

# The Caliper

Volume 12 Number 2

Fall 1995

A Publication  
for  
Users of  
Vernier Software  
Products

## Two New Versions of Graphical Analysis!

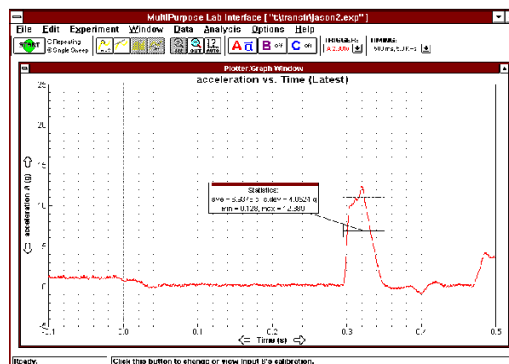
**W**e are very pleased to announce two new versions of our popular Graphical Analysis program. Graphical Analysis provides an inexpensive, easy-to-use tool for producing graphs in a science class. It can also help students learn how graphs can be used to find the relationship between variables. Graphical Analysis sells for \$49.95, which includes a high school or college department site license. Why spend hundreds, or even thousands of dollars on graphing programs that were really designed to do business graphs?

New features of the new Windows and Macintosh 2.0 versions of Graphical Analysis:

- Automatic curve fitting (polynomials, inverse, exponentials, etc.)
- Manual curve fitting (for mathematical modeling exercises)
- Text window (for teacher instructions or student notes)
- Histograms
- Full-screen printing—data table and graphs on one sheet and in one operation
- Importing of data from TI graphing calculators (and even directly from the CBL)

### Graphical Analysis for Windows®

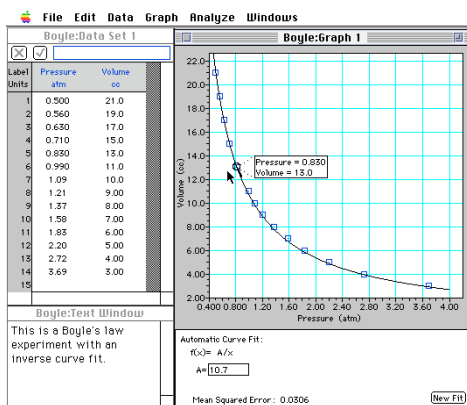
Graphical Analysis for Windows can be used with either Windows 3.1 or Windows®95. It brings all the flexibility and power you would expect in a Windows program, with the ease of use Graphical Analysis is famous for. Order code GA-WIN, \$49.95.



### IN THIS ISSUE

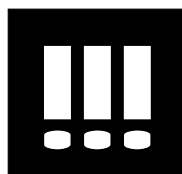
#### NEW PRODUCTS:

- GRAPHICAL ANALYSIS • WINDOWS/MAC 2.0 VERSION
- LOW-g ACCELEROMETER •
- DISSOLVED OXYGEN PROBE •
- CONDUCTIVITY PROBE •
- NEW FORCE SENSOR •
- ELECTRICITY TIPS
- INNOVATIVE USES
- SCIENCE JOKES



### Graphical Analysis 2.0 for Macintosh®

This is the first major upgrade of our Macintosh Graphical Analysis program. Current Graphical Analysis for Macintosh owners can upgrade to the new version for \$20 (send in your original disk, with our logo label). If you purchased Graphical Analysis for Mac after Sept. 1, 1995, we will send a free upgrade at your request. First-time buyers can purchase Graphical Analysis for \$49.95 (order code GA-MAC).

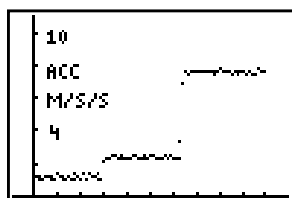


# NEW PRODUCTS!

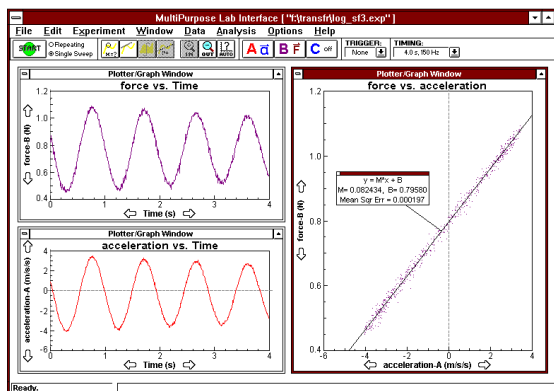
## Low-g Accelerometer

About a year ago, we introduced the first Accelerometer (order code ACC-DIN) for use with our lab interfaces and the CBL. This popular sensor has a range of  $\pm 245$  m/s/s ( $\pm 25$  g) and is great for studying collisions, centripetal acceleration, and any situation with fairly large accelerations.

