Vernier

College Edition

SPRING 2020 • Vol. 37 • No. 1

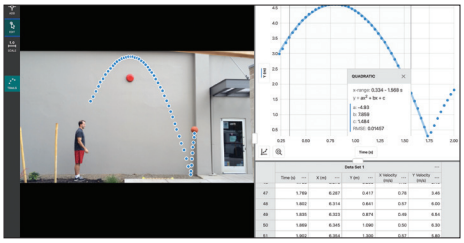
THE Caliper NEWSLETTER

Remote Learning Solutions

We understand how difficult the coronavirus crisis continues to be for instructors, lab managers, administrators, and students. So many of you are trying to quickly stitch together an online learning curriculum with limited institutional resources, all while trying to keep in mind that students might have limited access to technology. To help support you right now, we have created several free remote learning resources. Explore these solutions in the sections below.

We hope the experiment ideas, technology, and software detailed in the rest of these pages will help inspire you when it's time to plan for next semester.

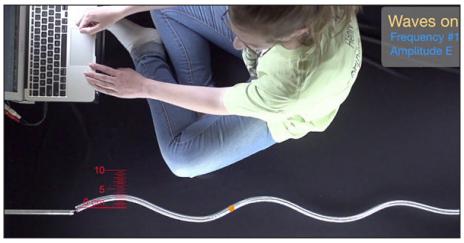
See our online training for remote learning at www.vernier.com/remote-learning



Study Physics Anywhere with Vernier Video Analysis™

Vernier Video Analysis is a physics-focused tool where students can use their mobile devices to insert their own videos with recorded motion, mark points to track the object in motion, and set the scale of the video. This app brings physics and video analysis to all your students regardless of their location. An extended free trial is available through June 2020.

Read more on page 2.



Pivot Interactives: Perfect for Distance Learning

Pivot Interactives is a video-based science learning environment. With more than 200 interactive activities, the high-quality videos from Pivot Interactives give your students the opportunity to observe and study hard-to-replicate experiments and phenomena no matter where they are.

A free 30-day trial and reduced subscription pricing are now available.

Read more on page 3.

Analyze Experiment Data at Home

To help ensure students continue to sharpen their critical-thinking skills and learn key scientific concepts during this precarious time, Vernier has put together the Experiment and Sample Data Library. This collection of over 200 free experiments with sample data files covers many subjects, and is available to you and your students for free. Though students won't be performing the experiments themselves, they can perform their own analysis of the sample data and answer questions based on their results.

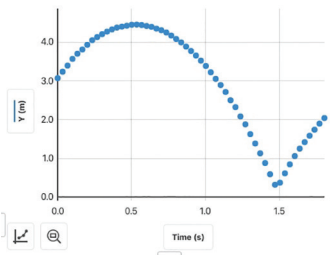
Read more on page 3.

Learn more about these free resources at **www.vernier.com/remote-learning**

Bring Video Analysis to Your Students in a Dedicated and Streamlined Application

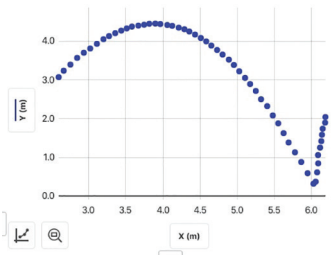
Vernier Video Analysis,™ a new member of our family of apps, is available. Right now, you can get a free trial through June and take advantage of our special introductory pricing.

Many physics instructors have long used the video analysis feature in Logger *Pro*® as a tool to help students learn key topics such as projectile motion, uniform acceleration, center of mass motion, and topics outside of mechanics. There's nothing quite like a video that the students have captured themselves to pique interest in a concept. Vernier Video Analysis now brings this tool to desktop and laptop computers, as well as Chromebooks, smartphones, and tablets.



With the ability to measure the location of an object frame by frame as it moves, Video Analysis lets students build motion graphs for just about any motion that can be captured in a short video.

To illustrate how Vernier Video Analysis works, we analyzed a basketball in flight. It is easy to collect such a video with a mobile device. When you're recording motion with students, be sure to set up in a location with plenty of light to obtain high quality video. Once the video has been captured, the analysis can begin.



We like to play the video first and ask students to sketch expected graphs of position and velocity. Then, the ball position can be marked frame by frame. If a meter stick is included in the frame of the video, students can also mark the ends of the meter stick to set the scale in the Video Analysis app.

