Vernier

2017

CATALOGUE

Vernier Software & Technology

Vernier Software & Technology was co-founded in 1981 by Dave and Christine Vernier. Dave's background as a physics teacher and Christine's knack for business combined to form a company with a deep commitment to education.

Thirty-six years later, the company is still owned by Christine and Dave, along with 11 employee owners who have backgrounds in science and math education, as well as business.

2016 Best Companies to Work For in Oregon

2016 Healthiest Employers

2016 Best Green Companies in Oregon

2016 Top Work Places in Oregon

2016 Corporate Philanthropy Award

Vernier is proud to be recognized for its philanthropic commitment, environmental policies, steady growth, and as one of the Best 100 Companies to Work For in Oregon for 16 years.

2017 CATALOGUE

Co-founder, David Vernier and CEO, John Wheeler, host local science and engineering students for National Manufacturer's Day.

Pioneering New Technology

Go Direct Sensors—USB and Wireless

This year, we are excited to introduce our new Go Direct sensors—a family of sensors that connect directly to Chromebooks, mobile devices, or computers (macOS or Windows). With Go Direct sensors, simply connect via Bluetooth or USB and start collecting data; there is no need for an interface. Currently we have 16 Go Direct sensors, and we will release more throughout the year.

We are also introducing a new, free version of Graphical Analysis 4 software for macOS and Windows. You can now have a consistent data-collection experience across all your platforms—computers, iOS and Android devices, and Chromebooks.

For nearly 20 years, we included word-processing files on CD when you purchased our lab books, and before that, we shipped floppy disks! Well, the world has changed; many teachers don't even have a computer with a CD drive. We now offer electronic versions of our lab books in addition to the printed format. Regardless of which version you purchase, you can download and edit the most up-to-date, word-processing files of all your Vernier experiments when you log in to our website.

Should you be in the Portland, Oregon area, we invite you to stop by for a tour of our building or to attend one of our Summer Institutes.

We also encourage you to give our products a try for a 30-day (or longer) preview. Feel free to contact any of us personally at any time. We love to hear from our customers!

John Wheeler
CEO
jwheeler@vernier.com

David Vernier
Co-President
dvernier@vernier.com

Christine Vernier
Co-President
cvernier@vernier.com

John Wheeler, CEO, volunteers in a local classroom through a program called STEM Connect.

Vernier Data-Collection Technology 2017 Catalog

What's NEW

Data Collection for iOS and Android™ Devices, Chromebooks,™ and BYOD

Data Collection with Chromebooks

Connect a sensor or data-acquisition device directly to a Chromebook and collect data with our free Graphical Analysis™ 4 software.

See pp. 22–23.

Data Collection with BYOD

If your students bring their own devices for science lab, use Data Sharing to wirelessly transfer data to one or more mobile devices.

See page 27.

Data Collection with Mobile Devices

Wirelessly stream data to an iPad,® iPhone,® or Android device with LabQuest Stream™ or our Go Direct technology and our free Graphical Analysis 4 software.

See pp. 24–25.

Go Direct™ Family

Wired or wireless—you have the flexibility to choose. Our Go Direct sensors connect directly to Chromebooks, mobile devices, or computers. With both USB and wireless connectivity, you have the freedom to connect to a wide variety of platforms. That's boundless versatility, simplicity, and opportunity for exploration.

Pioneering new technology to collect, analyze, and interpret data is central to our mission to inspire scientific curiosity in students around the world.

Go Direct is perfect for educators who

- Are new to probeware
- Plan to equip a new science laboratory
- Need an affordable solution that includes free software and all-in-one sensors
- Are using computers, Chromebooks, and mobile devices for data collection
- Teach chemistry, middle school science, or physical science—hundreds of ready-to-use experiments

Go Direct sensors are backed by Stellar Service from Vernier, which means that you will have award-winning technical support, 24/7 access to our online technical information library and videos, hands-on workshops, webinar training, and a community that provides best practices and innovative uses of probeware.

Electronic Versions of Lab Books

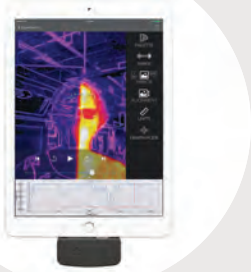
Our award-winning lab books are now available as eco-friendly electronic downloads in addition to the traditional print format.

When you purchase the electronic version of a lab book, you receive

- Access to the most up-to-date versions of experiments on all supported software including Logger *Pro* 3, LabQuest App, Graphical Analysis 4* and EasyData*
- Word-processing files of the student pages so you can edit the experiments to match your teaching style
- PDF files of all experiments for easy viewing on tablets and mobile devices
- Teacher information PDF files including sample data and graphs, a complete materials and supplies list, and other supplemental resources
- A generous site license—purchase once and share files with other instructors in your school or college department
- Easy access to all of the books you have purchased when signed in to your Vernier account

Additional benefits of the electronic versions of our lab books

- Save money by not paying for printing and shipping
- No need for a CD drive



Thermal Analysis™ for FLIR ONE™

Use the Thermal Analysis app to study thermal energy concepts by analyzing images and video captured with the FLIR ONE Thermal Camera for iOS.

See page 26.

Fluorescence UV/VIS Spectrophotometer

Our affordable Fluorescence/UV-VIS Spectrophotometer, designed specifically for upper-level college chemistry courses, allows students to easily and accurately conduct quinine sulfate, DAPI, GFP, and tryptophan fluorescence experiments.

See page 73.

Google Science Journal

With the Science Journal, your students can organize their ideas into projects, make predictions, take notes, collect data in multiple trials, and then annotate results. Simply connect one of over 48 compatible sensors with the Go Wireless® Link or connect Go Wireless Heart Rate to begin wirelessly streaming data to your Android™ device.

www.vernier.com/science-journal

Kestrel® DROP Wireless Data Loggers

Kestrel DROP Wireless Data Loggers are small, rugged, and accurate environmental data loggers. Collect temperature, relative humidity, and pressure data on the Kestrel LiNK app for iOS and Android devices.

See page 95.

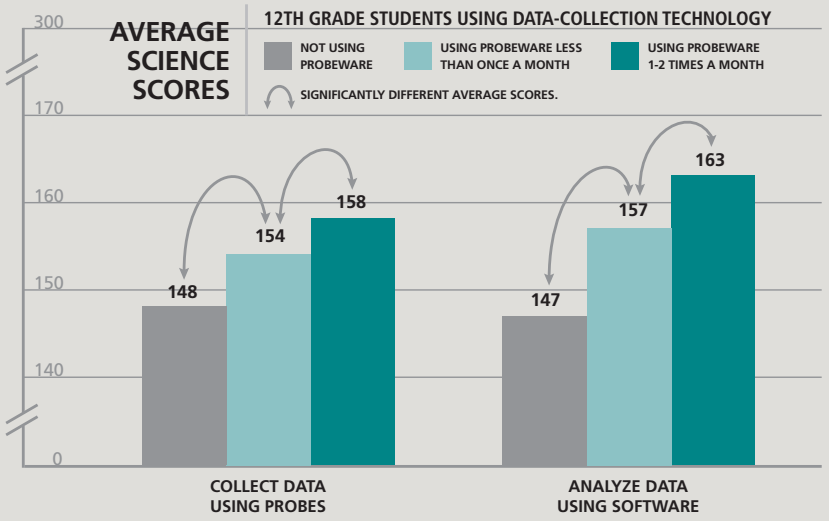
* When available

Why Teachers Choose Vernier

1

Improves test scores

Use of technology tools for data collection, analysis, and visualization—capabilities supported by Vernier probeware and software—can provide a learning advantage to students, as evidenced in student test scores in science (National Center for Education Statistics, 2002, 2012; Schneider et al., 2002).



Source: The 2000 NAEP Science Assessment. This study of 49,000 US students shows that students who used probeware to collect and analyze data scored significantly higher on tests than those who did not.

Get details at www.vernier.com/research

2

Creates a deeper understanding of science concepts

Use of technology tools for data collection, analysis, and visualization to teach scientific practices and support scientific investigations can help to deepen student understanding of science concepts.

"Students using data-logging probes along with the LabQuest software allows teachers to plan lessons that make abstract ideas concrete and enables students to access complex and interesting science in ways that we were previously unable to. Our students are very confident in using the technology. It is clear to me that of all the things we have done to improve the quality of science education, the implementation of the Vernier technology has been the most significant."

—Stephen Daly,
Riyadh Schools,
Riyadh, Saudi Arabia

3

Supports Next Generation Science Standards (NGSS) and state standards

Student hands-on use of technology tools for data collection, analysis, and visualization is recommended in guidelines and requirements from influential national organizations and state standards.

"When you teach students how to use a probe, they can quickly jump ahead with doing real science. Once they understand what the motion detector does, for example, they can develop questions about velocity and acceleration and then use the detectors to find the answers, analyze a lot of data efficiently, and use their data and graphs to communicate their results. They apply several of the NGSS practices in each lab, and they think it's really cool, too, so I'm sneaking in a lot of learning while they're having fun."

—Ann Hammersly,
Retired, Chaparral High School,
Scottsdale, Arizona

Download our white paper on probeware and student performance
www.vernier.com/whitepaper

4

Allows more time for teaching and learning

Real-time data collection provides students an opportunity to identify relationships quickly and frees class time for student engagement in higher order thinking skills, such as analysis, synthesis, and evaluation.

"The range of compatible sensors from Vernier was extensive. … We have found the equipment extremely useful in demonstrating to pupils how our simplistic experiments relate to, and might be conducted, in industry. In some of our experiments, the equipment provided more teaching time without taking the practical element of the sciences away. The LabQuest 2 has also allowed us to carry out meaningful experiments that we have not been able to do before."

—Chris Jessop,
AKS School,
Lytham, United Kingdom

5

Easy to use

At Vernier, we know that classroom technology has to be easy—easy for teachers and easy for students. Creating technology that is intuitive and built for the rigors of science education is our top priority.

"The Scottish Advanced Higher Chemistry course requires pupils to carry out a 20 hour project independently. Many of them carry out investigations on colour chemistry, and it was for this reason that I decided to purchase two LabQuest 2 devices. … They are robust and extremely user friendly. Students found them easy to use and gave them results that could be inserted into their writeup."

—J Anderson,
St Aloysius' College,
Glasgow, United Kingdom

6

Builds student interest in science

Using probeware engages students, let's them visualize real-world data, and teaches them to predict, analyze, and draw conclusions based on evidence.

"The LabQuest 2 can build interest in science, make experiments come alive, and deepen understanding of complex concepts. The affordable handheld tool supports student-centered, inquiry-based learning, high-end data collection, and critical analysis as budding scientists use real tools to conduct real-time investigations of natural phenomena."

—Carol Holzberg,
Greenfield Public Schools,
Greenfield, Massachusetts

7

Backed by unmatched training and technical support

Quickly find answers to your technical questions using a variety of Vernier-provided resources. If you're looking for the personal touch, call and speak with a former teacher, a lab book author, or a technical expert—people committed to extraordinary customer service.

"Thanks for all of your hard work and innovation. Your company truly understands science education from the teacher's perspective, and my colleagues and I agree that Vernier is the most teacher-friendly company we have ever worked with."

—Dana Munn,
Martha's Vineyard Regional High School,
Oak Bluffs, Massachusetts

Go Direct™ Data Logging

Complete sensing solution in each sensor—
collect and directly stream data to your device.

What You Need

1 Platform

Whether you have a one-to-one initiative or a BYOD program, we have the data-collection solution for you. Collect and stream data directly to a Chromebook,™ computer, or mobile device.

Chromebooks

Mobile Devices
iOS® and Android™

Computers
Windows and macOS

BYOD

2 Software

Graphical Analysis™ 4 software facilitates student understanding with real-time graphs of experimental data.

See pp. 10–11.

3 Go Direct Sensors

Our Go Direct sensors connect directly to your mobile device, Chromebook, or computer using our free Graphical Analysis 4 software—no additional equipment or software purchases necessary. Go Direct sensors can be used wired via USB or wirelessly via Bluetooth,® allowing you to choose the best solution for your classroom or laboratory.

See pp. 7–9.

4 Experiments

Save time integrating data-collection technology into your curriculum with well-tested, customizable experiments.

See pp. 141–149.

Learning Unbound

USB or wireless—the versatility is built into the sensors so you have the flexibility to choose. Go Direct sensors connect directly to student computers, Chromebooks, or mobile devices so there's no interface needed. That's freedom, versatility, and boundless opportunity.

Go Direct sensors are perfect for educators who

- Are new to probeware
- Plan to equip a new science laboratory
- Need an affordable solution that includes free software and all-in-one sensors
- Are using computers, Chromebooks, and mobile devices for data collection

Teacher Friendly, Student Centered

- Free Graphical Analysis 4 software
- 16 new Go Direct sensors
- Backed by Stellar Service from Vernier

Go Direct Temperature

GDX-TMP

With Go Direct Temperature, students can monitor temperatures from –40°C to 125°C. Conduct endothermic and exothermic reactions, investigate the freezing and melting of water, measure the energy content of foods, examine the absorption of radiant energy, or monitor environmental conditions.

Go Direct Temperature Teacher Pack

GDX-TMP-TP

Includes eight Go Direct Temperature Probes and a Charging Station.

Go Direct Force and Acceleration

GDX-FOR

Go Direct Force and Acceleration includes a 3-axis accelerometer and 3-axis gyroscope. Take it on a roller coaster, swing, or slide. Suspend several Go Direct Force and Acceleration Sensors from the ceiling to perform a 3-D vector force experiment, or attach a string to the hook and whirl it in a horizontal or vertical circle. In wireless mode, your imagination is the only limiting factor!

Go Direct pH

GDX-PH

Go Direct pH is an important and versatile sensor for lab and field activities alike. Conduct acid-base titrations, monitor pH change during chemical reactions, test the pH and alkalinity of bodies of water, investigate household acids and bases, or examine the cause and effect of acid rain.

Go Direct pH Teacher Pack

GDX-PH-TP

Includes eight Go Direct pH Sensors and a Charging Station.

Go Direct Motion

GDX-MD

This sensor accurately measures distance to an object using ultrasonic pulses, and its built-in temperature compensation adjusts for the speed of sound in different environments. Students can use Go Direct Motion with graph matching to illustrate changes in position and velocity. Explore concepts and studies in mechanics, such as position, velocity, acceleration, momentum, and simple harmonic motion. The wireless connection accommodates experimental setups for relative motion studies.

Go Direct Light and Color

GDX-LC

Go Direct Light and Color combines the power of visible light, UVA/UVB, and RGB sensors to measure source emission, transmittance, and reflection of light in the visible light to ultraviolet electromagnetic spectrum. Explore light intensity as a function of distance, conduct polarized filter studies, observe the flicker of fluorescent lamps, perform reflectivity studies, and analyze RGB color contribution.

Go Direct 3-Axis Magnetic Field

GDX-3MG

This sensor measures the components of the magnetic field along three orthogonal axes. Students can also measure the field along just two axes, or only one axis, choosing the direction that is best for the experiment. Its range allows students to study the Earth's magnetic field or investigate magnetic fields of permanent magnets, electromagnets, and solenoids.

Go Direct SpectroVis® Plus

GDX-SVISPL

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus. With a range of 380 to 950 nm, students can easily collect a full wavelength spectrum (absorbance, percent transmission, fluorescence, or intensity) in less than one second. Different modes of data collection make it easy to study Beer's law, monitor rates of reaction, conduct enzyme kinetics experiments, and perform colorimetric or fluorescent bioassays. To collect data with Go Direct SpectroVis Plus on computers, Chromebooks™, and mobile devices, download our free Vernier Spectral Analysis software. Students may also connect to LabQuest or to a computer running Logger *Pro* 3 to perform analysis.

Go Direct Colorimeter

GDX-COL

Use this sensor to explore absorbance and percent transmittance in a variety of experiments including: analyzing Beer's law (absorbance *vs.* concentration) and kinetic studies (concentration *vs.* time). Students select between four wavelengths (430 nm, 470 nm, 565 nm, 635 nm) to set up their experiment.

Go Direct Gas Pressure

GDX-GP

Monitor the pressure of a gas (up to 400 kPa) in a variety of experiments. Explore pressure-volume or temperature-pressure relationships, investigate grip strength and muscle fatigue, monitor transpiration of a plant, and more. Includes a syringe, tubing, and stoppers to ease setup for experiments, such as Boyle's law.

Go Direct Conductivity

GDX-CON

Demonstrate the diffusion of ions through membranes, investigate the difference between ionic and molecular compounds, or measure Total Dissolved Solids (TDS). Our Go Direct Conductivity determines the ionic content of an aqueous solution by measuring its electrical conductivity (up to 20,000 µS/cm). It features a built-in temperature sensor to simultaneously read conductivity and temperature. Automatic temperature compensation allows students to calibrate the probe in the lab and then make measurements outdoors without temperature changes affecting data.

Go Direct Radiation Monitor

GDX-RAD

Explore radiation statistics, measure the rate of nuclear decay, and monitor radon progeny. This easy-to-use sensor detects alpha, beta, gamma, and X-ray radiation, and it includes LED and audible indicators for each detection.

Go Direct Voltage

GDX-VOLT

Go Direct Voltage combines a wide input voltage range (±15 V) and high precision, making it an excellent choice for lab investigations of both AC/DC circuits and electromagnetism. Use this probe to measure the voltage in simple circuits, to study basic principles of electrochemical cells, or to investigate the resistivity of different metals.

Go Direct Melt Station

GDX-MLT

Teach students the visual detection capillary method of melting point determination with Go Direct Melt Station. It accurately measures melting temperatures of a solid (up to 260°C), and the real-time graphing provides a unique perspective of the melting process. A wide-angle observation and magnification window, LED-lit heater block, and adjustable tilt base, allow students a clear view of the substance as they witness the state change.