Our new Low-g Accelerometer (order code LGA-DIN, \$88) has greater resolution and lower noise. Its range is  $\pm 50$  m/s/s ( $\pm 5$  g). It is perfect for use with cars (real and toy), elevators, pendula, and other situations with lower accelerations. It is sensitive enough to measure the angle of the accelerometer from horizontal (vertical component of gravity). Here are two sample graphs made with our new Low-g Accelerometer:



*Centripetal Acceleration on a Turntable at Three Different Angular Velocities—Done with a CBL and a TI-82.*

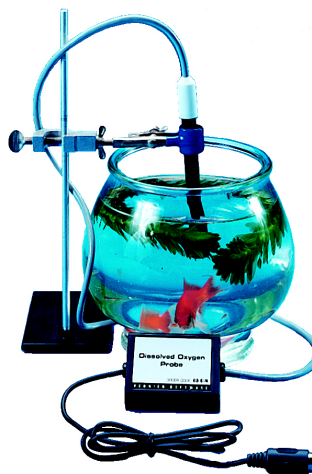


*Acceleration of a mass oscillating on a spring, including a force vs. acceleration graph—MPLI for Windows was used. (Thanks to Nusret Hisim (Walkersville HS, Walkersville, MD for the idea).*

### Attention: Web Surfers

Articles included in this newsletter, along with other useful information from Vernier Software, are located on the World Wide Web at <http://www.teleport.com/~vernier>

## Dissolved Oxygen Probe



You can now make fast, accurate measurements of dissolved oxygen in water samples using our new Dissolved Oxygen Probe. This probe, reasonably priced at \$189, has a range of 0-20 mg/L (ppm) of dissolved oxygen. It has built-in temperature compensation, which means you can do your calibrations in the lab, and then make measurements outdoors without having to recalibrate.

The probe has a fast response time, reaching 95% of full reading in 30 seconds. This probe is great for biology, chemistry, ecology, or integrated science courses.

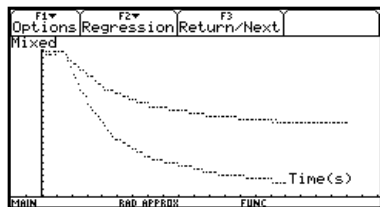
You may have heard how difficult it can be to change membranes on other dissolved oxygen probes. This is not the case with our D.O. Probe—disposable caps with pre-fit membranes allow you to quickly and conveniently change membranes. Two membrane caps are included with the probe.

Calibration is easy with this new sensor. Simply place the electrode in the zero-oxygen solution provided with the probe for the 0% calibration point. For the 100% calibration point, place the electrode in air (or better yet, in water-saturated air, using a sealable bottle that we provide). The electrode can be calibrated in any units you choose: % D.O., mg/L, or ppm dissolved oxygen.

The Dissolved Oxygen Probe can be used with any Vernier interface (ULI, Serial Box Interface, MPLI, VIU), as well as with the Texas Instruments CBL system. Dissolved oxygen data can be collected in the field using either the CBL System or a laptop computer along with a battery-powered Serial Box Interface. We will ship our first Dissolved Oxygen Probes on January 15. You can order now using the order code DO-DIN. Included in the \$189 price is the probe, amplification box, zero-oxygen solution, two membrane caps, a 100% calibration bottle, electrode filling solution, and a probe information booklet. Replacement caps are available for \$9.50 (order code MEM).

**NEW!**

## TI-92 Graphing Calculator



The new TI-92 graphing calculator from Texas Instruments will be available in early December. It features a larger, higher-resolution screen, a QWERTY keyboard, pull-down menus, and much more memory so you can collect and store more data. We have already developed programs to allow this new calculator to be used with the CBL for data collection. The sample TI-92 screen above shows data collected with a CBL. We will be selling the TI-92 for \$180 (order code TI-92).

**NEW!**

## PASCO Force Sensor

We are now selling a new force sensor designed and built by PASCO scientific. The folks at PASCO have built a deluxe force sensor designed specifically to fit on PASCO dynamics carts. As a result, it's great for collision experiments and Newton's third law experiments. This Force Sensor has two ranges ( $\pm 10$  N and  $\pm 50$  N) and a mechanical tare button. It is a very low-noise, stable Force Sensor. It is compatible with all of our interfaces and with the CBL. The new PASCO Force Sensor (order code CI-6618) sells for \$169. An optional Accessory Bracket for mounting this Force Sensor onto the PASCO Dynamics Track is sold separately for \$64 (order code CI-6564).



**NEW!**

## Conductivity Probe

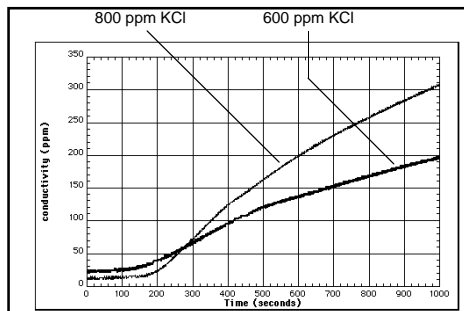
We are also proud to announce our new Conductivity Probe. This probe is great for environmental testing of water samples for salinity, total dissolved solids (TDS), or conductivity. The Conductivity Probe is useful in chemistry, biology, and physical science classes. You can perform all of the conductivity experiments in our *Chemistry with Computers*, *Chemistry with CBL*, and *Physical Science with Computers* lab manuals with this sensor. Biology teachers can use this probe to demonstrate the migration of ions through membranes or to monitor changes in ion levels (such as  $\text{HCO}_3^-$ ) in aquatic systems.

You can take readings in units of conductivity ( $\mu\text{S}/\text{cm}$ ) or concentration (mg/L and ppm as TDS or NaCl). The Conductivity Probe can monitor conductivity at three different sensitivity settings:

- 0-100 mg/L TDS or 0-200  $\mu\text{S}$
- 0-1000 mg/L TDS or 0-2000  $\mu\text{S}$
- 0-5000 mg/L TDS or 0-10,000  $\mu\text{S}$

Conductivity is directly proportional to concentration over the entire range.

The probe has a fast response time, reaching 98% of full value in less than 10 seconds. It's easy to calibrate the probe.

