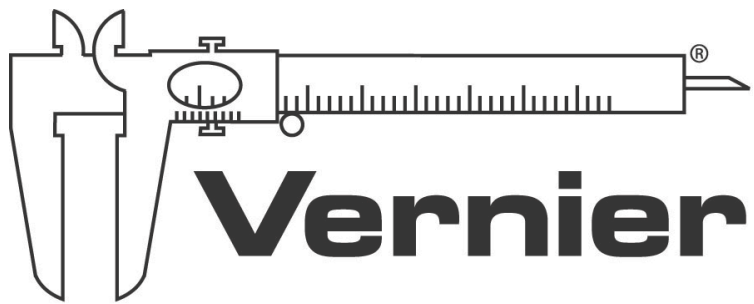# Vernier LabQuest™ Reference Guide
Version 1.1

Welcome to Vernier LabQuest

LabQuest Reference Guide

This is the LabQuest Reference Guide. It is an extended guide to using the Vernier LabQuest. Also available is the shorter LabQuest Quick-Start Guide, included in print in the LabQuest box.

An updated version of this Reference Guide may be available at http://www.vernier.com/labquest/updates

This guide is written for the second release of the LabQuest software, version 1.1, released in April 2008. There will be additional updates to the LabQuest App and the LabQuest operating system. See *Install LabQuest Updates* later in this guide for instructions.

The LabQuest Hardware

Find the power button ⏻ in the upper left corner, and press it. If the screen does not light after a moment, connect the power adapter to LabQuest and to a power source.

LabQuest is controlled both by the touch screen and by the hardware keys below the screen. The button you will use most often is the collect button ▶ located just below the screen. On the left side of LabQuest are the audio ports and the power port, used to recharge the battery. On the right side are two digital sensor ports, used for Motion Detectors, Drop Counters, and other digital sensors. The top edge of LabQuest has four ports for sensors such as pH, Temperature and Force. Also on the top edge are a stylus storage slot, a full size USB port for printers, USB drives, and other peripherals, an SD card slot for memory expansion, and a mini USB port for connecting LabQuest to a computer. On the underside are the battery compartment and a stylus tether attachment point.

Turn off your LabQuest by pressing the power button for about a second.

For longest use, charge your LabQuest overnight.

## Items Included with LabQuest

> LabQuest unit
> Printed LabQuest Quick-Start Guide
> A CD or CDs containing
> - computer software
> - LabQuest Reference Guide
> - flash introduction
>
> USB cable
> Power adapter
> Stylus (2)
> Stylus tether kit

Collect Data with LabQuest

Here's how to quickly collect some data with your new LabQuest.

1. Wake up your LabQuest by pressing the silver power button on the upper left corner. If your LabQuest does not wake, your battery may be discharged. Connect the LabQuest to its power adapter, and continue.

2. Connect an analog sensor (auto-ID capable) to one of the ports on the top edge of LabQuest. Something simple like a temperature, light or force sensor is best. LabQuest will set itself for data collection with that sensor. Note the live readout on the Meter screen.

3. Press the Collect button just below the LabQuest screen. Data collection will begin, and a graph will show your data being plotted in real time.
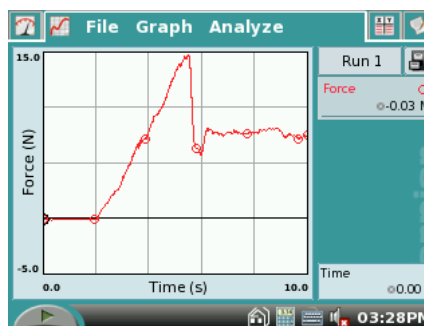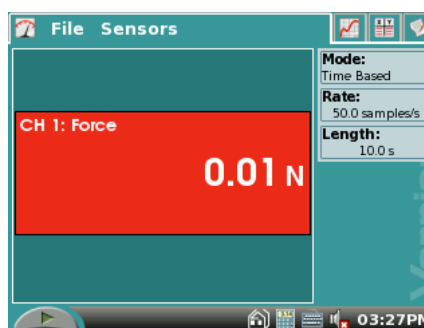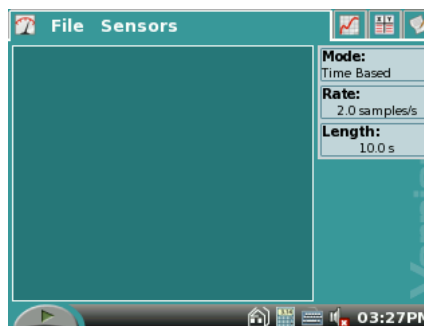
Charge your LabQuest overnight for a full battery charge.

LabQuest App Introduction

The LabQuest is both hardware and software. The software called LabQuest App is the data collection heart of your LabQuest. When you wake a LabQuest using the silver power button, the LabQuest App is started. What follows is a brief introduction to LabQuest App. See the section titled "Additional LabQuest App Features" for more information.

Take some data using the steps in the previous section, and then try some LabQuest analysis features.

Use the Stylus to Examine Your Data

Tap on the graph itself, near some feature of interest on your graph. The Examine cursor jumps to the nearest data point of the x-value you tapped. Cursor lines highlight the x- and y-axis values, and the right-side readouts display the associated numerical values of the
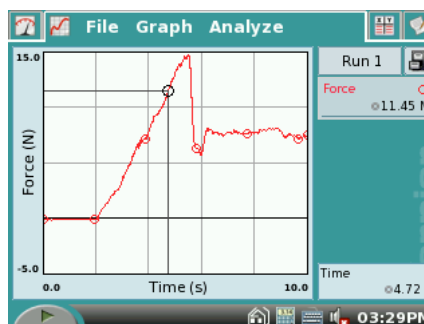
point. You can make fine adjustments to the cursor location by using the left and right cursor keys below the screen.

The Analyze menu enables additional ways to inspect your data. Tap Analyze, and then tap Tangent. Now tap near an interesting place on your graph; a tangent line is drawn in addition to the examine cursors. On the right side of the graph the numerical value of the slope is shown.
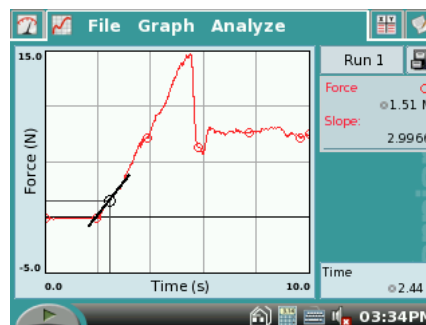
To turn off the Tangent function, choose it again from the Analyze menu.
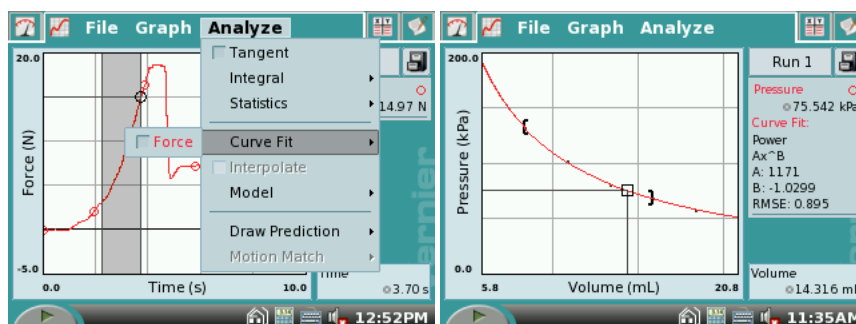
Select a Region for Statistics

Some analysis functions allow you to select a range of data. To select a range, use the stylus to drag across the region of interest. Now you can perform tasks like integrals, statistics, or curve fits. Try this: Drag across a feature on your graph, and then select Statistics from the Analyze menu, choosing the particular sensor or column.
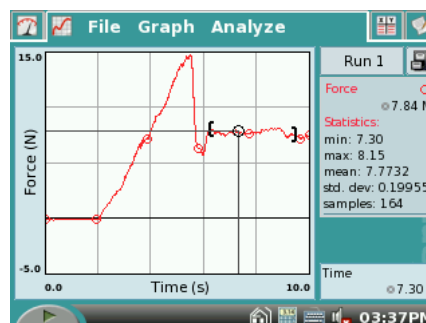
The graph now shows the selected region, and descriptive statistics are displayed to the right of the graph. You can remove the statistics display by choosing Statistics again from the Analyze menu.

