Logger *Pro*™ Tutorials

Version 1.1
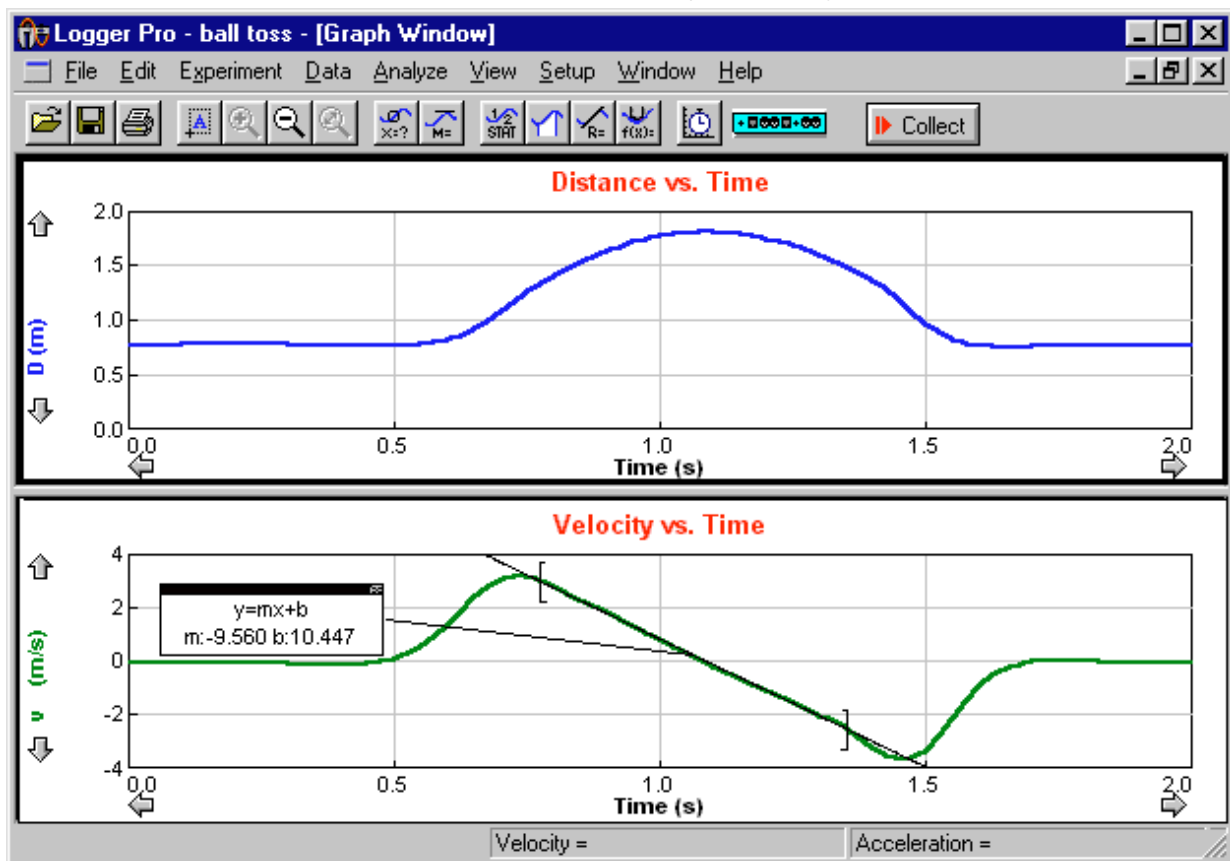
3/04/99

Logger *Pro* Tutorials

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Tutorial Overview

Purpose of tutorials

The Logger *Pro* package includes six short tutorials for first-time users, either students or teachers. They are suitable for reference or for duplication and distribution to classes. First-time users should work through one introductory tutorial and the advanced tutorials as needed.

The tutorials are bound separately from the manual for easy duplication.

Introductory tutorials

The first two tutorials, Temperature Measurement and Motion Detection, are both introductions to using Logger *Pro*. Temperature Measurement can be used by all students, while Motion Detection is intended for physics or integrated science students.

Advanced tutorials

The remaining tutorials are intended to be read after either of the first two tutorials are completed, and provide instruction on performing specific tasks with Logger *Pro*. These tasks include

- analyzing data and changing what is graphed
- fitting curves to data
- saving files and printing or transferring data
- creating new columns for data

The advanced tutorials can be done in any order.

Preliminary setup

The tutorials assume that Logger *Pro* has been installed and an interface (a ULI or Serial Box Interface) is properly connected to the computer. Installation instructions are located in the Teacher's Guide.

Tutorial: Temperature Measurement
with Logger *Pro*

About the tutorial

This tutorial will show you how to make simple measurements using a temperature probe and Logger *Pro*. You will also learn to perform some basic analysis of those data. You may never need to learn more about Logger *Pro*, but advanced users will want to explore the menus and the How To section to make the best use of the program's capabilities.

Verify the equipment setup

First, check to see that you have all of the equipment and software needed. You should locate these items:

- Macintosh or PC running Windows®
- Logger *Pro* software icon on your computer
- Universal Lab Interface (ULI), or a Serial Box Interface, with 9V power supply and serial interface cable.
- Direct-Connect Temperature Probe or a Standard Temperature Probe, plugged into DIN 1 of the ULI or Port 1 of the Serial Box Interface.
- 2 cups, one with hot and one with cold water

The interface

The interface converts the signals from the temperature sensor to a form that the computer can read. Be sure that the green light is on. The interface cable should already be connected to your computer.

Logger *Pro*

Logger *Pro* is the software that controls the interface and displays the results of the temperature sensor measurements. The remaining instructions will teach you to work with Logger *Pro*.

Start Logger *Pro*

▸ Using the method appropriate for your computer, start the Logger *Pro* application. (Double-click on the Logger *Pro* icon, or select Logger *Pro* in the Start Menu.)

You should see a screen like the one shown below. If not, then Logger *Pro* is having trouble communicating with the interface. Be sure the interface is getting power so that the green light of the interface is on, and that the serial cable is plugged into both the computer and the interface. Try starting again.

Screen elements
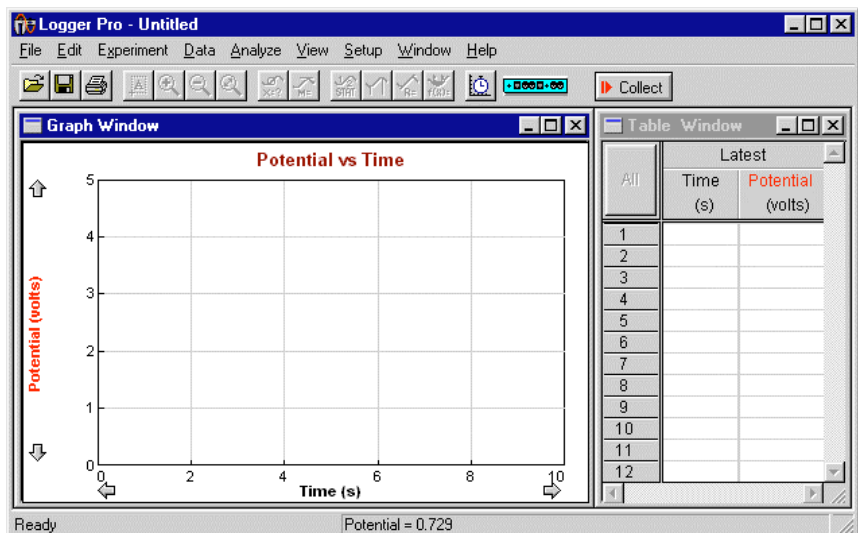
The Logger *Pro* screen contains, from top to bottom, the following major elements: the menu bar, a toolbar containing the collect button, a graph window, a data window, and a status bar.

