V E R N I E R   S O F T W A R E   &   T E C H N O L O G Y

The Caliper

Volume 18 Number 1 Spring 2001

Vernier

The Caliper is a Publication for Users of Vernier Products

2001 OREGON BUSINESS 100 BEST COMPANIES TO WORK FOR

Vernier Celebrates 20th Anniversary!

Vernier Software & Technology celebrates its 20th anniversary this summer. It has been an amazing period of growth and change for our company, and for the world of computers in general. Our first programs could easily fit on a 127-k Apple® II 5 1/4-inch disk. They were about the same size as the splash screen that appears for approximately one second when you start Logger *Pro*™. The first programs ran on 1-MHz machines; our programs now run on 1000-MHz machines.

In 20 years, our company has grown from two part-time people in a house and garage to about 60 people in a 30,000-ft^2 office building. We have great employees and we are proud to have been named by *Oregon Business* magazine as one of the "100 Best Companies to Work For" the past two years.

You will see a time line with some of the major events in the development of Vernier Software & Technology in this newsletter. We have had 20 consecutive years of growth and we thank you, our loyal customers, for your support. We will be sponsoring 20th Anniversary events at both the AAPT and the ChemEd 2001 meeting this summer. We hope to see you at one of these events to thank you in person!

David Vernier (circa 1981) with some of his students and, of all things, a Vernier caliper.

NEW! Sound Level Meter

We have sold microphones for many years. They record waveforms for tuning forks, musical instruments, human voices, etc. Over the years, many teachers have asked for a way to collect sound levels in decibels. Our newest sensor, the Sound Level Meter, makes this possible. The Sound Level Meter has an output port so that it can be connected to any of our interfaces. The input range of the sensor is 30 dB to 130 dB. The Sound Level Meter also has an LCD display, which allows you to use it as a stand-alone device.

You can collect sound level data in many real-world situations:

- Before, during and after a concert or dance.
- Throughout the day in a school hallway or shopping mall.
- Judge cheering contests at pep rallies.
- Outside and inside a car equipped with a stereo system.
- Make and test a model of an ear and ear canal.

Sound Level Meter *(for Vernier LabPro™, CBL 2™ and CBL™)*
Order Code SLM-BTA $209

Sound Level Meter *(for ULI and Serial Box Interface)*
Order Code SLM-DIN $207

IN THIS ISSUE

NEW! Data Collection Accessories

We have two new ways to make it easier to collect data outside the classroom.

The **DataVest** holds a LabPro or CBL 2, calculator, and several sensors. It is perfect for collecting data on amusement park rides where you don't want your equipment flying around.

DataVest .... DV $26

No longer will you hear your students say, "Ms. Jones, my LabPro fell in the lake!" The **Vernier Neck Strap** secures the LabPro or CBL 2 and calculator around your student's neck. This allows for water quality testing without the risk of dropping the equipment in the water!

Vernier Neck Strap .... VNS-5 ....5 straps/$15

Amusement Park Physics

A popular use of our sensors and LabPro or CBL 2 is collecting data at amusement parks. The most commonly used sensors are the Low-g Accelerometer, 3-Axis Accelerometer, and Barometer. The accelerometers are used to measure the accelerations experienced in rides, and the Barometer is used to measure relative heights. We have two new guides to help you with this type of data collection. *Data Collection at the Amusement Park* is a manual written by Clarence Bakken, a physics teacher at Gunn HS in Palo Alto, CA. Clarence has been collecting data at amusement parks since 1995. Much of the manual is built around his use of our equipment at Paramount's Great America Physics Day in Santa Clara, CA. He provides specific instruction on the use of sensors, Logger *Pro* computer software, and the DataMate or Physics calculator programs. This manual can be downloaded free from our web site.

Another source of information is *Amusement Park Physics* by Nathan Unterman, a physics teacher at Glenbrook North HS, IL. This new book provides a wealth of information about planning an amusement park study program in your classroom. The book comes complete with student sheets for activities that can be performed at amusement parks or carnivals. The selection of activities is large enough that you can pick activities specific to your situation. Traditional equipment (such as spring accelerometers) and technology-based equipment (such as our accelerometer) are both discussed. Activities and sample data are provided for those who do not have access to an amusement park. The book includes tips on managing amusement park field trips.

