

A Publication  
for  
Users of  
Vernier Software  
Products

# The Caliper

Volume 13 Number 1

Spring 1996

## Rave Reviews for Graphical Analysis!

Graphical Analysis for Windows will be featured in the *Media & Methods* magazine Awards Portfolio issue (May/June 1996). Vernier Software is recognized "for commitment and creativity in the production of outstanding educational materials and services for educators nationwide."



Both the Windows and Macintosh 2.0 versions of Graphical Analysis are reviewed in the Winter issue of the *Physics Courseware Communicator* from North Carolina State University. The programs are rated as "Highly Recommended." The review states: "Graphical Analysis offers more powerful curve fitting functions than major spreadsheets like Microsoft *Excel* and is considerably less expensive. Graphical Analysis is a bargain which should find a home in all high school and many college physics labs."

But more importantly, *teachers* like the programs. Recently, an informal survey was conducted on the CHEMED-L List Serve about inexpensive graphing programs. To quote from the summary, "The hands-down favorite is Graphical Analysis from Vernier Software." Graphical Analysis for Windows (order code GA-WIN) and Macintosh (order code GA-MAC) are each \$49.95.

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#### NEW PRODUCTS:

- TI-83 •
- Rotary Motion Probe •  
and Software

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#### CHEMISTRY CORNER

#### SCIENCE

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#### SCIENCE HUMOR

## **NEW!** TI-83 Graphing Calculator

The newest graphing calculator from Texas Instruments, the TI-83, is now available. The TI-83 can be thought of as a second generation TI-82. In fact, the keyboard and menus are almost identical to the TI-82. If you know the TI-82, you will be able to immediately use the TI-83. Even so, the TI-83 has a number of improvements over the TI-82:

- The high contrast display makes viewing easier (especially when viewed by more than one person).
- Lists on the TI-83 can contain up to 999 elements and the number of lists is limited only by the memory available. This is especially useful to CBL users.
- Lists can be given names.
- Enhanced data analysis features include sine and logistic regression.
- An Equation Solver is used to interactively solve for any variable in an equation.
- Advanced statistics features make the calculator perfect for AP Statistics.



You should definitely consider this new calculator if you plan to purchase graphing calculators this year. See page 6 for more information. And the best news is: Our price for the TI-83 is the same as for the TI-82, \$89 (Order Code TI-83).

**NEW!**

# Rotary Motion Probe Rotary Motion Software

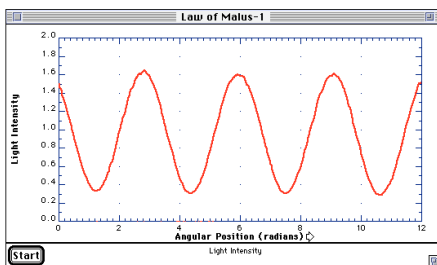
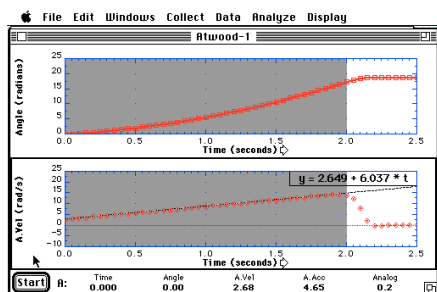


## For Rotary Motion . . .

Our new Rotary Motion Probe for the ULI lets you monitor angular motion accurately and easily. It has a resolution of 0.25 degrees and is direction sensitive. You can use our new ULI Rotary Motion software to graph angular displacement, angular velocity, and angular acceleration.

Typical experiments include

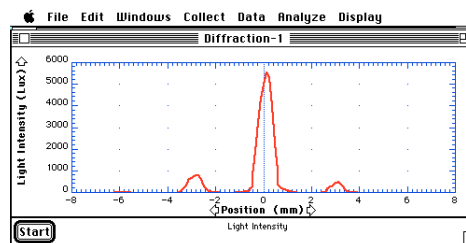
- Atwood's machine experiments
- Measuring moments of inertia
- Torque experiments
- Transmission of light through polarizing material as a function of angle
- Magnetic damping
- Physical pendulum
- Chaos (pendulum driven by a mechanical oscillator)



## or Linear Motion . . .

Even though we call it a Rotary Motion Probe, it can also be used to measure linear position very accurately. You simply roll the pulley of the sensor along a table and you can measure distance to a fraction of a millimeter. At the same time, you can monitor velocity or acceleration, or a different sensor. This allows you to do a variety of experiments, such as:

- Monitor light intensity as you move a Light Sensor through a diffraction pattern.
- Monitor light intensity vs. distance as you move away from a light source.
- Monitor magnetic field strength as a function of position.