‣ Choose Open from the File menu.

‣ Choose the file *Temperature Tutorial*[1] from the _Tutorials[2] folder and click on Open.

Open experiment file
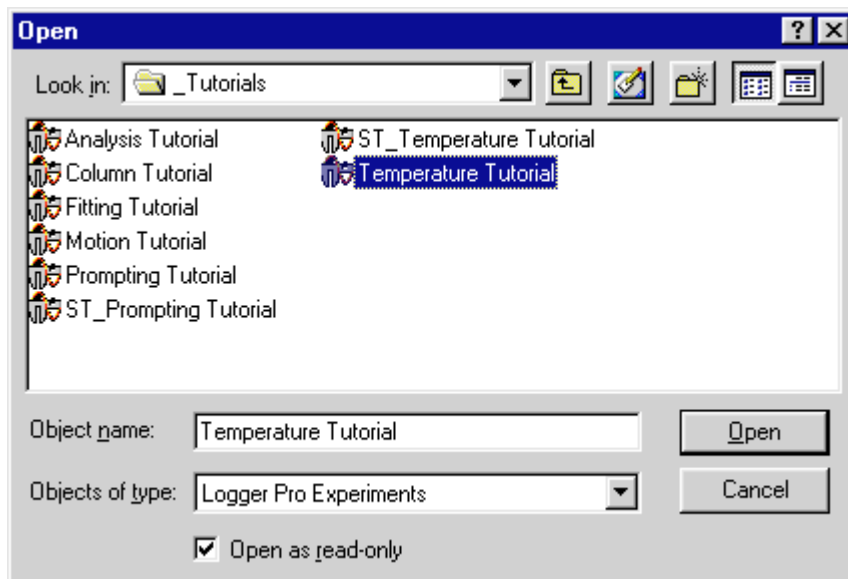
‣ You may be prompted to save your data; for now, click on the No button to load the new file without saving.

The Logger *Pro* screen will look like this after you click OK to dismiss the experiment note:
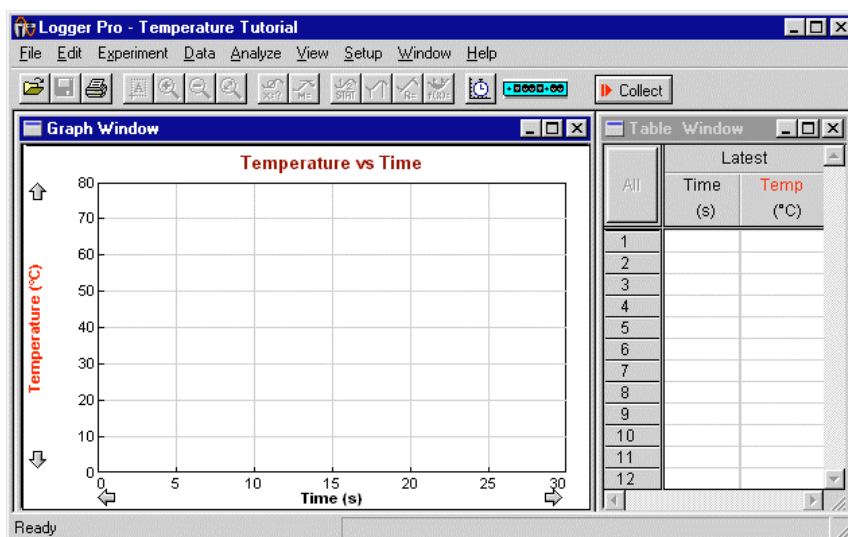
Start data collection

‣ Click on the Collect button on the Logger *Pro* screen.

Keep the temperature sensor sitting on the table, away from warm things like the computer. What's the room temperature? Now breathe on the sensor and watch the temperature rise. After 30 s data collection will stop. You can click on the Collect button again to discard the current run and take more data.

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[1]If you are using a Standard or Quick Response Temperature Probe (with a box in the cable) rather than a Direct Connect Temperature Probe (no box) then instead open the file *ST_Temperature Tutorial*.

[2]In Windows 3.1 you will generally see only the first six characters of the full folder or file name, *e.g.*, _TUTOR~1 for the _Tutorials folder.

Measure temperature of hot water

▸ Fill a cup with hot water and another with cold water.

▸ Click on Collect.

As data are being collected,

▸ place the sensor in the hot water to measure the temperature. Allow Logger *Pro* to complete data collection.

Notice that the sensor does not read the new temperature instantly; it takes a little while to respond. This is a characteristic of the sensor. About how long does it take for your sensor to stabilize at the water's temperature?

Store run

When you get a useful run, you will often want to preserve it for comparison to subsequent runs. To store your current run, choose Store Latest Run from the Data menu. These data will be preserved when you collect additional data. (Note: This action does not, however, save the data to disk. You do that using the file menu.)

▸ Once Logger *Pro* stops taking data, store your last run.

Measure temperature of cold water

▸ Start data collection while the sensor is still in the hot water.

▸ Move the sensor into your cold water after a few seconds of data have been collected, and allow Logger *Pro* to complete taking data.

What is the temperature of your cold water?

Prompted data acquisition— taking discrete data points

Sometimes when you take data with Logger *Pro* there is some information that you want to enter about each measurement. For example, suppose you want to measure the temperature of a water sample as you add warmer water. You might stop, stir, and measure the temperature after every 10 mL-addition of water. *Prompted* data acquisition allows you to enter the volume of added water, and even to graph it. Here's an example of using prompted data acquisition. Don't be terribly careful about the water quantities below; the goal is to see how Logger *Pro* works in this mode, not to do a careful scientific experiment.

▸ Open the experiment file *Prompting Tutorial,* found in the Tutorial folder[3].

▸ You may be prompted to save your data; for now, click on the No button to load the new file without saving.

▸ Fill a cup about halfway with cold water.

▸ Click on Collect.

Notice the Keep button that appears next to the Stop button:

▸ Put the temperature sensor in the water, and stir.

You can see the temperature reading in the status bar, but the value won't be recorded just yet.

▸ Once the temperature reading is stable, click on Keep to have Logger *Pro* record it.

Notice that Logger *Pro* is now prompting you for the volume of added water in the region just right of the Stop button.

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[3]If you are using a Standard or Quick Response Temperature Probe, use the file *ST_Prompting Tutorial* instead.

> ‣ Type **0** (zero) in the region right of the Stop button and press Enter.

> ‣ Add about 10 mL (or a half-centimeter or so) of hot water to your cup, and stir with the temperature sensor for a few seconds.

> ‣ Click on Keep, and type **10** for the approximately 10 mL water you just added.

> ‣ Keep adding hot water in ~10-mL steps, stirring and recording the new temperature once the value stabilizes. For the second addition enter 20 for the water volume, which is the *total* volume you added since starting the experiment. Then repeat for 30, 40, and 50 mL.

> ‣ Click on Stop to end data collection.