Amusement Park Physics .... APP $21.95

Vernier in Antarctica

Vernier sensors have been used for exciting data-collection activities in some interesting locations over the years. We can now count Antarctica among these. From January 5 to February 7, 2001, chemistry teacher Kevin LaVigne from Hanover HS, NH, participated in a program called "Teachers Experiencing Antarctica and the Arctic." Kevin joined a research team under the direction of Drs. Ross Virginia (Dartmouth College) and Diana Wall (Colorado State University) that is studying life in extreme environments. This team is conducting on-going research into the Antarctic nematode community and the soil chemistry that supports this community.

One of the tests Kevin performed involved monitoring soil pH at 15-minute and 2-hour intervals. He quickly realized that the pH meter that had been sent to the site for this purpose was not performing at the level required to collect the necessary data. Fortunately, Kevin had a LabPro and a Vernier pH Sensor with him. The probe was used to collect over 200 soil pH readings, and Kevin was asked to leave it behind so that it would be available for the team to use next year!

Kevin LaVigne tests soil samples using the Vernier pH Sensor and LabPro.

The TEA ("Teachers Experiencing the Antarctic and the Arctic") program is supported and directed by the Army Corps of Engineers Cold Regions Research and Engineering Laboratory, Rice University, and the American Museum of Natural History. Additional funding is provided by the National Science Foundation. If you would like more information about Kevin's experiences or about TEA, check out http://tea.rice.edu/tea_lavignefrontpage.html.

Original CBL—at a Great Price!

Even though CBL 2 and LabPro are replacing the original CBL, we still have some original CBLs available. If you are on a limited budget or want to supplement the CBLs that you already have, the CBLs are available for $83 each (order code CBL).

The Caliper is published semiannually by Vernier Software & Technology. It is distributed free of charge to Vernier customers.

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Respiration and Photosynthesis Using the CO_2-O_2 Tee

Would you like your students to discover what really happens to gas levels during respiration and photosynthesis? The CO_2-O_2 Tee (order code CO2-TEE, $5) now makes this possible. The CO_2-O_2 Tee can be used with a CO_2 Gas Sensor and an O_2 Gas Sensor to monitor gaseous carbon dioxide and oxygen levels simultaneously in a closed system. The Tee is designed to fit snugly into the neck of the 250-mL Nalgene bottle that ships with both sensors, as shown in Figure 1. With the bottle on its side and the tapered end of the Tee inserted into the bottle, the O_2 Gas Sensor fits into the top opening of the Tee while the CO_2 Gas Sensor fits into the opening directly across from the bottle.

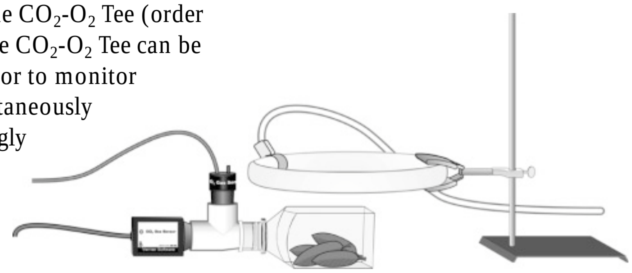


Figure 1 Photosynthesis

For an easy, yet elegant, photosynthesis/respiration experiment, put some leaves or small plants into the Nalgene bottle and set up a round, 30-W, fluorescent light, as shown in Figure 1. The data in Figure 2 was taken with eight Wisconsin Fast Plant seedlings planted in a 50/50 mixture of vermiculite and peat. The seedlings were one week old. Initially, the bottle was wrapped in aluminum foil so that the plants were in the dark. The aluminum foil was then removed and the light turned on to allow photosynthesis to occur. This can also be done with fresh-cut spinach leaves, as shown in Figure 1.

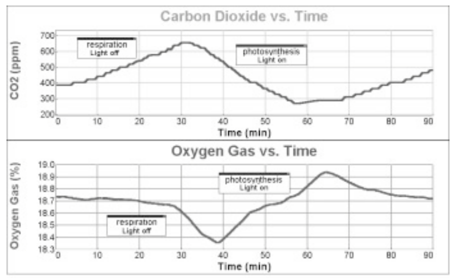


Figure 2

An experiment file for monitoring both gas levels simultaneously is available in Logger *Pro* 2.1.1 in the CO2 Gas Sensor or the Oxygen Gas Sensor folder. The file is called CO2 & O2.mbl.

