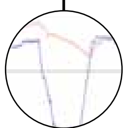
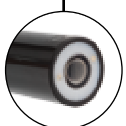
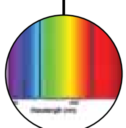
THE CALIPER

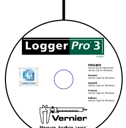
Vernier
MEASURE. ANALYZE. LEARN.™

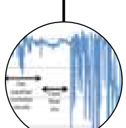
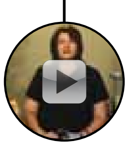
THE CALIPER IS A PUBLICATION FOR USERS OF VERNIER PRODUCTS

FALL 2010 | VOL 27 NO.2

IN THIS ISSUE



FREE Vernier Video Physics for iPhone® and iPod touch® Mobile Digital Devices

Vernier announces Video Physics, an iPhone and iPod touch app for doing video analysis. Now you can take the video analysis power of Logger *Pro* out in the field. We even took the app to a baseball game, and analyzed a pitch on the spot. Video Physics is free through the end of 2010.

Start with one of your own videos, take a new one, or use one of our sample videos. Track an object using our novel multi-touch cursor, and set the video scale. View graphs of the trajectory, position, and velocity as a function of time.

If you want, you can set the origin to whatever works with your experiment. You can also rotate the coordinate system, as needed.

Once you've finished analysis, you can send your work to Logger *Pro* for further work or printing. Your completed videos are stored within the app for later reference.

Courtesy of Apple

What motion will you analyze? And did we say free?

Video Physics requires iOS 4. For more info, visit www.vernier.com/videophysics

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NEW High Current Sensor

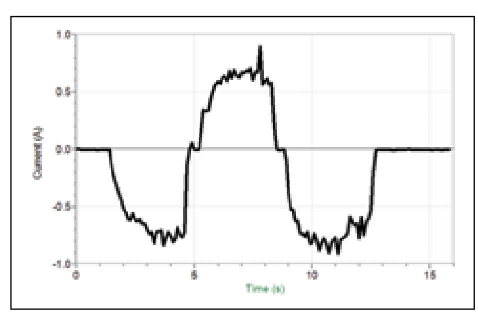
ORDER CODE **HCS-BTA, $79**

Do you do experiments with solar panels or other high-current devices? We've often been asked to offer a current sensor that can handle the higher currents from hand-crank generators, large batteries, and solar panels—and now we have one!

The new Vernier High Current Sensor has a range of ±10 A. Current is measured with a Hall effect sensor, which uses the magnetic field created by the current. That means that no sense resistor is required, reducing the effect of the sensor on your circuit. A magnetic shield keeps measurements undisturbed by external fields. There's a user-replaceable fuse inside to protect the sensor.

The graph shows the current from a common hand-crank generator, which requires the wider range of the High Current Sensor.

For currents below 600 mA, the original Current Sensor (DCP-BTA, $39) is still available and is the better choice for low-current experiments.

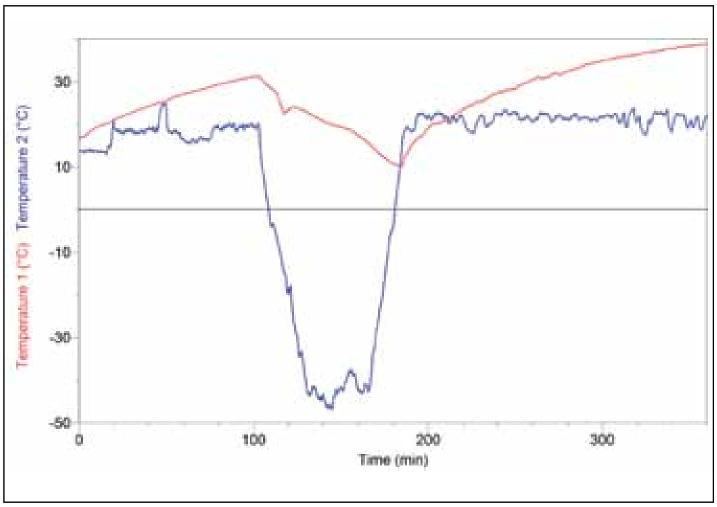


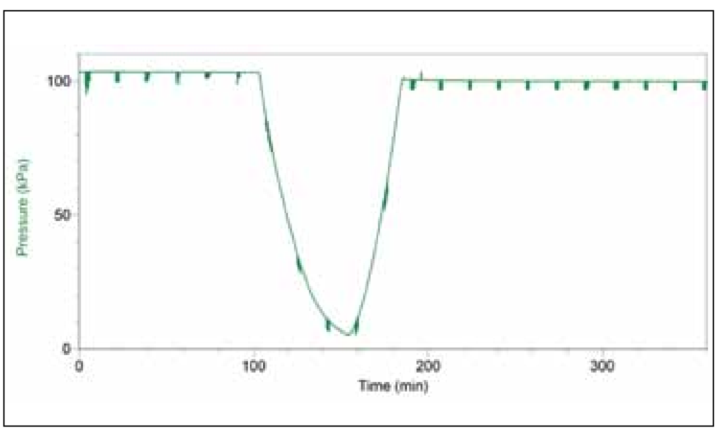
Current from a Genecon hand crank generator, turned one way, then the other

Near-Space Balloon Mission

With the guidance of instructors Richard Piccioni and Craig Butz, high school students from The Bay School of San Francisco launched a 2.3 meter (8 ft) helium balloon equipped with a video camera, Vernier Temperature and Gas Pressure Sensors, and Vernier LabPro into the atmosphere.

The flight lasted 1 hour and 22 minutes, reaching an altitude of 75,000 feet, or at a level above 95% of the Earth's atmosphere by mass, before the balloon burst. Two temperature probes were used: one inside a box used to insulate the data collection equipment and one outside. The interior temperature stayed relatively constant, whereas the exterior temperature decreased to –47°C.





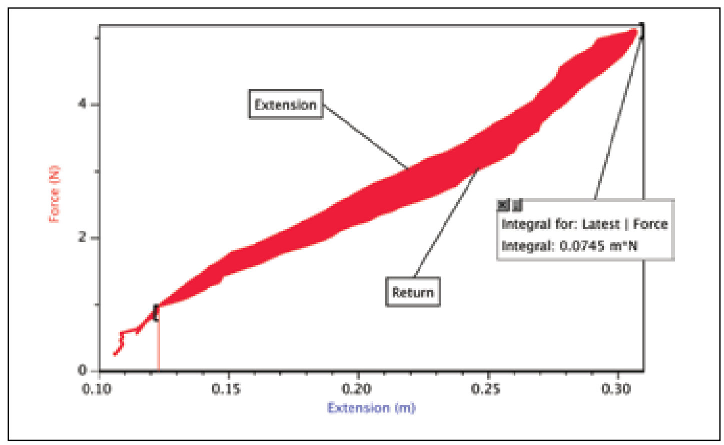
Temperature inside the payload and outside (top graph) and pressure (bottom graph)

The balloon apparatus used the APRS (Automated Packet Reporting System) to track location, and had at least six satellite signals at all times. The noise on the pressure graph is assumed to be from the periodic transmissions from the APRS. To ensure a safe landing and retrieval of the equipment, a 5-foot diameter parachute was used on descent. For more information, including a great movie about the project, visit http://ikaros.xrg.us

Elastic Hysteresis of a Rubber Band

Professor Richard G. Born, from Northern Illinois University, devised an experiment to study hysteresis, the delay of time between a force being placed upon a system and the exhibited reaction. Born placed a 7 inch rubber band on a Vernier Dual-Range Force Sensor (DFS-BTA, $109), with a Motion Detector (MD-BTD, $79) placed on the floor below the rubber band. He extended the rubber band downward, pulling it with his hand, and released it upward, loading and unloading the rubber band. The Motion Detector recorded the position of his hand. During the five-second trial, Born sampled the extension distance and the magnitude of the force applied to the sensor.

To analyze the results, Born compared the measured force in Newtons, with the extension of the rubber band in meters. Students could see that the rubber band did not obey Hooke's law, resulting in a non-linear relationship. Also, there was more force applied during the loading than the unloading of the rubber band, indicating that the system lost energy. This is represented in the space between the loading and unloading curve on the graph. Using the Integral function of Logger *Pro*, it was possible to determine the area between the loading and unloading sections of the graph, and to quantify the energy loss in Joules (N•m).



Net work done on rubber band during extension and return

Video Analysis of the "Old Spice Guy"

Heather M. Whitney, Ph.D., of Wheaton College in Wheaton, IL, set out to estimate the acceleration of the infamous "Old Spice Guy" from television and YouTube ads. She found this inspiration while participating in a LivePhoto workshop here at Vernier headquarters. Whitney used video analysis in Logger *Pro* to track points on the man's body as he made a so-called swan dive into a shallow pool. The video presented a challenge to analyze, because the camera panned, and the Guy moved toward the camera during the dive. Nevertheless, using a clever technique to establish a scaling factor, she accounted for these changes. Whitney then compared her estimate of the Old Spice Guy's vertical acceleration with the acceleration due to gravity on Earth. Heather invites readers to find out whether the Old Spice Guy is phenom or fake on her blog: http://heathermwhitney.com/2010/07/21/livephoto-workshop/

AAPT Photo Contest

Each year, Vernier is proud to co-sponsor the American Association of Physics Teachers High School Photo Contest. The contest is held during the AAPT Summer Meeting. We are always amazed at the creativity of these students.

