Vernier

the CALIPER

FALL 2012 | VOL 29 NO.2

A PUBLICATION FOR USERS OF VERNIER PRODUCTS

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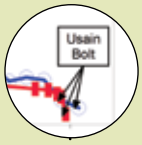

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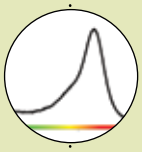

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New Ethanol Sensor Increases Options for Biology Experiments

ETH-BTA, $109

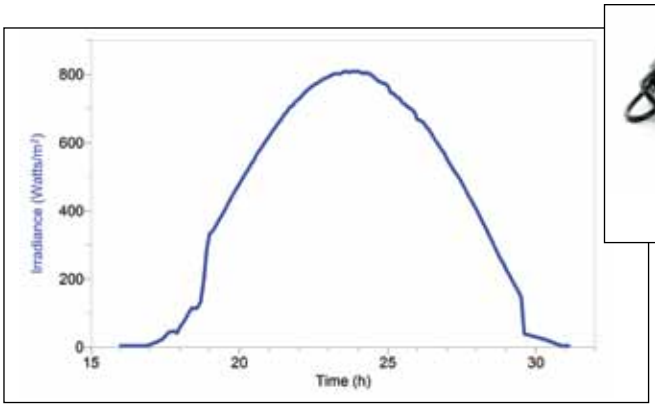
Vernier's newest addition to our biology offerings is the Ethanol Sensor. Understanding metabolic pathways, particularly those involved in respiration, is an essential component of every biology curriculum. Unfortunately, the processes involved are complex and often difficult for students to grasp. Experiments that clearly show the products of aerobic and anaerobic respiration are essential to student understanding.

Until now, students could detect and measure only two products of respiration using Vernier sensors: carbon dioxide and oxygen gas. This works well for studying aerobic respiration, but what about anaerobic respiration, such as fermentation? Yeast and other organisms that utilize alcoholic fermentation produce ethanol in addition to carbon dioxide gas. The new Ethanol Sensor is great at detecting the low levels of ethanol that are produced by yeast during fermentation and, as the data on page 9 show, you can use this sensor along with a CO_2 Gas Sensor to simultaneously measure ethanol and CO_2 gas production.

(continued on page 9)

New Pyranometer

Solar power experiments are becoming more popular. To help with this trend, in 2010 we introduced two new sensors for use with large solar panels: a High Current Sensor and a 30-Volt Voltage Probe. We have also had requests for a sensor to measure total solar radiation. Our new Pyranometer measures the power of electromagnetic radiation in watts per square meter. It is sensitive to near infrared, visible, and UV radiation, where 90% of solar energy is concentrated. This sample graph shows the irradiance in watts/m² as a function of time on a clear day. Our Pyranometer has a dome-shaped top to allow it to handle a wide range of sun angles. The Pyranometer comes with a 6 m cord. For more information go to www.vernier.com/pyr-bta



Pyranometer readings on a clear day

PYR-BTA, $199

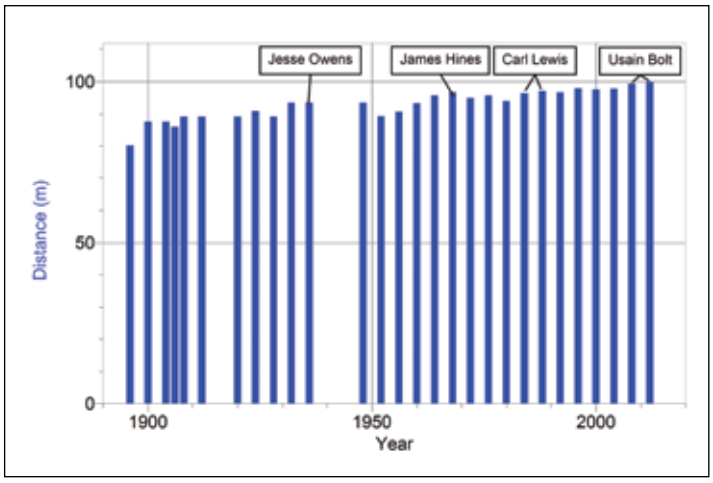
PHYSICS

Using Olympic Results to Teach Graphing Skills

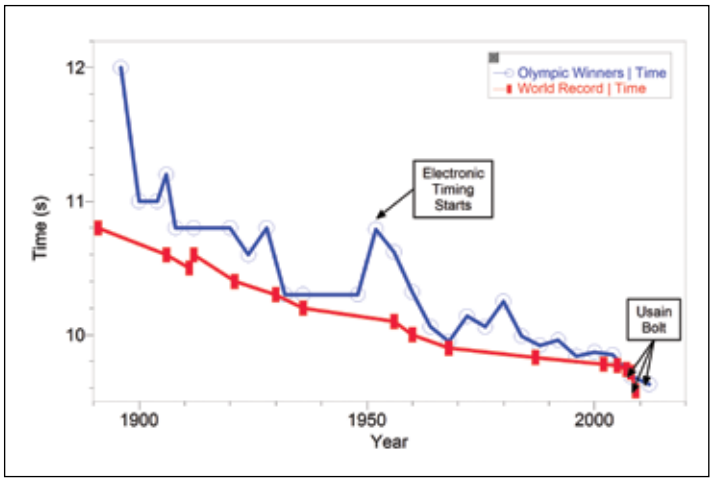
Analyzing Times from the Hundred-Meter Dash

Many students were fascinated by the recent Olympics. One way to capitalize on this interest is to have the students use Olympic results to improve their graphing skills and learn some kinematics. We have created a Logger *Pro* file that uses historic times for the 100-meter dash to simulate the finish of a race with all the Olympic winners. The top of each bar on the graph shows where the runner would have been at the finish. We assumed constant velocity and calculated distance traveled in the time of the most recent (and fastest) race.

The 1896 winner would have been a full 20 meters behind the most recent winner. The Logger *Pro* file also has a page with a graph comparing Olympic and world records over time. It is relatively easy to modify this file for any event that a student is interested in studying. The Logger *Pro* file is available at www.vernier.com/r1231



A simulated race with all Olympic 100-meter dash winners



Olympic and world records in the 100-meter dash

AAPT Photo Contest

The 2012 AAPT Photo Contest, sponsored by Vernier, was held at the summer meeting of the American Association of Physics Teachers in Philadelphia. Students submitted photos that demonstrated physics concepts, along with an explanation of the physics involved. Attending members voted on the entries. The quality of these photos is better than ever. When digital photography became common, the number and quality of images became noticeably better, which makes an interesting, pedagogical point about rapid feedback and ease of data collection.

For details about the contest and to see the photo winners for 2012, visit www.vernier.com/r1232

1st Place, Contrived Category: Coin Stack, Helias Catholic High School, Student: Zixuan Zhang, Teacher: Matt Zeitz

1st Place, Natural Category: Flower Refraction, Greenwich High School, Student: Noah Fram-Schwartz, Teacher: Ellen Lewis

25 YEARS AGO

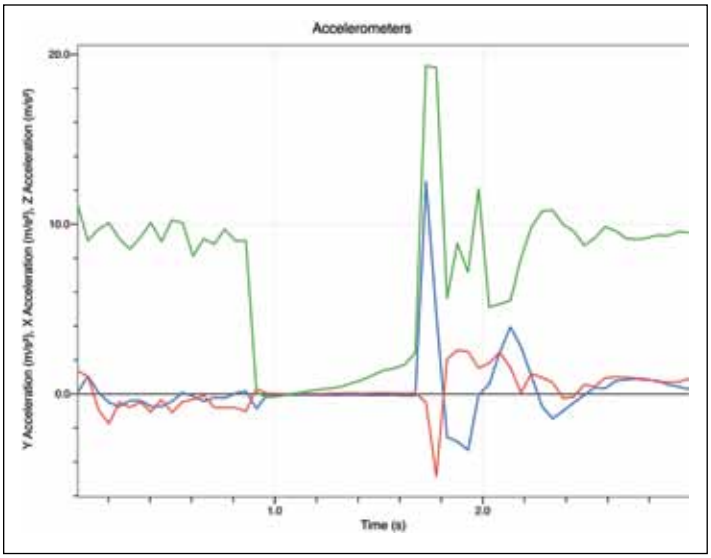
25 Years Ago in *The Caliper:* We introduced our first pH sensor, and we provided a detailed comparison of the characteristics of the game ports on various models of Apple II computers: Apple II+, IIe, c, and GS.

