Vernier

the CALIPER

FALL 2014 | VOL 31 NO.2

A PUBLICATION FOR USERS OF VERNIER PRODUCTS

in this issue

NEW Go Wireless® pH

Available October 2014

We've expanded our line of Go Wireless sensors with the new Go Wireless pH. This versatile pH sensor is perfect for anyone wanting to do wireless pH measurements using supported Bluetooth® Smart Ready devices such as LabQuest 2 (model LQ2-LE) or iPad®- (third generation or newer). The sensor includes a removable pH electrode that attaches to the handle using a BNC connector. This allows you to use the sensor with other electrodes, such as our ORP (Oxidation Reduction Potential Electrode), our Tris-Compatible Flat pH Electrode, and even some third-party electrodes. This feature also makes it easy to replace the pH electrode, when necessary. *(continued on page 14)*

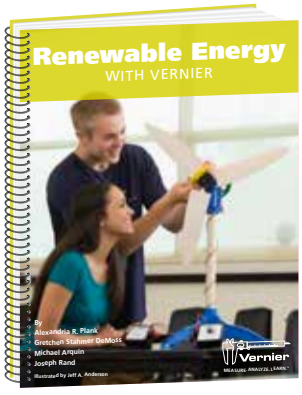
GW-PH, $99

NEW Renewable Energy with Vernier

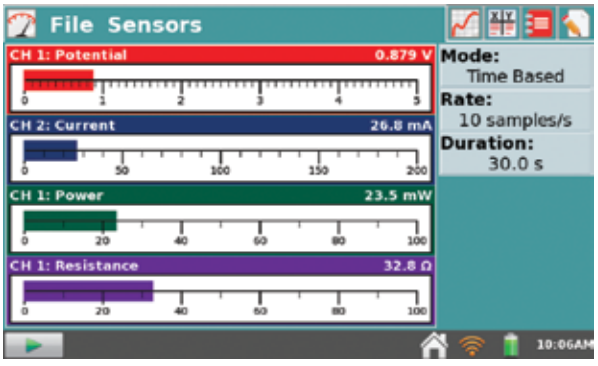
Vernier Offers a Complete Solution for Renewable Energy Education

Renewable energy education is becoming increasingly important as teachers are challenged to engage students in STEM education. Vernier now offers a complete renewable energy education solution with the release of the new *Renewable Energy with Vernier* lab book, the Vernier Energy Sensor and Variable Load, and the KidWind Wind and Solar Energy Experiment Kits.

The *Renewable Energy with Vernier* lab book, which was written and aligned to the Next Generation Science Standards (NGSS), contains 26 experiments, including inquiry investigations, engineering projects, and more. It was co-authored by renewable energy experts at KidWind and Vernier and contains a wide range of high school level experiments that *(continued on page 14)*



REV, $48

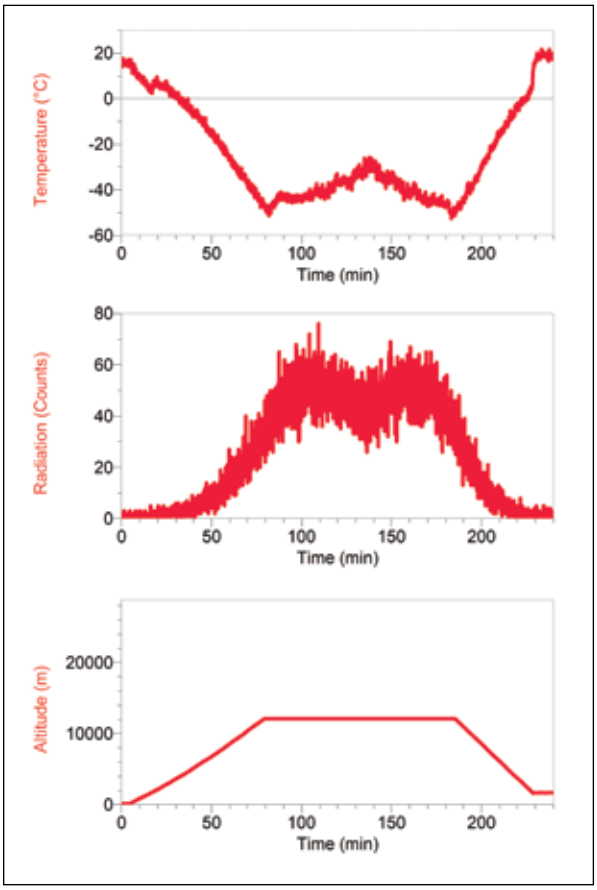


Dynamic meters in LabQuest App

PHYSICS

LabQuest 2 on a Balloon Flight Near Space

James Snyder and his student, Cali Mendoza, a junior at Anderson Valley High School in Boonville, CA, recently sent a LabQuest 2 and several sensors up with a weather balloon that traveled into near space. They estimate that the balloon reached 25,000 m (82,000 ft). It landed over 220 km (137 miles) from the launch site. The balloon rose and expanded until it burst and then dropped with a parachute back to earth. They got some amazing data and photos.



Data from the balloon flight, up and down

There are a number of fascinating things about these data:

- The count rate was measured with the Vernier Radiation Monitor. It reached a high of about 60 counts/5 second interval. This is about 60 times the typical background radiation levels measured at the earth's surface. Also, notice that the count rate actually went down slightly at the high point of the flight. This surprising result has been noted by others (Pfotzer Maximum).
- The temperature was measured with a Vernier Thermocouple. The temperature decreased to below –50°C and then increased slightly at higher altitudes, as it is known to do in the stratosphere.
- The altitude data were taken with the GPS system built into every LabQuest 2. At first, the constant readings for the middle of the trip were surprising, but then they realized that GPS systems do not work at high altitudes. In this flight, the limit appears to be 12,098 m (39,700 ft). This restriction is included in the GPS system available to civilians to prevent GPS from being used for missile guidance. (For the same reason, it will not work when traveling faster than 450 m/s [1000 mph]). Snyder's calculus students extrapolated from the incomplete altitude data to estimate the height at which the balloon burst.

This was the Boonville Space Program's sixth balloon launch. They started the program using LabPro interfaces. The goal of this launch was a student-designed experiment to test the effects of high-altitude radiation on seed germination. The student, Cali Mendoza, sent a variety of vegetable seeds up on the balloon and kept a control group on earth. The seeds were then germinated together under the same conditions. Results were not conclusive, but research will continue this year. For more information and to see more photos, go to www.boonvillespaceprogram.com

Left top: The weather balloon being prepared; Left bottom: The payload; Right: Photos taken from a camera on the weather balloon

YEARS AGO IN *THE CALIPER*

30 years ago in *The Caliper*, we introduced our Temperature Plotter for Apple II program. In those days, we sold the temperature sensors in kit form, as well as assembled. (Perhaps this was an early version of the Maker movement.)

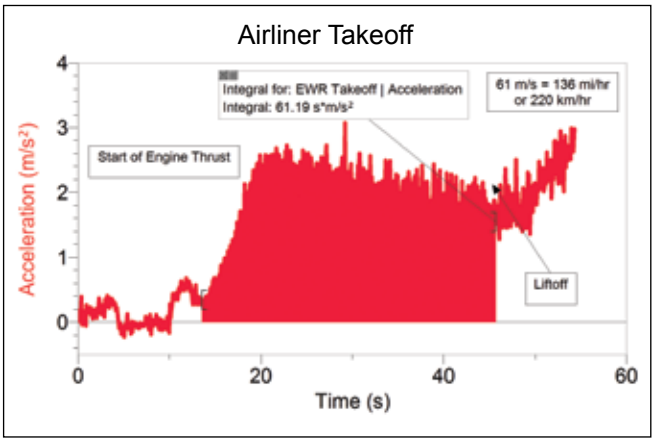
20 years ago in *The Caliper*, we introduced a radical new product called Calculator-Based Laboratory™ (CBL). It was made by Texas Instruments, and we worked closely with them to support it in our software and with our sensors. CBL was a huge hit in those days when computers were too expensive for most schools.

PHYSICS

Airliner Takeoffs and Landing with Graphical Analysis™

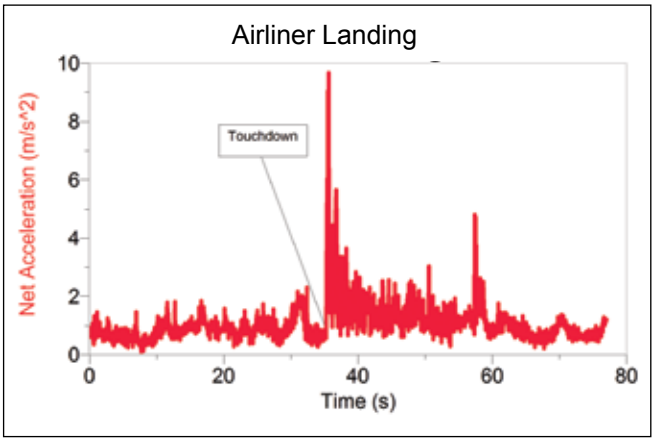
Recently the FAA and the airlines changed the rules to allow the use of tablets during takeoffs and landings. We could not resist getting acceleration data using the iPad's built-in accelerometers and Graphical Analysis for iPad®, iPhone®, or iPod touch®.

Clarence Bakken, a long-time consultant for Vernier, recently collected data using Graphical Analysis on an iPad during a Boeing 737 takeoff. The iPad was leveled and held steady relative to the airplane throughout data collection. On the graph, the integral from the start of engine thrust through the time of liftoff was calculated. You can see the liftoff event on the graph where the acceleration appears to increase. This is really caused by the plane's nose lifting up. The integral is about 61 m/s (136 mph), which is within the range of expected takeoff speeds for that aircraft. It might be interesting to ask students why the acceleration decreases during the trip down the runway.



Acceleration of a Boeing 737 during takeoff

Here are the results of a landing. Note that the Accelerometer readings while the plane is still flying are difficult to interpret, since the orientation of the plane changes somewhat on the final approach.