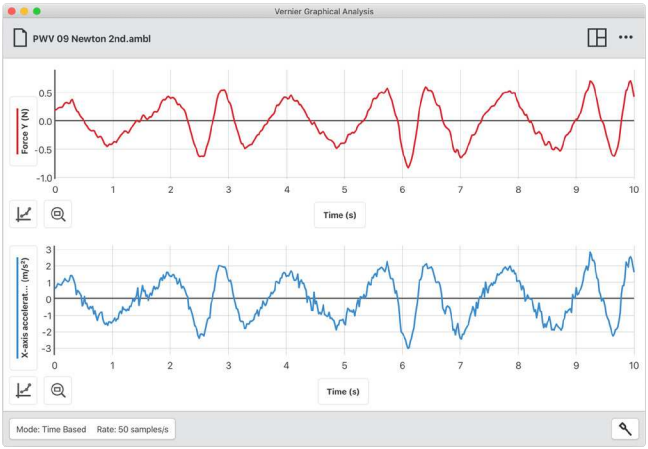
Video Analysis creates familiar graphs and data tables that have the same graph options, curve fits, and other analysis tools as our Graphical Analysis™ 4 app. In the example graphs, we've plotted Y position as a function of time, and Y *vs.* X position. Asking students to explain why these graphs are similar but not identical is an excellent discussion starter.

Learn more about Vernier Video Analysis, download the activity, and sign up for a free trial at **www.vernier.com/c2017**

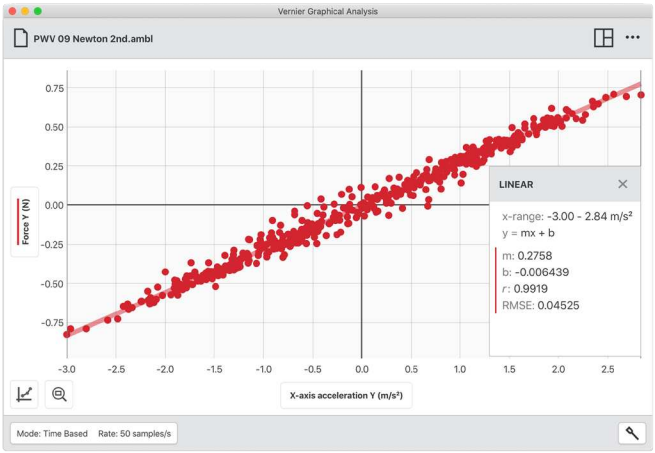
Experiment and Sample Data Library

Are your students stuck at home with no lab equipment? To assist you as you adjust to online teaching, we are introducing the Vernier Experiment and Sample Data Library—a free library of over 200 experiments along with sample data files that you can distribute to your students at home. Students won't actually conduct the experiment themselves, but they can follow along with the written procedure and then perform their own analysis of the sample data provided using one of our data-collection and analysis apps.

For example, the graphs below show the sample data provided for Newton's second law in our free Graphical Analysis™ 4 app. A Go Direct Sensor Cart measured force and acceleration as it was moved back and forth using the force sensor.



Guided by the instructions provided, your students end up with meaningful analysis relating force and acceleration, as shown in the graph below.



The Library contains many experiments across a variety of subject areas including biology, chemistry, and physics.

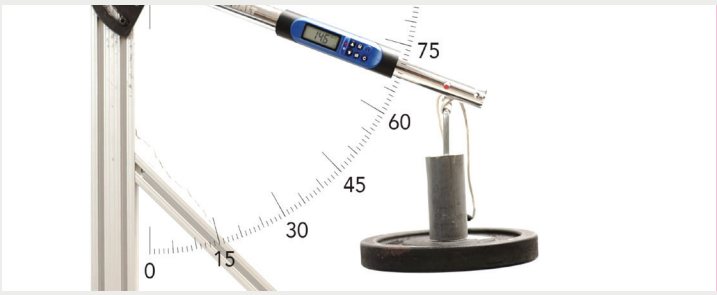
Sample data files are provided in one of the following Vernier apps, all of which are free for the remainder of the school year or longer:

- **Graphical Analysis 4.** Always free and available for Windows,® macOS,® Chrome OS,™ iPadOS,® iOS, and Android.™
- **Spectral Analysis.** Always free and available for Windows, macOS, Chrome OS, iPadOS, iOS, and Android.
- **Logger *Pro*.** Free through October 1, 2020, and available for Windows and macOS.
- **Video Analysis.** Free through June 30, 2020, and available for Windows, macOS, Chrome OS, iPadOS, iOS, and Android.