The Rotary Motion Probe is manufactured by PASCO scientific. PASCO makes a number of accessories to go with the probe, including Rotational Accessory, Linear Motion Accessory, Chaos Accessory, and extra pulleys.

Our Rotary Motion software can also be used with PSL or Team Labs Rotary Motion Probe, or even with home-made shaft encoder devices, if an adapter is used. Contact Vernier Software for more information.

- Rotary Motion Probe ..... CI-6625 ..... \$169.00
- Rotary Motion Program
- Macintosh Version ..... M-RT ..... \$30.00
- IBM Version ..... PC-RT ..... \$30.00

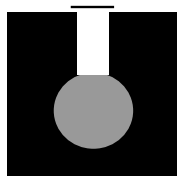
Note: The Rotary Motion software works with all *ULI<sub>1</sub>S* and original ULIs with EPROM versions 5.12 or later. If you have an original ULI, check the EPROM version label on the IC. If it is an EPROM number lower than 5.12, you will need an EPROM upgrade. Call Vernier Software for details.

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### 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>

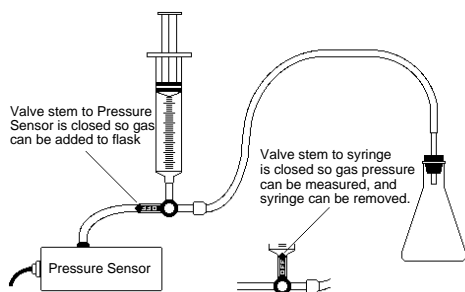


# Chemistry Corner

by Dan Holmquist

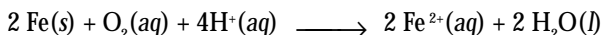
Here are two nice chemistry demonstrations using Vernier sensors. The first one illustrates Dalton's law of partial pressures and Avogadro's law, and was submitted by Nusret Hisim (Walkersville HS, MD). Nusret uses our Pressure Sensor (order code PS-DIN, \$66) to confirm that when consecutive equal volumes of a variety of gas samples are added to a container, the pressure increase in the flask is the same, no matter what the molecular weight or size of the molecules.

Start with a 200-250 mL bottle or flask filled with air at ~1 atm. First add 20 mL of air (~29 amu) using the syringe, and use a Pressure Sensor to monitor the increase in pressure. Next add 20 mL of a gas with a lower molecular weight, such as helium (4 amu) or natural gas (~16 amu). Now add 20 mL of a gas with a higher molecular weight, such as carbon dioxide (44 amu) or argon (40 amu). Each time, draw the gas into the syringe, allow it to equilibrate to atmospheric pressure, and use the 3-way valve to add the gas to the bottle. Nusret says many of his students are surprised when 20 mL of helium gas results in the same pressure increase as 20 mL of "heavier" gases like carbon dioxide. This demonstration should help students understand the interplay of Avogadro's law (equal gas volumes contain equal numbers of molecules) and Dalton's law of partial pressures.



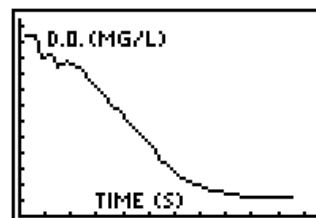
A flask volume of 250 mL will allow you to add four gas samples, resulting in a total pressure of about 1.3 atm. The syringe, 3-way valve, luer-lock connector, and plastic tubing shown here are included when you order a Pressure Sensor.