Go Direct ORP

GDX-ORP

Go Direct ORP (Oxidation-Reduction Potential) measures the ability of a solution to act as an oxidizing or reducing agent. Determine the equivalence point of an oxidation-reduction titration, measure the oxidizing ability of chlorine in swimming pools, or investigate the amount of hydrogen peroxide in a commercial product.

Go Direct Constant Current System

GDX-CCS

Determine Avogadro's number and perform various electroplating and electrolysis experiments. This system combines a DC power source with a built-in current sensor to eliminate the need for a separate power supply. It can deliver up to 0.6 A at 5 V DC.

Go Direct Drop Counter

GDX-DC

Conducting a titration has never been easier. Our Go Direct Drop Counter precisely records the number of drops of titrant added during a titration and then automatically converts it to volume. Use it in conjunction with our other Go Direct sensors, such as Go Direct pH, Go Direct Conductivity, or Go Direct ORP to perform acid-base, conductometric, or potentiometric titrations.

Graphical Analysis™ 4 Software

Collect, share, and analyze sensor data with our free software for Chrome,™ iOS,® Android,™ Windows, and macOS

Graphical Analysis 4 works with more sensors than any other software. You can collect data from nearly all Vernier devices using Graphical Analysis 4, including

- standard sensors connected to a compatible interface
- Go Direct sensors
- LabQuest 2 or Logger *Pro* Data Sharing source

Standard Sensors

Use Graphical Analysis 4 with over 60 standard Vernier sensors. Connect standard sensors to LabQuest Mini, LabQuest Stream, or LabQuest 2, depending on your platform's connection needs.

See pp. 28–29 for standard sensors.

See page 13 for interface options.

Go Direct™ Sensors

Use Graphical Analysis 4 with our growing collection of Go Direct sensors connected by Bluetooth® or USB as needed by your platform.

See page 28 for Go Direct sensors.

Data Sharing

Students can work together in a lab group to collect data on either LabQuest 2 or a computer running Logger *Pro* software and share the data over a network. Each lab group member will then receive the same data on any platform with Graphical Analysis 4 to analyze separately.

See page 27.

Download Graphical Analysis 4

ANDROID APP ON Google Play

Download on the App Store

available in the chrome web store

Graphical Analysis 4 for Windows and macOS available at www.vernier.com/graphical-analysis

Award-Winning

//CODiE// 2014 SIIA CODiE WINNER

SIIA CODiE 2014 Winner for best educational app for a mobile device

BEST EDUCATIONAL SOFTWARE AWARDS – Winner of 19TH ANNUAL – BESSIE AWARDS – ComputED Gazette, Carlsbad, CA

BESSIE Award for best educational software for multi-level/data analysis

Key Features

Data Collection

- Collect data from multiple sensors simultaneously, either with a multiple-channel interface such as LabQuest Stream™ or by using multiple Go Direct sensors. Use Data Sharing to retrieve data from just about every Vernier sensor.
- Select time-based or event-based data collection, including events with entry.
- Adjust data-collection rate and duration as needed.
- Trigger time-based data collection on sensor values.
- Calibrate sensors, although most of the time this is not needed.
- Enter data manually or using the clipboard.
- Change display units on many sensors.
- Draw predictions before data collection.
- Perform Graph Matching exercises with a Motion Detector.

Data Analysis

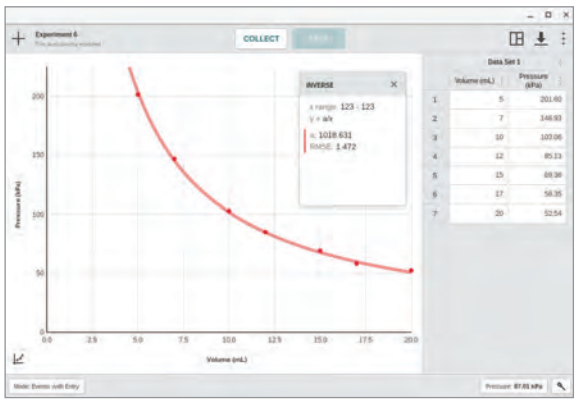
- Display one, two, or three graphs as needed.
- Set the graph scale.
- Select what is graphed on each axis, and select line- or point-style graphs.
- Calculate descriptive statistics on all or some of your data.
- Fit lines and curves to some or all of your data.
- Define calculated columns based on sensor columns. Use this to linearize a graph, for example.
- View data in a table.
- Highlight and read values from a graph.
- Interpolate and extrapolate using graphed data.

Data Sharing

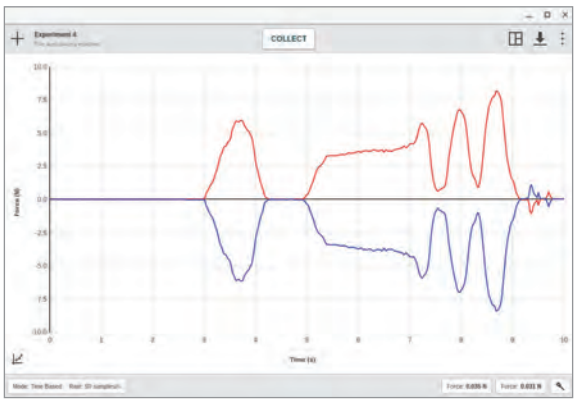
- Receive data shared from LabQuest 2 or a computer running Logger *Pro* to support 1:1 lab groups.

Data Storage

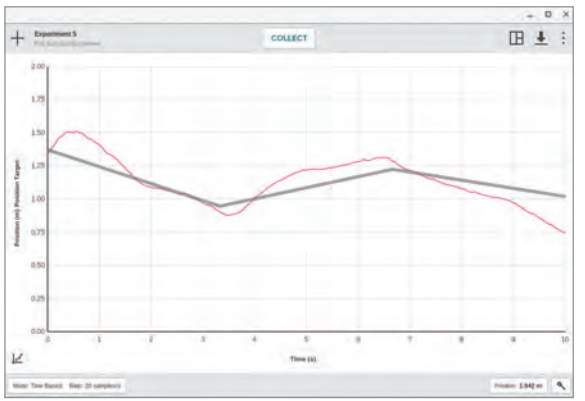
- Store and retrieve previously shared data collection and analysis sessions.
- Save Graphical Analysis 4 software data files with analysis for use in Logger *Pro* 3.



Choose from standard curve fit equations to analyze experimental data. Boyle's law data requires an inverse fit.



Collect data from multiple sensors simultaneously. Use two force sensors to demonstrate Newton's third law.



Perform graph match exercises with a Motion Detector.

Interface Data Logging

Connect a standard sensor to a Vernier interface to collect and analyze data on your device.

What You Need

1 Platform

Finding the right data-collection solution starts with selecting your platform.

Platform	LabQuest 2 Standalone data logger	Computers Windows and macOS	Chromebooks™	Mobile Devices iOS and Android™	BYOD	Texas Instruments Calculators
Pages	14–17	20–21	22–23	24–26	27	150–153

2 Software

Visualize and analyze sensor data with real-time graphing and analysis tools. Select the software appropriate for your platform.

Software	Pages
LabQuest 2 App	15–17
Logger *Pro* 3	20–21
Graphical Analysis 4 for Chrome, iOS, Android, macOS, and Windows	22

3 Interface

A sensor interface is a device with a data-acquisition processor that sends data to the software. There are several interface options to match your platform, budget, and data-collection needs.

See page 13.

4 Standard Sensors

Choose from 88 sensors for chemistry, biology, physics, STEM, math, K–8, water quality, physiology, physical science, environmental science, renewable energy, and Earth science.

See pp. 28–29.

5 Experiments

Save time integrating data-collection technology into your curriculum with over 1,000 well-tested, customizable experiments from Vernier lab books. Each lab book includes essential teacher information and word-processing files of the student instructions.

See pp. 140–149.

Interface Comparison

Interface	Supported Platforms: Recommended for	Supported Platforms: Also works with	Maximum Sampling Rate	Rechargeable Battery	Supports Multiple Sensors	Supports Digital Sensors (motion detectors, photogates, etc.)	Key Features

LabQuest® 2
LABQ2
 
	• Standalone data logger
	• BYOD classrooms
	• 1-to-1 classrooms
		• Computers
		• Chromebooks
		• Mobile devices
		  ○ iOS devices
		  ○ Android devices
			100,000 per second	Yes	Yes	Yes	• Functions as a standalone data logger
							• Supports all platforms
							• Streams data wirelessly to multiple devices using Wi-Fi
							• Supports the use of multiple sensors simultaneously
							• Includes five built-in sensors, including GPS

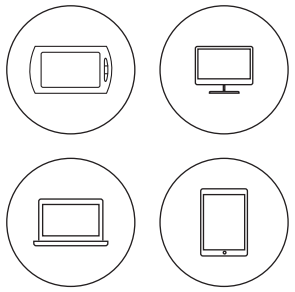
LabQuest Stream®
LQ-STREAM
 
	• Mobile devices
	  ○ iOS devices
	  ○ Android devices
		• Computers
		• Chromebooks
			• 100,000 per second via USB
			• 10,000 per second via wireless
				Yes	Yes	Yes	• Provides the data-collection power of LabQuest 2 without the screen
							• Communicates wirelessly with iOS and Android devices using Bluetooth wireless technology as well as with computers with a compatible radio
							• Connects via USB to computers and Chromebooks
							• Supports the use of multiple sensors simultaneously

LabQuest Mini LQ-MINI 	• Computers • Chromebooks	—	100,000 per second	—	Yes	Yes	• Provides the data-collection power of LabQuest 2 without the screen • Connects via USB to computers and Chromebooks • Supports the use of multiple sensors simultaneously

Go Wireless® Link
GW-LINK
 
	• Mobile devices
	  ○ iOS devices
	  ○ Android devices
		• LabQuest 2*
		• Computers*
			20 per second	Yes	No	No	• Offers a low-cost option for collecting data with iOS and Android devices
							• Communicates wirelessly with mobile devices using Bluetooth wireless technology
							• Supports the use of a single sensor at a time

Go! Link® GO-LINK 	• Computers • Chromebooks	• LabQuest 2	200 per second	—	No	No	• Offers a low-cost option for collecting data with computers and Chromebooks • Communicates via USB with computers and Chromebooks • Supports the use of a single sensor at a time

* Additional hardware may be required.



Data Collection with LabQuest 2

The most engaging, effective approach to science education is hands on with students collecting and analyzing data to understand and apply core concepts in all the science disciplines, technology, engineering, and math. Graphing and analyzing data is an essential component of the inquiry and learning process, and LabQuest 2 is a powerful, connected, and remarkably versatile data-logging solution.

Why? LabQuest 2 can serve as a standalone data logger, connect to a computer or Chromebook, or wirelessly transfer data to mobile devices. This makes it the preferred choice for instructors and students in the laboratory, in the classroom, and in the field.

LabQuest 2

LABQ2

The freedom to inquire.
The technology to excel.

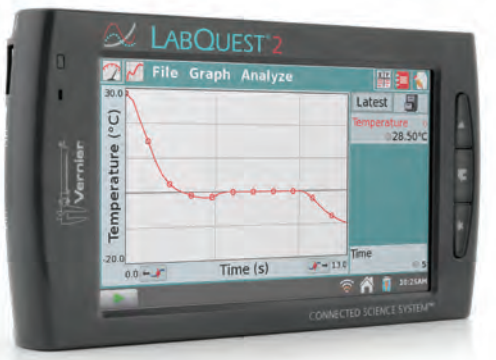
- Use as a standalone device with all of the Vernier sensors (Go Direct™ sensor support available fall 2017).
- Connect to a Windows or macOS computer for use with Logger *Pro* 3 or Graphical Analysis 4.
- Transfer data wirelessly to iOS devices, Chromebooks,™ Android™ tablets, computers, and other mobile devices with Graphical Analysis 4.

Technical Specifications	
Screen size	11.2 cm × 6.7 cm
Screen resolution	800 × 480 color display
Weight	350 g
CPU	800 MHz application processor
Battery	Lithium-ion rechargeable battery; carries a one-year warranty

Included with LabQuest 2:
LabQuest 2 unit, rechargeable battery, USB cable, power adapter, stylus, stylus tether

Award-Winning

LABQUEST® 2



Features

Full sensor support
Compatible with all Vernier sensors (Go Direct sensor support available fall 2017)

High-resolution touch screen
- 12.8 cm, 800 × 480 pixel resolution
- Designed for both stylus and touch
- Wide viewing angle for lab groups

Built-in sensors
- GPS
- 3-axis accelerometer
- Ambient temperature
- Light
- Microphone

Fast data collection
100,000 samples per second

Powerful analysis tools
Statistics, curve fits, integral function, and modeling

High-capacity, lithium-ion rechargeable battery

Wireless connectivity
- Wi-Fi
- Bluetooth

Ports & Connectivity

USB port for use with USB sensors, flash drive, or other USB peripherals.

Two digital sensor ports for use with motion detectors, photogates, drop counters, and more.

Three analog ports for use with most sensors, such as temperature, pH, and CO_2 sensors.

Power port for use with AC or recharge the LabQuest built-in battery.

Micro SD/MMC card slot

USB connectivity
Connect your LabQuest 2 to a Windows or macOS computer or a Chromebook to collect data.

Audio in (left)
Audio out (right)
Connect speakers, microphone, power amplifier, or headphones.

Built-in Software

Analysis Features

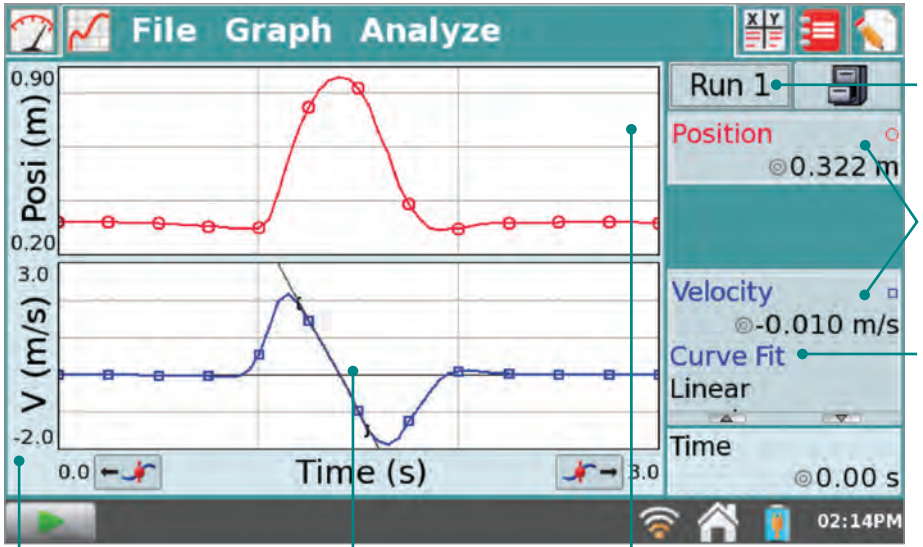
- Perform curve fits.
- View graphs in landscape and portrait orientations.
- Supports built-in sensors—GPS, microphone, accelerometers, relative light sensor, temperature.
- Draw a prediction before collecting data.
- Display two graphs at once.
- Display a tangent line on the graph.
- Use the Integral function tool.
- Calculate statistics for your data.

Built-in Applications

- Camera App (requires USB camera)
- Stopwatch
- Periodic table
- Scientific calculator
- Audio function generator
- Power amplifier (requires Vernier Power Amplifier)

Other Great Features

- Transfer data wirelessly (using Wi-Fi) to iPad, Chromebooks, computers, Android, and other mobile devices.
- Export data to Graphical Analysis 4 and Logger *Pro*.
- Use with our LabQuest Viewer software for instructions, demonstrations, and class discussions.
- More than 100 preloaded lab instructions from our popular lab books are available.
- Add notes in the Notes field.
- Record voice annotation with internal microphone.
- Find slopes, fit a line to a portion of your data, and display position data and its derivatives.



Easily store and recall multiple runs.

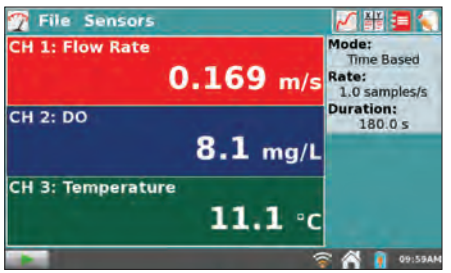
View a live display of sensor data.

Display curve fit statistics.

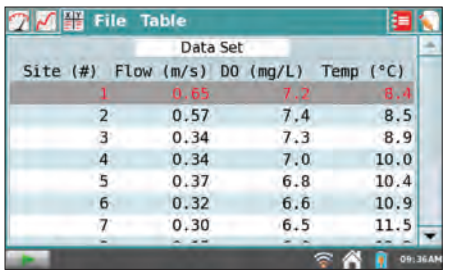
One or two high-resolution plots of data displayed in real time.

Curve fits and other analysis tools are available.

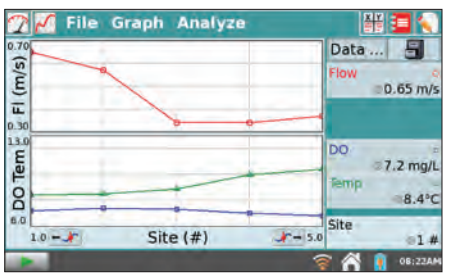
Quickly access graphs, tables, and meters.



Meter



Data Table



Graph

One-Touch Simplicity

The LabQuest App gives your students real-time graphing capabilities in a handheld device. It's powerful—yet beautifully simple.

Your students can collect data and view them in a Data Table, Meter, or Graph View.