PHYSICS

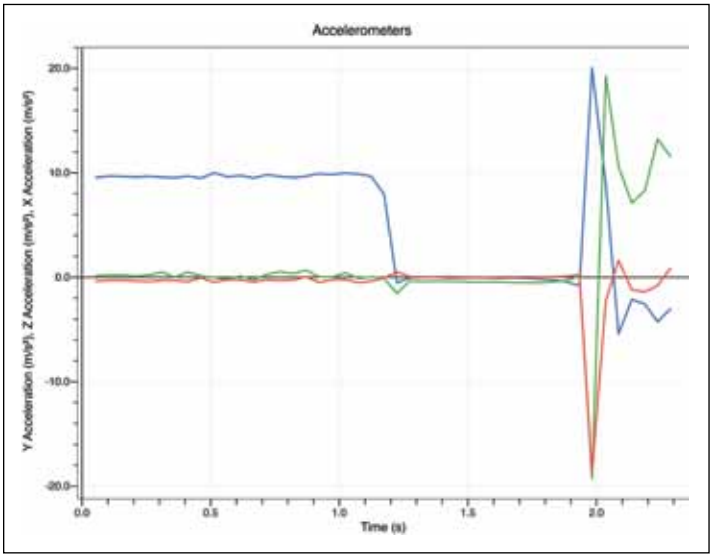
From the Journals

"Speed of Sound Versus Temperature Using PVC Pipes Open at Both Ends," *The Physics Teacher*, September 2012, by Michael Bacon, Thiel College, Greenville, PA. In this article, Bacon explains how to use the Vernier LabQuest, Microphone, and Temperature Sensor to study the relationship between speed of sound and air temperature.

"iPad and Weightlessness," *The Physics Teacher*, May 2012, by Taoufik Nadji. Now that cell phones and tablet computers have built-in accelerometers, it is natural that physics instructors would want to use them for experiments. In this article, Nadji suggests (carefully) dropping an iPad® onto an outstretched sheet held by students. Since our Graphical Analysis™ for iPad collects data from the iPad's built-in accelerometers, we could not resist trying this experiment. In our results, shown below, we noticed an interesting thing about dropping iPads. The acceleration is different depending on whether you drop it with the screen facing the ceiling (lots of drag) as compared with the screen facing horizontally toward the wall (very little air resistance). The air resistance shows up on the upper graph, Notice that the Z-axis acceleration is near zero at the start of the drop and then increases as air resistance becomes more important.



iPad dropped on its back with the screen facing the ceiling



iPad dropped on its edge with the screen facing the wall

INNOVATIVE USES

Houston School Makes a Guitar to Study String Vibration

Brian Lamore at The Village School in Houston, TX, crafted a simple experiment on string vibration. Lamore's students connected a rubber band to a Dual-Range Force Sensor to create a cheap "guitar" with which to study the relationship between tension and frequency. Students plucked the rubber band and monitored the force readings at 1000 Hz.

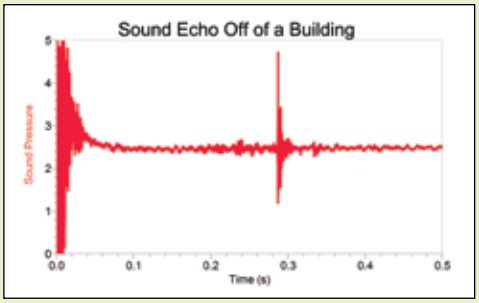
Using a rubber band in this way introduces several factors of complexity, such as:

- change in mass per unit length
- change not always proceeding according to Hooke's law
- temperature sensitivity

The situation offers opportunities for possible extended investigations.

Creatively Measuring the Speed of Sound

Sam Barnum at West Point Grey Academy, Vancouver, BC, developed a lab for using the internal microphone on a LabQuest to measure the speed of sound. Barnum's students assembled outside with claves or large pieces of wood. They clapped the claves together and measured the time for sound to echo off a nearby building. The lab instructions for students can be downloaded at www.vernier.com/r1233



PHYSICS & ENGINEERING

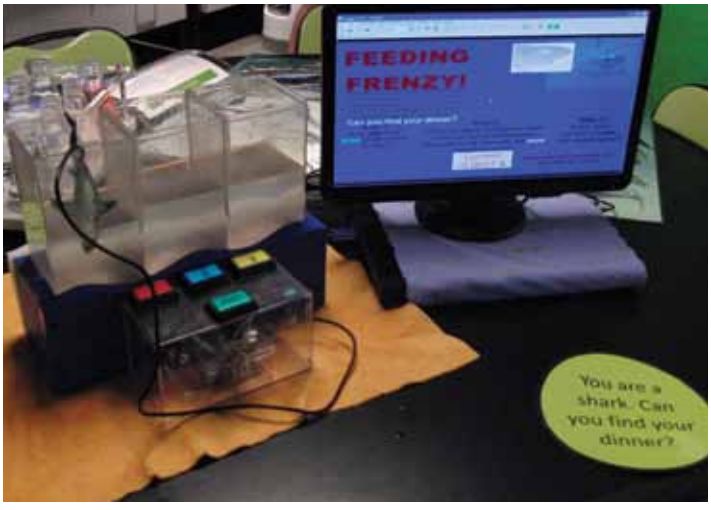
Hands-On Labs Engage Museum's Guests at Discovery Place

For eight years, Tim Pula has created hands-on labs in science centers, including Discovery Place in Charlotte, NC. In 2005, with the support of Vernier consultant Walter Rohr, Tim began using Vernier sensors and Logger *Pro* software to engage visitors in the exploration of scientific principles. Through these exhibits, visitors can

- Investigate the ampullae of Lorenzini using a Current Probe attached to a toy shark. Visitors get to "be the shark" by detecting the electric current produced by model fish in the water.
- Explore the relationship between speed, distance, and time using a toy car, a track, and a Vernier Photogate. Participants learn to convert between m/s and mph.
- Test the thrust of different propeller arrangements using a Dual-Range Force Sensor mounted behind a sled on bearings.
- Explore the cost of electrical energy using Watts Up Pro and an array of household items.
- Measure the speed of the air flowing through a race car carburetor. Explore how the restrictor plates and the level of throttle affect the flow.

"I have sought to incorporate this equipment into classes, demonstrations, and hands-on science activities accessible to all museum guests," says Tim. "Vernier's products have allowed us to create guest experiences that are both engaging and give immediate data as feedback. Many of our corporate sponsors have been impressed with the level at which we engage guests using live data collection."

Tim has created over 20 hands-on activities using Vernier equipment, engaging visitors of ages 2 to 100 years. Learn more about Discovery Place at www.discoveryplace.org



Museum visitors simulate a shark's ability to detect electric current through use of a Current Probe and Logger Pro.

Studying the Effectiveness of Helmets

Lots of attention has recently been given to the issue of brain injuries to young people in sports activities. This has led to quite a few science projects looking into the effectiveness of helmets. Kevin Bruff of Portsmouth, RI, has worked with students to do a very nice study of inflatable helmets used for lacrosse or field hockey. They used our Low-g Accelerometer embedded in a foam head. The report can be downloaded from www.vernier.com/r1234

A weighted ball rolls down the ramp (left) crashing into a helmet containing the model head and accelerometer (above).

ANNOUNCING A NEW ENGINEERING CONTEST!

Award Honors Innovative Uses of Vernier Sensors with NI LabVIEW™

The use of National Instrument's LabVIEW software with Vernier sensors provides educators with a powerful way to introduce STEM concepts, teach LabVIEW, and perform engineering labs. How are you using this combination in your teaching?

To recognize creative teaching using Vernier sensors and LabVIEW, we are launching a contest for high school and college teachers; one award will be granted for high school and one for college. Prizes will include $1,000 in cash, a $3,000 gift certificate for Vernier technology, and $1,500 toward expenses to attend the 2013 American Society for Engineering Education conference in Atlanta, Georgia.

