Vernier

the CALIPER

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A PUBLICATION FOR USERS OF VERNIER PRODUCTS

in this issue

NEW Vernier Motion Encoder System: Measurement of Jerk

The ultrasonic motion detector has been a groundbreaking sensor in physics education. The importance of real-time graphing to student learning was clearly demonstrated using the motion detector. But, a motion detector can be finicky to set up and use, and sometimes graphs are noisier than we'd like. We wanted to do something even better, so we made the Motion Encoder System.

The Vernier Motion Encoder System is a complete dynamics system with carts, track, and associated hardware, featuring a novel optical motion encoder to measure cart position. The optical motion encoder consists of three parts: a Motion Encoder Cart with a sensor and transmitter, a Motion Encoder Receiver that connects to your interface, and a track equipped with a Motion Encoder Strip. *(continued on page 2)*

VDS-EC, $424

NEW Go Wireless® Temp

A Cool Probe for the Classroom

GW-TEMP, $75

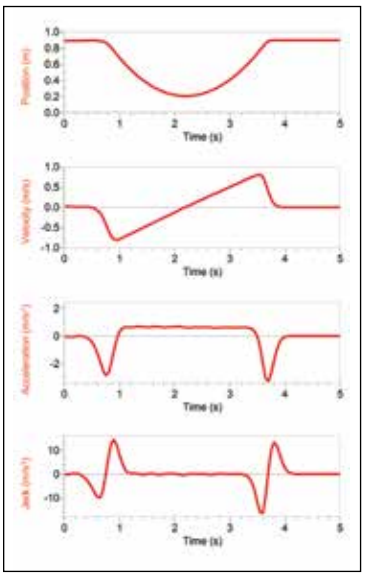
Go Wireless Temp is a versatile temperature probe that is quickly finding its place in the lab. This rugged probe is perfect for anyone wanting to do temperature experiments using an iPad® or iPhone®.

- Connect to a single Go Wireless Temp to collect data for graphing and additional data analysis.
- Use our free sample labs, modified for Go Wireless Temp, available on our website at www.vernier.com/gw-temp
- Change the name of your probes for easy identification when connecting or monitoring.
- Monitor live readings from multiple Go Wireless Temp probes on one or more iPad devices simultaneously.
- Use the FREE Go Wireless Temp App to display and graph temperature readings in either Celsius or Fahrenheit.
- Extend data collection and analysis features using Graphical Analysis for iPad (available for purchase on the App Store).
- Save money when you purchase our Go Wireless Temp Teacher Pack (includes an 8-unit Charging Station, GW-TEMP-TP, $550).

PHYSICS

NEW Vernier Motion Encoder System: Measurement of Jerk *(continued from cover)*

The cart senses motion with optical detectors underneath the cart and beams the information to the receiver by infrared light. With no sound bouncing from stray objects or different parts of the cart, the data are pristine.



Even the acceleration and jerk graphs are pristine for this cart-on-ramp experiment

With the Motion Encoder System, the position, velocity, and even the acceleration graph looks great. Just for fun, we created a graph of the time derivative of acceleration, commonly called *jerk*. If you think about what it feels like in a car when the acceleration suddenly changes (the time derivative of acceleration is non-zero, in physics-speak) you'll know that this quantity is well named.

Creating a useful graph of jerk requires that the underlying position data are very clean, as any bit of noise will be magnified by the successive derivatives.

Here's the family of graphs for a cart rolling up and down an inclined track. With sufficiently low friction, the acceleration should be nonzero and constant while the cart is freely rolling. The jerk should then be close to zero in the same time interval. As you can see, the graph of jerk is close to zero throughout the rolling time, but it is non-zero when the cart is launched and caught. Data from a conventional motion detector wouldn't look nearly this clean.

In addition to such high-quality data, the Motion Encoder System is very easy to set up, with non-critical assembly and immunity to noise from other objects and other encoder systems. No finesse is required—it just works every time.

Between quick and non-critical setup, and data this clean and free of extraneous spikes, your students can focus on the physics. Isn't that the point?

If you already own a Vernier Dynamics System, economical upgrade kits are available, so you can add encoder capability to parts you already own. See vernier.com/vds-ec for more details.

The Vernier Motion Encoder System works with LabQuest 2, original LabQuest, LabQuest Mini, and LabPro.

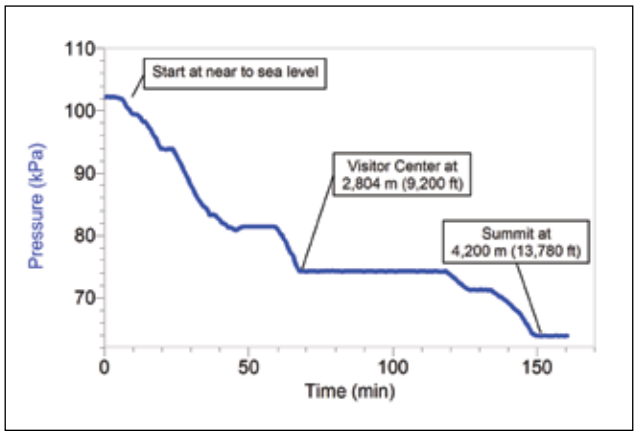
The Vernier Motion Encoder System (VDS-EC, $424) includes a 1.2 m Dynamics Track/Optics Bench, Motion Encoder Cart and Receiver, Plunger Cart, and Track Accessories.

Mauna Kea

Hawaii is the only place on Earth where you can drive from sea level to over 4,000 meters (almost 14,000 feet) in a couple of hours. Dave Vernier recently made the trip with a LabQuest 2 and a Gas Pressure Sensor in the vehicle.

Note that the pressure drops to about 60% of normal air pressure at the top. The 50-minute stop along the way is partially to let people acclimate so they are less likely to get altitude sickness.

Observatories at the summit of Mauna Kea



Atmospheric pressure data collected during a drive to the top of Mauna Kea

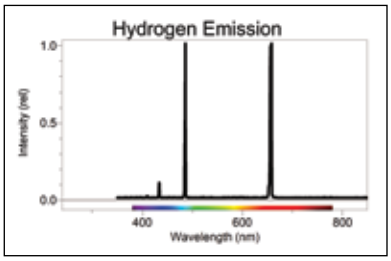
Using the NEW Vernier Emissions Spectrometer to Quantitatively Investigate Hydrogen and Helium Emissions

The Vernier Emissions Spectrometer is a new addition to Vernier's line of products for spectroscopy. With a spectral range of 350–900 nm and a wavelength accuracy of ±2 nm, it is an ideal tool for quantitatively investigating the emission spectra of gas discharge tubes, light bulbs, and LEDs in your classroom. One classical use of the Emissions Spectrometer is an investigation

PHYSICS AND ENGINEERING

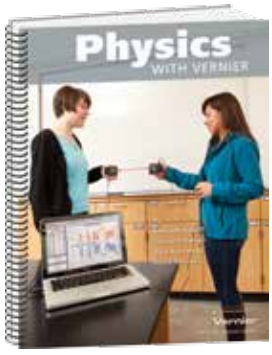
of the Balmer Series of the hydrogen emission spectrum. The scientists at Vernier have written two experiments to help you and your students perform this fundamental experiment: "The Spectrum of Atomic Hydrogen," Experiment 21 in *Advanced Physics with Vernier–Beyond Mechanics* and "The Rydberg Constant" (available for free on our website, www.vernier.com/vsp-em). In addition, Richard Born, Ph.D., a professor who uses our products frequently, contributed an experiment, "A Quantitative Investigation of the Helium Spectrum," for use with the Vernier Emissions Spectrometer. The full experimental write-up is available for free on our website at www.vernier.com/r141

VSP-EM, $799



Spectrum of hydrogen gas discharge tube for investigation of Balmer lines

Updated *Physics with Vernier* Lab Book is Now Available



PWV, $48

The second edition of *Physics with Vernier* is now shipping. Many experiments have been updated and improved to include better Preliminary Questions to help get students thinking about the activity, enhanced graphics, and time estimates for each experiment. Instructor pages now include more equipment and data-collection tips, as well as new sample results.

The new edition also includes experiments updated for use with some of our newer equipment, such as the Vernier Projectile Launcher used in Experiment 8B, "Projectile Motion," and the Optics Expansion Kit and Polarizer/Analyzer Set used in Experiments 28A and 28B, "Polarization of Light." Experiment 28B also utilizes the Rotary Motion Sensor to simplify data collection.