Acceleration of an airliner while landing

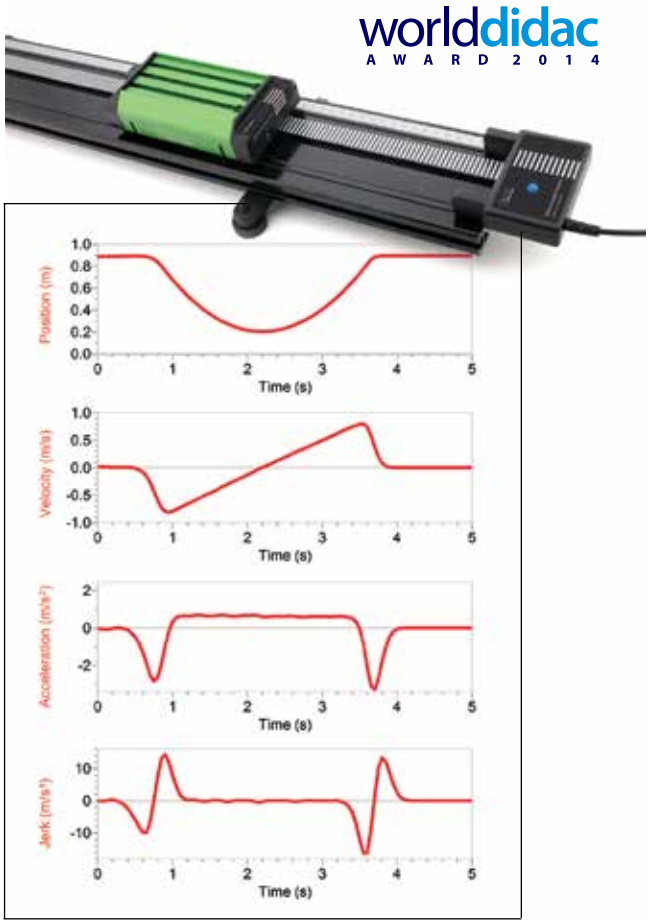
Motion Encoder System Wins Worlddidac Award

Leading International Award Recognizes High Quality and Innovative Educational Products

The Motion Encoder System was named a winner of the 2014 Worlddidac Awards! For more than 30 years, the Worlddidac Foundation's Worlddidac Awards have honored high quality and innovative educational products through its internationally recognized program.

Based on the original Vernier Dynamics System, the Vernier Motion Encoder System (VDS-EC, $424) is a complete system for studying dynamics. It includes carts, a track, and associated hardware, in addition to a new optical motion encoder to record cart positions. The Motion Encoder Cart uses an optical sensor, positioned beneath the cart, to sense the passage of the cart over a marked strip on the track. The position information is sent as an encoded IR signal to a receiver at the track's end. This optical-only system provides more repeatable and noise-resistant motion data when compared with a traditional ultrasonic motion detector, which is sometimes affected by stray ultrasound reflections.

www.vernier.com/vds-ec



Even a graph of jerk is clean.

PHYSICS

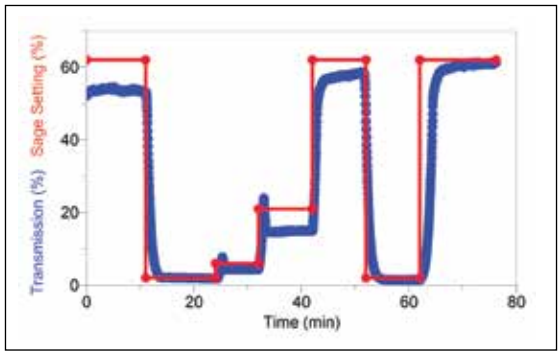
SageGlass® Performance

In the article on page 19 about the new addition to the Vernier building, the electrochromic windows called SageGlass are mentioned. Being a sensor company, we, of course, had to measure just how much light the windows absorb on each setting.

Since daylight varies moment by moment, we couldn't just measure the light passing through the window with a single sensor; we had to also measure the light striking the window. As a result, we used two Vernier Light Sensors, one behind the glass and one in front of the glass, both pointing toward the sky. We then used the calculated column feature of Logger *Pro* to calculate the ratio of the two values to determine the transmission of the glass. By switching through the four settings for the glass (2%, 6%, 21%, and 62%), we measured the actual transmission for each phase.

Inspecting the graph, you can see that it takes some time for the glass to respond to a new setting, but the transmission really does change dramatically.

If you visit our classroom, you'll see how we can dim the room for projection at the touch of a button. It's pretty cool!



SageGlass transmission at each of four settings and then repeating maximum and minimum transmission

NEW Fan Cart for Physics

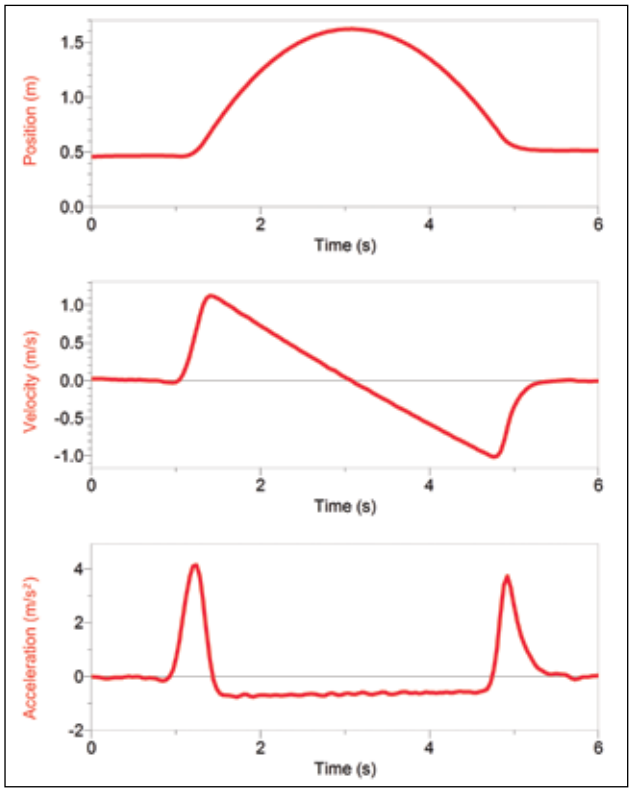
A new Vernier Fan Cart with high accelerations, variable mass, variable thrust, and variable thrust angle is now available for your dynamics system. Use this cart to study constant acceleration with your students without the confounding second dimension sometimes introduced by a cart on a ramp.

CART-F, $94

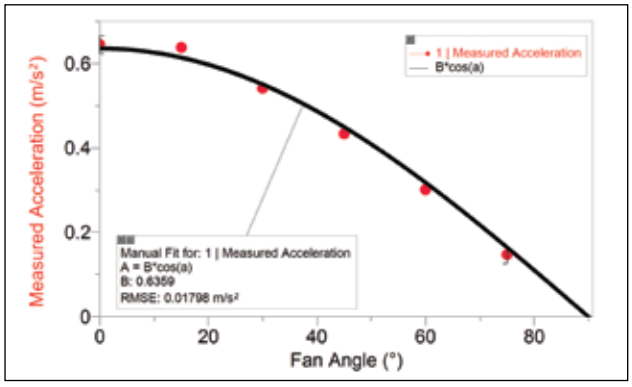
In order to create the highest acceleration possible from a fan cart, we put our superb low-friction wheels on a big fan. This construction keeps the total mass low, resulting in high acceleration. A high acceleration means that data are clean and graphs are clear, with friction easily ignorable. Three speeds are available to study acceleration as a function of force. Even better, you can turn the fan at an angle to the direction of travel, allowing students to experiment with and understand force vector components.

Two mass trays and included masses make it easy to change the mass without changing the thrust force. We include a sail attachment so you can test your students with the fan-on-a-sailboat puzzle.

Our new Fan Cart (CART-F, $94) can be used with the standard Motion Detector and a Vernier Dynamics System, or you can get the Encoder Fan Cart (CART-FEC, $199) to enjoy the simple and super-clean data from our Motion Encoder System.



Constant acceleration with Fan Cart. Note how clean the acceleration graph is. The cart was launched and caught by hand.



Effect of thrust angle on acceleration. We expect that the component of the force parallel to motion will be proportional to acceleration.

PHYSICS

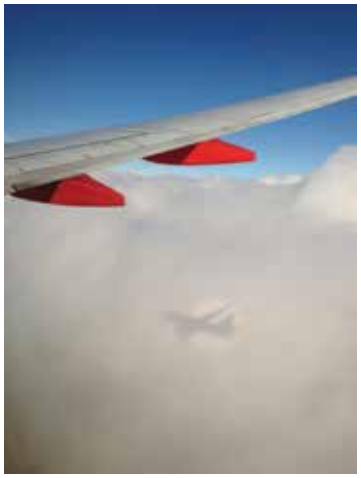
AAPT Photo Contest 2014

The 2014 AAPT Photo Contest, sponsored by Vernier, was held at the summer meeting of the American Association of Physics Teachers in Minneapolis, MN. For this popular event, students submitted photos that demonstrated physics concepts, along with an explanation of the physics involved. AAPT members voted on the entries. As usual, the quality of the images submitted is remarkable. When digital photography became common, the number and quality of images was noticeably better, which makes an interesting pedagogical point about rapid feedback and ease of data collection.

This year, the contrived photo shows a nearly spherical droplet in a Rayleigh jet acting as a converging lens. The natural photo captures a glory taken from an airplane window. It's remarkable what a phone camera can do.

For details about the contest and to see all the photo winners for 2014, visit www.aapt.org/Programs/Contests

1st Place, Contrived Category: Water Droplet Acts as Converging Lens, Student: Edward Friedrich Myers, Teacher: David Lapp, School: Tamalpais High School, CA



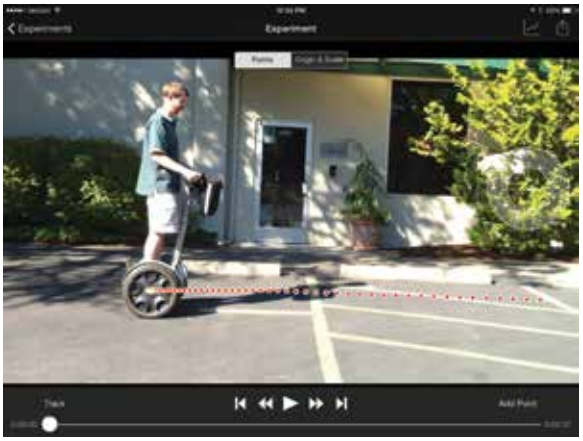
1st Place, Natural Category: Above the Horizon, Student: Briana Maria Ferrara, Teacher: Maria Aparicio, School: West Boca High School, FL

Video Physics™ Gets Supercharged with Object Tracking

If you like physics and you have access to iPad, iPhone, or iPod touch, you probably already know that the Vernier Video Physics app is the best way to grab high-quality video in the field and to easily perform powerful analyses of the motion of an object. Using the multi-touch interface, students can quickly track an object frame by frame, generate graphs of the motion, and even export to Graphical Analysis for powerful tools like linear and quadratic fits. Video Physics has won multiple awards and appreciation from teachers and students for its power and value.

This fall, Video Physics will become even more powerful, with the addition of automated object tracking. Highlight an object, tap a single button, and watch as Video Physics tracks the object frame by frame. You can still fine tune the tracking manually.

Download Video Physics today on the App Store. Video Physics with Object Tracking will be a free update to all users.