Notice that you now have a graph of water temperature as a function of the volume of added water. You entered the water volume, and time is not displayed at all.

Quit Logger *Pro*

To quit Logger *Pro*,

> ‣ choose Quit or Exit from the File menu.

You will be prompted to save your data; for now, click on the No button to quit without saving.

Tutorial: Motion Detection with Logger *Pro*

About the tutorial

This tutorial will lead you through making simple measurements using the Motion Detector and Logger *Pro*. You may never need to learn more about Logger *Pro* and the Motion Detector, but advanced users will want to explore the menus and the How To section to make the best use of Logger Pro's capabilities.

Verify the equipment setup

First, check to see that you have all of the equipment and software needed. You will need to find these items:

- Macintosh or PC running Windows

- Logger *Pro* software icon on your computer

- ULI, or Universal Lab Interface, with 9V power supply and serial interface cable. The Serial Box Interface cannot be used with this tutorial.

- Motion Detector plugged into the telephone-style Port 2 of the ULI

- meter stick

The Motion Detector

The Motion Detector is used to measure the distance from itself to a target object. It emits ultrasonic pulses and detects the echo from the target. The usable range of the Motion Detector is about 0.4 to 6 meters.

The ULI

The ULI is an interface which converts the signals from the Motion Detector to a form that the computer can read. Turn on the ULI, and be sure that the green light is on. Connect the Motion Detector to Port 2.

Logger *Pro*

Logger *Pro* is the software which control the ULI and displays the results of the Motion Detector measurements. Much of the remaining instruction will teach you to work with Logger *Pro*.

Set up the Motion Detector

▸ Place the Motion Detector on your desk or table with the gold disk pointing upward.

Be sure that there are no obstructions above the Motion Detector (the ceiling is OK!) or closer than 0.5 m to the side. You will soon use your hand as the moving target for the Motion Detector.

Start Logger *Pro*

▸ Using the method appropriate for your computer, start the Logger *Pro* application.

You should see a screen like the one shown below after you dismiss the experiment note by clicking OK. If not, then Logger *Pro* is having trouble communicating with the ULI. Be sure the ULI is turned on, plugged in, and the serial cable is plugged into both the computer and the ULI. Try starting again.
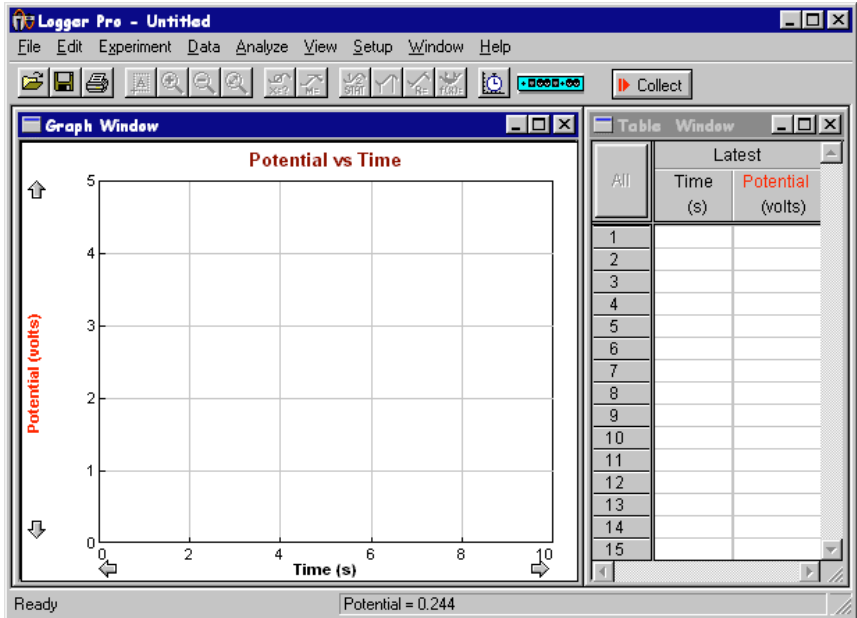
Open an experiment file

▸ Choose Open from the File menu.

▸ In the file list that appears choose the file *Motion Tutorial*[4] from the _Tutorials folder and click on Open.
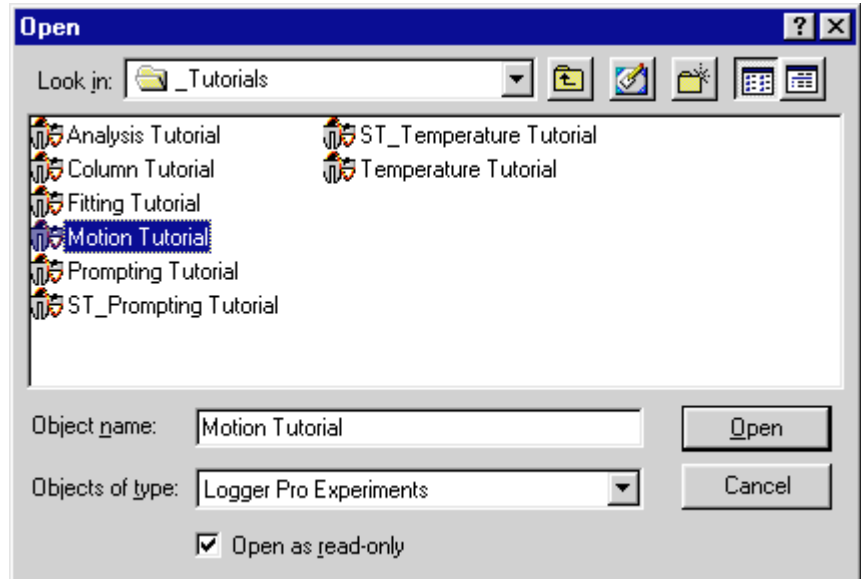
▸ You may be prompted to save your data; for now, click on the No button to load the new file without saving.

By opening this file you are loading a particular configuration for Logger *Pro* so that it's ready to take data with the Motion Detector.

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[4]In Windows 3.1 you will generally see only the first six characters of the full file or folder name. For example, *Motion Tutorial* will appear as MOTION~1.MBL.
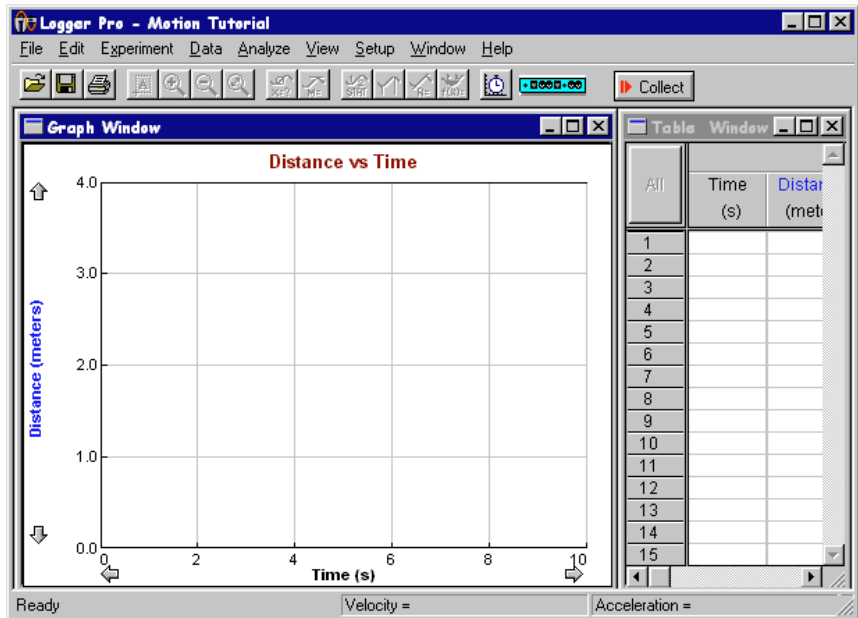
*Logger Pro*

Screen elements

The Logger *Pro* screen contains, from top to bottom, the following major elements: the menu bar, a toolbar containing a collect button, graph and data windows, and a status bar.