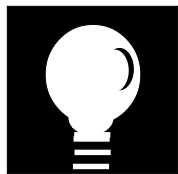


We collected this data by inserting the Conductivity Probe into a piece of dialysis tubing containing distilled water (tied off at both ends). We then suspended the dialysis tubing and probe in a beaker containing 600 ppm (mg/L) KCl solution. We then repeated the experiment using 800 ppm KCl. The difference in the rate of flow of ions through the membrane can be seen in this graph.

You can load saved calibrations using any of the Vernier data-collection programs. Alternatively, you can do a quick two-point calibration: the probe is left out of solution for one calibration point (0 mg/L) and is placed in a known standard (500 mg/L solution is provided) for a second calibration point. More precise calibration in two different standards is also possible using our software.

The Conductivity Probe uses alternating current at its electrodes; this prevents polarization and electrolysis, so that solutions being tested are not fouled. Corrosion of metal electrodes is not a problem with this epoxy-body graphite electrode. It has built-in temperature compensation, which allows you to do your calibrations in the lab, and then make measurements outdoors without temperature changes affecting conductivity readings.

We will be shipping our first Conductivity Probes on January 15. You can order now using the order code CON-DIN, \$79. Included in the \$79 price is the probe, amplification box, 500 mg/L standard calibration solution, and a probe information booklet.



# Innovative Uses

In the October 1995 issue of *The Physics Teacher*, Colin Terry (Ventura College, Ventura, CA) describes measurements of the magnetic field of a Slinky™ toy used as a solenoid. Two nice things about using the Slinky are (1) You can insert our Magnetic Field Sensor (MG-DIN) between the coils and measure the field at different positions; and (2) You can vary the coil spacing to see how it affects the field. You can even start the slinky oscillating and monitor the changes in the field with time.

The cover story in the September 1995 issue of *The Physics Teacher* was "Computer Physics on the Playground." The article contains interesting results obtained by using CBLs and Motion Detectors to study playground equipment. If you have a CBL (or a portable computer) and you teach physics, check out this article. The authors are Richard Taylor and David Hutson (J.J. Pearce HS, Richardson, TX), Wesley Krawiec (The Kiski School, Saltsburg, PA), and Jhone Ebert and Robin Rubinstein (Green Valley HS, Henderson, NV).



More articles on using our Accelerometer at amusement parks are appearing in science journals. Charles Reno (Hawken School, Gates Mills, OH) and Bob Speers (Firelands College of Bowling Green State University, OH) published a great article, "Accelerometer Measurements in the Amusement Park," in *The Physics Teacher* (September 1995). Bob Speers also published an article in the November, 1995 issue of *Sensors* magazine.

If you have not tried using two force sensors to demonstrate Newton's third law, check out the article "Exploring Newton's Third Law" by Kathy Malone and Bob Reiland (Shady Side Academy, Pittsburgh, PA) in the September 1995 issue of *The Physics Teacher*.



Keith F. Forton (Traverse City Senior HS, MI) sent us some graphs of amusement park ride acceleration data and a variety of other interesting CBL data. One experiment that Keith sent us was actually done by fifth grader Barbara Weber (Old Mission Elementary School, Traverse City, MI). Barbara graphed the melting of ice cream and frozen yogurt and looked for differences in melting point and melting rate. Further research may be required.

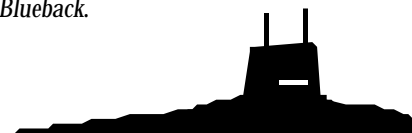
Peter LeMaire and Charles Waiveris (Central Connecticut State University) have investigated some "New Forklore about Water" and report on it in the October 1995 issue of *The Physics Teacher*. Using our ULI, Data Logger, and IBM computer, they investigate the hypothesis that water heated in a microwave oven cools faster than water heated on a stove.

Ray Hahn (Massapequa HS, Massapequa, NY) recently used our ULI Timer program to determine the instantaneous and average speed of electric slot cars at a back-to-school night. Some of the parents were so impressed that they donated used computers for his science program.

Jim Ealy (The Peddie School, Hightstown, NJ) has been using a CBL and some of our sensors to gather data in a radio-controlled airplane. He even published an article in *R/C Soaring Digest*, July 1995. You may want to check out The Peddie School web site (<http://www@peddie.k12.nj.us>) for information on this.

The apparatus note "Measuring the Magnetic Force on a Current-Carrying Conductor" by W. Herreman and R. Huysentruyt (both from Belgium) in the May 1995 issue of *The Physics Teacher* shows how to use an electronic balance for a quantitative study of magnetic forces. If you have an Ohaus balance with a RS-232 port, you can use our Mass Plotter program to make this into a good demonstration. Mass Plotter is available for Macintosh, MS-DOS, and Apple II for \$39.95 each.

The Oregon Museum of Science and Industry is using a ULI and probes from Vernier Software to study pressure, temperature, and sound (using a hydrophone) in the Willamette River. Students will be lowering our probes into the river from the submarine *USS Blueback*.

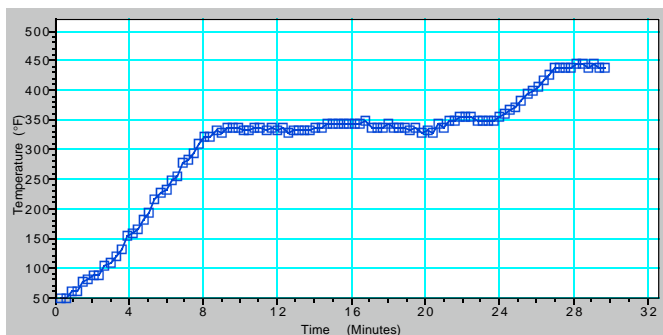


Howard Brody (University of Pennsylvania) had a very interesting article in *Physics Today* (March 1995) entitled "How Would a Physicist Design a Tennis Racket." He used our MPLI interface for part of his investigation.