Norma Mackenzie (Charlotte Country Day School, NC) uses our new Dissolved Oxygen Probe (order code DO-DIN, \$189) to demonstrate the well-known reaction of iron with molecular oxygen that occurs when iron rusts:



Add 150 mL of water to a 250-mL beaker, and place it on a magnetic stirrer. Add a stirring bar to the beaker. Put the tip of the probe through a piece of aluminum foil and then through a plastic wrap to cover the surface of the water—this prevents oxygen from redissolving. Wrap the tip of the probe with a piece of filter paper using a rubberband to protect the probe membrane from whirling iron filings. Suspend the Dissolved

Oxygen Probe with a utility clamp so its tip is submerged and above the stirring bar. Set the data collection for 25 minutes. When the water is nearly saturated with oxygen, begin data collection. After 10 to 15 seconds, add 4 g of iron filings, which will adhere to the stirring bar. Students can then watch the decrease in dissolved oxygen concentration as the iron depletes molecular oxygen from the water, as shown here:



Since we began shipping our new Conductivity Probe (order code CON-DIN, \$79), many customers have requested updated copies of the *Chemistry with Computers* or *Chemistry with CBL* labs that use the new probe. In the original versions, we used a homemade conductivity probe, constructed from Radio Shack parts. If you own one of these manuals, and wish to obtain the revised paper copy of the experiments for the new Conductivity Probe, send us a FAX or e-mail requesting a free copy. Use one of these order codes: CON-EXPTS-MAC, CON-EXPTS-IBM, or CON-EXPTS-CBL.

Spectronic Instruments, Inc. (formerly a division of Milton Roy) has two new spectrophotometers: the Spectronic 20+ and the Spectronic 20D+. Instead of a phototube, they now use a solid state detector that covers the entire 340 to 950 nm wavelength range. The good news is that the current versions of the Vernier Spectrophotometer Program (Mac and IBM) work for the Spectronic 20+ and the 20D+ (as well as the 20, 20D, Flinn Spectrophotometer, and the Vernier Colorimeter). The Spectronic 20+ uses the same cable as the Spectronic 20 (SPC-DIN, \$25). The 20D+ uses the same cable as the 20D (SPC-MAC, SPC-IBM, \$25). By the way, it is also possible to interface the Spectronic 20, 20+, 20D, or 20D+ to the TI CBL System. We have written a program called *Spectro* for TI calculators and the CBL that allows you to collect, display, and analyze data for absorbance (or % transmittance) vs. time, absorbance vs. wavelength, or absorbance vs. concentration experiments. This program is included on the Vernier CBL Data Collection Disk (order code CBL-DP-M or CBL-DP-I, \$10). The SPC-DIN cable and a CBL-DIN adapter are required.

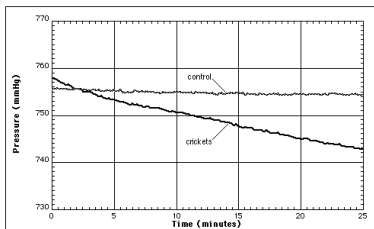
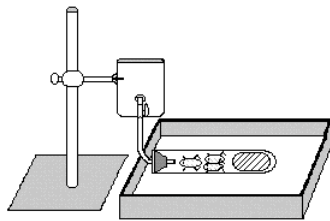


# Biology Corner

by Scott Holman

## Respiration in Plants and Animals

Our new Biology Gas Pressure Sensor (order code BGP-DIN, \$65) is ideal for monitoring gas pressures in closed systems. For example, you can determine the respiration rates of insects and germinating plants.

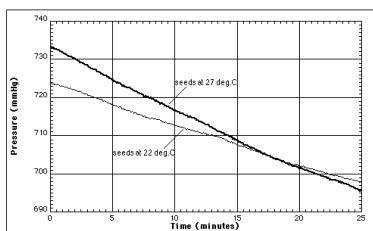


Respiration of Crickets at Room Temperature

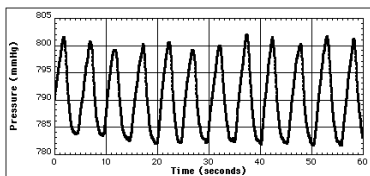
To monitor respiration in insects, cut the stem from a Beral pipet and fill the bulb with sodium hydroxide pellets. Seal the bulb with a piece of Parafilm and perforate it with holes to allow air to flow into the bulb. Place

the filled bulb into a 20 x 150-mm test tube, along with five adult crickets. Seal with a one-hole rubber stopper fitted with a piece of glass tubing. Connect a two-inch section of plastic tubing to the glass tubing and connect it to the Biology Gas Pressure Sensor. Place the sensor valve in the open position. Collect data for a 15-minute period using any of the Vernier interfaces or the CBL System.