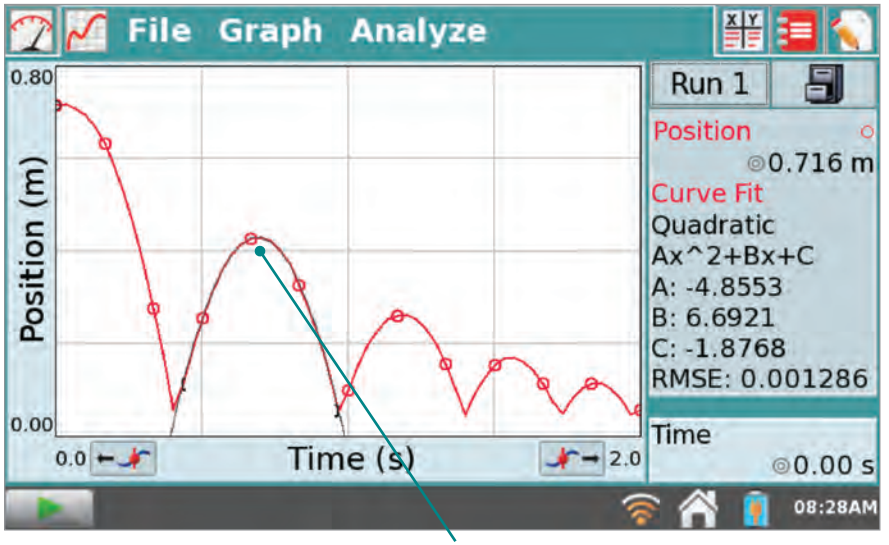
For Compatible Sensors

Wondering which sensors are supported?

LabQuest 2 works with all of our sensors (Go Direct sensor support available fall 2017). Check our website for the latest sensor compatibility.

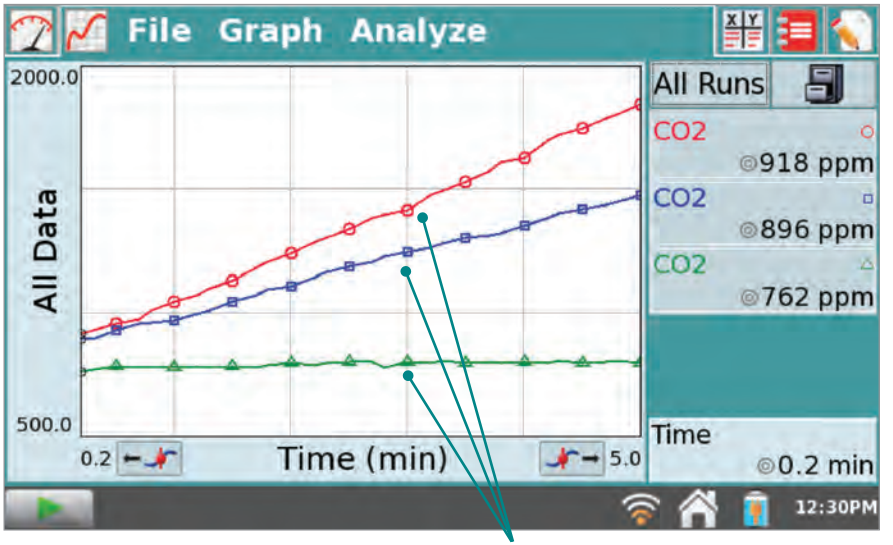
www.vernier.com/labquest2

Data Analysis at Your Fingertips



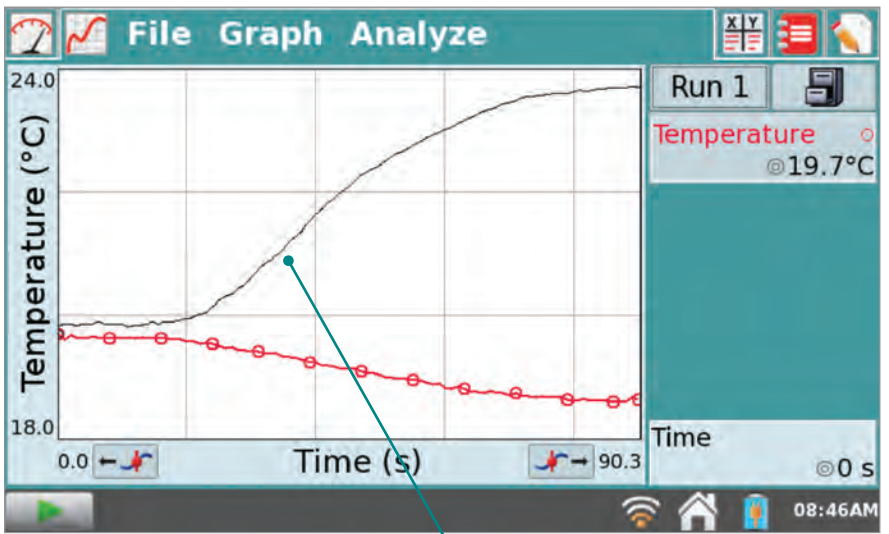
Position vs. *time graph of a bouncing ball*

Easily analyze any portion of your data by first selecting a region.



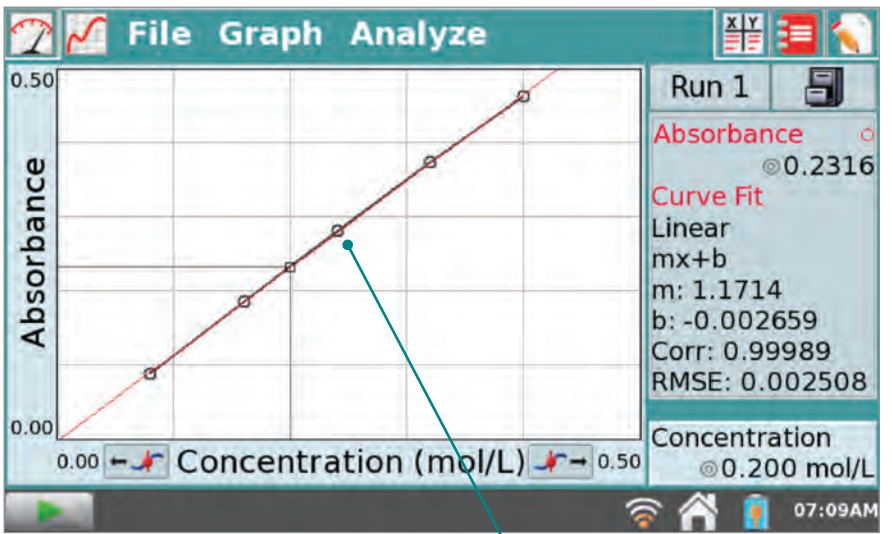
Investigating the rate of cellular respiration at different temperatures

Display data from several sensors or runs on one graph.



Temperature vs. *time graph as an Alka-Seltzer® tablet dissolves in water*

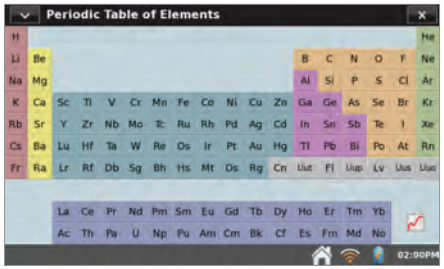
Use the draw prediction tool to reinforce the scientific process and to help identify misconceptions.



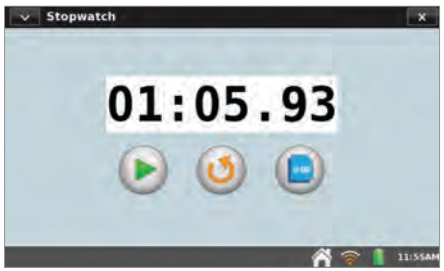
Beer's law analysis of nickel (II) sulfate solution

Use the analyze tools to determine the concentration of an unknown.

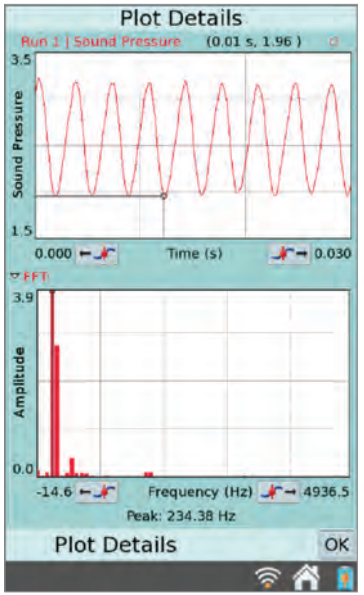
Additional Applications and Features



On-board Periodic Table Application



Stop Watch Application

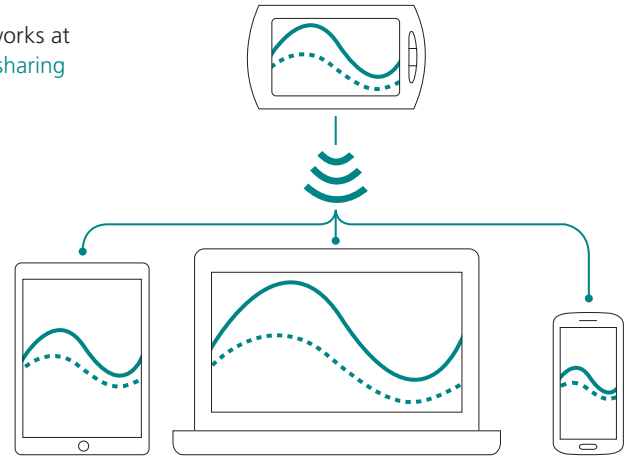


Advanced features include FFT analysis.

Wirelessly Transfer Data to Chromebook™ Computers, iPad®, Android™ Tablets, and Mobile Devices

With Data Sharing and LabQuest 2, students can share and analyze real-time data on any number of mobile devices for a truly hands-on, collaborative learning environment. Use LabQuest 2 to transfer data wirelessly to one or more mobile devices running Graphical Analysis 4.

See how Data Sharing works at www.vernier.com/data-sharing



LabQuest Charging Station

LQ2-CRG

Want a way to charge and store your LabQuest 2 or LabQuest Stream units? The LabQuest Charging Station has four charging slots with LEDs to indicate the charging status.

Note: If you need to charge an original LabQuest, contact us for inserts.

LabQuest Viewer® Software

LQ-VIEW-E

Use the LabQuest Viewer software to enhance group presentations and effectively demonstrate LabQuest functionality. This software allows you to view or control any LabQuest on your network directly from your classroom computer.

Compatible with both Mac and PC. Computer software includes a site license for every teacher's computer in your school or college department.

LabQuest Viewer® App for iPad

LabQuest Viewer App for iPad allows you to use your classroom iPad to wirelessly view and control LabQuest. When used with a projector, you can easily display any LabQuest screen for the entire class to see.

Download on the App Store

Interface Data Collection with Computers

For computer users, we have two cost-effective interface options for data collection. If you plan to conduct experiments using multiple sensors and a computer, LabQuest Mini is an easy and affordable interface that connects to a computer via USB. Paired with our Graphical Analysis 4 or Logger *Pro* 3 software, your students can conduct a wide variety of hands-on investigations.

For data collection with a single sensor, check out our Go! Link single-channel interface, which works with many of our sensors.

How It Works

1. Students begin their experiment by connecting sensors to their computer through a sensor interface.
2. Using Graphical Analysis 4 or Logger *Pro* 3 computer software, students set experiment parameters and start data collection.
3. Real-time sensor data is shown in a graph, a meter, or a table to accommodate different learning styles.
4. Students annotate their graph, perform curve fits, run calculations, and more.

LabQuest Mini

LQ-MINI

Affordable. Powerful. Easy to Use.

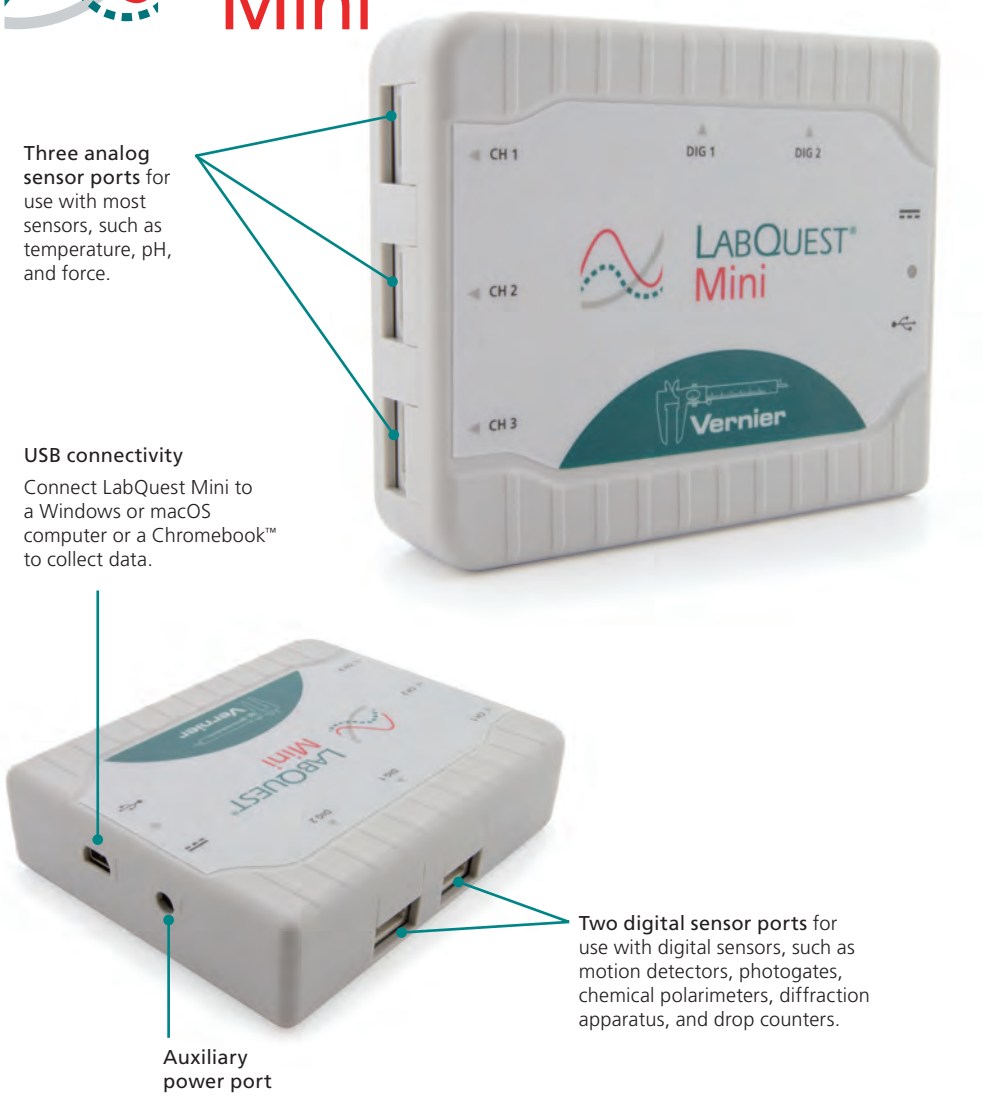
LabQuest Mini brings the power of our award-winning LabQuest technology to teachers who don't need the versatility of a standalone device. The perfect solution for educators collecting data with a computer, LabQuest Mini interfaces with Graphical Analysis 4, Logger Lite, and Logger *Pro* software for unparalleled power, analysis, and curricular support.

Features

- 100 kHz maximum sampling rate gives you the unrivaled power of LabQuest.
- Five sensor ports give you the flexibility to choose from over 60 compatible sensors.

Technical Specifications	
Dimensions	10.5 cm × 8.5 cm × 2.6 cm
Computer connection	USB 2.0 Full Speed
Software requirements	• Graphical Analysis 4 • Logger *Pro* 3 • Logger Lite 1.5 or newer
Analog inputs	3
Digital inputs	2
Maximum sampling rate	100,000 samples per second

LABQUEST® Mini



Three analog sensor ports for use with most sensors, such as temperature, pH, and force.

USB connectivity

Connect LabQuest Mini to a Windows or macOS computer or a Chromebook™ to collect data.

Two digital sensor ports for use with digital sensors, such as motion detectors, photogates, chemical polarimeters, diffraction apparatus, and drop counters.

Auxiliary power port

Award-Winning

"Excellent product that will serve many classroom environments well."

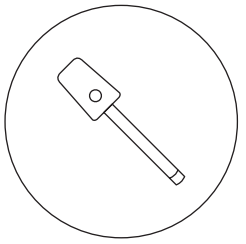
— Tech & Learning

For Compatible Sensors

Wondering which sensors are supported?

Our engineers are continually adding updates and sensor compatibility. Check out which sensors can be used with computers based on interface and software selections.