## About Thermocouples

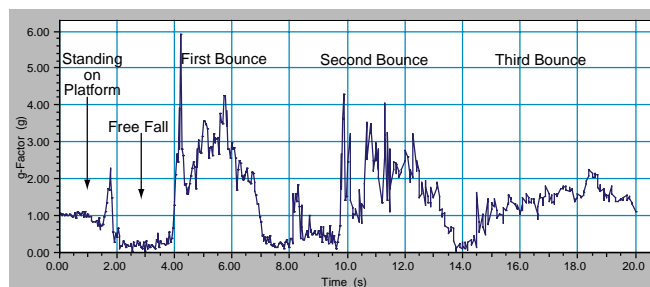
One of the sensors we may have neglected over the years is our Thermocouple (TCA-DIN). There really are many interesting activities that can be done with this inexpensive (\$35) sensor. Louis Nadelson (Capital HS, Olympia, WA) published an article in the March 1995 issue of *The Science Teacher* with suggested activities using the Thermocouple. He recommends that students use the Thermocouple to study candle flames and electric hot-air popcorn poppers. In his class, students determine how hot the popcorn has to be to pop. You can also use our Thermocouple in a Bunsen burner flame to show what part of the flame is the hottest.

Here is a graph we made when we were checking our oven to see if the thermostat was adjusted properly. It turns out it was working well for 350° F and 450° F.

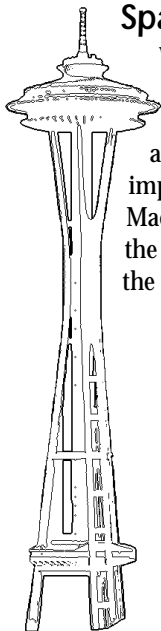


## Bungee Jumping Accelerometers

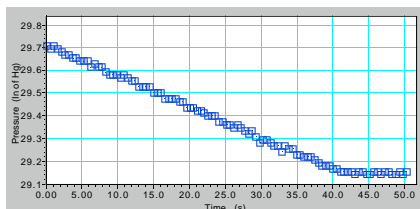
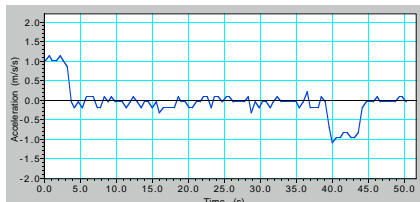
Our 25-g Accelerometer (ACC-DIN) has made possible many physics investigations that were previously almost impossible. Students and teachers have enjoyed taking our Accelerometer on amusement park rides, on airplanes, in cars, and now, even on bungee jumps. Six people from the Project PHYSLab program went bungee jumping with three Vernier Software Accelerometers mounted on their backs. The three accelerometers were mounted at right angles. The results of one jump (by David Bermudez, Sunriver Preparatory School, Sunriver, OR) are shown below. We imported the data from the CBL into Graphical Analysis and calculated a net "g-factor." The g-factor is 1 g when the person is standing on the platform, and drops to zero during the free fall. It reaches 4 or 5 g's during the bounces. Other physics teachers who took the plunge were Danielle Spaete, Tom Anderson, Pete Parlett, Jon Fishwild and Chad McCartney.



## Space Needle Science

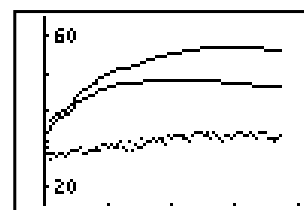


We recently took a trip up the elevator in the Seattle Space Needle with a CBL, our new Low-g Accelerometer, and our Barometer. Here are the resulting graphs after the CBL data was imported into Graphical Analysis 2.0 for the Macintosh. Note the acceleration at the start and at the end of the ride, and the pressure change during the ride.



## Solar Heating Inside a Car

One of the great things about the CBL is that it lets you collect data in interesting places. Chuck Vonder Embse (Central Michigan University) suggested that it would be interesting and educational to investigate the temperature inside a closed car on a hot summer day. We gave it a try and here are our results from an August day in Oregon. We graphed the outdoor temperature, passenger compartment temperature, and trunk temperature. The bottom line indicates the outside temperature, the middle line is the trunk temperature, and the top line is the temperature in the passenger compartment. All temperatures are in degrees Celsius. The graph started at noon and went to 4 pm with the car in full sun. Note that the inside of the car reached almost 60° C (140° F), even though the outside air reached only about 90° F.



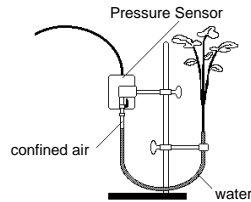


# Biology Corner

## Rate of Plant Transpiration

by Scott Holman

Here is an easy experiment to show the effect of leaf transpiration on the flow of water into plants. Water evaporates from the leaves of the plant, causing more water to be drawn into the stem. *Evaporative pull* results in a reduced pressure in the confined air column (labeled in the figure). A Pressure Sensor, connected to any Vernier interface or to the CBL System, is used to monitor the change in pressure.

