Vernier

THE Caliper

A Publication for Users of Vernier Products

SPRING 2017

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IN THIS ISSUE

Go Direct™ Sensors

Unleash Student Curiosity

John Wheeler, CEO

As introduced in our 2017 catalog, we have a new family of sensors, our Go Direct sensors, that provides a unique mix of technology, simplicity, and affordability. Each of the 16 Go Direct sensors is a self-contained data-collection system capable of logging and streaming data through a USB or wireless connection to your Chromebook,™ Windows® or macOS® computer, or iOS® or Android™ device.

Vernier has a long history of bringing new technology into the classroom. The current popularity of activity trackers and wearable devices has led to the development of low-cost, low-energy wireless products. Using this new technology, we are providing science classrooms with a simple, powerful, and affordable family of sensors. These new sensors have sophisticated data-collection and processing engines that allow them to be optimized for the parameter being measured. This enables Go Direct sensors to be affordable, accurate, reliable, and easy to use in the classroom.

Our popular LabQuest interfaces and standard sensors, used in classrooms around the globe, will continue to be supported, as they offer a versatile platform for data collection. Our Go Direct sensors provide another option to empower students to engage in hands-on science.

Regardless of which solution you choose, all of our products are backed by our award-winning software, teacher-tested curricula, and stellar service.

For more information, visit **www.vernier.com/go-direct**

The Great American Eclipse

August 21, 2017

David Vernier, Co-Founder

Dave Vernier in the Australian Outback collecting data during a 2002 total solar eclipse with a very old laptop and a Palm Pilot

This summer, many people in the United States will have their first chance in 38 years to experience a total solar eclipse. Called the Great American Eclipse, it is a total eclipse only in the United States. The path of totality extends from Oregon to South Carolina.

We are very excited about this eclipse and have two special events related to it:

Eclipse Viewing Glasses

We gave away 4,000 eclipse viewing glasses to teachers who stopped by our booth at NSTA in Los Angeles. We are also offering inexpensive packages of 40 Eclipse Glasses (EC-GL40, $16) for you to use with your students (while supplies last).

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Data Collection Pooling

A total solar eclipse is an amazing event. If you read about eclipses (see **www.vernier.com/eclipse** for several good references), you will find people often report

- The temperature drops as the eclipse proceeds
- The wind increases as totality approaches
- The sky gets bluer as totality approaches

Will all of this really happen? It is a great time to take some data! Consider using our sensors to gather data on all of the following.

Light Level

We have a number of light sensors, and they measure different regions of the spectrum:

- Our new Go Direct Light and Color Sensor (GDX-LC) reports visible and UV light levels, as well as color intensity. It will provide especially interesting data.
- The Vernier Light Sensor (LS-BTA) measures visible light level (what a human eye senses).
- The Pyranometer (PYR-BTA) measures total solar radiation.
- UVA and UVB sensors (UVA-BTA and UVB-BTA) measure specific parts of the UV spectrum.
- Our spectrophotometers, set up for studying the emission spectra from the sun, will give interesting data and information about how the color of light changes, especially if you collect and save a complete spectrum multiple times before, during, and after the eclipse.

Temperature

There will probably be a noticeable temperature change during the eclipse. Is the change gradual or is there a big change at totality? How is the temperature change related to light level changes? It might be best to use a temperature sensor that responds quickly to changes in air temperature, such as our Surface Temperature Sensor (STS-BTA).

Wind Speed

Many people have reported increased wind as the eclipse approaches totality. Use an Anemometer (ANM-BTA) to measure wind speed.

We encourage you to collect data during the event and share it with us. In the next issue of this newsletter, we will share a summary of the data we receive. It will be interesting to compare data taken by different student/teacher groups in different regions of the United States. You can also post data and results on social media with the hashtag #VernierEclipse.

For more information and tips for using Vernier probeware, check out **www.vernier.com/eclipse**

© kubotake / Wikimedia Commons

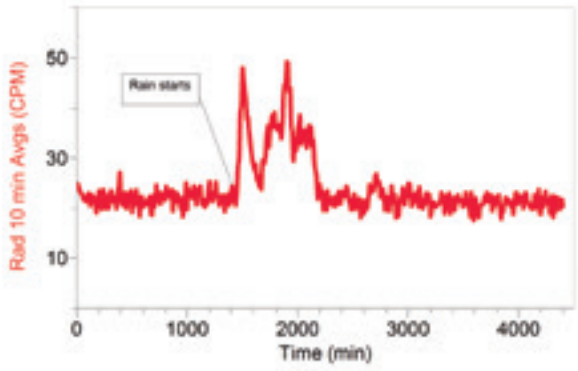
INNOVATIVE USE

Radioactive Rain

Dr. Andy Johnson, Black Hills State University, Spearfish, SD

What happens to the radiation level when it rains? Check out this surprising graph, showing data collected using a Vernier Radiation Monitor and LabQuest 2 on September 21–25, 2016 in Spearfish, South Dakota. The Radiation Monitor was sealed in a plastic bag and laid on the ground. Radiation was counted in one-minute intervals. The graph initially shows normal background radiation. For the first day (1440 minutes), the radiation counts varied randomly over a range of about 10 CPM to 35 CPM with an average of 22 CPM, which is typical for the area around Black Hills State University (BHSU). Then, it rained. The spikes in readings are due to radon daughters being washed down to the ground during multiple episodes of rainfall.

^{222}Rn is a decay product of trace amounts of ^{238}U in soil. Because it is a noble gas, radon escapes the soil and enters the atmosphere. With a half-life of almost four days, ^{222}Rn mixes into the lower atmosphere where it transforms into ^{218}Po (half-life 3 minutes) and then to ^{214}Pb and ^{214}Bi, with half-lives around 30 and 20 minutes, respectively. These unstable atoms adhere to dust and water droplets. Precipitation carries them to the ground where they emit additional radiation and turn into ^{210}Pb, which has a half-life of 22 years—comparatively almost stable and not detected in trace quantities.