If you already own a copy of *Physics with Vernier* and would like the updated files for the student pages, email us at bookupdates@vernier.com. We will send you a link to download the updated student files. If you would rather have a printed copy that includes the updated student and teacher pages, plus a CD, the book can be purchased for $48 (order code PWV). Correlations to the AP* Physics 1 and 2 curricula can be viewed at www.vernier.com/ap-pwv

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STEM at the Racetrack

In 2013, Project Lead The Way (PLTW) partnered with INDYCAR® to create a unique outreach initiative for eighth-grade students called The Future of Fast. Activity pods were set up at various INDYCAR race venues throughout the country to provide hands-on STEM activities centered on the INDYCAR car, tires, fuel, engine, and safety. The goals of these INDYCAR-themed activities were to show students how engineers and scientists play key roles in the sport, to highlight connections between what students study in the classroom and real-world situations, and to ignite student interest in math and science.

In one of the race-day activities, students were challenged to design, build, and test a barrier crash zone using simple construction supplies. Prior to starting the challenge, students learned about the incredible forces experienced by drivers during a crash, heard about how INDYCAR engineers developed the SAFER Barrier (Steel and Foam Energy Reduction) to provide crash zone protection, and examined an actual SAFER Barrier.

Students were divided into teams of four and were provided with materials, dimensions, and constraints for the challenge. Data from a baseline test using a piece of wood as a barrier were also provided to the students so that they could compare their results to acceleration values of a worse-case scenario. Each team was then given 15 minutes to construct a prototype, measure performance, discuss modifications, modify the design, and repeat the iterative design and test process. To test their barriers, students used a Vernier LabQuest 2 and a 25-g Accelerometer attached to a small model car to collect data while the car rolled down a track and into the barrier they designed. Following this fun and competitive challenge, the teams discussed their results, designs, and what makes an effective SAFER Barrier.

Vernier has developed a strong partnership with Project Lead The Way. We value their mission to prepare students for the global economy. By providing a comprehensive curriculum package based on national standards, focusing on teacher training, and integrating Vernier technology and sensors, the PLTW biomedical programs, engineering programs, and outreach initiatives are extremely valuable for schools that are integrating hands-on, project-based STEM curriculum.

For more information on the INDYCAR racing series, visit www.indycar.com

For more information on PLTW and their STEM education curricular programs used in elementary, middle, and high schools across the U.S., visit www.pltw.org

ENGINEERING

Vernier Products for Arduino™

In the last issue of *The Caliper*, we announced the availability of sample code and instructions for do-it-yourself interfacing of our sensors with Arduino microcontrollers (www.vernier.com/arduino). SparkFun has now developed a new product, the Vernier Arduino Interface Shield for Arduino. This shield was developed for use with the SparkFun RedBoard Arduino but will work with the Arduino Uno and other Uno equivalents like the Leonardo. It even works with the new Intel Galileo.

The Vernier Arduino Interface Shield is now available from Vernier. It has two BTA ports for analog sensors and two BTD ports for digital sensors, allowing you to collect data from up to four sensors simultaneously. Using sketches (Arduino code) downloaded from our website, Vernier sensors will auto-ID. You can be collecting data in minutes.

We are also now selling the SparkFun RedBoard, which is SparkFun's version of Arduino Uno. RedBoard works great with the Vernier Arduino Interface Shield and is less expensive than many other versions of Arduino Uno. A USB cable is included.

SparkFun RedBoard
ARD-RED, $29
includes cable

Vernier Arduino Interface Shield
BT-ARD, $25

Vernier and LEGO® MINDSTORMS® EV3

We find that using robotic systems is a great way to engage students in STEM activities and to teach the engineering cycle of design-test-redesign. In the past, we've worked with LEGO to introduce our sensors into the LEGO NXT robotics system using the NXT Sensor Adapter (BTA-NXT, $39). We have also created a native programming block for the LEGO MINDSTORMS NXT software, the Vernier NXT Sensor Block.

Recently, LEGO brought to market the LEGO MINDSTORMS Education EV3, an upgraded robotics system with enhanced capabilities. This system has its own software. While the Vernier NXT Sensor Adapter is electrically compatible with the new system, the EV3 Software requires a new, native sensor control programming block similar in concept to, but incompatible with, the NXT software. We have a preliminary version of the new Vernier EV3 Sensor Block available for free download at www.vernier.com/lego-ev3

INNOVATIVE USE

Electric Shock Drowning

This year, the FIRST® LEGO® League competition theme was "Nature's Fury: Prepare, Stay Safe, Rebuild." Team 1110, the CyborGirlz of Regina Caeli Academy in Spring, Texas, was inspired to study flood conditions based on reports from recent flooding in Ningbo, China. By interviewing survivors, the team learned that many people perished from a phenomenon called "electric shock drowning." Live power wires under the water create electric fields in the water. Gradients in these fields drive current through the victims, paralyzing their muscles. As little as 6 mA of current can freeze a person's muscles. The victim cannot move and then drowns.

The CyborGirlz created a small robotic boat, called the Aquabot. The boat carried a LEGO NXT robot, two Vernier NXT Sensor Adapters, and two Vernier Current Probes with leads immersed in the water. Electric field gradients in the water drove current through the Current Probes, which was read by the NXT controller. The controller then powered two fans to move the boat through the water toward the region of higher current.

The robot was programmed to stop at the point of maximum danger and sound an alarm. In field trials using a one dimensional water tank, the Aquabot found the source of the electric fields in the water.

This project gave students their initial engineering design experience of identifying a problem, researching the problem, brainstorming and investigating an idea, creating and testing a design, modifying the design, retesting, and finally seeing the system work in operation.

A film of the project is available at http://youtu.be/hPftdh10WnA

More information about electric shock drowning can be found at www.electricshockdrowning.org

The Aquabot with one LEGO NXT robot, two Vernier NXT Sensor Adapters, and two Vernier Current Probes

ENGINEERING

Vernier Engineering Contest Winners

Vernier Software & Technology sponsors a contest for educators who creatively use Vernier sensors to introduce engineering concepts or engineering practices. The prizes for the winners include $1,000 in cash, $3,000 in Vernier technology, and $1,500 toward expenses to attend either the NSTA STEM conference or the ASEE conference. This $5,500 award is presented to one college instructor, one high school teacher, and one middle school teacher.

CONGRATULATIONS TO THE 2013 WINNERS!

Deborah Munro, an Engineering instructor at University of Portland, created a low-cost, easy-to-implement introduction to biomechanics for seniors in mechanical engineering. A series of six labs provides students with hands-on experience acquiring and analyzing data, as well as video, using Logger *Pro* software and Vernier physiology sensors. The course culminates with the students answering their own open-ended research question.

Gary Garber, an Engineering and Physics teacher from Boston University Academy, had high-school students work together to design and build a system for calculating rocket height. STEM concepts in this project included measuring the impulse of the engine using a Dual-Range Force Sensor, building triangulation stations and algorithms for measuring the height, investigating electronic tracking and video methods, and creating computer programs to estimate the height.

Julianne King, a teacher from Regina Caeli Academy, had middle-school students investigate "Electric Shock Drowning." (See the article on page 4 for details.)

For details about the contest and to see the winning videos, visit www.vernier.com/grants/engineering

Engineering Contest – Enter to Win!

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

Maybe your students are using Vernier sensors to test a design project. Or maybe you are challenging your students to build an automated device using the Vernier Digital Control Unit (DCU) and Logger *Pro* software. 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 your projects and you might win!

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 or the 2015 ASEE conference. Entries will be accepted through January 15, 2015. For complete rules and to submit an online application and video showcasing your entry, go to www.vernier.com/grants/engineering

Marbles in Motion

For the second year in a row, Vernier teamed up with a local organization, Business Education Compact (BEC), to bring the joy of engineering to local students through a program called BEC STEM Connect. Volunteers from Vernier spent time with fourth and fifth grade students at Vose Elementary in Beaverton, Oregon, answering the questions, "What is engineering?" and "What do engineers design?"

Students at this Title I school had the opportunity to design and build a ramp for a marble that needed to strike a target zone on the floor. They based their designs on what they learned about potential energy and kinetic energy.

New Adapter and Sample Programs for NI myDAQ

The NI myDAQ from National Instruments is a data-acquisition instrument designed for students performing hands-on engineering, measurement, and control experiments. The new Vernier myDAQ Adapter allows you to connect two Vernier analog sensors and one digital sensor to the NI myDAQ interface.

The NI myDAQ is programmed with NI LabVIEW™ software, introducing students to software that is used throughout the engineering disciplines in both research and industry. LabVIEW sample programs are available on the Vernier website to help you get started using Vernier sensors with NI myDAQ. Use the examples and the programming tips in the Vernier myDAQ Adapter User Manual to create your own programs to take biomedical measurements, calibrate sensors, or build sensor-based automation and control projects.