Select a Region for Curve Fit

Curve fits can also start with a selection. Otherwise, the entire graph is used. To perform a curve fit, drag across a region of the graph if you want to make a selection. Then choose Curve Fit from the Analyze menu. In the new screen, you will see your graph, as well as a menu of fit equations. Display the equations by tapping the down-arrow to the right of the list. Tap Linear to perform a linear fit to your data. The fit coefficients are shown. To place the fit on your main graph, tap OK. The fit and its statistics are shown on the main screen.

Once you have performed a curve fit, you can use the Interpolate function to read values off of the fitted function. Choose Interpolate, and tap on the graph. The examine lines now locate a position on the fitted function, and coordinates along the fitted line are shown to

the right of the graph. You can tell that LabQuest is in the Interpolation mode by the square cursor shown at the Examine point.

To remove the fit, choose Curve Fit again from the Analyze menu.

Multiple Runs

You can collect several runs for comparison. Tap the file cabinet icon ; the run will be stored, and the graph cleared. Collect another run by pressing the Collect button. Your new run is displayed on the graph. To see your first run, tap the button reading Run 2, and select either Run 1 or All Runs. In this way you can gather multiple runs for comparison, and view just the ones you want.
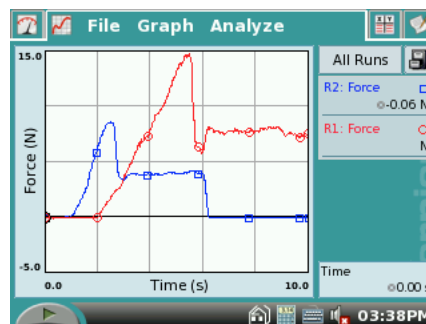
Use LabQuest with a Computer

Software Requirements

Your LabQuest comes with computer software. Use either Logger Lite 1.4 (or newer) or Logger *Pro* 3.6 (or newer) with LabQuest. If you already own Logger *Pro* 3, updates to Logger *Pro* are available for free download at www.vernier.com/tech/lpupdates.html

A compatible version of computer software is included with your LabQuest. Install the software from the included CD if you do not have compatible software already installed.

Connect the LabQuest to your computer using the included USB cable. The mini end connects to LabQuest, and the full-size end connects to an available USB port on your computer.

The LabQuest can be used with a computer in two ways. Data can be collected directly to Logger *Pro* or Logger Lite, or you can retrieve previously collected data from the LabQuest to either program.

Collect Data with LabQuest Directly to Logger Lite or Logger *Pro*

1. Connect a sensor to LabQuest. Something simple like force or temperature[1] is a good choice.
2. Launch Logger *Pro* or Logger Lite. The computer will detect the LabQuest and the attached sensor, and display a graph ready for data collection.
3. Click the Collect button in Logger *Pro* or Logger Lite to collect data.

Automatically Transfer Data from LabQuest to the Computer

If you collect data in LabQuest App, and you then connect the LabQuest to a computer, Logger Lite or Logger *Pro* will automatically detect the presence of the remote data and offer to retrieve it.

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[1] The sensor used must be auto-ID-capable.

Collect some data on LabQuest so you can try this. Then, connect the LabQuest to your computer and launch Logger Lite or Logger *Pro*. The computer application will detect the LabQuest and its data, and display a dialog indicating that remote data are available. Follow instructions in that and subsequent dialogs to download data to the computer.

LabQuest Browser

Logger *Pro* and Logger Lite allow you to copy files back and forth between the LabQuest and your computer, as well as delete files on the LabQuest unit. Access these functions from the LabQuest Browser, found on the File menu in Logger Lite or Logger *Pro*.

Manually Transfer Data from LabQuest to Computer

In addition to the automatic detection of recent data in LabQuest by Logger *Pro* or Logger Lite (described in the preceding sections) you can also download any saved data from LabQuest to the computer. After an experiment is complete on LabQuest, choose Save from the LabQuest File menu. Give the experiment an identifying name. You may save multiple LabQuest files on LabQuest this way.

> Tip: When taking data in the field, store experiments as files on the LabQuest. To do this, choose Save from the File menu, and give the experiment a descriptive name. Choose either the LabQuest, or optionally a USB drive or SD card, as the location. This way you can save as many experiments as you like. Later, you can either use LabQuest Browser in Logger *Pro* or Logger Lite to open the files, or connect the USB drive or SD card to your computer and open the files directly in Logger *Pro* or Logger Lite.

On the computer, choose Open from the LabQuest Browser, which is found in the File menu. Select the desired file from the LabQuest, and open it. Your LabQuest file will be opened on the computer, including any data, notes, and data collection configuration. Only one file can be opened at a time. You may choose to subsequently save the data as a Logger *Pro* or Logger Lite file.

> Tip: If sensors are still connected when a LabQuest file is opened in Logger Pro or Logger Lite, the sensors will be ignored. To enable the sensors, choose New from the File menu in the computer application.

Another option is to Import data from the LabQuest. Import differs from Open in that only the data in the LabQuest file are added to the current computer session. This allows you to compile data from multiple LabQuest sessions into a single computer session for graphing and comparison.

> Tip: Compile class results from multiple LabQuest files (or multiple LabQuests) by repeatedly importing data into a single Logger *Pro* or Logger Lite file.

Manually Move Data from Computer to LabQuest

Data and/or sensor configurations can be saved to the LabQuest from your computer. Open a computer file, or set up the computer for the data collection details you desire.

Choose Save As… from the LabQuest Browser (found in the File menu), and enter a descriptive file name. Any data, and the sensor configuration, will be stored on the LabQuest as a LabQuest file. Any features in the computer file not existing on LabQuest (such as embedded images, video analysis, graph annotations or most calculated columns) will be ignored on LabQuest.

Delete Data on LabQuest

The LabQuest Browser includes a Delete function. Choose Delete from the LabQuest Browser, and select the file you want to remove from LabQuest.

> Tip: Use the LabQuest Browser to mass delete files from LabQuest. Click to select multiple files, and click Delete. This is the only way to delete more than one file at a time.

Remote Setup of LabQuest from Logger *Pro*

Logger *Pro* allows you to configure LabQuest for data collection from the computer. Set up Logger *Pro* as desired for your sensors, data collection rate and duration. Choose Remote→Setup→LabQuest from the Experiment menu. Disconnect the LabQuest when prompted. Collect data on LabQuest using its screen and keys. Notes: This feature is not available in Logger Lite, and is equivalent to setting up LabQuest using LabQuest App controls.

Additional LabQuest App Features

This section reviews the features and functions of the LabQuest App in detail. First the overall LabQuest screen, and then the four tabs and their special contents, are described.

The LabQuest App Screen

There are four tabs across the top of the LabQuest screen: the Meter, Graph, Table, and Notes tabs. Tap a tab to display its screen. Across the bottom of the screen are icons for Collect, Home, Calculator, Keyboard, Sounds, Battery, and the current time. The Battery icon is not shown on the LabQuest Emulator, used to make these screen images. The bottom-row icons are always visible, but the tabs are only present when LabQuest App is active.
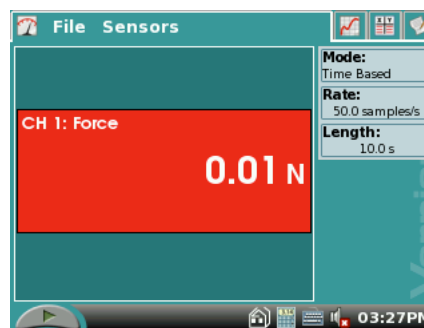
All four tabs share the same File menu, used to open existing files, save data into a file, print, and perform other tasks.

File Menu

The File menu is similar to the File menu on a computer. Here you can save and open files, print, change settings, and quit the application. LabQuest App can read and write files to LabQuest memory, a sort of virtual hard disk. Files contain experimental setup, data, analysis, and notes. Files allow you to retain a collection of past work, either for later referral


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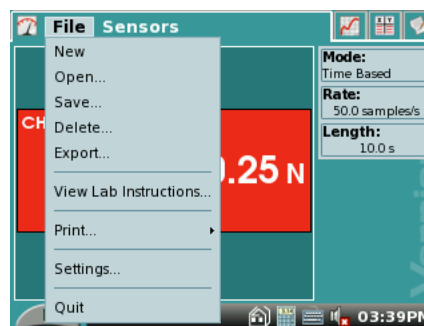
on the LabQuest, or for download to a computer. If you only want to download the current LabQuest session to computer, it is not necessary to save a file. Connect LabQuest to a computer, and launch Logger *Pro* or Logger Lite.