Ground level radioactivity (10 minute average)

The upshot is that rain and snow are temporarily radioactive! This is completely normal.

Dr. Andy Johnson of the Inquiry into Radioactivity project at BHSU uses these data to support radiation literacy. Rain data like these help students realize that they are living on a radioactive planet. And it is handy that some radon daughters—^{214}Pb and ^{214}Bi—have half-lives that are of the right scale, so that these radon daughters are detectable and don't last very long.

Complete Chemistry Solution Using Go Direct™ Sensors

Are you new to probeware? Need an affordable chemistry solution? Wireless or USB—the versatility is built into our new line of Go Direct sensors, so you have the flexibility to choose. Go Direct sensors connect directly to student computers, Chromebooks, or mobile devices. The sensors are supported by our free Graphical Analysis™4 app and can be used with over 100 chemistry experiments in our updated 4th edition chemistry lab books—now available digitally. For more information, visit **www.vernier.com/chemistry**

Go Direct Sensors for Chemistry

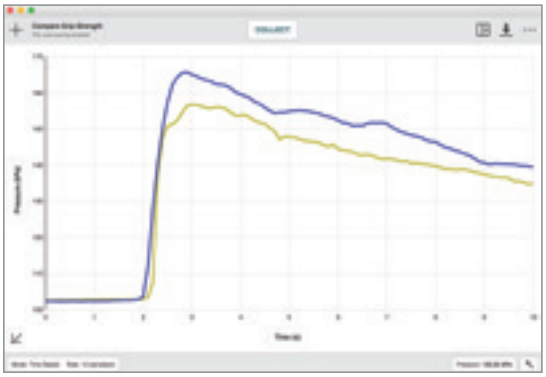
- Go Direct Colorimeter
- Go Direct Conductivity
- Go Direct Constant Current System
- Go Direct Drop Counter
- Go Direct Electrode Amplifier
- Go Direct Gas Pressure
- Go Direct Melt Station
- Go Direct ORP
- Go Direct pH
- Go Direct Radiation Monitor
- Go Direct SpectroVis Plus
- Go Direct Temperature
- Go Direct Voltage

For a complete list of Go Direct sensors, visit **www.vernier.com/go-direct**

NEW Gas Pressure Accessory for Measuring Grip Strength

Everyone loves the "Get A Grip" activity from our *Middle School Science with Vernier* lab book in which students connect a plastic bottle to our Gas Pressure Sensor to measure grip strength. Because it can be difficult to find the right bottle, we now offer easy-to-use, reusable bulbs. A set of four latex- and phthalate-free Gas Pressure Sensor Bulbs costs only $21. The accessories that came with your Gas Pressure Sensor include all of the parts required to attach the bulb. A replacement set of accessories can be purchased (PS-ACC, $12). For help getting started, watch our quick tips video at **www.vernier.com/r171**

GPS-BULB4 $21



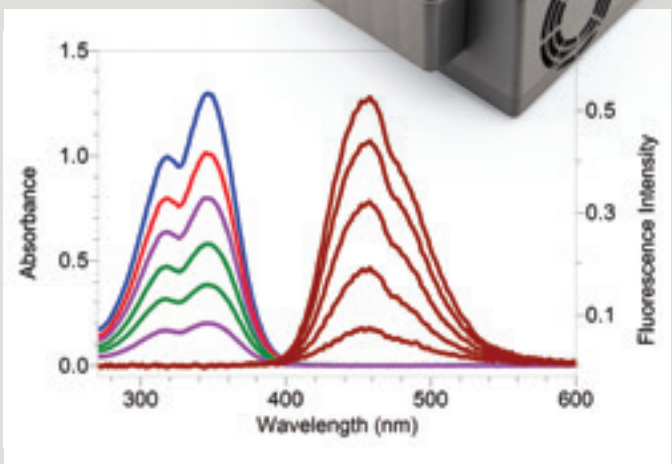
Comparing grip strength between left and right hands with the Gas Pressure Sensor and Bulb

An updated version of the "Get a Grip" activity using the Gas Pressure Sensor Bulb can be found at **www.vernier.com/r172**

Using the **NEW** Vernier Fluorescence/UV-VIS Spectrophotometer to Quantitatively Investigate Quinine Fluorescence

The Vernier Fluorescence/UV-VIS Spectrophotometer is a new addition to our line of spectrometers and spectrophotometers. It has a spectral range of 220–900 nm, photometric accuracy of ±5%, wavelength accuracy of ±2 nm, and a fluorescence detection limit of 1 mg/L quinine sulfate. This makes it an ideal tool for quantitatively investigating the absorbance and fluorescence spectra of compounds such as quinine sulfate, DAPI, GFP, rhodamine, and tryptophan. One classical use of a fluorescence spectrophotometer is an investigation of quinine sulfate. Scientists at Vernier have written "Absorbance and Fluorescence Characterization of Quinine" to help you and your students perform this fundamental experiment. To download a student experiment and helpful instructor information, visit **www.vernier.com/vsp-fuv**