For more information on the Vernier myDAQ Adapter and to view the User Manual, go to www.vernier.com/bt-mdaq

To download our NI myDAQ LabVIEW examples, go to www.vernier.com/lv-downloads

BT-MDAQ, $59

ENGINEERING & MATH

New Design for the Digital Control Unit (DCU)

The Vernier DCU is an electronic device that allows on/off control of motors, lamps, LEDs, buzzers, and other DC electrical components. It works with any Vernier interface that has at least one DIG port (SensorDAQ, LabPro, LabQuest 2, original LabQuest, and LabQuest Mini). The DCU can be used to create sensor-based projects such as alarm systems, temperature-controlled environments, automated scientific instruments, kinetic sculptures, and smart robots. DCU projects are a great way to introduce STEM, engineering, electronics, programming, or the mathematics of feedback and control.

The DCU provides the capability of controlling digital output lines via the digital ports on Vernier interfaces in response to input from Vernier sensors. The output voltage, up to 12 volts, is set by an external supply, and each line can source up to 600 mA of current.

DCU-BTD, $61
DCU Power Supply, IPS, $12

The redesigned DCU is completely compatible with all previous Vernier interfaces and instructional materials. As in the past, its six output lines are controlled using either Logger *Pro* or National Instrument's LabVIEW software. The new unit features a detachable screw terminal connector. This allows a modular approach to the creation of experimental setups using the DCU. Each experiment can be connected to its own screw terminal and rapidly swapped in and out of the DCU. On the circuit board at the end of the device are indicator LEDs and a variety of header pins to offer an alternative connection to the device under test. Users wishing to control the DCU with Arduino should refer to the Vernier website at www.vernier.com/arduino

30 *years ago in the* CALIPER

This is the 30th anniversary of this newsletter. The first issue included the following:

- We announced upgrades for our Frequency Meter, Precision Timer, and Graphical Analysis Apple II programs.
- We announced our first (and it turned out to be only) Commodore 64 program.
- We also announced our first parts kit for building a photogate. Previously, we had just provided the instructions and a list of parts and encouraged people to buy them at RadioShack®.

Award Winning Research Uses Vernier and TI Technology

by Erick Archer, Texas Instruments

My wife and I have two great boys, Owen (11) and Hayden (12). Back in September, Hayden came home from school and announced he was required to do a science fair project for his 7th grade science class. We discussed several ideas. The one that stood out dealt with West Rowlett Creek, the creek that runs through our neighborhood. The kids in the neighborhood like to play in the creek, and both Owen and Hayden have been a part of several cleanup projects over the years. For the science fair project, we talked about possible pollution in the creek and the importance of protecting it from harm.

As Hayden's mentor, I got him started using a TI-Nspire CX handheld and Vernier sensors. He used a Stainless Steel Temperature Probe, a Conductivity Sensor, a pH Sensor, and the new Optical DO Probe (much easier to use than the regular Dissolved Oxygen Probe, by the way). He also used a standard Secchi disk, and a tape measure to determine creek width and depth. This served as a way to determine how recent precipitation levels may influence the concentration of solutes in the creek. It did not take him long to use the technology on his own. He visited the creek over a two and a half month period, taking readings at four different sites: one upstream of our neighborhood, two within the neighborhood, and one downstream of the neighborhood.

Having access to his school's data-collection technology really made a difference in what Hayden was able to achieve. He received an honorable mention at his school's science fair, which advanced him to the regional competition. He won first place in Environmental Science at the Dallas Regional Science & Engineering Fair, making him eligible to compete in the Exxon Mobile Texas State Science & Engineering Fair in San Antonio. He is very excited and feels like his project is making people aware of the importance of water quality of aquatic ecosystems. Hayden is very happy about the awareness he has generated.

Erick Archer is a former teacher with a background in biology. He is currently Market Strategy & Programs Manager for Science & STEM Education at Texas Instruments.

CHEMISTRY

Vernier UV-VIS Spectrophotometer

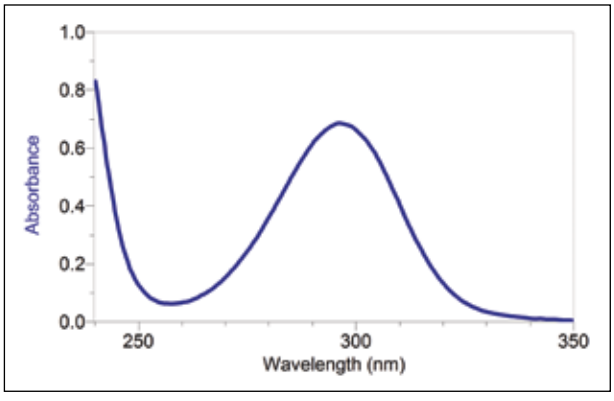
Several years ago, we introduced the SpectroVis Plus Spectrophotometer as a cost-effective option for teachers who were searching for a spectrometer that measured absorbance in the visible light region. The SpectroVis Plus has been popular in biology and chemistry classrooms for investigating compounds that absorb light in the wavelength range from 380 nm to 950 nm. We are excited to announce an important addition to our spectroscopy options.

The new Vernier UV-VIS Spectrophotometer is an affordable instrument for measuring the absorbance spectra of compounds in the wavelength range from 220 nm to 850 nm. Use the UV-VIS Spectrophotometer to collect a full absorbance spectrum and select a specific wavelength, in order to monitor the rate of a reaction or collect data for an absorbance *vs.* concentration experiment. The spectrophotometer uses a linear CCD detector with a deuterium and incandescent lamp for the UV and visible region, respectively. The UV-VIS Spectrophotometer requires a standard 1 cm path length cuvette and comes with two Starna Cells' quartz cuvettes.

The UV-VIS Spectrophotometer makes it possible to conduct some experiments with fewer chemicals. For example, the original version of Experiment 22, "The Synthesis and Analysis of Aspirin," from *Advanced Chemistry with Vernier*, used a Colorimeter or visible spectrophotometer to test the absorbance of the salicylic acid impurity after it had been prepared with an iron solution to give it color in the visible spectral region. Because salicylic acid has a maximum absorbance around 300 nm in the UV region, the Vernier UV-VIS Spectrophotometer is able to directly test for the impurity.

VSP-UV, $1,999

We have written an updated version of Experiment 22 using the Vernier UV-VIS Spectrophotometer for analysis and made it available for download from our website. The updated version, along with additional free experiments and more information on the Vernier UV-VIS Spectrophotometer, can be found at www.vernier.com/vsp-uv



Absorbance spectrum of salicylic acid

Demonstrating the Existence of Polyatomic Ions

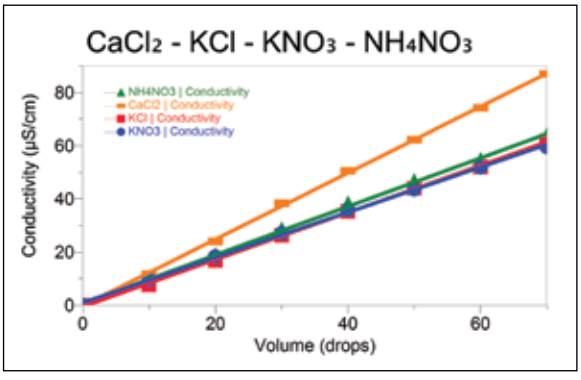
An Extension to Experiment 14, "Conductivity of Solutions," from *Chemistry with Vernier*

One of the most disappointing things for a teacher is not being able to provide evidence for a claim that students find difficult to accept. When students ask how it is possible to know that $CaCl_2$ produces three ions, while $NaNO_3$ produces only two, it is difficult to provide an easy, convincing answer. Larry Dukerich, a chemistry and physics teacher with over 34 years of teaching experience, developed an extension to Experiment 14, "Conductivity of Solutions," in *Chemistry with Vernier,* to help demonstrate the existence of polyatomic ions.

Solid substances known as salts (e.g., potassium chloride, potassium nitrate), yield ions when dissolved in water. These ions permit the flow of an electric current through the solution. Increasing the ion concentration increases the ability with which the solution carries an electric current and results in a higher conductivity. This experiment can provide data to support the claim that some ions are polyatomic.

Students and instructors can perform trials with solutions of different salts, including KCl, $CaCl_2$, KNO_3, and NH_4NO_3. Comparing the graphs of conductivity *vs.* drops of solution added for the electrolytes shows that the slope for $CaCl_2$ is 1.5 times as great as that of KCl. Since conductivity is proportional to the number of ions in solution, the data will support the hypothesis that each formula unit of $CaCl_2$ produces three ions for every two produced by KCl. However, the existence of polyatomic ions still needs to be addressed.