We encourage you and your students to consider entering the contest next year. Entry information and 2010 winners are at http://www.aapt.org/Programs/contests/photocontest.cfm

"Connecting Branches" by Brittany Illana Fader, West Boca Raton High School (Teacher Maria Aparicio)

"Slap Shot" by Joshua John Garcia, Kuna High School (Teacher DaNel Huggins)

Induction and Hard Drives

To help his physics students understand the concept of electromagnetic (EM) induction, Brian Lamore, physics teacher at The Chinquapin School in Highlands, TX, devised an experiment involving strong neodymium (Nd) magnets, #28 magnet wire, and the Vernier Instrumentation Amplifier (INA-BTA, $59).

To connect the concept with a relevant application, Brian used older hard drives and floppy disks as examples, since they operate on the principle of EM induction—where a change in magnetic flux induces an emf in a conductor. When the reading head with its small coil moves over the magnetic surface of the disk, small signals are interpreted by the coil as digital 1's and 0's.

In class, Brian wound the wire 50 times around his index finger, sanded the wire's ends, and inserted them into the Amplifier. He showed students the results when one magnet passed the coil, when five of all the same polarity passed, and when three of one polarity and two of the other passed. Each polarity reads differently, thus signaling digital 1's and 0's.

Brian even set the coil in harmonic motion and ran a magnet past it to produce a damped sinusoidal waveform. "This relatively simple experiment has great potential for investigations into not only electromagnetism, but also electronics and calculus," Brian said. Brian used Logger *Pro* to collect and graph all data.

Solar System in a Box

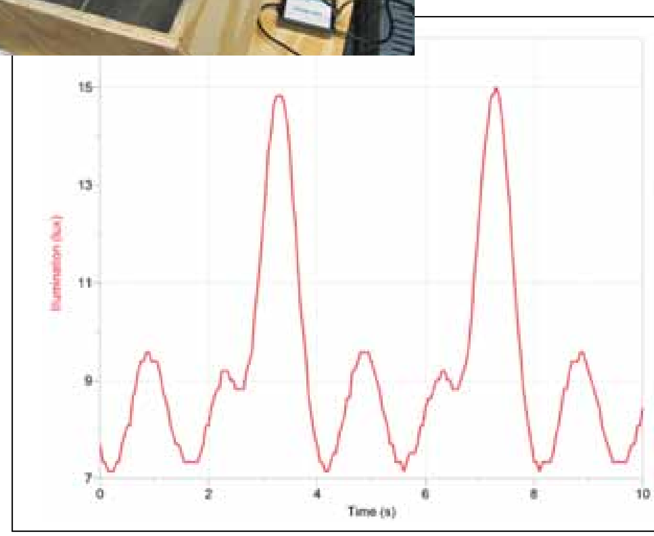
Astronomy instructors sometimes struggle with how to teach complex theories in a laboratory setting. This is especially true for an introductory class composed of mostly non-science major students. Gadsden State Community College instructor, Brian Geislinger, devised a model star system in the lab to show his students how professional astronomers gain much information just from the light that is projected from across the universe.

"When I began building models, I wasn't sure if the experiment would work the way I intended, or if the sensors would be sensitive enough to detect the changes in the light," Brian said. "But the setup worked out beautifully."

The model solar system was set up with light bulbs placed in an enclosed wooden box. With this setup, students were able to gather data using a Vernier LabQuest and Light Sensor (LS-BTA, $55) over a relatively short period of time. The light bulbs dimmed and brightened at varying speeds and intensities in order to mimic the light patterns of Cepheid variable stars, supernovas, and rotating planets. "[The students] watch the motors swinging artificial 'planets' around their light bulb-powered 'Suns,'" Brian said. "And you start to see another set of light bulbs going off."

Brian Geislinger is a 2010 NSTA/Vernier Technology Award recipient for his lab entitled "Understanding the Significance of Light Curves."

Planet is illuminated from the side while the Light Sensor records reflected light off of varying light and dark patches on the surface of the planet as it rotates.



Students describe different features of the resulting graph and determine periodicity of the rotation from the analysis. The sensitivity of the Vernier Light Sensor is excellent for studying these small variations. Note that the maximum illumination only reaches approximately 15 lux.

NEW

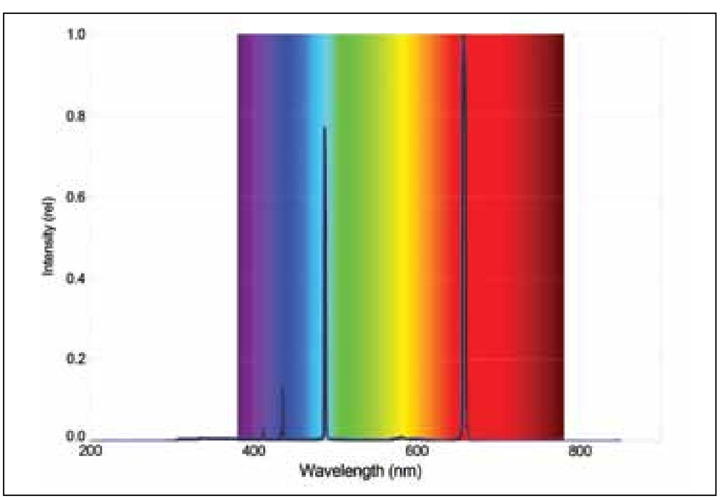
Measure Gas Discharge Tube Emissions

by Jack Randall

Attention chemistry and physics teachers! You now have a cool way to display and measure gas discharge tube emissions with our new Spectrum Tube Power Supplies and gas discharge tubes. These products are designed to be safe, convenient, and long lasting. One version of the Power Supply even has a carousel that holds up to eight gas discharge tubes. The gas tubes are permanently enclosed in plastic carriers that protect the tubes from breakage. There are no through-the-glass electrodes, so the tubes last far longer than other designs.

The Red Tide Emissions Spectrometer and Optical Fiber are used here with the Spectrum Tube Carousel Power Supply.

To get you started with this new product, we have written a sample lab experiment that explores the Balmer lines of the hydrogen gas emissions spectrum and guides the student to confirm, through calculation, the Rydberg constant. Visit our web site to download a copy of this lab from www.vernier.com/rydberg



Emission spectrum of hydrogen

Spectrum Tube Carousel Power Supply ST-CAR $275
Spectrum Tube Single Power Supply ST-SPS $225

All tubes are $36 each, sold separately:

Hydrogen, ST-H	**Nitrogen, ST-N**
Neon, ST-NE	**Carbon Dioxide, ST-CO2**
Argon, ST-AR	**Air, ST-AIR**
Helium, ST-HE	

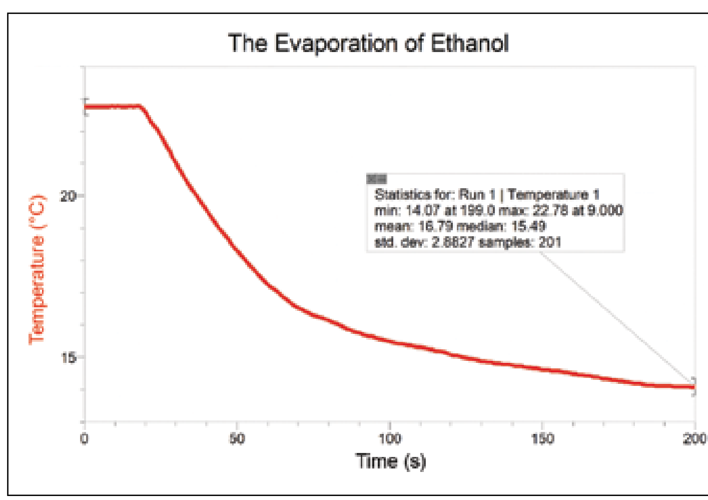
Investigating Chemistry through Inquiry

Our newest chemistry lab manual, *Investigating Chemistry through Inquiry* (CHEM-I, $48), has been a big hit among high school and university instructors. We have heard that the inquiry format and the extensive instructor resources are especially valuable. The book's authors, Don Volz and Ray Smola, designed the format to follow the guidelines established by NSTA for inquiry-based laboratory activities. Don and Ray also included a wealth of information for the instructor, from comprehensive lists of researchable questions to scoring rubrics to a huge repository of sample data.

As additional kudos, the book was given high marks in a review published in the August 2010 edition of the *Journal of Chemical Education*.