Calculator Program Update

If you are using DataMate with a LabPro or CBL 2, you might be interested in version 6.13 of the program. The most important changes in the version are the following:

- Prevention of data loss when an auto-ID sensor is unplugged. In previous versions of DataMate, the program would automatically check for a new sensor when an auto-ID sensor was unplugged. In the process, any data in the calculator would be deleted. To prevent this, the program now performs an automatic sensor check only when a new auto-ID sensor is plugged in or when the CLEAR button is pressed.
- Improved power management for long-term data collection
- Support for our Sound Level Meter.

This version is now available as a part of our latest firmware update. The update can be downloaded from our web site at www.vernier.com/calc/glupdate.html. Download and install the firmware update onto your LabPro or CBL 2 and then transfer DataMate to your calculator.

Our PHYSICS program for the original CBL has been updated to support the new Sound Level Meter. The updates can be downloaded from our web site at www.vernier.com/legacy/cbl/progs.html.

Back in 1987 . . .

Opening of first office outside of the house.

10 years ago in this newsletter

We introduced our first book of experiments, *Chemistry with Computers*, by Dan Holmquist and Don Volz. We introduced our newest sensor, the Barometer/Pressure Sensor. We also discussed running Apple II programs on the new Macintosh LC.

1981

Placed first ad in AAPT *Announcer*

First Apple II programs: Kinematics, Projectiles, Wave Addition, Orbit, Charged Particles, Vector Addition

1982

Attended first conference (AAPT)

Graphical Analysis for Apple II

First data collection program: Precision Timer for Apple II

1984

Published first Newsletter

Attended first NSTA National Convention

First Macintosh® at Vernier

Temperature Probe systems, in kits & assembled

1985

Voltage Plotter for Apple II

First hard drive at Vernier

1986

First laser printer at Vernier (Apple LaserWriter)

How to Build a Better Mousetrap

1987

Smart Pulley Timer

pH System, parts kit or assembled

Part of company moves out of garage & house

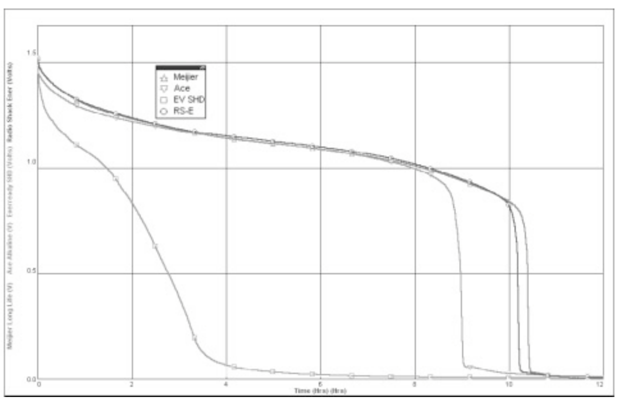
First IBM® computer at Vernier

Innovative Uses

Parker Moreland, Danbury, CT, has come up with many clever uses of our products over the years. This time, he performed a simple experiment using Logger *Pro*, LabPro, and four temperature probes. It is a study of how well various insulated tumblers keep a liquid warm. The best was an expensive, vacuum tumbler, followed by an inexpensive, polystyrene double-walled tumbler, then a polypropylene double-walled mug, and finally a thin, glass tumbler. Eight ounces of hot water was poured into each tumbler and a temperature sensor was placed in each. Parker says a surprise was that the double-walled tumblers and mugs that are so popular now are only a little better than glass.

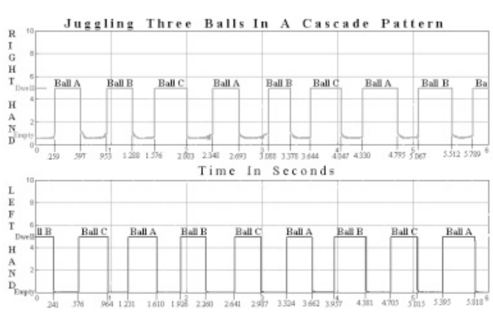
Data Collection in Elementary School

Keith F. Forton (Traverse City Central HS, MI) has had great success using our data collection equipment in elementary schools. He has done studies using Thermoses® (similar to the one above), batteries, and a sound meter. He has found elementary students to be very excited about studies like these. Here is a sample student graph showing four different batteries used under the same load conditions.