In the procedure, the next set of trials investigates the conductivity of KNO_3 and NH_4NO_3, both of which contain polyatomic ions. The evidence for polyatomic ions is noticeable when comparing the slopes of the graphs of conductivity *vs.* number of drops for solutions of KNO_3 and NH_4NO_3 to those of KCl and $CaCl_2$. The KNO_3 and NH_4NO_3 graphs will have slopes agreeing with KCl but not $CaCl_2$, suggesting both KNO_3 and NH_4NO_3 dissociate into two ions. To download the student instructions and teacher notes for the experiment, go to www.vernier.com/r142



Comparing the conductivity of a three ion compound with two ion compounds

CHEMISTRY AND BIOLOGY

New Design for the Drop Counter

Our popular Drop Counter has a new look for 2014! The Drop Counter is commonly used with sensors such as the pH Sensor and Conductivity Probe to automatically record the volume of liquid added to a mixture. The redesigned Drop Counter is better than ever, with new features that improve its overall ease of use:

- The wider drop-detecting area is able to record drops at rates as high as six drops/second.
- A new red LED blinks each time a drop is detected, providing confirmation that all is going well.
- The Drop Counter still has two sensor slots: The smaller slot can now be adjusted to accommodate a variety of temperature probes and thermometers, as well as to help position the probe or thermometer properly. The larger slot fits most stick-type sensors, from pH Sensors to Ion-Selective Electrodes to Dissolved Oxygen Probes.
- The updated ring stand clamp allows for a wider range of ring stand sizes and for clamping to a lab frame.

The Drop Counter is an integral part of several of our acid-base titration experiments. Check out Experiment 24 in *Chemistry with Vernier*, Experiment 7 in *Advanced Chemistry with Vernier,* or Experiment 17 in *Investigating Chemistry through Inquiry.*

VDC-BTD, $99

Choosing a Spectrometer

Vernier offers a number of spectrometers. Which spectrometer is right for you? This is an important question. The first step begins with identifying the applications for which you want to use your spectrometer. We offer spectrometers that measure absorbance, fluorescence, and/or emissions. To help you decide which one is right for you, visit the spectrometer web page at www.vernier.com/spectrometers

We sell two visible-range spectrometers that can be used to study compounds that absorb light from 380 to 950 nm. SpectroVis Plus (SVIS-PL, $469), a great, budget-friendly option, offers fluorescence capabilities with excitation at two different wavelengths, 405 and 500 nm. The Vernier Spectrometer (V-SPEC, $1,399), powered by Ocean Optics™ technology, is an excellent choice for college chemistry.

Do you study absorbance spectra of compounds in the ultraviolet range? Check out the new Vernier UV-VIS Spectrophotometer (VSP-UV, $1,999). With the UV-VIS Spectrophotometer you can monitor the rate of a reaction or collect data for an absorbance *vs.* concentration experiment for compounds that absorb light in the UV and visible range (200 to 850 nm). UV-VIS Spectrophotometer specifications and free, downloadable experiments can be found at www.vernier.com/vsp-uv

If your application involves looking at emissions spectra from light bulbs or gas discharge tubes, you may be interested in the new Vernier Emissions Spectrometer (VSP-EM, $799). The Vernier Emissions Spectrometer gives precise measurements over a range of 350 to 900 nm.

If you remain undecided about which spectrometer would be the best option for you, watch our Tech Tips video, "Which Spectrometer is Right for Me?," at www.vernier.com/v185 And, of course, if you continue to have questions, feel free to call and ask for a chemistry specialist.

Experiments Using Our New PAR Sensor

Colleen McDaniel, one of our Biology Specialists, has found that our new PAR (Photosynthetically Active Radiation) Sensor is an excellent sensor for biology, environmental science, and agricultural science experiments. The PAR Sensor reports Photosynthetic Photon Flux Density (PPFD), measured in units of micromoles of photons per meter squared per second (μmol m^{-2} s^{-1}). This is the power of electromagnetic radiation in the spectral range that is used by plants for photosynthesis (400–700 nm). The sensor has a waterproof sensor head, which makes it ideal for use in aquatic field studies. But it can also be used with artificial light sources, which makes it excellent for investigating photosynthesis or primary productivity in the classroom.

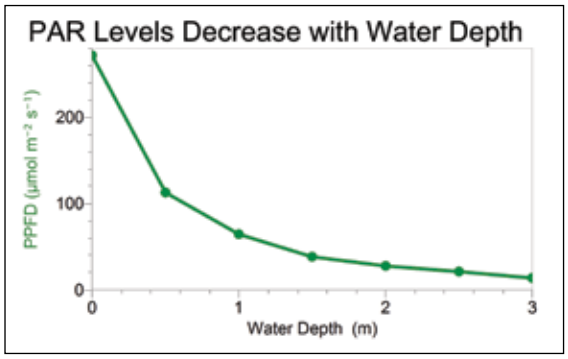
With this in mind, we have developed three new experiments, "PAR Attenuation in Water," and two new versions of "Photosynthesis and Respiration" using the PAR Sensor and CO_2 Gas Sensor. In the first experiment, students observe how PAR attenuates with water depth in the field. With the PAR Sensor attached to a Secchi disk,

PAR-BTA, $189

PAR Sensor mounted on a Secchi disk

BIOLOGY

Colleen McDaniel lowers the PAR Sensor and Secchi disk into the Willamette River

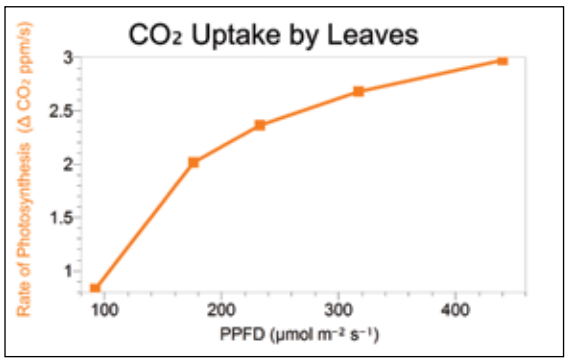


Light attenuation as a function of depth

students measure PAR values at different depths. Our sample data, shown above, illustrate how PAR attenuates as a function of depth in Portland's Willamette River.

In "Photosynthesis and Respiration," students use a CO_2 Gas Sensor and a PAR Sensor to investigate how PAR levels influence photosynthetic rate. As shown in the sample data below, as PAR level increases, so does the rate of photosynthesis. Two versions have been developed—a standard version and an inquiry version.

Student and teacher instructions for all three activities described above are available as free downloads at www.vernier.com/par-bta



Relationship of photosynthetic rate to PAR level

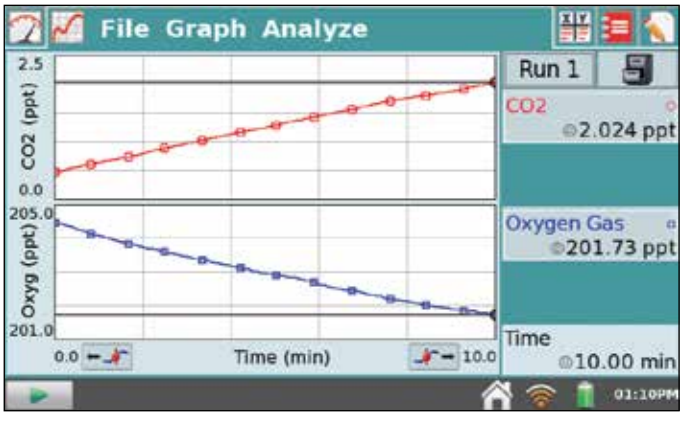
Tips and Tricks for Excellent Cellular Respiration Data

Cellular respiration is a fundamental concept in biology. Our CO_2 and O_2 Gas Sensors make it easy for your students to study this concept, producing excellent data, as shown below. However, you can't just place a few peas in a chamber and expect to see great results when using both sensors at the same time. Our resident biologists have recently revisited the "Cellular Respiration" experiments in *Biology with Vernier* and *Advanced Biology with Vernier* to provide you with the following tips and tricks for consistently good results when using both sensors.

- For best results, you should follow the Teacher Information, which calls for using peas that have been allowed to germinate for three days. However, you can still get very good data with peas that have been soaked for 12–24 hours. You just need to use more peas.
- Blot the peas with a paper towel before you put them in the chamber. Excess water vapor can interfere with both sensors.

- Use the BioChamber 250 as the sample chamber, and fully line the bottom with peas to maximize the number of peas in the chamber. Twenty-five peas work fine if you are just using the CO_2 Gas Sensor. But we recommend using at least 40–50 peas if you want to see significant changes in oxygen concentration. This is very important, especially if you are using peas that have only been germinating for 12–24 hours.
- Oxygen levels are very high in ambient air (20.9%) and your students are measuring a relatively small change in concentration over time in this experiment. This change will be much easier to observe if your students change the units to ppt or ppm.

By following these suggestions, you and your students should get good results when using the CO_2 and O_2 Gas Sensors at the same time.