To give you a little taste of the experiments in *Investigating Chemistry through Inquiry*, we're featuring lab activity #8 – "Evaporation and Intermolecular Attractions in Alkanes and Alcohols." You may know this experiment as one of the tried and true activities we've used frequently in workshops and demonstrations. You'll be pleasantly surprised by Don and Ray's version of this classic experiment. Give it another look and see the new possibilities revealed when this lab is explored through an inquiry-based approach.

Below is shown one of the many sets of sample data. Download a copy of this lab at: www.vernier.com/cmat/chemi.html



Temperature vs. time for ethanol evaporation

Vernier pH Sensors Get Better and Better

by Dan Holmquist

We have made many significant improvements to our pH Sensor line in the past several years. We have gradually informed customers about these improvements in our catalog, lab books, and sensor booklets, but we thought a good summary would let more people be aware of these changes, and be able to take advantage of the improvements. By the way, some of these improvements are available even if you have an older pH Sensor!

pH Sensor Questions & Answers

Q: Are Vernier pH Sensors custom calibrated, or do you still use a "generic calibration"?

A: Our pH Sensors (PH-BTA, $79, shown below) are now individually custom calibrated, and have been since early 2008.

Q: What is a "custom calibration"?

A: In the case of pH Sensors, we actually do a very accurate factory calibration of each pH Sensor prior to shipping. This means that when you receive the electrode, and put it into a pH buffer, you will see a reading that is within the accuracy range ±0.1 pH unit. In buffer pH 7.00, for example, you will see a reading between 6.90 and 7.10, frequently as close as 6.98 or 7.01. Previously, we applied a "generic" calibration (think of it as an "average" value) to all of our shipping electrodes. Given variation from sensor to sensor, the accuracy level was ±0.3 pH unit, so custom calibration represents a significant improvement.

Q: How long will this calibration last? Can I do my own custom calibration later on?

A: Every pH Sensor has a slight change in response with time. How long before you have to recalibrate? That depends on the accuracy level required by your usage. In some cases, you will never need to calibrate. But if you find that after 6 months or a year, your accuracy has drifted outside this range, maybe to ±0.15 pH units, you can easily do a two-point calibration in two buffer solutions. Once you have done this calibration, while still on the calibration screen in Logger *Pro* or LabQuest App, go to the Storage tab and save the calibration to the sensor. You now have a new custom calibration stored on that sensor.

Q: Is the custom calibration loaded when connected to a LabQuest or to a computer with interface?

A: Yes!

Q: Does Vernier have other pH amplifiers to allow me to use my third-party electrodes with Vernier data collection?

A: Yes. If you own third-party pH electrodes, you can purchase our Electrode Amplifier, (EA-BTA, $40). As shown here, this amplifier has been greatly reduced in size (from its previous larger-size plastic box). One end has our BTA sensor connector, while the other end has a standard BNC connector.

Electrode Amplifier EA-BTA, $40

Q: Does Vernier sell a pH electrode that can be used with the Electrode Amplifier?

A: Yes, we sell a high-quality pH Replacement Electrode (7120B, $37) with a BNC connector, requires the Electrode Amplifier.

Replacement Electrode 7120B, $37

Q: Can I store a custom calibration on the Electrode Amplifier when it is used with a third-party pH Electrode (or Vernier 7120B)?

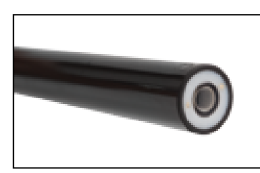
A: Yes. The Electrode Amplifier has a calibration memory chip onboard, so your careful two-point calibration can be stored on that chip, using Logger *Pro* or LabQuest.

Q: Do my older Vernier pH Sensors have a calibration memory chip on them to store a custom calibration?

A: Maybe. Every Vernier pH Sensor manufactured since the year 2000 has this chip. (This style sensor is identifiable because the amplifier is built into the sensor handle (one piece, with either a gray-green or blue shaft.) Even though we didn't start custom calibration until 2008, you can actually do your own careful two-point calibration of any of these older models, and then save the calibration to its chip with Logger *Pro* or LabQuest. Your older pH Sensor is now calibrated "as good as new."

Q: I notice that Vernier now has a third option for pH, the Tris-Compatible Flat pH Sensor. How is it different from your pH Sensor?

A: This new specialty pH sensor uses a double-junction electrode, making it compatible with tris buffers and solutions containing proteins. The flat glass shape also makes it ideal for measuring the pH of semisolids, such as food or soil.



Q: Can the Tris-Compatible Flat pH Sensor (FPH-BTA, $99) be used for chemistry or water quality, too?

A: Yes, but keep in mind we recommend the pH Sensor (or the pH Electrode + Electrode Amplifier), for chemistry and water quality. However, if you want a general-purpose electrode that also has a double junction (and therefore is tris-compatible), the FPH-BTA will work fine for these other purposes (e.g., titrations, water testing).

Use the SpectroVis® Plus to Study Neurotransmitters

by John Melville, Ph.D.

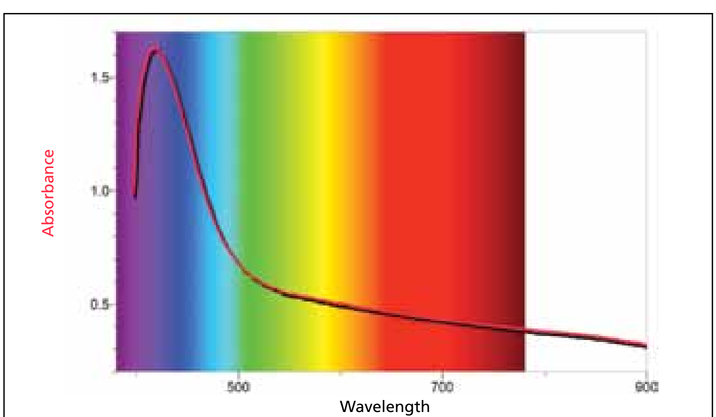
Neurons communicate with each other and the rest of the body by releasing neurotransmitters. Neurotransmitters are small chemicals that bind to receptors on other neurons, cells, or tissues of the body. It is very difficult to study neurotransmitters directly. In many cases, the activity of an enzyme that produces or breaks down a neurotransmitter is studied instead.

I developed an advanced laboratory exercise on neurotransmitters using our SpectroVis Plus spectrometer. Vertebrate skeletal and cardiac muscles are controlled by neurons that release the neurotransmitter acetylcholine (ACh). These muscle cells contain an enzyme called acetylcholinesterase (AChE) that rapidly breaks down ACh into the compounds acetate and choline, terminating the action of the neurotransmitter.

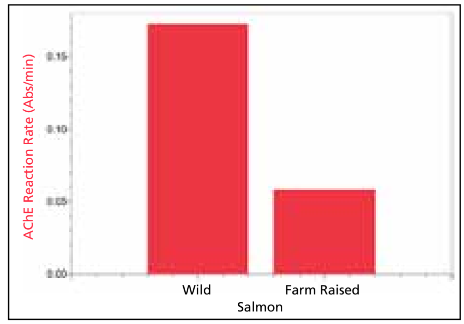
A simple method for assaying the activity of AChE is the Ellman method. The compounds acetylthiocholine iodide (ACTHi) and dithiobisnitrobenzoate (DTNB) are added to a solution containing AChE. AChE breaks ACTHi down into acetate and thiocholine. Thiocholine then reacts with DTNB to form a compound called 5-thio-2-nitrobenzoate (TNB). As shown in the graph below, TNB is a yellow-colored compound with a peak absorbance at 412 nm. The rate that TNB is produced during the reaction is a function of AChE activity.

Acetylcholinesterase is an excellent enzyme for the college laboratory. AChE has been thoroughly researched and is medically important. The pharmacology of the enzyme is well known, and enough enzyme for an entire class period can be isolated from a single frozen chicken heart or a small piece of fish fillet. This enzyme also lends itself to guided-inquiry based exercises, many of which are listed in the teacher's section of our latest edition of *Advanced Biology with Vernier*.

I was aware that the gene for acetylcholineserase can be regulated by the activity of a muscle. As a result, I decided to see if wild salmon fillets would contain more acetylcholinesterase activity than fillets from farm-raised salmon. Wild and farm-raised salmon fillets were obtained from the local grocery store. Tissue samples were prepared and tested using the Ellman method as described in Lab 16 in *Advanced Biology with Vernier*. The results are provided in this graph. You can see that wild salmon tissue breaks down acetylcholine almost five times faster than tissue from farm-raised salmon.



Absorbance spectrum of TNB using the Ellman method



AChE activity from wild and farm-raised salmon

If you want to repeat this experiment, or have questions about Lab 16 or any of our other *Advanced Biology with Vernier* exercises, contact me at jmelville@vernier.com

Determining Soil Composition along the Virginia Creeper Trail

Steve Ahn, from Abingdon High School in Abingdon, VA, took his students on a science expedition along the Virginia Creeper Trail, where approximately 400 million years ago the land was covered by a shallow sea. As a result of the subsequent sedimentation, the soil now exhibits alternating bands of limestone and shale. "I wanted my students to get a sense of the wonder, history, and beauty of this place," Steve said. "In order to do that, I knew we had to get on our bikes and collect data."