Start data collection

For your first measurement with Logger *Pro* and the Motion Detector, how about seeing how high the ceiling is above you?

▸ Click on the Collect button on the screen.

You may hear a clicking sound from the Motion Detector—that is normal. Observe the graph that is being drawn. Logger *Pro* will take data for ten seconds. You should see a graph like this one (you may need to click on the Autoscale button to bring the line on scale):
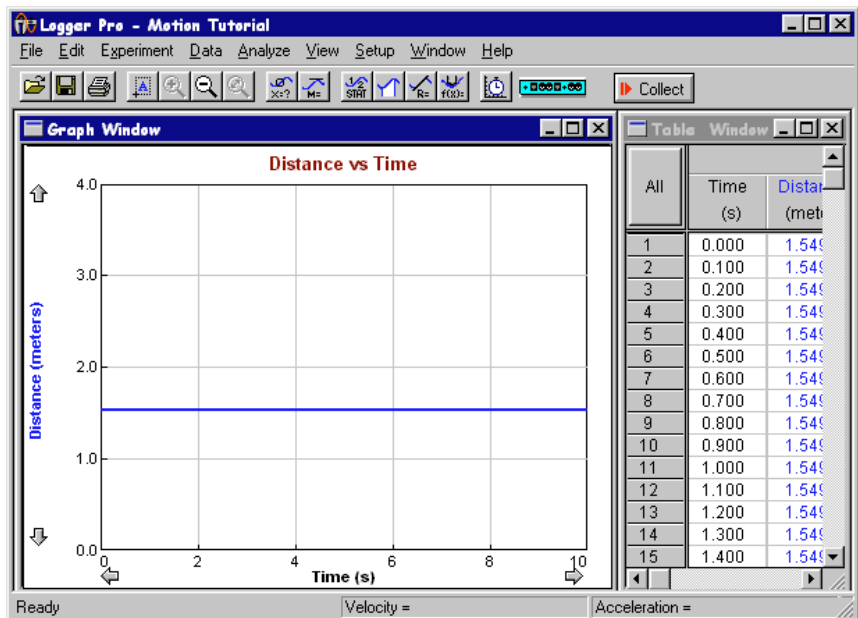
In this case it shows that the ceiling is about 1.5 m above the Motion Detector, and that it isn't moving. On your graph, the vertical axis is distance, and the horizontal axis is time.

‣ Check to see that the distance reported makes sense, and verify it with a meter stick.

If the Motion Detector measurement is noisy or obviously wrong, then you've got some other object in the way of the Motion Detector. It's possible that the Motion Detector is reporting the distance to a light fixture, so try different placements on the table.

As data are gathered, the graph line extends to the right in real time. Data collection will stop once the right side of the graph is reached, or sooner if you click on the stop button. In the future you will want to use this real-time feature to help you connect an object's motion to its graphical representation.

‣ Now hold your hand steady about a meter above the Motion Detector and click on the collect button.

The data you gathered on ceiling position will disappear, and now the position of your hand is recorded.

‣ Before data collection stops, move your hand up and down a bit to see how the graph responds. Don't get closer than 40 cm to the detector[5].

You should see something like this:
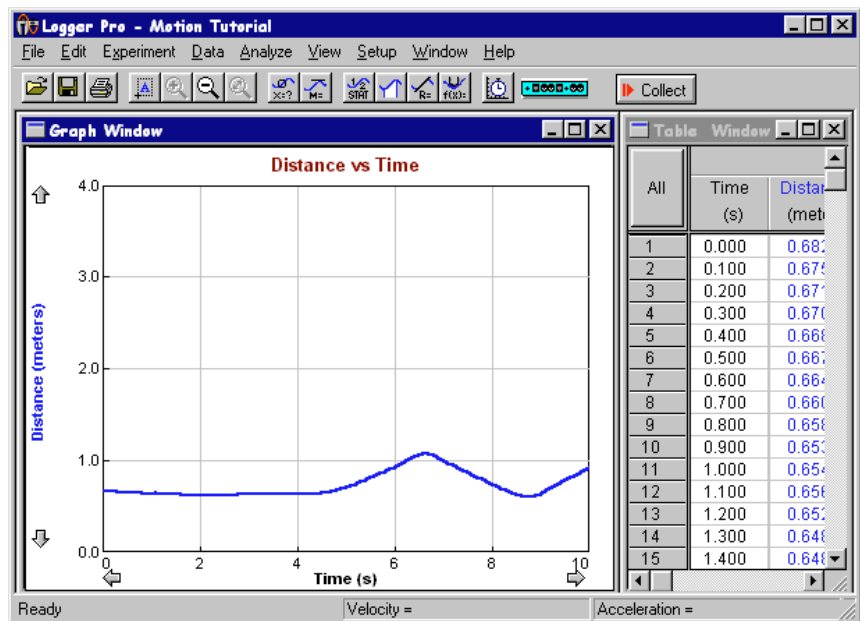
Can you point to the place on the graph when your hand was farthest from the Motion Detector? How about the closest? For the sample screen shown here, the times of farthest and nearest position are about 0.60 m and 1.08 m, respectively. Note that if you pull your hand away from the Motion Detector, the Motion Detector records the ceiling position instead. The distance to the nearest object in front of the Motion Detector is always reported. If you click on the Autoscale button the graph will rescale and make it easier to read the values.

Store run

When you get a useful run, you will often want to preserve it for comparison to subsequent runs. To store your last run, choose Store Latest Run from the Data menu. Those data will be preserved when you

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[5]If the Motion Detector's target gets closer than about 40 cm, the reported distance will probably be wrong. You might try an experiment to see how close you can get to your detector and still get useful data.

collect additional data. This action does not, however, save the data to the hard disk or a floppy disk. If you quit Logger *Pro* without explicitly saving, the data will be lost.

▸ Store your latest run by choosing Store Latest Run from the Data menu.

▸ Take another run of your hand motion, and see how it compares to your last run.

Can you exactly match your stored motion? It's hard!

Displaying velocity and acceleration

Logger *Pro* can also display the velocity and acceleration of the detected object. Click on the y-axis label, and you will get this dialog:
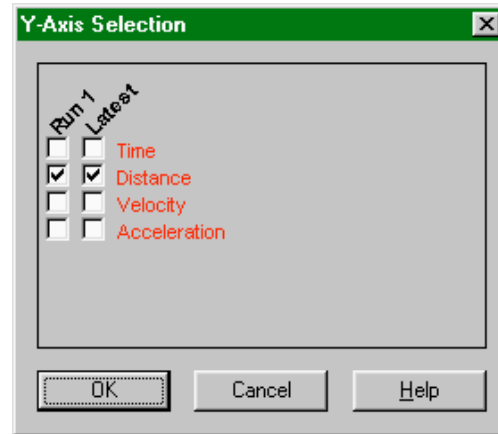
To display the velocity and acceleration plots, check the items in the list and click on OK. It is easy to make a complicated and hard-to-read graph, so deselect any runs or columns you do not want to see.