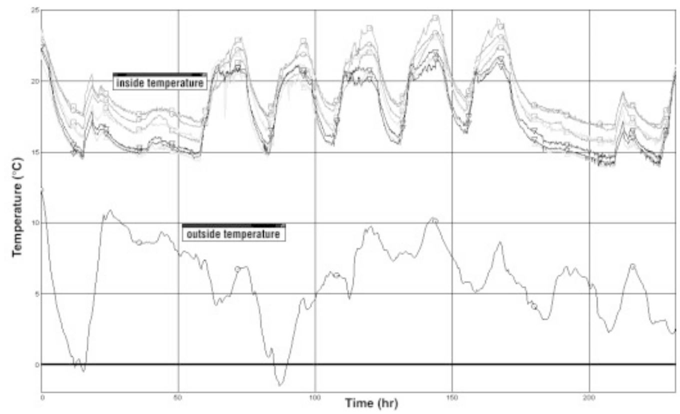
Juggling with Logger *Pro*

Check out www.jug.net/wt/jgpl.htm for a remarkably complete collection of information about the science of juggling. William V. Thayer, (St. Louis CC at Meramec, Kirkwood, MO) even includes this sample graph made with Logger *Pro* showing the position of the balls during a juggling session. He made this graph using special gloves with aluminum-foil strips wired so that if adjacent strips were shorted out, the voltage goes to five volts. He then juggled metal-coated balls, reading the voltage from each glove using Logger *Pro*. From the information in this graph, you can find the time that the ball stays in the hand, the height of each toss, and lots of other interesting information.



Long-Term Remote Data Collection

LabPro and CBL 2 can collect data without being attached to a computer or calculator. Long-term remote data collection can easily be done with either of these interfaces by batteries. The maximum duration of data collection depends on which sensors are used and the data rate chosen. The graph below shows temperature data collected on seven LabPros over a period of 10 days. The LabPros were positioned throughout our building and collected data at a rate of six samples per hour. The same seven LabPros were used for two more 10-day data collection runs. After 20 days, all seven LabPros were still going strong. At the end of 30 days, three of the seven sets of batteries were dead.



Temperature of the Vernier office over a period of 10 days collected on seven LabPros positioned throughout the building.

Some sensors, such as our CO_2 Gas Sensor and Dissolved Oxygen Probe, need to have continuous power supplied to them. This limits the length of time you can collect data in the field, but with a little planning, you can have a successful experiment. The CO_2 Gas Sensor will last approximately six hours when powered by four AA batteries. The Dissolved Oxygen Probe should last eight hours. The data rate does not affect the power usage in this case, since the power to the sensors is always on. If your experiment calls for data collection over an extended period of time, the External Battery Cable (order code EBC, $6) allows you to use a 6-V lantern battery to power your LabPro or CBL 2 when AC power is not available. This makes it possible to collect data with the CO_2 Gas Sensor for up to 54 hours and for approximately 72 hours with the Dissolved Oxygen Probe.

While this is only one example of long-term remote data collection, it provides some good guidelines for planning your next remote experiment.

Support Materials for Grants

Many of you have requested support material for grant proposals or justification to your administrators for the use of technology for data collection. A bibliography of articles and research papers about the use of computers and calculators for data collection is now available on-line at www.vernier.com. Many of the articles and papers are available on the web, and links have been made to those pages from the bibliography. Click the News button on our home page for more information.

Battery-Saving Tips for LabPro

One of the great features of LabPro is that it can be powered with batteries rather than using AC electricity. The following tips should help you prolong the life of your batteries when collecting data using LabPro and a calculator or computer.

