THE CALIPER

Vernier
CELEBRATING 30 YEARS

THE CALIPER IS A PUBLICATION FOR USERS OF VERNIER PRODUCTS SPRING 2011 | VOL 28 NO.1

in this issue

Vernier Software & Technology to Award $300,000 in Technology Grants

Celebrating thirty years of business, Vernier says "thanks" to science educators with thirty $10,000 grants

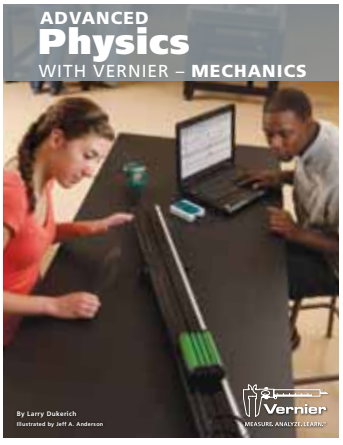
When David and Christine Vernier first launched Vernier Software & Technology 30 years ago, they wanted to have an impact on science education. Decades later, to celebrate our 30th anniversary, we are offering $10,000 technology grants to 30 schools.

We are providing the 30 grants to ten elementary or middle schools, ten high schools, and ten college or university science departments to honor the important work science teachers do every day. Each grant awardee will receive $10,000 worth of Vernier technology equipment of their choosing.

"We have had an amazing 30 years of helping educators integrate technology into their science labs," said David Vernier, co-founder of Vernier and a former physics teacher. "It gives us great pleasure to be able to give back to the community that has supported us for so many years."

Applications are due by June 1, 2011, with winners being announced by September 15, 2011. For complete details and to view the grant application, visit www.vernier.com/30years

$48
ORDER CODE
PHYS-AM



NEW! *Advanced Physics with Vernier – Mechanics*

by Larry Dukerich

Advanced Physics with Vernier - Mechanics is a set of new experiments for a more in-depth introductory physics course. The book contains four introductory activities and 19 student experiments. Seventeen experiments use sensors with LabQuest, LabQuest Mini, or LabPro with Logger *Pro* software, or with LabQuest as a standalone device. Two experiments use the video analysis capabilities of Logger *Pro*. These

Continued on page 4

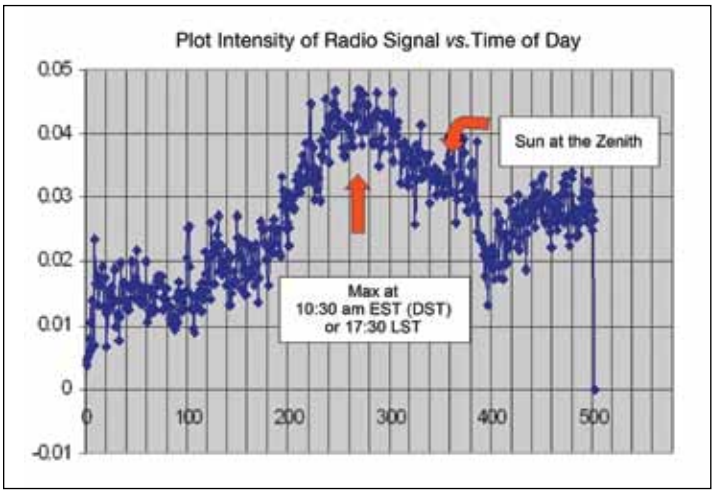
PHYSICS

Locating a Black Hole

Using a Go!Link, the Instrumentation Amplifier, and Logger *Pro* software

Students at Madonna High School, in Weirton, WV, recently applied Vernier hardware and software to the task of locating a massive black hole believed to exist at the center of our galaxy.

Using a short wave radio, some custom circuitry, the Vernier Instrumentation Amplifier, a Go!Link and Vernier Logger *Pro* software, students were able to monitor electromagnetic radiation emanating from Sagittarius A* (pronounced "Sagittarius A-star"), a radio source in the area around the black hole. These radio waves are apparently produced by the destruction of matter in an accretion disk surrounding the black hole. The EM radiation is distributed broadly across radio frequencies; students chose to monitor 87.10 MHz, a short wave band near the frequency reserved for radio astronomy. Sampling at a rate of 500 samples per day over four days, students recorded the time of day when the peak in EM intensity was observed. Students were able to compare their results to astronomical data, verifying that their measurements correlated with the right ascension of Sagittarius A*.



A composite of the mean intensity of four days of sampling at 500 samples per day shows two maxima, one for the zenith of the Sun, and one for the right ascension of Sagittarius A.*

Do You Have a Physics Question?

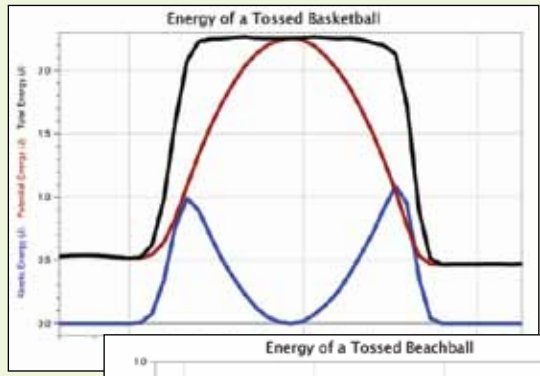
Call Matt! Matt Anthes-Washburn is a new Vernier Technology Specialist in physics and iOS development. He is a PAEMST presidential awardee, with 10 years of experience teaching physics and AP Physics in New York, Boston, and Denver public schools. Matt's first computer was an IBM PCjr (with cartridges and sidecars), and his first tech support work was maintaining a network of TRS-80s in elementary school.

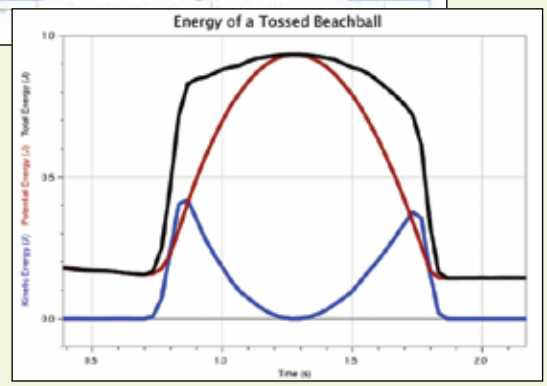
PHYSICS PUZZLE by Matt Anthes-Washburn

While performing an experiment from the *Physics with Vernier* lab book, "Energy of a Tossed Ball," Kathy Morello and her students from St. Joseph's Academy in Baton Rouge, LA found some perplexing results. In the experiment, a Motion Detector is used to measure the position and velocity of a ball tossed vertically. The relative quantities of gravitational potential energy (GPE) and kinetic energy (KE) are compared to the total mechanical energy (TME). Usually, we see that GPE increases as the ball rises and decreases as the ball falls, while the KE follows an inverse pattern. During the period the ball is in the air, the TME is generally constant (although frictional forces can cause the TME to decrease noticeably in some cases).

Morello and her students found precisely these results until they performed a trial with a beach ball. Unexpectedly, students found that the TME increased as the ball rose, an apparent increase in energy! Have they violated the law of conservation of energy? Where did this extra energy come from? Was there something wrong with the way they performed their measurements?

After some initial investigations, in which I was able to repeat Ms. Morello's results, I found that this question will likely lead to interesting teaching opportunities and perhaps new areas for independent student investigation. In order to encourage others to explore and debate this phenomenon, we are opening the discussion to the Vernier community at www.vernier.com/discussion/physics-puzzle





PHYSICS

NEW! Centripetal Force Apparatus

Centripetal force is a difficult topic to teach, and it is even more difficult to study in the physics lab. Many physics instructors skip this activity, because it is just hard to do a careful, quantitative experiment. We have a new apparatus to help your students explore this common topic.