Some tips for using the Motion Detector

• In using the Motion Detector, it is important to realize that the ultrasound is emitted in a cone about 30º wide. Anything within the cone of ultrasound can cause a reflection and possibly an accidental measurement. A common problem in using Motion Detectors is getting unintentional reflections from a desk, chair, or computer in the room.

• If you begin with a velocity or acceleration graph and obtain a confusing display, switch back to the distance graph to see if it makes sense. If not, the Motion Detector may not be properly detecting the target.

• The Motion Detector does not properly detect objects closer than 0.4 m. The maximum range is about 6 m, but stray objects in the wide detection cone can be problematic at this distance.

• Sometimes a target may not supply a strong reflection of the ultrasound. For example, if the target is a person wearing a bulky sweater, the resulting graph may be inconsistent.

• If the velocity and acceleration graphs are noisy, try to increase the strength of the ultrasonic reflection from the target by increasing the target's area.

Quit Logger *Pro*

You've now learned how to gather motion data using the Motion Detector with Logger *Pro*. Other tutorials will show you how to analyze your data, to fit curves to the data, to save and print your data, and to define new columns for data.

▸ Quit Logger *Pro* by choosing Quit or Exit from the File menu. Do not save any changes.

Tutorial: Analyzing Data

Once you have taken some data with Logger *Pro*, there are a number of things you can do with those data to understand them. This tutorial will teach you how to use some of the analysis features of Logger *Pro*.

‣ Start up Logger *Pro*

‣ Choose Open from the File menu.

‣ Select the file *Analysis Tutorial* from the _Tutorials folder and click on Open.

You have just loaded sample data to use in this tutorial.
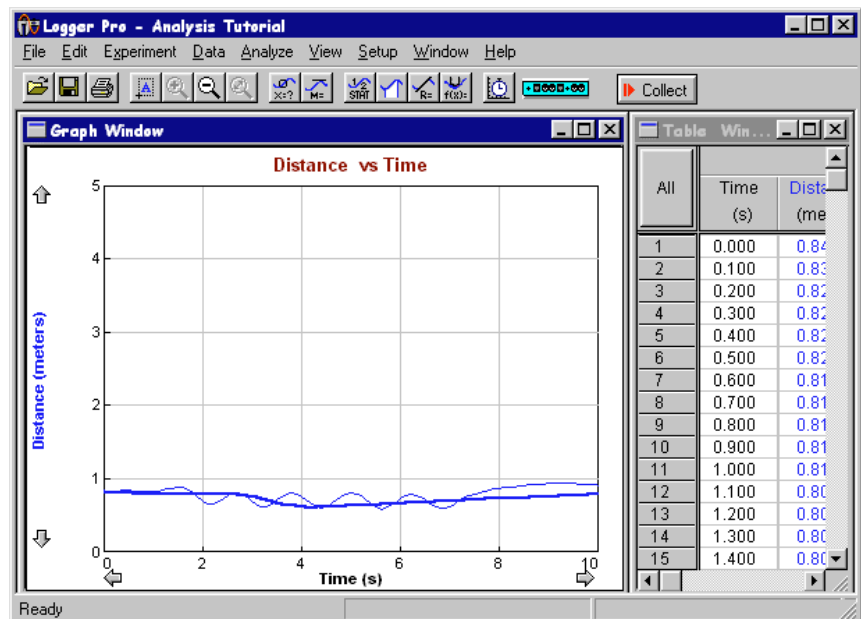
Changing the graph

There are a number of useful ways to display the data gathered by Logger *Pro*. You might want to simply change the limits on the y axis to study a portion of the data. Or, you might want to add a descriptive title to the graph. You can do both of these by clicking different parts of the screen.

First, try changing the limits of the y axis. The numbers at either end of the axis can be edited.

‣ Click on the **5** at the top end of the y axis. The number will be high-lighted.

‣ Type a **3** to replace it and press enter.

The graph will rescale. You can change the horizontal axis in the same way.

You can also ask Logger *Pro* to rescale the graph automatically.

‣ Choose Autoscale from the View menu or click on the Autoscale button on the toolbar.

The graph now shows the entire range of data.

Change the graph title

You can change the graph title.

‣ Click on the graph title.

‣ Type in a new title of your choice and click on OK.

Your title is now in place.

Inspecting data

Sometimes you will want to see the coordinates of a particular place on a graph.

‣ Choose Examine from the Analyze menu, or click on the Examine button on the toolbar.

‣ Move the pointer along the graph.

Notice the new legend that appears on the graph. Then, as you move the pointer across the graph, you will see a numerical readout change, reporting the coordinates of each plotted quantity at the indicated time.

Data table window

As you move the pointer across a graph the data table scrolls to the corresponding time. Data columns are color-coded to match the lines drawn on the graphs.

You can turn off the readout floating box and cursor.

‣ Select Examine again from the Analyze menu to turn off Examine mode. You can also click on the Examine button again to turn off the mode.

Removing data

To remove a set of data, you can choose Delete Run from the Data menu. While the mouse pointer is over Delete Run you will see a list of all the stored data, including the latest run.

‣ Delete all but the latest run now.

‣ Autoscale the graph to reset the y axis range.

Your graph screen should have only the most recent data plotted now.
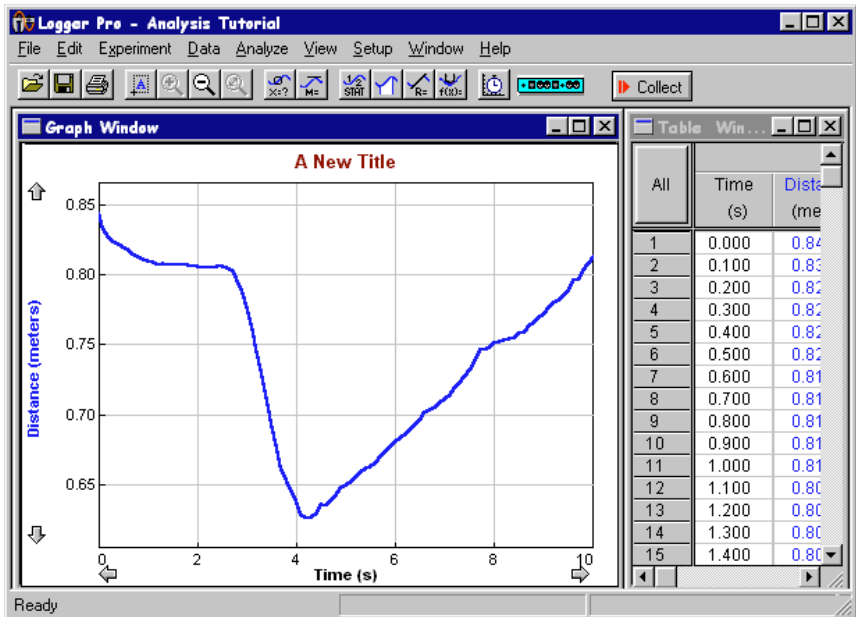
Changing what is graphed

Any column of data from a single run can be plotted against any other column. Time, while usually plotted on the horizontal axis, need not be plotted at all if it is not appropriate. For example, you might want to plot velocity as a function of position in some dynamics studies. To do this you must change what is plotted on one or both axes.