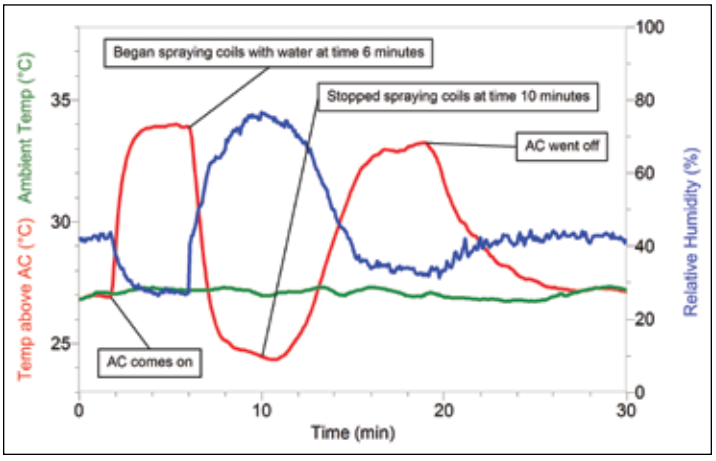
Instructors interested in this grant must submit a written project summary and a video showing creative ways to use Vernier sensors with NI LabVIEW software. Grant applications are due January 15, 2013. To learn more about the contest visit www.vernier.com/grants/labview

ENGINEERING

Evaporative Cooling of Air Conditioning Coils

Many parts of the country experienced extremely hot and dry weather this past summer. One effect of this was increased electricity demand for air conditioning in houses and places of business. An air conditioner works by compressing a refrigerant gas, which increases its temperature. The hot gas is contained in coils and outside air is forced over the coils, transferring thermal energy into the surrounding environment. After running through the exterior coils under pressure, the gas is allowed to expand in the internal chilling unit. The expansion of the gas causes its temperature to drop. This cooled gas is then put through another set of coils on the inside of the house and inside air is forced over these coils, cooling and drying the air inside the house. In dry parts of the world, people use a similar process to run evaporative coolers (sometimes called "swamp coolers") that rely only on the evaporation of water to cool the air and not on the compression and expansion of a refrigerant gas.

David Carter, Vernier's STEM Training Director, wondered what effect using evaporative cooling of the outside AC coils would have on his central-air system. He used two Stainless Steel Temperature



Temperature and relative humidity changes as water is sprayed on AC coils

Probes (TMP-BTA, $29) to measure the ambient air temperature and the temperature of the air ejected from above the external fan of the AC unit. In addition, he placed a Relative Humidity Sensor (RH-BTA, $69) above the unit. When the unit came on, he let it run for a few minutes and then sprayed the coils gently with water from a hose. The graph above shows the results of this experiment.

The green line represents the temperature of the ambient air. The red line is the temperature above the unit where the air drawn through the coils is exhausted. The blue line is the relative humidity of the air above the unit. Notice that the ambient air temperature remains fairly constant for the entire experiment, while the exhaust air temperature fluctuates widely as the coils were sprayed and then allowed to dry.

The first increase of the exhaust air temperature shows the temperature of the air exhausted by the outside unit as the unit turns on. Notice that it is about seven degrees warmer than the air entering the coils. The exhaust air temperature dropped by ten degrees, even dropping to a temperature below ambient, when water was sprayed on the external coils at the six-minute mark. This cooling effect was caused by the evaporation of the water on the coils. The relative humidity of the air above the unit increased by 50% when the coils were sprayed. It takes a tremendous amount of energy for water to undergo a phase change from liquid to gas, causing this drop in temperature. At ten minutes, water was no longer being sprayed on the coils and the air coming out of the AC unit returned to being warmer than ambient and the relative humidity dropped again.

The data show that spraying water on the coils causes the exhaust temperature to drop below ambient temperature. This may be a way, in the future, to reduce the energy consumption of air conditioning by making it easier for AC to transfer heat to the hot, outside environment.

An idea for further study would be to use an Extra-Long Temperature Sensor (TPL-BTA, $72) to measure the temperature of the air coming out of the inside vent pipe.

Mars Yard

Using LEGO NXT Robots with Vernier Sensors to Simulate a Mission on Mars

The Space Foundation (Colorado Springs, CO) uses Vernier's NXT Sensor Adapter and sensors with LEGO NXT robots in their "Mars Yard." The combined technologies permit middle school students to simulate robotic rover missions on the "Red Planet." As you can see from the photo, the Mars Yard looks pretty realistic!

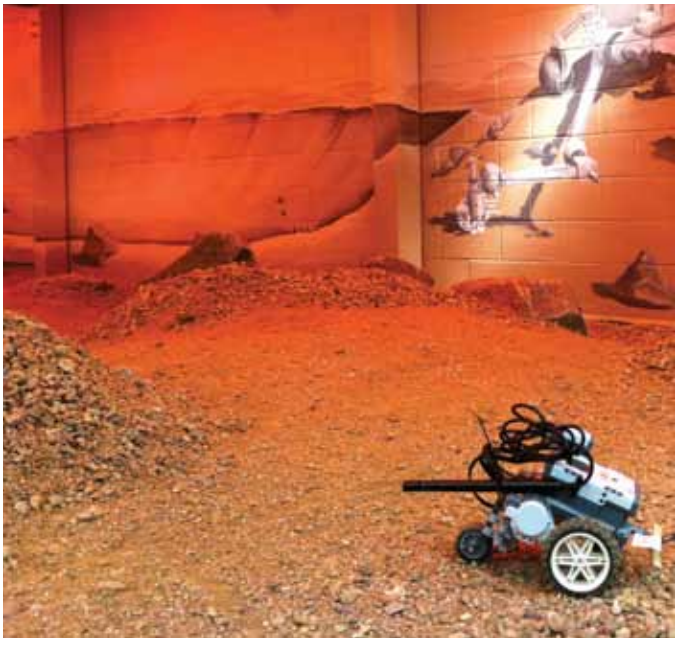


Photo: Elias Molen

The "Mars Yard" at the Space Foundation

ENGINEERING & CHEMISTRY

Engineering an Electric Piano

Using Vernier SensorDAQ and NI LabVIEW™

Steve Decker, an instructor of electronics at Oregon Episcopal School in Portland, used the *Hands-On Introduction to NI LabVIEW with Vernier* book to acquaint his students with instrumentation control. After completing exercises in the lab book, Decker's students created independently designed projects to demonstrate what they had learned. In one recent class, for example, two students created an electric piano. The team coupled the NI LabVIEW program with the Vernier SensorDAQ data-acquisition interface to measure a variable voltage. The students then used their data to set the frequencies of the tone coming from a computer.

With this approach, analog output from the SensorDAQ provided a 5 V DC source. Each "key" then created a different resistive voltage divider, which produced a unique reading on the Voltage Probe. The readings obtained determined the frequencies (C4 to C5) for the tone generator in LabVIEW as played back through the computer speakers. The students added a second sensor, as well, to control the amplitude of the tone. For this, they chose the Vernier Light Sensor (LS-BTA, $55), which measures ambient light. The team scaled values derived from this sensor to match the rest of the system and modulated the overall amplitude of the signal produced.

Possible extensions to this project include enabling

- multiple tone generators with independent amplitudes to produce harmonic content for the tones, which improves sound quality.
- two or more keys to be pressed at the same time to produce a chord.
- a simple voltage divider made up of one fixed resistor and a photoresistor to produce the variable voltage that controls the frequency, which produces a more continuous, Theremin-like effect.

STEM Solutions Activity: Build a Photogate

We recently posted new STEM activities on our web site. Several of these involve having your students build their own sensor. One example is to build a photogate sensor. A photogate consists of a light source and a light detector and is used for very precise measurements of high-speed or short-duration events. A phototransistor often serves as the light detector. It has very high resistance (over 100 kΩ) when it is in the dark, but the resistance drops to only a few hundred ohms when light shines on it. With this light-sensitive switch, you can detect when an object moves through the space between the light source and the phototransistor, interrupting the path of light from the source to the detector.

Once your photogate sensor has been designed and built, it can easily be connected to a LabQuest 2, LabQuest, LabQuest Mini, or LabPro, with a Vernier Digital Breadboard Cable (BB-BTD, $11) and used with Logger *Pro* software for many different types of timing experiments. Typical applications include free fall acceleration, the period of a pendulum, or the velocity of a ball rolling down a track. You might also consider building a phototachometer to determine the rotational rate of a rotating object, measuring the "hang time" of a volleyball or basketball player's jump, or measuring the initial velocity of a projectile.

When performing an activity such as this, students gain insight into design, construction, troubleshooting, and evaluation. Just as important, they learn what steps are required to successfully complete a project and work within a team. We have developed several activities designed to help you incorporate STEM into your curriculum. To see a copy of this sensor activity, as well as others, go to www.vernier.com/r1236

An infrared LED and phototransistor are used to build a photogate.