A rotating beam holds a variable mass, as well as a counterweight. The variable mass is on low-friction bearings, and is held to the circular path by a string. The string is attached to a force sensor via a swivel and pulleys. The beam can be spun by hand or by a falling mass. A slotted wheel on the beam allows for precise speed measurements using a photogate.

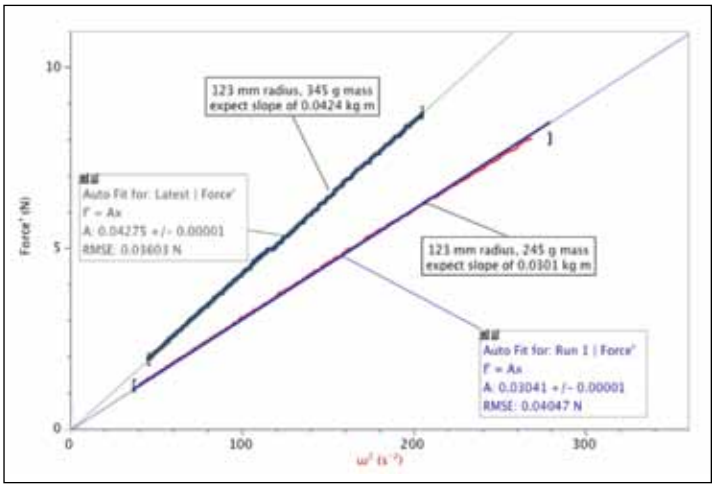
$299 ORDER CODE CFA

You supply either a Dual Range Force Sensor (DFS-BTA) or a Wireless Dynamics Sensor System (WDSS) for the force measurement. The speed can be measured using a Vernier Photogate (VPG-BTD) or a Vernier Rotary Motion Sensor (RMV-BTD). Data can be collected using a LabQuest, LabQuest Mini, or a LabPro.

To illustrate the capability of the CFA, we did a quick experiment using a different perspective than is often used. We know $F=mv^2/r$, but that's the same as $F=m\omega^2 r$, where ω is the angular velocity of the mass. This suggests an experiment that lets us explore a variety of speeds with one run and with a very simple graphical result. If we just spin the beam by hand and let it slow down over 30 or 40 seconds, we'll have force as a function of angular speed. A graph of force *vs.* the square of the angular speed is a direct proportionality, where the slope represents the product of the mass and radius, since $F=(mr)\omega^2$.

We used Logger *Pro* to collect and graph the data, although you can do the same with LabQuest App.

Other things you can try with the CFA are experiments with a falling mass to study moments of inertia, torque, and angular acceleration. The new *Advanced Physics with Vernier – Mechanics* book includes an experiment with the apparatus.



In this graph, two combinations of mass and radius were used; in each case, the slope is the product of mass and radius, and the functional relationship is a proportionality. We used a Photogate and Dual Range Force Sensor here, since those will be most commonly available.

Video Physics

Winners Share Their Projects

Congratulations to the winners of the Vernier Video Physics contest! Winning entries included a demonstration of the circular motion of a hover puck, the cycloid nature of a rolling steel can, and the frame of reference of a supermarket checkout belt. Three grand prize winners each received an iPod touch with HD video recording, and second prize winners received gift cards to the iTunes store.

Winning projects can be seen at www.vernier.com/ios/contest.html and through a free update to Vernier Video Physics in the iTunes App Store: http://bit.ly/videophysics

New features of Video Physics include pinch-to-zoom and panning of high resolution videos, Spanish language support, and additional options for importing and exporting video. Video Physics was recently featured as "New and Noteworthy," and "What's Hot" in the App Store. Thanks for helping to spread the word.

Scan the QR code above with your mobile device to go to the App Store.

iPod touch photo courtesy of Apple

PHYSICS

Advanced Physics with Vernier – Mechanics *Continued from cover*

experiments represent most of the experiments included in the mechanics portion of a college course or an advanced physics course in high school, including an AP or IB Physics course.

This book is unlike traditional lab manuals, which often guide students through the verification of physics concepts. This book takes the approach of providing students the opportunity to carefully examine phenomena and try to make sense of their findings. This leads the students to the discovery of important concepts.

The experiments assume that there will be regular interactions with an instructor and between student groups. While the experiments are designed around these interactions, they are not open-ended experiments that lack closure or direction. In addition, the experiments address the key concepts of a rigorous introductory physics course in a way that ensures all students will be prepared to move forward in the curriculum.

Instructor notes include discussion on how to lead students through a successful experiment. The book includes many extensions to challenge the most talented students.

Experiments include the investigation of:

- Motion on an Incline
- Error Analysis
- Newton's First Law
- Newton's Second Law
- Newton's Third Law
- Projectile Motion
- Energy Storage and Transfer: Elastic Energy
- Energy Storage and Transfer: Kinetic Energy
- Energy Storage and Transfer: Gravitational Energy
- Impulse and Momentum
- Momentum and Collision
- Centripetal Acceleration
- Rotational Dynamics
- Conservation of Angular Momentum
- Simple Harmonic Motion: Mathematical Model
- Simple Harmonic Motion: Kinematics and Dynamics
- Pendulum Periods
- Physical Pendulum
- Center of Mass

An Improvement to the Inverse Square Law Light Experiment

Richard Borne (Northern Illinois University) has suggested an improvement to the Inverse Square Law Light Experiment using our Optics Expansion Kit (order code OEK). He noticed that the intensity of our white LED lamp decreases somewhat over time when it is first turned on. Since students doing this experiment may take a few minutes to collect the light intensity *vs.* distance data, his suggestion is to turn on the LED light sources for a half hour or more before starting data collection. We have modified the documentation in our Optics Expansion Kit and the instructions for our Inverse Square Law lab to include these suggestions. Dr. Borne has nicely documented light intensity variation and its impact on the experimental results in the article. You can see graphs of his results at www.vernier.com/innovate/155

Physics Articles Using Vernier Products

There have been lots of great projects in *The Physics Teacher* using our software and hardware:

Logger *Pro* 3

"An Experimental Investigation of the End Effects for Blue Man Group® Pipes" by M. E. Bacon and Steven Torok (Thiel College, Greenville, PA) in the March 2011 issue uses our LabQuest and its internal microphone with Logger *Pro* to study a version of this unusual instrument built using pipes open on both ends.

"Using 'Student Technology' in Introductory Physics: A Comparison of Three Tools to Study Falling Objects" by Fabio Saraiva da Rocha, Fabio Fajardo, Maricarmen Grisolia, Julio Benegas, Robert Tchitnga, and Priscilla Laws is in the March 2011 issue. It is an interesting article that came out of a meeting of physics instructors from all over the world, many from countries where very minimal physics apparatus is available. They compared three methods of taking experimental data on falling objects: Vernier Go!Motion, video analysis using a cell phone, and video analysis using a more expensive digital video camera.

Logger *Pro* 3

"Innovative Interactive Lecture Demonstrations Using Wireless Force Sensors and Accelerometers for Introductory Physics Courses" by G. Yoder and J. Cook (Eastern Kentucky University) in the December 2010 issue describes several great demonstration ideas using our Wireless Dynamics Sensor System (WDSS) and Logger *Pro*.

"Experiments with Helium-Filled Balloons" by Anthony C. Zable (Portland Community College, OR), in the December 2010 issue, has some innovative experiments using our Gas Pressure Sensor and temperature sensor.

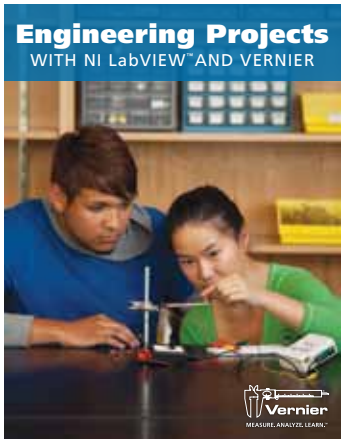
Logger *Pro* 3

"Measuring Model Rocket Engine Thrust Curves" by Kim Penn and William V. Slaton (University of Central Arkansas), in the December 2010 issue, describes how to use our Dual-Range Force Sensor and Logger *Pro* software to graph thrust *vs.* time for model rocket engines.