While we strongly advocate for hands-on science whenever possible, we understand that many schools are in a situation where it is not currently possible. We hope you and your students find this option helpful. If you have any questions, please feel free to contact us at support@vernier.com

Visit the Experiment and Sample Data Library at **www.vernier.com/sample-data-library**

Keep Students Engaged Remotely with Pivot Interactives



As 90 percent of schools are experiencing closures due to the COVID-19 pandemic, many educators are scrambling to find ways to teach classes remotely. Remote learning comes with a different set of challenges than the ones teachers face in the classroom or laboratory, but both types of learning need to engage students' interest. Hands-on science is a great way to capture students' attention, but with students stuck at home without the right equipment, teachers might feel as if they don't have the right resources.

Pivot Interactives, an online learning environment with more than 200 experiment videos spanning a wide variety of subjects, is just the right tool to help students learn remotely. Pivot Interactives has student assessment and classroom management features built into the experience, which means teachers don't have to create their own means of evaluation.

Designed to help teach students hard-to-replicate phenomena, Pivot Interactives is a great remote learning tool for any educator hoping to keep students engaged in science. This tool is a powerful supplement to hands-on experimentation, enabling students to vary experimental parameters one at a time to view results from a set of many recordings of the same experiment. While the students aren't conducting the experiment themselves, this ability to interact with experimental parameters and collect their own data allows students to gain a deeper understanding of the scientific concepts involved.

This web-based teaching resource has free trials and reduced pricing available to help teachers finish out the school year. To learn more about Pivot Interactives, visit **www.vernier.com/pivot-interactives**

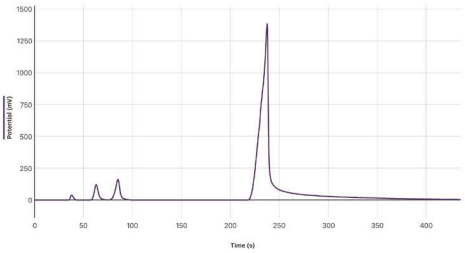
Engineering Outreach with Vernier Technology

Maija Benitz, Assistant Professor of Engineering at Roger Williams University (RWU), has just deployed 29 upper-level engineering students, along with 57 wind turbine kits, to 11 classrooms to coach 232 fourth graders as they design wind turbine blades from cups, coffee filters, cereal boxes, toilet paper rolls, and straws. In a few months, the wind turbine kits will be back at the university being used by first-year engineering majors in the Introduction to Engineering course to investigate concepts in civil, mechanical, and electrical engineering.

Benitz first used the Vernier wind turbine kits with fourth graders after hearing from the local school district about a pressing need to integrate engineering into the elementary classroom. Benitz formed an interdisciplinary collaboration with Dr. Li-Ling Yang, Associate Professor of Science Education, to design a community engagement project in which upper-level engineering majors paired with sophomore-level education majors to teach local fourth graders about wind energy.

Read more about Benitz's engineering outreach project at **www.vernier.com/c2018**

New Go Direct Mini GC Detects Polar and Nonpolar Compounds



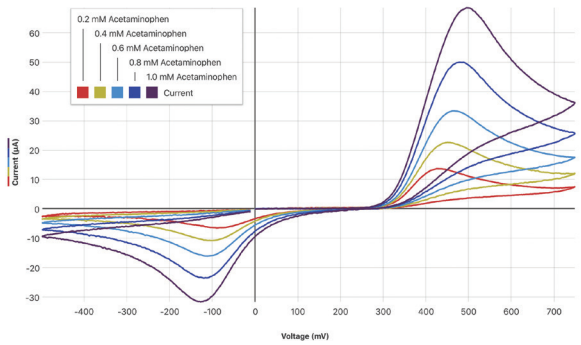
Separating a mixture of acetates and alkanes

It's been about a decade since we released the Mini GC Gas Chromatograph and educators have loved it. However, with the original version, only polar compounds such as alcohols, esters, and ketones can be injected. With the release of our new Go Direct® Mini GC,™ teachers and students can now detect both polar and nonpolar compounds, including alkanes and aromatics.

To take advantage of the expanded capabilities, new experiments, such as "Gas Chromatography Basics: Column Temperature and Loading," are included with the product as a free download. In this experiment, students inject a polar and nonpolar compound mixture and learn how adjustments to experimental parameters affect compound separation. These parameters affect the interaction between the analytes and stationary phase, which make for a great discussion about intermolecular forces.