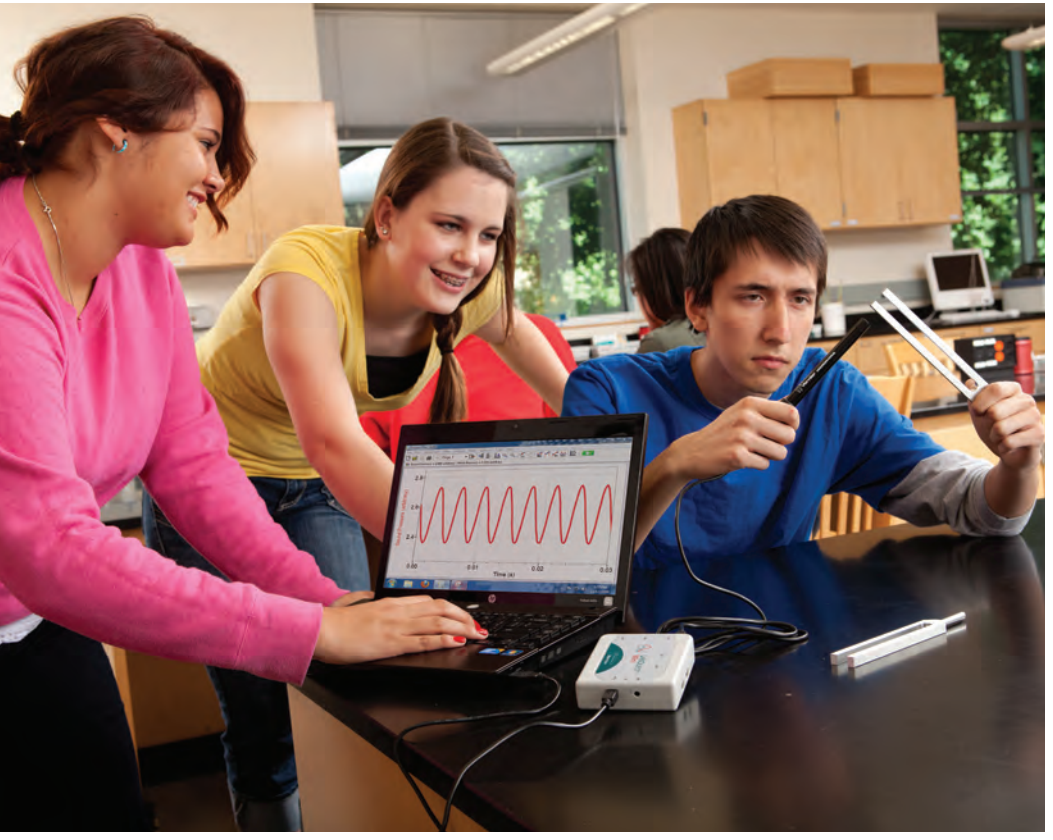
www.vernier.com/computers



Go Direct™ Family

Consider Go Direct sensors if you prefer all-in-one sensors that do not require an interface. Graphical Analysis 4 software works with all Go Direct sensors, which can be used either by USB connection or by a compatible wireless connection.

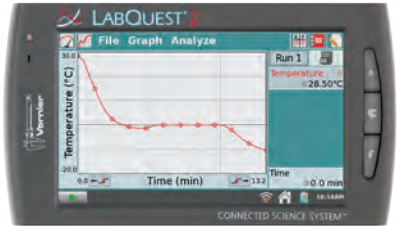
www.vernier.com/gdx



Other Compatible Interfaces for Data Collection with Computers

LabQuest® 2

LABQ2



When you are looking for the flexibility to connect to a computer, wirelessly transfer data to tablets (via Wi-Fi), or use an all-in-one standalone data logger, LabQuest 2 is the perfect choice. This versatile data-collection interface is compatible with all your standard Vernier sensors.

See pp. 14–17 or www.vernier.com/labq2

LabQuest Stream®

LQ-STREAM

Designed to meet the needs of mobile learning environments, LabQuest Stream can either connect directly to a student computer or a Chromebook or wirelessly stream data to a mobile device or a compatible computer.

See page 24 or www.vernier.com/lq-stream

Go! Link®

GO-LINK

Plug a Go! Link directly into your computer or Chromebook and collect data from over 58 Vernier sensors.

See page 23 or www.vernier.com/go-link

Logger *Pro* 3

Real-Time Graphing and Powerful Analytical Tools

Logger *Pro* is our flagship data-collection and analysis software for Windows and Mac. With the complete suite of data-collection and analysis tools, Logger *Pro* is suitable for all students, beginning to advanced.

- Logger *Pro* is the most popular data-collection program in science education. Why? Teachers tell us that students find our software to be very easy and intuitive to use.
- One program does it all—for all of your computers AND your students' personal computers.
- Think of Logger *Pro* as the digital data hub of your classroom and lab. It can gather data from a variety of sources, including LabQuest 2, original LabQuest, LabQuest Mini, LabQuest Stream, LabPro, Go! Link, OHAUS® balances, compatible TI graphing calculators, spectrometers, GPS units, manual entry, and more. Logger *Pro* also shares data wirelessly with Chromebook,™ iPad,® Android™ tablets, and other mobile devices.

Don't need all this power or working with younger students? Logger Lite, a streamlined subset of Logger *Pro*, is available at no charge for use with LabQuest 2, LabQuest Mini, Go! Link, Go!Temp, and Go! Motion.

GREAT VALUE

Logger *Pro* 3

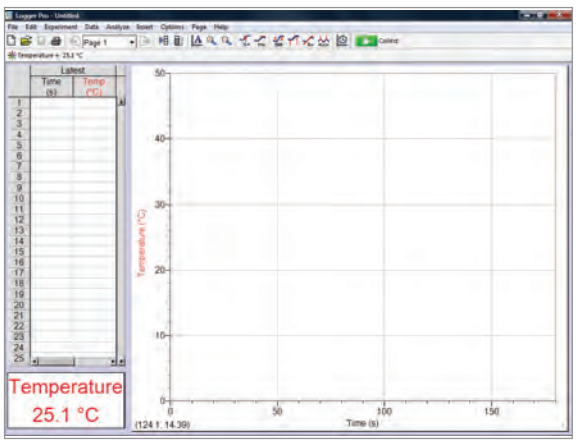
with manual and CD LP

electronic download* LP-E

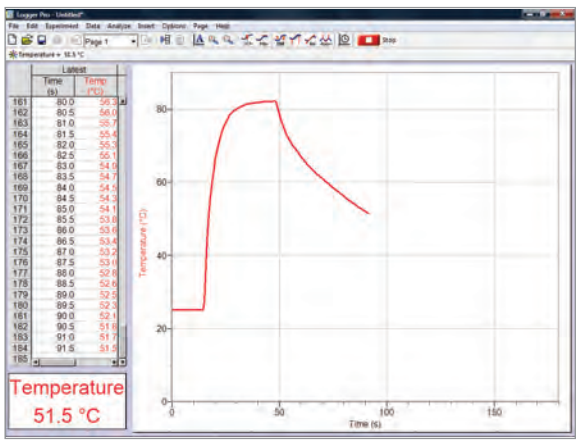
- Logger *Pro* 3 includes a site license for your entire school or college department.
- Site license includes home computers of faculty.
- Site license includes home computers of students—let them take it home!
- Satisfy licensing without counting computers.
- Logger *Pro* 3 updates are free.
- Logger *Pro* 3 Data Sharing
  - Supports Graphical Analysis™ 4 for iOS, Android, Chrome™ and computers.
  - Streams data to multiple devices, allowing for 1:1 learning in lab groups and classrooms.

Award-Winning

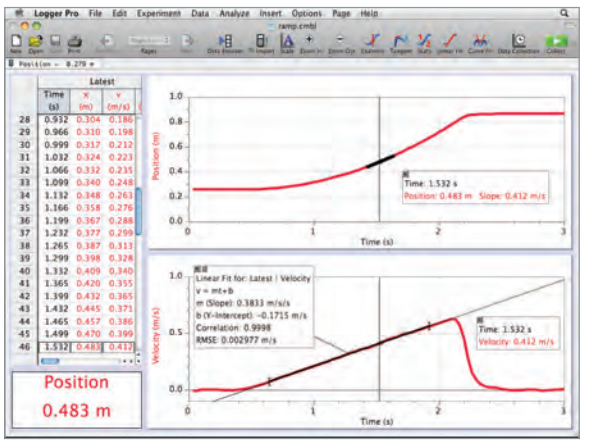
** Provide an email address to which we will send download information.*



Start Logger Pro *with a temperature sensor connected. A graph, data table, and meter are all ready to go. Click Collect, and you're taking data.*



After you click Collect, Logger Pro *draws the graph in real time, and the data table and digital meter update continuously.*



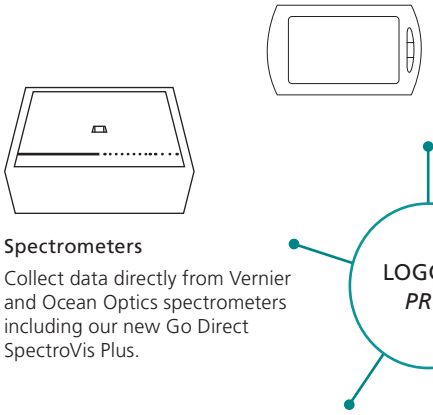
Draw tangent lines to find local slopes and fit lines to selected regions—the analysis tools you need in Logger Pro *are at your fingertips.*

Logger *Pro* Features

- Auto-ID sensors make setup effortless—simply connect a sensor, open Logger *Pro*, and click Collect.
- Collect live data from more than 80 different sensors and devices.
- Draw predictions on a graph before collecting data.
- Use a variety of data-collection modes for your experiment: time-based data, selected events, events with typed-in entries, photogate, radiation counting, and more.
- Manually enter data for graphing and analysis.
- Import data from LabQuest, mobile devices, and calculators.
- Lay out graphs, tables, and text across multiple pages to describe your experiment.
- Read values and slope from graphs using examine and tangent line tools.
- Print graphs and data tables.
- Graph data in a variety of ways, including XY graphs, log graphs, double-Y graphs, strip charts, and FFT graphs.
- Model data with user-adjustable functions.
- Extract data from movies using frame-by-frame video analysis.
- Capture video from video cameras or import compatible movie files.
- Calculated columns allow you to graph new quantities, such as kinetic energy.
- Perform GC (gas chromatograph) peak analysis.

Note: Logger *Pro* cannot be used to collect data with our Go Direct sensors (other than Go Direct SpectroVis Plus).

Why Do I Need Logger *Pro*?



Vernier LabQuest 2 and Original LabQuest

Collect live data from LabQuest, retrieve existing data, or open saved files on LabQuest.

Spectrometers

Collect data directly from Vernier and Ocean Optics spectrometers including our new Go Direct SpectroVis Plus.

Vernier LabQuest Stream

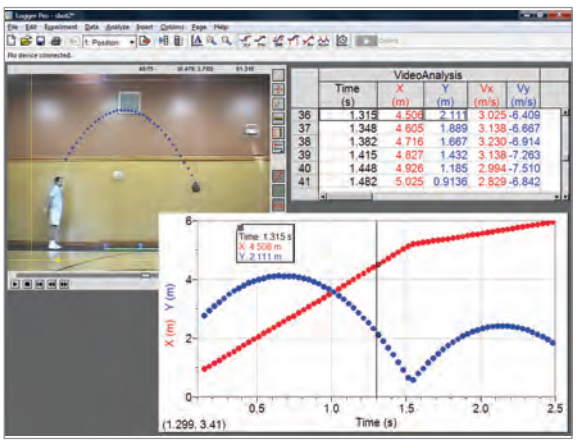
Connect a LabQuest Stream directly or wirelessly stream data to a compatible computer.

Graphical Analysis™ for BYOD

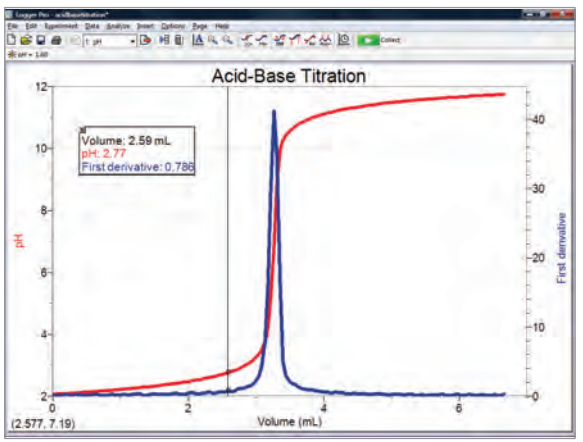
View and analyze data streamed from Logger *Pro* to multiple tablets and auto-save data for later work.

Vernier LabQuest Mini

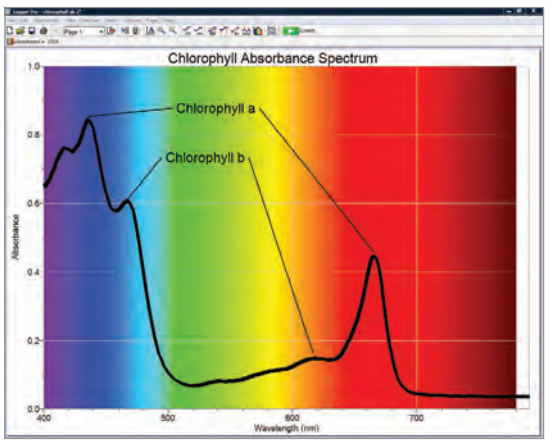
Connect a LabQuest Mini and use 84 different sensors.



Analyze videos to study the motion of individual or multiple objects. This feature alone is worth the price of Logger Pro!



Create double-Y graphs to tell complex stories with simplicity.



Collect absorbance data from Go Direct SpectroVis Plus, Vernier UV-VIS Spectrophotometers, or Ocean Optics Spectrometers.

Data Collection with Chromebooks

For Chromebook™ users, we have two cost-effective interface options for data collection. If you plan to conduct experiments using multiple sensors and a Chromebook, LabQuest Mini is an easy and affordable option that connects to a Chromebook via USB. Paired with our Graphical Analysis 4 software, your students can conduct a wide variety of hands-on investigations.

For experiments with a single sensor, check out our Go! Link single-channel interface that works with many of our sensors.

How It Works

1. Students in a lab group set up an experiment with Vernier sensors and an interface, such as LabQuest Mini.
2. Using Graphical Analysis 4, students set experiment parameters and start data collection.
3. Real-time sensor data is shown in a graph, a meter, or a table to accommodate different learning styles.
4. Students analyze data in class or at home, all in Graphical Analysis 4.

Investigating grip strength with Graphical Analysis 4 software

LabQuest® Mini

LQ-MINI

LabQuest Mini brings the power of our award-winning LabQuest technology to teachers who don't need the versatility of a standalone device. It is the perfect solution for educators collecting data with a Chromebook. LabQuest Mini interfaces with our Graphical Analysis 4 software for data collection and analysis.

FREE

Graphical Analysis™ 4 Software

Graphical Analysis 4 software allows students to collect real-time sensor data using a Chromebook for analysis and sharing in the classroom. Graphical Analysis 4 facilitates hands-on learning with tools that allow students to work with data in tables, calculate statistics, or perform curve fits. Students can easily create and send a finished lab report to their instructor, or save their work to Google Drive™ for further study.

Key Features

- Work with sensor data in graphs or tables.
- Perform curve fits, including linear, quadratic, or natural exponent.
- Create and edit graph titles; annotate data.
- Send finished reports to an instructor.
- Export graphs and data.

www.vernier.com/graphical-analysis

Download Graphical Analysis

available in the chrome web store

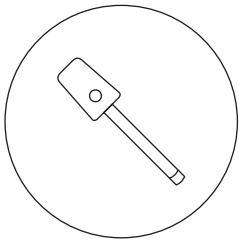
Award-Winning

For Compatible Sensors

Wondering which sensors are supported?

Our engineers are continually adding updates and sensor compatibility. Check out which sensors can be used with Chromebook devices based on interface selections.

www.vernier.com/chromebook



Go Direct Family

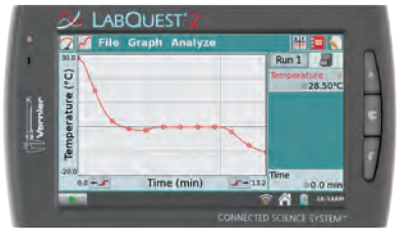
Consider Go Direct™ sensors if you prefer all-in-one sensors that do not require an interface. Graphical Analysis 4 software works with all Go Direct sensors, which can be used either by USB connection or by a compatible wireless connection.

www.vernier.com/gdx

Other Compatible Interfaces for Data Collection with Chromebooks

LabQuest 2

LABQ2



When you are looking for the flexibility to connect to a Chromebook, wirelessly transfer data to tablets, or use an all-in-one standalone data logger (via Wi-Fi), LabQuest 2 is the perfect choice. This versatile data-collection interface is compatible with all your standard Vernier sensors.

See pp. 14–17 or www.vernier.com/labq2

LabQuest Stream

LQ-STREAM

Designed to meet the needs of mobile learning environments, LabQuest Stream can either connect directly to a student computer or a Chromebook or wirelessly stream data to a mobile device or a compatible computer.

See page 24 or www.vernier.com/lq-stream

Go! Link

GO-LINK

The Go! Link USB sensor interface is a quick and affordable way to get started with data-collection technology with computers or Chromebooks. It's a single-channel interface that connects most Vernier sensors to your computer or Chromebook USB port.

www.vernier.com/go-link

Data Collection with Mobile Devices

Collecting data on iPad,® iPhone,® or Android™ devices? We offer two pathways for interface data acquisition. LabQuest Stream™ gives a student the ability to collect data using one or more sensors with a mobile device. Using our free, award-winning Graphical Analysis™ 4 software, students can draw predictions, deeply analyze data, and draw conclusions based on evidence.

For experiments with a single sensor, check out our Go Wireless Link single-channel interface that works with many of our sensors.

How It Works

1. Students in a lab group set up an experiment with Vernier sensors and an interface with wireless capabilities, such as LabQuest Stream.
2. Using the Graphical Analysis 4 software for iOS or Android, students set experiment parameters and start data collection.
3. Real-time sensor data is shown in a graph, a meter, or a table to accommodate different learning styles.
4. Data can be analyzed on the mobile device in class or at home.