New

New will reset data collection mode and calibrations to defaults, and will clear any existing data. You will be prompted to save any unsaved data.

Open

Open displays a list of the files available on your LabQuest. Initially this list is empty. Choose a file by tapping it, and then tap OK. Files may be located in the LabQuest flash memory, an SD card, or a USB drive.
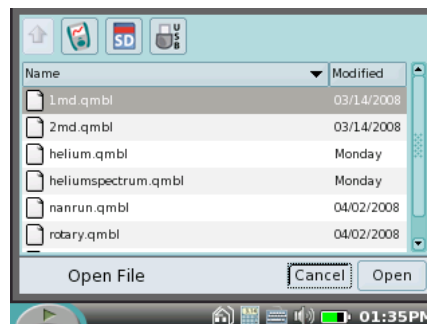
Save

Save lets you give the current LabQuest session a name, and then writes it to the selected location. This location could be the internal LabQuest memory, an SD card, or a USB drive.

Delete

Delete displays the same list as Open, but instead allows you to choose a file for deletion. You can delete only one file at a time.

Export

Export is used to create data files in text format for use with other applications. A typical use of this is to save a text file to an SD card or a USB flash drive, in order to open later in a computer spreadsheet. An exported file contains all column values from all runs in the current session.

View Lab Instructions

View Lab Instructions displays a list of the built-in laboratory instructions.

Print

Print → Graph, Table, My Notes, Lab Instructions, Screen. These options send the chosen object to an attached HP printer.

Settings

Settings… controls options for the current session; these settings are saved within a LabQuest file. Calculated columns may use trigonometric calculations; choose degrees or radians here. The default is radians. Derivative functions, which are part of the automatic setup for Motion Detectors, can be set to use a varying number of points for the calculation. The default of 7 points is good for many experiments, but you may want to choose a larger number for human-scale
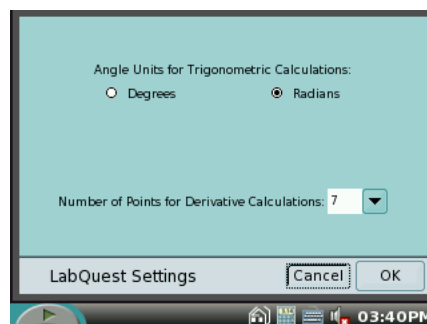
experiments, or a smaller number for cart-based experiments. Both settings return to the default on choosing New from the File menu, or after turning on the LabQuest.

Quit
Quit will exit the LabQuest App. Only advanced users need this feature, as other applications can be run simultaneously with LabQuest App.

Print from LabQuest
LabQuest will print to many Hewlett-Packard printers, including:

|		
LaserJet 1160	LaserJet 2015	Officejet Pro K550
LaserJet 1200	DeskJet 4160	DeskJet 6940
LaserJet 2420	DeskJet 460	DeskJet 930C

See www.vernier.com/labqprinters for an up-to-date list of compatible models.

Connect a compatible printer to the full-size USB port on LabQuest, and turn on the printer. The Print menu item is located in the File menu. From Print you can choose to print just the graph, the data table, your own notes, the lab instructions, or the screen as it is currently displayed.

If LabQuest does not find a compatible printer, an error message will be displayed on attempting to print.

Use an External SD Card or USB Flash Drive with LabQuest
LabQuest will recognize additional storage space in a connected SD (Secure Digital) card or a USB flash drive. The drive or card may be formatted in FAT16 or FAT32 (the most common Windows and Mac OS formats) for reading and writing. LabQuest cannot read NTFS- or HFS+-formatted drives.
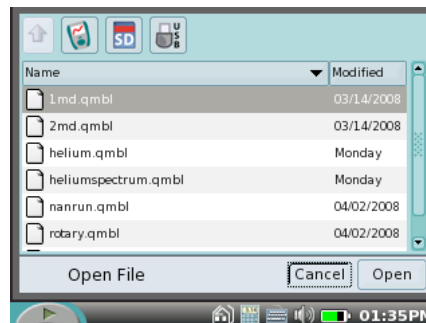
In the Save, Open or Export dialogs, additional storage space on an SD card or a USB drive will show up as an additional icons. Tap to switch to the SD card or USB drive. You will see any existing directories (folders) on the device. Double-tap to open a directory. Tap the up arrow to go up a directory. Tap the LabQuest icon to switch back to the internal storage space. You cannot create directories within LabQuest App, but you can use directories that already exist on the SD card or USB drive.

Tip: Wait a few seconds before using the File menu after inserting a USB drive or an SD card for the LabQuest OS to find the device, or the storage won't show up as available.

Tip: Organize your files on a USB drive or SD card by creating any needed folders on a computer before you use the drive or card with LabQuest.

Meter Screen

The Meter screen displays a digital meter for each sensor, the current mode, and the data collection parameters. Several shortcuts are available on the Meter screen. Tap on a meter to zero, calibrate, reverse, or change units on its sensor. Tap the Mode field to adjust data collection details.

Sensors Menu

The Sensors menu gives access to detailed setup controls.

Sensor Setup

Use Sensor Setup to configure the internal microphone and internal temperature sensors, as well as legacy non-auto-ID sensors. For each channel in use, select a sensor name, and then select new units as desired. Most sensors are auto-ID, and so you will not need to set them up this way.

Data Collection

The Data Collection menu allows you to set data collection mode and parameters. Choose between time-based, events with entry, and other data collection modes. For time-based experiments, set the experiment length and data rate. You can get to the same settings by tapping the Mode field on the Meter tab. LabQuest chooses appropriate rate and experiment length based on the sensors connected, but you can override the defaults in this dialog.

Mode: Time-Based Data Collection

Time-based data collection is the default mode, where sensor readings are recorded at regular time intervals. The rate and duration of the experiment can be set. The total number of samples to be collected is displayed. Under some circumstances the Rate and Length fields will highlight in yellow or red.
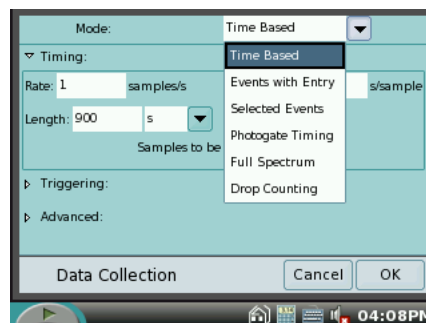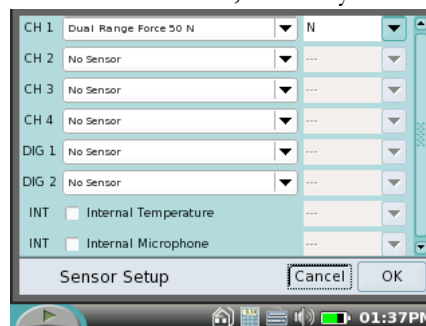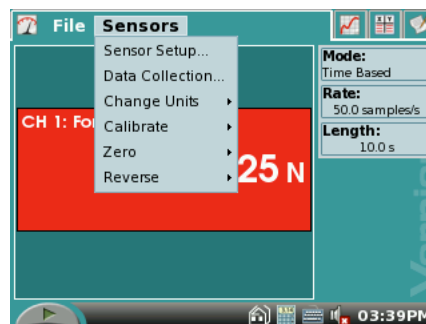
Yellow/Warning level
- The Rate is faster than the recommended fastest rate of a connected sensor.
- The Rate is slower than the recommended slowest rate of a connected sensor.
- The number of samples could lead to performance issues. Performance of LabQuest App is reduced when collecting over 10000 samples.

Red/Unsupported level
- The Rate is faster than a connected device and/or sensor configuration can possibly handle.
- The Rate is slower than a connected device and/or sensor configuration can handle.
- The Number of samples exceeds the storage available.

- The Number of samples exceeds 2000 at rates faster than 80 kHz. The number of samples always includes the pre-trigger samples.

Mode: Triggering

Triggering is only available in Time Based mode. When enabled, LabQuest will wait for a trigger condition to be met before beginning data collection. For example, you might wait to collect data until a force sensor is rising over 2 N. The sensor name, the level, and the direction of change (increasing or decreasing) can all be set here. A limited number of points before the trigger condition is met can also be saved with your data.