See the full list of the class of acceptable compounds and free experiments available for the Go Direct Mini GC at **www.vernier.com/gdx-gc**

Tools to Teach Electrochemistry in Your Undergraduate Chemistry Course



Cyclic voltammograms of acetaminophen at various concentrations

Electrochemistry, a fundamental component of modern technology, is a crucial element of several rapidly growing fields of work, such as energy storage, battery chemistry, and materials science. Yet students often cringe at the topic of electrochemistry and get very little hands-on exposure to it in the classroom. The Vernier Go Direct® Cyclic Voltammetry System solves this problem with its simple design, complete system approach, free e-book, and free software.

As a tiny potentiostat, Go Direct Cyclic Voltammetry System is a great tool for teaching the fundamental electrochemistry methods of cyclic voltammetry, bulk electrolysis, and open circuit potentiometry. Students can apply analytical techniques to determine the acetaminophen concentration in medication, to explore antioxidants in everyday beverages, to investigate Faraday's law, and to understand cyclic voltammetry using ferricyanide.

Learn more about the Go Direct Cyclic Voltammetry System and how it can help you easily incorporate electrochemistry into your laboratory curriculum at **www.vernier.com/c2019**

LabArchives and Vernier Improve Access to Lab Content

With LabArchives and Vernier, instructors can give students the opportunity to gain practical and relevant data-collection and analysis experience through an intuitive digital platform.

Learn how LabArchives and Vernier are changing the way students access experiments at **www.vernier.com/lab-archives**

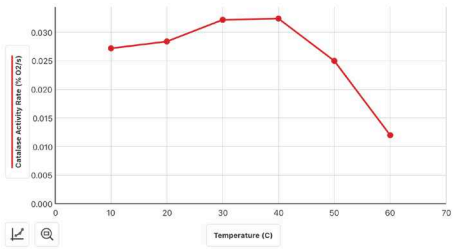
COMING SOON

Vernier and Lt by ADInstruments

With the Lt platform and Vernier technology, educators can engage students with our editable, innovative experiments. There are many learning platforms out there; what sets Lt apart is that students can collect real-time data with Vernier sensors in this platform. This function means students have a truly interactive and personalized learning experience.

Learn more about engaging students with Vernier technology and Lt by ADInstruments at **www.vernier.com/adinstruments**

Enzyme Action: Temperature of Denaturation

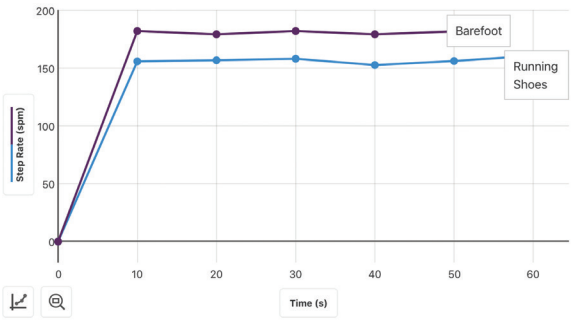


Temperatures above 40°C appear to denature the enzyme catalase.

In traditional laboratory investigations of catalase and temperature, students measure the reaction rate of the enzyme by placing the substrate and enzyme in a reaction vessel at different temperatures. This is a potential confounding factor, as higher temperatures may denature the enzyme, leading to a decrease in reaction rate. Students don't know whether the decrease in reaction rate was due to the temperature moving outside the enzyme's preferred range or to denaturation of the enzyme.

Students can incubate a sample of the enzyme at a given temperature for 10 minutes, bring the enzyme back to room temperature, and then add the enzyme to the reaction vessel with the substrate before using an O_2 gas sensor to measure the reaction rate. Following this procedure, the reaction is always performed at room temperature. As shown in the graph above, treating the enzyme to temperatures above 40°C causes a marked decrease in the reaction rate. Since the reaction occurred at room temperature, we know that the enzyme begins to denature at temperatures greater than 40°C.

Download the modified instructions on measuring the heat of denaturation using our Go Direct O_2 Gas and Graphical Analysis™ 4 at **www.vernier.com/c2020**



Comparison of step rate (spm) when wearing running shoes and running barefoot

Investigate the Biomechanics of Running

We recently used our Go Direct Respiration Belt to investigate the biomechanics of running. This sensor has a built-in pedometer that can measure steps and step rate. With this in mind, we modified our "Barefoot Running" experiment, which is available as a free download.