Food Dye Forensics Experiment Using the SpectroVis Plus

by Jack Randall

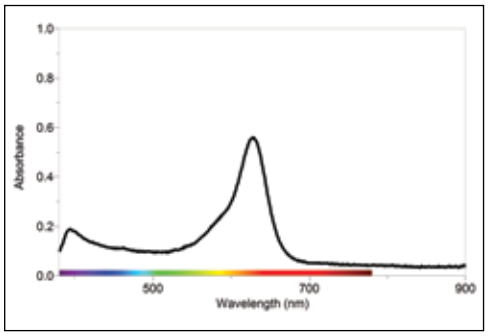
Long ago, when I was a high school chemistry teacher, my students ran a forensics experiment using a Spectronic 20 spectrophotometer. The students measured the absorbance spectra of food dyes in various sports drinks to determine which drink had been "poisoned." The Spectronic 20 used by my students worked very well, but this was long ago, and it took upwards of 30 minutes to collect a single absorbance spectrum; thus, the entire experiment consumed two to three days of lab time. Now, we have the Vernier SpectroVis Plus spectrophotometer (SVIS-PL, $459) that can collect

CHEMISTRY

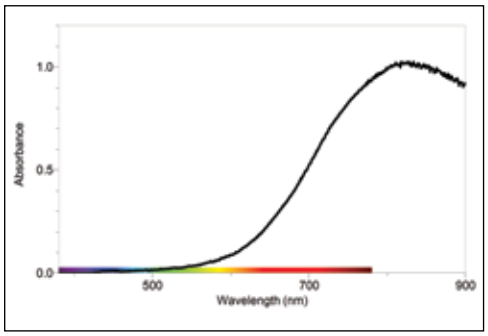
an absorbance spectrum in seconds, and this interesting, fun experiment can easily be completed in less than an hour.

In the experiment, the students are given several sports drink samples that have been found in a school gym locker room. The drinks have a blue, purple, or green color. One of the drinks has been "poisoned" by the addition of copper (II) sulfate, $CuSO_4$. Because the sports drinks themselves are colored, the bluish color of the $CuSO_4$ cannot be spotted by the naked eye. However, the SpectroVis Plus can see the $CuSO_4$. The students measure the absorbance spectra of the seven FD&C food dyes acceptable for use with foods, a solution of $CuSO_4$, and several sports drink samples. By comparing the graphs, the students can find the "poisoned" sports drink, as well as determine the specific food dyes added to each beverage.

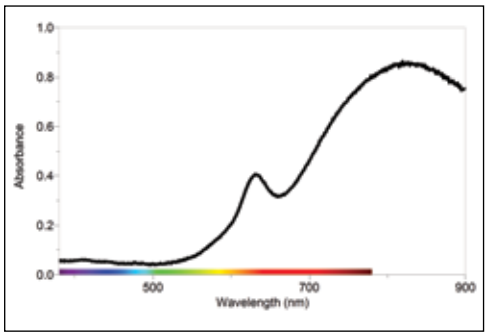
The sample graphs below show typical results from the experiment. For the complete lab, go to www.vernier.com/r1237



Mountain Berry Blast® PowerAde



0.1 M $CuSO_4$ Solution



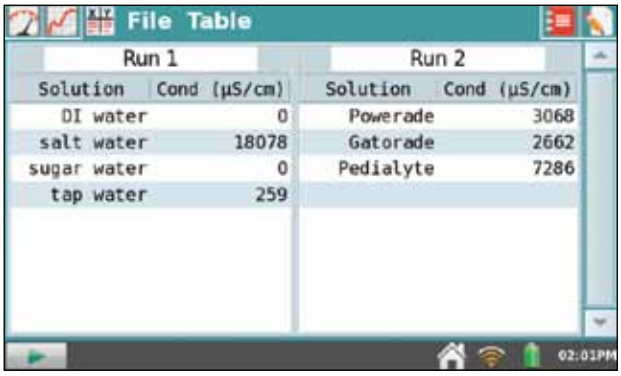
Mountain Berry Blast® PowerAde and 0.1 M $CuSO_4$ Solution

Thirst Quenchers Inquiry Experiment

Inquiry experiments can be designed to be carried out using everyday household items. In this experiment, students use common beverages to investigate the relationship between conductivity and electrolyte levels. The experiment uses a Conductivity Probe (CON-BTA, $95) and LabQuest 2 (LABQ2, $329) for data collection and analysis.

Students begin the experiment by measuring the conductivity of distilled water. They add table salt to distilled water to measure the conductivity of a strong electrolyte, and then add sucrose to distilled water to measure the conductivity of a non-electrolyte. Lastly, students measure the conductivity of tap water; depending on the hardness of your local water, the conductivity of the tap water can vary greatly.

Upon completion of this preliminary activity, a discussion with students to develop researchable questions is important. If you choose the open inquiry method, you can encourage students to contribute their own researchable questions and hypotheses. We recommend that you provide the students with a list of supplies that are available to minimize unusual requests and encourage them to read the ingredient label when generating researchable questions. If you choose the guided inquiry approach, a list of researchable questions will be presented to the students. Sample data comparing the conductivities among the electrolyte drinks (Gatorade, Powerade®, Pedialyte®) are shown below.


File Table

Run 1		Run 2	
Solution	Cond (µS/cm)	Solution	Cond (µS/cm)
DI water	0	Powerade	3068
salt water	18078	Gatorade	2662
sugar water	0	Pedialyte	7286
tap water	259		

02:01PM

Data table comparing conductivities among the electrolyte drinks

After students have completed their experiment, bring the class together and share the results. This phase of the process encourages communication among the student groups and can lead to a better understanding of the topic.

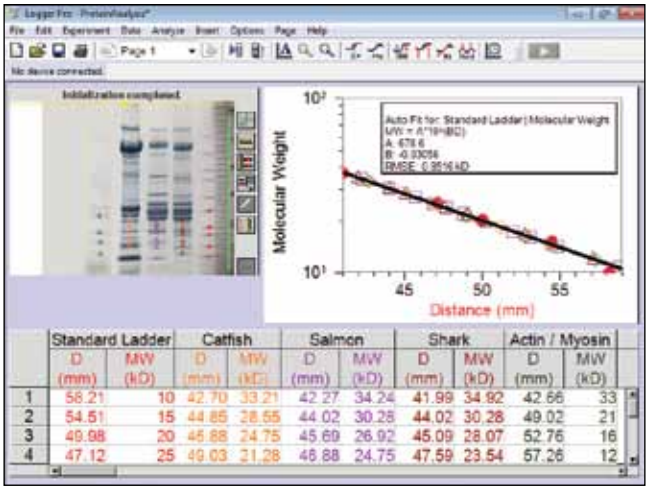
This inquiry experiment was designed by Greg Dodd, a high school chemistry teacher from West Virginia with over 40 years of teaching experience. The Thirst Quenchers Inquiry Experiment is available as a Word® file that can easily be modified to fit your teaching environment. To download this experiment, go to www.vernier.com/r1238

If you are looking for more inquiry-based experiments, our lab book, *Investigating Chemistry though Inquiry* (CHEM-I, $48), contains 25 experiments designed for inquiry-based learning.

BIOLOGY

Did you know that you can use Logger *Pro* to analyze electrophoresis gels?

We are often surprised when teachers tell us they have never heard of the Gel Analysis feature in Logger *Pro*. This powerful feature is absolutely free if your school or college department owns Logger *Pro*. Gel electrophoresis is a method of separating macromolecules by fragment length (e.g., DNA and RNA), by charge, or by size (e.g., proteins) using an electric field and a gel matrix. Specific dyes and/or stains are used to mark the molecules of interest. As shown in the data below, Logger *Pro* provides students with a fast, easy way to document and analyze gel electrophoresis images. After inserting a photo taken with a ProScope HR, a digital camera, or an existing photo from a file, Logger *Pro* can be used to create a standard curve and calculate the molecular weight or number of base pairs for each experimental band in just a few minutes.