VSP-FUV $2,750



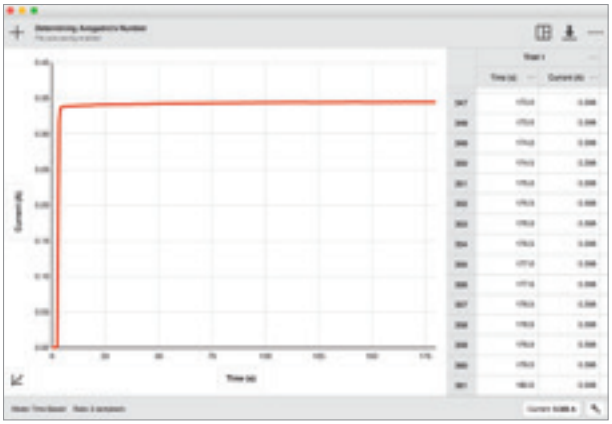
Quinine sulfate spectra are shown at varying concentrations. Absorbance (left) and fluorescence with excitation at 375 nm (right)

Determining Avogadro's Number

Nüsret Hisim, Chemistry Educational Technology Specialist

"Equal volumes of different gases at the same temperature and pressure contain equal numbers of particles." Amedeo Avogadro made this profoundly simple and unexpected statement in 1811, well before the discovery of electrons, protons, or neutrons. Today, the value called Avogadro's number is central to many calculations and measurements done in chemistry.

A clever way for your students to determine Avogadro's number is to follow electrons as they move during an electrochemical reaction. In "Determining Avogadro's Number" from our *Advanced Chemistry with Vernier* lab book, we follow the electrons with the new Go Direct™ Constant Current System (GDX-CCS, $59). The benefit of using this technology is that it combines a power supply and an ammeter in one easy-to-use system, greatly simplifying equipment setup. Students measure the current used to remove copper metal from a copper electrode over time. Knowing the mass of copper converted from the metallic form to the ionic form Cu^{2+} in solution allows your students to make a very good estimate of Avogadro's number. What a great way to apply electrochemistry, oxidation/reduction, and stoichiometry.



Monitoring current delivered during electrolysis using the Constant Current System and Graphical Analysis 4

Like all of our new Go Direct sensors, the Go Direct Constant Current System has both wireless and USB capabilities and can be used with our free Graphical Analysis 4 app on computers, Chromebooks, and mobile devices. The standard version of this sensor, the Vernier Constant Current System (CCS-BTA, $59), can also be used for this experiment.

For detailed instructions, visit **www.vernier.com/r173**

NEW 4th Edition Lab Books with Graphical Analysis™ 4 Instructions

Our 4th edition lab books are now available as eco-friendly electronic downloads in addition to the traditional print format. The updated 4th editions also include newly added Graphical Analysis 4 instructions for use with Go Direct sensors or with standard sensors connected to an interface. Updated lab books include *Chemistry with Vernier*, *Advanced Chemistry with Vernier*, *Investigating Chemistry through Inquiry*, *Vernier Chemistry Investigations for Use with AP Chemistry*, *Middle School Science with Vernier*, and *Physical Science with Vernier*.

If your school or department already owns a copy of one of our lab books, the electronic files and resources are available in your Vernier account. Log in or create your account at **www.vernier.com/account**

Winners of the Vernier $5,500 Engineering Grant

Vernier Software & Technology sponsors a contest for educators who creatively use Vernier sensors to introduce engineering concepts or engineering practices to their students. 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.

Congratulations to the 2017 Winners!

Carl Stoltz, an engineering, physical science, and physics teacher at Hononegah High School in Rockton, Illinois, wanted to integrate NGSS HS-PS4-1 (use mathematical representations to support a claim regarding relationships among frequency, wavelength, and speed of waves traveling in various media) into both his conceptual and general physics classes. He created a project that combines learning the physics of sound waves with practicing engineering principles.

Tate Rector, an engineering and Project Lead The Way teacher at Beebe Junior High in Beebe, Arkansas, has his students attempt to solve a problem facing their community. One group of students used a Vernier Temperature Probe, LEGO® EV3, and Arduino™ to develop a safety device for cars that warns operators when the interior is becoming too hot for infants.

Honorable mention goes to the following teacher:

William Anderson at St. Louis University High School in St. Louis, Missouri, will be launching a weather balloon twice each school year to understand the structure and function of the atmosphere and to investigate seasonal and altitudinal changes in atmospheric conditions.

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

Quantifying Sources of Systematic Error in Video Analysis Experiments

John Zwart, Kayt Frisch, and Tim Martin,
Dordt College, Sioux Center, IA

Video analysis experiments have strong potential to reinforce student learning and build intuition; however, in the intro physics lab, students often find experimental values that are substantially different from the expected results (e.g., a curve-fit derived value for g of 11.59 ±0.02 m/s² for a tossed golf ball). Despite giving students specific instructions for setting up video equipment, we frequently see poor experimental results. This suggests that small variations in the experimental setup produce significant systematic errors. We investigated what happens when students deviate slightly from two specific tips: "place a ruler, meter stick, or other scale item in the same plane as the motion being recorded" and "position the camera so the line of sight is normal to the plane of motion." We also investigated the effect of different focal length choices, specifically a wide angle setting (shortest focal length, widest field of view, objects appear smaller) and a telephoto setting (longest focal length, narrow field of view, objects appear larger).

Meter stick array used to investigate motion in a different plane than the reference length. The middle meter stick was used as the "true" reference length.

To investigate the "place a ruler, meter stick, or other scale item in the same plane as the motion being recorded" tip, we used an array of meter sticks and measured distance relative to the center meter stick. We found that when using the wide-angle setting, an object placed 40 cm in front of the reference meter stick would appear 40% larger than its actual size, while an object placed 40 cm behind the reference meter stick would appear 20% smaller than the true size. The effect diminished to 10–15% for the normal and telephoto settings. For a student's experimental setup, this means that the apparent distance traveled by a tossed ball would appear longer or shorter than the actual distance.