- Quit the DataMate program when you are finished collecting data with the calculator.
- Make sure the power to the LabPro is turned off before storing it. Do this by removing all sensors from the LabPro, then pressing the Start/Stop button followed by the Quick Set-Up button. Two red flashes and beeps indicate the power is OFF.
- Whenever possible, use the AC Power Supply with sensors that either draw a lot of power or need to be continually powered. These sensors include the CO_2 Gas Sensor, Dissolved Oxygen Probe, EKG Sensor, Motion Detector, Flow Rate Sensor, pH Sensor, Dual-Range Force Sensor, Ion-Selective Electrodes, and the Turbidity Sensor. An alternative is to use the External Battery Cable (order code EBC, $6) with a 6-V lantern battery.
- Always exit Logger *Pro* with the LabPro still attached to the computer.
- Update your Logger *Pro* software to version 2.1.1. It has better power-saving features than previous versions.
- For long-term storage, remove one battery.

Science Humor

Q: What do you call a part-time band leader?

A: A semi-conductor.

(Thanks to Jo King, Caprock HS, Amarillo, TX, for sending this one!)

Q: Why do chemists like nitrates so much?

A: They're cheaper than day rates.

Have you upgraded your version of Logger *Pro* lately?

You can download a new version from our web site for free. Simply click on "Logger Pro 2.1.1 update" on our Home page.

Workshops

Chautauqua Short Courses: Promoting Active Learning in Introductory Physics Courses

Instructors: Priscilla Laws, David Sokoloff, and Ronald Thornton

May 10-12, 2001, Dickinson College, Carlisle, PA.

August 3-5, 2001, University of Oregon, Eugene, OR.

These NSF-sponsored courses are open to college teachers. High school teachers are also admitted if space is available. There is a small application fee, but no tuition. For more information contact David Sokoloff at sokoloff@oregon.uoregon.edu.

Physics Modeling Workshops

Sponsored by Arizona State University, these 1- to 3-week long modeling workshops provide opportunities for science teachers to strengthen their background in the use of the Modeling Instruction pedagogy and the appropriate use of technology in the science classroom. See the Modeling Instruction Program web site at http://modeling.la.asu.edu/modeling-HS.html for times and locations.

Teachers Teaching with Technology™ (T³™)

T³ provides training for educators who are interested in enhancing the teaching and learning of mathematics and science through appropriate use of educational technology. Workshops that will be held this summer include Chemistry/Biology and Enviromental Science. For details, see www.t3ww.org/t3/pdmenu.htm.

Two-Day Hands-On Training: T³ Vernier Affiliate Workshops

Extensive training on how to collect data with TI Graphing Calculators and Windows or Macintosh computers. The dates and locations of the workshops are May 30-31 (Katy, TX); June 4-5 (Waco, TX); June 21-22 (Columbus, MS); June 25-26 (Palm Harbor, FL); July 10-11 (Indiana, PA); July 18-19 (Pomona, NJ). For local contact information and details, see www.t3ww.org/t3 or www.vernier.com.

AP Environmental Science Workshops

North Carolina State University, Raleigh, NC, June 18-22. Contact Charles F. Lytle at lytle_bio@ncsu.edu.

The Bolles School, Jacksonville, FL, July 9-13. Contact Ted Lyon at lyont@bolles.org.

Integrating Computers into Laboratory Instruction

This conference for university, college, and secondary science chemistry faculty will be held at Montana State University, Bozeman, July 11-13. Contact John Amend, Professor of Chemistry, Montana State University, jamend@montana.edu.

1988

Graphical Analysis (MS-DOS®)

Precision Timer (MS-DOS)

1989

First FAX number at Vernier

MPLI interface for Apple II & MS-DOS

First Vernier e-mail address

Standard Temperature Probe

1990

Universal Lab Interface (ULI)

MacMotion, MacTemp, Event Counter, Event Timer, & Data Logger

Light Sensor

Magnetic Field Sensor

1991

Chaos in the Laboratory

Barometer/Pressure Sensor

Graphical Analysis (Macintosh)

1992

Student Force Sensor

Heart Rate Monitor

1993

Serial Box Interface

Colorimeter

ULI Timer

1994

Introduction of CBL by Texas Instruments

Direct-Connect Temperature Probe

MS-DOS versions of ULI programs

Event Counter

MPLI for Windows®

Accelerometer

Move to new office building

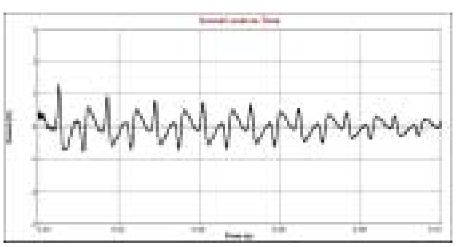
Speed of Sound in Air

There are a number of ways to measure the speed of sound in air. Some use simple equipment, and others use computer- or calculator-based technology. A common, non-technical method uses a tuning fork to set up resonance in a column of air. The length of the resonating air column, along with the frequency of the tuning fork, is used to calculate the speed of sound.