‣ Click on the y-axis label.

You will see a dialog box with all of the column headings in the data table available.

‣ Click on the selection boxes so that only the Velocity column is checked.

‣ Click on OK.

‣ Click on the x-axis label to get the x-axis selection dialog.

‣ Click on the Distance selection button and click on OK.

You should see a plot of velocity as a function of position. Physicists call this a *phase plot*. Now you will change the plot back to a conventional velocity as a function of time graph.

‣ Click on the x-axis label to get the x-axis selection dialog.

‣ Click on the Time selection button and click on OK.

You should see a velocity *vs.* time graph.

Tangent lines

Logger *Pro* can draw tangent lines to any curve on screen.

‣ Choose Tangent from the Analyze menu or click on the tangent button on the toolbar, and point at a portion of the data with the mouse.

Logger *Pro* will draw the tangent line at the current mouse pointer position; its slope is displayed in the legend box. Move the pointer to see other tangents.

‣ Turn off tangent mode by choosing Tangent from the Analyze menu again (or you can use the toolbar).

Integrals

Similar to the tangent function, you can integrate your data. To integrate a region,

‣ select a region of your data by dragging across it with your mouse.

Two vertical bars should appear to indicate the selected region.

‣ Choose Integrate from the Analyze menu or click on the integral button on the toolbar.

The area between the curve and the horizontal axis will be shaded, and the numerical result displayed in a *floating box* as shown here. You can drag the box to any place on the graph you want. To remove the integral, click on the upper right corner of the floating box. To integrate all of the data choose integral with no selection made in the graph window or data table.
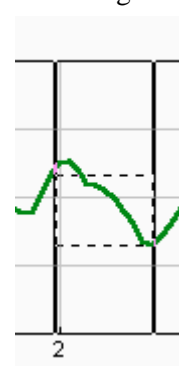
Integral:
1.250 m*s

‣ Remove the integral by clicking the upper-right corner of the floating box.

Statistics

You can also ask Logger *Pro* to calculate the mean, maximum, minimum, and standard deviation on part or all of your data. To find statistics on part of the data,

‣ select a range of data by dragging across it.

‣ Choose Statistics from the Analyze menu. You can also press the statistics button on the toolbar.

A moveable floating box will appear with the results. To remove the floating box, click on the upper-right corner of the floating box. For

statistics of the entire data set choose Statistics with no data selected. If you have already selected data, clear that selection by clicking once in the graph region of the graph. The vertical selection bars will disappear.

Quit Logger *Pro*

You've now learned how to change the graph scale, obtain numerical data from the graph, draw integrals and tangent lines, and perform statistical calculations on a data set. Another tutorial will show you how to fit lines and curves to your data.

‣ Quit Logger *Pro* by choosing Quit or Exit from the File menu. Do not save any changes.

Tutorial: Fitting Lines and Curves to Data

Logger *Pro* will fit a variety of functions to your data, and then plot the function and report the fit statistics. This tutorial will lead you through a number of fitting exercises.

‣ Start up Logger *Pro*.

‣ Choose Open from the File menu.

‣ Select the file *Fitting Tutorial* from the _Tutorials folder and click on Open.

You have just loaded some sample data to use in this tutorial.

Fitting a straight line to data

Often data show a linear trend, and you want to know the slope of that trend. Locate a part of the data that seem to follow a more or less straight line. It doesn't have to be very straight.

‣ Select these data by dragging the mouse pointer across the region.

‣ Choose Linear Fit from the Analyze menu. You can also click on the Linear Fit button on the toolbar.[6]
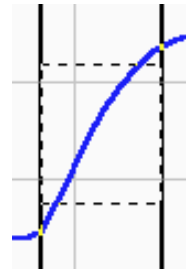
Logger *Pro* now plots the best-fitting line and displays the fit statistics in a floating box. Since your selection is not necessarily the same as used here, your fit parameters may differ.
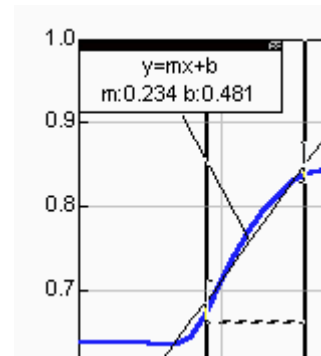
Removing a fit

To remove a fitted line and parameters,

‣ click on the close box (the upper right corner) of the floating box.
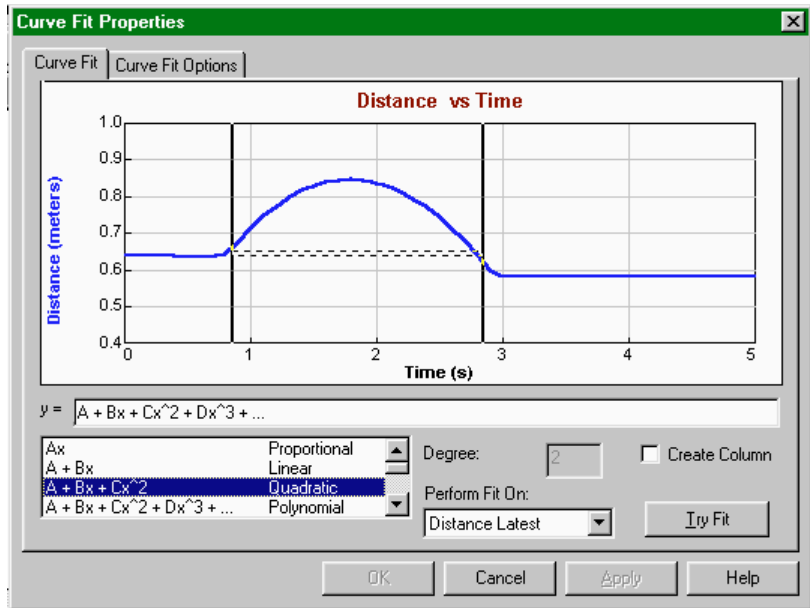
Fitting more complex functions to data

You can also fit more complex functions to your data.

‣ Select the curved region of data with the mouse.

‣ Choose Curve Fit from the Analyze menu. You can also click on the Curve Fit button on the toolbar.

A dialog box will open:

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[6]You can also perform a linear fit using the more general Curve Fit command, but more steps are required.

You can select the desired function from the scrolling list at the lower left by clicking it. For this example,

▸ choose the Quadratic function from the Function list.

▸ Choose the Distance Latest column from the Perform Fit On list.

▸ Click on the Try Fit button at lower right.

You will see a trial fit drawn on the draft graph. You can modify the fit as desired by changing the selection range or equation used, and clicking Try Fit again. Once your are satisfied with the fit,

▸ click on OK to return to the main graph window.

Interpolate

Once you have performed a fit, you can use it to interpolate between data points.

▸ Choose Interpolate from the Analyze menu.

Move the cursor to the desired region, and read off the coordinates of the curve from the legend box. Note that you are not reading the coordinates of the data but of the fitted line.

▸ Turn off interpolate mode by choosing Interpolate from the Analyze menu again.