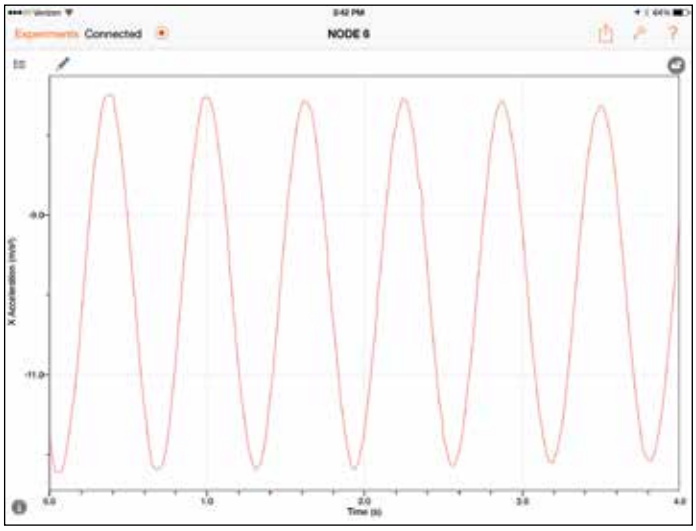
Cellular respiration in germinating peas

BIOLOGY AND ENVIRONMENTAL SCIENCE

NODE Wireless Sensors

Wireless sensors offer a new way to investigate scientific phenomena using mobile devices. Vernier has partnered with Variable, Inc. to support their NODE sensors as one of our entries into this new world. The NODE Sensor Platform is a compact battery-powered Bluetooth device containing a 3-axis accelerometer, gyroscope, and magnetometer. Only 9 cm in length and 2.5 cm in diameter, you can get it into small spaces, or have it serve as the experimental object, such as a pendulum bob. Additional sensor modules can be attached to NODE, making it a versatile tool for science education. It communicates with most iOS and many Android devices using a collection of free apps by Variable, Inc. Key NODE sensors are also supported in Vernier's Graphical Analysis for iPad, providing additional ways to analyze the data.

Using the NODE Sensor Platform, your students can investigate the physics of motion with its built-in 3-axis accelerometer and gyroscope. Studying simple harmonic motion is as easy as attaching a NODE to a spring and using Graphical Analysis to collect and analyze data. There is also an on-board, 3-axis magnetometer that can be used to study magnetic fields.



Simple harmonic motion with the NODE Sensor Platform and Graphical Analysis for iPad

By attaching the CLIMA module to NODE, your students can study the weather, with the sensors measuring temperature, barometric pressure, relative humidity, and light level. Any of these four sensors can also be used individually; for example, learn about the Earth's albedo by using the light sensor to compare the reflectivity of light off of various colors. The temperature sensor can be used to monitor the temperature of your classroom overnight. The possibilities for you and your students to explore their world with this module are endless.

The THERMA module is an infrared temperature sensor that, when attached to NODE, can measure the surface temperature of objects from as close as one inch to as far as 15 feet. Monitor the temperature of a beaker of ice water as it heats to boiling. Add hot water to a variety of travel mugs and use THERMA to see which one stays the coolest on the outside. Comparing insulators is a breeze when you can instantly measure the outside surface temperatures of the objects being studied.

Several other modules are available now, including the LUMA Smart Flashlight and CHROMA Color Sensor. More are on the way. We think you and your students will find many uses for this innovative technology.

Instructions for the simple harmonic motion and reflectivity of light investigations mentioned above are available at www.vernier.com/node

Sensor Platforms
NODE Sensor Platform for iOS, NODE-IOS, $99
NODE Sensor Platform for iOS and Android, NODE-IA, $149

Sensor Modules
THERMA NODE Module, NODE-THERMA, $75
CLIMA NODE Module, NODE-CLIMA, $50
CHROMA NODE Module*, NODE-CHROMA, $99
LUMA NODE Module*, NODE-LUMA, $25
*Not supported in Graphical Analysis

Our New Saltwater Aquarium

We can wirelessly collect, analyze, and share sensor data from our new saltwater aquarium, located in the main lobby of the Vernier office in Beaverton, Oregon. The 125-gallon tank is now home to over 22 different species of fish, shrimp, crabs, anemones, and corals.

Our new PAR Sensor (measuring the level of photosynthetically active radiation), Optical DO Probe (measuring dissolved oxygen), Salinity Sensor, pH Sensor, and Stainless Steel Temperature Probe connected to two LabQuest 2 units help to monitor the tank's health. Visitors to our office can use their iPhone, iPad, or Android devices to connect to each LabQuest 2 using the QR codes posted on a sign on the tank.

Measuring photosynthetic light levels and dissolved oxygen concentration in the saltwater aquarium using the PAR Sensor and the Optical DO Probe

ENVIRONMENTAL SCIENCE

Vernier Partners with KidWind

We recently teamed up with KidWind, a leader in renewable energy education, to offer wind and solar energy education kits. We are now the sole manufacturer and distributor of the KidWind wind and solar products. We're excited to integrate our sensors, including the new Vernier Energy Sensor, with the model wind turbines and solar panels. This allows students to explore electrical concepts and quantify energy and power output of small turbines and solar power.

The Wind Turbine Hub, included in the Advanced and Basic Wind Experiment Kits, makes it easy for students to design their own blades and test blade variables. Integrating the Next Generation Science Standards (NGSS) Science and Engineering Practices including Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions, and Engaging in Argument from Evidence is now easier than ever. We've written some experiments to help you get started. See www.vernier.com/kidwind

Vernier Volunteers with Restoring Ecosystems, Educating Future Conservation Leaders (REEF)

Vernier specialists, Colleen McDaniel and Kristen Nelson, volunteered their time to instruct students from Taft High School in Lincoln City, Oregon, about sampling water quality with LabQuest 2 at nearby Crowley Creek. Crowley Creek feeds into the Salmon River Estuary and provides an excellent opportunity to educate students about water quality.

Students used the Optical DO Probe, pH Sensor, Salinity Sensor, Stainless Steel Temperature Probe, and PAR Sensor to sample water directly in Crowley Creek. This was an introduction to hands-on water investigations they will experience later in class. Chemistry teacher, Dustin Quandt, will be working with almost 100 students to monitor different locations contributing to the Salmon River Estuary throughout the rest of this school year. He reached out to the REEF program to establish this outdoor field trip for his students.

Salmon River Estuary on the Oregon coast

The Restoring Ecosystems, Educating Future Conservation Leaders (REEF) program is an educational partnership developed by Salmon Drift Creek Watershed Council to protect and restore local watersheds, to provide environmental awareness, and to provide conservation career development. REEF is collaborating with the Oregon Coast Aquarium and the Ocean Literacy Initiative to deliver watershed science programs and watershed field trips for students at Taft High School.

For more information regarding the REEF program, visit www.salmondrift.org

New Products for Renewable Energy

We are excited to announce the release of the Vernier Energy Sensor and the Vernier Variable Load. Together, these two new products offer an easy way to quantify energy and power output of small wind turbines and solar panels.

The Vernier Energy Sensor (VES-BTA, $69), with a range of ±30 V and ±1000 mA, allows your students to easily connect a wind turbine or solar panel to the source terminals and connect a load to the load terminals. There's no need to wire a complicated circuit. Designed specifically to handle the demands of the KidWind wind turbines and solar panels, the Vernier Energy Sensor is the perfect sensor for renewable energy data collection.

The Vernier Variable Load (VES-VL, $49), is a versatile variable resistive load with a range of 6 Ω to 255 Ω. It has a maximum input power of 1 W. Designed to be used with the Vernier Energy Sensor, it's now easier than ever to match the internal resistance of your wind turbine generators so that your students can maximize the power output of their turbines. Explore the relationship between load and power output with a free experiment available from www.vernier.com/kidwind

To help you make the most of the Vernier Energy Sensor and the Variable Load, we will be releasing a new lab book later this spring. *Renewable Energy with Vernier* covers topics in renewable energy, including wind, solar, and thermal/solar energy. This exciting new book also addresses the Science and Engineering Practices included in the Next Generation Science Standards.

SOFTWARE

Software Updates

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

LOGGER *PRO* 3.8.6.2

Logger *Pro* 3.8.6.2 was released in January 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 Windows 8.1 and Mac OS X 10.9, as well as these new sensors: PAR Sensor, Vernier UV-VIS Spectrophotometer, Vernier Emissions Spectrometer, and the Vernier Motion Encoder System. Experiment files for *Physics with Vernier* have been updated for the new edition.

We have again updated support for the Connected Science System. Logger *Pro* can share sensor data with iPad, Android, and other mobile devices using Graphical Analysis or Vernier Data Share web app. 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—no waiting for a CD or download link.

LABQUEST APP 2.2.1

LabQuest App 2.2.1 for LabQuest 2 was released in January 2014. Version 2.2.1 adds support for new sensors: PAR Sensor, Vernier UV-VIS Spectrophotometer, Vernier Emissions Spectrometer, and the Vernier Motion Encoder System. Meters have been enhanced with new analog display modes and digital filtering. Wi-Fi connection stability has been improved.