LabQuest Stream®

LQ-STREAM

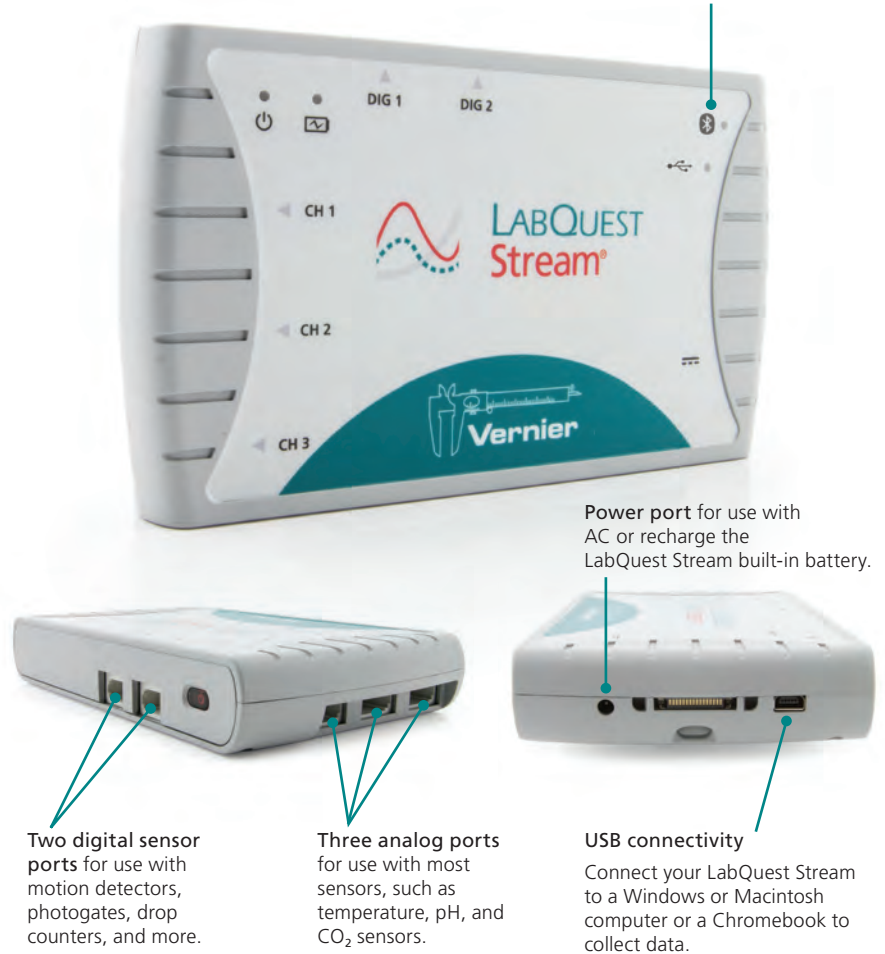
Mobile-friendly technology that expands possibilities

With LabQuest Stream, our wireless and USB sensor interface, students have the freedom and flexibility to simultaneously collect data from multiple Vernier sensors using a mobile device, a Chromebook,™ or a computer. Just like the name suggests, students can stream data directly to a mobile device using Bluetooth® wireless technology rather than Wi-Fi. That's especially important for schools where network access may be limited or restricted. In addition, LabQuest Stream includes USB connectivity, which allows it to connect directly to a Chromebook or a computer when needed.

Technical Specifications

Software requirements	• Graphical Analysis 4 • Logger *Pro* 3 • Logger Lite 1.5 or newer
Analog inputs	3
Digital inputs	2
Wireless sampling rate	10,000 samples per second
Wired sampling rate	100,000 samples per second

LABQUEST Stream®



Bluetooth wireless technology delivers real-time data collection with mobile devices and supported computers.

Power port for use with AC or recharge the LabQuest Stream built-in battery.

Two digital sensor ports for use with motion detectors, photogates, drop counters, and more.

Three analog ports for use with most sensors, such as temperature, pH, and CO_2 sensors.

USB connectivity

Connect your LabQuest Stream to a Windows or Macintosh computer or a Chromebook to collect data.

Features

- Multi-channel sensor interface supports both wireless data collection for mobile devices and USB data collection for computers and Chromebooks so it works in the lab, the classroom, and in the field
- Five sensor ports give you the flexibility to choose from over 50 Vernier sensors to support multi-variable experiments and data-logging activities
- Real-time wireless data collection—up to 10,000 samples per second
- Rapid, real-time data collection—up to 100,000 samples per second—when connected via USB
- High-capacity, rechargeable battery accommodates multiple lab experiments in several classes each day

FREE

Graphical Analysis 4 for iPad, iPhone, iPod touch,® and Android

Students use the Graphical Analysis 4 software to wirelessly collect, analyze, and share sensor data in science and math classrooms. Graphical Analysis 4 facilitates student understanding with real-time graphs of experimental data. Students enhance their work and lab reports with statistics and curve fits.

Download Graphical Analysis

Download on the App Store

ANDROID APP ON Google Play

Award-Winning

//CODiE// 2014 SIIA CODiE WINNER

BEST EDUCATIONAL SOFTWARE AWARD — Winner of 10TH ANNUAL BESSIE AWARDS

Key Features

- Manually enter data.
- Analyze data.
- Display one, two, or three graphs simultaneously.
- View data table with row-by-row entry and multiple columns.
- Edit and auto-save data, graphs, annotations, statistics, and curve fits.
- Draw predictions on a graph.
- Pinch to scale graph.
- Examine and select data.
- Perform curve fits, including linear, quadratic, natural exponent, and more.
- Add graph titles.
- Export graphs and data.

Other Compatible Interfaces for Data Collection with Mobile Devices

LabQuest 2

LABQ2

When you are looking for the flexibility to connect to a computer or Chromebook, wirelessly transfer data to tablets, or use an all-in-one standalone data logger, LabQuest 2 is the perfect choice. This versatile data-collection interface is compatible with all your Vernier sensors.

See pp. 14–17 or www.vernier.com/labq2

Go Wireless Link

GW-LINK

Connect one of over 48 compatible sensors to a Go Wireless Link interface and use them as wireless sensors with your iPad, iPhone, Android tablet, Chromebook or compatible computer.

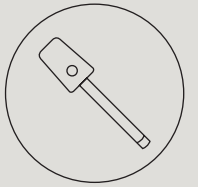
www.vernier.com/gw-link

For Compatible Sensors

Wondering which sensors are supported?

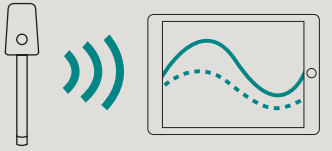
Our engineers are continually adding updates and sensor compatibility. Check out which sensors can be used with mobile devices based on interface selections.

www.vernier.com/mobile



Go Direct™ Family

Do you prefer all-in-one sensors, without the need for an interface? Consider Go Direct sensors. Compatible with Graphical Analysis 4 software, students can directly connect sensors, either through USB or via a compatible wireless connection.



See pp. 6–9.

Thermal Analysis for FLIR ONE™ App

Explore transmission of infrared light through different materials—the acrylic panel on the left lets visible light through but blocks infrared.

Thermal Analysis allows students to study thermal energy concepts by analyzing images and video captured with the FLIR ONE Thermal Camera for iOS (FLIRONE-IOS). Using the app, as well as investigations created by Vernier, students can measure temperature changes on the skin, track heating due to friction, analyze the transparency of materials in infrared versus visible light, and more. Our free Thermal Analysis app is available for download on the App store.

Use Thermal Analysis for FLIR ONE in the classroom to

- Graph live temperature data during an experiment.
- Mark up to four locations or regions on the image to determine the minimum, maximum, or average temperature.
- Capture temperature data for everything within a video frame allowing you to analyze any object at any time.
- Export thermal image videos to the Photos app or to our Graphical Analysis 4 software for further analysis.

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

Download on the App Store

Video Physics™

Perform Automated Object Tracking on iPad®, iPhone®, and iPod touch®

Video analysis of an accelerating Segway®

Video Physics is perfect for physics students and instructors to perform on-the-go analysis of motion. Measure the velocity of a swing, a roller-coaster, or a basketball free-throw shot.

Use Video Physics for iPad in the classroom to

- Capture a new video using the built-in camera, choose a video from your Photos collection, or use one of our sample videos.
- Track an object automatically or manually add points to the video frame.
- Set the scale of the video using an object of known size.
- Optionally set coordinate system location and rotation.
- View graphs of trajectory and x/y position and velocity.
- Export video with points.
- Email the video and data for further analysis in Vernier Logger *Pro* software for macOS and Windows.
- Open data files directly in our Graphical Analysis 4 software.

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

Download on the App Store

App of the week · Awards of Excellence Winner! · Best Educational Software Awards Winner of 19th Annual BESSIE AWARDS · //CODiE// 2012 SIIA CODiE FINALIST · bett AWARDS 2015 FINALIST

BYOD

Data Collection for BYOD

A Bring-Your-Own-Device Initiative empowers students to learn on the device that they are most comfortable with, and we provide the perfect solution for your data-collection needs.

Classrooms collecting data on mobile devices can use a Data Sharing source (LabQuest 2 or Logger *Pro*), which wirelessly streams data to mobile devices using a Wi-Fi connection. Students can work together in a lab group to wirelessly collect experiment data and then each lab group member can analyze data independently. Data Sharing is a one to many solution that's both elegant and powerful.

How It Works

1. Students in a lab group set up an experiment with Vernier sensors and a Data Sharing source.
2. Students use our free Graphical Analysis™ 4 software to wirelessly start data collection. Data is streamed from the Data Sharing source to each students' device.
3. Each lab group member performs data analysis independently.
4. Students take their data and analysis home on their respective device for further analysis and lab reports.

Data Sharing

Use Data Sharing to wirelessly view, collect, analyze, and share experimental data. Transfer data to a Chromebook,™ mobile device, or computer running Graphical Analysis 4 software for hands-on, collaborative learning with individual accountability.

Data Sharing Sources

Enable LabQuest 2 or Logger *Pro* as Data Sharing sources to transfer Vernier sensor data over a network to Data Sharing apps.

Teachers

- Use a robust data-collection system that is compatible with tablet-based, Chromebook, and bring-your-own-device (BYOD) classrooms.
- Have the flexibility to use LabQuest 2 with iPad, Chromebook, Android, and other mobile devices, as well as to use it as a standalone device or with computers.
- Have access to world-class technical support that includes both former science teachers and technology experts.

Students

- Wirelessly collect scientific data using a variety of sensors and digital tools.
- Analyze an individual copy of collected data.
- Annotate data, perform curve fits, and make statistical calculations to build evidence of personal understanding.
- Tap, drag, pinch, and stretch graphs in an immersive, multi-touch environment.
- Create a lab report or submit data to the teacher via email, camera roll, print function, and even third-party apps for notes and reports.

//CODiE//
2014 SIIA CODiE FINALIST

2014 SIIA CODiE Award Finalist Best Science/Health Instructional Solution

This award recognizes the best instructional solution for science and health curricula and content for students in the PK–12 or postsecondary market.

Vernier sensors are designed specifically for education and are held to high standards for quality and durability.

Sensors & Accessories

The Vernier Sensor Advantage

Outstanding Performance

With 36 years of experience developing technology for education, we design our sensors for active, hands-on experiments. Vernier sensors are rugged, classroom-proven technology that are well supported and easy to use. The sensors provide consistent, high-quality results for the demands of the classroom.

Connect & Collect

Simply connect, and you're ready to collect. All Vernier sensors on the following pages are automatically detected and set up for data collection when used with Vernier software. It's student-friendly technology designed for ease of use.

Generous Warranty

Buy with confidence. Most Vernier sensors are covered by a 5-year warranty. We have rarely charged a customer for a repair, no matter how old the equipment.

Standard Sensors

Our standard sensors require an interface, such as LabQuest 2, LabQuest Stream, or LabQuest Mini. The interface sends information from the sensor to the data-collection and analysis software on a device such as a computer, Chromebook™, or mobile device.

For more information on sensor compatibility, visit www.vernier.com/sensors

NEW

Go Direct Sensors

Sensor	Order Code	Page
NEW Go Direct 3-Axis Magnetic Field	GDX-3MG	139
NEW Go Direct Colorimeter	GDX-COL	64
NEW Go Direct Conductivity	GDX-CON	63
NEW Go Direct Constant Current System	GDX-CCS	65
NEW Go Direct Drop Counter	GDX-DC	64
NEW Go Direct Electrode Amplifier	GDX-EA	65
NEW Go Direct Force and Acceleration	GDX-FOR	139
NEW Go Direct Gas Pressure	GDX-GP	63
NEW Go Direct Light and Color	GDX-LC	139
NEW Go Direct Melt Station	GDX-MLT	65
NEW Go Direct Motion	GDX-MD	139
NEW Go Direct ORP	GDX-ORP	65
NEW Go Direct pH	GDX-PH	62
NEW Go Direct Radiation Monitor	GDX-RAD	63, 139
NEW Go Direct SpectroVis Plus	GDX-SVISPL	64
NEW Go Direct Temperature	GDX-TMP	62
NEW Go Direct Voltage	GDX-VOLT	65, 139

Standard Sensors

Sensor	Order Code	Page
Accelerometers		
3-Axis Accelerometer	3D-BTA	138
25-g Accelerometer	ACC-BTA	138
Low-g Accelerometer	LGA-BTA	138
Anemometer	ANM-BTA	111
Barometer	BAR-BTA	web
Blood Pressure Sensor	BPS-BTA	web
Charge Sensor	CRG-BTA	137
CO_2 Gas Sensor	CO2-BTA	46
Colorimeter	COL-BTA	69

Standard Sensors

Conductivity Probes		
Conductivity Probe	CON-BTA	68
Platinum-Cell Conductivity Probe	CONPT-BTA	68
Constant Current System	CCS-BTA	web
Current Probes		
Current Probe	DCP-BTA	136
High Current Sensor	HCS-BTA	web
Diffraction Apparatus	DAK	135
Digital Control Unit	DCU-BTD	86
Dissolved Oxygen Probes		
Dissolved Oxygen Probe	DO-BTA	web
Vernier Optical DO Probe	ODO-BTA	47
Drop Counter	VDC-BTD	69
EKG Sensor	EKG-BTA	47
Electrode Amplifier	EA-BTA	67
Energy Sensor	VES-BTA	102
Ethanol Sensor	ETH-BTA	48
Flow Rate Sensor	FLO-BTA	97
Force Sensors		
Dual-Range Force Sensor	DFS-BTA	138
Force Plate	FP-BTA	130
Mini GC Plus Gas Chromatograph*	GC2-MINI	74
Gas Pressure Sensors		
Gas Pressure Sensor	GPS-BTA	68
Pressure Sensor 400	PS400-BTA	68
Goniometer	GNM-BTA	web
Hand Dynamometer	HD-BTA	47
Heart Rate Monitors		
Exercise Heart Rate Monitor	EHR-BTA	46
Go Wireless Exercise Heart Rate Monitor	GW-EHR	46
Go Wireless Heart Rate	GW-HR	46
Hand-Grip Heart Rate Monitor	HGH-BTA	46
Instrumentation Amplifier	INA-BTA	web

Ion-Selective Electrodes		
Ammonium Ion-Selective Electrode	NH4-BTA	web
Calcium Ion-Selective Electrode	CA-BTA	web
Chloride Ion-Selective Electrode	CL-BTA	web
Nitrate Ion-Selective Electrode	NO3-BTA	web
Potassium Ion-Selective Electrode	K-BTA	web
Light Sensor	LS-BTA	web
Magnetic Field Sensor	MG-BTA	web
Mass (OHAUS Balances)	Varies by model	69
Melt Station	MLT-BTA	75
Microphone	MCA-BTA	138
Motion Detectors		
Motion Detector	MD-BTD	138
Go! Motion*	GO-MOT	109
CBR 2 (for calculators)	CBR2	151
Motion Encoder System	DTS-EC	127
O_2 Gas Sensor	O2-BTA	46
ORP Sensor	ORP-BTA	web
PAR Sensor	PAR-BTA	43
pH Sensors		
Glass-Body pH Electrode BNC (requires electrode amplifier)	GPH-BNC	67
pH Sensor	PH-BTA	67
Tris-Compatible Flat pH Sensor	FPH-BTA	48
Photogate	VPG-BTD	138
Polarimeter (Chemical)	CHEM-POL	75
Power Amplifier	PAMP	130
Projectile Launcher	VPL	131
Pyranometer	PYR-BTA	103
Radiation Monitor	VRM-BTD	137
Relative Humidity Sensor	RH-BTA	web
Respiration Monitor Belt	RMB	web
Rotary Motion Sensor	RMV-BTD	130
Salinity Sensor	SAL-BTA	web

Soil Moisture Sensor	SMS-BTA	48
Sound Level		
Sound Level Meter	SLM-BTA	138
Sound Level Sensor	SLS-BTA	138
Spectrometers*		
Vernier Emissions Spectrometer	VSP-EM	132
Vernier Flash Photolysis Spectrometer	VSP-FP	73
NEW Vernier Fluorescence/UV-VIS Spectrophotometer	VSP-FUV	73
NEW Go Direct SpectroVis Plus	GDX-SVISPL	71
Vernier UV-VIS Spectrophotometer	VSP-UV	72
Vernier Spectrometer (Ocean Optics)	V-SPEC	web
Spirometer	SPR-BTA	41
Structures & Materials Tester	VSMT	84
Temperature Probes		
EasyTemp* (for calculators)	EZ-TMP	151
Extra-Long Temperature Probe	TPL-BTA	97
Go!Temp*	GO-TEMP	109
Infrared Thermometer	IRT-BTA	web
Stainless Steel Temperature Probe	TMP-BTA	66
Surface Temperature Sensor	STS-BTA	66
Thermocouple	TCA-BTA	66
Wide-Range Temperature Probe	WRT-BTA	66
Turbidity Sensor	TRB-BTA	web
UV Sensors		
UVA Sensor	UVA-BTA	web
UVB Sensor	UVB-BTA	web
Voltage Probes		
Differential Voltage Probe	DVP-BTA	136
Voltage Probe	VP-BTA	web
30-Volt Voltage Probe	30V-BTA	web
Wireless Dynamics Sensor System	WDSS	129