Our results show that significant systematic errors can occur for relatively small deviations from ideal camera/reference placement, particularly when using a wide-angle lens. If you use a zoom lens, standing farther away and using the telephoto setting will reduce the likelihood of these types of systematic errors. When using a fixed lens that is wide angle (such as a typical cell phone), you need to be particularly careful when setting up the video collection equipment.

For more detail, visit **www.vernier.com/r174**

INNOVATIVE USE

The Greenhills Renewable Energy Dashboard

GRED dashboard displaying rooftop data from green roof, solar array, and wind turbine

Innovatively using Vernier technology beyond the walls and time constraints of a typical classroom, Chris Gleason, a middle school science teacher, and her husband, Jim, a retired electrical engineer, created the Greenhills Renewable Energy Dashboard (GRED). GRED collects, displays, and archives continuous, real-time performance data from the rooftop renewable energy resources at Greenhills School in Ann Arbor, Michigan. These include a 10 W wind turbine, a 5 W solar array, and a living green roof that covers portions of the school's standard white roof. GRED also captures environmental data, including wind speed and solar irradiance, from a rooftop Davis weather station.

The GRED components are on display inside the school. Control and data acquisition is enabled by multiple Vernier technologies: two SensorDAQ® interfaces, four current sensors, three voltage sensors, two rooftop temperature sensors (one pinned to the white roof and one tucked under the green roof), and a Digital Control Unit (DCU). The wind turbine and solar array are connected to a 12 V battery via their respective charge controllers that provide power to two 5 W LEDs.

A custom LabVIEW program displays selected real-time and historical data. The program also archives all of the data in spreadsheet files for access by teachers and students. The on/off state of the LEDs are controlled by the LabVIEW program (via the DCU and a relay) to periodically illuminate a dedication wall.

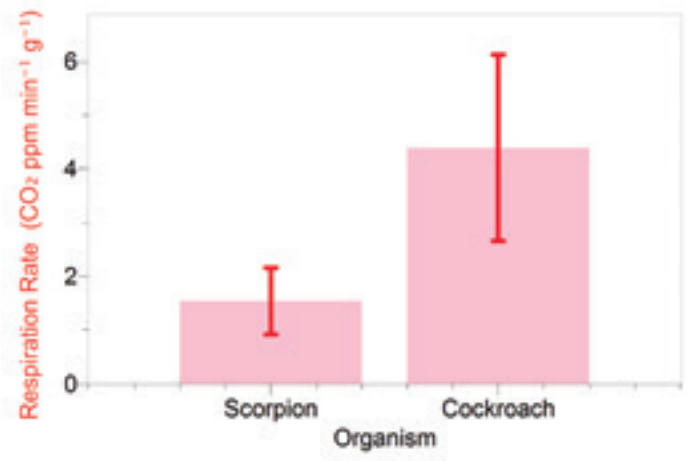
Chris Gleason believes GRED exemplifies how middle and high school science teachers can enhance student learning by integrating educational resources related to energy, weather, data analysis, and STEM.

In the hope that GRED will be useful to other middle and high schools and will lead to the development and sharing of ideas on how to better leverage the existing investment, including hardware architecture and control software, GRED data and documentation are available at **www.vernier.com/r175**

Study the Evolution of Respiratory Systems with a CO_2 Gas Sensor

Darwin's theory of evolution is a central concept in biology, and many instructors have been asking how our sensors can be used to teach evolutionary concepts. Experiments that investigate comparative physiology are often a good place to start, and Dr. Sara Tallarovic at the University of the Incarnate Word in San Antonio, Texas, has developed a simple activity that works well. In this activity, Dr. Tallarovic has her students investigate the comparative respiratory physiology of members of the phylum Arthropoda using a Vernier CO_2 Gas Sensor.

While both scorpions and cockroaches are found within the phylum Arthropoda and are similar in size, they are categorized in different classes and occupy different niches. For example, desert scorpions live in hot, arid, desert environments and survive with minimal amounts of water and food, while cockroaches live in warm, humid, tropical environments and constantly forage for food. Scorpions and cockroaches also have very different respiratory systems. Scorpions have specialized respiratory structures in their abdomen called book lungs, so called as they resemble a folded book. In contrast, cockroaches have a specialized tracheal system, which resembles a series of air-filled tubes that are located throughout the animal.



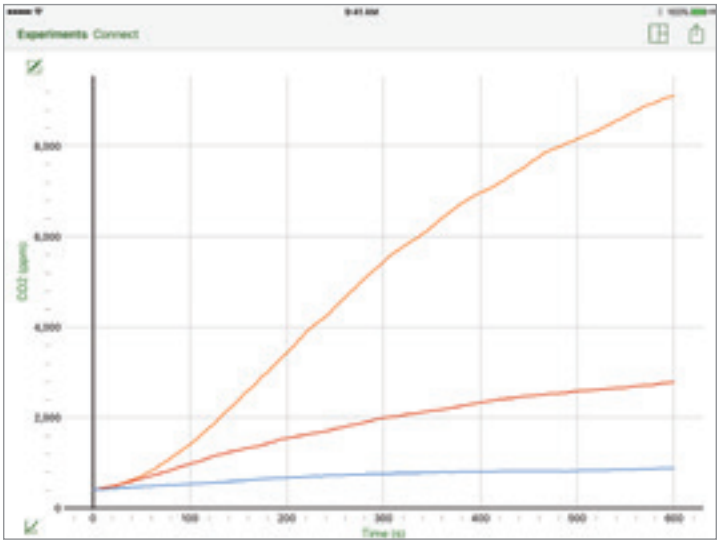
Comparing the respiration rates of arthropods

Dr. Tallarovic has her students measure the respiration rate of scorpions and cockroaches using a respiration chamber and the CO_2 Gas Sensor. The students measure the respiration rate and then compile the class data to find the mean and standard deviation of the respiration rate for each species. An independent t-test is then done to determine if the respiration rates are significantly different. As can be seen in the graph, scorpions have a lower respiration rate than cockroaches, suggesting that each species has evolved to occupy different ecological niches.