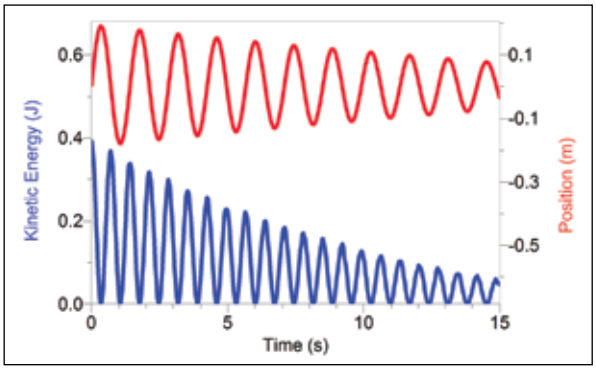
Track an object in Video Physics with the touch of a button

Damped Harmonic Motion

Lots of things vibrate, or oscillate, in harmonic motion. Most of them eventually stop, and so are described by the term "damped harmonic motion." Richard Born, from Northern Illinois University, has put together a nice investigation of this motion using a Vernier Encoder System, two Dual Range Force Sensors, a Photogate, and springs from the Springs Set.

He attached the springs to either end of a dynamics cart and then measured the spring tension using force sensors. The motion encoder records the cart position, and the photogate is used to acquire a precise period for the motion.

Once the motion is recorded, the mathematical modeling of the motion, force, and energy can be done. For the full story, see www.vernier.com/r143



The position and kinetic energy of a cart in damped harmonic motion are related. When the cart is at an extreme position, the speed is zero, and so is the energy. The energy goes through two cycles for every one cycle of position.

PHYSICS AND ENGINEERING

Vernier in the Science Journals

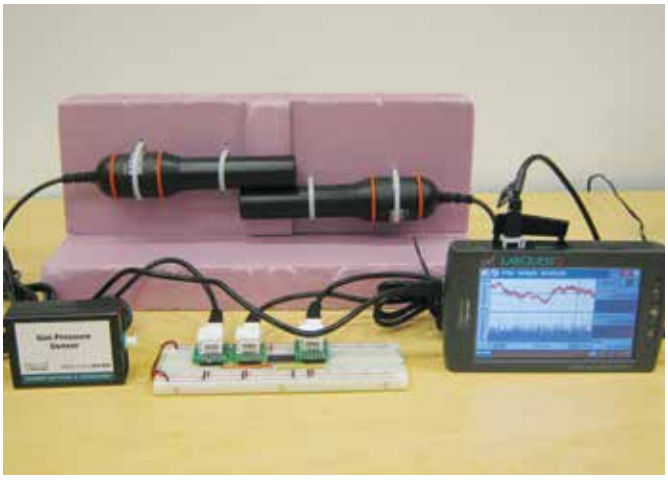
Detecting Cosmic Rays from Supernovae and Other Catastrophes

Bernhard Beck-Winchatz; David Jabon; Science, Technology, Engineering, and Mathematics (STEM) Studies, DePaul University, Chicago, IL; *The Classroom Astronomer 2014*, 5, 6-11.

This is a great article showing how to do coincidence counting using two (or more) of our Vernier Radiation Monitors, some simple circuitry on a breadboard, and a LabQuest 2. They make a muon telescope from two Vernier Radiation Monitors, and experimentally show that muon count rate increases with altitude.

The editor of *The Classroom Astronomer* was kind enough to put a copy of the article online so that interested teachers can read it. www.classroomastronomer.com/resources/muonarticle.pdf

On the home page of *The Classroom Astronomer* there is another article, "Using Vernier Sensors to Monitor Light, Temperature and Sky Color During Any Solar Eclipse," by Larry Krumenaker. A group of astronomers and astronomy educators used our LabQuest, temperature sensor, Light Sensor, and SpectoVis to monitor conditions during the annular eclipse on May 20, 2014. Subscriptions to *The Classroom Astronomer* are available at www.classroomastronomer.com



This is a muon telescope built from Vernier Radiation Monitors. Events that trigger both detectors are located along a line passing through both Geiger tubes.

Friction and the Intuition-Outcome Disparity

Peter Kalajian; Maria Makarova; Watershed School, Camden, ME, and ITESM, Guadalajara, Mexico; *The Physics Teacher 2014*, 52, 172.

In the series of investigations explained here, the authors have students make predictions about frictional force and how it varies. Often there are a lot of student misconceptions on this topic. Students are then asked to investigate experimentally using a Vernier Dual-Range Force Sensor and Logger *Pro*. They also use the LEGO® MINDSTORMS® NXT Robotic System to produce the constant velocity motion as a part of this STEM activity.

LEGO® MINDSTORMS® EV3 and Vernier Sensors

By Dave Vernier

About a year ago, LEGO introduced a new robotics system called MINDSTORMS EV3. The previous LEGO robotics system was MINDSTORMS NXT. We have an adapter (BTA-NXT, $39) for connecting Vernier sensors to the NXT, and a Vernier Sensor Block (free downloadable code) to allow our sensors to be used with the NXT software. We even have two books of science labs and robotic projects to be done with the NXT (STEM and STEM 2).

So, do our sensors work with the EV3? The same adapter we use for connecting Vernier sensors to the NXT will work with the EV3, so that is not a problem. However, the EV3 robotics system uses an entirely new software environment, so the NXT programs do not work on the EV3. We have been working to make it possible to use our sensors with EV3 software, and we now have a Vernier Sensor Block for EV3 on our website. It is available for free download at www.vernier.com/ev3-sensor-block

Additional materials for the EV3 include (available October 2014):

- EV3 versions of the robotic projects used in our STEM and STEM 2 books
- A Mars exploration booklet written for a week-long middle school summer program

www.vernier.com/lego-ev3

Vernier Engineering Award

Win a $5,500 Award from Vernier

Tell us how you are using Vernier sensors in the classroom to teach engineering concepts and engineering practices, and you could win one of three $5,500 awards (one for middle school, one for high school, and one for college).

Are your students using Vernier sensors in the engineering design process? Maybe you are challenging your students to control digital output based on sensor input. Are you testing trusses and building bridges? Perhaps your students are writing NI LabVIEW™ or ROBOTC® code to read a Vernier sensor from a robotics platform such as LEGO, VEX®, or Arduino™. Tell us about it so that you might win!

Applications will be judged on innovative ideas, engineering objectives, and the ease for others to replicate the project. Each award will consist of $1,000 in cash, $3,000 in Vernier technology, and $1,500 toward expenses to attend either the 2015 NSTA STEM conference in Minneapolis or the 2015 ASEE conference in Seattle.

For complete rules and to submit an online application and video showcasing your entry, go to www.vernier.com/grants/engineering

ENGINEERING AND MATH

Stopping a Zombie Apocalypse with TI and Vernier Technology

By Fred Fotsch

Summertime finds parents scrambling to find meaningful activities that will enrich their child's education and also provide a deserved break from the routine of the traditional school year. Of late, theme-based STEM camps have popped up all over the nation to offer our children the opportunity to learn more about science, engineering, and mathematics topics while stimulating their interest in STEM careers in a fun and meaningful learning environment. Texas Instruments T^3 National Instructors have created several theme-based STEM camps for middle and high school students that incorporate the power of TI-Nspire simulation activities with hands-on data collection using an assortment of Vernier sensors.

Different versions of these camps have been held in locations across the country, one of which was a Zombie STEM Camp at South Laurel High School in London, KY. The central theme for this camp was the study, identification, prevention, and cure of a hypothetical zombie apocalypse. Armed with TI-Nspire handhelds and Vernier probeware, students used the *STEM Behind Hollywood: Zombie Apocalypse* activities to explore NGSS curriculum standards and participate in activities that incorporate science and engineering practices.

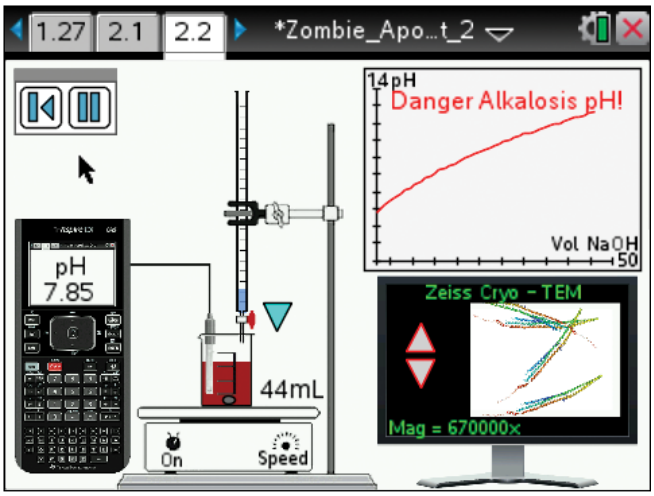
Gelatin model of a brain used in STEM activity

One of the many activities in the Zombie Camp curriculum involves a simulation of the titration of zombie blood and brain tissue. The storyline suggests that a zombie apocalypse was caused by an incorrectly folded protein, known as a prion, that has spread and infected humans. The activity focuses on a biochemist, who theorizes that this pathogenic agent could be destroyed, and the patient cured, by raising the blood pH to 7.6. Students explored protein folding and misfolding using an interactive simulation on the TI-Nspire handheld. They also learned about and practiced the skills involved in titrations in a similar simulation.

Having learned the essential concepts needed to understand the cause of zombiism and having considered a possible mechanism to cure the affected patients, students performed a titration using "zombie brain" tissue with a Vernier pH sensor connected to a TI-Nspire handheld. The zombie brain was actually a gelatin mold of a brain with citric acid added to simulate the low pH of brain tissue caused by zombiism. Students took a sample from the brain and proceeded to halt the zombie apocalypse and save civilization using their newly acquired STEM knowledge and skills.

Participants in this camp had fun learning about zombies and actually doing the tasks required to identify and cure a zombie patient. Next school year, if you find some of your students suffering from zombiism late in the day, try using Vernier probeware and TI-Nspire handhelds with the free *STEM Behind Hollywood* curriculum available on stemhollywood.com to bring them back to the world of the living!

Fred Fotsch is a T^3 national instructor and science teacher at Glendale High School, Springfield, MO.



TI-Nspire titration simulation

A New Face in Our Engineering Education Department

The newest addition to our Tech Support/R&D Department is Tom Smith. Tom has a B.S. in Chemical Engineering from Oregon State University and a Master's degree in Environmental Engineering from Tufts University. He has taught physics, AP Physics C, and Principles of Engineering over the last nine years at Lake Oswego High School in Oregon. The last two summers Tom has co-lead a junior high summer camp for students interested in environmental engineering. Tom is an avid gardener and is looking forward to becoming a (more) car-free commuter.

CHEMISTRY

Chemistry Experiments and NGSS

Are you looking for a chemistry experiment to support the Next Generation Science Standards (NGSS)? A common investigation in chemistry classrooms is studying reaction rates. Experiment 12, "The Decomposition of Hydrogen Peroxide," from *Advanced Chemistry with Vernier* (CHEM-A, $48) and Experiment 22, "Reaction Rates," from *Investigating Chemistry through Inquiry* (CHEM-I, $48) are two examples where students investigate the decomposition rate of hydrogen peroxide. Experiment 22, "Reaction Rates," is the inquiry version where the method involves students designing and carrying out an investigation.