Microphones and computer- or calculator-based technology provide other methods. Experiment 24, Speed of Sound, in our *Physics with Computers* and *Physics with Calculators* lab books uses such a method. In this experiment, a microphone records an initial sound and one or more echoes as the sound travels up and down the tube. The time between the initial sound and the echoes, along with the length of the tube, is used to calculate the speed of sound.

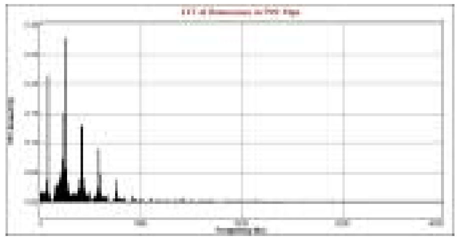
Using a microphone and calculating an FFT

Logger *Pro* software can be used to perform a Fast Fourier Transform (FFT) analysis on a set of data. The FFT tells you the amplitudes and frequencies of a collection of sine waves that, when added together, would sound the same as the original waveform. An FFT can also be used to measure the speed of sound by determining the fundamental frequency of a column of air. For example, take a 1-m section of PVC and close off one end. Loosely place a cap over the other end. When the loose cap is quickly removed, a low-pitched sound is produced.



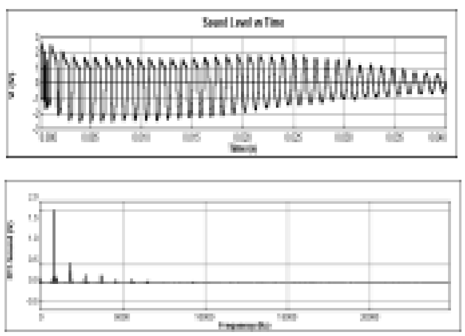
Waveform generated when one end of a closed PVC pipe is quickly removed

If an FFT calculation is performed, the fundamental frequency of the sound can be determined. In this example, the fundamental frequency is 85 Hz. The wavelength of this sound is approximately four times the length of the column. In this example, the speed of sound is 4∗1 m∗85 Hz, or 340 m/s.



FFT of waveform generated with PVC pipe

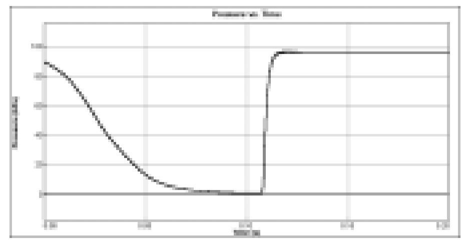
This method can be applied to other columns of air, such as a 20-mL syringe. To try this, push the plunger all the way into the cylinder. Seal the open end with a finger. With the other hand, quickly pull the plunger out of the syringe. A high-pitched "pop" will be heard. Here is a sample set of data showing the raw waveform and the FFT. In this example, the fundamental frequency of the sound is 928 Hz. The length of the syringe is 8.6 cm. Therefore, the speed of sound of the air in the syringe is 4∗0.086 m∗928 Hz, or 319 m/s. (If we corrected for the effective length of the tube (L=l+0.4 d), we would get a velocity of 348 m/s.)



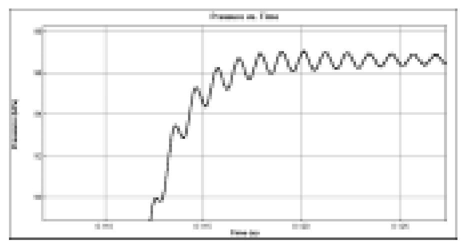
Waveform and FFT for the "pop" created as a plunger was pulled out of a syringe