Dr. Tallarovic has graciously allowed us to share her experimental write-up. You can find the student and teacher instructions, along with a simple primer on how to conduct statistical tests, at **www.vernier.com/r176**

For questions, contact biology@vernier.com

Study the Carbon Cycle with a CO_2 Gas Sensor and Soil



Soil respiration measured at three different locations with the CO_2 Gas Sensor

Studying soil is an easy way to introduce students to the role of cellular respiration in the carbon cycle. The Great Lakes Bioenergy Research Center (GLBRC) has developed a set of free, NGSS-aligned, classroom materials to guide educators through using different methods to measure cellular respiration from soil microbes, often referred to as soil respiration. Vernier biologists tested this activity and found that it produces great results. We used our CO_2 Gas Sensor to compare soil respiration at three locations around the Vernier office. The orange trace on the graph shows that the soil respiration rate was highest in planter boxes that had recently been placed on our roof. The blue trace in the graph shows that the soil respiration rate was lowest around compacted soil next to a large tree. For a full description of this activity and a link to download related materials and instructions, see **www.vernier.com/r177**

If you have any questions about this activity, contact biology@vernier.com

Job Opening Announcement

The Vernier Biology Department is hiring! If you want to be part of the future of biology at Vernier, consider applying for our Biology Educational Technology Specialist position. We're looking for someone who is currently teaching or has recently taught biology using Vernier products. If you want to live in Oregon and be part of one of the "100 Best Companies to Work for in Oregon" (17 times!), consider applying today. We'd love to have you join our team.

Application deadline is May 30, 2017. For more information, visit **www.vernier.com/jobs**

NSTA Recommends Go Wireless® Heart Rate

Go Wireless Heart Rate received a positive review from Edwin P. Christmann, who writes for the National Science Teachers Association blog. The review describes the Go Wireless Heart Rate as an "incredibly user-friendly device" and an "excellent tool for meeting the instructional objectives."

Read the full review at **www.vernier.com/r178**

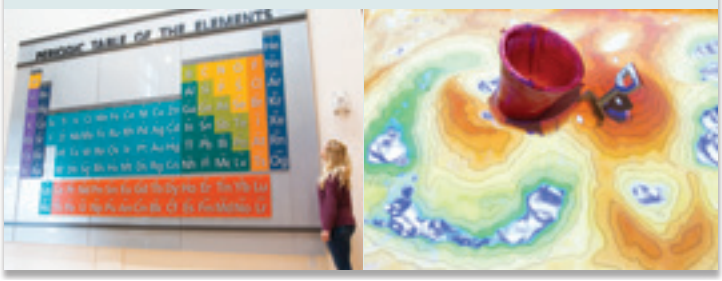
Ecology/Environmental Science Teaching Award Winner Announced

Doug Anderson of Brentwood High School in Nashville, Tennessee, was the 2016 recipient of the National Association of Biology Teachers' NABT Ecology/ Environmental Science Teaching Award. This award, sponsored by Vernier, was presented at the 2016 NABT Professional Development Conference in Denver, Colorado. Mr. Anderson is an AP Environmental Science teacher who uses a place-based approach in his environmental science course.

This award is given to a secondary school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his/her commitment to the environment into the community. For more information, visit **www.nabt.org**

Additions in the Vernier Building

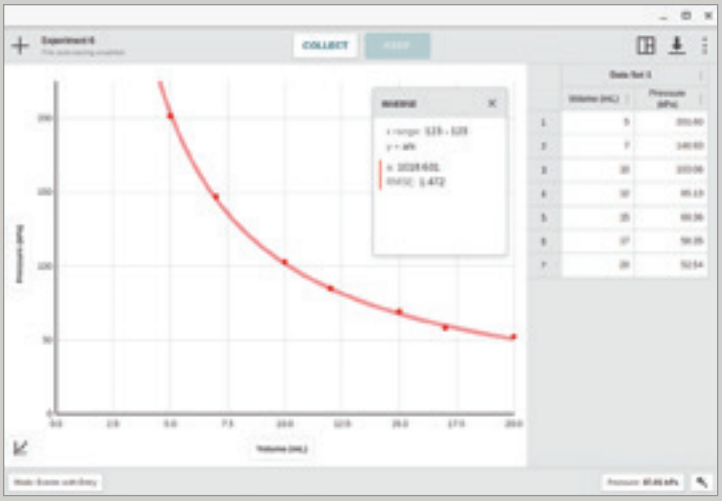
If you are in Portland, Oregon, stop by our office to see two new additions: an augmented-reality sandbox and an update to our giant periodic table to include the four recently named elements. See our augmented-reality sandbox in action at **www.vernier.com/r179**



NEW Graphical Analysis™ 4

We are pleased to announce our free Graphical Analysis 4 app for just about any device your students have: Windows, macOS, Chromebook, iOS, and Android. This makes it easy for your students to collect data on one device, move the file to a different device through a convenient path such as Google Drive,™ and continue analyzing the data.

With core analysis features such as curve fits, statistics, and calculated columns, Graphical Analysis 4 fulfills the majority of your data-collection and analysis needs. Graphical Analysis 4 is not an update to old software; it is a new and modern data-collection and analysis application that supports most Vernier sensors, including our new Go Direct™ family of sensors.



For Spring 2017, we've updated four of our chemistry lab books, as well as the middle school and physical science books, to work with Graphical Analysis 4. More books will be updated throughout the year.