We have again updated support for the Connected Science System with a new version of the Data Share web app.

We recommend that all LabQuest users update to this release. This free update to LabQuest 2 is available at www.vernier.com/lq2updates

LABQUEST APP 1.7.1

LabQuest App 1.7.1 for the original LabQuest was released in January 2014. Version 1.7.1 adds support for new sensors: PAR Sensor, Vernier Emissions Spectrometer, Vernier UV-VIS Spectrophotometer, and the Vernier Motion Encoder System. For more information about this free update, see www.vernier.com/lqupdates

LOGGER LITE 1.6

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

VIDEO PHYSICS FOR iOS

The current version of Video Physics is 1.2.1, updated in August 2013. The new version improves navigation between the graph and video. Note that this, and the previous versions, added the important ability to export video analysis data to Graphical Analysis for iPad. Once in Graphical Analysis, you can perform selections, add annotations, perform curve fits, and create high-resolution graphs.

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

GRAPHICAL ANALYSIS FOR iPAD

An update to Graphical Analysis for iPad, 2.0, is available in the App Store. This update adds support for Go Wireless Temp, as well as the NODE Sensor Platform and its THERMA and CLIMA modules. Significant updates for iOS 7 compatibility are also made.

GO WIRELESS TEMP APP

The first release of the free Go Wireless Temp app is now on the App Store. This app is exclusively for basic data collection with Go Wireless Temp.

UPCOMING SOFTWARE RELEASES

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

- LabQuest Viewer 2.0 for Windows and Mac, with display of multiple simultaneous LabQuest screens and support for Mac OS X 10.9
- LabQuest Viewer 2.0 for iPad
- LabQuest App 2.3, with improved Wi-Fi behavior, support for the Vernier Energy Sensor, and support for Go Wireless Temp on compatible LabQuest 2 interfaces (LQ2-LE models only).
- Logger *Pro* 3.8.7, with support for the Vernier Energy Sensor, as well as updated Data Sharing
- LabQuest 1.7.2, with support for the Vernier Energy Sensor

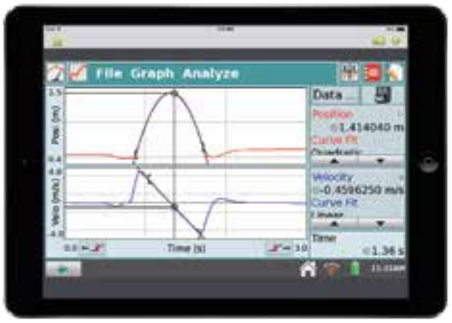
SOFTWARE

LabQuest Viewer for iPad

LabQuest Viewer app is now available for iPad. With the new app you can

- See a list of LabQuests that are on the same network as your iPad.
- Select your LabQuest to display its screen right on your iPad.
- Tap on the displayed LabQuest to change data-collection parameters, start data collection, and perform data analysis—just as you would the LabQuest itself.
- Use the Share feature to save images of the LabQuest screen that you can use in documents.
- Present different LabQuests by selecting another one from the list—it's that easy!

The LabQuest Viewer app can also be used with an original LabQuest with the LabQuest Wi-Fi USB Adapter (WIFI-USB, $59). For more information, go to www.vernier.com/lq-view-app



Available on the App Store

View and control any LabQuest on your network directly from your iPad.

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-owned devices. You can use a purchase order 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. For more information, see www.apple.com/itunes/education

Vernier Accounts: Update Your Software

Did you know that you and your IT team can download the latest versions of Logger *Pro* and LabQuest Viewer from the Vernier website? A Vernier account lets you send update instructions, passwords, and links to your IT department. When it is time for the IT team to update your computers, you can help them by granting free, 24/7 access to the software you need. Sign up for an account at www.vernier.com/account

Graphical Analysis for Android

In 2012, we introduced a version of Graphical Analysis for iPad, bringing data collection and analysis to a multi-touch interface. This year, we are expanding our offering with Graphical Analysis for Android. Using the Data Sharing feature in LabQuest 2, each student receives an individual copy of experiment data for analysis. Students annotate the data, perform curve fits, and make statistical calculations to build evidence of understanding. Students can even make a prediction or analyze manually entered data. Graphical Analysis for Android will be available soon for download on Google Play.

What do you have for Chromebook™?

Chromebooks and Chrome OS™ are supported by the Vernier Data Share web app. Vernier Data Share allows for real-time data collection and analysis from multiple devices, with an offline mode for finishing a lab at home. Students can also download their graphs and data for use with Google Drive™, Google Docs™, and Google Sheets. To get started, enable Data Sharing on LabQuest 2 or Logger *Pro* (version 3.8.6 or newer).

For more information, see www.vernier.com/chromebooks

Vernier in the Science Journals

Hockey, iPads, and Projectile Motion in a Physics Classroom

***The Physics Teacher,* September 2013, by Richard P. Hechter, University of Manitoba, Winnipeg, MB.** Our Video Physics app for iPad is used to collect data on a hockey puck's path through the air. Logger *Pro* is used for further analysis. The author explains some pedagogical advantages of this activity.

Electromagnetic Induction with Neodymium Magnets

***The Physics Teacher,* September 2013, by Deborah Wood, College of William and Mary, and John Sebranek, Southwest HS, Green Bay, WI.** In this article, the authors show how to build an apparatus to nicely demonstrate Lenz's law of induction with falling magnets.

A Progression of Static Equilibrium Laboratory Exercises

***The Physics Teacher,* October 2013, by Mickey and Andrew Kutzner, Andrews University.** This is a detailed series of lab experiments using our Dual-Range Force Sensor to explain the statics of bridges, catwalks, and cantilevers.

Mouthpiece and Bell Effects on Trombone Resonance

***The Physics Teacher,* January 2014, by Michael C. LoPresto, Henry Ford College, Dearborn, MI.** This article shows how to use PVC pipe and a trumpet mouthpiece to make a musical instrument and then study the frequencies it produces related to the tube length of the instrument. It also explains how the presence of a bell at the end of the tube can change the tone quality, as shown using an FFT. Logger *Pro* or a LabQuest would handle this well.

On the Intensity Profile of Electric Lamps and Light Bulbs

***The Physics Teacher,* November 2013, by Xavier Bacalla and Edcel John Salumbides, University of San Carlos, Cebu, Philippines and VU University, Amsterdam, The Netherlands.** The light intensity vs. time graphs over a short time (0.1 s) are compared for fluorescent and incandescent lamps.

Pulse Oximetry in the Physics Lab: A Colorful Alternative to Traditional Optics Curricula

***The Physics Teacher,* November 2013, by Ellynne Kutschera, Justin C. Dunlap, Misti Byrd, Casey Norlin and Ralf Widenhorn, Portland State University.** The authors explain the principles of pulse oximetry. They use our SpectroVis Plus to show how the ratio of light transmissions at two wavelengths can lead to a non-invasive determination of the oxygen level of blood.

Measurement of the Convective Heat-Transfer Coefficient

***The Physics Teacher,* February 2014, by Rosaria Conti, Aurelio Agliolo Gallitto, and Emilio Fiordilino University of Palermo, Italy.** This article explains how to use temperature *vs.* time graphs made as water cools toward thermal equilibrium in various containers to determine the convective heat-transfer coefficient.

Tracking Heat Islands

***Make Magazine,* February 2014, by Forrest M. Mims III. Also found at makezine.com/projects/make-37/trackingheatislands** The experiment uses LabQuest 2 (with GPS) and a Surface Temperature Sensor to study temperature variation as you drive.

Are you looking for a bargain?

Bargains galore can be found in the "Clearance" section of our website. Most of the items in this section have been used once or twice for a workshop or for product testing. They have all been refurbished and carry our full warranty. Availability of an item may be limited. Here are some examples that are available as of the printing of this newsletter:

- Original LabQuest (with power supply and cable), LABQ-L, $225
- Hand-Grip Heart Rate Monitor, HGH-BTA-L, $89
- Chloride Ion-Selective Electrode, CL-BTA-L, $134
- Calcium Ion-Selective Electrode, CA-BTA-L, $134
- Original Motion Detectors with cable, MDO-BTD, $5 (These older, blue Motion Detectors have a range of 0.5 m to 6 m and do not have a switch.)

See available items at www.vernier.com/clearance

Original Motion Detector MDO-BTD, $5
includes cable

Original LabQuest LABQ-L, $225
includes power supply and cable

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.

INTERNATIONAL AWARD FOR LABQUEST

BUSINESS JOURNAL CORPORATE PHILANTHROPY AWARD FOR 2013

FASTEST GROWING PRIVATE COMPANIES

PLACED 26TH OF 100 BEST GREEN COMPANIES IN OREGON

2013 HEALTHIEST EMPLOYERS 2ND PLACE

HALL OF FAME OREGON BUSINESS AWARD

JOB OPENING AT VERNIER

Vernier's engineering education department is currently hiring an Engineering Educational Technology Specialist. If you want to help shape the future of STEM education at Vernier, consider applying.