Mode: Advanced Settings

The Advanced field allows you to enable Oversampling, which samples the sensor at a rate higher than the number of samples per second you set, and then averages those readings. Also, you can enable Repeat mode, which starts a new run as soon as the current run has ended.

Mode: Events with Entry

Sometimes experiments do not depend on time, but depend on the setting of some other quantity. For example, in a Boyle's law experiment one wants to know the pressure as a function of the volume of gas. In this case the Events with Entry mode is used. When setting up this mode, you can enter a name and units for the entry column, such as "Volume." Scroll down to see the option "Average over 10 seconds." This setting will cause LabQuest to take a ten-second average for each reading, which is particularly useful for water quality studies. Once data collection is started with the collect button, a Keep button appears. Tap the Keep button to record the sensor value, and then LabQuest will prompt for the Entry value. Sensor values are plotted versus the Entry values. No time information is recorded in Events with Entry mode.
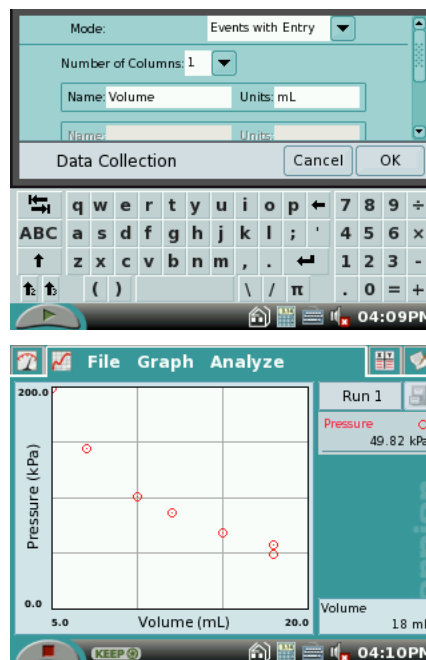
Mode: Selected Events

Selected Events is like Events with Entry, except that entries of 1, 2, 3… are entered automatically for you. No time information is recorded in Selected Events mode.

Mode: Photogate Timing

Photogates require a different set of timing options. When a photogate is detected, LabQuest switches to Photogate Timing mode. Within Photogate Timing there are additional modes.

End data collection settings in Photogate Timing have two choices: either the collection runs until the user taps stop, or the collection can be set to end after a defined number of events. A block/unblock pair counts as two events.

Various photogate modes are available to set what LabQuest calculates from the raw block and unblock times. The mode labeled None will generate a table of only the raw block and unblock times.

Mode: Motion Timing

Motion Timing is used for picket fences and ultra pulley experiments, and yields position, velocity and acceleration data. The distance between block events can be set; default values for common objects are already defined for you.

Mode: Gate Timing

A speed can be calculated from knowing the block to unblock time from an object of known length passing through a photogate. In Gate Timing you enter a length in meters, and LabQuest App finds the speed from the block to unblock time interval.

Mode: Pulse Timing

If you know the distance between a pair of photogates, the block-to-block time interval can be used to find a speed. Pulse timing finds a speed based on the block-to-block time interval, and a distance entered.

Mode: Pendulum Timing

The period of a pendulum can be accurately determined if the pendulum bob passes through the gate. LabQuest reports the time from a block event to the third block event, ignoring the one in between, so that a complete period is measured.

Mode: Drop Counting

Drop counting mode is a combination digital/analog mode. Each time a drop through a Vernier Drop Counter is detected, a counter is incremented, and any analog sensors, such as a pH sensor, are read. In this way the pH as a function of volume can be plotted.

In any dialog that requires the entry of either text or numbers, a keyboard will pop up as needed. Tap the field into which you want to place text or numbers, and tap the needed keys.

Change Units

Each sensor has its own set of available units for display. To see the available choice, choose Change Units, choosing the sensor in question. Choosing a new unit will change all existing runs for that sensor to the new unit, as well as any subsequent runs. You can change units in the Sensors menu or in the meter popup menu.
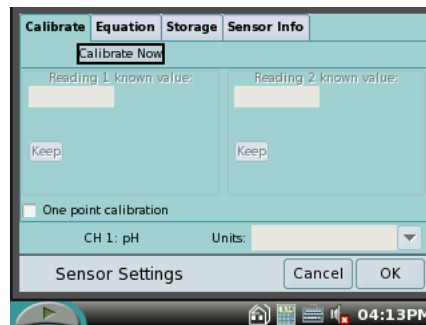
Calibrate

Most sensors do not need to be calibrated, as a factory
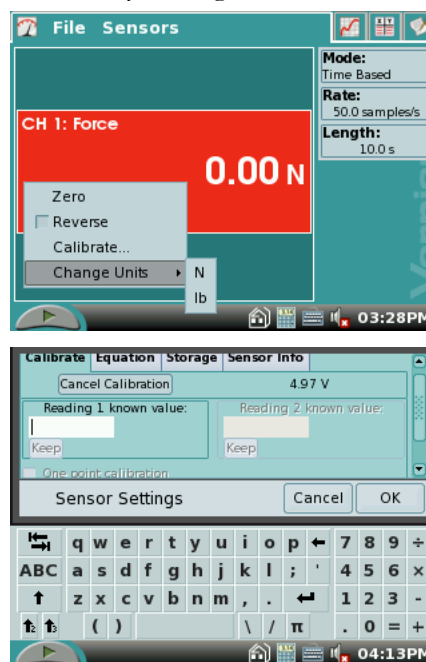
calibration for that sensor is read from the sensor when LabQuest identifies it. However, some sensors require calibration.

Calibration requires that you have two reference conditions available for a sensor. For example, for a pH sensor you might have buffers of pH 4 and 10. We will use that as an example here. Choose calibrate, selecting the particular sensor as necessary. You will see the calibration dialog. Tap the Calibrate Now button to begin. Place the pH sensor in the pH 4 solution. Let the reading stabilize a few seconds, or until you see only small variations. Use the keyboard to enter a **4** in the Reading 1 known value field, and tap Keep. Place the pH sensor in the pH 10 solution. Enter **10** in the Reading 2 field. After the reading settles, tap Keep. Tap OK to complete the calibration.

The one-point calibration option allows you to calibrate with only one reference. This only introduces an offset in the reading, but this is sometimes all that is needed.

Calibration of the Stainless Steel Temperature Probe and Surface Temperature Probe are not supported in LabQuest at this time.

The Units selection in the Calibration dialog allows you to alter the units of your calibration.

There are additional tabs on the Calibration dialog. Equation lets you view or alter the numerical calibration information. Tap Apply if you make changes to use the new values. Storage lets you choose how the new calibration will be saved. For example, if you perform a calibration and want to go back to it later, have the storage option checked to save the calibration with the LabQuest file. Tap OK; save the LabQuest file. Later, open that file, and the calibration will be used. The Sensor Info tab contains information from the auto-ID chip on the sensor, if present.

Tip: Use Logger *Pro* to write custom calibrations back to the sensor so that the calibration will be used automatically whenever the sensor is used with LabQuest.

Zero
Zero will set the current sensor reading to zero by adding an offset to the current reading. Not all sensors allow zeroing.

Reverse
Some sensors read both positive and negative. For example, the Force sensor reads positive when it is pulled, and negative when compressed. Choosing the Reverse option will swap the sign of the readings. Not all sensors can be reversed.

Graph Screen
LabQuest App automatically switches to the Graph screen when data collection begins.

There are several important shortcuts on the Graph screen. After collecting data, tap on the graph itself to read values from the examine cursors. Read values in the readouts to the right. Tap the file cabinet icon to store a run; choose between stored runs with the menu to the left of the cabinet icon.

Graph Menu

In the Graph menu itself, you can choose what is plotted, how the graph is scaled, choose point protectors or connecting lines, and choose data to ignore by striking through the values. You can choose to display two smaller graphs if desired.