To download the macOS and Windows versions of Graphical Analysis 4 directly from the Vernier website, visit **www.vernier.com/downloads**

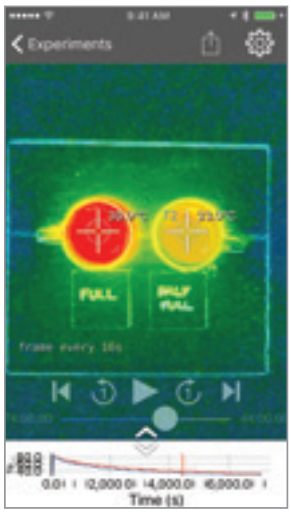
Get the Chrome, iOS, and Android versions from the respective app stores.

In short, Graphical Analysis is an old name for a new application. We think you'll like it a lot.

Did you know?

In 1982, Vernier released an Apple II program called Graphical Analysis. It allowed students to type in data and see a graph, and then fit curves and do calculations on the data. There was nothing like it. Since then, there has always been a Vernier application available under that title—for Windows, Macintosh, and more recently iOS, Chrome, and Android. Each title has carried on the tradition of providing student-friendly graphing and data-analysis tools.

Introducing Vernier Thermal Analysis™ Plus App for iOS



Using the time-lapse feature, cooling water is tracked by Thermal Analysis Plus for almost 2 hours.

We have released a new version of our popular Vernier Thermal Analysis app. Vernier Thermal Analysis™ Plus for FLIR ONE™ is designed for anyone who wants to create infrared time-lapse video and temperature data sets. Without the time-lapse feature, videos are limited by device capacity to several minutes at most. With time-lapse capabilities and an external power source, you can collect thermal video data for hours.

The Plus version includes all the features of our original Thermal Analysis app, so students can also observe temperature changes on the skin, illustrate convection, track heating due to friction, analyze the transparency of materials in infrared compared to visible light, and much more. Vernier Thermal Analysis Plus is available in the App Store.

This year, FLIR is introducing two new models of FLIR ONE: The 3rd generation FLIR ONE and the FLIR ONE Pro. Both versions of Thermal Analysis will support both new versions of the camera soon after they are available.

For more information, see **www.vernier.com/thermal-analysis**

Software Updates

We regularly release software updates to support new sensors, add new features, and fix the occasional bug. Keeping up to date with software releases is one way to keep things running smoothly in your classroom or lab. Have you updated your Vernier applications recently? Updates are free, and in the last year we've released updates for nearly all our software.

For updates to our computer software (e.g., Logger *Pro*) and LabQuest App, visit **www.vernier.com/downloads**

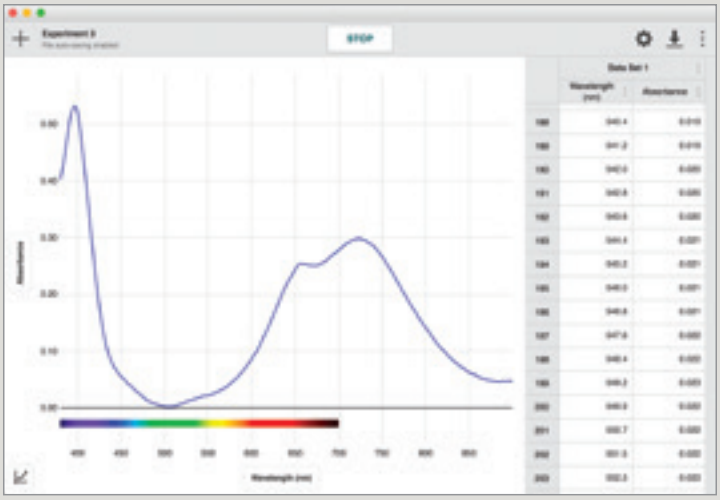
For updates to Chrome,™ iOS,® and Android™ applications, search the respective store, or visit **www.vernier.com/downloads**

10 Years Ago in This Newsletter

In 2007, we announced LabQuest, our first standalone lab interface. LabQuest was a huge hit and is still used by thousands of science teachers around the world—we know because we still fix them and send them back for more data collection. A new version of LabQuest, LabQuest 2, came out in 2012.

NEW Vernier Spectral Analysis™ 4: Dedicated Spectroscopy

Spectral Analysis 4 is our new, free, streamlined spectroscopy app for just about any device your students have: Windows,® macOS,® Chromebook,™ iOS, and Android. It works with our SpectroVis® Plus Spectrophotometer and the new Go Direct™ SpectroVis Plus Spectrophotometer.



Absorbance spectrum of nickel (II) sulfate in Spectral Analysis 4

Spectral Analysis 4 focuses on spectrometers allowing students to quickly collect and analyze spectrometer data with no extraneous functions. Students use the goal-based setup to choose to measure Absorbance (or transmittance) *vs.* Wavelength, Concentration, or Time. The app is then configured for data collection. After data collection, analysis features such as curve fits, interpolation, and calculated columns are available.

Download the macOS and Windows versions directly from the Vernier website (**www.vernier.com/downloads**), and get the Chrome, iOS and Android versions from the respective app stores.

For more information, see **www.vernier.com/til/3885**

Science Humor

Chemistry class can be a little depressing.
The cylinders know more than you do; they've already graduated.

How can you tell the difference between a chemist and a plumber?
Ask them to pronounce "unionized."

A group of protesters in front of a physics lab:
"What do we want?"
"Time travel"
"When do we want it?"
"Irrelevant"

Why can't atheists solve exponential equations?
Because they don't believe in higher powers.