A similar setup can be used to monitor the respiration of germinating seeds. This graph shows the respiration of germinating pea seeds at two different temperatures. (Contributed by Carol Leibl, James Madison HS, San Antonio, TX).



Respiration of Germinating Pea Seeds at Two Different Temperatures

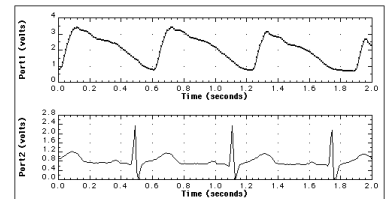


Normal Respiratory Patterns

The Respiration Monitor Belt (order code RMB, \$58), when connected to the Biology Gas Pressure Sensor, can be used to monitor human respiration rates. The belt fits snugly around a person's diaphragm. As the individual breathes, their chest cavity expands and contracts, changing the air pressure inside the belt's air bladder.

## Monitoring the Heart's Electrical Activity

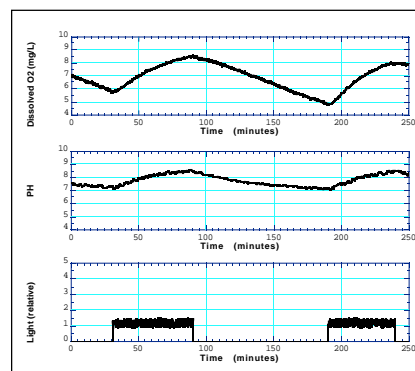
The EKG Sensor (order code EKG-DIN, \$145) is the latest addition to our growing line of probes for the biology teacher. This sensor is compatible with all of our interfaces, including the Texas Instruments CBL. When the sensor's three electrode leads are attached to a person, the electrical activity associated with the contraction and relaxation of their heart can be monitored. You can also use our Heart Rate Monitor in conjunction with the EKG to correlate the electrical activity of the heart with the heart rate.



Heart Rate Monitor and EKG Sensor

## Photosynthesis

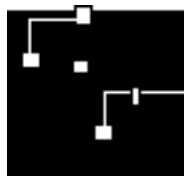
Herbert Dutton, a retired limnologist in Cable, WI, has been doing some interesting experiments involving photosynthesis with our new Dissolved Oxygen Probe (order code DO-DIN, \$189). Herbert placed an aquatic plant in a small jar and then surrounded it with circular fluorescent lamps. He used a magnetic stirrer in the jar. He then monitored dissolved oxygen concentration, light level, and pH. He turned on the lamp for two intervals during this experiment. Notice the rapid increase in oxygen level and pH in the graphs below. Herbert suggests that for rapid response like this, you should use a small volume of water and a very bright light source.



### Coming Soon: *Biology with Computers*

This will be the latest in our series of lab manuals. This new book will be available June 15th. It has labs for use with the Serial Box Interface or ULI and can be used with either Macintosh or IBM-compatible computers.

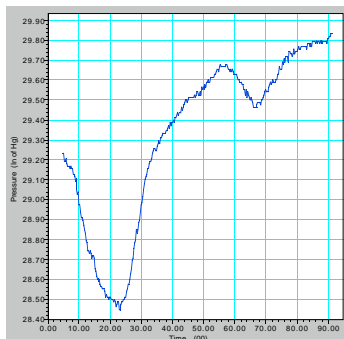
Order code BWC-MAC or BWC-IBM ..... \$35



# Bits & Bytes

## Stormy Weather

In December, we had a big storm in Portland. Trees were knocked down and we lost our power for 12 hours. Here is a graph of pressure vs. time taken with CBL and then imported into a Macintosh using Graphical Analysis and TI-GRAPH LINK. Notice the pressure approaches 28.4 in. Hg at the peak of the storm. A second minor storm came through two days later.



For those of you using *Real Time Physics - Mechanics*, we now have two new energy labs available (labs 11 and 12). We also have preliminary versions of Electricity experiments for use with our Current and Voltage Probes. Contact our office and request the Real Time Physics energy or electricity labs and we will send you free copies. Specify whether you want the Macintosh or IBM version.

Mike Farmer has produced a book, *Science Projects: A Modular Approach*. It is available from AET, P.O. Box 37, Tigerville, SC 29688 for \$12.00. It has project ideas, suggestions on how to do data analysis, sources of science equipment, lists of journal references about projects, and tips for entering science competitions. It has a lot of good information for anyone interested in science projects.