"An Inexpensive Cosmic Ray Detector for the Classroom" by Jeffrey D. Goldader and Seulah Choi (The Baldwin School, Bryn Mawr, PA), in the December 2010 issue, explains how they built a cosmic ray detector to use with LabPro.

ENGINEERING

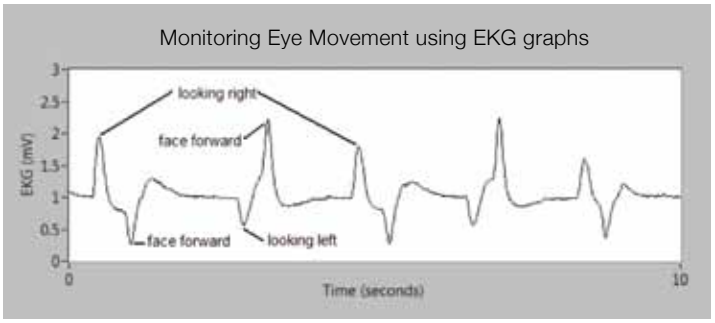
NEW! Engineering Projects Lab Book



$48 ORDER CODE EPV

Engineering Projects with NI LabVIEW™ and Vernier is a new book that introduces students to engineering concepts such as sensor construction, analog and digital input, control systems, and voltage dividers. There are 12 projects and challenges, essential teacher information in each chapter, and sample LabVIEW programs included on CD.

In Chapter 8, the project's design requirements instruct the students to create a data-acquisition program to display and analyze an EKG waveform. They are given background information on the five major deflections on a normal EKG, how to properly connect an EKG Sensor to a test subject, and tips for using the graphical analysis tools of a LabVIEW graph. Once they complete this project, the students are posed a challenge to compute the subject's heart rate from the EKG waveform. They must work with the waveform and determine how to design an appropriate signal processing algorithm.



Chapter 8 concludes with an Extreme Challenge—to use the EKG Sensor to detect the electrical changes that occur in the movement of the eyes, and to turn on a green LED when the subject looks right, and a red LED when the subject looks left. The chart above shows the EKG reading of a subject looking left and right. Notice the peaks and valleys that occur in the waveform when the subject looks left and right, but also when looking forward.

Students who take on this challenge will be learning how the EKG Sensor works, signal processing, digital output, LabVIEW programming, troubleshooting, and many other pieces required to solve this problem. And if they can activate an LED based on eye motion, perhaps they will wonder what else they can do?

To view a pdf of this chapter, as well as the other chapters in this book, and to see a few demonstration photos and videos, go to www.vernier.com/epv

What Can You Teach with Vernier and LabVIEW?

National Instruments recently ran a contest called "What can you teach with LabVIEW?" Teachers were invited to submit videos showing creative ways to use LabVIEW to teach science and engineering concepts in the classroom. Winners were awarded prize money and a technology bundle. Several users of Vernier technology were prize winners or received honorable mention including:

Ralf Widenhorn, Justin Dunlap, Elliot Mylott, Ryan Klepetka (Portland State University)
Computed Tomography Scanner
http://www.youtube.com/watch?v=YQ_KgU42uRU

Dominic Audia and Doug Herman (Iowa City West High School)
Heart Rate Monitor with Audible Alarm
http://www.youtube.com/watch?v=lP4I6HbpQIA

Rebecca Morrison (Runnels School)
Singing Magnets
http://www.youtube.com/watch?v=Rgs95LdHZWc

Nelson Nunalee (Ravenscroft School)
Video Mood Ring
http://www.youtube.com/watch?v=jvAwZgMy9oE

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 12 years in a row.

FASTEST GROWING PRIVATE COMPANIES

INTERNATIONAL AWARD FOR LABQUEST

PLACED 10TH OF 100 BEST GREEN COMPANIES IN OREGON

2005 PHILANTHROPY AWARD

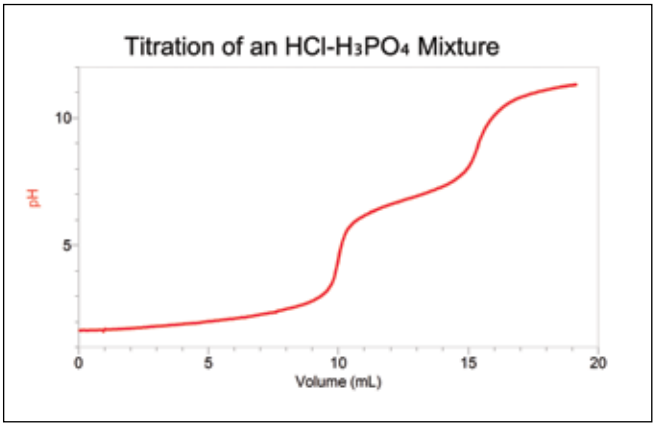
OREGON BUSINESS AWARD

CHEMISTRY

Investigating an Acid Mixture

An interesting and challenging problem for AP Chemistry students is the investigation of a mixture. For this issue of *The Caliper,* we offer a chemistry experiment in which the student analyzes a mixture of hydrochloric acid, HCl, and phosphoric acid, H_3PO_4. The student is presented with the task of conducting a seemingly routine acid-base titration. However, the student must analyze the titration data to determine how much HCl and how much H_3PO_4 were in the mixture. As an added bonus, the student will determine the K_{a2} of H_3PO_4.

For the complete lab, go to www.vernier.com/innovate/156



Two New Faces in Our Chemistry Department

We are pleased to introduce the two newest additions to the chemistry department at Vernier: Dr. Melissa Hill and Dr. Elaine Nam. Melissa and Elaine have been busy with the development of our products for organic chemistry. They are always available for any of your chemistry questions.

Dr. Melissa Hill

Dr. Elaine Nam

Dr. Melissa Hill earned her Ph.D. in Biophysical Chemistry from the University of California at Davis. Throughout her dissertation research, she used numerous time-resolved spectroscopic techniques to analyze kinetic and thermodynamic parameters of vitamin B6-dependent enzymes. Melissa's Bachelor of Science is in biochemistry from St. Edward's University in Austin, Texas. Her undergraduate research focused on the organic synthesis of phosphate-binding molecules. She has taught various chemistry courses at both the undergraduate and graduate levels, including general chemistry, organic chemistry, biochemistry, physical chemistry, spectroscopy and their respective laboratory sections.

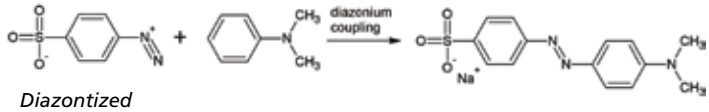
Dr. Elaine Nam began her chemistry career with a B.A. in chemistry from Pomona College in Claremont, CA. Her studies continued by receiving an M.Sc. from San Francisco State University, working on remediation studies of arsenic and selenium from soil and sediment, and a Ph.D. in Chemistry from the University of Washington in Seattle, where her work focused on biomimetic modeling of enzyme active sites. It was while working at the University of Washington that she was introduced to Vernier probeware. As a laboratory instructor for general chemistry, her teaching experience included the use of TI calculators with LabPro.

Organic Chemistry Experiments with Vernier

By Melissa Hill, Ph.D.

