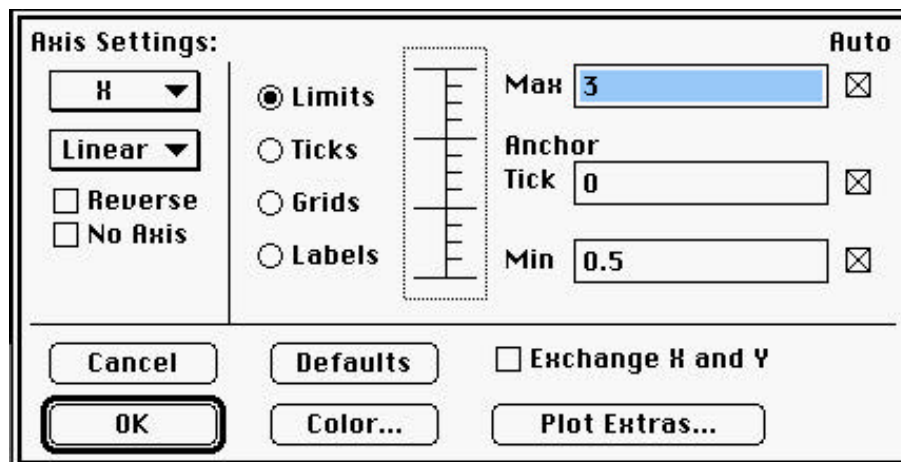
Click on **New Plot** and a scatter plot will be created:



Modifying Plot Axes

You can now modify the plot created if necessary. To change the axes to include the origin:

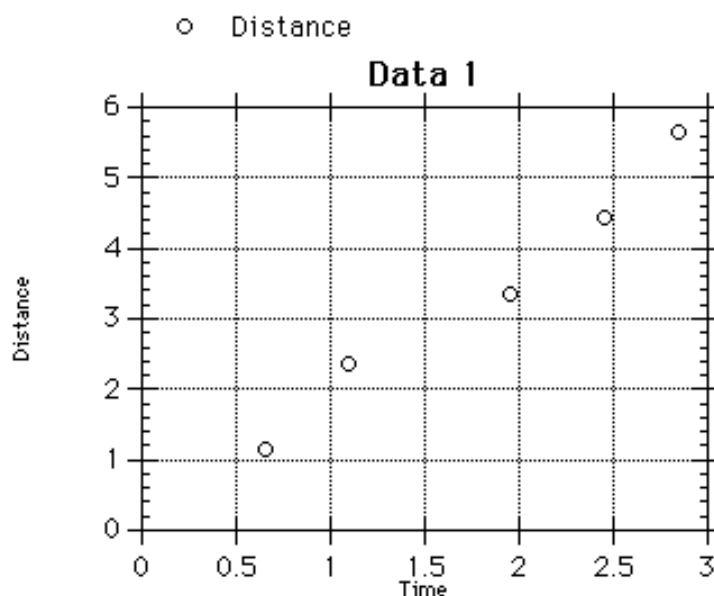
1. Select **Axis Options** from the **Plot** menu. The following dialog box appears:



Notice the dialog box appears with available options for the **X** axis.

2. Click in the button in front of **Limits** if it is not already darkened.
3. Change the value in the **Min** field from 0.5 to 0.
4. Select the **Y** axis in the pop-up menu under **Axis Settings**.
5. Again be sure the **Limits** option is selected and change the **Min** setting to 0.
6. Click **OK** and the plot will now show the axis changes you have made.

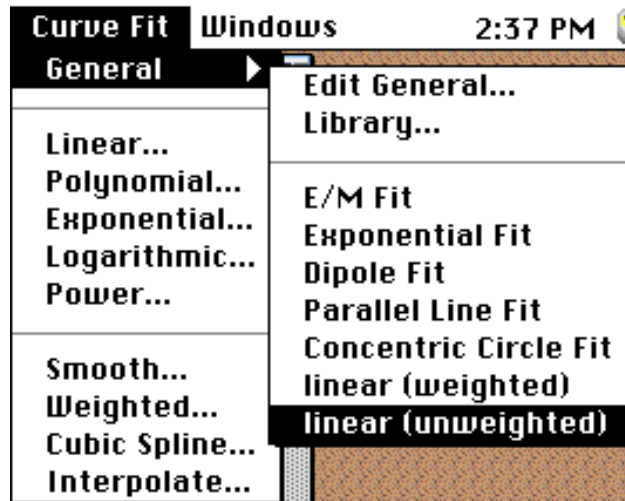
You can also change the spacing of tick marks, grids, and axis labels using the **Axis Options** selection from the **Plot** menu.



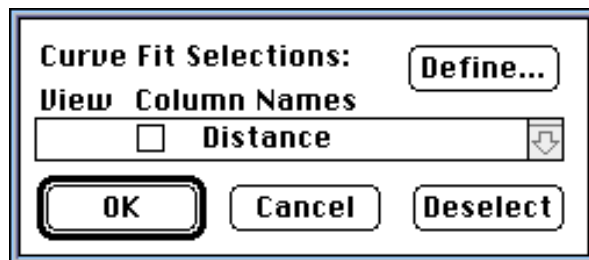
Curve Fitting

You will usually fit your data to a specified curve or equation specified in the lab manual. In this particular example, we will try fitting the data to a *straight-line* or *linear* curve fit.