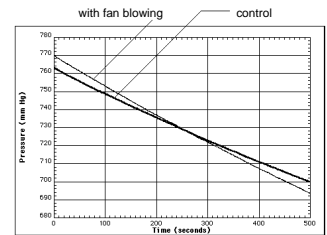


Use a razor blade or scalpel to cut the stem of a tomato plant seedling 2-3 cm above the soil; then carefully re-cut the stem at a 45° angle. Then bend a piece of plastic tubing into a U-shape—the piece of tubing that is shipped with the Vernier Pressure Sensor (3-mm inside diameter) works well. Next, use the syringe that comes with the Pressure Sensor to draw water into the tubing—the water level should be within 2 cm of the top of both ends of the “U”. Place a generous amount of petroleum jelly 1.5 cm above the cut end of the stem; do not let any of the petroleum jelly cover the fresh cut of the stem. Raise one end of the plastic tubing until water is at the top of the other end. Carefully force the plant stem down into the water and tubing until the petroleum jelly connects with the end of the tubing. Try to avoid air bubbles. Spread the jelly around the stem and tubing where they meet for an air-tight seal.

Secure the seedling in an upright position with a utility clamp (see figure). Close the valve that leads to the Pressure Sensor and connect the loose end of the plastic tubing to the valve opening. The cut stem of the seedling should be 5-7 cm below the level of the valve on the Pressure Sensor. Secure it with a utility clamp.

Make sure that no water enters the valve of the Pressure Sensor. Once connected, there should be about 3-4 cm of confined air in the tubing between the water level and the valve. As long as the base of the plant is below the level of the valve, there will be no chance of water moving into the Pressure Sensor.

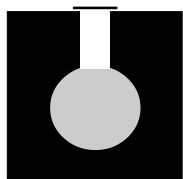
Open the valve of the Pressure Sensor. Set up your computer or TI calculator and CBL to collect real-time data. Load a pressure calibration in mm Hg, scale the vertical axis from 650 to 800 mm Hg, the horizontal axis from 0 to 5-10 minutes, and begin collecting data. The setup can be used repeatedly throughout the day. If an air bubble develops just below the plant stem, simply disconnect the stem, refill the water, and reconnect the stem and tubing. We collected one set of sample data (the control) using this method. The second set of data was collected with a fan blowing across the surface of the plant leaves, resulting in a faster drop in pressure.



### Coming Soon!

We are working on two new books for use with either Macintosh or IBM-compatible computers and our Serial Box Interface or ULI. Here are the approximate release dates and prices:

	Order Code	Price	Release Date
<i>Physical Science with Computers</i> (Serial Box and ULI Version)	PSWC-M (Macintosh)	\$35	February 1996
	PSWC-I (IBM)	\$35	February 1996
<i>Biology with Computers</i> (Serial Box and ULI Version)	BWC-M (Macintosh)	\$35	Summer 1996
	BWC-I (IBM)	\$35	Summer 1996



# Chemistry Corner

by Dan Holmquist

During the past few years, many chemistry teachers have enjoyed constructing 9-volt battery/LED conductivity probes to test for the presence of dissolved ions in solution. Now Vernier Software has developed a new Conductivity Probe to allow your students to determine precise concentrations of dissolved ions or the conductivity of solutions (see page 3 for details). Students can now discover many principles of solutions and liquids with this easy-to-use probe. For example, the following readings were obtained when the Conductivity Probe was placed in three 0.0050 M chloride solutions (in microSiemens):

NaCl	721 $\mu\text{S}$
CaCl <sub>2</sub>	1251 $\mu\text{S}$
AlCl <sub>3</sub>	1650 $\mu\text{S}$

Based on this data, students might discover for themselves that each of these compounds produces different ratios of ions when they dissociate in water. Notice that the ratio of conductivity values (1.8 to 3.0 to 4.0) is very close to the mole ratio of ions formed when each compound dissociates: 2 to 3 to 4.

Information about relative strengths of acids can quickly be determined. Here are some values we obtained when placing the Conductivity Probe in 0.0050 M acid solutions, arranged here from weakest to strongest:

HC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	142 $\mu\text{S}$	$K_a = 1.8 \times 10^{-5}$
H <sub>3</sub> PO <sub>4</sub>	1230 $\mu\text{S}$	$K_{a1} = 7.5 \times 10^{-3}$
HCl	1990 $\mu\text{S}$	$K_a = \text{very large}$

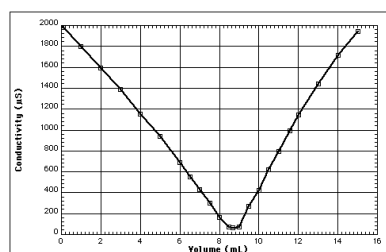
Concentrations of total dissolved solids in samples are easily determined. We found it interesting that distilled water had a conductivity reading of only 4.7  $\mu\text{S}$ , while Portland tap water was determined to be 30.2  $\mu\text{S}$  (our tap water is some of the softest water in the U.S.). We brought back samples from a recent Texas science teachers' meeting—Dallas tap water had a conductivity reading of 297  $\mu\text{S}$  and Corpus Christi had a

reading of 1267  $\mu\text{S}$  (a conductivity reading of 1267  $\mu\text{S}$  is equal to about 630 mg/L of total dissolved solids).

In performing a titration using the Conductivity Probe, we added 0.010 M sulfuric acid to 0.0010 M barium hydroxide:



Notice that this reaction results in a minimum conductivity value at the equivalence point, since the barium hydroxide precipitate and water yield very few aqueous ions.



Finally, we couldn't resist taking the Conductivity Probe into the field to analyze the salt content (in mg/L as NaCl) of the nearby Columbia River as tides move salt water from the Pacific Ocean up into the lower reaches of the river. We collected water samples at several sites and analyzed them using the conductivity probe. Here are data showing the salinity of the samples starting at the mouth of the Columbia (distance = 0) to a distance of nearly 50 km upstream:

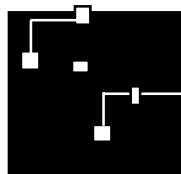
Distance (km)	Concentration (mg/L as NaCl)
0.0	26,059
16.4	2,076
46.4	42.9
61.9	42.9

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

Apple II and Macintosh are registered trademarks of Apple Computers, Inc.  
 IBM is a registered trademark of International Business Machines Corp.  
 MS-DOS, Microsoft and Windows are registered trademarks of Microsoft Corporation.  
 Calculator-Based Laboratory, CBL and TI-GRAPH LINK are trademarks of Texas Instruments, Inc.