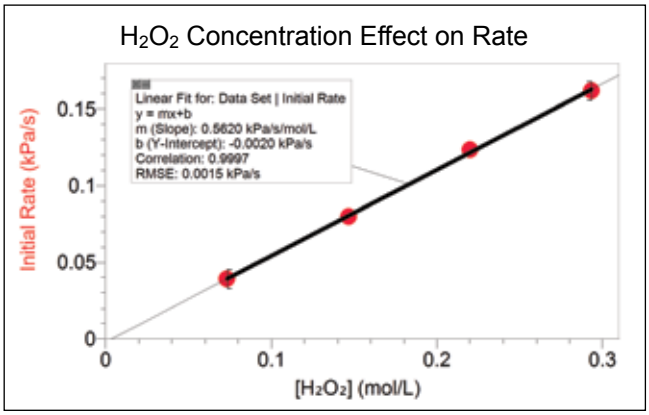
Both experiments study the effect of temperature or concentration change of the reacting particles on the rate at which the reaction occurs, which is an integral part of NGSS Performance Expectation HS-PS1-5. Both also explore chemical reaction rates covered in Disciplinary Core Idea (DCI) HS-PS1.B Chemical Reactions, and include Crosscutting Concepts and Science and Engineering Practices.

Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
HS-PS1.B: Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	Patterns Cause and effect	Constructing explanations and designing solutions Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking

The decomposition of hydrogen peroxide produces oxygen gas as a product according to the reaction listed below. As the concentration or temperature is varied, students monitor the reaction using a Gas Pressure Sensor (GPS-BTA, $83), since the production of oxygen gas will increase the pressure in the closed reaction vessel.

$$2\ H_2O_2(aq) \xrightarrow{k} 2\ H_2O + O_2(g)$$

Because this reaction proceeds slowly under standard conditions, a catalyst, potassium iodide, is used so that the reaction proceeds at a measurable rate. The amount of catalyst added is held constant while either concentration or temperature is changed. The data analysis will show that the rate of oxygen gas production is proportional to the decomposition rate of hydrogen peroxide.



The increase in hydrogen peroxide concentration is proportional to the increase in decomposition rate.

The objective of analyzing the effect of temperature is for the student to calculate the activation energy for this reaction, which engages students in using mathematics and computational thinking. The catalyst concentration can also be varied to examine its influence on the rate. Students can also investigate different catalysts.

Vernier lab experiments are a great option to help support students in three-dimensional learning. For answers to questions about these experiments or other content inquiries, contact us at chemistry@vernier.com

Vernier in the Chemistry Journals

Combining FTIR Spectroscopy and the Vernier Gas Chromatograph: Analysis of a Binary Mixture

Logan A. Schmitz; Kimberly A. Gerling; Joseph M. Fritsch; David B. Green; Department of Chemistry, Pepperdine University, Malibu, CA; *Chem. Educator* 2014, 19, 14–17.
This article describes a laboratory investigation in which a binary mixture of organic compounds is analyzed first by FTIR spectroscopy to identify the predominant functional groups possessed by the components in the mixture, followed by the determination of the components of the mixture with gas chromatographic separation using a Vernier Mini GC.

Exploration of Thermochromic Materials Using Experimental and Theoretical Infrared and UV-Visible Spectroscopy

Kelsey Costello; Kevin Thinh Doan; Kari Lynn Organtini; John Wilson; Morgan Boyer; Greglynn Gibbs; and Lorena Tribe; Division of Science, The Pennsylvania State University–Berks Campus, Reading, Pennsylvania; *J. Chem. Educ.* 2014, 91, 883–888.
The authors explore the hypothesis that crystal violet lactone is responsible for the thermochromic properties of a sipping straw using FTIR spectroscopy for experimental determinations of vibrational frequencies, SpectroVis Plus spectrophotometer to

CHEMISTRY

obtain the absorbance spectra for warm and cold sipping straws to quantify the color change, and the software packages Spartan and Gaussian 09 for theoretical calculations.

Field and In-Lab Determination of Ca^{2+} in Seawater

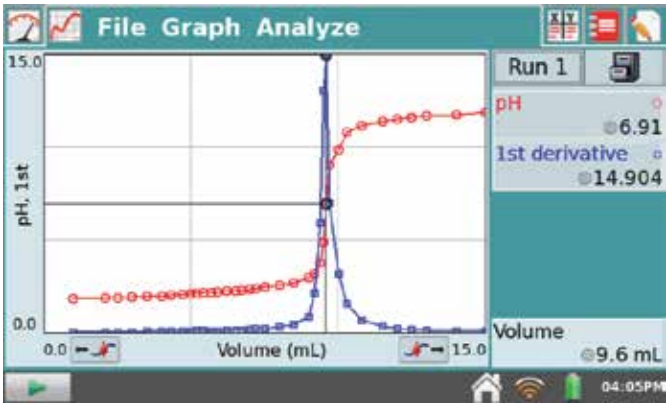
Robin Stoodley; Jose R. Rodriguez Nuñez; and Tessa Bartz; Department of Chemistry, University of British Columbia, Vancouver, British Columbia, Canada; *J. Chem. Educ.* Articles ASAP (As Soon As Publishable). http://goo.gl/pGmkPK
The authors combine portions of classic undergraduate quantitative analysis experiments with a field-sampling experience to create a two period (2 × 3 h) comparison-based experiment for second-year university students. LabQuest is paired with a Calcium Ion-Selective Electrode for potentiometry measurements, and the results are compared with potentiometric and colorimetric titration using ethylenediaminetetraacetic acid (EDTA).

Proflavine-DNA Binding Using a Handheld Fluorescence Spectrometer: A Laboratory for Introductory Chemistry

Swapan S. Jain; Christopher N. LaFratta; Andres Medina; and Ian Pelse; Department of Chemistry, Bard College, Annandale-on-Hudson, New York; *J. Chem. Educ.* 2013, 90, 1215–1217.
The experiment uses SpectroVis Plus connected to a LabQuest to introduce students to drug binding to DNA. Students monitor the changes that occur in fluorescence intensity when proflavine binds to DNA in the presence and absence of sodium ions. Stock solutions of proflavine were titrated with DNA at room temperature, and the accompanying changes in fluorescence were measured.

Titrations Made Easier with the NEW Go Wireless pH

Using the new Go Wireless pH is an easy and accurate way to get equivalence point information from your titration experiments. After placing the Go Wireless pH in your titration setup, simply connect the Go Wireless pH to your LabQuest 2 (model LQ2-LE). Set the mode to Events with Entry and proceed with the titration. After your titration is finished, you can graph the first derivative to accurately determine the equivalence point.



Comparing the first derivative and titration graph to determine the equivalence point

Celebrate National Chemistry Week

October 19–25, 2014

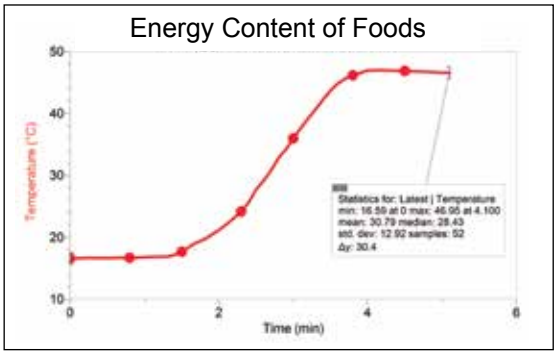
National Chemistry Week (NCW) began in 1987 as National Chemistry Day, and it is a great way to encourage students to learn chemistry. Annual themes help give direction and variety to the celebration each year. This year, National Chemistry Week will take place Oct 19–25, and the theme is "The Sweet Side of Chemistry—Candy."

Celebrate National Chemistry Week with an experiment that investigates the energy content in various food items, such as cashews, marshmallows, peanuts, and popcorn. In Experiment 16, "Energy Content of Foods" from *Chemistry with Vernier* (CWV, $48), students use a Stainless Steel Temperature Probe (TMP-BTA, $29) to determine the energy released (in kJ/g) as the various foods burn. For an inquiry version, check out Experiment 6, "Investigating the Energy Content of Foods" from *Investigating Chemistry through Inquiry* (CHEM-I, $48). In addition to the food items listed, students can explore the energy content in chocolate and non-chocolate candies. Students can look at different types of candies for patterns in the amounts of energy released.

Not all candies contain the same amount of energy. The quantity of energy stored in the candy will vary, based on the amounts of sugar, fat, and protein. Food labels list the energy in units of Calories. The large calorie or food calorie (Cal) is the amount of energy needed to increase the temperature of 1 kg of water by 1°C, and there are 4.184 kJ in one Calorie.

As an added bonus for this experiment, show your students the "Combustion of a Peanut M&M®" video available in the Sample Movies folder in Logger *Pro* 3. This video demonstrates the difference in food calories between the sugar coating (4 Cal/g), the fat (9 Cal/g), and protein (4 Cal/g) in a peanut M&M. A peanut M&M is dropped into molten potassium chlorate with a thermocouple located near the melt. When the M&M hits the oxidizing agent, the candy ignites and the temperature goes up and then plateaus. However, once the sugar is burned off, the temperature shoots up again due to the difference in heat of combustion between fat and carbohydrate.

Tell us how you celebrate National Chemistry Week using Vernier probeware. Email us at chemistry@vernier.com



The temperature change of water using the energy released from burning a peanut

BIOLOGY

Which Vernier Dissolved Oxygen Probe is Right for Me?

Let's start with the answer—the Optical DO Probe (ODO-BTA, $389) is right for you. It's faster and easier to use than the traditional Dissolved Oxygen Probe (DO-BTA, $209). With no filling, warming, calibrating, or stirring required, there is significantly less prep time and fewer ways to go wrong with the Optical DO Probe. As a result, students get better data. This ease of use also allows students from every age group, from elementary to university, to accurately measure dissolved oxygen concentrations in water.

As a bonus, we are extending the warranty on the Optical DO Probe Replacement Cap (ODO-CAP, $49) from one year to two years. This change is retroactive, so anyone who has already purchased an Optical DO Probe is grandfathered into this free extended warranty.

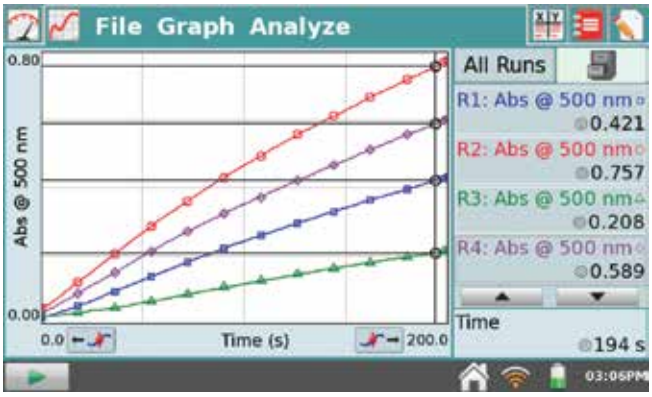
So why would anyone choose to buy the traditional Dissolved Oxygen Probe? One reason may be because it is less expensive. We understand budgets are tight. But this is one case where you might want to consider buying fewer Optical DO Probes in order to stay under budget. With no prep work or calibrations to complete, student groups can easily share.