Good news for all you organic chemists out there! Our chemistry offerings have expanded to incorporate organic chemistry experiments that utilize four sensors: Melt Station (MLT-BTA $399), Wide-Range Temperature Probe (WRT-BTA $64), SpectroVis Plus (SVIS-PL $449), and Vernier Mini Gas Chromatograph (GC-MINI $1749). There are 16 Organic Chemistry experiments available for free download. The experiments cover a broad range of topics, including synthesis, separation methods, analysis of unknowns, and thermodynamic properties. Each of these files includes a complete student lab handout, instructor information on preparing reagents, hazard information on chemicals used, and sample graphs. As always, they are in Microsoft Word format, so you can edit them to your specifications. These files can be found at www.vernier.com/organic

One experiment, highlighted here, is the organic synthesis of methyl orange and how this has important applications to the textile industry. Methyl orange, 4-4-[(dimethylamino)phenylazo] benzenesulfonic acid, is an azo dye that forms orange crystals and is commonly used as an acid-base indicator, due to the fact that its anion form is yellow and its acid form is red. It can be synthesized from sulfanilic acid and N,N-dimethylaniline using a diazonium coupling reaction, a common reaction for treating an aliphatic amine to yield a carbocation.



Diazontized sulfanilic acid *N,N-dimethylaniline* *Methyl orange*

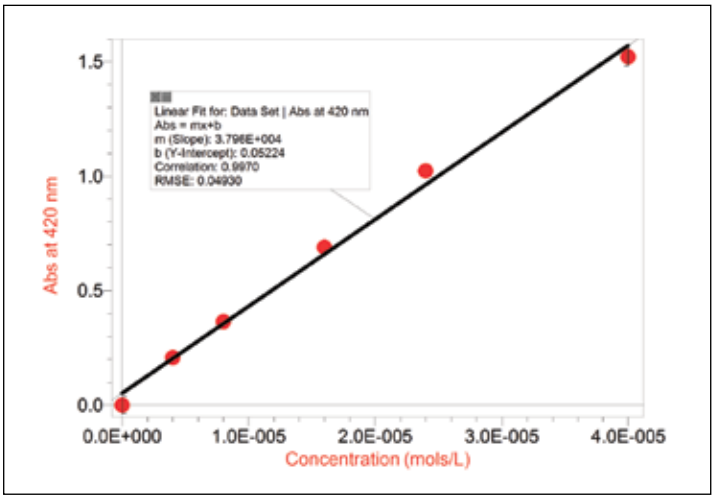
After students have completed their syntheses, the precise concentration of synthesized methyl orange, and thereby the

CHEMISTRY

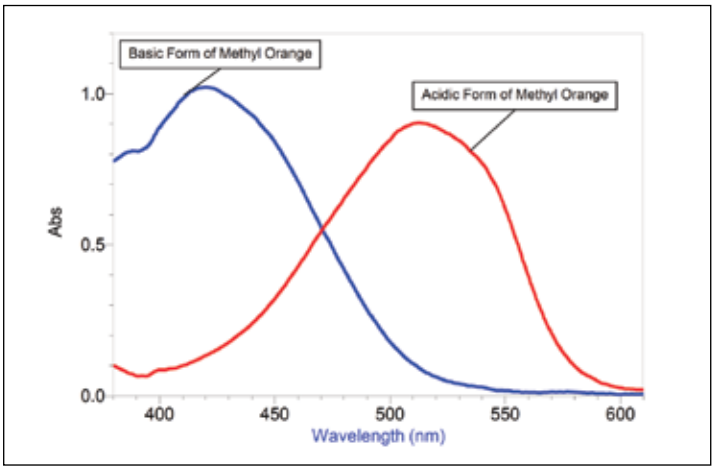
Synthesized methyl orange

product purity, can be determined using the Vernier SpectroVis Plus spectrophotometer after performing a Beer's law analysis on a methyl orange standard. Students can also observe the visible absorption spectral changes associated with the acidic and basic forms of the compound. The synthesized methyl orange can then be used to dye various types of fabrics, so students can experience firsthand the importance of organic chemistry in the textile industry.

Detailed student instructions for this synthesis are available for free download at www.vernier.com/organic



Beer's law analysis of pure methyl orange



Absorbance spectrum of lab-synthesized methyl orange

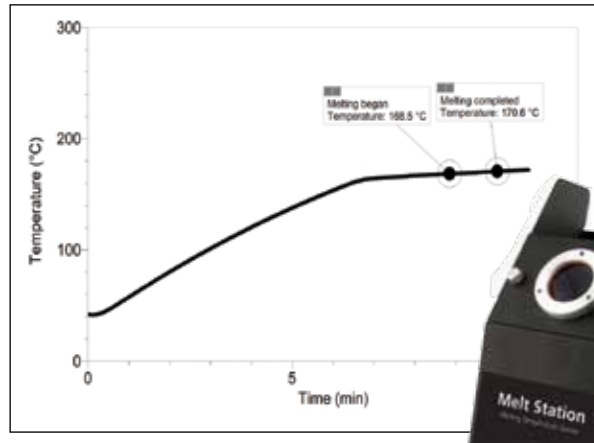
NEW! Melt Station

Determining the Melting Temperature of Solids

Vernier has expanded our chemistry offerings to incorporate organic chemistry with the addition of Melt Station, a new sensor for determining the melting temperature of solids. Melting temperature is a physical property often used to help identify compounds or to check the purity of a compound. Pure organic compounds generally have a sharp melting temperature, typically melting over a few degrees. The presence of an impurity lowers the pure compound's melting temperature and broadens the temperature range over which it melts. As a result, a solid's melting temperature is useful not only as an aid in identification, but also as an indication of purity.

Melt Station reports accurate temperature results using a built-in RTD (resistance temperature detector), over a range from ambient to 260°C. A high-quality 6X magnification viewing lens allows for clear observation of the samples, and an innovative, adjustable tilt offers an optimal viewing angle. For added safety, Melt Station has an automatic shut-off feature. A cooling fan significantly reduces waiting time between tests.

Melt Station connects to a Vernier interface (LabQuest, LabQuest Mini, Go!Link, or LabPro), allowing you to monitor and record readings with Logger *Pro* 3 software or LabQuest App. A new feature of Logger *Pro* and LabQuest App is the ability to observe a graph of time-dependent temperature data combined with a new Data Mark feature, providing excellent accuracy and precision. The sample data show a time-dependent temperature graph with the Data Marks indicating the melting temperature range of acetaminophen. For free experiments using Melt Station, go to www.vernier.com/organic



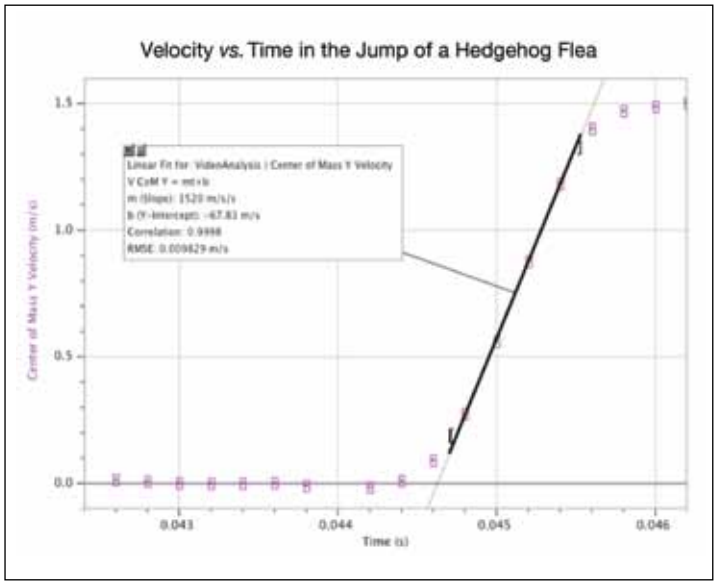
Logger Pro *graph of the melting temperature of acetaminophen*

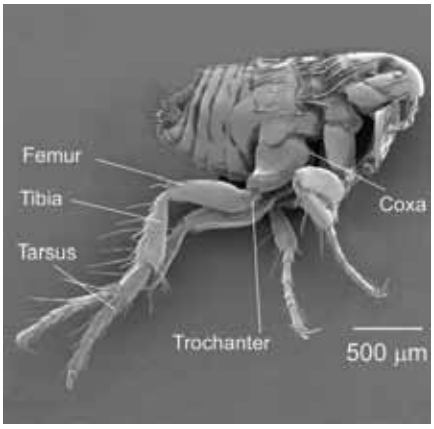
$399 ORDER CODE MLT-BTA

BIOLOGY

Biomechanics of a Jumping Flea

We've all heard of the age-old Bennet-Clark/Rothschild debate about flea jumping, right? Just to refresh your memory, Henry Bennet-Clark, the researcher who discovered in 1967 that fleas store the elastic potential energy for their jump in a material called resilin, made predictions on the mechanics of flea jumping. Bennet-Clark hypothesized that fleas take to the air by use of the tarsus (toe) in the application of a liftoff force. On the other hand, Miriam Rothschild proposed that fleas use their knees (trochanters) to push off.