Graph Options

For full control over how the data are graphed, choose Graph Options. Here you can choose the columns used for the x- and y-axes and the top/bottom and left/right limits. Selecting Autoscale will cause the graph range to adjust to the data range after data collection ends. Autoscale from 0 does the same, but includes the origin. Manual scaling will respect values entered in the range limits, unless incoming data falls outside the range. In this case the range will expand to include the data. To enter range limits, tap in each field and use the keyboard to enter numeric values. Dismiss the keyboard by tapping the keyboard icon.
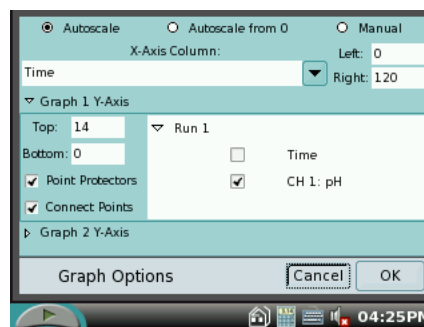
The Point Protectors option will mark some, but not all, of the points with a mark such as a circle or diamond. This allows easy identification of a trace by the corresponding mark in the graph legend. On by default, turning off the point protectors may be desirable if only one trace is being viewed.

The Connect Points option connects data points with straight-line segments. These lines help the eye follow the data trend, but in some cases are not appropriate. On by default, unchecking Connect Points will leave only the actual points on the graph.

Columns being graphed on the y-axis are checked. If multiple runs are present, you can quickly choose which runs are plotted by tapping to place checkmarks in the runs you want to see.

LabQuest can display either one or two graphs. The two graphs share a common x-axis column and range. Tap the diamond next to Graph 1 Y-Axis or Graph 2 Y-Axis to show or hide the settings for that-axis. If no column is selected for Graph 2, only one graph will be drawn.

When you are done setting Graph Options, tap OK to return to the Graph screen.

Show Graph

The Show Graph menu item lets you quickly jump between the two graphs or both graphs.

Strike Through Data/Restore Data

The Strike Through Data option allows you to ignore selected data. Struck data are ignored for analysis and graphing. Select a region on the graph, then choose Strike Through Data. The data are ignored. To reverse this action, choose Restore Data.

Autoscale Once

Autoscale Once will set the graph ranges so that all points are plotted.

Zoom In/Zoom Out

You can view a smaller region of the graph by dragging across it to select, and choosing Zoom In. Zoom Out will reverse that zoom.

Analyze Menu

The Analyze menu gives access to additional tools such as tangent lines, integrals, statistics and curve fits. Those functions that depend on a set of data will operate on either the whole graph or just a portion of the data, as selected by dragging the stylus across the graph. If no selection is made, the calculation will use the entire range.
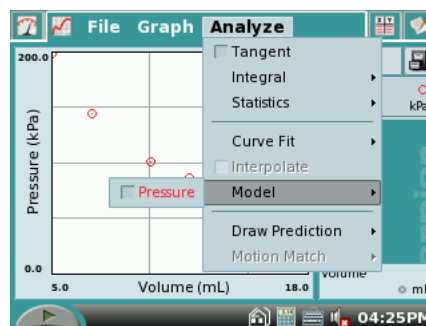
The analysis information is shown on the right side of the screen. Scroll arrows will appear if needed. Tap the analysis information to show the values on a detail dialog for ease of reading.

The functions that include a checkbox for a sensor or column name are toggles. To enable the function, choose the sensor or column name. To disable the function, choose the sensor or column name a second time.

Tangent

The Tangent mode enhances the Examine cursor by adding a tangent line and numeric display of slope as you tap locations on the graph.

Integral

Select a region if needed, and then choose Integral, followed by the sensor or column name. The Integral will be drawn, and the numeric result displayed to the right of the graph.

Statistics

Select a region if needed, and then choose Statistics, followed by the sensor or column name. Descriptive statistics will be displayed to the right of the graph. If a region is selected, brackets are drawn to indicate the region used for calculations.
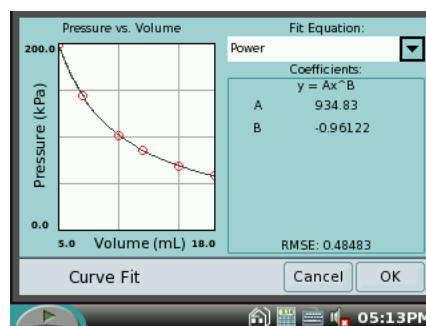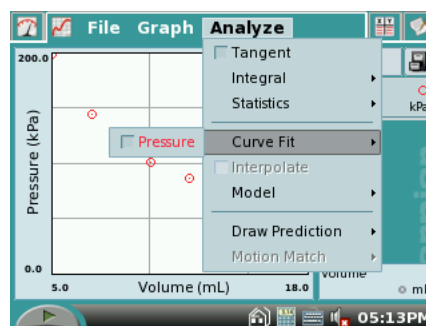
Curve Fit

Curve Fit allows you to automatically fit a chosen function to your data. If a region of the graph is selected, only that region is used for fitting. If there is no selection, the entire width of the graph is used. Choose the desired fit equation from Proportional, Linear, Quadratic, Power, and Natural Exponent. On choosing the fit equation, LabQuest will perform the fit and display the coefficients and Root Mean Square Error (RMSE). Tap OK to return to the main Graph screen. Choose Curve Fit again to remove the fit.
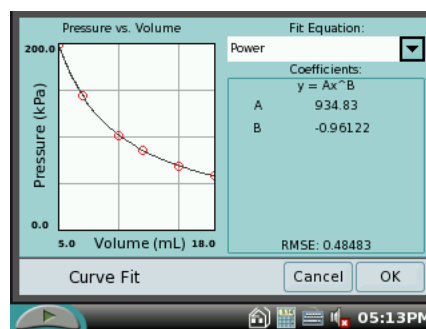
Tip: The RMSE (root mean square error) is a measure of how well the fit matches the data. The smaller the RMSE, the close the data are to the fitted line. The RMSE has the same units as the y-axis data.

Once you have a fit on the main graph, you can choose Interpolate from the Analyze menu. Tap on the graph to read values from the fitted curve (as opposed to reading from the data) as a function of the x-axis value. Turn off Interpolate by selecting it again.

Model

Model allows you to manually fit a chosen function to your data. Choose Model, and then choose a function. The parameters A, B and C are adjustable. Change them by direct entry or by using the up and down arrows to the right of the values. Tap OK to place the model on your main graph.
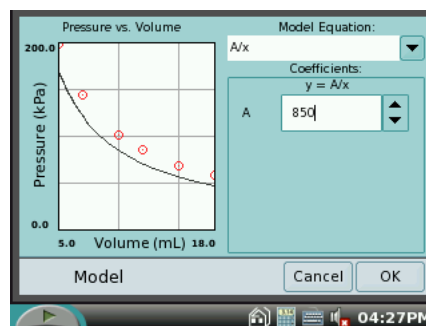
Tip: If no function appears when modeling, your parameters are defining a curve that is outside of the plot window.

Draw Prediction

The Draw Prediction choice gives you a free-hand sketch tool superimposed over a graph. This can be used for a variety of purposes, but most often is used to sketch a prediction of how a graph will appear once data are subsequently collected. Choose Draw Prediction, and then Graph 1 or 2 as desired. You will then see a sketching screen. Drag the stylus across the screen for smooth curves, or tap the screen to connect the taps with straight-line segments. The Reset button will remove your sketch if you need to start over. Tap OK to place your sketch on the main graph. To remove a prediction, choose Draw Prediction again from the Analyze menu.
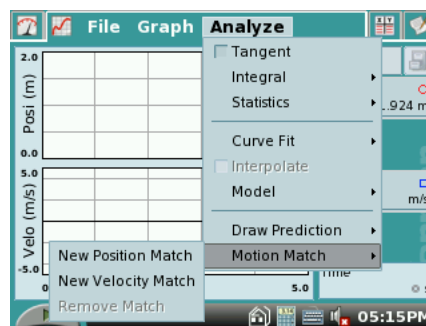
Motion Match

The Motion Match menu item is only available if a Motion Detector is connected. You have a choice of a new Position or Velocity match. In each case LabQuest generates a random target graph for matching exercises. Only the selected graph, Position or Velocity, is shown in match mode. You may collect data over the target graph as many times as you like. To see a new target graph, choose New Position Match or New Velocity Match again. Remove Match removes the target graph.
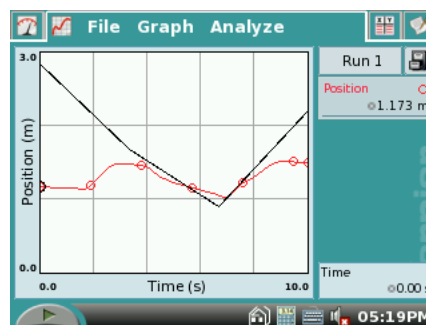
Table Screen

The Table screen shows a data table view of your experiment. There are several shortcuts on this screen.