Using Logger Pro *to analyze SDS-PAGE gels*

The Gel Analysis feature is used in the "Introduction to Molecular Evolution" investigation found in our new *Investigating Biology through Inquiry* lab book (BIO-I, $48). In this inquiry investigation, students extract proteins from muscle tissue, conduct electrophoresis of the resulting protein extracts, analyze the results using Logger *Pro*, and then use the results to construct a cladogram. This is an excellent inquiry activity that teaches core concepts in evolution. This activity is also correlated to AP* and IB** standards. You can find out more about this exercise at www.vernier.com/bio-i

The "Forensic DNA Fingerprinting" experiment in our *Advanced Biology with Vernier* lab book (BIO-A, $48) also uses the Gel Analysis feature in Logger *Pro*. In this experiment, students use a forensic technique to analyze DNA samples from five "suspects." The DNA is digested with a fixed set of restriction enzymes, separated by gel electrophoresis, and then analyzed for patterns of similarity with the crime scene sample. From these results, students then identify the perpetrator. Gel analysis is also used in the "Analysis of Precut Lambda DNA" experiment found in this book. You can find out more about both of these experiments at www.vernier.com/bio-a

You can purchase everything you need to perform these experiments from Vernier and our partner, Bio-Rad Laboratories, Inc. In fact, through the end of 2012, Bio-Rad is offering a 10% discount off of all of their kits that are aligned with either *Investigating Biology through Inquiry* or *Advanced Biology with Vernier*. To find out more about Bio-Rad kits and this discount, visit www.vernier.com/bio-rad

For information on gel analysis webinars, see page 15.

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

** The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

A New Face in our Biology Department

Meg Griffith joins Vernier as our new Biology Educational Technology Specialist. Meg earned her B.A. from Willamette University with a major in environmental science and a minor in biology. She also completed her M.A.T. from Willamette University's School of Education. Prior to her position at Vernier, she taught biology and ecology at Sunset High School in Beaverton, Oregon, for nine years. During her summer breaks from teaching, Meg participated in a variety of summer research projects further preparing her for work at Vernier. Her research and teaching interests include biogeography, ecology, forestry, evolution, environmental science, and water quality. Meg enjoys birding, running, and camping with her family.

Logger *Pro* Goes Microscopic

Did you know that Logger *Pro* software can capture images from many digital microscopes, including Ken-A-Vision®'s Digital Comprehensive Scope 2 Dual Purpose Microscope? As demonstrated in the images below, this digital microscope works very well with Logger *Pro*'s Video Capture and Photo Analysis features, which allow the user to take still images, videos, and even time lapse video sequences. Just connect the USB cable from the digital

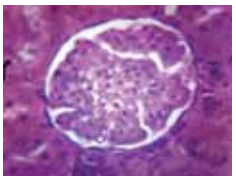


Image of a glomerulus (400X)

Image of C. elegans (40X)

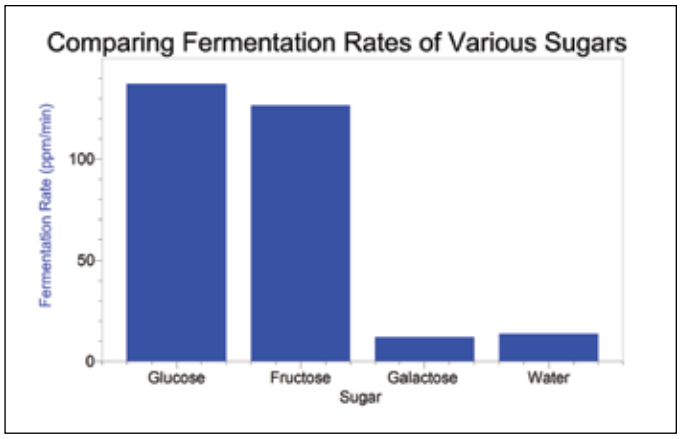
Image of an onion root tip (100X)

BIOLOGY

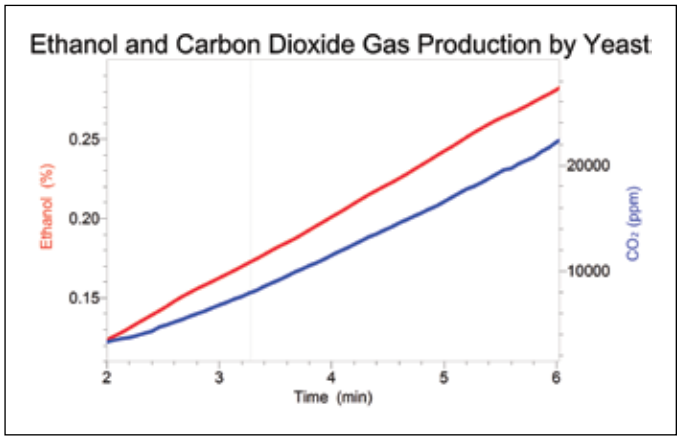
microscope to any computer that has Logger *Pro* installed, and your students can view, capture, and analyze images from any live or prepared microscope slide. Using Logger *Pro* with a Ken-A-Vision microscope, a ProScope HR, or another digital microscope provides one more opportunity for student learning in today's modern biology classroom.

New Ethanol Sensor *(continued from cover)*

Our new experiment, "Fermentation of Sugars with Yeast" uses the Ethanol Sensor to study sugar metabolism. The sample data below show that yeast can metabolize glucose and fructose much better than galactose. We have also adapted the "Sugar Metabolism with Yeast" investigation in our new and popular *Investigating Biology through Inquiry* lab book (BIO-I, $48) for use with the Ethanol Sensor. Download both of these exercises at www.vernier.com/eth-bta



Fermentation rates of monosaccharides



Measuring CO_2 gas and ethanol production during fermentation

The Ethanol Sensor will be available in October 2012. For more information about the Ethanol Sensor or our *Investigating Biology through Inquiry* lab book, contact the Vernier Biology Department at biology@vernier.com

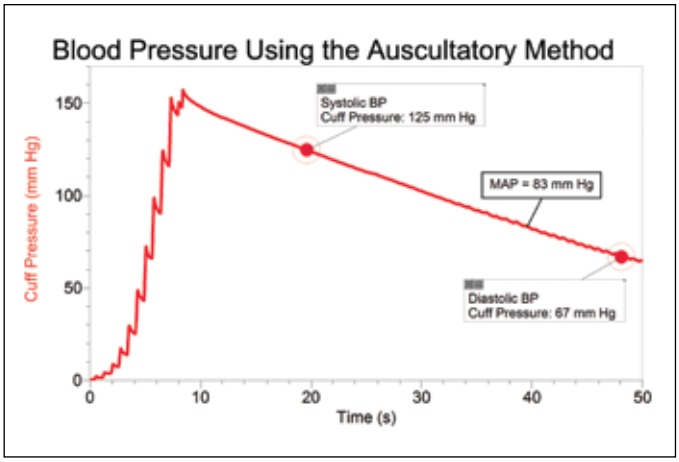
Comparing Blood Pressure Methods

By John Melville, Ph.D.

Laura Cerletty, a physiology teacher at Whitnall High School in Greenfield, WI, and Stephen Biscotte, a physiology teacher at Cave Spring High School in Roanoke, VA, have developed an innovative way to compare two methods of measuring blood pressure using Vernier products. The Data Mark feature in Logger *Pro* and LabQuest app make this possible.

The most common method of measuring blood pressure is called the auscultatory method. In this method, a stethoscope is used to listen for pulsations in the brachial artery as pressure is released from a blood pressure cuff. The pressure when the first pulse is heard is the systolic blood pressure. As the pressure is released from the cuff, the pulses in the artery become less audible. The pressure at which the pulse can no longer be heard is the diastolic blood pressure. The Data Mark feature of Logger *Pro* or LabQuest app is used to mark the systolic and diastolic pressures as air is released from the cuff.

The method that most automated blood pressure devices, including the Vernier Blood Pressure Sensor (BPS-BTA, $105), use to calculate blood pressure is called the oscillometric method. This method is based on the principle that blood pumped through the arteries by the heart causes the arterial walls to flex. When a cuff is placed around the upper arm and is inflated and then deflated at a constant rate, arterial pressure pulses form. These pressure pulses can be detected in the pressure cuff using a pressure sensor. The peak-to-peak amplitude of each pulse increases and then decreases as the pressure in the cuff decreases. The cuff pressure that corresponds with the largest pressure pulse corresponds with the mean arterial pressure. The systolic and diastolic blood pressures are then calculated using an algorithm built into the software.



Using the Data Mark feature to measure blood pressure

As shown in the data above, you can easily compare these two methods. Instructions can be downloaded at www.vernier.com/r1239

If you have any questions about this exercise or other physiology experiments, contact our Biology Staff Scientist, John Melville, at physiology@vernier.com

ENVIRONMENTAL SCIENCE

Water Quality Investigations in the Grand Canyon

In July, students in Alex Canale's chemistry class at Saint Peter's Preparatory School in New Jersey took LabQuest on a ten-day adventure to the Grand Canyon to investigate the water quality of the Colorado River and its tributaries. The students were thrilled to collect real-time data while experiencing the beautiful surroundings.