We are looking for someone with teaching experience in physics and/or engineering using Vernier products; experience with STEM topics such as robotics and programming, Physics First, NGSS, and AP/IB physics are all of interest. We have been named one of the "100 Best Companies to Work For in Oregon" for 14 years. Vernier Software & Technology is an Equal Opportunity and Affirmative Action Employer.

Applications will be accepted online through May 5, 2014 at www.vernier.com/jobs

Summer Storage Tips

Packing up your Vernier equipment for storage over the summer? Here are a few tips to ensure proper storage over summer break:

- Turn your LabQuest 2 or original LabQuest completely off and disconnect from the Charger. In sleep mode, the battery drains much more quickly than when the unit is all the way off. To fully shut down, press and hold the power button for a full five seconds until LabQuest 2 displays the Shutdown message or an original LabQuest displays a black screen. If your school storage area is especially hot when the air conditioning is off for the summer, we recommend that you keep them in a location that remains cooler.
- Store your pH Sensors and Oxidation-Reduction Potential (ORP) Sensors vertically in the storage solution provided. The storage solution needs to be replaced once a year, and replacement solution can be purchased, if needed (PH-SS, $16). If the solution looks cloudy before vacation, it is probably best to change it before you leave.
- Make sure no liquid (either in a cuvette or spilled) is inside your Colorimeter.
- Store your Oxygen Gas Sensors upright using the 250 mL Nalgene bottle that was shipped with the sensor.
- Make sure your Dissolved Oxygen Probes are completely dry after emptying the filling solution and rinsing the sensor electrode and cap.
- Keep your Ion-Selective Electrodes in the humid environment of the storage bottles in which they were shipped. If the sponge at the bottom of the storage bottle has dried out, simply add a few drops of distilled water.

For these tips and more, visit www.vernier.com/til/1060

Shh!

Twitter user @Washington_STEM tweeted "Using @VernierST sound probe to help with classroom management. #shhhhhh" in December. @Washington_STEM is Ben Barkey, of the Washington STEM Academy in Warsaw, IN.

Sound Level Meter
SLM-BTA, $165

Maintaining Your Sensor Cables

Using sensors day after day with several classes results in wear and tear on your equipment. We try to make our equipment sturdy enough to use for many years, however, cables sometimes get frayed with frequent use.

You can help prevent premature cable breakage through proper cable wrapping and preventative maintenance. First, sensor cables should not be wrapped around the sensor. While it might be tempting to wind the Stainless Steel Temperature Probe's cable as tightly as possible around the shaft, or to wind the Photogate cable tightly around the Photogate, this can lead to premature fraying and breakage. For proper cord storage techniques, see www.vernier.com/til/2377

What if your cables start to fray? You need to prevent further damage. While we do have a generous five-year warranty on most of our products, frayed cords are not an item we repair. One solution is to wrap a sticky and unsightly blob of electrical tape around the fraying portion. A neater solution that we have found is to use sugru® (www.sugru.com). Sugru is a moldable silicone rubber that cures in about 24 hours. Follow the directions on the package. Mold the sugru around the frayed portion of the wire and let it cure. Your wires should last you a while longer this way!

Frayed cables with sugru in packet (above) and cables after the application of sugru (right)

Vernier/NSTA Technology Award Winners Announced

Recipients each win $5,500 in cash and technology

Co-sponsored by Vernier and NSTA, The Vernier/NSTA Technology Awards recognize educators for their innovative use of data–collection technology. Christine and David Vernier presented each of this year's winners with their awards at the NSTA conference in Boston. Each winner receives $1,000 in cash, $3,000 in Vernier technology, and $1,500 towards expenses to attend the conference. Below are brief synopses of the 2014 award-winning entries.

ELEMENTARY SCHOOL

Bill Burton
The Lamplighter School, Dallas, TX

Bill Burton uses a Vernier Force Plate during a lesson that allows his first-grade students to explore friction. During the investigation, students experience the forces required to overcome friction as they pull themselves across several hundred tennis balls. As students experience this activity, a graph of the data collected by the Force Plate is projected on an interactive whiteboard for class discussion.

MIDDLE SCHOOL

David Auerbach
Cardigan Mountain School, Canaan, NH

Encouraging hands-on scientific discovery, David Auerbach has students participate in the C-Prize project, a takeoff of the X-Prize, in which students construct and test rocket prototypes to learn about speed, velocity, and acceleration. Additionally, they identify variables, develop hypotheses, and analyze data using photogates.

Christine Gleason
Greenhills School, Ann Arbor, MI

Focusing on the themes of energy and sustainable resources, Christine Gleason has her eighth-grade students build a classroom-sized alternative energy system as part of an end-of-year project. With the help of technology, students will take electrical power measurements (comparable to those being made on the school's rooftop wind turbine system) on their own classroom projects and then improve upon their designs.

HIGH SCHOOL

Gary Garber
Boston University Academy, Boston, MA

Unlike many traditional high school pendulum experiments, Gary Garber's students use sensors—including photogates, motion detectors, and accelerometers—as well as computer modeling, to further their physics understanding. In addition to analyzing their own findings, students are able to analyze data that Garber collected using the Vernier Wireless Dynamics Sensor System during a pendulum experiment on a NASA reduced gravity flight.

Brian Bollone
Northview High School, Grand Rapids, MI

Students in Brian Bollone's class will use an array of Vernier sensors to research quantitative questions regarding measurable chemical factors during animal decomposition. During the activity, students will correlate their data with daily qualitative measurements of entomological activity and photographs, and they will test their hypothesis using still-born fetal pigs.

Ashley Webb
DeSoto Central High School, Southhaven, MS

With the help of teacher Ashley Webb, the "Creating Leaders in STEM" program at Central High School in Southhaven, Mississippi, provides innovative opportunities for AP Physics and AP Environmental Science high school students to review for their AP tests. In addition, students help sixth-grade students at the junior high school engage in hands-on, inquiry-based STEM education using probeware.

COLLEGE

Dr. Paul Adams
Fort Hays State University, Hays, KS

Dr. Paul Adams' engineering students use technology to conduct high-altitude ballooning challenges. To further expand on these challenges, Dr. Adams will have students migrate the Vernier sensors to an Arduino, an open-source electronics prototyping platform, to create a lighter system to reduce the cost of the balloon launch.

Interested in submitting an application of your own?

Applications are due November 30, 2014. **www.vernier.com/grants**

SCIENCE HUMOR

So, a bar walks into a physicist... Sorry, wrong frame of reference.

As a child, I was obsessed with the difference between sine and cosine. As I got older, I realized it was just a phase.

PROFESSIONAL DEVELOPMENT

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.

These workshops are perfect for science educators interested in
- Evaluating our award-winning data-collection technology
- Getting started with probeware and data collection
- Refreshing their knowledge of Vernier equipment
- Learning from the experts

Attendees receive
- Four hours of free training
- Light lunch or dinner
- Workshop Training Manual on CD
- Discount on an equipment package

AL	Birmingham 4/17
AZ	Phoenix 4/26
AR	Little Rock 4/15
CA	San Bernardino 4/28; Irvine 4/29, 4/30; San Jose 5/7; Oakland 5/8
CO	Ft. Collins 4/14; Denver 4/15; Colorado Springs 4/16
CT	Hartford 4/22
MS	Jackson 4/16
NJ	Newark 4/24; Princeton 4/26
NY	White Plains 4/23
SD	Rapid City 4/12
TN	Memphis 4/14

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 team's busy schedule. Recorded versions are available for download, and topics include

- LabQuest 2 and the Connected Science System
- Biotechnology: Gel Analysis
- Physics: Video Analysis
- Chemistry: pH Titration
- Chemistry: Beer's Law

www.vernier.com/webinars

Chautauqua Short Course: *Research-Based Active Learning in Introductory Physics*

June 15–17, 2014, Portland, Oregon	
Instructors:	Priscilla Laws, Dickinson College David Sokoloff, University of Oregon Ronald Thornton, Tufts University

This hands-on course is designed for university, college, and high school physics instructors who are interested in making learning in their introductory course more active, either within a traditional course structure (lectures, labs, and recitation hours) or by re-structuring their course (e.g., into a workshop or studio course). Graduate credit will be available.

Participants will be introduced to physics education research-validated strategies for each component of the introductory course, such as *Interactive Lecture Demonstrations* (ILDs), *RealTime Physics* (RTP) labs, *Activity Based Tutorials, Collaborative Problem-Solving Tutorials, Workshop Physics,* and *Physics with Video Analysis*, along with strategies for analytic mathematical modeling. Some recent developments include the new electricity and magnetism labs in the 3rd Edition of RTP, ILDs using personal response systems (clickers), and interactive video analysis. The tools and software accompanying these active learning strategies are available for both Mac and Windows computers.