Scan the QR code above with your mobile device to go to this article's url.

Researchers Gregory Sutton and Malcom Burrows, at Cambridge University, recently revisited the debate, applying high-speed imagery, shot at 5000 frames per second, to the problem. The researchers found that, while both the trochanter and tarsus often make contact with the ground, the measured acceleration continues throughout the flea's jump, even after the trochanter has left the ground, while the tarsus is the only source of liftoff force. Additionally, in 10% of jumps, fleas push off using only the tarsus, and the resulting acceleration is unaffected. Amazingly, that acceleration is around 1,500 m/s^2, or 150 *g*!

Conclusion? Fleas don't use their knees; they go with their toes. Sutton and Burrows were kind enough to share sample video files of hedgehog flea jumps, which you can download and analyze yourself using the video analysis features of Logger *Pro* 3. To download the files, go to www.vernier.com/innovate/157

To carry out the analysis, we tracked the head and the tail with separate point series and used the new Center of Mass feature of Logger *Pro* 3.8.4 to track the flea's motion. We imported an electron micrograph (provided), to scale the video, using the flea's tibia and the Photo Analysis feature of Logger *Pro* 3. Finally, we adjusted the frame rate to 5000 fps. Our measured acceleration agreed with that found by Sutton and Burrows.

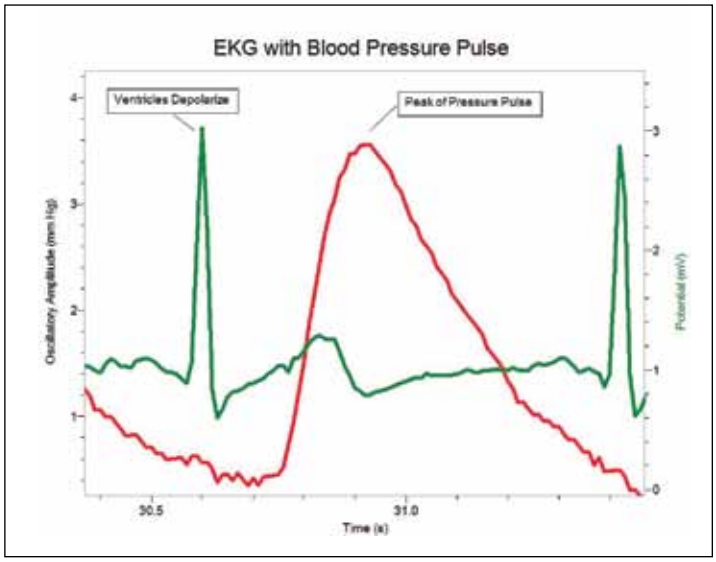
REFERENCE: Sutton, G. P. and Burrows, M. (2011). Biomechanics of jumping in the flea. J. Exp. Biol. 214, 836-847.

Looking for ways to include inquiry investigations in your biology class? Check out the "Cell Respiration" investigation available at www.vernier.com/cmat/esi.html

Monitor Blood Pressure and EKG Simultaneously Using Logger *Pro*

By John Melville, Ph.D.

John Melville, our Biology Staff Scientist, has developed an innovative way to demonstrate how the electrical and physical events of the cardiac cycle are related using a Blood Pressure Sensor (BPS-BTA $105) and an EKG Sensor (EKG-BTA $147) with our award-winning Logger *Pro* software.



Blood pressure is a measure of the changing fluid pressure within the circulatory system. It varies from a peak pressure produced by contraction of the left ventricle of the heart, to a low pressure,

BIOLOGY

which is maintained by closure of the aortic valve and elastic recoil of the arterial system.

An electrocardiogram (ECG or EKG) is a graphical recording of the electrical events occurring within the heart. In the healthy heart, there is a pacemaker in the right atrium (the sinoatrial node) that initiates an electrical sequence of events in the heart. This impulse then passes between the atria to the atrioventricular node, and from there to the ventricles. The ventricles depolarize and contract, producing the peak blood pressure within the circulatory system.

If you measure arterial blood pressure while you perform an EKG, you should see that each QRS complex of the EKG will occur just before a pressure pulse occurs in an artery. This is a common exercise or demonstration in college physiology courses. As shown in the graph provided, you can easily demonstrate this to your class using Logger *Pro* Software. All you need is a Blood Pressure Sensor, an EKG Sensor, and an appropriate Vernier interface (LabQuest, LabQuest Mini, or LabPro).

To record a Blood Pressure Pulse and EKG simultaneously, follow the directions at www.vernier.com/innovate/158.

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

"I love your products and your customer service. Every chance I get, I encourage others to purchase your products as well. Thanks again!" – Amy Fowler Murphy, University of Montevallo, Montevallo, AL

"Your products are very high quality and durable, but your service is even better. If you guys ever decide to manufacture an automobile let me know. I would love to purchase it." – Matt Bradley, Madison High School, Madison, OH

SCIENCE HUMOR

Q: What is the simplest way to observe the optical doppler effect?

A: Go out at night and look at cars. The lights of the ones approaching you are white, while the lights of the ones moving away from you are red.

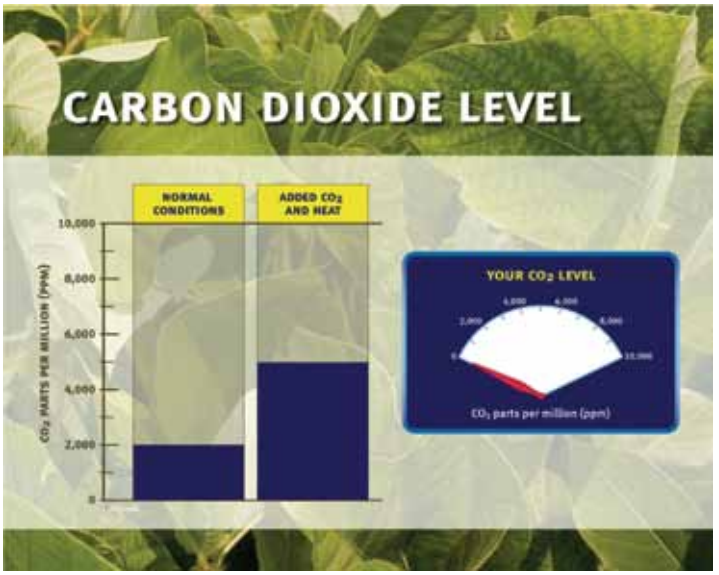
Q: Does a radioactive cat have 18 half lives?

And a couple of bar jokes…

- Helium walks into a bar. The bartender says, "Sorry, we don't serve noble gases here." Helium doesn't react.
- A bar walks into a guy, oh sorry, wrong reference frame.

CO_2 Sensor in Museum Exhibit

Jeff Kennedy Associates, Inc. and scientists from Brown University have developed an interesting museum exhibit using three of our CO_2 Sensors. We wrote the software for it using LabVIEW. As you can see in the photo, there are two sealed containers containing plants. In this case, they used kudzu, a rapidly growing invasive plant on the east coast. One container has normal air. The CO_2 level in that container is monitored with one sensor. The other tank has a pipe leading into it where visitors are asked to exhale



their breath in order to add extra CO_2. A second sensor monitors the (higher) CO_2 level in that tank. The third sensor reads the CO_2 concentration in the pipe. The idea is to see how much the extra CO_2 encouraged the kudzu growth. The apparatus was part an exhibit called "Seasons of Change" that opened at the EcoTarium in Worcester, MA. It will be traveling to other locations, and other versions, customized for other regions of the country, are planned.