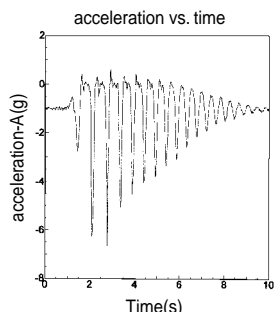
Jim Malone (Mercersburg Academy, Mercersburg, PA) had an article in the April 1996 *The Physics Teacher* giving tips on how to improve the accuracy of photogate timing. There was also a lengthy article on the same subject several years ago by Eugene P. Mosca and John P. Ertel (U.S. Naval Academy) in the September 1989 issue of *The American Journal of Physics*.

The January 1996 issue of *The Physics Teacher* had a good article on coupled harmonic oscillators by Norris W. Preyer (Eastern Oregon State College). He used a ULI, Motion Detector, and MacMotion to graph the motion of air track gliders connected with springs. The article shows how MacMotion's FFTs and a spreadsheet can be used to do extensive analysis and modeling of this motion.

Verne B. Bell (C.F. Brewer HS, TX) uses a CBL and our Student Force Sensor to measure the thrust of model rocket engines. He also uses CBL and a Motion Detector or a Smart Pulley to measure launch acceleration.

John K. Vandervelde (Amherst Middle School, Amherst, VA) has his students design boat hulls from pine blocks. The goal, of course, is to minimize drag. They use Precision Timer to time the boats as they are pulled through a tank. An article about this appeared in the December 1995 *Tech Directions* magazine.

Vernier Software lab interfaces were mentioned in the April 1996 *Scientific American* Amateur Scientist column. The column explains how to make a three-dimensional seismograph with the same sensor that we use in our Low-g Accelerometer.



Wm. R. Cranford (Jackson Central-Merry HS, Jackson, TN) uses one of our accelerometers to graph the motion of students as they jump from a stool onto a small trampoline. A CBL is held by the student. Here is a sample graph. Note the decreasing amplitude of the bounces.

*Promoting Active Learning in Introductory Physics Courses* (June 6-8, 1996, University of Oregon, Eugene) is a Chautauqua short course designed for those interested in making major changes in introductory physics or other science courses. The instructors are Priscilla Laws, Dickinson College; David Sokoloff, University of Oregon; and Ronald Thornton, Tufts University. There are no registration fees or tuition. The course is open to teachers of undergraduate students in two-year and four-year colleges and universities. High school teachers will be admitted if space is available. For more information and an application contact David Sokoloff, (541) 346-4755 (sokoloff@oregon.uoregon.edu).

## **NEW!** Products in Our 1996 Catalog

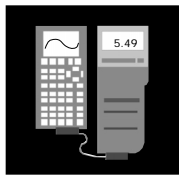
We added more new products to our catalog this year than ever before. We have several new sensors for use in biology classes: Biology Gas Pressure Sensor (BGP-DIN, \$65), Respiration Monitor Belt (RMB, \$58), EKG Sensor (EKG-DIN, \$145), Dissolved Oxygen Probe (DO-DIN, \$189) and Conductivity Probe (CON-DIN, \$79). Check out the Biology Corner and Chemistry Corner for ideas using these probes.

Our newest book, *Physical Science with Computers* (PSWC-MAC or PSWC-IBM), has 41 ready-to-use labs. Most of these labs can be done with either the Serial Box or ULI. We continue a tradition of Vernier Software books—we provide word-processing files for the student handouts on disk so that you can edit them if you choose.

We also have two new CBL-related products: Dual-Photogate Adapter for CBL (CBL-2P, \$18), and a package of six CBL biology labs (TI-BLG, \$10).

Contact us if you need a new catalog or if you want more information on any of these products.





# CBL Corner

by Rick Sorensen

Here are some frequently asked questions we get about CBL and graphing calculators.

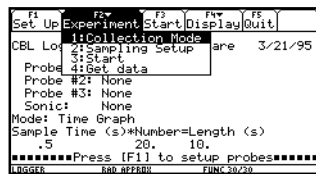
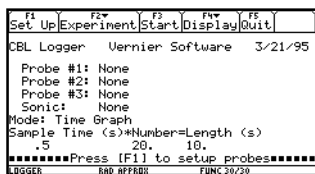
## Which calculator should I buy?