Measure the speed of sound with a Gas Pressure Sensor

The 20-mL syringe mentioned above is provided with our Gas Pressure Sensor. Set up an experiment to collect pressure as a function of time. Set the experiment length to 0.2 s and the sample rate to 10,000 Hz or higher. Set triggering so that data collection begins as the pressure falls. Start the data collection and quickly pull out the plunger. A graph will show a rapidly dropping pressure and a faster return to atmospheric pressure. The region of the graph where the pressure is returning to atmospheric pressure appears to show noise. Zooming in on this region reveals a periodic variation in the pressure. The Gas Pressure Sensor is detecting a change in pressure due to the sound wave traveling up and down the syringe. It should be possible to calculate the speed of sound from this data. The time interval between the first peak and the tenth peak is 0.011 s^2, therefore, the period of the oscillation is 0.0011 s and the frequency is 909 Hz. The speed of sound would be 4∗0.086 m∗909 Hz, or 313 m/s (which corrects to 342 m/s).

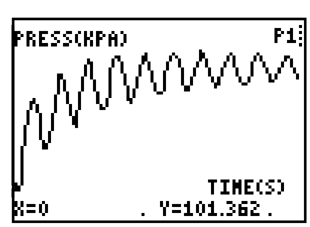


Gas pressure data collected as a plunger is pulled completely out of a syringe



Zooming in on the region where the pressure returned to atmospheric level

These graphs show data collected with a LabPro and Logger *Pro* software. The experiment can also be done with a TI Graphing Calculator and the DataMate or Physics programs. Since you cannot store as many points on the calculator, the experiment has to be designed to record only the region of interest. This is done by starting the data collection as pressure returns to atmospheric pressure. Set the sample intervals as small as possible. If you are using LabPro or CBL 2, set the interval to 0.0001 s. If you are using the original CBL, set the interval to 0.00164 s. Set the number of data points to 200. Set triggering to occur as the pressure increases and the trigger level reaches 40% of the atmospheric pressure.



Data collected with a LabPro, the DataMate program, and a TI-83 Plus calculator

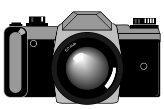
Bits and Bytes

Our Oregon state legislature is considering a bill to ban the sale of products containing mercury. Apparently Minnesota, Vermont, Maine, and New Hampshire already have similar bills. Mercury is extremely toxic and the disposal of mercury-containing products is a big problem. This is just one more reason for using our LabPro and Stainless Steel Temperature Probes.

We have been shipping our Digital Control Unit (DCU) for about two years. At first it only worked with the original CBL and, therefore, only for use with calculators. When LabPro came out, it became possible to control the DCU with a computer. We have now rewritten the DCU manual and included sample programs to help you with that programming. We explain how to use Visual Basic (Windows) and REALbasic (Macintosh), and we include sample programs in each language. The sample programs and new manuals are available at www.vernier.com/dcu/dcuprogs.html.

Biology Labs Revised to Meet AP® Objectives

There is good news for those of you using our sensors and interfaces to do the recommended AP Biology labs. Some of the experiments in our *Biology with Computers* and *Biology with Calculators* books have been updated to include activities that will help meet the recommended objectives. Of the 12 AP labs, seven of them can now be done using our data collection products: Diffusion and Osmosis (Exp. 4 and Exp. 22), Enzyme Action: Testing Catalase Activity (Exp. 6), Photosynthesis (Exp. 10), Transpiration (Exp. 7), Cell Respiration (Exp. 11), Primary Productivity (Exp. 25), and Heart Rate & Physical Fitness (Exp. 27). A correlation of AP Biology lab objectives and our objectives can be accessed from our News page at www.vernier.com/news.html. Those of you who already own our biology lab books can receive the new experiment Word files by e-mailing your request to gstahmer@vernier.com. Please include your zip code in your request for verification.