Participants will receive complimentary copies of the active learning curricula, along with *Teaching Physics with the Physics Suite*, a comprehensive book by E.F. Redish (University of Maryland) on strategies for implementing physics education research-based curricula. The curricula are also available in the High School e-dition, which is a more convenient form for high school use. Physics topics will be chosen from both semesters of the introductory physics course.

For more information and to register, visit
http://pages.uoregon.edu/sokoloff/CHAUT.htm

Modeling Workshops at Arizona State University

Arizona State University in Tempe invites high school physics, chemistry, and physical science teachers nationwide to enroll in its summer 2014 Modeling Workshops. Modeling Workshops thoroughly address many aspects of high school science teaching, including strategies for integrating model-centered, guided inquiry teaching methods with course content. Workshops incorporate up-to-date results of physics and science education research, sample high school curricular materials, hands-on use of technology, and experience in collaborative learning. For more information and specific site dates, visit
www.vernier.com/training/independent

PROFESSIONAL DEVELOPMENT

Hands-On Summer Institutes

School may be closed this summer, but the learning never stops at Vernier. Join us for a full-day exploration of Vernier's award-winning line of computer and handheld data-acquisition technology. You'll leave the workshop ready to excite your students' learning with data collection.

The cost of the institute is $99, which includes a lab book of your choice. Please see our website for Training Package pricing. The registration form can be found at www.vernier.com/training/summer-institutes

AR	Little Rock 6/20
DC	Washington 7/18
IA	Des Moines 6/25
IL	Chicago 6/27
MA	Boston 7/9
MD	Baltimore 7/16
MN	Minneapolis 6/23
MT	Missoula 8/6
NY	Long Island 7/11
OR	Beaverton 8/13
PA	Philadelphia 7/14
TX	San Antonio 6/16; Dallas 6/18
VA	Norfolk 7/21
WA	Spokane 8/8

Free Hands-On Training at Conferences

Vernier will offer hands-on workshops at each of these conferences. For a full listing of our conference exhibits, check our website at **www.vernier.com/conferences**

- **NSTA STEM Forum & Expo,** New Orleans, LA, May 14–17
- **American Association of Physics Teachers** Minneapolis, MN, July 26–30
- **Biennial Conference on Chemical Education** Allendale, MI, August 3–7
- **International STEM Education Association** Branson, MO, October 12–14
- **New Jersey Science Convention** Princeton, NJ, October 14–15
- **NSTA Area Conference,** Richmond, VA, October 16–18
- **NSTA Area Conference,** Orlando, FL, November 6–8
- **National Association of Biology Teachers** Cleveland, OH, November 12–15
- **Conference for the Advancement of Science Teaching** Dallas, TX, November 20–22
- **NSTA Area Conference,** Long Beach, CA, December 4–6

Hands-On Summer Institutes in Oregon

Join us at our office in Beaverton, Oregon for any of seven institutes we are conducting this summer. You will be able to take a tour of our new office addition, visit the Vernier "museum," and even take a ride on our new slide! Details on all of these workshops can be found at www.vernier.com/training/subject-specific-institutes

Two-Day, Subject-Specific Institutes

BIOLOGY/AP BIOLOGY JULY 21–22

This 2-day, hands-on workshop gives you the opportunity to explore how to integrate probeware into your biology courses. Specific emphasis will be placed on conducting inquiry-based laboratory investigations.

Experiments and sensors include
- Grip Strength and Muscle Fatigue – Hand Dynamometer
- Cell Respiration – CO_2 Gas Sensor
- Yeast Metabolism and Evolution of Yeast – CO_2 Gas Sensor
- Testing Catalase Activity – Gas Pressure Sensor
- The Visible Spectra of Plant Pigments – SpectroVis Plus
- Primary Productivity – Optical DO Probe
- Introduction to Biofuels and Evolution of Cellobiase – SpectroVis Plus

The registration fee, $199, includes lunch and a copy of the Vernier lab book, *Investigating Biology through Inquiry*.

PHYSICS JULY 16–17

This 2-day, hands-on physics workshop gives you the opportunity to explore data collection and video tools offered by Vernier. Learn basic and advanced skills in Logger *Pro*, such as configuring graphs, performing custom curve fits, setting up calculated columns, and customizing data-collection modes. Video analysis using computers and tablets will be covered.

Topics include
- Dynamics and kinematics using the new Motion Encoder Cart and the Vernier Dynamics System
- Optics and diffraction using the Optics Expansion Kit and the Diffraction Apparatus
- Circuits using the Vernier Circuit Board

The registration fee, $199, includes lunch and a copy of *Physics with Vernier*, 2nd edition.

PROFESSIONAL DEVELOPMENT

AP CHEMISTRY JULY 24–25

Learn how Vernier products and lab books can be used to meet requirements of the new AP Chemistry framework. Specific emphasis will be placed on inquiry-based methods of conducting experiments.

Examples of experiments and sensors that will be covered include
- Acid-Base Titration: Determining the K_a of a Weak Acid – pH Sensor
- Determining the Rate Law of a Chemical Reaction – SpectroVis Plus
- Identifying an Unknown Solid by Melting Temperature – Melt Station
- A Redox Titration – Oxidation-Reduction Potential (ORP) Sensor
- The Determination of an Equilibrium Constant – SpectroVis Plus
- Analyzing a Mixture with a Gas Chromatograph – Mini GC Plus

The registration fee, $199, includes lunch and a copy of the Vernier lab book, *Investigating Chemistry through Inquiry*.

One-Day, Subject-Specific Institutes

ENVIRONMENTAL SCIENCE / FIELD BIOLOGY JULY 23

Learn how to integrate probeware into your environmental science or field biology course during this 1-day workshop. Specific emphasis will be placed on conducting inquiry-based investigations.

A variety of investigations and sensors will be covered, including
- Biochemical Oxygen Demand – Optical DO Probe
- Primary Productivity – Optical DO Probe
- Investigating Water Quality – Conductivity Probe, pH Sensor, Turbidity Sensor
- Soil and Acid Rain – pH Sensor
- Microclimates – PAR Sensor, Temperature Probe, UVB Sensor

The registration fee, $99, includes lunch and a copy of the Vernier lab book, *Investigating Environmental Science through Inquiry*.

ENGINEERING JULY 14, 15

Engineering and STEM with Logger *Pro* – JULY 14

Explore several ways to use Logger *Pro* software and Vernier technology to introduce STEM and engineering during this 1-day, hands-on workshop.

You will learn how a Digital Control Unit (DCU) can be used to develop logic-based, sensor-control systems, and how you can use Logger *Pro* software for testing as you work through revisions using the engineering design method.

Some of the exercises you will perform:
- Controlling inexpensive DC devices (motors, buzzers, LEDs, and others) with the DCU
- Creating an automated, sensor-controlled apparatus
- Calibrating an analog sensor
- Building your own sensor
- Investigating student bridges

The registration fee, $99, includes lunch and a Vernier Digital Control Unit.

Vernier Sensors with Arduino™ – JULY 15

The availability of inexpensive, easy-to-program microcomputers, such as Arduino, make STEM and engineering projects easy and affordable.

This 1-day, hands-on workshop gives you the opportunity to explore different ways to use your Vernier sensors with an Arduino microcontroller. You will learn the fundamentals of programming the Arduino and be introduced to the sample code available on our website.

Some of the topics that will be included:
- Connecting and calibrating Vernier sensors
- Writing programs (called sketches for Arduino) to read Vernier sensors
- Logging data with Arduino and exporting data to Logger *Pro* for analysis
- Creating interactive Arduino projects

The registration fee, $99, includes lunch and a Vernier Arduino Interface Shield and an Arduino RedBoard.

Vernier Sensors with LEGO® – JULY 15

LEGO robotics technology provides an engaging and popular way to introduce students to robotics, STEM, and engineering concepts.

During this 1-day, hands-on workshop, you will explore different ways to use your Vernier sensors with LEGO robotics. You will learn how to use Vernier sensors in the LEGO software development system, as well as how to create engaging projects.

Examples of topics that will be covered:
- Explore how to use Vernier sensors with LEGO robotics systems.
- Write LEGO MINDSTORMS programs to read Vernier sensors.
- Create hands-on projects that are great for getting students interested in STEM.

The registration fee, $99, includes lunch, a copy of *STEM 2 with Vernier and LEGO MINDSTORMS NXT* lab book and an NXT Sensor Adapter.

Vernier
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NEW Vernier Energy Sensor

www.vernier.com/ves-bta

The new Vernier Energy Sensor offers an easy way to quantify voltage, current, power, and energy output of small wind turbines and solar panels such as those used in our KidWind Experiment Kits. **SEE PAGE 11.**