There is no simple answer to this question. Will it be used in math as well as science classes? Will it be used at the geometry or calculus level? Will it be used extensively with the CBL? How much do you want to spend? These are just a few of the questions you may have to ask yourself. If you plan to use a calculator primarily with CBL, we think the new TI-83 is a good choice. It will allow you to get all 512 readings from the CBL, and it has an improved screen. Most of the books of CBL experiments have been written for the TI-82—these books will need only minor modification to work with the TI-83. Many math teachers love the TI-92 with its symbolic manipulation and interactive geometry applications. Students should note that the TI-92 is not allowed during AP exams, but the other calculators are.

The chart on the opposite page shows some of the differences between the calculators. Please note it does not include the features common to all the calculators, e.g., trigonometric functions, programming, fraction conversions.

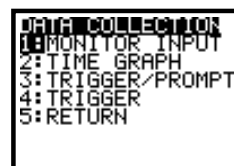
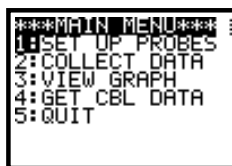
## I have my CBL. Now where do I get calculator programs?

There are a number of ways to get these programs. You can write your own or have a student write them. This can be educational (and for some people, like us, fun), but it can be a lot of work. You can manually type in programs from published lists. Lists of programs can be found in the *CBL Experiment Workbook* and on the information sheets that accompany our probes. Typing in these programs can be very frustrating, and we recommend it only as a last resort. Most people want complete, ready-to-use programs for data collection with the CBL. Realizing this, we have developed a collection of menu-driven programs for use with TI-82, TI-83, TI-85, and TI-92 calculators. Here are some sample screens from the TI-92 program CBLOGGER. It uses pull-down menus throughout, giving it the feel of a computer program.



We have tried to reduce the number of programs needed to perform experiments. For example, our new CHEM-BIO program for either the TI-82 or TI-83 now supports eighteen

probes that can be used in chemistry and/or biology. The list of probes includes pH, temperature, Dissolved Oxygen, and Conductivity. Our PHYSICS program for the TI-82 or TI-83 supports fifteen probes, including accelerometers, force sensors, microphones, and Motion Detectors. Both of these programs are menu driven, making it easy to set up and perform a variety of experiments. Here are some typical screens from the CHEM-BIO program:



Where do you get these elaborate programs? There are many ways to get the programs. The good news is that the programs are either free or very inexpensive.

- Use Mosaic or Netscape on the Internet to download the files from the following site:  
<http://www.ti.com/calc/docs/cbl.htm>
- Use a telecommunications program and a modem to download the programs posted on the Project PHYSLab BBS. You can connect with the site electronically at (503) 203-5118. Log in as a new user. Follow the menu instructions and select Libraries at the Main Menu. Choose the CBL library to locate the programs.
- Some programs are included on the TI-GRAPH LINK disk.
- The programs can also be purchased on disk from Vernier Software for \$10. An IBM-compatible disk (order code CBL-DP-I) or a Macintosh disk (order code CBL-DP-M) is available.

Once you have the programs, you will need to load the programs into a computer and use a TI-GRAPH LINK cable to download them into the calculator.

## How do I keep the programs from being accidentally edited?

Accidentally editing a program is a frustrating problem. We are eliminating this problem by protecting our TI-82, TI-83 and TI-92 programs. (TI-85 programs cannot be protected.) When the program is protected, neither your students nor you can edit the program on the calculator. Protected programs can only be edited using TI-GRAPH LINK and a computer. Also, if you have other programs that are not protected, use TI-GRAPH LINK to protect them. Refer to the TI-GRAPH LINK manual for details on how to protect programs.

FEATURES	TI-82	TI-83	TI-85	TI-92
Function Graphing	Up to 10	Up to 10	Up to 99	Up to 99
Parametric Graphing	Up to 6	Up to 6	Up to 99	Up to 99
3D Graphing				✓
Vectors			✓	✓
1-Equation Solver		✓	✓	
System of Equation Solver			✓	
Complex Numbers		✓	✓	
Symbolic Manipulation				✓
Interactive Geometry				✓
Differential Equation Solving			Up to 9th Order	
Graphing				
Trace data on Stat Plots	✓	✓		✓
Graph Styles		✓		
Number of Lists	6	Limited only by memory	Limited only by memory	Limited only by memory
Maximum List Length	99	999	Limited only by memory	Limited only by memory
Statistics				
Regression Models	8	10	8	8
Inferential Statistics		✓		
Plot Definitions	3	3		9
Spreadsheet-like List Editor	✓	✓		✓
Display Pixel Size	96 x 64	96 x 64	128 x 64	240 x 128
Display Lines x Characters	8 x 16	8 x 16	8 x 21	Graphical
<b>PRICE</b>	\$89	\$89	\$105	\$178