With the assistance of a Vernier LabQuest, GPS, pH, and Light Sensors, Steve's students took measurements of unknown soils. Armed with their data, students then hypothesized about the compositions of the two soils and confirmed their findings with the use of detailed geologic maps. "This lab would not have been possible without the Vernier LabQuest and probes," Steve said. "Having this data-collection technology opens doors to realizing ideas that used to fall into the realm of the 'impossible.'"

http://www.vacreepertrail.com/

NABT Ecology/Environmental Science Teaching Award

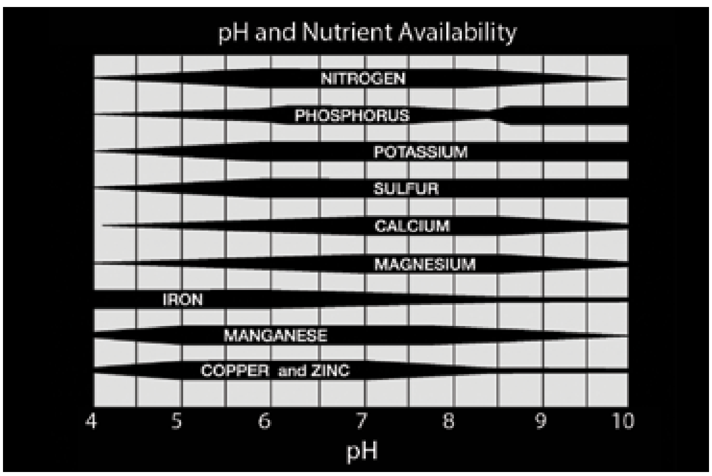
Vernier is again sponsoring the NABT Ecology/Environmental Teaching Award that will be given to a high school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his/her commitment to the environment into the community. Our sponsorship of this award includes $1000 toward travel to the NABT Professional Development Conference and $500 of Vernier equipment. The recipient also receives a plaque to be presented at the NABT National Convention, and a one-year complimentary NABT membership. The nomination deadline is March 15, 2011.

www.vernier.com/nabtaward

Measuring the pH of Soil with the New Tris-Compatible Flat pH Sensor

When you think of pH, you probably think of liquid acids and bases. But soil can be acidic or basic, too. Soils with pH above 7 are basic or sweet. Soils with pH below 7 are acidic or sour.

The pH of soil is an important factor in determining which plants will grow because it controls which nutrients are available for the plants to use. Three primary plant nutrients—nitrogen, phosphorus, and potassium—are required for healthy plant growth. They are the main ingredients of most fertilizers that farmers and gardeners add to their soil. Other nutrients, such as iron and manganese, are also needed by plants, but only in very small amounts.



To measure the pH of soil, the standard method is to mix equal parts of soil and distilled water, let sit, and then measure the pH of the resulting slurry. Our regular pH Sensor (PH-BTA, $79) has a glass bulb that performs very well in liquids, but is easier to break when used in this type of semi-solid. It can also be difficult to clean the soil out from around the glass bulb at the tip of the electrode. A more appropriate sensor is our new Tris-Compatible Flat pH Sensor (FPH-BTA, $99). This new specialty pH sensor has two unique features that make if perfect for use in agricultural science courses and some biological applications.

- The flat glass sensing surface makes it ideal for measuring the pH of semisolids, such as food or soil slurries. While the glass can still break, it is thicker and the flat shape makes it less vulnerable than a bulb. It is easier to clean than a bulb, and the flat shape allows for smaller sample sizes, as well.
- It has a double-junction electrode, making it compatible with Tris buffers and solutions containing proteins or sulfides. Single-junction electrodes, like our pH Sensor, will eventually become clogged with precipitates formed from the reaction between these compounds and the AgCl gel.

For all chemistry and most biology experiments, we continue to recommend our pH Sensor. The pH Sensor is custom calibrated, faster responding, and less expensive than the Tris-Compatible Flat pH Sensor.

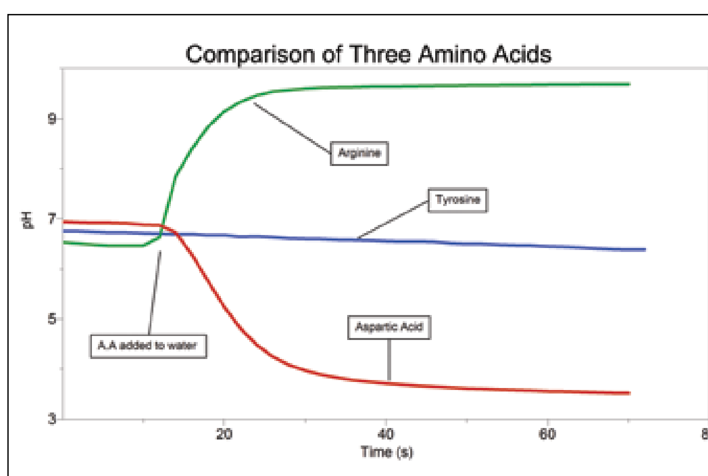
Tris-Compatible Flat pH Sensor
ORDER CODE **FPH-BTA, $99**

Demonstrate the Properties of Amino Acids with a Tris-Compatible Flat pH Sensor

by John Melville, Ph.D.

A key concept in biology is how the structure of a protein determines its function. All proteins are made up of amino acids. The primary structure of a protein refers to the sequence of amino acids of which the protein is composed. The primary structure determines how the protein will fold, which will in turn determine its function. There are 20 different amino acids that are commonly found in proteins, and each one has a different side chain. These side chains are very important, because they impart each amino acid with different characteristics.

Amino acids can be characterized as polar, nonpolar, or charged. Charged amino acids are further characterized as acidic or basic. Uncharged amino acids can be considered neutral. As shown in the graph below, you can easily demonstrate if an amino acid is basic, acid, or neutral by using our new Tris-Compatible Flat pH Sensor. All you need is some water, a magnetic stir station and a few amino acids. You can start with the amino acids arginine, tyrosine, and aspartic acid. Arginine is basic, tyrosine is neutral and aspartic acid is acidic.



pH measurement of amino acids using the Tris-Compatible Flat pH Sensor

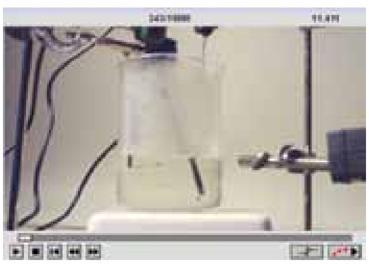
Sensors at Home, Work and Play

by David Vernier

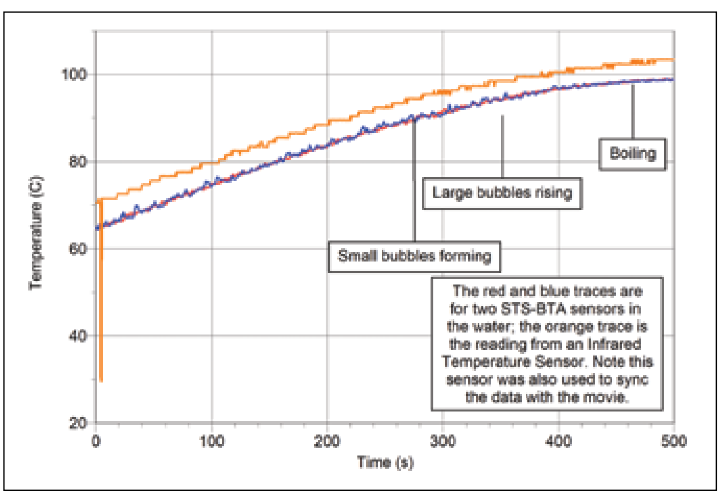
We are often thinking of ways to use our sensors to help us investigate everyday events. Here are the results of some recent experiments we did here at the office.

When is Water Really Boiling?