LabQuest and an array of sensors were used to investigate the mineral content, including calcium ions, of Havasu Creek. The Calcium Ion-Selective Electrode detected levels of calcium ions ranging from 55.4–59.7 mg/L, depending on the location. Students used the *Water Quality with Vernier* lab book to compare their values with sites throughout the United States. After seeing that their levels were higher than average, students set out to research why.

The bright blue color of the water in Havasu Creek and the travertine formations were the first indications that mineral levels would be high. Additional research revealed that Havasu Creek originates from springs in the Redwall Limestone geologic formation, composed primarily of calcium carbonate from the shells of sea creatures. Limestone is also deposited on the creek bed. Compared to spring-fed drinking water from Supai and the South Rim (10.8 mg/L and 24.7 mg/L, respectively), the creek had significantly higher levels of calcium. The Supai levels were comparable to the levels found at their school's drinking water (10.6 mg/L).

The LabQuest and sensors provided a rich field experience. Students were able to note important features of the landscape that were integral to their understanding of the science behind their results. This is an example of experiential learning at its best.

Chemistry students study Havasu Creek in the Grand Canyon.

National Geographic Grosvenor Teacher Fellows Use LabQuest 2 in the Arctic

National Geographic Education Programs and Lindblad Expeditions partnered to give several K–12 educators the opportunity to travel aboard the *National Geographic Explorer* to Norway and Arctic Svalbard this summer. While on the ship, Fellows were able to use LabQuest 2 and several sensors with vacationing students to monitor air and sea temperature, ocean salinity, wind speed, and more. High school biology teacher and Grosvenor Fellow JoAnn Moore enjoyed using the Vernier equipment, stating, "The kids had great experiences as they discovered physical features that could be measured in the very cool habitat of the Arctic. Having used this equipment for many years in my classroom, it is great to see these tools used in this new learning environment." Fellows also interacted with the other travelers on board and developed activities for their own classrooms. It was an ideal opportunity for bringing together science and geography while providing an amazing adventure for some outstanding teachers.

For more information, visit education.nationalgeographic.com

Teacher Fellows and other travelers aboard the National Geographic Explorer *observe a polar bear on the ice.*

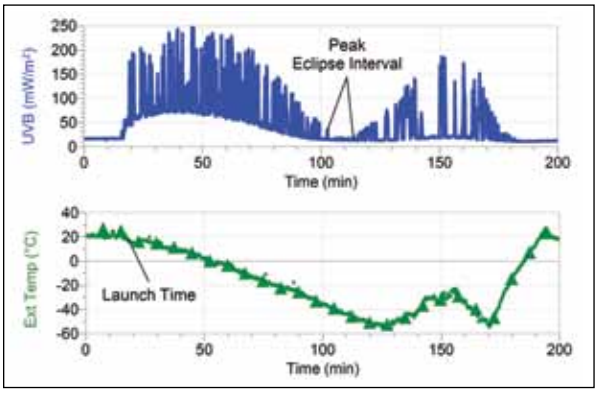
Vernier Sponsors Ecology/ Environmental Science Teaching Award

Each year, Vernier sponsors the NABT Ecology/Environmental Science Teaching Award. This award is given to a secondary school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his or her commitment to the environment into the community. Vernier's sponsorship of this award includes $1,000 toward travel to the NABT Professional Development Conference and $500 of Vernier equipment. The recipient also receives a recognition plaque to be presented at the conference and a one-year complimentary NABT membership. Applications for the 2013 award will be available later this fall, and the deadline for submission is March 15, 2013. To sign up for notification of the application's availability, go to www.vernier.com/grants/nabt

ENVIRONMENTAL SCIENCE & SOFTWARE

Collecting Data from a High-Altitude Balloon Launch

Jim Snyder and his students at Anderson Valley High School, in Boonville, CA, did an amazing high-altitude balloon launch during the annular eclipse this past spring. The balloon included a LabQuest, UVB Sensor, Anemometer, and two temperature sensors: a Thermocouple for external temperature readings (since they expected very low temperatures) and a Stainless Steel Temperature Probe in the balloon capsule. The UVB data are especially interesting because they show a decrease in UVB during the eclipse. A video from the launch is available at www.vernier.com/r1241



UV level and external temperature during partial solar eclipse, taken from a high-altitude balloon

Custom Calibrate Your Vernier Sensor

Most Vernier sensors come with a stored, factory calibration that works well for the majority of science classroom experiments, particularly those that look at relative changes. However, if you have an experimental application that requires an accurate, absolute value, you may want to perform a custom calibration. This custom calibration does not need to be repeated each time you use the sensor because you can store a calibration to an individual sensor. That means that every time you connect the sensor to any Vernier interface, the sensor will be ready to use the custom calibration.

For chemistry, biology, and water quality, some sensors that benefit from performing a custom calibration include pH, Conductivity, Salinity, newer Oxygen Gas Sensors[1], and Dissolved Oxygen Probes. For physics, you may want to calibrate Force Sensors, Accelerometers, and the Magnetic Field Sensor.

To perform a custom calibration, you will need some kind of external references, such as known, good pH buffer solutions. For more information, follow the instructions at www.vernier.com/til/2341/

To store the custom calibration on your sensor so it will be used every time, follow the instructions at www.vernier.com/til/2342/

[1]Only Oxygen Gas Sensors made in the last five years can have the calibration stored on the sensor.

Connected Science System Updates

The Connected Science System (CSS) lets you and your students view and analyze your sensor data on multiple devices. Many components of CSS have been updated, so you can now share, display, view, and analyze data in even more ways.

DATA SHARING FOR LOGGER *PRO* IS NOW AVAILABLE – Now you can use iPad devices, and smartphones, or any device with a browser, even if you use LabPro, LabQuest Mini, or Go!Link for data collection. Initially available only with LabQuest 2, you can now enable the Data Sharing feature in Logger *Pro* to share and display your data on multiple devices. Enable Data Sharing to share data with Graphical Analysis for iPad and Vernier Data Share web app. Data Sharing allows all students in a lab group to have their own copy of the data, which they can then graph, analyze, and annotate when creating their lab report. Since each student can have his or her own copy of the data, the analysis is unique to each student. Students are able to collaborate, yet have individual accountability.

GRAPHICAL ANALYSIS FOR IPAD – Graphical Analysis for iPad has also been updated and now includes sample data, new options for removing student data from the history, and the ability to import files from Logger *Pro*, LabQuest app, Video Physics for iOS, and PC and Mac Graphical Analysis, as well as general CSV files. Using Graphical Analysis for iPad, you can now apply statistics and curve fits to multiple selections, change the colors, and easily adjust the position of the information on the screen. Graphical Analysis now works well both in 1:1 environments and in classes that share iPad devices.

VERNIER DATA SHARE WEB APP – Connect to Logger *Pro* and LabQuest 2 using a modern browser to use Vernier Data Share. The newly updated Vernier Data Share web app includes an offline mode, printing, and data export for students to finish a lab at home using smartphones, tablets, laptops, and more.

Get the new Data Sharing features by updating your LabQuest 2 to version 2.1 or Logger *Pro* to version 3.8.6. Both updates are free. (Logger *Pro* 3.8.6 will be available in early October.)

New Discussion Forums

Vernier's new discussion forums are a good place to trade and sell used Vernier equipment, share lab ideas, ask support questions, and more. Here are the new features:

- One username and password. Use your Vernier web account for ordering, participating in the forums, and more.
- Mobile-friendly. The forums are optimized for smartphones and tablets, as well as desktop browsers.

Check it out at www.vernier.com/forums

SOFTWARE

Software Updates

We regularly release updates to support new devices and add new features. Keeping up to date with software releases is one way to keep things running smoothly in your classroom or lab. Have you updated your Vernier applications recently?

If you have an account on the Vernier web site and have a purchase history of Logger *Pro*, you can download its full installer at any time—no need to wait for a CD or download link.

LOGGER *PRO* 3.8.6 – Logger *Pro* 3.8.6 will be released in early October, 2012. This update is free to users of any version of Logger *Pro* 3 and will be available at www.vernier.com/lpupdates

Version 3.8.6 adds support for OS X 10.8 Mountain Lion and preliminary support for Windows® 8, which has not been released as of this mailing. The version also adds support for newly introduced sensors, greatly expands options for the Digital Control Unit, and offers new digital filtering for noise reduction of sensor data.