## Science Internet Sites

We often get calls asking for suggestions for science-related Internet sites. Here are some suggestions from the technical support staff at Vernier Software:

**Science and Math Ed. Resources**—A great place to start; has links to thousands of other sites

<http://www-hpcc.astro.washington.edu/scied/science.html>

**Project PHYSLab**—Physics information and labs

<http://physlab.catlin.edu/>

**Texas Instruments/CBL**—Includes CBL programs from Vernier

<http://www.ti.com/calc/docs/cbl.htm>

**Access Excellence**—Information for biology teachers

<http://www.gene.com/ae/>

**NASA**—A wealth of material; includes many photos

[http://www.nasa.gov/NASA\\_homepage.html](http://www.nasa.gov/NASA_homepage.html)

**Chemistry Information**—Two great chemistry sites

<http://www.indiana.edu/~cheminfo/>

<http://www.cci.unl.edu/Chemistry/APEquations/APEquations.html>

**WeatherNet**—Weather information and maps

<http://cirrus.sprl.umich.edu/wxnet/>

**Physics Academic Software**—Physics simulation software

<http://www.aip.org/pas/pashome.html>

**National Science Teachers Association**

<http://www.nsta.org/>

**Discovery Channel**

<http://www.discovery.com/>

**Vernier Software**—Our personal favorite

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



## Humor

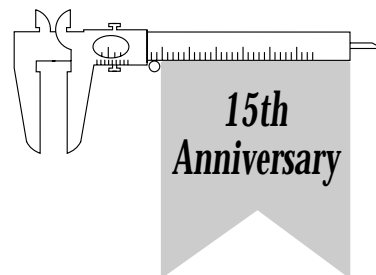
One of the hardest things to do in putting together this newsletter twice a year is coming up with good, clean, non-offensive, science humor.

This time I got Dan Holmquist to come up with some chemistry humor. Dan got these from a CHEMED-L List Server. If you have contributions, please send them in for use in our next newsletter.

1. Why does hamburger have lower energy than steak?
2. What is  $(\text{H}_2\text{O})_4$  ?
3. Name:  $\text{Ba}(\text{Na})_2$   
 $\text{Co}(\text{Fe})_2\text{ClO}_4\text{Er}$
4. What do you call a convict that likes to clown it up?
5. What is the role of a medical doctor ?

And if they don't, you . . .

1. Because it's in the ground state.
2. Drinking.
3. Banana.
4. Silicon.
5. Helium or curium.
- Barium.



## UPCOMING EVENTS

We will be exhibiting at all of the following conferences. If you attend, stop by and say hello.

- 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 will be hosting a 15th Anniversary party at the AAPT Summer Meeting!)*
- California Science Teachers Association Conference ..... Sacramento, CA ..... October 3-6
- Northwest Math Conference ..... Portland, OR ..... October 10-12
- Oregon Science Teachers Association Conference ..... Hillsboro, OR ..... October 11
- National Association of Biology Teachers National Convention ..... Charlotte, NC ..... October 16-19
- NSTA Western Area Convention ..... Phoenix, AZ ..... October 17-19
- Science Teachers Association of Texas ..... Austin, TX ..... Oct. 31-Nov. 2
- NSTA Southern Area Convention ..... Atlanta, GA ..... Oct. 31-Nov. 2
- Washington Science Teachers Association Conference ..... Port Angeles, WA ..... November 1-2
- North Carolina Science Teachers Conference ..... Greensboro, NC ..... November 13-14
- NSTA/STAO Eastern Area Convention ..... Toronto, Canada ..... November 21-23
- NSTA Global Summit on Science Education ..... San Francisco, CA ..... December 27-29

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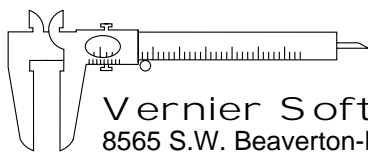
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