1. Go to the **Curve Fit** menu, drag down to **General**, then to **linear (unweighted)**.



The following dialog box will appear:



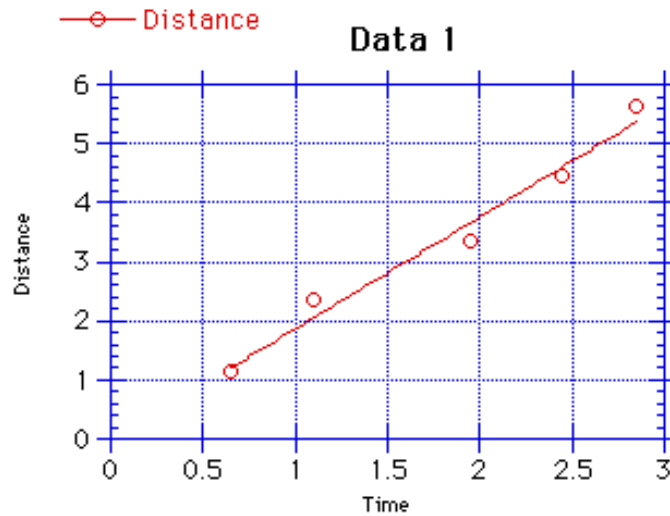
2. Click in the box for the Column named **Distance**.
3. Click **OK**.

- Check to make sure that the **Display Equation** option under the **Plot** menu has a check mark beside it, as shown below. If it is not checked, select **Display Equation** with the mouse. When this option is checked, the equation for the curve fit line will be displayed.



KaleidaGraph will calculate the least-squares straight-line or linear fit to the data and display the

y = m1+m2*m0		
	Value	Error
m1	-0.017143	0.33746
m2	1.8929	0.17062
Chisq	0.29343	NA
R	0.98803	NA



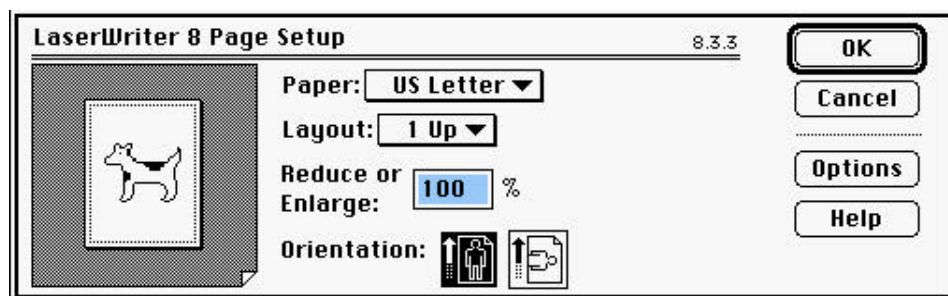
fitted line.

When KaleidaGraph does a curve fit, the independent variable (in this example, time) is called **m0**. The curve-fit coefficients are called **m1**, **m2**, etc. In this example of a straight line or linear curve fit, **m2** is the slope of the straight line, and **m1** is the y-intercept. The table shows the values for **m1** and **m2** and also gives a value of the “error” (uncertainty) associated with each as determined by the curve fitting procedure. The farther your data points lie off the best-fit line, the larger the “error” will be.

Printing

To print a copy of your plot:

1. Make sure that the plot window is active (foremost). Click on it if necessary to make it active.
2. Choose **Page Setup** from the **File** menu. The dialog shown below will appear. It also will appear the first time you print during a session.



3. Make sure the dialog is set to print at 100% size, with the orientation shown above. Click **OK**.
4. Choose **Print Graphics** from the **File** menu. A print dialog box will appear. Click **Print**.
5. Your plot will be printed by the laser printer located in Rm. 210.

Saving Your Data and Plot

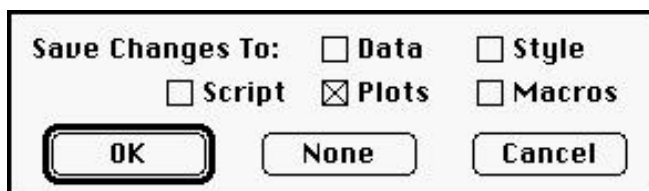
It's a good idea to save your work on a personal floppy disk.

1. Click on the plot window to make it active.
2. Select **Save Graph As...** under the **File** menu.
3. Insert a floppy disk. If the disk is new and unformatted, you will be asked to name the disk and format it. Be sure to choose PC format if you will later open this document on a PC.
4. Specify a name for the file that will be created on your disk. Click **Save**.

Your graph and the data associated with it will be saved on the floppy disk as a KaleidaGraph file.

Quitting KaleidaGraph

When you are finished, select **Quit** from under the **File** menu. The following dialog box will appear asking if you want to save your work.