Of particular note in this version is added optional support for the Connected Science System. Logger *Pro* now includes Data Sharing, a feature that allows Logger *Pro* to share data with Graphical Analysis for iPad and with the Vernier Data Share web app that runs in a modern browser such as Chrome or Safari.

Expect the next release of Logger *Pro* in early 2013.

LABQUEST 1.7 – LabQuest 1.7 for the original LabQuest will be released in early October, 2012. Version 1.7 adds support for newly released sensors and improves graphing for spectrometers. This free update will be available at www.vernier.com/lqupdates

LABQUEST 2.1 – LabQuest 2.1 for LabQuest 2 will be released in late September, 2012. This is the first update for LabQuest 2. Version 2.1 greatly improves battery performance, adds support for newly released sensors, and improves graphing for spectrometers. Enterprise Wi-Fi networks (those with username/password combinations) can now be joined with LabQuest 2.

The Data Sharing feature has been enhanced. Vernier Data Share web app now allows printing and data export and improves the layout of analysis information.

This free update to LabQuest 2 will be available to download at www.vernier.com/lq2updates

LOGGER LITE 1.6 – Logger Lite 1.6 was released in April, 2012 to support LabQuest 2. The previous release of Logger Lite added support for LabQuest Mini and Windows 7 (including 64-bit machines), as well as linear fits. The free update is available at www.vernier.com/llupdates

VIDEO PHYSICS – Video Physics 1.1.3 is available in the App Store for iPad, iPhone, and iPod touch. Look for a free update with enhanced Graphical Analysis integration before the end of this year.

GRAPHICAL ANALYSIS FOR iPAD – An update to Graphical Analysis for iPad, 1.2, was released in the App Store in August, 2012. This release improves the discovery of new data sources on the network and allows import of data from Video Physics for iOS. An option to clear data history improves usability in shared-device environments. This is a free update and is available in the App Store.

VOLUME PURCHASING – Did you know that your school or department can purchase in volume to distribute apps such as Video Physics and Graphical Analysis to multiple devices? This is a way to distribute iOS apps to both school-owned and student devices. You can use purchase orders or a credit card, and school purchases are tax exempt. You receive a 50% discount when purchasing 20 or more copies of Vernier Video Physics or Vernier Graphical Analysis. For more information, see www.apple.com/itunes/education/

LOGGER *PRO* UPDATE OFFERS DIGITAL FILTERING AND NEW DIGITAL CONTROL UNIT OPTIONS

Logger *Pro* 3.8.6 offers new calculated columns. All are digital filtering functions, designed to improve and clarify the display of sensor data. The high-pass filter reduces the effect of a varying baseline on signals, improving data such as that from the EKG sensor. The low-pass filter reduces distracting, rapid variations in signals. Both filters have adjustable cutoff frequencies. The time-decay filter applies a simple adjustable time constant to the data, smoothing out rapid fluctuations while preserving long-term trends.

The Digital Control Unit (DCU) is an accessory popular with those doing engineering and STEM activities. It offers digital output lines that can be used to control motors, lights, and other parts of a project. Logger *Pro* now offers more detailed control of the lines, allowing for more sophisticated projects to be constructed. For example, one can now enable independent digital lines to sensor data based on multiple logical comparisons, such as IF and AND, time, and fixed values.

All LabQuest 2 Owners Should Update to 2.1

Many of you will be using your LabQuest 2 units for the first time this fall. One of the first things you should do is update your software to the new 2.1 version. We made a number of improvements to the LabQuest 2 software for better battery and Wi-Fi performance. You *will* want these improvements.

Updating is easy. You'll need a USB flash drive. Download the updater file and copy it to the flash drive. Connect your LabQuest to power and insert the flash drive. Respond to a few prompts on the screen, and you'll have an updated LabQuest. More detailed steps are available on the download page. www.vernier.com/lq2updates

SOFTWARE

NEW: Laboratory Access for Blind or Low Vision (BLV) Students with the Talking LabQuest

by Roger Tower of Independence Science

Blind and Low Vision students can now participate independently alongside their peers in hands-on experiments as a result of the work being done through Vernier's partnership with Independence Science.

Developed to encourage a greater interest in STEM fields of study, the Talking LabQuest breaks down the barriers of the typical science classroom for students who are Blind or Low Vision by allowing these students the opportunity for an interactive, hands-on laboratory experience.

The Department of Education's Office of Human Rights, along with Americans with Disabilities Act of 1990 (ADA) and Section 504 of the Rehabilitation Act of 1973 (Section 504), require that, whenever available, individuals with disabilities are provided the same educational benefits and technology as those provided to individuals without disabilities. The Talking LabQuest now provides BLV students the same science laboratory learning opportunity, with the same substantially equivalent ease of use, as sighted students.

The Talking LabQuest can be ordered as a complete unit, or you can order the Sci-Voice Software separately to add speech to any original LabQuest units that you currently own.

To purchase, or for more information on the Talking LabQuest, contact Independence Science directly at 866-862-9665 or email Info@IndependenceScience.com

The Talking LabQuest in action

SCIENCE HUMOR

A Higgs boson walks into a Catholic church and finds the service has already started.

"Stop," he yells to the priest, "You can't have mass without me!"

– Thanks to Terry Flanagan and Tom Sandin

LabQuest Viewer

LabQuest Viewer software for OS X and Windows allows you to see the screens of all the LabQuest units in your classroom. You can even control LabQuest from your computer; the LabQuest units and your computer need only be on the same network. And, because the connection to LabQuest is wireless, the handhelds are not tied to one location in the lab!

Imagine these scenarios:

- Projecting your computer screen to the class, you start LabQuest Viewer to show the screen of your own LabQuest. Now you can show students how to use LabQuest, or even do a demonstration for them. Best of all, you and your LabQuest are not tethered by wire to the projection computer.
- Using LabQuest Viewer on your laptop, you monitor the progress of the lab groups. When one group falls behind, you can provide appropriate guidance.
- A student group has a particularly interesting run, and you select their LabQuest to project to the whole class for discussion.
- Student groups present their results to the class, with each group projecting their own graphs to the entire class—all without the students ever leaving their lab benches.
- A LabQuest is ready to collect data in an awkward location, such as in a fume hood, on the roof, or in the next room. You use LabQuest Viewer to initiate data collection, store runs, and even email the results, without touching the LabQuest.

LabQuest Viewer is compatible with both the LabQuest 2 (with built-in Wi-Fi), and with the original LabQuest (with the LabQuest WiFi USB Adapter). Check out the video summarizing LabQuest Viewer features at www.vernier.com/lq-view/

LabQuest Viewer, LQ-VIEW, $49

VERNIER AWARDS

Vernier is proud to be recognized for its philanthropic commitment, steady growth, and as one of the Best 100 Companies to Work For in Oregon—for 13 years in a row.

INTERNATIONAL AWARD FOR LABQUEST

FASTEST GROWING PRIVATE COMPANIES

PLACED 25TH OF 100 BEST GREEN COMPANIES IN OREGON

2011 HEALTHIEST EMPLOYERS 6TH PLACE

OREGON BUSINESS AWARD

LabQuest 2 and the Connected Science System™ Win Leading Education Awards and Receive Excellent Reviews

Since the release of LabQuest 2, science educators have applauded our new interface for its reliability, performance, and ease of use. Whether you are looking for a robust data-collection solution for the lab or the field, LabQuest 2 delivers state-of-the-art technology for STEM education. Also, educators who want to connect iPad and other mobile devices with probeware will find LabQuest 2 to be the most versatile interface available.

LabQuest 2 and the Connected Science System Win Worlddidac Award

The Worlddidac Foundation honored both LabQuest 2 and the Connected Science System with a Worlddidac Award—LabQuest 2 for hardware and the Connected Science System for software.

"The Worlddidac Award is presented every two years to innovative and pedagogically valuable products with a high potential to improve learning or teaching. Winning products are chosen by a jury of education experts based on a product's overall educational value, design, sustainability, and more."

LabQuest 2 wins a Readers' Choice Award from eSchool Media

The publication, *eSchool News*, named LabQuest 2 one of "Fifty of the best ed-tech products for schools" and granted LabQuest 2 a Reader's Choice Award as judged by educators across the country.