For additional information about the museum exhibit, go to http://seasons.terc.edu/abouttheexhibit.html

Scan the QR code above with your mobile device to go to the exhibit web site.

SOFTWARE & HARDWARE

Software Updates

Have you updated your Vernier applications recently? 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.

LOGGER *PRO* 3.8.4 – Logger *Pro* 3.8.4 was released in February, 2011. This update is free to all users of any previous version of Logger *Pro* 3, and is available at www.vernier.com/lpupdates

Version 3.8.4 adds Data Marks and Data Tags, allowing you to attach notes to particular data points. Data Marks were developed to support the new Melt Station. Video analysis acquires several new features, including the ability to automatically skip frames and to calculate the center of mass for multiple objects.

In case you're several versions back, version 3.8.3 added support for Ocean Optics devices in 64-bit Windows systems, as well as localization to nine non-English languages. A moveable linear curve lets students adjust the fit by dragging the line itself. 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 1.5 – LabQuest 1.5 was released in March, 2011. Version 1.5 adds Data Marks and Tags, as well as the new Data Matrix. The Matrix is ideal for water quality testing with multiple sensors on multiple sites and days. LabQuest now supports the WDSS, with the addition of a Bluetooth radio dongle. New sensor support includes the Melt Station and the Anemometer.

This free update is at www.vernier.com/labquest/updates/

The previous 1.4 update added 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

Scan the QR code to the left with your mobile device to go to the software update section of our web site.

Accessibility Features in Logger *Pro*

In the new Windows version of Logger *Pro* 3.8.4, we greatly improved the accessibility features for blind and low-vision students. Access these features by selecting Accessibility from the File menu. You can check a box to turn on Continuous Tone Meters. This causes the program to play a tone with a frequency depending on the sensor reading; for example, you can hear a frequency increase when the temperature of a probe increases. Note that this can be useful for sighted people. It is a great way to find shorts, loose wires, and intermittent connections. You can also use it to alert you with sound of an event, like a peak on a Mini GC graph.

There is also an option for Audio Graph playback. When this is selected, the program will play sound to represent a graph of previously collected data.

We have also improved the Logger *Pro* support for JAWS software for blind students.

Você fala português?

Did you know that our software is available in several languages?

New languages supported in Logger *Pro* 3.8.4 include Czech, Polish, and Dutch. We now directly supply English, Spanish, French, German, Italian, Portuguese, Russian, Dutch, Czech, Polish, and Arabic on the principal Logger *Pro* CD, but Logger *Pro* and Logger Lite are each available in 14 languages. LabQuest App is available in 25 languages!

How to Store Your LabQuests

Question: What is the best way to store a LabQuest over summer vacation?

Answer: The best treatment is to simply box up the LabQuest for the summer, and leave it disconnected from the charger. Over the summer, the battery will slowly lose its charge, but it will be undamaged. When you return in the fall, we recommend that you charge the LabQuest for a full 8 hours before using it. When you first turn on a Labquest, it may take as long as 3 minutes for it to reboot if the battery completely lost charge.

Exposing the battery to temperatures over 35°C (95°F) will significantly reduce its lifespan. If your school storage area is unusually hot when the air conditioning is off for the summer, you may want to keep your LabQuest in a location that remains cooler.

More details on the longevity of the battery can be found at www.vernier.com/til/1768.html

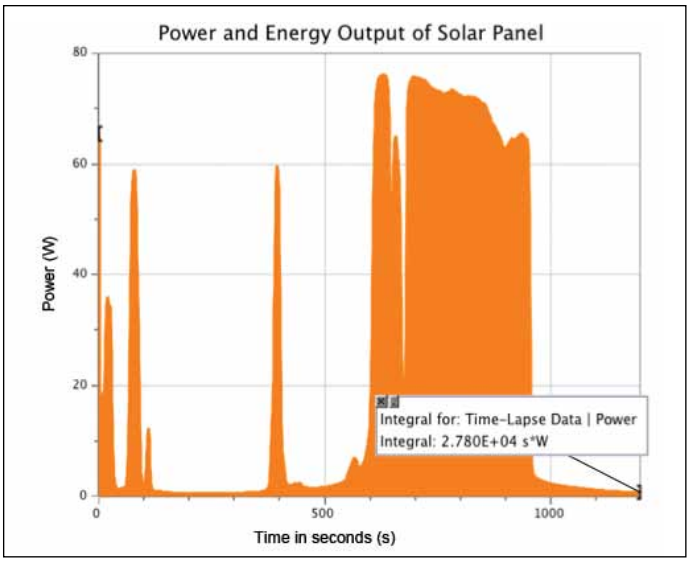
ENVIRONMENTAL

Experimenting with Solar Panels

Using the New High Current Sensor and the 30-Volt Voltage Probe

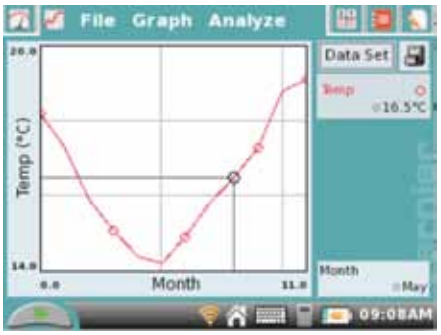
Two of our newest sensors, the High Current Sensor and the 30-Volt Voltage Probe, are well suited for exploring solar panels. During some of our early prototyping, we thought it would be nice to take some data with accompanying video. The result is a very interesting Logger *Pro* project: as the passing clouds block the panel, a connected automobile head lamp dims and there is a drop in the measured current, voltage, and power. When under direct sunlight, you can see nice peaks in each of the graphs, and the head lamp shines brightly. We connected the solar panel to a head lamp, with a High Current Sensor in series and a 30-Volt Voltage Probe across the two terminals of the lamp. We used the Video Capture feature of Logger *Pro*, setting the Time-Lapse Capture options to 1 second between frames. The video was synchronized with data collection, with a duration of 20 minutes (1200 s). Using current and voltage data, we created a calculated column for power (current * voltage). We even used the integral tool to measure the total amount of energy produced (27,800 W*s or 27.8 kJ).

For more information go to www.vernier.com/innovate/159



Data Matrix: Making Field Work Easier

LabQuest has always been a great tool for collecting data in the field. The new Data Matrix data-collection mode in LabQuest App v. 1.5 (released in March) takes it to a whole new level. You can now freely move between sites and days within one file, placing each piece of data exactly where it belongs. Moving around between multiple sites throughout the day? The Data Matrix makes it easy to keep your data organized. Coming back to the same site next month? Not a problem. Just open the original file and drop the new data in the appropriate place. This is illustrated in the graph below, where river temperature data were measured once per month over the course of a year.



Another major enhancement in the Data Matrix is that sensors can now be connected and disconnected at any time without stopping data collection. This new flexibility allows you to test for an unlimited number of parameters at a given site even though LabQuest has a limited number of ports. It also opens the door to collecting data with incompatible sensors—use them one at a time and the incompatibility goes away.

Whether you are studying water quality over the length of a river or over the course of a year, the Data Matrix will be an invaluable tool for you and your students. Give it a try by updating to LabQuest App v. 1.5 and downloading the instructions at www.vernier.com/datamatrix

LabQuest Battery Boost Provides More Time in the Field

Now that fieldwork is so easy with the Data Matrix, you may find that you want to spend more time outside than your LabQuest battery allows. That's where our new LabQuest Battery Boost can help. This compact external battery pack provides hours of additional use of your LabQuest when AC power is not available. The Battery Boost (LQ-BOOST $45) can be charged using your LabQuest power supply, a car charger (included), or through a computer's USB port. Once charged, connect it to your LabQuest and enjoy hours of additional data-collection time. If you are driving from site to site, the Battery Boost's car charger accessory (included) allows you to plug your LabQuest directly into your car as a power source while it also charges the internal battery.