Barefoot running is a running trend that was popularized by Christopher McDougall in the book *Born to Run*. Traditional running technique emphasizes a heel-to-toe foot strike. Without the padding provided by traditional running shoes, barefoot running minimizes heel strike. This leads to an increase in step rate, or cadence, of the barefoot runner. As shown in the graph above, barefoot running leads to an increase in stride rate of the subject.

Essential instructor information and word-processing files of student instructions for the experiment, "The Biomechanics of Running," are available as a free download at **www.vernier.com/c2021**

2020 Vernier/NSTA Technology Award Winners Announced

Each year, Vernier Software & Technology and the National Science Teaching Association (NSTA) recognize seven educators for their innovative use of data-collection technology in the science classroom or laboratory.

Chosen by a panel of NSTA-appointed experts, the 2020 winners each received $1,000 in cash, $3,000 in Vernier products, and up to $1,500 toward expenses to attend an NSTA conference.

This year's winner for college is

Estelle Lebeau

Johnson & Wales University in Providence, RI

Read more about her innovative project at **www.vernier.com/c2022**

2020 Winners of the Vernier $5,500 Engineering Grant

Congratulations to the 2020 Winner!

David Carter, an instructor at Kansas State University, Engineering Extension, uses wind energy to introduce middle school, high school, and college students to engineering and design concepts. This includes a statewide challenge, a STEM summer institute, Introduction to Mechanical Engineering 101, and an "Energy Library" for Kansas K–12 schools.

To see details about the contest and videos of the winning entries, visit **www.vernier.com/c2023**

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 help things run smoothly in your classroom or lab. Have you updated your Vernier applications in the last few months? Updates are free, and with the release of new Go Direct sensors, we've updated nearly all our software.

For updates to Logger *Pro*® 3 for macOS and Windows, as well as for LabQuest® App, visit **www.vernier.com/downloads**

35 Years Ago in this Newsletter

We were proud to announce that our Graphical Analysis II program had won an award from *Classroom Computer Learning*. Back then, the program was available only for Apple II. Now the program is available for Windows,® macOS,® iOS, iPadOS,™ Chrome,™ and Android.™ It's pretty amazing that we still have Graphical Analysis after all these years!

Share Your Experiments With Us

How are you using Vernier technology in your curricula? Share with us at **innovativeuses@vernier.com** and, if your article is published in our newsletter, you'll receive a $100 gift certificate.

Students Investigate the Effectiveness of Sunscreens

Douglas Harris, PhD, challenges his students to use data-collection technology to test real-world applications of chemistry in an investigation of the effectiveness of sunscreens. This assignment gives students both the opportunity to use data-collection technology and the foundational knowledge needed for future lab work.

Read more about this innovative use and download the experiment at **www.vernier.com/c2024**

Science Humor

Imagine if Americans switched from pounds to kilograms overnight. There would be mass confusion!

Follow @VernierST on Twitter

Vernier in the Journals

Recent journals have featured Vernier technology in the following articles:

- Electric Circuits as Seen by Thermal Imaging Cameras
- Design and Construction of a Low-Cost Arduino-Based pH Sensor for the Visually Impaired Using Universal pH Paper
- Exploring Chemical Equilibrium for Alcohol-Based Cobalt Complexation through Visualization of Color Change and UV–vis Spectroscopy
- Hot Reactions: Applying Infrared Thermography in the Chemistry Education Laboratory
- Revisiting the Determination of Percent Aspirin Lab: Using a Limiting Reactant Approach for Students to Also Determine the Amount of Iron (III) Chloride
- Aluminum Metal Digestion as a Demonstration of an Oscillating Voltage Reaction: An Application Beyond the Textbook

See the references and learn more about these uses at **www.vernier.com/c2025**

Vernier Software & Technology
13979 SW Millikan Way
Beaverton, OR 97005-2886

888-VERNIER (888-837-6437)
fax 503-277-2440

www.vernier.com
info@vernier.com

Logger *Pro*, LabQuest, Vernier and caliper design, Go Direct, and Vernier Spectral Analysis are our registered trademarks in the United States. Vernier Software & Technology, vernier.com, Vernier Video Analysis, and Graphical Analysis, are our trademarks or trade dress. All other marks not owned by us that appear herein are the property of their respective owners. macOS is a trademark of Apple Inc., registered in the U.S. and other countries.