- Tap the Run Name field, initially called Run 1, Run 2, and so forth, to edit the name of the run.
- Tap a column header (Time, Force, etc) to change the column name, display precision, or units.

Table Menu

The Table menu allows you to create, modify, or delete columns of data. Anything in columns can be graphed.
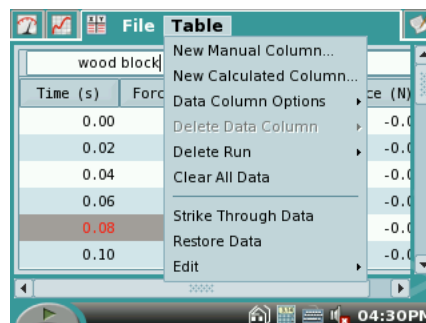
New Manual Column

New Manual Column creates an empty column into which you can enter or generate values directly.

New Calculated Column

New Calculated Column creates a new column whose values are based on other columns by a mathematical formula. For example, you might define a calculated column as the inverse square of another column. A calculated column can be used in graphs or in further calculated columns.

Data Column Options

Data Column Options allow you to set the column name, units, and display precision.

Delete Data Column, Delete Run and Clear All Data

Delete Data Column, Delete Run and Clear All Data allow you to remove columns, runs, or all of your data. Strike Through and Restore Data allow you to non-destructively ignore and restore data. Select a row or rows in the data table, and then use these commands. You can also select data in a graph, and use the same commands.

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The Edit item allows you to copy and paste values from one place to another. In particular you might copy a range of values and paste them into notes on the next screen, called the Notes screen.

Tip: To make a graph of data from other sources, enter values in two manual columns, and then plot them in a LabQuest graph.

Notes Screen

The Notes screen is a place to enter and view text and images. LabQuest includes over fifty prepared activities for use by students, and you can enter your own notes as you perform an experiment.

To open one of the prepared activities, choose View Lab Instructions… from the File menu, and select the desired file. More than fifty popular experiments in Chemistry, Physics, Biology, Earth Science, and Water Quality are available.
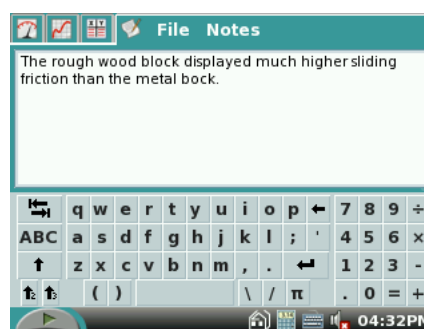
Notes Menu

The Notes menu allows you to toggle between the Lab Instructions and your own notes, called My Notes. The menu also gives access to standard edit commands of Cut, Copy, Paste, and Clear All. To enter text in My Notes, tap the keyboard icon on the bottom row of the screen. You can also attach a standard USB keyboard to the LabQuest, and use that to enter text.

Special Sensors

A few sensors deserve special instructions. They are the two internal sensors, and the USB-based spectrometers.

Internal Microphone

Configure the internal microphone using Sensor Setup… found in the Sensors menu. Tap the checkbox for Internal Microphone, and tap OK. At this point the microphone is used just like an external sensor.

Internal Temperature Sensor

Configure the internal temperature sensor using Sensor Setup… found in the Sensors menu. Tap the checkbox for Internal Temperature, and tap OK. At this point the temperature sensor is used just like an external sensor. However, since the sensor is internal to the LabQuest, it cannot respond rapidly to changing temperatures. It is designed only to measure ambient temperatures, and the associated slow change. The data rate is limited to no faster than one point every 20 seconds.

Spectrometers

LabQuest App supports the following USB Spectrometers.
- Vernier SpectroVis (SVIS)

- Vernier Spectrometer   (V-SPEC)
- Ocean Optics Red Tide (SPRT-VIS, SPRT-UV-VIS, ESRT-VIS)
- Ocean Optics USB2000
- Ocean Optics USB4000 (SP-VIS, SP-UV-VIS)

LabQuest may require the user of a powered USB hub with some SP-VIS units.

All spectrometers are auto-ID; connect a device, and select New from the File menu of LabQuest App if the spectrometer is not immediately found.

Spectrometers have their own specialized data collection modes and units. They can measure Absorbance, % Transmittance, and Intensity. Absorbance and Transmittance units require calibration with a clear cuvette before you can collect data. Intensity report the raw light intensity detected as a function of wavelength, and so does not require calibration.
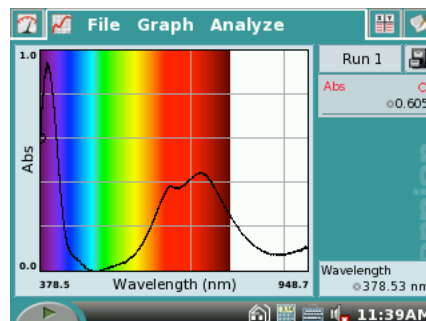
Once the data collection units are chosen, a data collection mode can be chosen. Modes appropriate for spectrometers are Time Based, Events with Entry, Selected Events, and the default, Full Spectrum.

In Full Spectrum mode the LabQuest App will display the chosen units (Absorbance, Transmittance or Intensity) as a function of wavelength. This graph allows you to inspect the entire spectrum for features, often for further analysis by choosing to collect data at only one wavelength.

Spectrometer Calibration

Calibration requires a cuvette filled with only the solvent used for your sample.

1. Tap the meter on the Meter Screen, and choose Calibrate.
2. Place the clear cuvette in the spectrometer.
3. Wait for the lamp warmup period to elapse. Skipping the warmup period may result in poor calibration.
4. Tap Finish Calibration. After a moment the message Calibration Completed will be displayed.
5. Tap OK to accept the calibration, or Cancel to discard.

This calibration will persist through the session in LabQuest App. Once the spectrometer is calibrated, you can proceed to make absorbance or transmittance measurements in any of the appropriate data collection
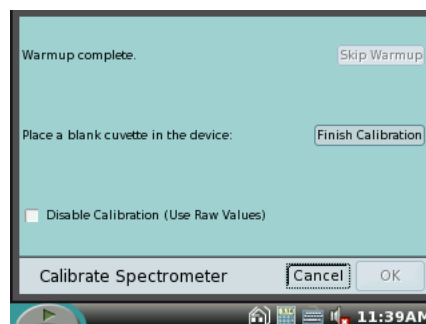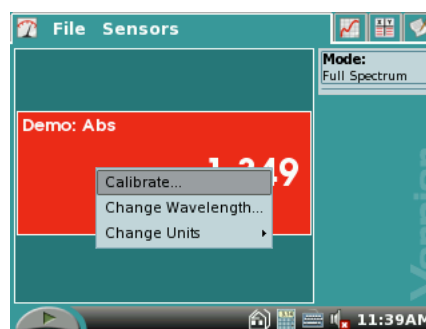
modes.

View Full Spectrum

Once a spectrometer is calibrated, place a sample in the cuvette holder. Tap Collect. Absorbance, Transmission or Intensity will be displayed as a function of wavelength. The spectrum will be updated as quickly as possible, with the previous spectrum replaced by the current one. When you tap Stop, the latest spectrum will be retained.

Change Wavelength

After observing a full spectrum sample (or if you already know the desired wavelength setting), return to the Meter screen. Tap the meter, and choose Change Wavelength… to reach a dialog where you can enter the desired wavelength in nm. This setting is used for modes other than Full Spectrum, so that the LabQuest App reports the current reading at the selected wavelength. This reading would then be collected as a function of time or events.

Example Spectrometer Application: Beer's Law

To illustrate the sequence of steps commonly used with a spectrometer, consider setting up a Beer's law experiment, where the ultimate goal is a graph of absorbance versus concentration of a sample of nickel sulfate at the wavelength of peak absorption. Making use of the details already given earlier, the general steps are as follows.