Vernier/NSTA Technology Award Winners

The Vernier/NSTA Technology Awards recognize the innovative use of data-collection technology in the science classroom or laboratory. Each winner is selected by NSTA and receives $1,000 in cash, $3,000 in Vernier products, and up to $1,500 toward expenses to attend the annual NSTA National Conference. Start planning your 2018 entry now. To apply, see **www.vernier.com/grants/nsta**

ELEMENTARY SCHOOL

Kathryn Eyolfson

Coyote Hills Elementary, Aurora, CO

STEM teacher Kathryn Eyolfson teaches her students about renewable and nonrenewable energy resources through inquiry and project-based learning. During one unit, fifth-grade students utilize Vernier technology as they apply science and engineering practices to construct wind turbines with the KidWind Advanced Wind Turbine Kit.

MIDDLE SCHOOL

Carrie Herndon

Metro East Montessori School, Granite City, IL

Each week, Carrie Herndon's students engage in various hands-on data-collection investigations at a nearby 260-acre farm. In one investigation, students carefully observed a beehive on the farm, took pictures, and used Vernier sensors to collect and analyze data after they noticed the bees were behaving in an unusual manner.

Terra McMillan

Thomson Middle School, Centerville, GA

Using her school's solar array and the associated monitoring database, along with Vernier probeware, Terra McMillan plans to implement even more inquiry-based data-collection experiments across all three of her school's grade levels. For example, in seventh-grade Life Science, students will use CO_2 Gas Sensors to learn how plants use energy from the sun during photosynthesis, acting almost like living solar panels.

HIGH SCHOOL

Amy Melby

Yuma High School, Yuma, CO

Physics students in Amy Melby's class will participate in a study of the Greater Prairie-Chicken to better understand whether the addition of wind turbines in nearby sandhills impacts the species. Students will record and analyze the various vocalizations produced by the birds, as well as the sounds generated by the turbines, using Vernier sensors.

Hannah Erickson

Boston Day and Evening Academy, Roxbury, MA

Hannah Erickson's school is located in a neighborhood of Boston with an asthma rate six times higher than the state average. Using Vernier sensors, Erickson plans to have her students gather data about atmospheric CO_2 levels both in the school's neighborhood and in a variety of other neighborhoods throughout the city to study the potential cause of this problem.

Dr. René Corrales

STAR Academic Center, Tucson, AZ

In Dr. René Corrales' physics class, students use Vernier sensors as part of a hands-on invesigation to study electric and magnetic field lines to see how those fields interact.

COLLEGE

Donald Carpenetti

Craven Community College, New Bern, NC

In Donald Carpenetti's Organic Chemistry II class, students are put in small groups to take part in original research projects involving data collection, such as developing a guided inquiry-based gas laws experiment incorporating pressure sensing technology and evaluating a solid mixture.

Spotlight on a Past NSTA Award Winner

A Hands-On Approach: Using Data-Collection Technology to Learn the Mechanics of a Water Rocket

Ashley Webb, DeSoto Central High School, Southhaven, MS

As a 2014 Vernier/NSTA Technology Award recipient, I have been able to make hands-on learning an ingrained part of my physics and chemistry classes. Vernier technology helps my students transform ambiguous concepts into tangible ideas, supports guided inquiry, and works masterfully for my visual and kinesthetic learners.

As part of our rocket project, my students identify a problem; brainstorm, design, and build a rocket to solve that problem; test and evaluate their design; redesign their rocket as necessary; and share their final project with the class. During the project, students use data to describe the mechanics of their rocket—from Newton's third law to the Impulse-Momentum Theorem to the idea of Conservation of Mechanical Energy.

Read more about Webb's project at **www.vernier.com/r1711**

Vernier in the Journals

More than Meets the Eye—Infrared Cameras in Open-Ended University Thermodynamics Labs

Emil Melander, Jesper Haglund, Matthias Weiszflog, and Staffan Andersson; Uppsala University, Sweden, *The Physics Teacher*, Vol. 54, No. 9, December 2016.

This article shows the advantages of using IR cameras and explains five laboratory assignments to have your students investigate. While the authors used IR cameras costing between $500 and $1500, we think these topics can be investigated with our FLIR ONE™ camera for less than half the price. Also, our free iOS app, Thermal Analysis,™ would do a great job on the analysis.

Suggested Products: FLIR ONE Thermal Camera, Thermal Analysis

Kinetic Explorations of the Candy-Cola Soda Geyser

Trevor P. T. Sims and Thomas S. Kuntzleman; *J. Chem. Educ.*, 2016, 93, 1809–1813.

The physical and chemical concepts and processes involving change in CO_2 concentration, mass, and pH as they apply to the NISD (nucleation-induced soda degassing) of carbonated soft drinks with Mentos® candy are studied. The author and his students carried out numerous experiments to set up and monitor these changes using a Vernier CO_2 Gas Sensor, an OHAUS® balance using Logger *Pro* software, and a pH sensor. Arrhenius plots were also done to determine the activation energy, E_a, for the change.

Featured Products: CO_2 Gas Sensor, OHAUS balance, and Logger *Pro*

Measuring Metabolism: Examining the Effects of Temperature on the Metabolic Rates of Beetles

Angela Chapman, Aaron Chila, Tracy McAllister, and Victor Aguilar; *The Science Teacher*, 2016, 83(7), 55–60.

This article describes a laboratory activity in which students determine the effect of temperature on the metabolic rates of bess beetles. Using a CO_2 Gas Sensor, students measure the production of CO_2 from beetles at 4°C, 25°C, and 32°C. From this data, students then mathematically determine the metabolic rate of the beetles.