I recently started using an electric pot for heating tea water. Early on, I sometimes assumed that the water was hot enough when I heard the loud "boiling" sounds. Yet, when I poured the water to make tea, it was not very hot. We decided to make a movie and take data to show how sound and visible bubbling are related to the temperature. We used a standard "trick" for synchronizing the movie with the data. Near the start of the movie, we moved our hand in front of the IR Thermometer (IRT-BTA, $159). This caused a drastic drop in the temperature reading for that sensor, and we can see the hand movement in the movie, so it is easy to synchronize the two. Note that the first bubbling starts about 90˚C, too cool for tea connoisseurs. In this experiment, we used two Surface Temperature Sensors (STS-BTA, $23) and an Infrared Thermometer to measure water temperature as we recorded the movie. Check out the Logger *Pro* file Boiling Water which includes this movie at www.vernier.com/innovate/141



Our boiling water apparatus

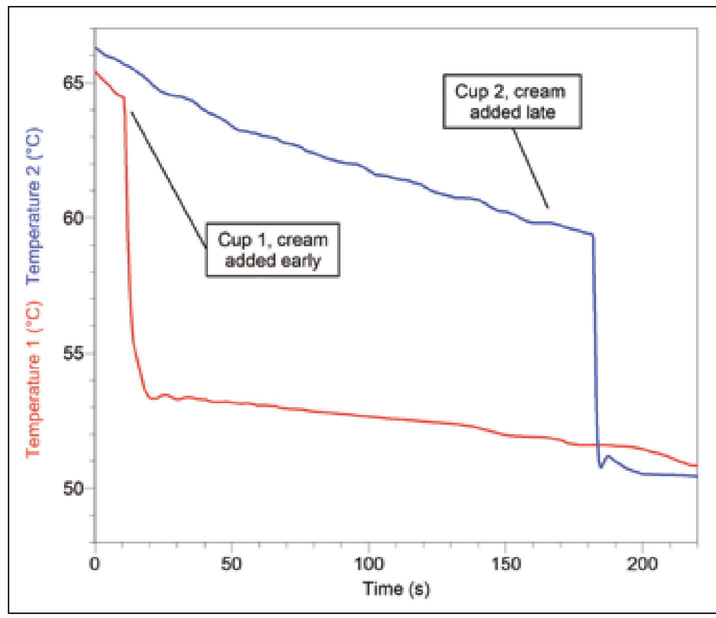


Temperature vs. *time as the water approaches boiling*

Cooling Coffee

A classic question that comes up among coffee drinkers is, "If you are going to add cream to coffee, is it better to add the cream immediately, or wait until later, assuming the goal is to have the coffee cool enough to be ready to drink as soon as possible?" Have your students predict and then try it.

Despite the fact that we added the cream early, on the cooler of the two cups, that cup came out hottest at the end of the experiment. This is a great demonstration of Newton's law of cooling. The Logger *Pro* file is CoffeeCooling.cmbl at www.vernier.com/innovate/142



Temperature vs. *time for the two cups of coffee*

Shoe Cushioning

Here is an activity that some of your students may find interesting. The goal is to test the cushioning for various shoes and boots. We measured the acceleration in a "heel drop" of standardized height.

We used a 25-g Accelerometer (ACC-BTA, $92) attached to a 500 *g* mass, placed inside the shoes. We used the 500 *g* mass that we sell for use with our Vernier Dynamics Carts. This mass works well because it has a hole in it, so it can easily be bolted to the Accelerometer.

The Accelerometer/mass was placed in the heel of the shoe, and the shoe was packed with recycled paper to keep things in place. We rested the tip of the heel of the shoe on a rod attached to a ring stand to standardize the drop distance. With a Logger *Pro* file set to trigger on an increase in acceleration

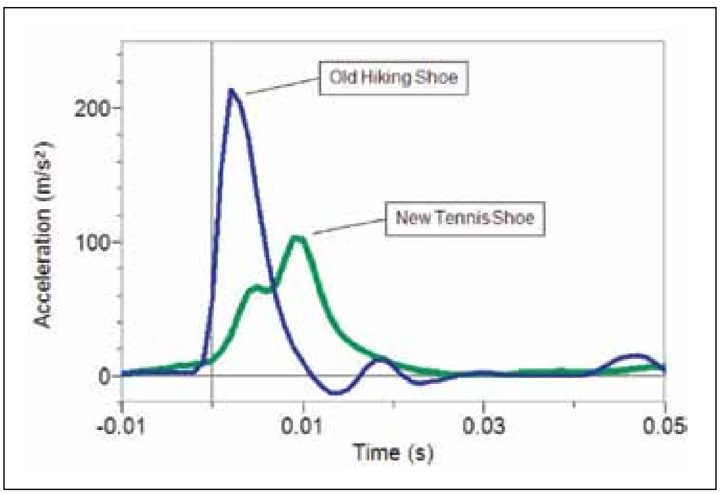
Shoe with accelerometer in heel

Rod on ring stand used to standardize heel drop

Shoe in position for drop

and a very high data-collection rate, we pushed the shoe off the rod with just enough force to release the shoe.

Typical drops are shown below. As you might expect, the peak acceleration varies with the shoe type and shoe condition. The most surprising thing is how large the accelerations are for even a drop of just a couple centimeters.

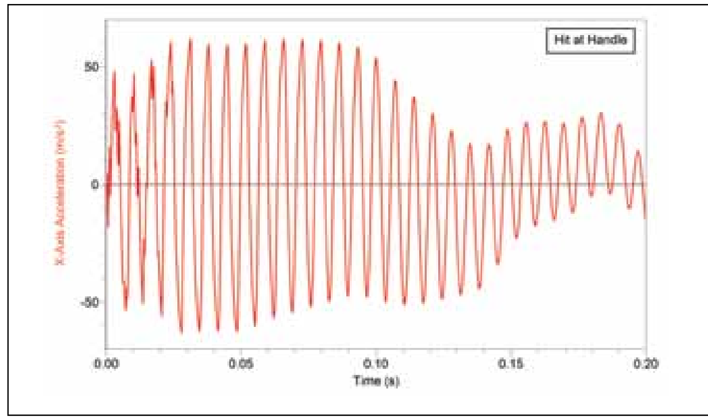


Acceleration data for typical drops

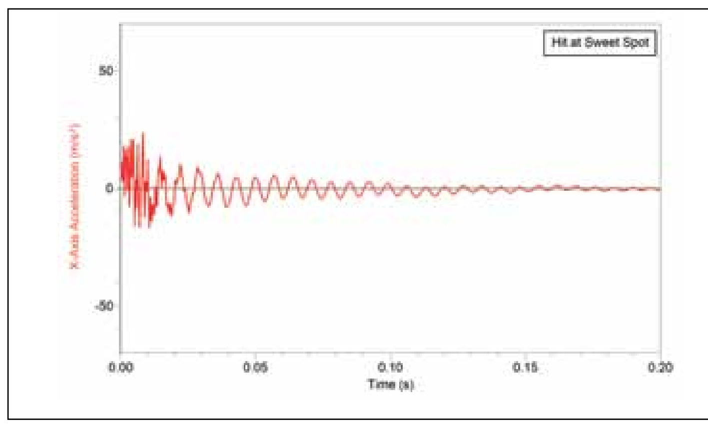
The Sweet Spot on a Baseball Bat

We recently attended the American Association for Engineering Education meeting in Louisville, KY. While there, we had a free afternoon, so we went to the Louisville Slugger Bat Museum. In the museum, they had an exhibit where they asked you to hold a baseball bat vertically, suspended by the knob, and then to tap it with another baseball bat at different spots along the bat. The idea was to see if you could find the "sweet spot," which is the center of percussion—where the rebound force of the bat is completely balanced out by the force of the ball. When the bat hits the ball at the sweet spot, the batter will feel very little vibration in the handle from the impact.

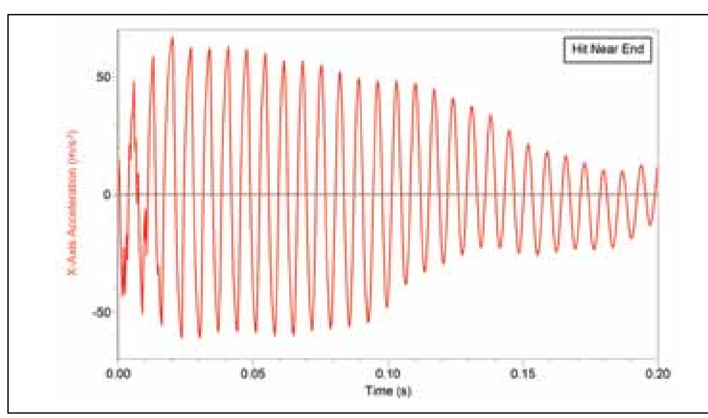
Michele Perrin, a teacher who works with us on projects in the summers, came up with the idea of mounting one of our Low-*g* Accelerometers (LGA-BTA $89), on the knob of the bat and monitoring the vibrations, while we do the tapping. Here are some results:



Hit at the handle of the bat



Hit at the sweet spot of the bat



Hit near the end of the bat

Sensors at Home, Work and Play

(continued from page 9)

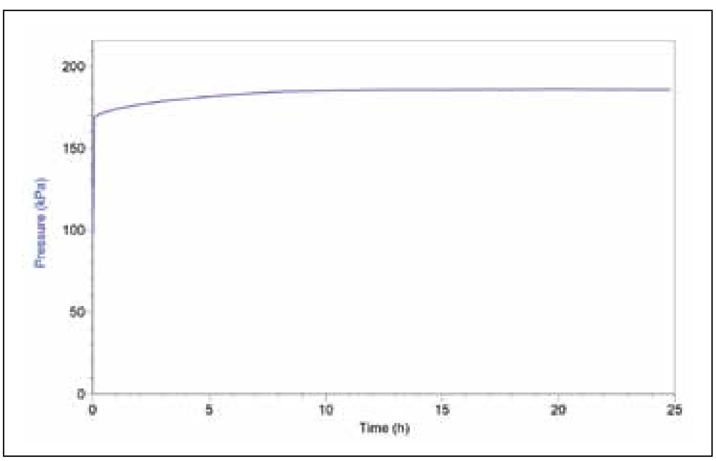
Fizz Keeper

Fizz Keeper and soda bottle with tubing attached

A Fizz Keeper is a device that is sold to preserve the carbonation in soft drinks. We decided to see if they really work at maintaining pressure in bottles.