ENVIRONMENTAL

NEW! Vernier Anemometer

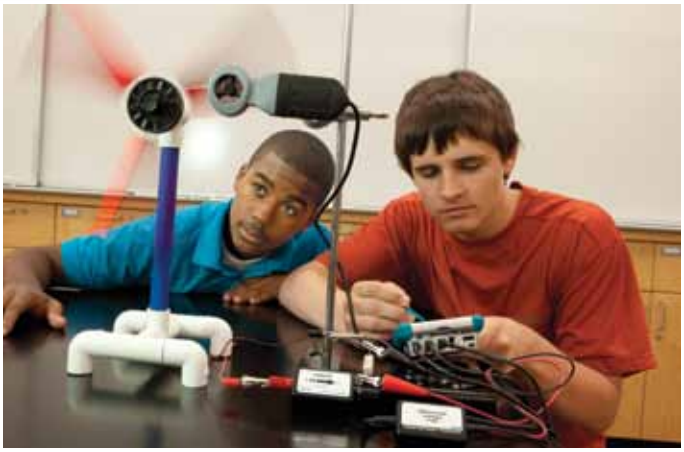
The Anemometer is now shipping. It is an impeller-type anemometer that measures wind speed in the range of 0.5 to 30 m/s (1 to 67 mph). The Anemometer fits in your palm for wind study measurements in the field. To use it, simply hold the Anemometer so that the wind blows directly into the sensor. You can also attach the accessory rod to a standard camera mount on the back. This allows you to position it in wind tunnels or in front of fans for wind turbine experiments.

Here are some other ways you may use the Anemometer:

- Measure the wind speed of air generated by a variable speed fan.
- Use an Anemometer, a Current Sensor, and a Differential Voltage Probe to investigate the effect of design, number, and size of rotors and blades of a windmill's electrical energy output.
- Use an Anemometer and an Infrared Thermometer (IRT-BTA) to determine how wind speed affects the rate of cooling of an object.
- Investigate why wind speed is slower over land than it is over the ocean.
- Use an Anemometer and a compass to determine wind direction.

Kid Wind Project® is working closely with Vernier to produce a series of experiments to quantify the power and energy output of Kid Wind's wind turbines. We have found their hardware easy to use, and it provides a large amount of data for a variety of simple or complex experiments that students commonly perform. A sample lab, "The Effect of Load on Power Output: Wind Turbines," is available for download at www.vernier.com/environmental/

$89 ORDER CODE ANM-BTA



Happy Trails to our Friend and Colleague, Dan Holmquist

Our long-time friend and colleague, Dan Holmquist, retires this year after 18 years with Vernier Software & Technology. A former chemistry teacher at the Department of Defense Schools in Germany, Dan was first introduced to Vernier products when he received a copy of Graphical Analysis as part of his Presidential Science Teaching Award in 1987. Dan became a user of our products and wrote our *Chemistry with Vernier* lab book with a fellow DoDEA teacher, Don Volz. Dan moved with his family from Germany to pioneer the business development of our chemistry department and has been the inspiration behind many of our most popular technology offerings. Over time, Dan became a Senior Partner with Vernier, and has helped shape the company's direction, while always emphasizing the philosophy of putting the teacher first.

So how do you honor someone who has given so much to Vernier? We dedicated a Periodic Picnic Table to him. The table includes the inscription, "In appreciation of Dan Holmquist, who was elemental in bringing chemistry to Vernier."

We at Vernier wish Dan happy travels, good health, and joyful days during his retirement. Dan remains a company owner, a mentor, and a friend to many of us at Vernier. We look forward to his continued guidance during product development and to the happy tales retirement will bring.

Teachable Moment

How Earthquakes Happen

Matt Kuchta (University of Wisconson-Stout) used our Dual-Range Force Sensor and Low-g Accelerometer to do a great demonstration of how earthquakes happen. See www.vernier.com/innovate/160

AWARDS

NSTA/Vernier Technology Awards

The award, co-sponsored by Vernier and NSTA, is part of the NSTA Teacher Award Program. Each year, educators are recognized for their planned or current innovative use of data-collection technology. Seven awards are available: one elementary, two middle level, three high school, and one college. The awards, each valued at $3,000, include $1,000 in cash, $1,000 in Vernier technology, and up to $1,000 in expenses for attending the NSTA convention. Below are brief synopses for the 2011 award-winning entries.

ELEMENTARY (GRADES K-5)

Lynn Fagerholm, Kenston Intermediate School/ Timmons Elementary, Chagrin Falls, OH

Using the activity "Newton on a Roll," Fagerholm plans to use Vernier technology to teach her 3rd–5th grade students scientific skills and principles by exploring the gravitational force on model cars traveling down a slope.

MIDDLE SCHOOL (GRADES 6-8)

Nicole Ackerson, Berkeley Preparatory School, Wesley Chapel, FL

Using Vernier data-collection technology, Dr. Nicole Ackerson will use her grant to teach 8th grade students about the benefits of aerobic activity through her "Get Heart Smart!" multidisciplinary project.

Rebekah Hammack, Stillwater Middle School, Stillwater, OK

Rebekah Hammack plans to teach her middle school students about environmental issues through the use of data-collection technology by presenting students with a scenario in which a coastal town has been devastated by a hurricane.

HIGH SCHOOL (GRADES 9-12)

Celeste Best, Oyster River High School, Durham, NH

In Spring 2010, Celeste Best led an interdisciplinary activity combining science and physical education. Working in teams, students used sensor technology to investigate the swing of a baseball bat, the serve of a tennis racket, and the swing of a golf club using 15-20 student subjects.

Lai Cao, Baton Rouge Magnet High School, Baton Rouge, LA

Cao engages her students in physics with a collection of hands-on activities.

Using a Vernier Force Sensor, she asks students to analyze the forces exerted on an object by investigating the effects on a wooden block when force is applied to it in different scenarios.

Frank Wood, Hardin Valley Academy, Knoxville, TN

As part of an astronomy enrichment program, Frank Wood has developed unique activities that incorporate data-collection technology to capture student interest in this science discipline. During his inquiry-based activity "Development of Future Propulsion Systems," Wood plans to have his high school students research the use of field force technology for future spacecraft propulsion.

COLLEGE

Julie Ealy, Pennsylvania State University, Center Valley, PA

Using Vernier's SpectroVis sensor, Julie Ealy, an associate professor of chemistry, had her second semester general chemistry students work in both small and large groups to conduct the "Kinetics of a Bleach Reaction" lab activity that investigated the reaction between bleach and dye.

2012 Technology Awards Entry

It's not too early to start thinking about your 2012 entry.

Deadline is November 30, 2011

www.vernier.com/grants/nsta.html

20 years ago in THE CALIPER

20 Years Ago in *The Caliper*:

20 years ago in this newsletter, we introduced two books. One was our first book of lab activities, *Chemistry with Computers*. It was written by Dan Holmquist and Don Volz for use with Apple II computers. Many other versions followed, to support MS-DOS, Macintosh, Windows, CBL, Palm PDAs, LabPro, and LabQuest.

The other was *Chaos in the Laboratory and 13 Other Science Projects using the Apple II*. In a lot of ways, our new *Engineering Projects with Vernier and NI LabVIEW* is a modern version of the same book—hands-on activities for students to build devices and write programs to control them.

TEXAS INSTRUMENTS

Introducing the New TI-Nspire™ CX Handhelds

Available May 2011

Texas Instruments has introduced its first color graphing handhelds, the TI-Nspire™ CX and TI-Nspire™ CX CAS. These new handhelds will make you feel like you are not in Kansas anymore. The screen is a full color, back-lit display that is easy to read, even in low-light situations. The new sleek design is sure to be a student pleaser, and the updated TI-Nspire software and rechargeable battery make it perfect for teachers, too.