* Connects via USB directly to LabQuest or a computer

Sensor Accessories and Replacement Parts

Part Name	Order Code
Blood Pressure Sensor	
Small Blood Pressure Cuff	CUFF-SM
Large Blood Pressure Cuff	CUFF-LG
Bottles	
Nalgene Bottle (250 mL)	CO2-BTL
Primary Productivity Kit	PPK
Turbidity Bottles (pkg. of 6)	TRB-BOT
Water Quality Bottles (pkg. of 8)	WQ-BOT
CO_2 and/or O_2 Gas Sensor	
BioChamber 250 (250 mL) (2 openings)	BC-250
BioChamber 2000 (2000 mL) (2 openings)	BC-2000
Grommets for CO_2 and O_2 (pkg. of 10)	CO2-GROM
Respiration Chamber (250 mL) (1 opening)	CO2-BTL
Colorimeters	
Cuvette Rack	CUV-RACK
Plastic Cuvettes (pkg. of 100)	CUV
Conductivity Probes	
Conductivity Low Standard (500 mL)	CON-LST
Conductivity Middle Standard (500 mL)	CON-MST
Conductivity High Standard (500 mL)	CON-HST
Dissolved Oxygen Probe (Optical)	
Optical DO Probe Metal Guard	ODO-GRD
Optical DO Probe Replacement Cap	ODO-CAP
Dissolved Oxygen Probe (Original)	
DO Calibration Solution (60 mL)	DO-CAL
DO Filling Solution (130 mL)	FS
DO Polishing Strips	PS
DO Probe Membrane Cap	MEM
Force Sensors	
Dual-Range Force Sensor Replacement Parts Kit	DFS-RPK
Bumper Launcher Kit	BLK
Hoop Bumpers for Bumper and Launcher Kit	HOOPS-BLK
EKG Sensor	
EKG Electrodes	ELEC
Ethanol Sensor	
Ethanol Cap Assemblies (pkg. of 3)	ETH-CAPS
Ethanol Stopper	ETH-STOP
Ethanol Tape	ETH-TAPE
Gas Pressure Sensors	
Pressure Sensor Accessories Kit	PS-ACC
#1 1-Hole Rubber Stopper	PS-STOP1
#5 2-Hole Rubber Stopper	PS-STOP5
Luer Lock Connector	PS-LUER
Plastic 2-Way Valve	PS-2WAY
Plastic Tubing	PS-TUBING
Plastic Tubing Clamps (pkg. of 100)	PTC
Stopper Stem	PS-STEM
Syringe (20 mL, plastic)	PS-SYR
Syringe (20 mL, plastic) (pkg. of 10)	PS-SYR10
Go Wireless Sensors/Go Direct Sensors	
Vernier Micro USB cable	CB-USB-MICRO
Go Wireless Charging Station	GW-CRG
Go Wireless USB Radio	GW-RADIO
Go Direct pH Replacement Electrode	GDX-PH-BNC
Go Direct ORP Replacement Electrode	GDX-ORP-BNC
Heart Rate Sensor	
Heart Rate Hand Grips	HR-GRIP
Exercise Heart Rate Strap	HR-STRAP
Ion-Selective Electrodes	
ISE Ammonium Replacement Module*	NH4-MOD
ISE Calcium Replacement Module*	CA-MOD
ISE Nitrate Replacement Module*	NO3-MOD
ISE Potassium Replacement Module*	K-MOD
ISE Ammonium Low Standard (500 mL)	NH4-LST
ISE Ammonium High Standard (500 mL)	NH4-HST
ISE Calcium Low Standard (500 mL)	CA-LST
ISE Calcium High Standard (500 mL)	CA-HST
ISE Chloride Low Standard (500 mL)	CL-LST
ISE Chloride High Standard (500 mL)	CL-HST
ISE Nitrate Low Standard (500 mL)	NO3-LST
ISE Nitrate High Standard (500 mL)	NO3-HST
ISE Potassium Low Standard (500 mL)	K-LST
ISE Potassium High Standard (500 mL)	K-HST
Melt Stations	
Melt Station Capillary Tubes (pkg. of 100)	MLT-TUBE
Mini GC/Mini GC Plus	
GC Septa (pkg. of 4)	GC-SEP
GC Syringe, 1 µL Hamilton	GC-SYR-MIC
Motion Detectors	
Motion Detector Clamp	MD-CLAMP
pH Sensors	
Electrode Tip Guard (pkg. of 2)	ETG
Microstirrer	MSTIR
pH Buffer Capsules (3 × 10)	PH-BUFCAP
pH Storage Bottles (pkg. of 5)	BTL
pH Storage Solution (500 mL)	PH-SS
Photogate	
Cart Picket Fence	PF-CART
Laser Pointer	LASER
Laser Pointer Stand	STAND
Photogate Bar Tape Kit	TAPE-VPG
Picket Fence	PF
Pulley Bracket	B-SPA
Ultra Pulley Attachment	SPA
Polarimeter (Chemical)	
Polarimeter Sample Cells (pkg. of 4)	CELLS-POL
Power Amplifier	
Accessory Speaker	PAAS-PAMP
Salinity Sensor	
Salinity Standard (500 mL)	SAL-ST
Spectophotometers	
Cuvette Rack	CUV-RACK
Plastic Cuvettes (pkg. of 100)	CUV
Quartz Cuvettes	CUV-QUARTZ
Fluorescence/UV Quartz Cuvette	CUV-QUARTZ-FUV
Spectrophotometer Optical Fiber (for GDX-SVISPL, VSP-UV, VSP-FUV)	VSP-FIBER
Spirometer	
Disposable Bacterial Filter (pkg. of 10)	SPR-FIL10
Disposable Bacterial Filter (pkg. of 30)	SPR-FIL30
Disposable Mouthpiece (pkg. of 30)	SPR-MP30
Disposable Mouthpiece (pkg. of 100)	SPR-MP100
Noseclip (pkg. of 10)	SPR-NOSE10
Noseclip (pkg. of 30)	SPR-NOSE30
O_2 Gas Sensor to Spirometer Adapter	O2-SPR
Spirometer Flow Head	SPR-FLOW
Turbidity Sensor	
Turbidity Bottles (pkg. of 6)	TRB-BOT
Turbidity Cuvette and Standard	TRB-ACC
Vernier Projectile Launcher	
Independence of Motion Accessory	IOM-VPL
Projectile Stop	PS-VPL
Time of Flight Pad	TOF-VPL
Vernier Structures & Materials Tester	
Truss Tester Accessory	VSMT-TRUSS
Wireless Dynamics Sensor System Accessory	
Bluetooth USB Adapter	BLUE-USB

* ISE modules have a life expectancy of 1 to 2 years. We recommend that you do not purchase ISE replacement modules too far in advance of their expected time of use; degradation occurs while replacement modules are stored on the shelf.

LabQuest 2 Accessories

LabQuest Viewer® Software

LQ-VIEW

Teach students how to use LabQuest by projecting your LabQuest screen. Display live images of all LabQuest units in your lab to monitor student progress. Compatible with both Mac and PC.

Computer software includes a site license for every teacher's computer in your school or college department.

LabQuest Viewer app is also available for iPad®.
See page 17.

LabQuest Lanyard

LQ-LAN

This lanyard connects to the back of your LabQuest, so you don't have to worry about students dropping their interface during field studies. Compatible with the original LabQuest and LabQuest 2.

LabQuest Battery Boost 2

LQ-BOOST2

The Battery Boost 2 is a rechargeable external battery for your LabQuest. With the Battery Boost 2, data can be collected for extended periods in the field where AC power is not available.

LabQuest 2 Stand

LQ2-STN

Use this stand to set LabQuest 2 at an angle for easier viewing. The stand can also reduce the possibility of damage due to spills by raising LabQuest 2 off of the lab bench.

LabQuest Charging Station

LQ2-CRG

Want a way to charge and store your LabQuest 2 or LabQuest Stream units? The LabQuest Charging Station has four charging slots with LEDs to indicate the charging status.

Note: If you need to charge an original LabQuest, contact us for inserts.

LabQuest 2 Lab Armor

LQ2-ARMOR

Add extra protection from spills and falls with Lab Armor for LabQuest 2. Molded rubber material helps prevent spills from getting into open ports.

Note: LabQuest 2 outfitted with Lab Armor will not fit in the LabQuest Charging Station.

Additional Accessories

Part Name	Order Code
LabQuest 2 Accessories / Replacement Parts	
LabQuest Charging Station	LQ2-CRG
LabQuest 2 Lab Armor	LQ2-ARMOR
LabQuest 2 Stand	LQ2-STN
LabQuest Power Supply	LQ-PS
LabQuest Tether (pkg. of 5)	LQ-TETH-5
LabQuest Lanyard	LQ-LAN
LabQuest 2 Battery	LQ2-BAT
LabQuest Battery Boost 2	LQ-BOOST2
LabQuest SD Card	LQ-SD
LabQuest 2 Stylus (pkg. of 5)	LQ2-STYL-5
Vernier Mini USB Cable	CB-USB-MINI
Original LabQuest Accessories / Replacement Parts	
LabQuest Power Supply	LQ-PS
LabQuest Tether (pkg. of 5)	LQ-TETH-5
LabQuest Lanyard	LQ-LAN
LabQuest Battery	LQ-BAT
LabQuest Battery Boost 2	LQ-BOOST2
LabQuest SD Card	LQ-SD
LabQuest Stand	LQ-STN
LabQuest Stylus (pkg. of 5)	LQ-STYL-5
LabQuest Wi-Fi USB Adapter	WIFI-USB
Vernier Mini USB Cable	CB-USB-MINI
Misc. Cables / Adapters / Power Supplies	
AC Adapter (for LabPro, CBL 2, or CBL)	IPS
Analog Sensor Extension Cable (2 m)	EXT-BTA
Digital Sensor Extension Cable (2 m)	EXT-BTD
Analog Protoboard Connector	BTA-ELV
Digital Protoboard Connector	BTD-ELV
Calculator-to-Calculator Link Cable	TI-CLC
Short Calculator Link Cable	TI-SLC
Go! Motion to Computer Cable	GMC-USB
LabPro → USB Cable (Mac or PC)	CB-USB
Analog Bare Wire Cable	CB-BTA
Digital Bare Wire Cable	CB-BTD
Easy to Go! USB Adapter	MINI-USB
Go! to Easy USB Adapter	USB-MINI
Motion Detector Cable	MDC-BTD
Vernier USB Type C to Micro USB Cable	CB-USB-C-MICRO
Vernier USB Type C to Mini USB Cable	CB-USB-C-MINI

More Online

Can't find the adapter you need? Check our complete list of adapters (including pictures) at www.vernier.com/adapters

Investigating plant pigments

View our Tech Tips instructional video at www.vernier.com/videos

Biology

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

NEW

Go Direct Sensors

Complete sensing solution in each sensor—collect and directly stream data to your device.

Sensor	Order Code	URL	Page
NEW Go Direct Colorimeter	GDX-COL	vernier.com/gdx-col	8
NEW Go Direct Conductivity	GDX-CON	vernier.com/gdx-con	9
NEW Go Direct Gas Pressure	GDX-GP	vernier.com/gdx-gp	8
NEW Go Direct Light and Color	GDX-LC	vernier.com/gdx-lc	8
NEW Go Direct pH	GDX-PH	vernier.com/gdx-ph	7
NEW Go Direct SpectroVis Plus	GDX-SVISPL	vernier.com/gdx-svispl	8
NEW Go Direct Temperature	GDX-TMP	vernier.com/gdx-tmp	7
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	9

Standard Sensors

Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
25-g Accelerometer	ACC-BTA	vernier.com/acc-bta	138
Blood Pressure Sensor	BPS-BTA	vernier.com/bps-bta	—
CO_2 Gas Sensor	CO2-BTA	vernier.com/co2-bta	46
Colorimeter	COL-BTA	vernier.com/col-bta	69
Conductivity Probe	CON-BTA	vernier.com/con-bta	68
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
Differential Voltage Probe	DVP-BTA	vernier.com/dvp-bta	136
Vernier Optical DO Probe	ODO-BTA	vernier.com/odo-bta	47
EKG Sensor	EKG-BTA	vernier.com/ekg-bta	47
Ethanol Sensor	ETH-BTA	vernier.com/eth-bta	48
Gas Pressure Sensor	GPS-BTA	vernier.com/gps-bta	48
Goniometer	GNM-BTA	vernier.com/gnm-bta	—
Hand Dynamometer	HD-BTA	vernier.com/hd-bta	47
Heart Rate Monitors			
Exercise Heart Rate Monitor	EHR-BTA	vernier.com/ehr-bta	46
Go Wireless Exercise Heart Rate Monitor	GW-EHR	vernier.com/gw-ehr	46
Go Wireless Heart Rate	GW-HR	vernier.com/gw-hr	46
Hand-Grip Heart Rate Monitor	HGH-BTA	vernier.com/hgh-bta	46
Light Sensor	LS-BTA	vernier.com/ls-bta	—
O_2 Gas Sensor	O2-BTA	vernier.com/o2-bta	46
PAR Sensor	PAR-BTA	vernier.com/par-bta	43
pH Sensors			
pH Sensor	PH-BTA	vernier.com/ph-bta	67
Tris-Compatible Flat pH Sensor	FPH-BTA	vernier.com/fph-bta	48
Respiration Monitor Belt	RMB	vernier.com/rmb	—
Soil Moisture Sensor	SMS-BTA	vernier.com/sms-bta	48
Spectrometers*			
NEW Go Direct SpectroVis Plus	GDX-SVISPL	vernier.com/gdx-svispl	45
NEW Vernier Fluorescence/UV-VIS Spectrophotometer	VSP-FUV	vernier.com/vsp-fuv	73
Vernier UV-VIS Spectrophotometer	VSP-UV	vernier.com/vsp-uv	72
Spirometer	SPR-BTA	vernier.com/spr-bta	41
Temperature Probes			
Go!Temp*	GO-TEMP	vernier.com/go-temp	109
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	48
Surface Temperature Probe	STS-BTA	vernier.com/sts-bta	66
Qubit Sensors			
Qubit EKG/EMG Sensor	Q-S207	vernier.com/q-s207	—
Qubit GRS Sensor	Q-S222	vernier.com/q-s222	—

*Connect via USB directly to LabQuest or a computer

Biology Lab Books

Title	URL	Page
Biology with Vernier	vernier.com/bwv	34
Investigating Biology through Inquiry	vernier.com/bio-i	36
Advanced Biology with Vernier	vernier.com/bio-a	38
Human Physiology with Vernier	vernier.com/hp-a	40
Agricultural Science with Vernier	vernier.com/awv	42
Water Quality with Vernier	vernier.com/wqv	39
Investigating Environmental Science through Inquiry	vernier.com/esi	39

Related Content

Environmental Science

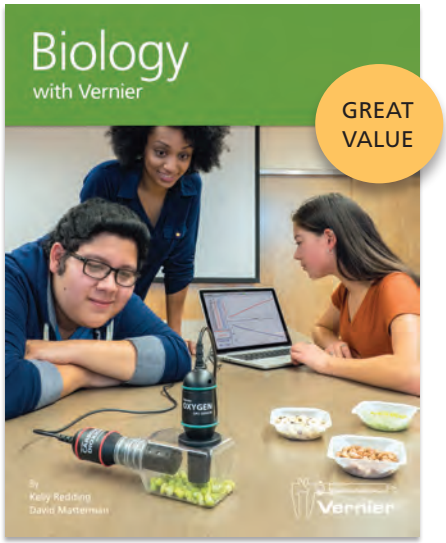
See pp. 92–103.

Investigating Solar Energy

See page 99.

Investigating Wind Energy

See page 99.



Biology with Vernier

Appropriate for high school and introductory college courses for non-majors, this book explores a variety of biology topics. Vernier lab books are loaded with helpful experiment ideas, extensions and challenges, and more.