Removing a fit

As before, you can remove a fit by clicking the close box of the floating box.

▸ Remove the fit.

Quit Logger *Pro*

You have now learned how to fit a line or a curve to your data, how to interpolate using those fits, and how to remove curve fits.

▸ Quit Logger *Pro* by choosing Quit or Exit from the File menu. Do not save any changes.

Tutorial: Saving Files, Printing, and Transferring Data

Once you get some useful data, you may want to save them to a floppy disk or a hard disk for future use, print them, or transfer them to another application such as a spreadsheet. This tutorial will show you how to do these things with some sample data found in a file. To load the file,

‣ Start up Logger *Pro*

‣ Choose Open from the File menu, and locate the file *Fitting Tutorial* in the _Tutorials folder.
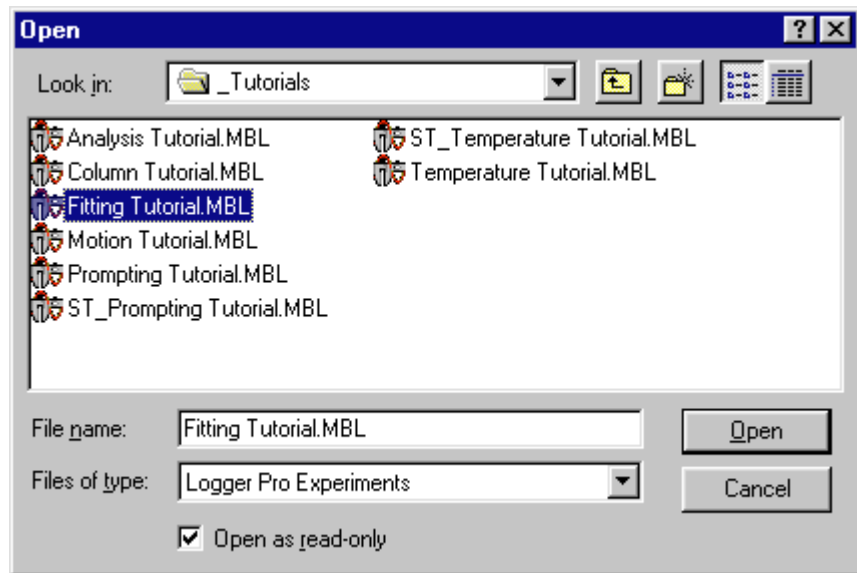
Note the field at the bottom of the dialog box marked Open as read-only. When this box is filled (the default), the Save command and the Save toolbar button are disabled in order to protect the original file. Usually you will want to save files under new names using Save As…. Leave the check-box filled.

‣ Click on Fitting Tutorial to select, and click on Open.

Saving an experiment file

It is very useful to preserve the current state of Logger *Pro* in a file. For example, you might configure Logger *Pro* to carry out a particular experiment, perform a calibration, and take some sample data. All the work just done can be retrieved later by opening a file. Such an *experiment file* contains the entire Logger *Pro* state: the sensor configuration including calibration (either from file or custom), the graph setup, and any data just collected or stored.

As an exercise, you will save a copy of the experiment file you just opened to a floppy disk.

‣ Insert a formatted floppy disk into your computer.

‣ Choose Save As from the File menu.

‣ Navigate to the floppy disk drive by using the drop down menu at the top of the dialog box. Scroll to the floppy disk drive and select it.

You will be prompted to choose a file name and a location for the file. Be sure you know in what folder you are about to save the file. Ask your instructor if you're not sure where to put the file.

▸ Enter a file name other than *Fitting Tutorial*[7].

▸ Click on the Save button to save your file.

Retrieving an experiment file

After saving the experiment to disk, you can retrieve it by choosing Open from the File menu as you did at the beginning of this tutorial. It is not necessary to do that now.

Printing a graph

When you get a graph the way you like it, you can print it.

▸ Click on the graph window to select it.

▸ Click on the printer icon on the toolbar.

▸ Click on Print or OK as appropriate for your computer.

Your graph will be printed.

Printing data

You can also print a data table by selecting it and clicking the printer button, but be careful. It is easy to acquire many pages of data. You may want to reduce the number of data points collected when setting up the experiment. The print preview command in the file menu will show what will be printed.

Transferring data to other applications

You may want to copy data to a spreadsheet or a graphing program.

▸ Click on the All button in the upper left of the Data Table Window to select the data.

▸ Choose Copy from the Edit menu.

In a moment you will switch to the receiving application. You do not need to quit Logger *Pro*; in fact it is much easier if you leave Logger *Pro* running so you can return to it later.

▸ Start up or switch to the receiving application.

▸ Position the insertion point or active cell in the upper left of the region where you want your data to be placed.

▸ Choose Paste from the Edit menu.

Your data will be placed in the receiving application, ready for further analysis.

Quit Logger *Pro*

You have now learned how to save an experiment with its data to a file, to retrieve such a file from disk, and how to transfer data to another application.

▸ Quit Logger *Pro* by choosing Quit or Exit from the File menu. Do not save any changes.

▸ Locate the experiment file you saved earlier and delete it (*not* the *Fitting Tutorial* file).

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[7]In Windows 3.1 you are limited to file names of eight characters or fewer.

Tutorial: Creating New Columns

You can ask Logger *Pro* to calculate new columns of data based on the data from the sensors. For example, you might want to calculate the reciprocal of a data column. This tutorial will lead you through creating such a column.

‣ Start up Logger *Pro*

‣ Choose Open from the File menu.

‣ Select the file *Column Tutorial* from the _Tutorials folder and click on Open.

You have just loaded some sample data to use in this tutorial.

Inspect the data

First, look at the data table window. You should see a data table window with Volume and Pressure columns. They are data from an experiment studying the relationship between the volume and pressure of a gas sample at constant temperature.
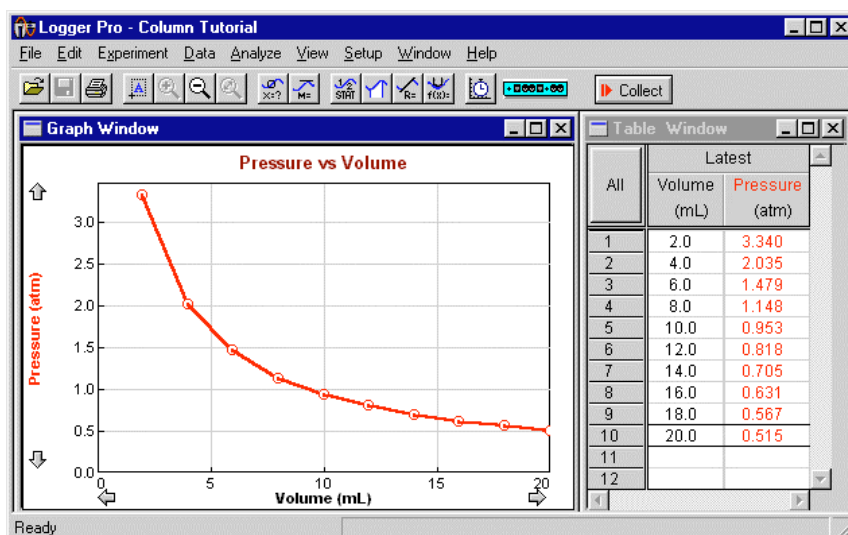
Create a new calculated column

Let's create a new column containing the reciprocal of the Pressure column. To create the column,

‣ choose New Column → Formula from the Data menu.