We used a special soda bottle to which we attached tubing to connect to our Gas Pressure Sensor (GPS-BTA, $83). We opened a bottle of soda, poured the contents into our special bottle, and then put the Fizz Keeper on the special bottle. Data collection was started. We quickly pumped up the pressure, and then let the bottle sit for 25 hours. As you can see, the pressure held fairly nicely.

The more general question of whether a Fizz Keeper is effective at keeping the carbonation in an opened soda bottle is more complicated. It could be a good topic for discussion in a chemistry class. Since the Fizz Keeper pumps air, not CO_2, into the bottle, does it really help at all in keeping the soda carbonated? For a good discussion on this, see http://en.wikipedia.org/wiki/Fizz_keeper



Pressure data in a soda bottle capped with a Fizz Keeper

Wine Pump

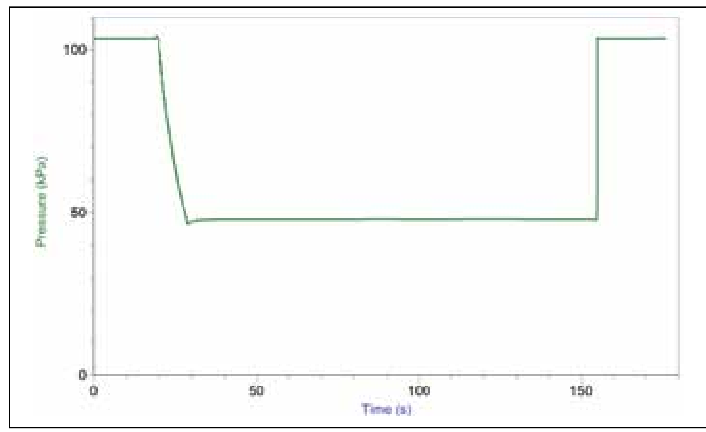
If you have a partially finished bottle of wine and you want to prevent the wine from oxidizing, you can use a wine pump. Many different styles are sold. They are usually hand-powered pumps that are used to lower the pressure in a wine bottle so there is less oxygen in the bottle. But how well do they work? We decided to do some tests. The tricky part was how to measure the pressure in the bottle. We ended up drilling a hole into the side of a wine bottle with a special drill bit made for drilling glass. We inserted one of our stopper stems with a Luer lock fitting in the hole, and sealed the hole with sealant. We used our Gas Pressure Sensor (GPS-BTA, $83) to measure the pressure.

Wine pumps

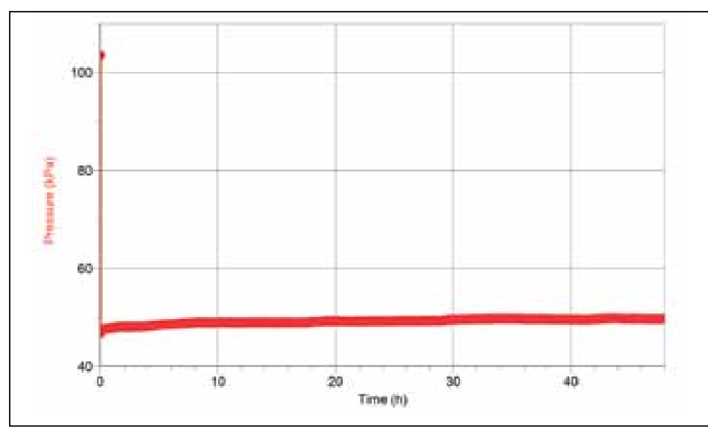
We tried two different models of wine pumps. Two sample graphs are shown below.

The top graph shows one model of wine pump. Note that the pressure is quickly reduced to a little less than a half atmosphere. It is difficult to get much lower pressure with these pumps.

We were curious if the pumps really held the pressure. The second graph is a two-day run with a different model of pump. Note that the pressure again is just a little less than half an atmosphere.



Pressure vs. *time using a wine pump*



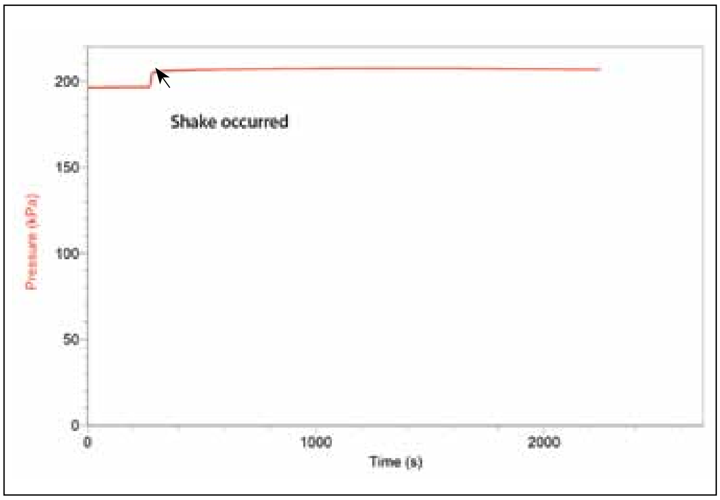
Bottle pressure over two days

Pressure in a Dropped Soda Can

In the book *What Einstein Told His Barber*, by Robert L. Wolke, there is a section discussing champagne, soda, and pressure. He says, "If I said that shaking a bottle of champagne, beer, or pop raises the gas pressure inside, 99 out of 100 people, even chemists and physicists, would agree. But it's not true." (page 232)

We were intrigued by this challenge. A quick search on the internet will lead you to many vigorous arguments both supporting and denying the pressure change on shaking. We did not have a quick way to measure the pressure inside a soda can, but we decided to use our special wine bottle. Our results are shown in the graph below.

We had a small change in pressure, but note that our situation was a little artificial. We had to fill our wine bottle with soda (actually Diet Pepsi). We let it sit for a couple of hours before we started the experiment, but our system probably did not have enough time to reach equilibrium. This subject could be a good one for student experimentation.



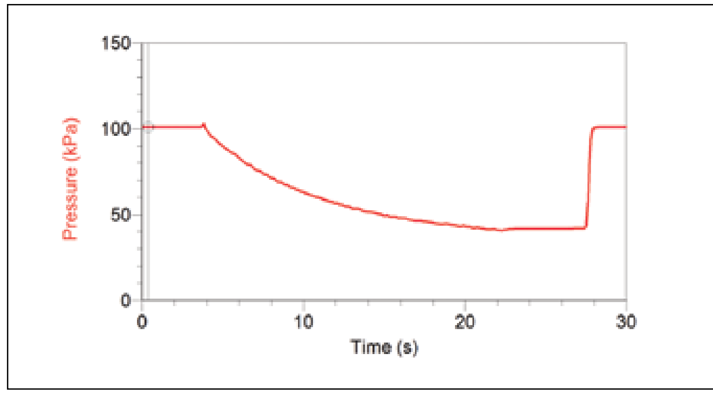
Pressure vs. *time as shake the container*

Vacuum Sealer

We sometimes use an inexpensive vacuum sealer here at our offices. I was curious about the pressures involved, and whether these could be used as an alternative to expensive vacuum pumps in the science lab. We put a partially inflated balloon in the sealer and ran it. The pressure reduction is modest, to about 0.4 atmosphere. At the end of the movie, we released a valve on the sealer to let the air back in.