More Online
Learn more about the experiments in *Biology with Vernier* at www.vernier.com/bwv

Electronic Version

BWV-E

When you buy the electronic version you receive

- 31 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

BWV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Biology with Vernier contains the following experiments:

Ⓢ Ⓓ Using a Temperature Probe
- Biodiversity and Ecosystems
- Energy in Food
- Aerobic Respiration
- Dissolved Oxygen in Water
- Watershed Testing
- Physical Profile of a Lake

Ⓢ Ⓓ Using a Gas Pressure Sensor
- Testing Catalase Activity
- Transpiration
- Cell Respiration
- Sugar Fermentation
- Effect of Temperature on Fermentation
- Osmosis
- Lactase Action
- Control of Human Respiration

Ⓓ Using an EKG Sensor
- Monitoring EKG

Ⓢ Ⓓ Using a Heart Rate Monitor
- Heart Rate and Physical Fitness
- Ventilation and Heart Rate

Ⓢ Ⓓ Using a CO_2 Gas Sensor
- Cell Respiration
- Respiration of Sugars by Yeast
- Effect of Temperature on Respiration
- Temperature of Cold-Blooded Organisms
- Lactase Action
- Photosynthesis and Respiration

Ⓓ Using a Colorimeter
- Photosynthesis
- The Effect of Alcohol on Biological Membranes
- Biological Membranes
- Population Dynamics

Ⓓ Using a Respiration Monitor Belt
- Control of Human Respiration

Ⓓ Using an O_2 Gas Sensor
- Photosynthesis and Respiration
- Enzyme Action
- Cell Respiration
- Oxygen Gas and Human Respiration
- Cold-Blooded Organisms

Ⓓ Using a Conductivity Probe
- Limitations on Cell Size
- Diffusion through Membranes
- Conducting Solutions
- Watershed Testing
- Physical Profile of a Lake

Ⓓ Using an Optical DO Probe
- Interdependence of Plants and Animals
- Aerobic Respiration
- Dissolved Oxygen in Water
- Watershed Testing
- Physical Profile of a Lake
- Primary Productivity

Ⓓ Using a pH Sensor
- Acids and Bases
- Interdependence of Plants and Animals
- Acid Rain
- Watershed Testing
- Physical Profile of a Lake

Ⓢ Starter Package

Ⓓ Deluxe Package

Video Online

Products for *Biology with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Order Code	Ⓢ Starter Package LQ2-BIO-ST	Ⓓ Deluxe Package LQ2-BIO-ODX
LabQuest 2 Interface	LABQ2	•	•
Stainless Steel Temperature Probe	TMP-BTA	•	•
Hand-Grip Heart Rate Monitor	HGH-BTA	•	•
Gas Pressure Sensor	GPS-BTA	•	•
CO_2 Gas Sensor	CO2-BTA	•	•
O_2 Gas Sensor	O2-BTA	—	•
Conductivity Probe	CON-BTA	—	•
pH Sensor	PH-BTA	—	•
Colorimeter	COL-BTA	—	•
Vernier Optical DO Probe	ODO-BTA	—	•
EKG Sensor	EKG-BTA	—	•
BioChamber 250	BC-250	—	•
BioChamber 2000	BC-2000	—	•
Respiration Monitor Belt	RMB	—	•

Ⓓ *Deluxe Package*

Ⓢ *Starter Package*

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

Capture Images with LabQuest 2

Did you know you can now use our digital microscopes and cameras with LabQuest 2? Our USB Digital Microscope (BD-EDU-100) and the Celestron® Digital Microscope Imager (CS-DMI), a drop-in digital microscope camera, work with computers or Chromebooks.™ We know that many schools can't have a computer at every microscope station, so we have added the ability to capture images from these devices on LabQuest 2.

Starting with LabQuest App v2.6, you are able to view and save images from both of these products. Simply connect the camera's USB cable to LabQuest 2 and launch the Camera App.

Mitosis in an onion root tip cross-section at 600× total magnification

Investigating Biology through Inquiry

Investigating Biology through Inquiry helps you integrate inquiry into your curriculum, whether you teach AP*, IB†, or college biology. This book is designed to meet the requirements for inquiry in AP Biology. Vernier inquiry-based lab books are loaded with helpful hints, sample researchable questions, and more.

More Online
Learn more about the experiments in *Investigating Biology with Vernier through Inquiry* at www.vernier.com/bio-i

Electronic Version

BIO-I-E

When you buy the electronic version you receive

- 22 ready-to-use student preliminary activities
- Access to up-to-date versions of the experiments
- Open- and guided-inquiry versions of all preliminary activities
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student investigations, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

BIO-I

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Investigating Biology through Inquiry includes the following investigations:

Using a Temperature Probe
- Water Monitoring
- Sugar Metabolism with Yeast
- Fermentation with Yeast

Using a Conductivity Probe
- Diffusion
- Water Monitoring

Using an O_2 Gas Sensor
- Testing Catalase Activity (O_2)

Using a pH Sensor
- Investigating Buffers
- Water Monitoring

Using a Heart Rate Monitor
Heart Rate

Using a CO_2 Gas Sensor
- Cellular Respiration
- Sugar Metabolism with Yeast
- Evolution of Yeast: Artificial Selection

Using an Optical DO Probe
- Investigating Dissolved Oxygen
- Investigating Primary Productivity
- Water Monitoring

Using a Gas Pressure Sensor
- Transpiration of Plants
- Testing Catalase Activity (Gas Pressure)
- Investigating Osmosis
- Fermentation with Yeast

Using Bioimaging Systems
- Introduction to Molecular Evolution

Using a SpectroVis Plus
- Plant Pigments
- Chemistry of Membranes
- Photosynthesis by Chloroplasts
- Evolution of Cellobiase in Fungi
- Analysis of Enzymes Using Tyrosinase
- Introduction to Biofuels: Enzyme Action
- Investigating Protein: The Bradford Assay

No Sensor Used
- Modeling Population Dynamics

Video Online

Products for *Investigating Biology through Inquiry*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

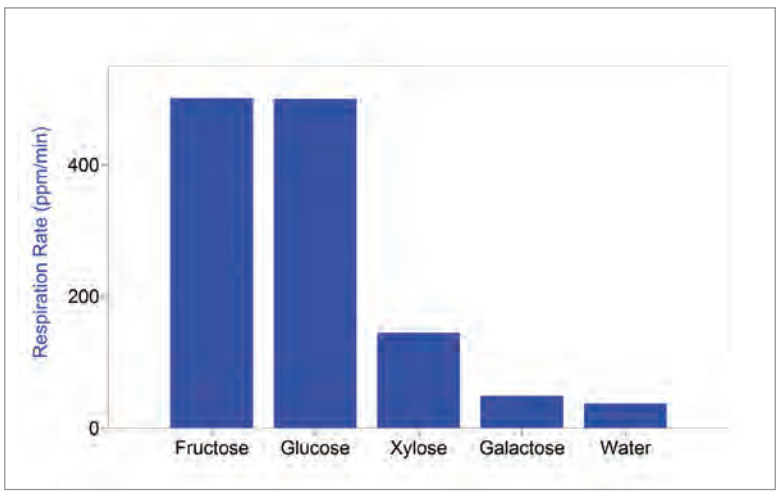
Sensors	Order Code
Stainless Steel Temperature Probe	TMP-BTA
Gas Pressure Sensor	GPS-BTA
NEW Go Direct SpectroVis Plus	GDX-SVISPL
CO_2 Gas Sensor	CO2-BTA
Conductivity Probe	CON-BTA
Vernier Optical DO Probe	ODO-BTA
O_2 Gas Sensor	O2-BTA
Hand-Grip Heart Rate Monitor	HGH-BTA
pH Sensor	PH-BTA

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.



Respiration rates of yeast fed various monosaccharides as measured using a CO_2 Gas Sensor

AP* Biology Teachers

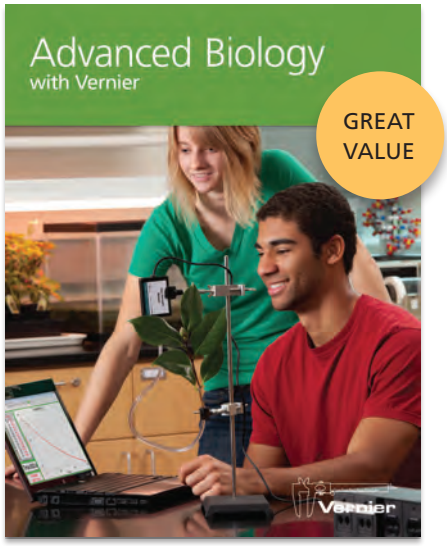
The AP Biology course supports inquiry-based lab experiences for students. Many of the experiments in *Investigating Biology through Inquiry* fit perfectly. We recommend that AP Biology teachers purchase this book. For a complete correlation of Vernier labs with each of the Big Ideas in the AP Biology Framework, visit www.vernier.com/ap

*AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

IB† Biology Teachers

The International Baccalaureate (IB) program has a complete set of objectives for an IB Biology class at the standard level (SL) and the higher level (HL). Many of the experiments in *Investigating Biology through Inquiry* fit perfectly. For a complete correlation of Vernier labs with IB Biology lab objectives, visit www.vernier.com/ib

†The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.



Advanced Biology with Vernier

Appropriate for advanced high school and college introductory biology courses, this book explores a variety of advanced biology topics. Vernier lab books are loaded with helpful experiment ideas, extensions and challenges, and more.

More Online
Learn more about the experiments in *Advanced Biology with Vernier* at www.vernier.com/bio-a

Electronic Version

BIO-A-E

When you buy the electronic version you receive

- 17 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

BIO-A

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Advanced Biology with Vernier contains the following experiments:

(For inquiry-based biology experiments, see page 36.)

Using a Temperature Probe
- Dissolved Oxygen in Water

Using a Gas Pressure Sensor
- Transpiration
- Cell Respiration
- Osmosis
- Enzyme Action

Using a CO_2 Gas Sensor
- Cell Respiration

Using an O_2 Gas Sensor
- Enzyme Action
- Cell Respiration

Using a Heart Rate Monitor
- Heart Rate and Physical Fitness

Using a Colorimeter or SpectroVis Plus
- Photosynthesis
- Enzyme Analysis using Tyrosinase
- Introduction to Neurotransmitters using AChE
- Macromolecules: Experiments with Protein

Using a Conductivity Probe
- Diffusion through Membranes

Using an Optical DO Probe
- Dissolved Oxygen in Water

Using a SpectroVis Plus
- Visible Spectra of Plant Pigments
- Determination of Chlorophyll in Olive Oil

Using a Blood Pressure Sensor
- Blood Pressure as Vital Sign

Using Blue Digital Bioimaging System
- pGLO Bacterial Transformation
- Analysis of Precut Lambda DNA: An Introduction to Restriction Enzymes
- Forensic DNA Fingerprinting

No Sensor Used
- Mitosis and Meiosis
- Plant Pigment Chromatography
- Genetics of Drosophila
- Population Genetics and Evolution
- Animal Behavior

Video Online

Products for *Advanced Biology with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Code	LQ2-AB-OSV
LabQuest 2 Interface	LABQ2	•
Stainless Steel Temperature Probe	TMP-BTA	•
Gas Pressure Sensor	GPS-BTA	•
Conductivity Probe	CON-BTA	•
CO_2 Gas Sensor	CO2-BTA	•
O_2 Gas Sensor	O2-BTA	•
Vernier Optical DO Probe	ODO-BTA	•
Hand-Grip Heart Rate Monitor	HGH-BTA	•
Blood Pressure Sensor	BPS-BTA	•
BioChamber 250	BC-250	•
Go Direct SpectroVis Plus	GDX-SVISPL	•

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

Additional Resources

Looking for more experiments for environmental science or tests for water quality? These books cover these topics in more detail and are a great addition to any science curriculum.

*AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

†The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

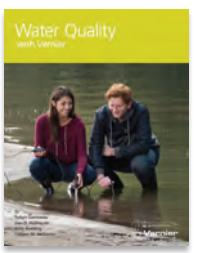
Investigating Environmental Science through Inquiry

Electronic Version: ESI-E

Printed: ESI

Investigating Environmental Science through Inquiry contains 34 inquiry-based, environmental science investigations. Each experiment includes a preliminary activity, teacher information, sample researchable questions, and sample data. Labs are correlated to AP* and IB† standards.

For a complete list of experiments, see page 94.



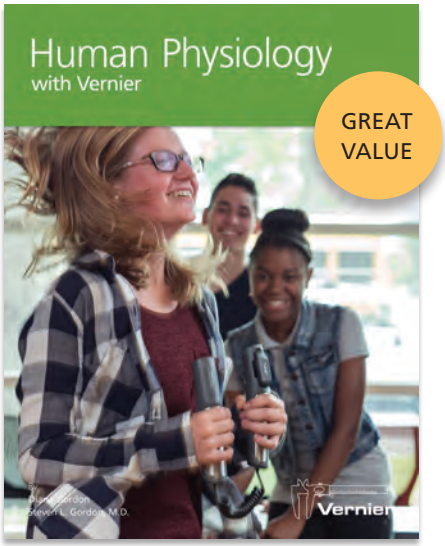
Water Quality with Vernier

Electronic Version: WQV-E

Printed: WQV

Water Quality with Vernier contains 16 water quality tests including pH, dissolved oxygen, turbidity, nitrates, and phosphates. All nine tests in the Water Quality Index (WQI) are supported and two additional activities encourage student investigation. A comprehensive introduction accompanies each test, providing important background information for your students.

For a complete list of tests and experiments, see page 96.



Human Physiology with Vernier

Appropriate for high school and introductory college courses, this book explores a variety of human physiology topics. Vernier lab books are loaded with helpful experiment ideas, extensions, and more.

More Online
Learn more about the experiments in *Human Physiology with Vernier* at www.vernier.com/hp-a

Electronic Version

HP-A-E

When you buy the electronic version you receive

- 24 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro* and LabQuest App
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

HP-A

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Human Physiology with Vernier contains the following experiments:

Using a Surface Temperature Sensor
- Warming Function of Nasal Passageways
- Effect of Vascularity on Skin Temperature Recovery

Using a Blood Pressure Sensor
- Blood Pressure as a Vital Sign
- Blood Pressure and Exercise
- Diurnal Blood Pressure Variation
- Heart Rate and Blood Pressure as Vital Signs
- Heart Rate, Blood Pressure, and Exercise

Using a Heart Rate Monitor
Heart Rate as a Vital Sign
- Heart Rate and Exercise
- Heart Rate Response to Baroreceptor Feedback
- Effect of Coughing on Heart Rate
- Heart Rate and Blood Pressure as Vital Signs
- Heart Rate, Blood Pressure, and Exercise

Using a Hand Dynamometer
- Grip Strength Comparison
- Grip Strength and Muscle Fatigue
- EMG and Muscle Fatigue

Using an EKG Sensor
- Analyzing the Heart with EKG
- Introduction to EMG
- Neuromuscular Reflexes (with Accelerometer)
- Neuromuscular Reflexes (without Accelerometer)
- Muscle Function Analysis
- EMG and Muscle Fatigue

Using a Spirometer
- Lung Volumes and Capacities
- Respiratory Response to Physiologic Challenges
- Analysis of Lung Function
- Oxygen and Aerobic Metabolism

Using an O_2 Gas Sensor
- Oxygen and Aerobic Metabolism
- Oxygen Extraction by the Lungs
- Effect of "Dead Space" on Oxygen Exchange

Using a 25-g Accelerometer
- Neuromuscular Reflexes (with Accelerometer)

Video Online

Products for *Human Physiology with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Code	LQ2-HP-DLX
LabQuest 2 Interface	LABQ2	•
EKG Sensor	EKG-BTA	•
Hand-Grip Heart Rate Monitor	HGH-BTA	•
Surface Temperature Sensor	STS-BTA	•
Blood Pressure Sensor	BPS-BTA	•
Hand Dynamometer	HD-BTA	•
Spirometer	SPR-BTA	•
O_2 Gas Sensor	O2-BTA	•
O_2 Gas Sensor to Spirometer Adapter	O2-SPR	•
25-g Accelerometer	ACC-BTA	•

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

Spirometer

SPR-BTA

The Spirometer is designed to make human respiratory measurements at rest and during moderate activity. Use it to perform a variety of experiments related to air flow and lung volume. The removable flow head (22 mm ID/30 mm OD) makes it easy to clean and sterilize.

Flow range	±600 L/min
Dead space	93 mL

For more information, see www.vernier.com/spr-bta

Spirometer Accessories

Disposable Bacterial Filter
(pkg of 10) SPR-FIL10
(pkg of 30) SPR-FIL30

Use of the disposable microbacterial filter significantly reduces how often you need to sterilize your spirometer's flow head. The filter's 30 mm ID opening allows for an easy, air-tight fit to the flow head.

Spirometer Flow Head
SPR-FLOW

An extra flow head eliminates equipment downtime while sterilizing your original flow head. The flow head consists of a polycarbonate outer body (22 mm ID/30 mm OD) with a stainless steel inner mesh.

Disposable Mouthpiece
(pkg of 30) SPR-MP30
(pkg of 100) SPR-MP100

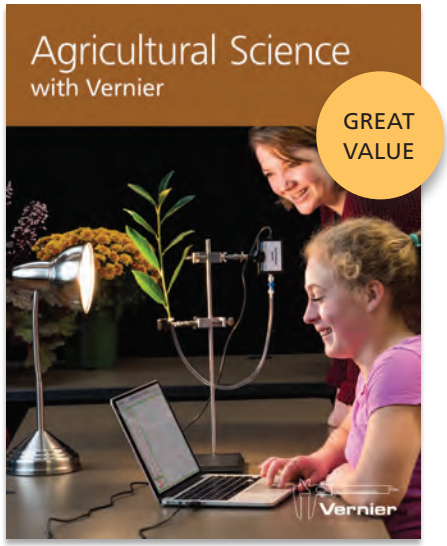
For a more sterile environment, use the cardboard mouthpieces to help eliminate the spreading of contagious material between students.

Noseclip
(pkg of 10) SPR-NOSE10
(pkg of 30) SPR-NOSE30

These plastic, foam-padded noseclips help increase the precision of your spirometry results by eliminating the escape of air through the nostrils during testing.

O_2 Gas Sensor to Spirometer Adapter
O2-SPR

This adapter facilitates the connection between an Oxygen Gas Sensor and a Spirometer when measuring the oxygen gas concentration and flow rate of exhaled air.



Agricultural Science with Vernier

Appropriate for high school, this book explores a variety of agricultural science topics. Vernier lab books are loaded with helpful experiment ideas, extensions, and more.