## Vernier Software

8565 S.W. Beaverton-Hillsdale Hwy.  
 Portland, OR 97225-2429  
 Phone (503) 297-5317 FAX (503) 297-1760  
 dvernier@vernier.com  
<http://www.teleport.com/~vernier>



# Bits & Bytes

## International Sales

Over the years, we have received occasional orders from outside the U.S. and Canada. Most of these orders were from teachers who had read about us in U.S. science teacher magazines or heard about us in workshops. We felt we needed someone with international sales experience to handle these sales and to help with the technical support. This summer we worked out an arrangement with ED.USA, an experienced international sales company. Effective immediately, most Vernier Software sales outside of the United States and Canada (except APO, FPO, and ISS Schools) will be handled by

### ED.USA

P.O. Box 808

Westmont, IL 60559

Phone: 708-968-1122 • Fax: 708-968-1133

Internet: edusa01@aol.com

The exception to this will be CBL-related items, sensors and books, most of which will be sold through the established network of Texas Instruments dealers in various countries.

## Vernier Software and **FLINN SCIENTIFIC INC.**

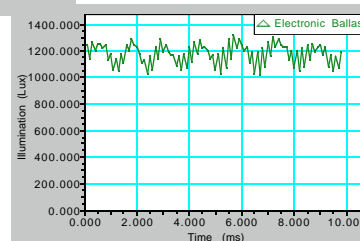
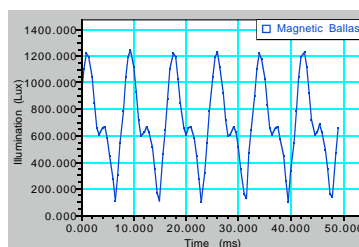
We are now working closely with Flinn Scientific, the established leader in high-school chemistry equipment and supplies, to make technology more accessible to high-school chemistry and biology teachers. Flinn Scientific will be including more of the Vernier Software lab interfacing products in their new catalog. We will also work with Flinn to develop new sensors and curricular materials. Watch for some exciting new products from the Vernier/Flinn team in chemistry and biology.

## MBL Comparison

The Spring 1995 issue of *Physics Courseware Communicator* included evaluations of 17 laboratory interfaces, ranging in price from \$99 (our Serial Box Interface) to \$1995. Our interfaces received very favorable reviews. If you are shopping for microcomputer-based laboratory equipment, you might want to get a copy of this issue. For subscription information or to purchase back issues, contact PCEP, Department of Physics, NCSU, Raleigh, NC 26795, pcep@ncsu.edu, fax (919) 515-2682.

## More Demo Complications

Three years ago in this newsletter we printed an article on how certain improvements in products have spoiled some favorite science demonstrations. In that article, we mentioned that Coleman lantern mantles are no longer radioactive and warned that electric blankets and video monitors do not emit as much radiation as they used to. Now there is another improvement in technology that may spoil a favorite demonstration. The graph at the left below shows the classic light intensity graph from a fluorescent lamp. New T-8 lamps, with electronic ballasts, operate at very high frequencies and do not show nearly as much of the characteristic 120-Hz flicker (right graph).



## Slow Prompted Input on Mac Plus

If you are using either Mac Plus or Mac SE computers and have experienced very slow data collection when doing prompted data collection using Data Logger 4.5, we have a solution. By prompted data collection, we mean situations where you type in the independent variable. Examples include acid-base titrations and Boyle's law experiments. The first release of Data Logger 4.5 handled this type of data collection poorly on older Macs. The version we are now shipping (4.5.9) solves this problem. Contact us to receive a free upgrade.

## Windows 95 Compatibility

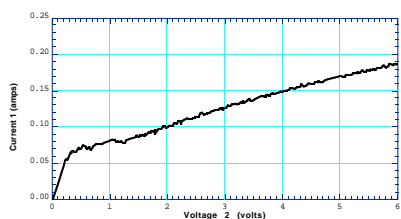
We have successfully tested both our MultiPurpose Lab Interface Program and Graphical Analysis for Windows on the Windows 95 operating system.



## Current and Voltage Probes

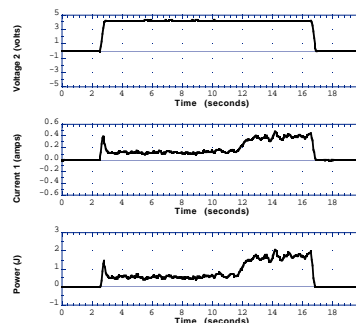
In the last issue of *The Caliper* we introduced our Current and Voltage Probes for use with either the ULI or the Serial Box Interface. The package includes two current probes (range =  $\pm 0.6$  amps) and two voltage probes (range =  $\pm 6$  volts). It sells for \$80 (order code CV-DIN). New Electricity software is available for use with either the Serial Box Interface or the ULI in either Macintosh (M-EL) or IBM (PC-EL) format at a cost of \$30. The Current and Voltage Probes can also be used with the CBL. Here are some experiments done with the Current and Voltage Probes:

- An obvious way to use these probes is for Ohm's law experiments with resistors. For an interesting variation, substitute a small lamp. Gradually increase the voltage applied to the circuit. As the lamp starts to glow, its resistance changes and a non-linear current vs. voltage graph is produced. The graph below shows that the current does not increase in proportion to the voltage. The graph shows a distinct "knee" as the resistance of the filament changes during heating.