Featured Products: LabQuest, CO_2 Gas Sensor, and Stainless Steel Temperature Probe

For more articles, visit **www.vernier.com/r1712**

Stellar Service Makes a Measurable Difference

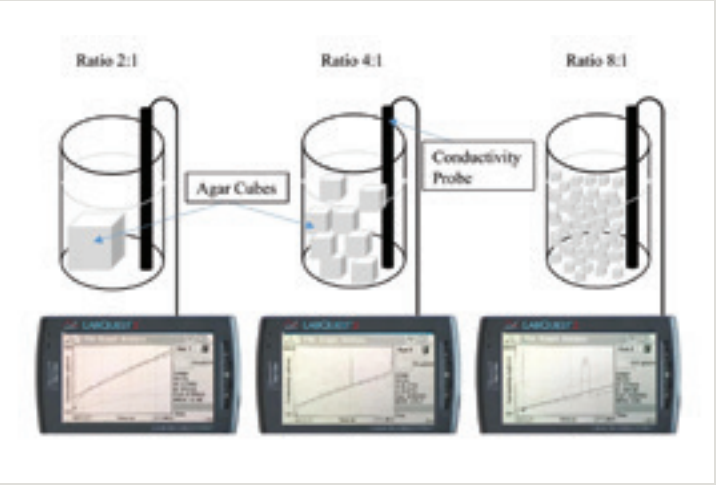
CASE STUDY

Vernier Technology Makes a Difference: Building Visual and Digital Literacy

Molly Sultany, Northwest Academy, Portland, OR

Integrating art and digital technology into my teaching, especially with my biology classes, has always been something I enjoyed and something that helps to engage and foster creativity in my students. Utilizing Vernier sensors has transformed the quality of lab experiences at my school, immersing students in cognitively demanding tasks that are highly rewarding. The sensors allow students to explore biological concepts with cutting-edge digital technologies while facilitating greater confidence and competency among students by helping them develop stronger quantitative and mathematical skills. Additionally, using Vernier lab investigations represents an excellent avenue to reinforce scientific thinking strategies while helping students develop visual literacy. When students are asked to interpret data and teach one another, their learning process becomes greatly enriched.

To read more about Sultany's inquiry-based experiments, astrobiology investigations using probeware, and her unit on "Limitations on Cell Size: Surface Area to Volume," visit **www.vernier.com/r1713**



Procedural sketch of the experiment "Limitations on Cell Size: Surface Area to Volume." Vernier technology used includes LabQuest 2 and the Conductivity Probe, and the data show linear regression. (Credit: Sushruta Chandramouli)

Educators worldwide use our technology, services, and resources to engage students in science investigations. Read how your colleagues make a measurable difference with Vernier and share your story at **www.vernier.com/stellar-service**

Summer is the perfect time to visit Oregon! And there is a wealth of things to see and do in Portland, including Powell's Bookstore, the International Rose Test Garden, and Voodoo Doughnut!

Oh, and you can attend one or more of our subject-specific workshops while you are here!

Hands-On Summer Institutes

Most schools may close for the summer, but the learning never stops at Vernier. Join us for a full-day exploration of our award-winning technology. Experiment with a variety of interfaces and sensors, including our new Go Direct sensors with options for wireless and USB connectivity. You'll leave the workshop ready to enhance your students' learning with data collection.

The cost of the institute is $99, which includes an electronic lab manual of your choice. For registration options, including discounted workshop hardware packages, visit **www.vernier.com/summer-institutes**

State	City	Date
CO	Denver	6/19
CA	San Jose	6/21
UT	Salt Lake City	6/22
NC	Raleigh	7/11
VA	Fairfax County	7/13
MO	St. Louis	7/17
IL	Chicago	7/19
OH	Columbus	7/21
PA	Philadelphia	7/24
NY	New York City	7/26
MA	Boston	7/28
OR	Beaverton	8/2
WA	Seattle	8/4

Two-Day, Subject-Specific Institutes

Held in Beaverton, Oregon, at the Vernier Office

Biology Institute

June 26–27, 2017

The $199 registration fee includes lunch and a copy of the lab book, *Investigating Biology through Inquiry*, a $48 value.

Chemistry Institute

June 29–30, 2017

The $199 registration fee includes lunch and a copy of a chemistry lab book of your choice, a $48 value.

Physics Institute

July 10–11, 2017

The $199 registration fee includes lunch and a copy of the lab book, *Physics with Vernier*, a $48 value.

Details are at **www.vernier.com/r1714**

Active Learning in Introductory Physics Courses

David Sokoloff, Priscilla Laws, and Ron Thornton will once again be conducting a 3-day workshop for college, university, and high school physics instructors at our office in Beaverton, Oregon, this summer. This year the hands-on workshop is July 29–31. Details are at **www.vernier.com/r1715**

One-Day, Subject-Specific Institutes

Held in Beaverton, Oregon, at the Vernier Office

Environmental Science Institute

June 28, 2017

The $99 registration fee includes lunch and a copy of the lab book, *Investigating Environmental Science through Inquiry*, a $48 value.

Engineering for Science Classrooms Institute

July 12, 2017

The $99 registration fee includes lunch and a Vernier Digital Control Unit, a $61 value.

Vernier Sensors with Arduino™ Institute

July 13, 2017

The $99 registration fee includes lunch and a SparkFun® Arduino RedBoard with a Vernier Interface Shield, a $50 value.

Renewable Energy Institute

July 14, 2017

The $99 registration fee includes lunch and a copy of the lab book, *Renewable Energy with Vernier*, a $48 value.

Details are at **www.vernier.com/r1714**

Can I preview Vernier equipment before purchasing?

If you are considering incorporating our technology into your classroom or laboratory, we offer a 30-day preview (or longer, if needed) for most of our products.

To get the most out of your preview, we recommend pairing the preview with a free one-hour, web-based training session with one of our specialists.

Contact Vernier Technical Support at support@vernier.com or 888-837-6437 to arrange a preview and a web-based training session.

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