The bottom line is that these devices might be useful for some science lab activities, but they do not produce very low pressure. On the other hand, the device works well for some applications, demonstrating what happens to objects containing air when the air pressure changes. Some students who have noticed puffed up bags of chips on airplanes or when visiting the mountains may find this interesting. The results of our experiment including a movie is included in the Logger *Pro* file at: www.vernier.com/innovate/148

Vacuum sealer with Vernier Gas Pressure Sensor connected



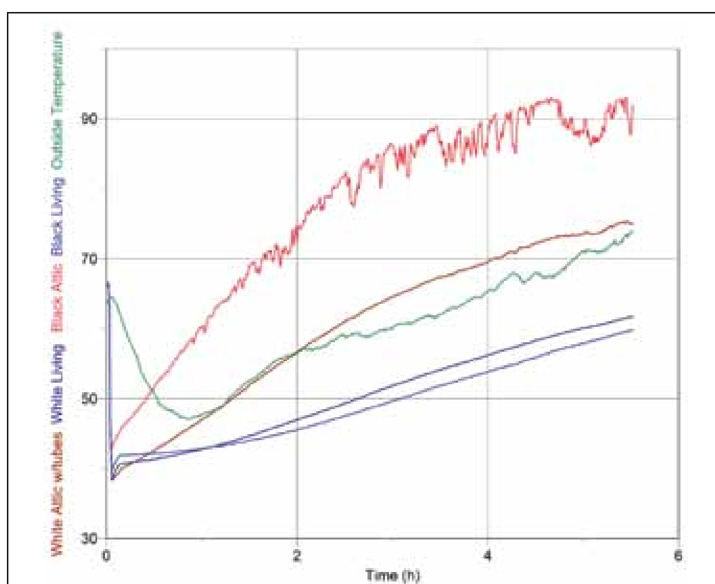
Pressure vs. *time as sealer is run and then released*

Roof Color

Alan Zube's Lemelson/MIT team from Washington County Technical High School in Hagerstown, MD, did a study of the effect of roof color on the temperature in houses. They actually built small, wooden houses for the testing.

Model houses built for the project

Their ultimate goal was to investigate whether it was possible to save energy with a roof that actually changed color. They came up with a very clever system using rotating tubes for the roof material. To read a report on the project, go to www.vernier.com/innovate/149



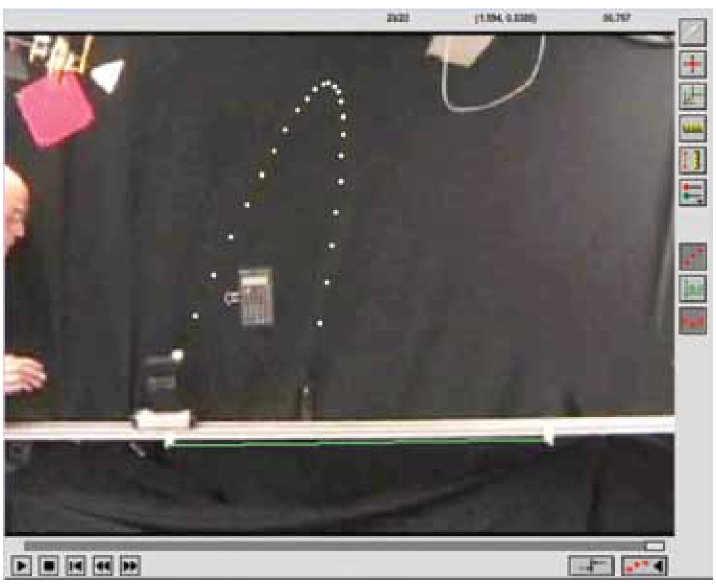
Temperatures in attics, living areas, and outside the two houses

Innovative Use of Logger *Pro* Video Analysis

Jeffrey Wetherhold from Parkland High School, Allentown, PA makes extensive use of video in his physics class. When experiments are difficult to create for the classroom, he has his students collect and analyze data using the video analysis feature of Logger *Pro.*

He recently sent us an activity that he uses with his students. He shows a video that is counter intuitive; the video shows a ballistics cart moving along a horizontal track. Halfway down the track, a ball is ejected from the cart. The cart and ball continue moving forward; however, shortly after that, they both start to move backward. After showing the video to his students, he has them investigate the motion using video analysis in Logger *Pro.*

The photo below shows the trace of the motion of the ball. The larger bright dot is actually from the last frame of the movie. If you are interested in Jeff's activity, we've posted it at www.vernier.com/innovate/150



How can you explain the cause of this motion?

National Lab Day

Students Create Science Projects with Vernier Products

The first National Lab Day is over, but the nationwide initiative that is National Lab Day continues to bring discovery-based science experiences to students by connecting educators, students, and volunteers. Vernier contributed to the cause by providing free equipment to several participating teachers. One winner of Vernier's "Adopt a National Lab Day Project" contest, Maria Brown of West Sayville, New York, submitted a project on behalf of her students who needed Vernier sensors to help them study the effect of salinity, flow rate, and temperature on the growth rate of the American Oyster. They are comparing two groups of oysters in two types of pools: a bay water pool and an upwelling pool. Using the donated equipment, her students now collect data every week using a Vernier LabQuest with a Stainless Steel Temperature Probe, a Salinity Probe, and a Flow Rate Sensor. In December, they will then measure the size of the oysters to see how the two environments affect their growth.

Congratulations to Ms. Brown and her students! For more info, see www.nationallabday.org

2011 Vernier/NSTA Technology Award

Win One of Seven Awards

Full-time science teachers from elementary to college level are eligible to apply for the Vernier/NSTA Technology Award. Vernier will provide up to seven awards, each valued at $3000, for educators who demonstrate innovative uses of data-collection technology using a computer, graphing calculator, or other handheld device in the science classroom.

The awards will be given to one elementary teacher, two middle-school teachers, three high-school teachers, and one college-level educator. Each will receive a $1,000 cash award, $1,000 in Vernier equipment, and $1,000 towards travel and expenses to attend NSTA's National Convention in 2011.

For guidelines, grant application and profiles of previous winners, visit: www.vernier.com/nstaawards

SOFTWARE UPDATES

Have you updated your Vernier software programs recently? We regularly release updates to support new devices, add new features, and yes, to fix the occasional bug! Here are the current release versions:

Logger *Pro* 3.8.3 – Logger *Pro* 3.8.3 will be released at the end of September. This update is free to all users of any previous version of Logger *Pro* 3, and is available at www.vernier.com/lpupdates

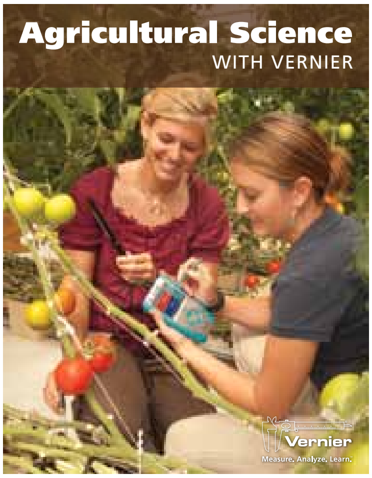
Version 3.8.3 adds support for Ocean Optics devices in 64-bit Windows systems, as well as localization to nine non-English languages. A new moveable linear curve lets students adjust the fit by dragging the line itself (great for IB teachers). The release includes support for the new LabQuest Mini and the Vernier SpectroVis Plus, and Windows 7, first introduced in version 3.8.2.

LabQuest 1.4 – LabQuest 1.4 was released in February 2010. We encourage all LabQuest users to install this free update, available at www.vernier.com/labquest/updates

The update adds support for the new SpectroVis Plus, as well as offering improved battery life, support for additional sensors, and printing to Wi-Fi printers.

Logger Lite 1.5 – Logger Lite 1.5 was released in March 2010, to support LabQuest Mini and Windows 7 (including 64-bit machines), and also adds linear fits. This free update is available at www.vernier.com/llupdates

NEW *Agricultural Science with Vernier*



Agricultural Science with Vernier
ORDER CODE **AWV, $48**

Many agricultural science teachers have been using Vernier data-collection products for years. Now, 29 experiments covering the diverse range of topics they teach have been collected in *Agricultural Science with Vernier*. This exciting new lab book contains experiments specifically chosen for teaching topics in agricultural science at the high school or college level. Experiments range from the investigation of factors affecting transpiration, to the temperature effect shearing has on sheep, to the development of an understanding of Ohm's law.

Here are just a few highlights of experiments in this book. You can view the entire table of contents at www.vernier.com/cmat/awv.html

- Fundamentals of Agricultural Science: Learn the basics of data collection and analysis, plus some foundational science such as acids and bases.
- Plant and Soil Science: Characterize soil types with our new Tris-Compatible Flat pH Sensor and Soil Moisture Sensor, then study plant science topics such as photosynthesis and transpiration.
- Animal Science: Measure the energy that comes from our food and the effects of insulation on animals.
- Energy and Electricity: Make a simple battery and measure the current and voltage from photovoltaic cells.
- General Topics in Agricultural Science: Learn to test water quality and study the interdependence between plants and animals.
- Mapping Field Data using GPS and GIS: An appendix explains how to use the Vernier GPS Sensor to geotag your data, then map it using Google Maps or ArcGIS Explorer software.

years ago in THE CALIPER

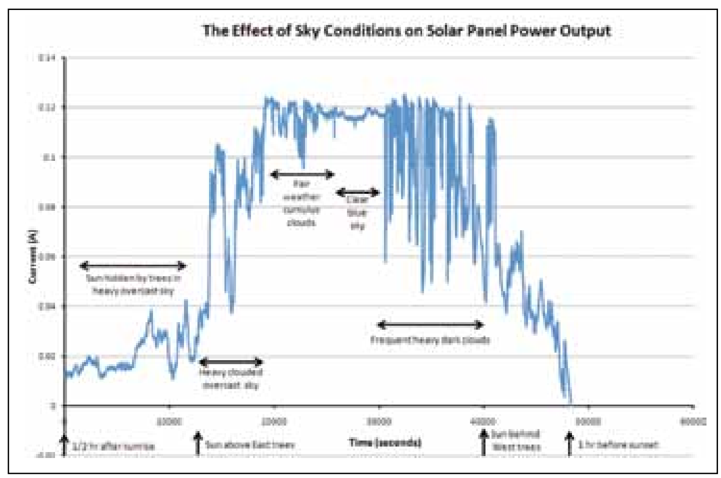
25 Years Ago in *The Caliper:*

In our Fall 1985 issue of this newsletter, we announced our Voltage Plotter program, Voltage Input Unit, and Advanced Interfacing Board for the Apple II. We also had a discussion of how Vernier programs could be used on hard disk drives, which were just starting to become available for Apple IIs.