By far, our favorite feature is the new DataQuest™ data-collection application (and not just because we wrote it!). Designed for the CX, this data-collection software offers more features than any of our previous calculator-based, data-collection software. Here are just a few of the features you will find in the DataQuest application:

- Color graphs
- All 58 of our BT-sensors are supported in a single application
- You can access the data table without leaving the application
- You can analyze a region of the data without deleting any data
- Supports NEW TI-Nspire™ Lab Cradle, EasyLink, and Go!Link sensor interfaces

- Supports EasyTemp, Go!Temp, CBR 2, and Go!Motion
- You can manually enter data for analysis of non sensor-based data
- Included free with TI-Nspire software, version 3.0 or newer

The new CX handhelds are sold individually, in a teacher bundle, or in school packs of 10. The individual handheld includes a rechargeable battery and AC wall adapter. The teacher bundle includes a handheld with rechargeable battery, wall adapter, and a single-user license of the TI-Nspire™ Teacher Edition Software. The school pack includes 10 TI-Nspire handhelds, each with a rechargeable battery, and a TI-Nspire™ CX Docking Station.

	TI-Nspire CX	TI-Nspire CX CAS
Individual Handheld	TI-NSCX $135	TI-NSCXCAS $138
Teacher Bundle (handheld + teacher software)	TI-NSCX-TB $203	TI-NSCXCAS-TB $206
School Pack (10 handhelds + Docking Station)	TI-NSCX-TPK $1,469	TI-NSCXCAS-TPK $1,499

The TI-Nspire™ Lab Cradle

Available May 2011

At the recent T³™ conference in San Antonio, TI introduced the latest interface for TI handheld data collection, the TI-Nspire Lab Cradle. The Lab Cradle is a multi-channel sensor interface that can be used with any TI-Nspire handheld (Clickpad, Touchpad, or the new CX) or TI-Nspire computer software. It has three analog and two digital ports and can be used with 58 of our sensors. The Lab Cradle comes with a rechargeable battery, which eliminates the need to constantly replace AA-batteries. The maximum sampling rate is 100,000 samples per second. The Lab Cradle requires a TI-Nspire handheld and computer software version 3.0 (available May 2011). This is a free update to existing TI-Nspire users. Note: The TI-Nspire Lab Cradle is for TI-Nspire technology only. For other TI graphing calculators, you will need to use the CBL 2 or LabPro interfaces.

The Lab Cradles are sold individually (order code TI-NSLABC, $145) or in a Pack of 5 (order code TI-NSLABC-5, $725). The Lab Cradle 5-Pack includes a convenient 5-unit charging bay at no additional cost. You can use the charging bay to recharge your TI-Nspire handhelds' rechargeable batteries at the same time.

Science with TI-Nspire Technology Lab Book

Available May 2011

$48 ORDER CODE SWN

Vernier is putting the finishing touches on the upcoming book, *Science with TI-Nspire Technology,* which will be available May 2011. The book is perfect for users of TI-Nspire handhelds and computer software who want to do data collection with Vernier sensors. It describes how to use the new Vernier DataQuest™ application that comes with the 3.0 version of the TI-Nspire software, and it contains 33 experiments in Earth science, environmental science, biology, chemistry, and physics.

PROFESSIONAL DEVELOPMENT

Free Hands-On Data Collection Workshops

Join us for a free, 4-hour, hands-on workshop to learn how to integrate our computer and handheld data-collection technology into your science curriculum. The workshops include lunch or dinner and lab handouts on CD. For more information and registration, contact us or visit our web site at www.vernier.com/workshop

Spring 2011 Hands-On Data Collection Workshops:

Arizona: Phoenix | **California:** Pasadena, Riverside
Colorado: Colorado Springs, Denver | **Delaware:** Wilmington
Maryland: Baltimore | **New Mexico:** Albuquerque
Pennsylvania: Allentown, Philadelphia | **Tennessee:** Knoxville
Virginia: Fairfax County | **Washington DC** | **Wyoming:** Cheyenne

VERNIER WEBINARS: 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.

HIGH SCHOOL 2-DAY INSTITUTES

	Raleigh, NC	Boston, MA
Biology/AP Biology	June 20–21	July 11–12
AP Chemistry	June 22–23	July 13–14
Physics/AP Physics	June 24–25	July 15–16

Biology/AP* Biology

These Biology/AP Biology Summer Institutes will feature hands-on training integrating technology into your biology and AP Biology classes. You will use LabQuest or a computer to collect and analyze data from classics like cell respiration, diffusion, and more. You will also perform DNA gel electrophoresis. The $199 registration fee includes a copy of *Advanced Biology with Vernier.*

AP* Chemistry

Vernier and Flinn Scientific will co-host these AP Chemistry hands-on technology institutes. The experiments, including 22 recommended by The College Board, will center around Vernier and Flinn equipment, supplies, and kits. The $199 registration fee includes a copy of *Advanced Chemistry with Vernier.*

Physics/AP* Physics

These hands-on institutes give attendees an opportunity to explore the use of technology in the teaching of physics. You will explore the features of Logger *Pro* software, using each Vernier physics sensor in at least one traditional experiment, inquiry activity, or lab practical. The $199 registration fee includes a copy of *Advanced Physics with Vernier - Mechanics.*

One Day Summer Workshops

Join us for a day to learn how to integrate our data-collection technology into your chemistry, biology, physics, middle school science, physical science, and Earth science curriculum. These 6-hour, hands-on workshops include lunch and lab handouts on CD. The cost of the workshop is $99.

June	July	August
Birmingham, AL	Baton Rouge, LA	Providence, RI
Memphis, TN	Chicago, IL	New York, NY
St. Louis, MO	Indianapolis, IN	Baltimore, MD
Dallas, TX	Columbus, OH	Beaverton, OR
Houston, TX		Seattle, WA

CANADIAN WORKSHOPS

Mississauga, ON: May 9, LabQuest | May 10, Logger *Pro*

Summer Workshops 2011: Play and learn this summer with Vernier hands-on data-collection workshops presented by Merlan Scientific.

To register, please go to www.merlan.ca or email info@merlan.ca

COLLEGE 2-DAY INSTITUTES

Vernier Headquarters – Beaverton, OR

College Biology	August 8-9
College Chemistry	August 10-11
College Physics	August 12-13

College Biology

In this institute, you'll conduct a series of labs that include cellular respiration, photosynthesis, transpiration, and enzyme kinetics. Explore fluorescence spectroscopy and basic protein biochemistry using our SpectroVis Plus Spectrophotometer/Fluorometer. The $199 registration fee includes a copy *Advanced Biology with Vernier.*

College Chemistry

Vernier and Flinn Scientific team up to present this institute. Investigate thermodynamics, kinetics, acid-base reactivity, and equilibrium. Data collection and analysis will open your eyes to new ideas for hands-on activities in your laboratory. Spectroscopy and gas chromatography experiments will be offered. The $199 registration fee includes a copy of *Advanced Chemistry with Vernier.*

College Physics

This institute will survey all data-collection and video tools offered by Vernier. Participants will learn both basic and advanced skills in Logger *Pro*. Video capture and analysis will be emphasized. Data collection will use LabQuest, LabQuest Mini, and wireless force sensors. The $199 registration fee includes a copy of *Advanced Physics with Vernier - Mechanics.*

For more information and registration for these training opportunities, go to **www.vernier.com/workshop**

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Toll Free 888-837-6437
www.vernier.com
13979 SW Millikan Way
Beaverton, OR 97005-2886
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30 × $10,000

WIN ONE OF 30 $10,000 TECHNOLOGY GRANTS!

Vernier is celebrating 30 years by putting money where **innovation** begins—into the hands of **STEM educators** and their students. How would *you* use a $10,000 technology grant to **teach fundamental science and technology skills** to the **next generation** of scientists and engineers? Start the wheels turning today! Grant applications are due **by June 1, 2011**. For more information and to submit proposals, go to

www.vernier.com/30years