The decision is yours, but when we need to measure the dissolved oxygen concentration in the Vernier office fish tank, we reach for the Optical DO Probe.

Student investigates primary productivity with the Optical DO Probe

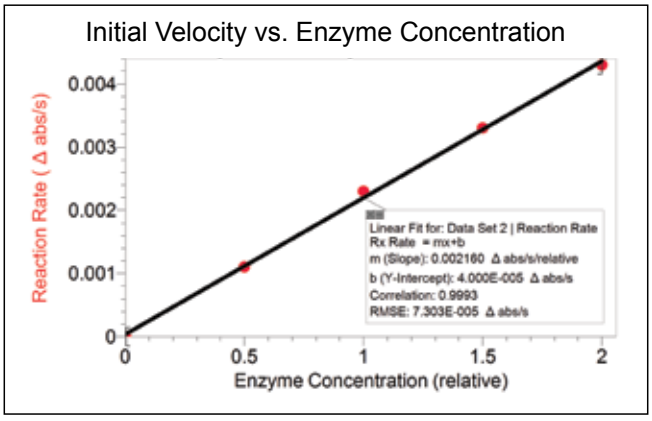
Use a SpectroVis Plus or Colorimeter to Monitor Turnip Peroxidase Activity

Understanding how enzymes work in biological systems is a critical and difficult concept for many students. This is one reason why the enzyme investigations in our *Investigating Biology through Inquiry* lab book (BIO-I, $48) have been very popular with biology teachers. The "Testing Catalase" experiment is also popular because it is inexpensive to perform. It uses some very simple materials, such as yeast and hydrogen peroxide. However, many of our customers who teach AP Biology have been asking us to write an inquiry-based enzyme investigation modeled after the Turnip Peroxidase activity in the *AP Biology Lab Manual*. This is an activity that is commonly referred to as the "Guaiacol lab."



Increasing enzyme concentration is associated with an increase in reaction rate

With this in mind, the Vernier Biology Department developed a new experiment, "Enzyme Analysis with Peroxidase," that uses turnip peroxidase. As shown in the data above, this activity uses a colorimetric assay to monitor enzyme activity. As a result, you need to use a SpectroVis Plus Spectrophotometer (SVIS-PL, $469) or Colorimeter (COL-BTA, $115) to perform this lab properly. The investigation includes a preliminary activity, teacher information, and sample researchable questions. It also includes sample data for popular investigations, such as showing that enzyme concentration is proportional to reaction rate.



Sample data showing that reaction rate (initial velocity) is proportional to enzyme concentration

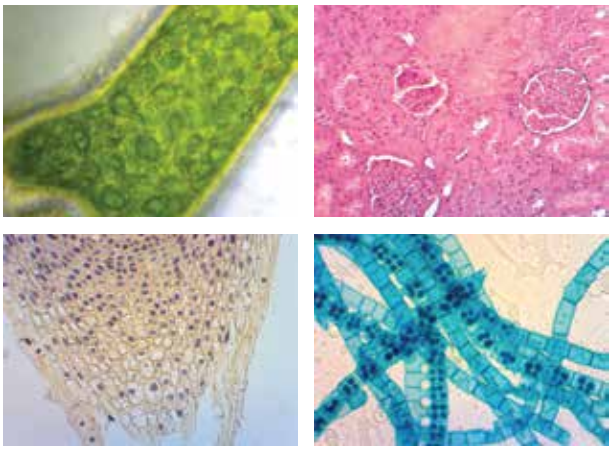
For more information about this investigation or our *Investigating Biology through Inquiry* lab book, contact the Vernier Biology Department at biology@vernier.com. If you want to learn how to perform this and other enzyme activities in our *Investigating Biology through Inquiry* book, come to our Inquiry-Based Biology workshop at the National Association of Biology Teachers Conference this year. This experiment is available for download at www.vernier.com/r144

BIOLOGY

NEW Digital Microscope Camera for Logger *Pro*!

Vernier is now offering a more affordable way to view images from your existing microscopes on a computer. The Celestron Digital Microscope Imager (CS-DMI, $79) is a 2 megapixel USB camera that turns your traditional compound or stereo microscope into a high-resolution digital imager. Simply replace the eyepiece of the microscope with the imager, and connect the USB cable to the computer. Use the included software or Logger *Pro* to view, capture, and analyze images, such as those shown below. Short video and time-lapse sequences can also be captured and analyzed.

For more information, visit www.vernier.com/cs-dmi



Images taken from a Celestron Digital Microscope Imager: chloroplasts in an algal cell (top left), kidney glomerulus (top right), an onion root tip (bottom left), and algal cells (bottom right)

NEW CO_2 Gas and Thermocouple Modules for NODE Wireless Sensor Platform

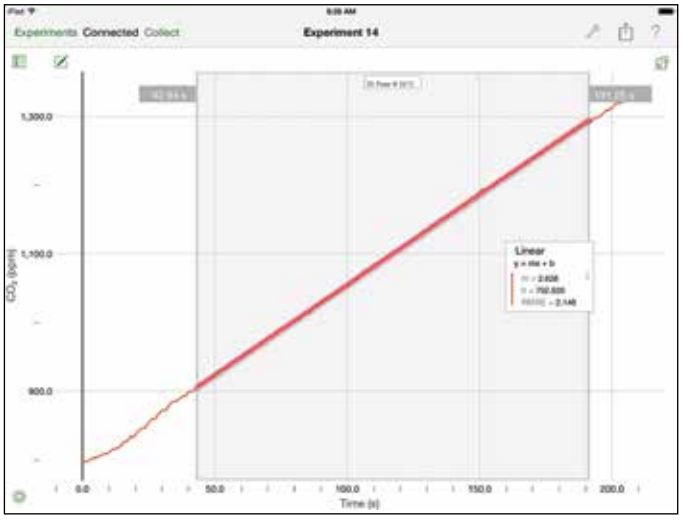
Earlier this year, we introduced you to the NODE Wireless Sensor Platform from Variable, Inc.—a sleek Bluetooth device for wirelessly collecting data with iOS and Android devices. Now, two new modules for the NODE have been released—the Thermocouple NODE Module (NODE-TCA, $85), and CO_2 NODE Module (NODE-CO2, $149). If you use Graphical Analysis for iPad or iPhone, the current version already supports these two modules; otherwise, you can use the free apps available from Variable Technologies. Note that both of these modules require a NODE Sensor Platform to function. Either the NODE Sensor Platform for iOS (NODE-IOS) or the NODE Sensor Platform for iOS and Android (NODE-IA) will work with these two new modules.

The Thermocouple NODE Module comes with a type K thermocouple wire capable of measuring temperatures from –200°C to 1200°C. Not only can the Thermocouple module measure the temperature of air and water, but the tip of the wire can be placed into extreme environments, such as liquid nitrogen, and most Bunsen burner flames. This ability to measure a wide range of temperatures can come in handy for a variety of testing needs in your classroom.

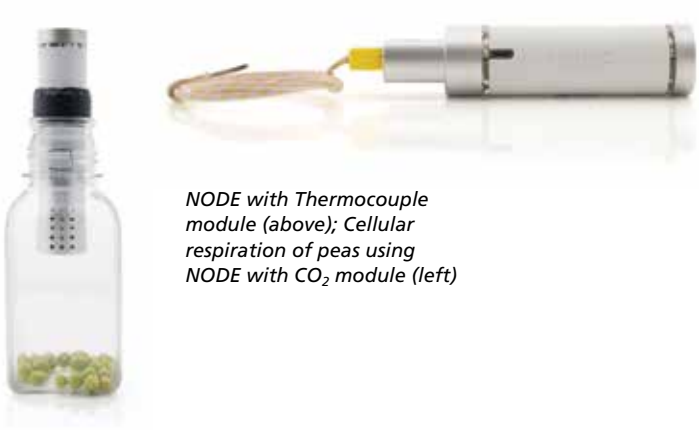
The CO_2 NODE Module, when attached to a NODE Sensor Platform, measures CO_2 gas concentration in air, and can be used for many of the same experiments we have written for our Vernier CO_2 Gas Sensor. Its smaller size and wireless connection to your mobile device give it added flexibility. Below we show the classic biology experiment studying cellular respiration of peas. A NODE equipped with the new CO_2 module was placed into a respiration chamber containing germinating peas. The resulting data, collected on an iPad using Graphical Analysis, shows the peas' respiration rate calculated from the slope of CO_2 gas concentration as a function of time.

Complete instructions for the lab can be downloaded at www.vernier.com/node-co2

Thermocouple NODE Module, NODE-TCA, $85
CO_2 NODE Module, NODE-CO2, $149
NODE Sensor Platform for IOS, NODE-IOS, $99
NODE Sensor Platform for IOS and Android, NODE-IA, $149



Respiration rate of germinating peas using CO_2 NODE Module

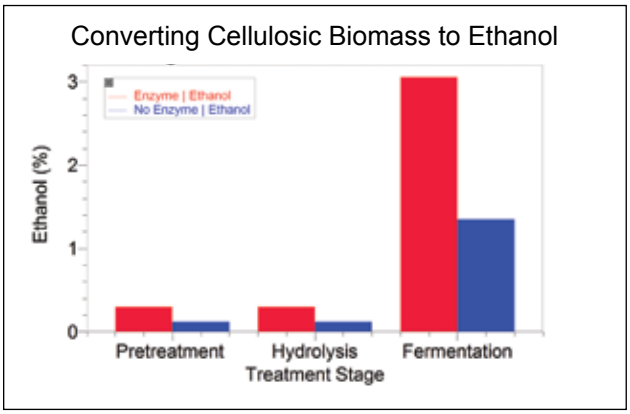


NODE with Thermocouple module (above); Cellular respiration of peas using NODE with CO_2 module (left)

BIOLOGY AND ENVIRONMENTAL SCIENCE

Great Lakes Bioenergy Research Center Uses Vernier Products to Measure Biofuels

If you are looking for inquiry-based activities that focus on bioenergy and biofuels, you should take a look at the classroom materials that are available on the Great Lakes Bioenergy Research Center for Education & Outreach website, www.glbrc.org. The mission of GLBRC Education & Outreach is to inform a variety of audiences about bioenergy research, energy concerns, and sustainability issues affecting the planet. Their goal is to broaden the understanding of current issues in bioenergy for the general public, students, and educators. The classroom materials on the website include a set of laboratory activities that can be used with Vernier probes to measure and analyze biofuels. Each activity also includes student handouts, teacher notes, and sample data.



Enzymatic degradation of cardboard results in increased ethanol production during fermentation

For example, "The CB2E: Converting Cellulosic Biomass to Ethanol" exercise is an excellent investigation on how different processes are used to turn cardboard or other forms of biomass into ethanol. An Ethanol Sensor (ETH-BTA, $109) is used to measure the amount of ethanol produced after biomass samples are subjected to different types of treatment. You can see from the data above that enzymatic digestion of cardboard is required to produce significant amounts of ethanol.