Reviews from Publications and Blogs

NSTA Blog – "It seemed obvious that the LabQuest 2 would be a real game changer in the data collection space, but after our field test, it seems more that the LabQuest 2 has invented an entirely new game." – Martin Horejsi

Tech & Learning – "Vernier's LabQuest 2 can build interest in science, make experiments come alive, and deepen understanding of complex concepts. The affordable handheld tool supports student-centered, inquiry-based learning, high-end data collection, and critical analysis as budding scientists use real tools to conduct real-time investigations of natural phenomena."
– Carol S. Holzberg, Ph.D.

Scholastic Administrator's Tech Tools – Grade: A, "A bargain, LabQuest is a modern-day science lab that fits in the palm of a hand." – Brian Nadel

Assistive Technology – "With the LabQuest 2, Vernier has transformed the way teachers need to think about teaching science in the classroom and provided them with an easy and powerful solution for capturing data in real time." – Brian Friedlander, Ph.D.

Read the reviews at www.vernier.com/labq2

New Vernier White Paper on Probeware

Vernier Technology Aligned to the *Framework for K–12 Science Education*

Research in Vernier's white paper, *What the Research Says About the Value of Probeware for Science Instruction*, supports the following findings:

- Use of data-collection technology can provide a learning advantage to students, as evidenced in student test scores.
- Probeware can help to deepen student understanding of science concepts.
- Hands-on use of technology tools is recommended in guidelines from national organizations such as ISTE, ASTE, and others.
- Use of technology tools for data collection, analysis, and visualization in a context of student scientific investigations can provide experiences with core scientific practices for students, as called for in the *Framework for K–12 Science Education*.

This helpful white paper includes an in-depth look at research that supports the findings listed above, and it provides a detailed bibliography for your reference. To download, go to www.vernier.com/whitepaper

New Instructional Videos Available in Our Video Training Library

NEW LABQUEST 2 INSTRUCTIONAL VIDEOS

- Introducing Vernier LabQuest 2
- Getting Started with LabQuest 2
- Graphical Analysis for iPad Overview
- Wireless Networking Overview with LabQuest 2
- Using Vernier Data Share Web App and LabQuest 2
- LabQuest Viewer Overview
- LabQuest Charging Station

NEW TECH TIPS FOR SENSORS

David Carter, our STEM Training Director, shot a series of instructional videos focused on sensors. You will find new training videos for the following sensors in our video training library and on each product web page:

- Differential Voltage Probe
- Troubleshooting and Changing a LabQuest Battery
- Magnetic Field Sensor
- Hand Dynamometer
- O_2 Gas Sensor
- High Current Sensor and 30-Volt Voltage Probe
- pH Sensor
- Light Sensor
- Conductivity Probe
- Dual-Range Force Sensor

For more information, visit www.vernier.com/latest-videos

Free Hands-On, Data-Collection Workshops

Whether you already own Vernier equipment or want to experience our new technology, this workshop is for you! You will conduct hands-on experiments using various sensors with our new interface, LabQuest 2. This versatile interface supports data collection as a standalone device, with a computer, and with iPad or other mobile technology. The workshops include lunch or dinner and lab handouts on CD. www.vernier.com/workshops

SEPTEMBER

10	Dallas, TX
11	Dallas, TX
12	Austin, TX
12	Tulsa, OK
13	San Antonio, TX
13	Oklahoma City, OK
15	Wichita, KS
17	San Antonio, TX
17	Topeka, KS
18	Corpus Christi, TX
18	Kansas City, MO
19	Houston, TX
20	Houston, TX
25	Des Moines, IA
26	Lincoln, NE
29	Sioux Falls, SD

OCTOBER

1	Minneapolis, MN
11	Portsmouth, NH
13	Boston, MA
13	Grand Rapids, MI
15	Providence, RI
15	Detroit, MI
16	Worcester, MA
17	Cleveland, OH
18	Albany, NY
18	Pittsburgh, PA
25	Columbus, OH
27	Dayton, OH
29	Indianapolis, IN
30	Green Bay, WI

NOVEMBER

1	Madison, WI
3	Milwaukee, WI
3	St. Louis, MO
5	Chicago, IL
5	Evansville, IN
6	Chicago, IL
7	Louisville, KY
8	Lexington, KY

Fall 2012 Online Webinars

No Travel Required! Vernier holds free, one-hour training events online. The presenter will give a tour of Vernier products and answer questions. All you need is a broadband internet connection and a phone line. Recorded versions will also be available for download. For more information, go to www.vernier.com/webinars

LabQuest 201 – September 4, 7, 28
iPad Uses with Vernier Technology – September 4, 24
Connected Science System – September 7, 24
Biotechnology: Gel Analysis – September 28

Plan Your Trip to Portland, Oregon

In 2013, there are two important science educator conferences here in our home town of Portland:

- American Association of Physics Teachers (AAPT), July 13–17, 2013
- National Science Teachers Association (NSTA), Western Area, Oct. 24–26, 2013

Plan your trip to Portland and stop in to see us. We are sponsoring activities at both of these conferences.

Vernier is Buzzing with Bees

Using the Vernier Force Plate to Monitor Honey Production

This spring, we added a bunch of fruit trees and blueberry bushes to our office property. At the suggestion of Matthew Denton, one of our long-time employees, we also added a beehive. The hive is located on our roof, and it is a high-tech beehive. The hive has a solar-powered fan to keep it cool on sunny days, and it is mounted on a Vernier Force Plate so we can monitor the day-to-day production of honey. We will be mounting a video camera near the entrance of the hive to allow anyone to view the bee activity.

Applications Open for Annual Vernier/NSTA Technology Awards

Award Increased to $5,500 in Prizes for Each Teacher

Vernier Software & Technology and the National Science Teachers Association (NSTA) are now accepting applications for the annual Vernier/NSTA Technology Awards. The 2013 awards program will recognize up to seven educators—including one elementary teacher, two middle school teachers, three high school teachers, and one college-level educator—who promote the innovative use of data-collection technology.

For ten years, Vernier has been recognizing innovative STEM educators with this grant, and this year Vernier and NSTA have increased the technology and cash prizes for each winning educator. Prizes include $1,000 in cash, $3,000 in Vernier products, and up to $1,500 toward expenses to attend the 2013 NSTA National Conference in San Antonio, Texas. Award recipients will be chosen based on their application, which is judged by a panel of NSTA-appointed experts. All applications must be submitted by November 30, 2012.

For more information, visit www.vernier.com/grants/nsta

BACK TO SCHOOL TECHNOLOGY TIPS

Learn tips for using the Connected Science System. Get step-by-step tutorials, videos, resources, and troubleshooting guides on using the Connected Science System in your classroom. www.vernier.com/support/css

Search FAQs from our Technical Information Library (TIL). Our Technical Information Library is full of tips, techniques, and answers to frequently asked questions about probeware. www.vernier.com/til

Vernier
MEASURE. ANALYZE. LEARN.™

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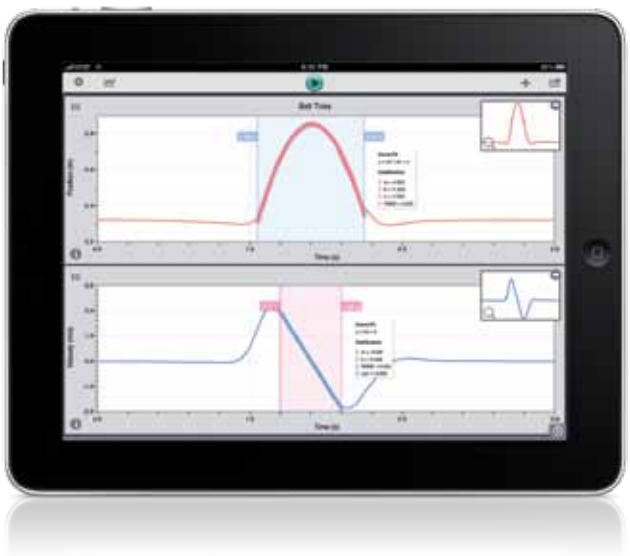
Gear Up for iPad Data Collection



LabQuest® 2
Collect and analyze data with iPad and other mobile devices.
www.vernier.com/labquest2

Graphical Analysis™ for iPad®
Download this iPad app to collect, analyze, and annotate data.
www.vernier.com/ga-ipad

Video Physics
Record video and analyze motion frame by frame.
www.vernier.com/videophysics