Solar Panels

Richard G. Born of Northern Illinois University has written up a nice lab showing the use of small (9-watt) solar panels while monitoring their output with our Voltage and Current Probes. He used small Christmas tree lamps as the load. For the complete article, go to www.vernier.com/innovate/151

Solar panel, LabQuest with LEDs used as the load



Current vs. *time over a day*

Honeymoon at Vernier

We had lots of visitors to our office this summer, but we were pleasantly surprised to have one young couple spend part of their honeymoon on a tour of our office! Congratulations to Meaghan and Stephen Berry, both science teachers at McGavock HS, Nashville, TN.

Meaghan and Stephen Berry

Vernier Gets Even Greener

Transforming Lawn into Bioswale

Combine 3000 square feet of unused lawn, a large puddle that forms in the parking lot during heavy downpours, an opportunity to collect water quality data, and you have a perfect storm of reasons for our latest sustainable project—a bioswale.

Our bioswale consists of a 100 foot long, 4 foot wide, meandering drainage course with gently sloped sides. It is filled with 2 inches of ¾ inch river rock, and planted with native grasses. The water-flow path is meant to maximize the time water spends in the swale, which aids the trapping of pollutants and silt.

Vernier bioswale traps pollutants and silt before they enter a nearby stream

Rainwater capture tank provides water for lawn

The swale begins at the low point of the parking-lot puddle, drops into a 6 inch deep water sample pool and flows until it reaches the terminus sample pool, 18 inches below the surrounding ground level. Any water remaining at the end of the bioswale after a heavy downpour enters the storm drain in smaller volume and cleaner.

Planted vegetation in and surrounding the bioswale is native to Oregon, ranging from Oregon Oak trees to Elk Blue Spreading Rush. The plants thrive in our wet Oregon winters and months-long dry summers and filter the water, removing phosphorous, soil sediments and other pollutants before it heads to our nearby Beaverton Creek.

Diverting Roof Drain Water

Since we had already engaged the design services of an engineer for the bioswale, we decided to add rainwater diversion to the bioswale project. About 10,000 square feet of the roof empties into a roof drain close to the bioswale, and is diverted with a valve into an above-ground 2500 gallon tank. Our water is utilized through a hose bib at the bottom of the tank for low-pressure lawn watering. The tank fills up with approximately every half inch of precipitation. Water depth in the tank is measured using a pressure sensor at the bottom of the tank.

SCIENCE HUMOR

At a major opera performance, the conductor fell ill at the last moment. The performance was about to be canceled, but somehow the producers managed to find a substitute conductor. The substitute made one mistake after another, and the music sounded horrible. People in the audience started booing and heckling him, and he just continued to conduct the orchestra, oblivious to the protests of the audience. His performance grew worse and worse. In fact, he was so terrible that no one could recognize the piece the orchestra was playing. Boos and catcalls continued and he became visibly angry, but he kept flailing away on the podium. Finally, he couldn’t take any more of the audience abuse. He lunged at the closest audience member and stabbed him with his baton. The victim died on the way to the hospital. With hundreds of witnesses, it was a short trial, and the substitute conductor was sentenced to death for murder. The day of his execution came, he was strapped into the electric chair, the switch was pulled, and 5000 volts of electricity was applied to his body. He just sat there smiling, still alive, and seemingly unaffected by the electricity. The power was turned off and he was allowed to go free, to the astonishment of the witnesses. A news reporter approached him, and asked “How were you able to survive all that electricity?” The man responded “I’m just a bad conductor.”

How do cells communicate with one another?

Cellular phones!

Thanks to Carrie Lewis, Caney Valley High, Ramona, Oklahoma

What did the flight attendant say to the turkey vulture that had two stinky dead animals tucked under his wings as he boarded the plane?

Only one carrion per person.

Thanks to Lois Gray New Harmony School, New Harmony, IN

Free Hands-On Workshops

Join us for one of our free, four-hour, hands-on workshops to learn how to integrate our computer and handheld data-collection technology into your chemistry, biology, physics, middle school science, physical science, and Earth science curriculum. The workshops include lunch or dinner and lab handouts. Visit our web site for up-to-date information and registration.

2010 Workshop Dates

Sept 8	Tulsa, OK	Sept 23	Houston, TX	Oct 18	Detroit, MI
Sept 9	Oklahoma City, OK	Sept 27	Omaha, NE	Oct 19	Toledo, OH
Sept 11	Wichita, KS	Sept 28	Des Moines, IA	Oct 21	Cleveland, OH
Sept 13	Topeka, KS			Oct 23	Pittsburgh, PA
Sept 13	Ft. Worth, TX	Oct 4	Indianapolis, IN		
Sept 14	Kansas City, MO	Oct 5	Chicago, IL	Nov 1	Manchester, NH
Sept 14	Dallas, TX	Oct 6	Cincinnati, OH	Nov 2	Boston, MA
Sept 15	Austin, TX	Oct 6	Chicago, IL	Nov 3	Worcester, MA
Sept 16	San Antonio, TX	Oct 7	Columbus, OH	Nov 4	Providence, RI
Sept 20	San Antonio, TX	Oct 7	Milwaukee, WI	Nov 15	St. Louis, MO
Sept 21	Corpus Christi, TX	Oct 12	Madison, WI	Nov 16	Evansville, IN
Sept 22	Houston, TX	Oct 14	Minneapolis, MN	Nov 17	Louisville, KY
Sept 22	Sioux Falls, SD	Oct 16	Grand Rapids, MI	Nov 18	Lexington, KY

Go to www.vernier.com/workshop to register for workshops.

Online Training
No Travel Required!

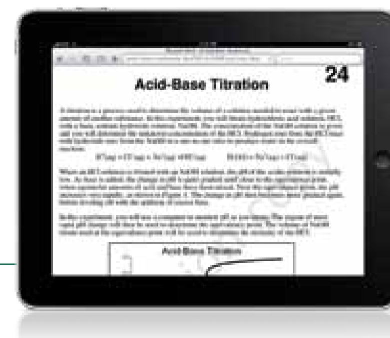
Join us for free, one-hour training events online. We are now offering topics in chemistry and physics. You can follow along with your own equipment or simply watch and learn.

LabQuest 101	Determining the Concentration of a Solution: Beer's Law	Physics with Video Analysis: Velocity and Speed
Sept 21, 23, 27, 29	Sept 27	Sept 29
Oct 5, 8, 12, 14, 26	Oct 8, 14	Oct 5, 12, 26
Nov 8, 22	Nov 8	Nov 22
Dec 7, 9, 14, 16	Dec 7, 14	Dec 9, 16

Go to www.vernier.com/webinars to register for online training.

NEW Vernier Labs on the iPad™

Did you know that you can read the student versions of all Vernier lab activities on your iPad? Visit www.vernier.com/ios for our iOS page. You'll find information on our Video Physics app, as well as links to all the labs in a format suitable for your iPad.



Courtesy of Apple

Vernier Technology Training in Canada

Merlan Scientific is offering Vernier workshops on the following days in 2010–2011.

Oct 22	Victoria, BC
Nov 12	Vernon, BC
Nov 19	Mississauga, ON
Nov 25	Kingston/Hastings PEC, ON
Nov 26	Ottawa, ON
Nov 26	Montreal, QC
Jan 31	Calgary, AB
Feb 1	Charlottetown, PEI
Feb 2	Mississauga, ON
Feb 25	Winnipeg, MB
Mar 14	Halifax, NS
April 8	London/Windsor, ON
April 15	Montreal, QC
May 9	Mississauga, ON

For more information and registration: www.merlan.ca/workshops

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Win a new iPod touch

Time to get creative! Download a free copy of Video Physics for your iPhone or iPod touch. Submit to Vernier your most innovative idea analyzing motion with Video Physics, and you could win an iPod touch with HD video recording.

For more information about Video Physics and the video contest go to: **www.vernier.com/videophysics**

Win an iPod touch!
www.vernier.com/videophysics

Courtesy of Apple