Current vs. Voltage for a Lamp

- You can also use the Current and Voltage Probes to study the power and efficiency of an electric motor. Connect a small DC electric motor and measure the current that it uses and the voltage drop across it. Use the New Column feature of the Electricity program to set up a column: Power (Watts) = current \* voltage. In the experiment below, the motor was turned on and run with no load until the 11-second mark. At that point, it started lifting a 100-g mass. Note the current and power surge when the motor first started and the increase in current when the load was applied.

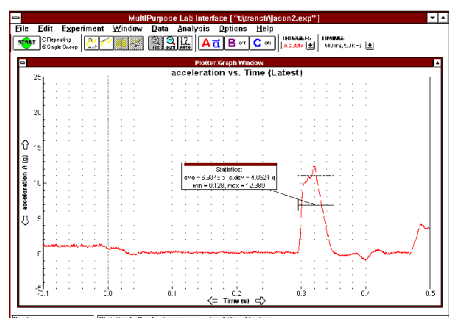


Current, Voltage, and Power for an Electric Motor

If you want to take this experiment further, the Electricity program will allow you to integrate over the power vs. time graph to determine the electrical energy and the efficiency of the motor.

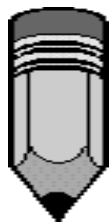
## Packing Contests

Use our original Accelerometer (ACC-DIN) to provide a packing contest for your students. This is a variation of the old egg-drop contest that provides numerical results. For a packing contest here at Vernier Software, we attached the Accelerometer to a 1-kg mass which the contestants then packed in a small cardboard box. They could use any packing material they wanted. They had to place the object in the center of the box and orient it so that when the box was dropped, the accelerometer would measure the vertical acceleration. Our contestants used all the standard packing materials,



as well as balloons and even pine branches. We used MPLI for Windows to plot the acceleration, dropping the box from 40 cm above the floor. We set triggering so that data collection began when the box was dropped. The winner was chosen based on the lowest maximum acceleration during the collision with the floor. Our winning entry was Jason Van Cleve, who used a commercial foam packing material, cut and arranged in a creative way.

Speaking of packing... We sometimes get complaints from customers regarding our occasional use of Styrofoam "packing peanuts." Just so you do not think we are environmentally thoughtless, we have not purchased that kind of packing material for many years. We have an informal arrangement with several local teachers, most notably Richard Duncan (Beaverton HS) and Dave Ehrenkranz (Westview HS), whereby they bring us any packing material that comes with their new science equipment orders. We re-use this packing material as a form of recycling.



## Contests and Workshops

### Project PHYSLab

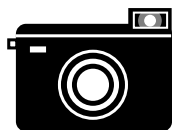
Project PHYSLab is a three-week computer interfacing workshop for high school physics teachers. The 1996 workshop will take place during the first three weeks in July at The Catlin Gabel School in Portland, Oregon. This is the fifth year for this workshop. It emphasizes laboratory interfacing, telecommunications, and low-cost lab equipment. The application deadline is February 15, 1996. For more information, contact Lowell G. Herr, Project PHYSLab Director, The Catlin Gabel School, 8825 S.W. Barnes Road, Portland, OR 97225, school: (503) 297-1894 Ext. 321, home: (503) 244-1924, herr@catseq.catlin.edu.

### The Institute for the Advancement of Science Teaching

The Institute for the Advancement of Science Teaching will present several summer workshops in late June 1996. These workshops focus on integrating computer technology into the Advanced Placement curriculum. Last year's program included presentations on using spreadsheets and our Graphical Analysis software for data analysis; using multimedia for content presentations; and using computer interfacing equipment for experimentation. For information contact Carol Leibl, 431 Deer Meadows, Canyon Lake, TX 78133, (210) 899-3923, cmleibl@tenet.edu.

### Teachers Teaching with Technology

The Teachers Teaching with Technology (T<sup>3</sup>) organization provides an excellent way to learn more about the use of graphing calculators in science and math. They sponsor national conferences and hundreds of summer workshops, including workshops on CBL for chemistry and physics teachers. Contact them at T<sup>3</sup>, Department of Mathematics, University of Texas at Arlington, Box 19408, Arlington, TX 76019, (817) 794-5828, t-cubed@ti.com.



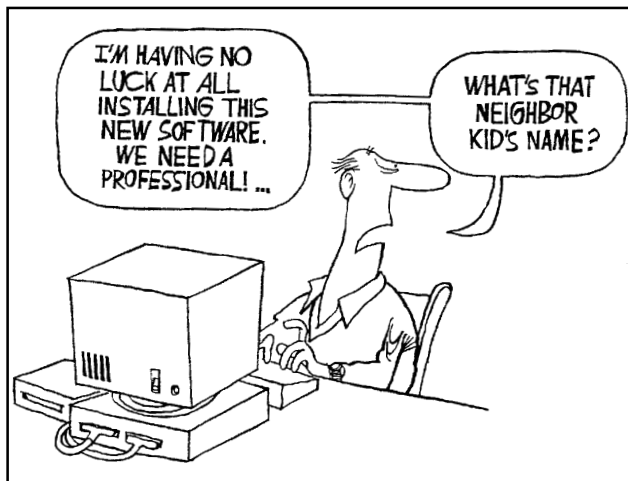
### AAPT Photo Contest

The 1996 AAPT High School Physics Photo Contest is underway. It is open to any high school student. Photos must be 8x10 inch, black and white or color, and taken by a student. There must be an accompanying paragraph (<250 words) describing the physics involved in the photo. Photographs will be judged by physics teachers attending the summer AAPT meeting in Maryland. Vernier Software supplies the prizes. For more information, contact Ann M. W. Brandon, Joliet West High School, 401 N. Larkin Ave., Joliet, IL 60435.