If you have already saved your work to a floppy disk, click **None**.

If you need to save your work at this point:

1. Make sure the **Plots** box is checked. You do not need to save your data separately if you have plotted it; the data will be saved along with the plot. If you have entered your data but have not yet plotted it, then you should check **Data**.
2. If the **Style**, **Script**, or **Macros** boxes are checked, uncheck them.
3. Click **OK**.
4. Insert a floppy disk. If the disk is new and unformatted, you will be asked to name the disk and format it.
5. Specify a name for the file that will be created on your disk. Click **Save**. After saving your work to the floppy, the KaleidaGraph application will quit. To restart it, either double-click on the Plot file that was saved on your floppy or select KaleidaGraph from the menu.

Before You Leave

When you have finished using the Macintosh, quit any program that is running (select **Quit** under the **File** menu or type **⌘-Q**). Then turn the computer off by selecting **Shut Down** from the **Special** menu. The computer will take a minute or so to reset and turn off.

Opening a Previously Saved Plot File

To resume working on a plot or data that you have previously saved:

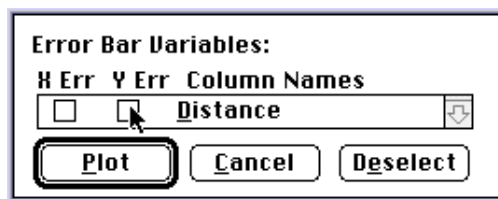
1. Insert the floppy disk with your saved plot file.
2. Double-click on the plot file. KaleidaGraph will launch and display your plot.
3. To display the data window containing your plotted data, click on the Data Icon located in the upper right hand corner of the plot window, shown below.

Adding Error Bars to Graphed Data

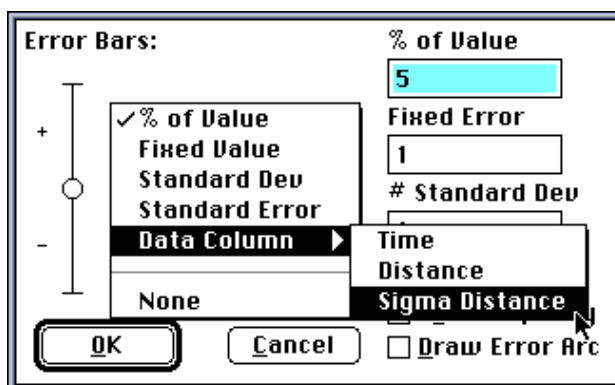
To add error bars to a graph, use a new column to enter the error or uncertainty associated with each data point. In the example below, the values of uncertainty associated with each distance in column 1 have been entered in column 2 (Sigma Distance).

	0	Time	1	Distance	2	Sigma Dist
0		0.65000		1.1000		0.050000
1		1.1000		2.3000		0.10000
2		1.9500		3.3000		0.10000
3		2.4500		4.4000		0.20000
4		2.8500		5.6000		0.20000
5						

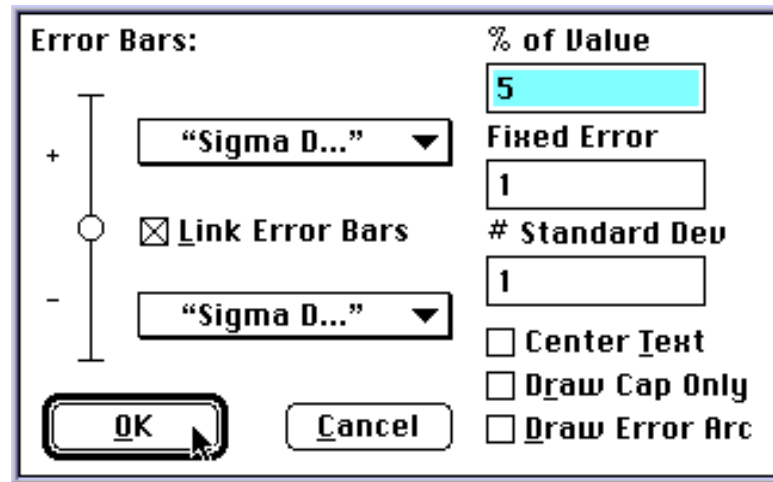
1. Select **Error Bars...** from the **Plot** menu.
2. Choose the **Y Err** selection.



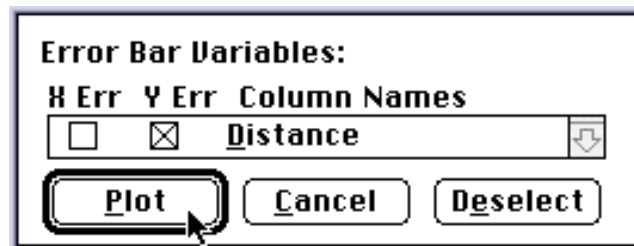
3. Select the data column containing the uncertainty or error in the y-axis data.



5. Select **OK** after selecting the appropriate column.



6. Select **Plot** to add the error bars to your existing graph.



When you are finished, your graph should look something like the one below.