For this and other free activities, visit www.glbrc.org/education

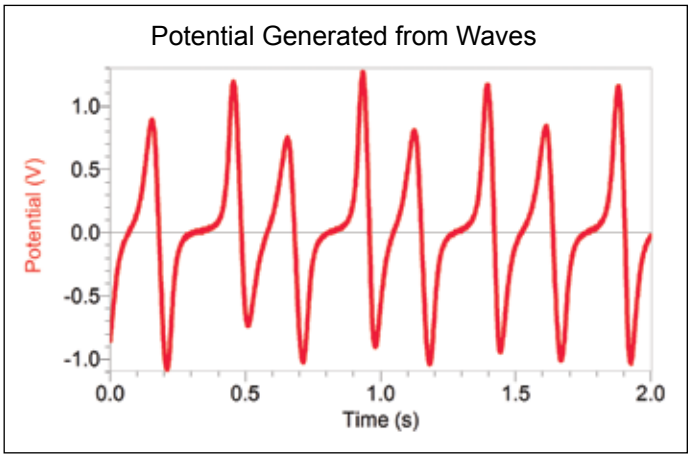
Vernier Sponsors NABT Ecology/ Environmental Science Teaching Award

Each year, Vernier sponsors the NABT Ecology/Environmental Science Teaching Award. The award includes $1,000 toward travel to the NABT Professional Development Conference and $500 of Vernier equipment. Applications for the 2015 Award will be available on the NABT website soon after the November conference, and the deadline for submission is March 15, 2015. Details can be found at www.vernier.com/grants/nabt

STEM and Ocean Wave Energy

The goal of the Wave Energy Program at Hatfield Marine Science Center (HMSC) in Newport, Oregon is to introduce and educate the public on how ocean waves can be used to generate electrical energy. As part of the Oregon Coast Regional STEM Hub, HMSC has developed wave energy curriculum modules that include wave energy kits. These modules and kits are used in K–12 classrooms across the state.

The wave energy kits developed by HMSC allow students to get hands-on experience with a STEM project. Using these kits, they design, develop, and test a wave energy generator in their classroom. Once they have a generator built and optimized, the students then travel to HMSC to test it in their wave tanks. The large wave exhibit in the HMSC Visitor Center includes a pair of 5 meter wave tanks with computer-controlled wave makers. These wave makers can produce consistent, repeatable waves from 10 cm to 19 cm high, with periods from 0.5 to 1.5 seconds. This allows students to test their wave generator and to study the optimal type of wave needed to produce electrical energy.



Data from wave tank as provided by the Hatfield Marine Science Center

Initially, HMSC was having problems measuring and displaying the output from the experimental wave energy generators built by students. They could not use standard digital multimeters (DMMs) because the voltage output from each generator coincides with the frequency of the waves being generated, which is 3–5 Hz. The slowly oscillating signals were too fast to be measured with the DC settings on a DMM, and yet they were too slow to be measured with the AC settings. HMSC found that a digital oscilloscope could work well, but it was difficult to set up, since the voltage output from a student generator could vary from 0.01 V to over 1 V. HMSC contacted Vernier and told us about the challenges they were facing. They needed something that was intuitive to use and could autoscale the data being generated. In addition, HMSC wanted to demonstrate the wave generators to large crowds of visitors and students. The solution was to use a Vernier Voltage Probe (VP-BTA, $12), a LabQuest 2 connected to a computer, and Logger *Pro* software to get the job done. HMSC now has a great way to measure, analyze, display, and teach students about harnessing ocean wave energy through STEM.

ENVIRONMENTAL SCIENCE

Students Use Vernier Technology to Study the Recovery of Mount St. Helens

By Robyn Johnson, Managing Director of Chemistry, Biology, and Environmental Science

In 1980, I was a high school student in Vancouver, Washington. From the school grounds, we had a clear view of Mount St. Helens, only 40 miles to the north. Throughout that spring of my senior year, we would occasionally see bursts of steam rise as small eruptions rocked the mountain and would run out of the building to see if it was "the big one." The big one didn't happen during our school day, but it did eventually arrive on Sunday morning, May 18, 1980. It was a devastating blow to all life in its path.

Mount St. Helens

Ever since that memorable day 34 years ago, scientists have been studying this unique, living laboratory as it recovers from the eruption. Recently, I was privileged to observe some 21st century high school students using Vernier technology to study the recovery of the land and the water in the blast zone. They are participating in a program run by the Mount St. Helens Institute, a non-profit organization that gives high school students a chance to work side by side with scientists, researchers, and natural resources professionals. Students are on the mountain for two days, using Vernier LabQuests and sensors to measure temperature, pH, turbidity, and total dissolved solids of newly formed ponds, existing lakes, and the newly formed Coldwater Lake. Each site is unique due to the disturbance type resulting from the 1980 eruption, the successional stage, and land use prior to and post eruption. "Field studies are an important aspect to understanding the scientific process and to engaging with the outdoor classroom," says Abigail Groskopf, Science Education Manager at the Mount St. Helens Institute. "The Vernier LabQuest and sensors expose students to accurate data-collection technology that can easily be recorded in the field and analyzed back in the classroom."

The students' researchable questions are not limited to the waters of Mount St. Helens. They are valid questions for surface water around the world. Sample questions include

- How does the temperature and diversity of detritus affect algae growth in ponds?
- Does the amount of detritus in a lake have an effect on lake pH?
- Does the temperature of lake water affect its macroinvertabrates?

Students return to their classrooms to analyze the data, and the program concludes with a conference and summit at Washington State University Vancouver. Over 150 students participated in the 2013/2014 school year with one student stating, "The most fun part of the experience was using the tools to collect the data." As a student watching the eruption in 1980, I never imagined that my career path would lead me to help develop these tools for the high school scientists of the future.

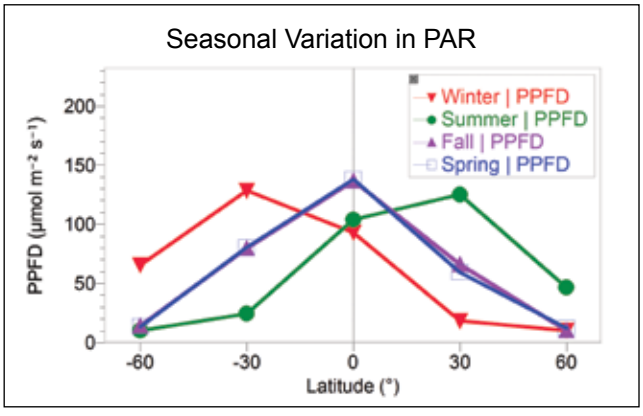
Mount St. Helens Institute

Students measure water quality of a pond on Mount St. Helens

Modeling the Sun's Influence on Growing Seasons

Using our new PAR (Photosynthetically Active Radiation) Sensor (PAR-BTA, $189), we have developed an investigation to model the angle of insolation and its impact on plant distribution and growing seasons across the globe. A halogen light bulb and globe are used to represent the sun and Earth while the Vernier PAR Sensor is placed on different latitudes to determine the amount of light available for photosynthesis at these locations. As shown in the sample data below, as the student changes the angle of the sun with respect to Earth to represent each season, the PAR value changes at each latitude measured.

Student and teacher instructions for this activity are available as a free download at www.vernier.com/r145



Model of PAR variation during seasons at different latitudes

ENVIRONMENTAL SCIENCE

NEW Go Wireless pH *(continued from cover)*

Go Wireless pH includes the following:

- Go Wireless pH
- USB charging cable
- Free app for iPad, iPhone, and iPod touch (available from the App Store)
- Free sample labs, modified for Go Wireless pH, available on our website at www.vernier.com/gw-ph

Also available

- Save money when you purchase our Go Wireless pH Teacher Pack (includes 8 Go Wireless pH sensors and an 8-unit Charging Station, GW-PH-TP, $760)
- Go Wireless Charging Station (order code GW-CRG, $40)—works for both Go Wireless pH and Go Wireless Temp
- Extend data collection and analysis features using Graphical Analysis for iPad, iPhone, and iPod touch (available for purchase on the App Store)

Renewable Energy with Vernier *(continued from cover)*

address objectives in integrated science, physical science, physics, and environmental science. All of the experiments are designed to support students in three-dimensional learning with the Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts for NGSS identified for each experiment in the Instructor Information pages.

Topics in the book include an overview of renewable energy, electricity basics, wind energy explorations including advanced topics such as solidity and power curves, solar electric explorations, and solar thermal investigations. Engineering projects include designing and building an efficient wind turbine, a wind farm, a solar charger, and a solar cooker. For a preview of all of the experiments and projects in the book, visit www.vernier.com/rev

As with all of our lab books, your copy of the book comes with student instructions for data collection using Logger *Pro* or LabQuest App, instructor information including sample graphs and data, answers to questions, helpful hints and tips, and a CD with all of the word-processing files for the student instructions so you can edit them to fit your instructional needs.

VES-BTA, $69

VES-VL, $49

Many of the experiments in the lab book utilize the Vernier Energy Sensor and the Vernier Variable Load. Both products were developed specifically with renewable energy education in mind. When used with current versions of our Logger *Pro* or Logger Lite computer software and LabQuest App, they provide a way for students to easily collect and analyze real-world data and quantify the voltage, current, power, and energy produced from wind turbines and solar panels. To learn more about the Vernier Energy Sensor, visit www.vernier.com/ves-bta or watch the Tech Tips video demonstrating the sensor at www.vernier.com/v189

The new lab book also makes use of some key KidWind wind and solar energy products, including the Advanced Wind Experiment Kit, the SimpleGEN Kit, the 2 V Solar Panel, and the Solar Thermal Exploration Kit. For more information on the KidWind products visit www.vernier.com/kidwind

SCIENCE HUMOR

Most people believe that if it ain't broke, don't fix it. Engineers believe that if it ain't broke, it doesn't have enough features yet.

To the optimist, the glass is half full.
To the pessimist, the glass is half empty.
To the engineer, the glass is twice as big as it needs to be.

A software engineer is sent on a shopping mission with these instructions: "Could you please go shopping for me and buy one carton of milk, and if they have eggs, get six!"

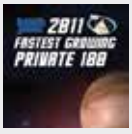
A short time later the engineer comes back with six cartons of milk. The spouse asks, "Why the heck did you buy six cartons of milk?"

The engineer replies, "They had eggs."

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 14 years.

BUSINESS JOURNAL CORPORATE PHILANTHROPY AWARD FOR 2013



FASTEST GROWING PRIVATE COMPANIES

2013 HEALTHIEST EMPLOYERS 2ND PLACE

PLACED 17TH OF 100 BEST GREEN COMPANIES IN OREGON

HALL OF FAME OREGON BUSINESS AWARD

Prices listed are for U.S. customers only.