## Humor

Here is an article from *Pro Factoids*, the Newsletter of Oregonians for Rationality. It caught my eye partly because Paul Doherty is a regular at AAPT and NSTA meetings:

"Ice crystals in the stratosphere, not divine retribution, were responsible for the eerie, colorful halo seen around the sun at midday throughout the Bay Area," reported the May 31, 1995 *San Francisco Chronicle*. Apparently the Morrison Planetarium in Golden Gate Park was inundated with calls, many from individuals concerned the halo was some kind of heavenly message. Paul Doherty, physicist at the Exploratorium Science Museum, said scientists didn't know for certain if the halo signaled the end of the world, "I think we're probably all right, but we'll know for sure in a few days. That's the scientific method."



JEFF STAHLER reprinted by permission of Newspaper Enterprise Association, Inc.

I think the above cartoon says a lot about the way many people feel about their computers these days. On a similar note, for those of you frustrated with computer acronyms, here is a way to remember PCMCIA, one of the new standards for interface cards: Think of it as standing for "People Can't Memorize Computer Industry Acronyms."

### Ten Years Ago in This Newsletter...

In our Fall 1985 issue we announced our newest program, Voltage Plotter for Apple II computers. It worked with either a game port interface called a "Voltage Input Unit" or an "Advanced Interfacing Board." We still sell improved versions of these products.

We mentioned hard disks for the first time and included special tips for those few Apple II users lucky enough to have a hard disk. We tested our programs on our 10-Meg Sider hard disk. Now most of our computers have more RAM than that!

Christine Vernier included a plea for science jokes for the newsletter. She said I was desperate for new material. Some things don't change.

—Dave Vernier

### How to contact Vernier Software

Mail: Vernier Software  
8565 S.W. Beaverton-Hillsdale Hwy  
Portland, OR 97225-2429

Phone: 503-297-5317

Fax: 503-297-1760

E-mail: [dvernier@vernier.com](mailto:dvernier@vernier.com)

WWW page: <http://www.teleport.com/~vernier>

Note that our mailing address changed in December 1994. Please make sure you and your business office are using the correct address.

## NEW PRODUCTS ORDER FORM

Please send me more information on your products! I am using the following in my classroom/lab:

Macintosh     IBM     Apple II     CBL

**Yes!** I would like to order the following new Vernier Software product(s):

**BILL TO:** Name \_\_\_\_\_ Office \_\_\_\_\_ Address \_\_\_\_\_ City/State/Zip \_\_\_\_\_ Date \_\_\_\_\_  
**SHIP TO:** Name \_\_\_\_\_ School \_\_\_\_\_ Address \_\_\_\_\_ City/State/Zip \_\_\_\_\_  
 Customer # \_\_\_\_\_ P.O. # \_\_\_\_\_ Phone \_\_\_\_\_

Quantity	Item	Order Code	Price	Total
	Graphical Analysis for Windows	GA-WIN	49.95	
	Graphical Analysis 2.0 for Macintosh	GA-MAC	49.95	
	Graphical Analysis Upgrade for Macintosh (include original disk)	UGA-MAC	20.00	
	Low-g Accelerometer	LGA-DIN	88.00	
	Dissolved Oxygen Probe	DO-DIN	189.00	
	Conductivity Probe	CON-DIN	79.00	

Please add shipping and handling (see below)

**Shipping and Handling**

U.S. orders: 3% (\$4.00 minimum)

**TOTAL**

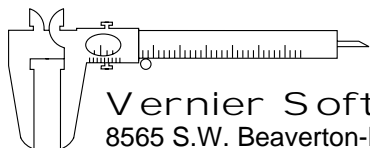
**Order by mail, phone, fax or internet:** 8565 S.W. Beaverton-Hillsdale Hwy.  
Portland, OR 97223-2429  
(503) 297-5317 • FAX (503) 297-1760  
Internet: [orders@vernier.com](mailto:orders@vernier.com)



## UPCOMING EVENTS

We will be exhibiting at all of the following conferences. If you attend, stop by and say hello. Contact us if you would like more information on these meetings.

National Science Teachers Association Regional .....	San Antonio, TX .....	December 14-16
American Association of Physics Teachers Winter Meeting .....	Reno, NV .....	January 13-18
National Science Teachers Association Regional .....	Rapid City, SD .....	February 8-10
Florida Educational Technology Conference .....	Orlando, FL .....	February 16-18
Texas American Association of Physics Teachers .....	Abilene, TX .....	March 14-15
Teachers Teaching with Technology .....	Jacksonville, FL .....	March 15-17
National Science Teachers Association National .....	St. Louis, MO .....	March 28-31
National Council of Teachers of Mathematics Annual Meeting .....	San Diego, CA .....	April 25-28
National Educational Computing Conference .....	Minneapolis, MN .....	June 11-13
Biennial Conference on Chemical Education .....	Clemson University, SC .....	August 4-9
American Association of Physics Teachers Summer Meeting .....	College Park, MD .....	August 5-10



Vernier Software  
 8565 S.W. Beaverton-Hillsdale Hwy.  
 Portland, OR 97225-2429  
 (503) 297-5317

BULK RATE U.S. POSTAGE PAID Portland, OR Permit No. 2508
--