You will see this new dialog box. You are about to fill in the Label fields as shown here.
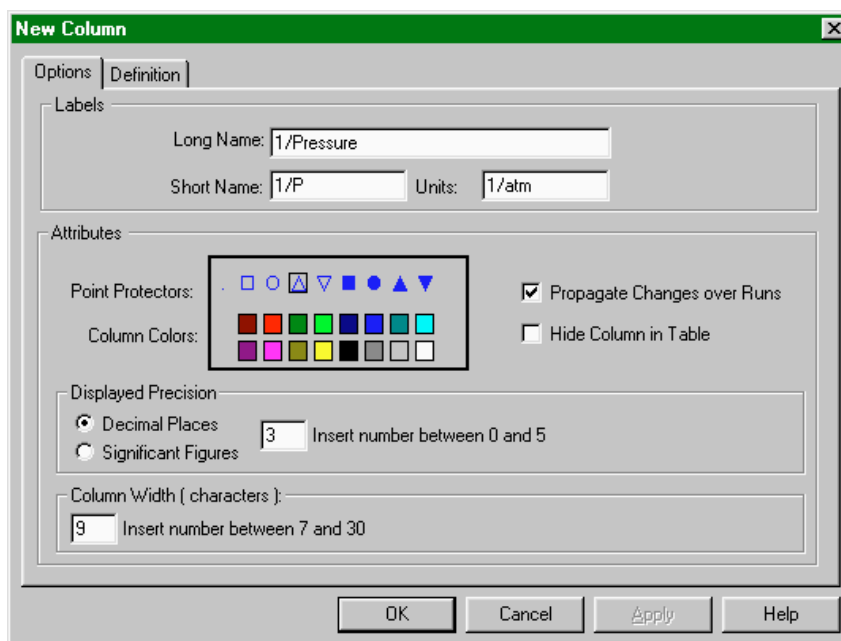
First we need to name the column and add units. The label field allows you to name the column; the name will be used to label the column and in graphing. For this example,

‣ in the Long Name field enter **1/Pressure**, and **1/P** in the Short Name field.

‣ In the Units field enter **1/atm**.

‣ Choose a Point Protector and color as you like.

Next you will switch to the second tab of the new column dialog box.

‣ Click on the Definition tab in the upper left region of the dialog box.
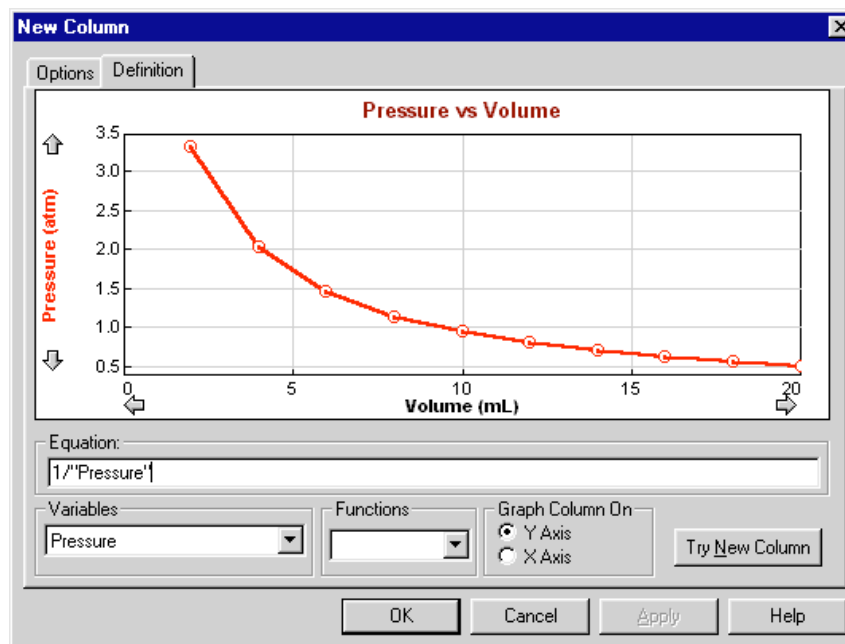
In this dialog box you will enter a formula for calculating the contents of a new column.

‣ Click in the equation field to place the blinking cursor there.

‣ Type **1/**

‣ Choose Pressure from the scrolling variable list.

Now look at what you've entered in the equation field. It should read **1/"Pressure".** This means that the new column will contain the reciprocal of the Pressure column on a row by row basis.

There is also a list of mathematical functions such as log( ) available for building formulas. You do not need to use the function list for this example.

The Graph Column On option gives you have the choice of graphing the newly-defined column on either the x axis or the y axis. In this case it is appropriate to use the default setting of y axis.

‣ Click on Try New Column to see the result of your entries. You should see the calculated column plotted on the y axis.

To accept the new column,

‣ click on OK.

You will see a graph of the data from the new column.
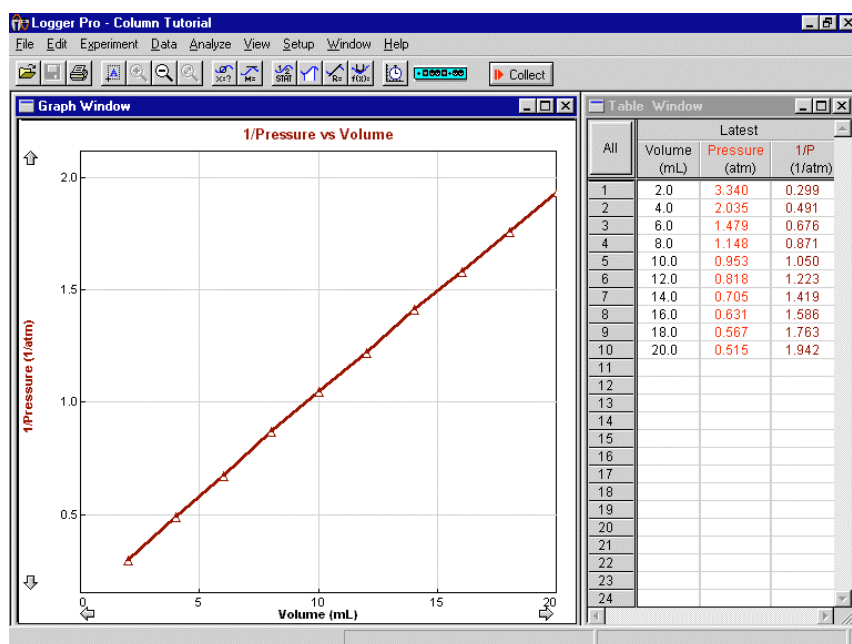
Note that the Table Window holds the newly defined column as well as the original columns.

In this example the graph of Inverse Pressure *vs.* Volume is a straight line, confirming that Pressure is inversely proportional to Volume[8]. It is easy to see with the calculated column, but more difficult to tell from the original data.

If you would like to fit a straight line to the new data, click on the Linear Fit button located on the toolbar. Look closely at the result, for the fit is so close to the data that the fitted line is hard to see.

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[8]That is, the data follow Boyle's law.

Quit Logger *Pro*

You have now learned how to define a new data column calculated from existing columns.

‣ Quit Logger *Pro* by choosing Quit or Exit from the File menu. Do not save any changes.

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