AAPT Photo and Video Contests

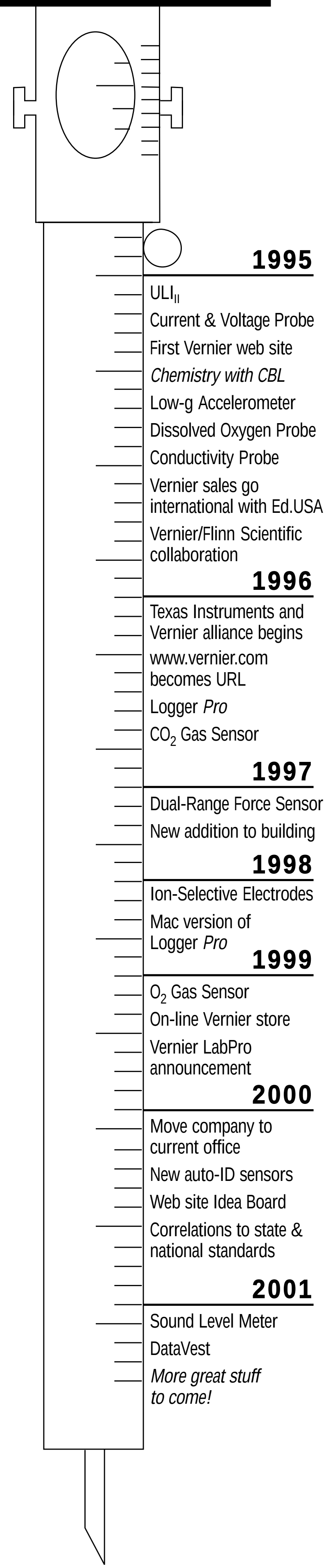
The 2001 AAPT high school physics photo contest is open to any high school student. Photos must be 8x10, in black and white or color. A paragraph (<250 words) describing the physics involved in the photograph must be included. There are two categories: Natural and Contrived.

The video contest is open to any student or faculty member. Submitted videos should demonstrate physics in action. There are two categories, Faculty and Student. Entries for both contests will be displayed and judged at the AAPT meeting in Rochester, NY. Vernier Software & Technology supplies the prizes for both students and teachers. For more information and contest rules, visit www.aapt.org/aaptgeneral/geneinfo.html.

Spectrophotometers and Logger *Pro*

Do you have a spectrophotometer that you would like to be able to interface with your computer? If so, you will be happy to learn that you can use Logger *Pro* software to collect data from Spectronic 20 series spectrophotometers (Spec 20, Spec 20+, Spec 20D, and Spec 20D+) with your Vernier interface. Note that these models all feature *analog* outputs, and are the ONLY spectrophotometers that are compatible with Logger *Pro*.

If you have a Spec 20, 20+, 20D, or 20D+, all you need is a cable (order code SPC-DIN for Serial Box Interface or ULI, or SPC-BTA for LabPro, $25) to connect your spectrophotometer to your computer interface. The Colorimeter folder in Logger *Pro* contains experiment files for Absorbance vs. Concentration and Absorbance vs. Time. We have added an additional experiment file for Absorbance vs. Wavelength to this set. To download all three, go to our web site and click on “Downloads.” Under “Free Stuff” click on “Spectrophotometer Program.”



Vernier

Free Evaluation Workshops

Join us for an evening to learn how to integrate our data-collection software, interfaces, and sensors into your classroom. These free, four-hour, hands-on workshops include dinner and lab handouts. Contact us or visit our web site for up-to-date information and registration.

April 23: Charlotte, NC
April 25: Raleigh, NC
April 26: Richmond, VA
April 30: Washington, DC

May 3: Philadelphia, PA
May 7: Newark, NJ
May 8: New York, NY
May 10: Stamford, CT

Sept. 10: San Antonio, TX
Sept. 12: Austin, TX
Sept. 13: Houston, TX
Sept. 17: Dallas, TX
Sept. 18: Dallas, TX
Sept. 20: Oklahoma City, OK

Oct. 10: Sacramento, CA
Oct. 11: San Francisco, CA
Oct. 15: San Jose, CA
Oct. 17: Los Angeles, CA
Oct. 18: Los Angeles, CA
Oct. 22: Las Vegas, NV

Nov. 12: Dayton, OH
Nov. 13: Cincinnati, OH
Nov. 15: Indianapolis, IN
Nov. 27: Miami, FL
Nov. 28: St. Petersburg, FL

Dec. 1: Orlando, FL
Dec. 3: Jacksonville, FL

Vernier Summer Workshops

Have you been looking for an excuse to visit the great Northwest? Sign up for one of our free, one-day workshops at our office in Portland, Oregon. Participants will receive intensive, hands-on experience in computer and calculator data collection. These workshops are offered on August 20, 22, and 24. Our workshops tend to fill up fast, so sign up on our web site today to secure your spot!

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