SOFTWARE

Introducing LabQuest Viewer® App for iPad

The LabQuest Viewer app is our latest app for iPad. Designed to be used by teachers, LabQuest Viewer allows you to view and control any LabQuest in your lab, and when using your iPad with a projector, display the LabQuest screen to the entire class. This is a perfect tool for whole-class demonstrations and student-led discussions. You can interact with the view on the iPad or the LabQuest from wherever you happen to be in the lab. You can also use the LabQuest Viewer app during labs to monitor student progress, identify when individual lab groups are struggling, and take advantage of teachable moments as they happen.

How is LabQuest Viewer different from Graphical Analysis?
While LabQuest Viewer and Graphical Analysis both interact with LabQuest 2, they do so in completely different ways. LabQuest Viewer is a tool for the teacher that enables direct interaction with a LabQuest—changing views, modifying settings, and interacting with data—on an iPad. You have the same screen layout and feature set as a LabQuest because you are monitoring the actual LabQuest screen. All of the data are stored on the LabQuest, not the iPad. This means that any change made affects everyone interacting with that LabQuest. Graphical Analysis is a student lab tool that brings a copy of data collected with a LabQuest to the iPad. Control of the LabQuest is limited to starting and stopping data collection (if enabled); all other settings are changed through direct interaction with the LabQuest. Graphical Analysis has its own view of the data, allowing a student to change their view as needed without interfering with anyone else's view of the data.

Can you use both LabQuest Viewer and Graphical Analysis?
Yes. These apps can be used together, allowing you to demonstrate the complete data-collection interaction all from the same iPad. There is no better tool than LabQuest Viewer for teaching your class how to use LabQuest for data collection. In particular, LabQuest Viewer gives you the additional freedom to move about the classroom while maintaining the ability to monitor what your students are doing. Likewise, there is no better student tool than Graphical Analysis for data analysis with Vernier sensors on an iPad.

LabQuest Viewer app for iPad and Graphical Analysis for iPad, iPhone, and iPod touch are available for purchase in the App Store.

Technical Specifications

- Use with any iPad running iOS 7.0 or newer
- View any LabQuest 2 using its built-in Wi-Fi or original LabQuest with a Wi-Fi dongle (sold separately)

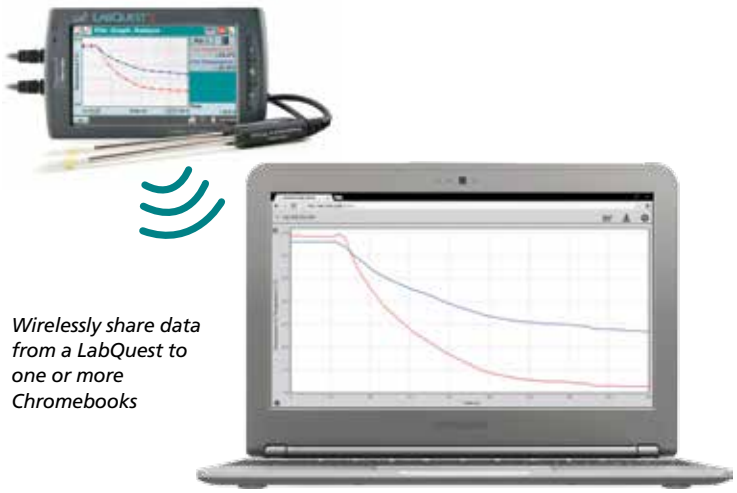
Related Products

- LabQuest Viewer software for Mac and Windows – see www.vernier.com/lq-view
- Graphical Analysis for Android – available from Google Play

LIMITED TIME BACK-TO-SCHOOL PRICING
LabQuest Viewer app for iPad
Now only $4.99 in the App Store. Offer good until October 31.

LabQuest 2 and Chromebook™: A Powerful Pair

Using Chromebooks in your science lab? LabQuest 2 provides real-time data sharing to Chromebooks for every lab group. Connect any of more than 80 compatible sensors to LabQuest 2 and instantly share data to a Chromebook, along with any other device with a browser. No account login or app download is required; Vernier Data Share web app is served directly from LabQuest 2 and is available at no cost.

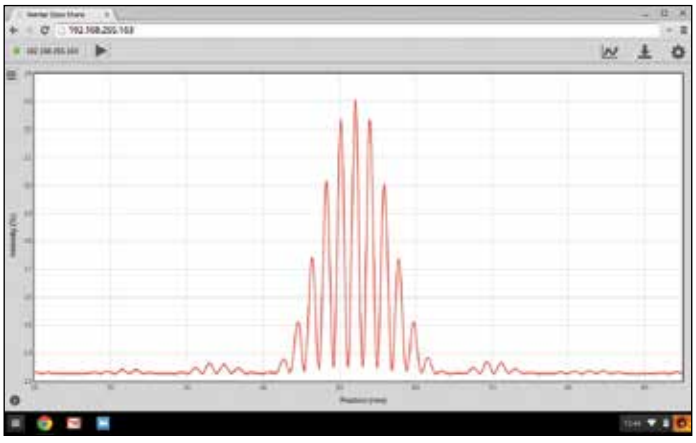


Wirelessly share data from a LabQuest to one or more Chromebooks

Students can analyze and annotate the data and save graphs or CSV files for use in other applications, such as Google Docs and Sheets or Plotly (http://plot.ly).

After class, students can finish their lab write up in offline mode. Vernier Data Share allows students to access their latest experiment and all the analysis, annotation, and export tools, even without access to LabQuest 2 or the Internet.

For more on using LabQuest 2 with Chromebooks see www.vernier.com/chromebooks



The Data Share app on a Chromebook showing data from a double-slit interference experiment

SOFTWARE UPDATES

LOGGER *PRO* 3.8.7

Logger *Pro* 3.8.7 was released in June, 2014. This update is free to all users of any previous version of Logger *Pro* 3, and is available at www.vernier.com/lpupdates

The new version adds support for the Vernier Energy Sensor, and it will graph XY uncertainty bars as boxes for visual fitting of lines.

We have again updated support for the Connected Science System. Logger *Pro* can share sensor data with Graphical Analysis for iPad, iPhone, and iPod touch and with the Vernier Data Share web app in any device running a modern browser. This new version of Data Share now supports Internet Explorer 11 and is fully compatible with iOS 7.

We recommend that all users of Logger *Pro* update to this release. With an account on the Vernier website and a purchase history of Logger *Pro*, you can download its full installer at any time—you don't have to wait for a CD or download link.

LABQUEST APP 2.3.3

LabQuest 2.3.3 for LabQuest 2, with support for Go Wireless Temp on supported LabQuest 2 hardware (LQ2-LE models only), was recently released. This release includes support for new sensors, including the Vernier Energy Sensor and Ohaus balances, and it adds the logarithmic curve fit option. Wi-Fi connection stability has been further improved.

We have again updated support for the Connected Science System. LabQuest 2 can share sensor data with Graphical Analysis for iOS and with the Vernier Data Share web app in any device running a modern browser. This new version of Data Share now supports Internet Explorer 11 and is fully compatible with iOS 7.

We strongly recommend that users of LabQuest update to this release, especially those using Wi-Fi features. This free update to LabQuest 2 is available at www.vernier.com/lq2updates

LABQUEST APP 1.7.2

LabQuest 1.7.2 for the original LabQuest hardware was released in May, 2014. Version 1.7.2 adds support for the Vernier Energy Sensor and adds the logarithmic curve fit option. For more information about this free update, see www.vernier.com/lqupdates

LOGGER LITE 1.7

Logger Lite 1.7 was released in July, 2014. It includes support for the Vernier Energy Sensor and Mac OS X 10.9. The free update is available at www.vernier.com/llupdates

VIDEO PHYSICS FOR iPAD, iPHONE, AND iPOD TOUCH

The current version of Video Physics is 2.0, updated in August 2014. This new version greatly enhances ease of use; it is easier to mark points, to delete points, adjust the origin, and set the scale. Visually the new version fits in with iOS 7 and the upcoming iOS 8.

Updates to Video Physics are always free and are available in the App Store.

GRAPHICAL ANALYSIS FOR iPAD, iPHONE, AND iPOD TOUCH

Graphical Analysis for iOS, 2.1.1, was released in August 2014. Graphical now supports iPhone and iPod touch in addition to iPad, as well as supporting the CO_2 Thermocouple modules for NODE.

GRAPHICAL ANALYSIS FOR ANDROID

Graphical Analysis for Android, version 1.1, was released in June 2014. Similar in features to the iOS version, but crafted for Android, Graphical brings history, curve fits, and data collection to this popular platform.

LABQUEST VIEWER FOR iPAD

New this year is LabQuest Viewer for iPad. Now you can keep tabs on your students' progress by wirelessly viewing their LabQuest screens. The current version is 1.0, and is available in the App Store. See article on p.15.

GO WIRELESS FOR iPAD, iPHONE, AND iPOD TOUCH

The first release of the free Go Wireless Temp app is now in the App Store. This app is exclusively for basic data collection with the Go Wireless Temp. The follow-up version, to be released in October, will be called Go Wireless, and will also support the Go Wireless pH sensor.

APPLE VOLUME PURCHASE PROGRAM

Purchasing apps for iOS devices can be a challenge for schools. Did you know that your school or department can purchase vouchers to distribute apps such as Vernier Video Physics to multiple devices? This is a way to distribute iOS apps to both school-owned and student devices. You can use purchase orders or credit card, and school purchases may be tax-exempt. You receive a 50% discount when purchasing 20 or more copies of Vernier Video Physics or Vernier Graphical Analysis. www.apple.com/itunes/education/

UPCOMING SOFTWARE RELEASES

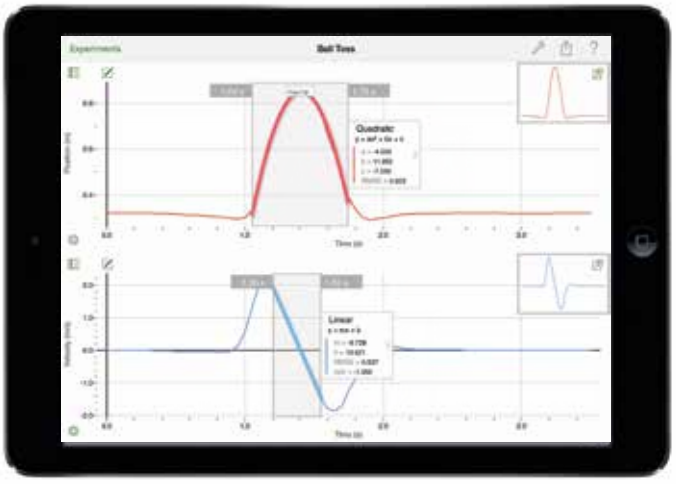
Several important releases will be available this fall. Watch for the following titles:

- LabQuest Viewer for Windows and Macintosh will have several updates, starting with support for OSX 10.9 and 10.10.
- Video Physics for iPad, iPhone, and iPod touch will have an additional release beyond 2.0 to introduce object tracking (see page 5).
- Graphical Analysis for Chromebook. This is a new product.