1. Prepare a selection of various concentrations of nickel sulfate, including a zero concentration cuvette with only the solvent.
2. Calibrate the spectrometer using the zero concentration (blank) cuvette.
3. Place one of the non-zero concentration cuvettes in the spectrometer, and measure the absorbance as a function of wavelength. From this graph, select the desired wavelength.
4. Set the chosen wavelength for further single-wavelength data collection. LabQuest App chooses the wavelength of maximum absorbance by default.
5. Change the data collection mode on the Meter tab to Events with Entry. Label the Entry column as Concentration, with units of mol/L.
6. Start data collection; place the lowest concentration cuvette in the spectrometer.
7. Tap Keep; enter the concentration when prompted.
8. Put in the next sample, tap Keep, and enter that concentration. Repeat this step for all samples.
9. Tap Stop.
10. Inspect your graph of absorbance versus concentration. If desired, fit a linear function to the data. After a linear fit has been performed, you can also interpolate between data points using Interpolate from the Analyze menu. This lets you estimate the concentration of an unknown sample using a reading on the meter screen.

Settings for Full Spectrum Mode

The Data Collection dialog for Full Spectrum Mode contains several settings for advanced users.
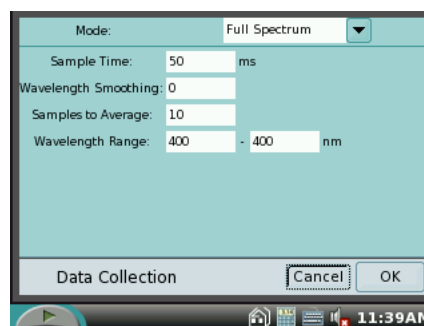
Sample Time

The Sample Time adjusts how long the spectrometer collects light for each sample. This value is set by the calibration routine, so changing it subsequently will ruin the calibration. Altering this value is useful for intensity measurements to keep peaks in range.

Wavelength Smoothing

Wavelength Smoothing adjusts the number of adjacent readings on either side of a given value that are used to calculate an average value. Increasing this number will smooth a full spectrum, effectively reducing the wavelength resolution.

Samples to Average

This sets the number of temporal samples taken to calculate an average. Increasing this value can improve the signal-to-noise ratio.

Wavelength Range

The Wavelength Range can be reduced before a calibration to optimize the calibration for that wavelength range. The particular spectrometer model determines the default wavelength range.

Additional LabQuest Tools

Across the bottom of the screen are icons for Collect, Home, Scientific Calculator, Keyboard, Sounds, Battery, and the current time.

Tapping the Home icon displays a menu for launching applications. Periodic Table, Sound Recorder, and Stopwatch applications are also available. You do not need to quit LabQuest App to launch another application.

A standard scientific calculator is called by tapping the Calculator icon. The calculator uses algebraic notation. You can use this calculator at any time; to dismiss it, tap the Calculator icon again. You can copy a calculator result and paste it into the Notes tab.

A QWERTY keyboard is called and hidden by tapping the keyboard icon. Often you will not need to summon the keyboard, as it will be displayed whenever alphanumeric input is required.

The Speaker icon allows you to adjust the volume of sounds produced by LabQuest.

Tap the Battery icon to see a status report of battery power.
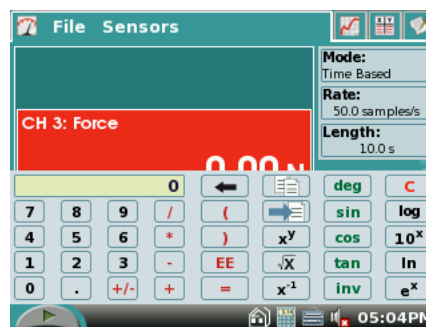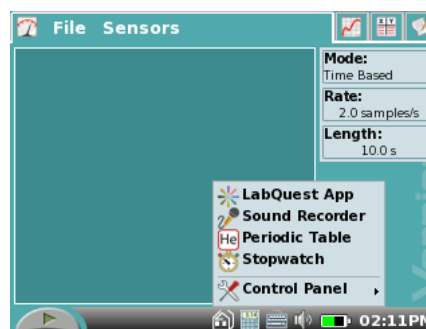
Hint: The battery icon updates every few minutes. As a result it might appear that a LabQuest, left charging while off, has not successfully charged. You can force the display to update by connecting and disconnecting the AC power supply while LabQuest App is running—or just by waiting a few minutes.

Set the time and date by tapping the time display at lower right. Usually this is not necessary as LabQuest time is synced to the computer's clock on connecting to Logger Lite or Logger *Pro*.

Accessory Applications

Several accessory applications can be launched from the Home menu. It is not necessary to leave the LabQuest App to use these accessories; to return to LabQuest App, either close the accessory using the close button in the upper right corner of the screen, or switch to the LabQuest App using the window button in the upper left corner.

Sound Recorder

The sound recorder is used to capture short audio clips, typically for voice notes. To record a clip, tap the round green record button. To stop, tap the square red stop button. Play the clip back using the green play button. The disk button allows you to save the clip, which can later be opened using the open file folder icon. The blank page icon clears out any current audio clip.

Tip: Use Sound Recorder to quickly make audio notes on experiments.

Periodic Table

The Periodic Table contains standard reference information on the elements. Tap an element to see details; close the detail window using the upper right close button.
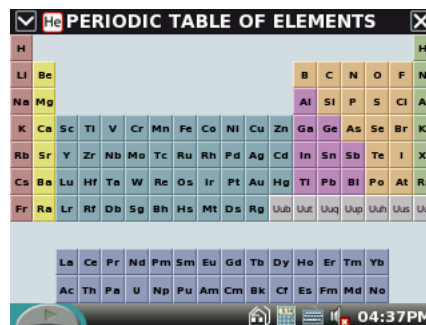
Stopwatch

The Stopwatch Application is a simple timer. Tap the start button to begin timing; tap it again to stop. Subsequent taps will continue to start and stop the timer. Tap the middle reset button to return the timer to zero. The copy button will place the current time on the clipboard for pasting into the Notes screen of LabQuest App, or into the calculator.

Control Panel

The Control Panel gives access to settings on LabQuest. To dismiss a control panel, tap the close button in the upper right corner of the screen.

Calibrate Screen

Use this if the screen does not respond to taps in the locations you expect.
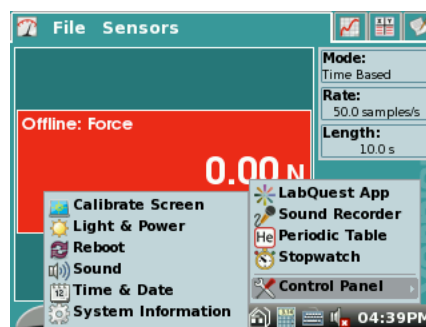
Tip: If the screen calibration has been changed so that you cannot tap on menus, use the hardware keys to display the home menu, cursor keys to highlight Control Panel, press right arrow to display the submenu, then cursor keys to highlight Calibrate Screen. Select that item by pressing OK. This will start the calibration routine without relying on the touch screen.

Light & Power

Light & Power controls screen brightness and the time to dim screen. A brighter screen users more battery power.

Reboot

Restarts LabQuest.

Sound

Sound controls sound output volumes for both the internal speaker and for any externally connected speakers.

System Information

Displays the version numbers of installed software. There are multiple tabs in this display. The Device tab includes a button marked Display License that will show the full text of the GPL software license. The Region tab contains a choice of display languages.

Time & Date

This item contains settings for time and date. When LabQuest is connected to a computer, the internal clock is set automatically.

Set LabQuest Language

LabQuest App can display menus in English, French, Italian, Spanish and German. To set the device language, open the Control Panel described above, and choose System Information. Select the Region tab, and choose the desired language. A restart will be required.
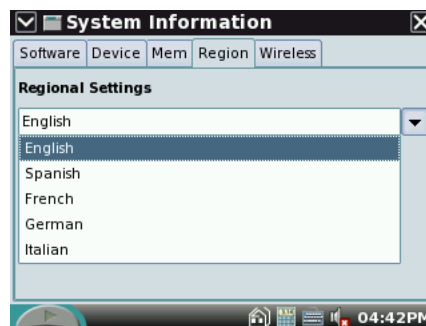
Hardware Keys on LabQuest

The front panel of LabQuest contains keys that allow you to perform many tasks without a stylus. The Collect button duplicates the on-screen collect button. The remaining buttons are:

- Escape. Dismisses a menu or dialog and takes no action.

- Screens. Cycles through the screens of LabQuest App.

- Menu. Pulls down the first menu available; to see additional menus use the right arrow key.

- Home. Displays the Home menu.

- OK. Executes the selected action.

- Cursor keys. Use these arrow keys to move through a menu or between menus, or to move the examine cursor across a graph.

The power button at upper left is used to place the LabQuest in a low-power state, and to wake it from that state. The LabQuest is not completely off when in the low-power state, and so the battery will eventually discharge when left in this state.

If you have unsaved data when you press the LabQuest power button, LabQuest App will prompt you to either save or discard the data before turning off. Or, if you press and hold the power button for more than five seconds, LabQuest will turn off, discarding any unsaved data.

LabQuest protects your data in low-battery situations. Shortly before the battery lacks sufficient charge to power LabQuest, LabQuest App will end any data collection in progress, and save data to a temporary file. Later, when LabQuest is recharged and LabQuest App restarts, you'll be prompted to either open or discard the temporary file.

When LabQuest turns on, LabQuest App is restarted, cleared of any previous data or sensor setup.

Care of LabQuest

LabQuest Battery

The LabQuest screen will dim after a few minutes of no use, even during data collection. However, it will not turn itself off until the battery is almost discharged. No data will be lost, as LabQuest App will save a backup file before shutting down.

Use only the supplied AC adapter to charge the LabQuest battery.

The LabQuest uses a high-quality lithium ion battery. This is the same chemistry used in premium laptop and cell phone batteries, and you can expect similar performance. There is never a need to condition the battery by regular full discharge/charge cycles.

To optimize battery day-to-day battery life, set the screen brightness to the minimum acceptable level, and turn off the LabQuest when it is not in use. Disconnect any sensors you are not actively using. Charge the LabQuest overnight before use to start the day with a full charge.

The battery takes about ten hours to completely charge. It is safe to leave the battery charging indefinitely, and there is no need to fully discharge the battery before charging. Battery life will depend on the sensors used, but in most cases you can obtain six or more hours of use of the LabQuest between charging.

For use with a computer either the battery must be charged or the LabQuest must be connected to AC power. The LabQuest cannot operate on USB power alone. When the LabQuest is turned off, the USB connection will, however, slowly charge the battery.

The long-term life of the battery will vary, but you can expect about three hundred to four hundred full charge/discharge cycles before the battery will need to be replaced. In this count, a charge from half-way to a full charge would count as half of a charge cycle. Exposure to temperatures over 35°C will significantly reduce battery life.

As a battery reaches the end of its useful life, the run time will become shorter and shorter. Eventually the run time will be too short for your application, and you will want to replace the battery.

Rechargeable batteries are considered a consumable, and as such are warranted for one year. In typical school use, however, the batteries will last for three years or more. Replacement batteries (order code LQ-BAT) are available from Vernier at low cost. Recycling information is available at www.rbrc.org.

LabQuest Case and Screen

The LabQuest is water and shock resistant. Do not submerge in liquids. Wipe clean with a damp cloth only; do not use any solvents including ammonia or glass cleaners.

Stylus Tether

LabQuest includes two styli and a tether. If desired, you can attach the tether to a stylus and the LabQuest. Additional styli are available from Vernier.

The LabQuest Emulator

The LabQuest Emulator (LQM) is included on the LabQuest CD. It is also available for download from www.vernier.com/labquest/updates

The LQM is computer software that can be used to demonstrate the functions of a LabQuest on a computer.

Tip: Use LQM to project the LabQuest for a group presentation. The emulator performs almost all functions of the LabQuest itself, including collecting data from a LabQuest unit connected to the computer.

Tip: Use LQM to make screen shots for written documentation. Most of the screen shots in this guide were made using LQM.

LQM is currently available for Windows XP and Vista only. A Macintosh version is planned.

Update LabQuest Internal Software

The LabQuest is a computer running its own version of the Linux operating system, and the LabQuest App, the Periodic Table and other features are programs that run in the operating system.

The LabQuest App will be updated from time to time to introduce new features and to improve performance. Most users will want to run the latest version available. Free updates are available from www.vernier.com/labquest/updates

Determine Internal Software Version

From the Home menu, choose Control Panel → System Information.

Install LabQuest Updates

Consult instructions at www.vernier.com/labquest/updates for details.
LabQuest devices can be upgraded either by placing certain files on a USB drive or SD card, or using a computer.

Upgrade LabQuest using a USB drive
1. Browse to www.vernier.com/labquest/updates
2. Follow the link there to the update download, and follow instructions found on the download page.

Upgrade LabQuest using a computer
Computer-based upgrades will be available beginning with Logger *Pro* 3.6.1, available in summer of 2008.

Specifications

LabQuest device

- ✓ 7 cm × 5.3 cm (8.9 cm diagonal) touch screen
- ✓ 320 × 240 pixel color graphic display
- ✓ Mass 350 g including battery
- ✓ 416 MHz Application Processor
- ✓ LED backlight
- ✓ Easily visible outdoors
- ✓ Excellent graphing and analysis capabilities
- ✓ Stylus and touch screen for navigation and user input
- ✓ 4 push buttons for quick function access
- ✓ 5-button navigation cluster
- ✓ On/off switch
- ✓ On-screen keyboard, plus easy ability to take notes during experiments
- ✓ 50 embedded experiments
- ✓ Periodic table application
- ✓ Software stopwatch application
- ✓ Six channels for Vernier sensors
- ✓ USB Standard-A port
- ✓ USB mini-AB port
- ✓ DC power jack
- ✓ SD/MMC expansion slot
- ✓ Audio In/Microphone/Out
- ✓ Rechargeable, high-capacity Li-ion battery
- ✓ DC charging/powering through external adapter (included)

Data Acquisition

- ✓ Works with most existing Vernier sensors
- ✓ 100kHz data collection rate (one sensor)
- ✓ 40 MB on-board data storage with expansion through SD/MMC card or USB drive
- ✓ 12-bit resolution
- ✓ Built-in air temperature sensor, microphone

Additional LabQuest Notes

LabQuest does not work with certain sensors.

- Wireless Dynamics Sensor System (WDSS). Bluetooth support is planned but is not available at this time.
- Digital Control Unit (DCU). LabQuest does not support the DCU at this time.
- Go!Temp. LabQuest does not support data collection from a Go!Temp.
- Go!Link. LabQuest does not support the Go!Link. Connect analog sensors directly to an analog port on LabQuest.
- Go!Motion. LabQuest does not support a USB connection to Go!Motion. Use a Motion Detector cable (MDC-BTD) instead.

The original release of LabQuest App (1.0, released fall 2007), did not support spectrometers, radiation monitors, blood pressure sensors, or rotary motion sensors. The internal microphone was not available for data collection.

LabQuest does not support any kind of wireless networking at this time.

LabQuest does work with most older Vernier sensors. An adapter, DIN-BTA, is required for sensors with a round, 5-pin DIN connector. Such sensors will not auto-ID, but can be set up manually using Sensor Setup found in the Sensors menu.

Curriculum Resources from Vernier Software & Technology

See www.vernier.com/cmat for a complete list of curricular materials available for LabQuest. Activity books contain multiple versions of activities, prepared for LabQuest, computer-based data collection using Logger *Pro*, and other data collection platforms.

Troubleshooting

Reset Your LabQuest

If your LabQuest stops responding, reset it. There are three ways to reset the LabQuest. Try these in the order listed below.

1. Soft Reset: For a low-impact restart, tap the Home icon on the bottom panel, select Control Panel, and then select Reboot.

2. Medium Reset: Reboot from the Control Panel as in the Soft Reset above. When the screen goes black, press the Reset button on the back of the LabQuest right below where the stylus slides into place. Use the stylus to press and hold the button for a several seconds.

3. Hard Reset: The last thing to try is the reset button on the back of the LabQuest right below where the stylus slides into place. Use the stylus to press and hold the button for a couple of seconds.

Note: Do not use a Hard Reset unless both the screen and hardkeys are not responding.

Get Additional Help

Additional help on using your LabQuest is available at www.vernier.com/labquest You may also contact Vernier directly at 888-837-6437 in the United States, or using info@vernier.com.

If your LabQuest was purchased outside the United States, please contact your distributor for assistance.

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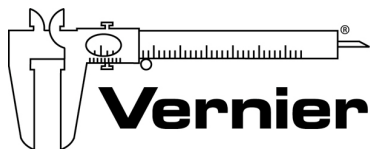
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Source code will be made available for download, or you may request a CD-ROM of the code. A shipping and handling fee will be charged for a CD-ROM.

The exact terms of GPL, LGPL and some other licenses are provided to you with the source code distribution. You may also read the license at http://www.gnu.org/licenses/

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