Power Up Your Tablets with Award-Winning, Data-Collection Apps

Graphical Analysis for iOS and Android

Students use Graphical Analysis to wirelessly collect, analyze, and share sensor data in science and math classrooms. Graphical Analysis facilitates student understanding with real-time graphs of experimental data.



Motion data for a tossed ball

"As a teacher, I love the fact that students get their own personal copy of experiment data to analyze and annotate. Using Vernier technology with mobile devices, students can work either in lab teams or individually, but the most critical part, the analysis, is the responsibility of the student." - Coleen Swihart, Middle School Science Teacher, Health & Science School, Beaverton, OR

Download on the App Store | GET IT ON Google play

Video Physics for iPad, iPhone, and iPod touch

Students can take a video of an object in motion, mark its position frame by frame, and set up the scale using a known distance. Video Physics then draws trajectory, position, and velocity graphs for the object.

Video analysis of an accelerating Segway®

"Vernier's Video Physics app for the iPad is a great way to not only show students how a physical phenomenon occurs, but help them graph it as well." - Brian Nadel, Scholastic Tech Tools

Download on the App Store

Applications Open for Annual Vernier/NSTA Technology Awards

Vernier Software & Technology and the National Science Teachers Association (NSTA) are now accepting applications for the annual Vernier/NSTA Technology Awards. The 2015 awards program will recognize up to seven educators—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.

Prizes include $1,000 in cash, $3,000 in Vernier products, and up to $1,500 toward expenses to attend the 2015 NSTA National Conference in Chicago, Illinois. 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, 2014.

The Vernier/NSTA awards program allows Vernier to recognize STEM educators who are using data-collection technology with their students in truly engaging and innovative ways. For more information about the award and to read about this year's winners, visit www.vernier.com/grants/nsta

Learning Science by Degree

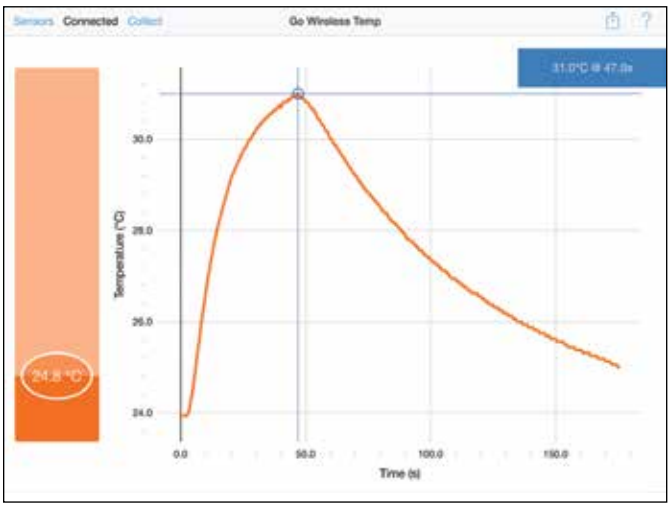
Go Wireless® Temp—Excerpt from a Review

By Carol S. Holzberg, PhD

On the Go

Vernier recently released Go Wireless Temp. This inexpensive, handheld tool works with Apple's iPad, iPod touch, and iPhone running iOS 7 using Vernier's Go Wireless app (available free from the App Store). The probe also works with Vernier's LabQuest 2 (LQ2-LE models only). To see if your LabQuest 2 is compatible, you can verify the model number listed on the back of the unit www.vernier.com/til/3085/

Vernier's Go Wireless app enables users to capture live temperature readings from the sensor and display them on a graph in Celsius or Fahrenheit scale. Thanks to its solid-state temperature sensor located at the tip of the probe, the device can measure temperatures as low –40°C (–104°F) to 125°C (257°F). Students are not tethered to the iOS device when collecting data. They can work up to three meters (~10 feet) away from a connected iOS device.



Go Wireless app on iPad

Student Learning

Common Core English Literacy Standards aren't the only standards that focus on real-world applications to foster deeper learning. The Next Generation Science Standards (NGSS) also recommend using real-world tools like temperature probes to complete hands-on investigations. Temperature is the focus of several "NextGen" standards, including the following:

Structure and Properties of Matter

2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
www.nextgenscience.org/2spm-structures-properties-matter

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
www.nextgenscience.org/msps-spm-structure-properties-matter

Chemical Reactions

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
www.nextgenscience.org/hsps-cr-chemical-reactions

What's Hands-On Got to Do With It?

Research by Johnson, Wardlow, and Franklin (1997) showed that hands-on instructional activities produce no statistically significant differences in student learning when compared to traditional worksheets. However, hands-on applications did make a significant difference in students' attitudes toward learning, serving as the impetus for more positive feelings about the content. Satterthwait (2010) suggests the reason for increased student engagement is that in hands-on activities, "students usually work in groups, interact with peers to manipulate various objects, ask questions that focus observations, collect data and attempt to explain natural phenomena." Go Wireless Temp motivates interaction with peers, playful what-if experimentation, and creative hypothesis testing. It gives children an opportunity to apply what they've learned and construct their own knowledge instead of just filling in a worksheet with memorized facts. The full review, including references, can be found at www.northstarforprincipals.com; however, a subscription is required to view.

Johnson, Donald M., Wardlow, George W., and Franklin, Timothy D. "Hands-On Activities Versus Worksheets in Reinforcing Physical Science Principles: Effects on Student Achievement and Attitude" (1997) *Journal of Agricultural Education,* Vol. 38, No 3, pp. 9-17

Satterthwait, Donna "Why are 'hands-on' science activities so effective for student learning?" *Teaching Science,* Volume 56(2), June pp. 7-10

For more information about Go Wireless Temp, visit www.vernier.com/gw-temp

Albert Einstein Distinguished Educator Fellowship Program

The Albert Einstein Distinguished Educator Fellowship Program is now accepting applications for the 2015–2016 fellowship year. This is an opportunity for K–12 STEM educators to serve an 11-month appointment in a federal agency or a U.S. Congressional office, offering their knowledge and experience to education programs or policy efforts.

Some outstanding contributions of past Einstein Fellows include designing and implementing national STEM education programs and drafting legislation and advising on policies that seek to improve K–12 education in the United States.

Applications are due November 20, 2014. For more information, visit http://science.energy.gov/wdts/einstein/

New Vernier Headquarters Addition

We are pleased to have finally completed the new 1,500 m^2 (16,000 ft^2) addition to our building. Some of the features of the addition are a new classroom for workshops, more efficient workspaces, windows with electrochromic glass that changes optical density (see story on p. 4), a giant periodic table, and a helical slide. More photos and information are available on our website at www.vernier.com/r146

Vernier and Intel Bring Hands-On Science to Students in Kenya

In 2013, Vernier donated temperature probes and motion detectors to the Karibu Centre, a preschool and after-school program in Thika, Kenya, operated by Orphans Overseas, a non-profit organization based in Portland, Oregon.

Karibu Centre students examine graph from their composting project

With support from an Intel volunteer team, the Karibu Centre launched its STEM after-school program, which serves 120 boys and girls from a nearby primary school. Intel created more than 30 interactive lesson plans around the themes of conservation, environmental science, biology, and mathematics. Many of these lesson plans incorporate Vernier probes, which enhance the students' ability to engage in active, inquiry-based learning. The Intel team provided extensive teacher training over a two-week period, including working with the teachers to enable them to create their own lesson plans using the Intel® classmate PCs and probes.

Access to education technology, such as PCs and probeware, is almost unheard of in Kenya, even at private international schools in the capital. Orphans Overseas, with support from Vernier and Intel, is giving opportunities to some of the most vulnerable children in Kenya so that they may gain 21st century skills and go further in their formal education.

Free Hands-On, Data-Collection Workshops

Calling all science educators! Join us for a four-hour exploration of the latest and greatest in Vernier probeware and data-collection technology. You will conduct hands-on experiments using various sensors with the LabQuest 2 interface and you'll get to try out our new Go Wireless sensors.

Perfect for science educators who
- Want to evaluate our award-winning technology
- Are new to data collection
- Need a refresher course on Vernier equipment
- Want to learn from an expert

Attendees receive
- Four hours of free training
- Light lunch or dinner
- Workshop Training Manual on CD
- Savings on a workshop package

For more information, go to www.vernier.com/workshops

IL	Chicago 11/1, 11/3
IN	Evansville 10/6; Indianapolis 10/28
KS	Topeka 9/27; Wichita 9/25
KY	Lexington 10/9; Louisville 10/8
MA	Boston 10/15, 10/16
MI	Detroit 10/21
MN	Minneapolis 10/8, 10/9
MO	Kansas City 9/29; St. Louis 10/2, 10/4*
NE	Lincoln 10/4
NH	Portsmouth 10/14
NY	Albany 10/29; Buffalo 11/1; Rochester 10/30
OH	Cincinnati 10/29; Cleveland 10/23; Columbus 10/30; Toledo 10/22
OK	Oklahoma City 9/24; Tulsa 9/23
PA	Pittsburgh 10/25
RI	Providence 10/18
SD	Sioux Falls 10/6
TX	Dallas 9/15, 9/16; Houston 9/9, 9/10; San Antonio 9/11, 9/13*
WI	Madison 11/5; Milwaukee 11/4

* Free Data-Collection II Workshops cover advanced topics and techniques for experienced Vernier users.

Personalized Webinars

We offer free, personalized webinars for your entire department that can focus on basic or advanced use in any subject area. Webinars are easy to set up and are flexible enough for your busy schedule.

For more information, visit www.vernier.com/webinars

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Vernier Software & Technology
13979 SW Millikan Way
Beaverton, OR 97005-2886
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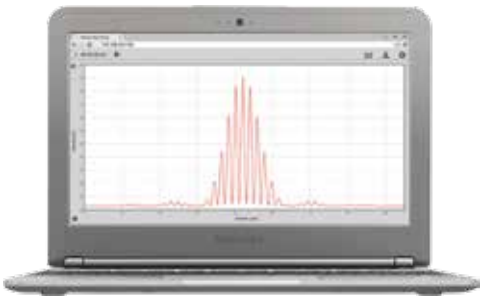
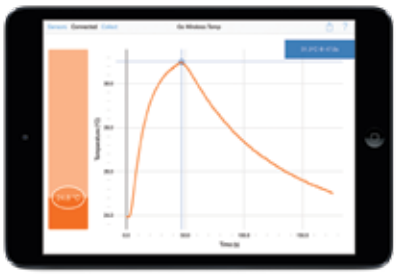
FREE Data-Collection Apps



Vernier Data Share web app

Use the Vernier Data Share web app with Chromebook™, iPad®, iPhone®, iPod touch®, and Android™ devices to collect, graph, and analyze data.
www.vernier.com/data-share

worlddidac AWARD 2014



Go Wireless® app

Students can wirelessly collect and display temperature data using Go Wireless Temp and the Go Wireless app.
www.vernier.com/gw-app

Instructor TEACHERS' PICK BEST OF 2014