More Online
Learn more about the experiments in *Agricultural Science with Vernier* at www.vernier.com/awv

Electronic Version

AWV-E

When you buy the electronic version you receive

- 24 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

AWV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Agricultural Science with Vernier contains the following experiments:

Using a Temperature Probe
- Reflection and Absorption of Light
- Soil Temperature
- The Greenhouse Effect
- Energy in Food
- Animal Temperature
- Energy Content of Fuels
- Watershed Testing
- Biodiversity and Ecosystems

Using a pH Sensor
- Acids and Bases
- Soil pH
- Watershed Testing
- Interdependence of Plants and Animals

Using a Conductivity Probe
- Diffusion through Membranes
- Conducting Solutions
- Soil Salinity
- Watershed Testing

Using a Gas Pressure Sensor
- Osmosis
- Transpiration
- Enzyme Action: Testing Catalase Activity
- Lactase Action

Using a Light Sensor
- Reflection and Absorption of Light

Using a Soil Moisture Sensor
- Soil Moisture

Using a CO_2 Gas Sensor
- Respiration of Sugars by Yeast
- Photosynthesis and Respiration (CO_2)
- Photosynthesis and Respiration (CO_2 and O_2)
- Cell Respiration (CO_2)
- Cell Respiration (CO_2 and O_2)
- Lactase Action

Using an O_2 Gas Sensor
- Photosynthesis and Respiration (O_2)
- Photosynthesis and Respiration (CO_2 and O_2)
- Cell Respiration (O_2)
- Cell Respiration (CO_2 and O_2)
- Enzyme Action: Testing Catalase Activity
- Oxygen Gas and Human Respiration

Using an Optical DO Probe
- Biochemical Oxygen Demand
- Watershed Testing
- Interdependence of Plants and Animals

Using a Current Probe
- Ohm's Law
- Photovoltaic Cells
- Wind Power

Using a Differential Voltage Probe
- Ohm's Law
- Lemon "Juice"
- Photovoltaic Cells
- Wind Power

Products for *Agricultural Science with Vernier*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Products	Order Code
Stainless Steel Temperature Probe	TMP-BTA
Tris-Compatible Flat pH Sensor	FPH-BTA
Conductivity Probe	CON-BTA
CO_2 Gas Sensor	CO2-BTA
Ethanol Sensor	ETH-BTA
Vernier Optical DO Probe	ODO-BTA
Differential Voltage Probe	DVP-BTA
Current Probe	DCP-BTA
Gas Pressure Sensor	GPS-BTA
O_2 Gas Sensor	O2-BTA
BioChamber 250	BC-250
BioChamber 2000	BC-2000
Light Sensor	LS-BTA
Soil Moisture Sensor	SMS-BTA

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

Using a PAR Sensor to monitor the amount of photosynthetically active radiation available for photosynthesis outside

PAR Sensor

PAR-BTA

The PAR (Photosynthetically Active Radiation) Sensor reports the photosynthetic photon flux density (PPFD), measured in units of micromoles of photons per meter squared per second. This is the power of electromagnetic radiation in the spectral range that is used by plants for photosynthesis. It features a waterproof sensor head and can be used to measure PPFD from sunlight and electric light sources. This sensor is ideal for experiments investigating photosynthesis and primary productivity and can be used in many agricultural and environmental science applications.

Range	0 to 2000 µmol m^{-2} s^{-1} in full sun
Wavelength range	410 to 655 nm

BlueView Transilluminator

BLUE-VIEW

The BlueView Transilluminator uses super-bright blue LEDs to illuminate electrophoresis gels stained with a variety of fluorescent stains such as SYBR® Safe. This combination is a safer alternative to ethidium bromide and a UV transilluminator. Includes the BlueView Transilluminator only.

- Accommodates gels up to 15 × 12 cm with a viewing area of 11 × 11 cm
- Can be used with a variety of fluorescent stains

For a complete imaging system, visit www.vernier.com/bl-dbs

Four Easy Steps for Gel Analysis

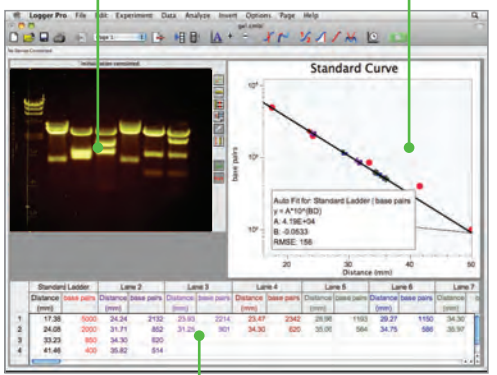
Vernier provides tools for digital photodocumentation and analysis of gel electrophoresis.

1	Run your gel.
2	Use our BlueView Transilluminator to image your gel.
3	Use a digital camera to capture a digital photo of the gel in Logger *Pro*, or take a picture with your cell phone and simply import into Logger *Pro*.
4	Use the Gel Analysis feature in Logger *Pro* to create a standard curve and determine the number of base pairs in each experimental band.

Using the Gel Analysis feature of Logger *Pro* 3

Gel image

Standard curve



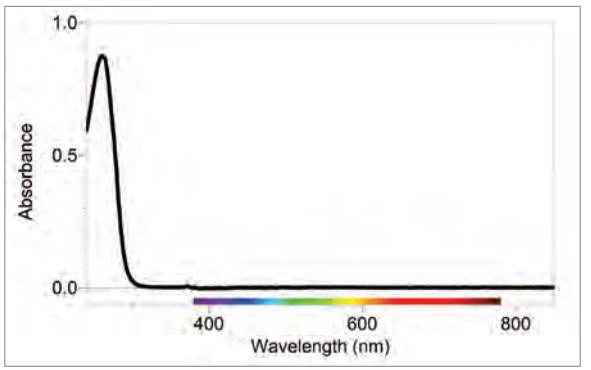
Data table containing migration distances and base pair values for each DNA band

Vernier UV-VIS Spectrophotometer

VSP-UV

The Vernier UV-VIS Spectrophotometer is a portable ultraviolet and visible light spectrophotometer. This accurate, easy-to-use instrument is ideal for measuring the absorbance spectra of various biochemical compounds, including DNA and proteins. It can also be used for kinetics studies, including enzyme assays. Connect directly to a computer (requires Logger *Pro*) or to LabQuest using a standard USB cable (included).

Wavelength range	220 to 850 nm



Starna DNACON 260/280 reference standard, designed to give the spectrophotometric 260/280 nm measurement ratio similar to that achieved when measuring pure DNA

See page 72 for more information.

Did you know?

Bio-Rad® combines high-quality supplies, equipment, and curricula with outstanding customer service and technical support—things we believe are important to teachers. Vernier and Bio-Rad enhance classroom experiences with joint experiments and curricula for biotechnology. Find additional information on biotechnology at www.vernier.com/biotech

NEW Go Direct SpectroVis® Plus

GDX-SVISPL

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus Spectrophotometer. Capable of connecting wirelessly or by USB, this device can easily collect a full wavelength spectrum (absorbance, percent transmission, or intensity) in less than one second. Once the peak wavelength is determined, you can establish the concentration of a solution (Beer's law) or monitor rates of reactions. A low light path allows the Go Direct SpectroVis Spectrophotometer to be used for microscale labs and biochemistry applications with micro and semi-micro cuvettes.

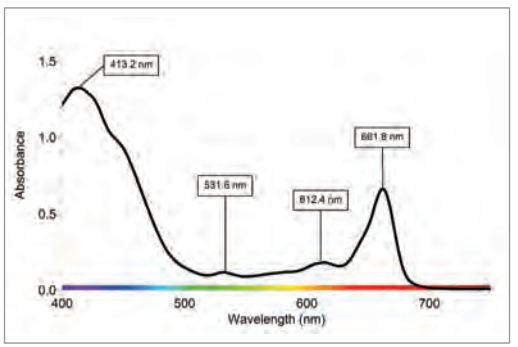
To collect data with Go Direct SpectroVis Plus on computers, Chromebooks™ and mobile devices, download our free Vernier Spectral Analysis software. Students may also connect to LabQuest or to a computer running Logger *Pro* 3 to perform analysis.

For detailed information on software compatibility, visit www.vernier.com/gdx-svispl

Product Specifications	
Wavelength range	380 to 950 nm (VIS-NIR)
Wavelength reporting interval	~1 nm
Light source	Incandescent and LEDs
Fluorescence	Two excitation sources centered at 405 nm and 500 nm

Use the **Spectrophotometer Optical Fiber** (VSP-FIBER) to measure light emissions of LEDs, fluorescent bulbs, or incandescent lights. For spectrum tube emissions, we recommend the Vernier Emissions Spectrometer on page 132.

Investigating plant pigments using a Go Direct SpectroVis Plus Spectrophotometer



Absorbance spectrum of spinach leaf extract using 70% isopropanol

Accessories

Plastic Cuvettes

Visible range, package of 100

CUV

CO_2 Gas Sensor

CO2-BTA

The CO_2 Gas Sensor measures gaseous carbon dioxide in two ranges. The lower range offers more sensitivity for cellular respiration and photosynthetic metabolism studies. Explore human respiratory changes in CO_2 levels based on exercise with the high range.

Low Range	0 to 10,000 ppm
High Range	0 to 100,000 ppm

BioChambers

BioChambers provide a way for both CO_2 Gas and O_2 Gas Sensors (or one of these and an Ethanol Sensor) to be used at the same time in a closed system.

BioChamber 2000, 2000 mL

BC-2000

BioChamber 250, 250 mL

BC-250

O_2 Gas Sensor

O2-BTA

The O_2 Gas Sensor measures oxygen concentration in air. The wide measurement range allows it to be used to study human and cellular respiration. Use the O_2 Gas Sensor to complement many experiments conducted using the CO_2 Gas Sensor.

Includes a 250 mL bottle that can be used to study the rusting of iron or as a respiration chamber for monitoring plants and insects.

Range	0 to 27% (0 to 270 ppt)
Normal operating temperature range	25°C (±5°C)

Heart Rate Monitors

Hand-Grip Heart Rate Monitor

HGH-BTA

The Hand-Grip Heart Rate Monitor makes it easy to monitor heart rate before, during, and after exercise. Data are wirelessly transmitted to a Vernier interface using the included receiver. Data can also be transmitted using Bluetooth® wireless technology.

Exercise Heart Rate Monitor

EHR-BTA

The Exercise Heart Rate Monitor is an excellent hands-free option for continuously monitoring heart rate. Using the chest strap, data are wirelessly transmitted to a Vernier interface using the Heart Rate Receiver. Data can also be transmitted using Bluetooth wireless technology.

Did you know?

Go Wireless sensors can connect to LabQuest 2 and mobile devices using Bluetooth wireless technology.

Go Wireless® Heart Rate

GW-HR

Go Wireless Heart Rate wirelessly transmits data from a pair of hand grips to iPad,® LabQuest 2, or Android™ devices.

Go Wireless® Exercise Heart Rate

GW-EHR

Go Wireless Exercise Heart Rate is a hands-free option for monitoring heart rate. Data are wirelessly transmitted from the chest strap to iPad, LabQuest 2, or Android devices.

EKG Sensor

EKG-BTA

Use the EKG Sensor to measure electrical signals produced by the heart and during muscle contractions.

- Make standard 3-lead EKG tracings to record electrical activity in the heart.
- Collect surface EMG recordings to study contractions in muscles in your arm, leg, or jaw.

Each sensor includes a package of 100 disposable electrodes.

EKG Electrodes (pkg of 100)

ELEC

Hand Dynamometer

HD-BTA

Our strain-gage based isometric dynamometer can be used to measure grip strength or finger-pinch strength. The Hand Dynamometer can be used alone or in combination with EMG recordings for detailed studies of muscular activity.

Force range	0 to 600 N
Typical accuracy	±0.6 N

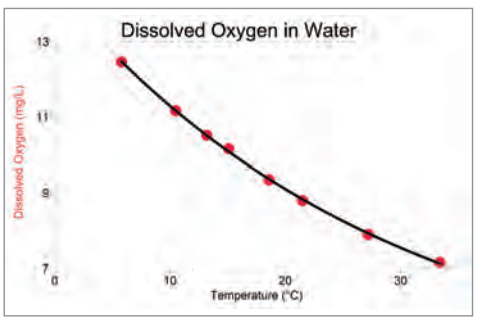
Vernier Optical DO Probe

ODO-BTA

Students can now measure the concentration of dissolved oxygen in water quickly and easily. The Vernier Optical DO Probe uses luminescent technology to provide fast, easy, and accurate measurements of dissolved oxygen concentrations, making it a terrific choice for biology, ecology, or environmental science courses.

- Plug-and-play technology—no filling solution, warm-up time, calibration, or stirring necessary
- Built-in temperature and pressure compensation
- Easy maintenance

Range	0 to 20 mg/L, 0 to 300% saturation
Response time	90% of final reading in 40 seconds
Temperature compensation	automatic from 0 to 50°C
Pressure compensation	automatic from 228 mmHg to 1519 mmHg



Saturated dissolved oxygen at various temperatures

Accessories

Optical DO Probe Metal Guard

ODO-GRD

Attach the guard to the Vernier Optical DO Probe to protect the cap and to help weigh down the probe when submerged.

Optical DO Probe Replacement Cap*

ODO-CAP

The cap is part of the sensing element. It will need to be replaced every few years.

* Optical DO Probe caps are warranted to be free from defects for a period of two years from the date of purchase; it is possible that you may get somewhat longer use than the warranty period.

Tris-Compatible Flat pH Sensor

FPH-BTA

The Tris-Compatible Flat pH Sensor uses a double-junction electrode, making it compatible with Tris buffers and solutions containing proteins. The flat glass shape also makes it ideal for measuring the pH of semisolids, such as food or soil.

Gas Pressure Sensor

GPS-BTA

The Gas Pressure Sensor has sufficient resolution and range to work for many biology experiments.

- Use the included airtight tubing clamps for transpiration experiments.
- Perform respiration experiments in small containers using included fittings.

Includes the Pressure Sensor Accessories Kit. For replacement parts, see page 30.

Stainless Steel Temperature Probe

TMP-BTA

This rugged and durable temperature probe has a sealed stainless steel shaft and tip that can be used in organic liquids, salt solutions, acids, and bases.

Range	–40 to 135°C

Colorimeter

COL-BTA

This 4-wavelength Colorimeter measures the amount of light transmitted through a sample at a user-selectable wavelength in order to determine the concentration of a solution. Features such as automatic sensor identification and one-step calibration make this sensor easy to use.

Wavelengths	430 nm, 470 nm, 565 nm, 635 nm

Ethanol Sensor

ETH-BTA

Use the Ethanol Sensor to measure the concentration of ethanol in air above an aqueous sample. It can be used to determine the rate of ethanol production during fermentation or to measure the discrete amount of ethanol in a given sample.

Range	0 to 3%

Soil Moisture Sensor

SMS-BTA

The Soil Moisture Sensor uses capacitance to measure the water content of soil. Simply insert this rugged sensor into the soil to be tested and the volumetric water content of soil is reported in percent. Use it to conduct experiments in ecology, environmental science, agricultural science, horticulture, biology, and more.

Range	0 to 45% volumetric water content

USB Digital Microscope

BD-EDU-100

The USB Digital Microscope gives you a live image that is very similar to what you would see with a traditional dissection microscope. This 5 megapixel camera connects to a computer, Chromebook,™ or LabQuest 2 via USB. It features 10–300× magnification with manual focus and an adjustable LED light source. In addition to capturing still images, you can also record short videos and time-lapse sequences*.

WORKS WITH LABQUEST 2
See page 35.

ProScope™ 5MP Microscope Camera

BD-PS-MC5UW

The ProScope 5MP Microscope Camera is a Wi-Fi and USB camera that simply replaces the eyepiece of a traditional compound or stereo microscope. This turns your personal computer, Chromebook, iPad® or Android™ device into a high-resolution camera for capturing high-quality digital images. With the Wi-Fi option, you can wirelessly send images to multiple iOS or Android devices.

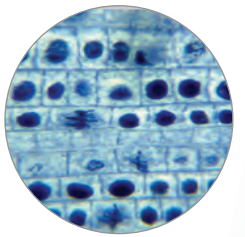
Celestron® Digital Microscope Imager

CS-DMI

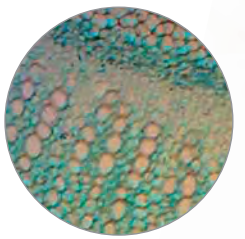
The Celestron Digital Microscope Imager turns your traditional compound or stereo microscope into a high-resolution digital imager using a computer, Chromebook, or LabQuest 2. The imager replaces the eyepiece of the microscope and connects directly to your device using the USB port.

- Instantly displays digital images on a computer, Chromebook, or LabQuest 2
- Takes still photos, movies, and time-lapse videos*
- Included adapter makes it compatible with both compound and dissecting microscopes

WORKS WITH LABQUEST 2
See page 35.



Onion root tip



Xylem and phloem tissue

Peacock feather

The Celestron Digital Microscope Imager turns your microscope into a high-resolution digital imager.

*Movies and time lapse only supported on computer

Using Go Direct SpectroVis Plus Spectrophotometer to examine the absorbance spectrum of copper (II) sulfate

View our Tech Tips instructional video at www.vernier.com/videos

Chemistry

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

NEW

Go Direct Sensors

Complete sensing solution in each sensor—collect and stream data directly to your device.

Sensor	Order Code	URL	Page
NEW Go Direct Colorimeter	GDX-COL	vernier.com/gdx-col	64
NEW Go Direct Conductivity	GDX-CON	vernier.com/gdx-con	63
NEW Go Direct Constant Current System	GDX-CCS	vernier.com/gdx-ccs	65
NEW Go Direct Drop Counter	GDX-DC	vernier.com/gdx-dc	64
NEW Go Direct Electrode Amplifier	GDX-EA	vernier.com/gdx-ea	—
NEW Go Direct Gas Pressure	GDX-GP	vernier.com/gdx-gp	63
NEW Go Direct Melt Station	GDX-MLT	vernier.com/gdx-mlt	65
NEW Go Direct ORP	GDX-ORP	vernier.com/gdx-orp	65
NEW Go Direct pH	GDX-PH	vernier.com/gw-ph	62
NEW Go Direct Radiation Monitor	GDX-RAD	vernier.com/gdx-rad	63
NEW Go Direct SpectroVis Plus	GDX-SVISPL	vernier.com/gdx-svispl	64
NEW Go Direct Temperature	GDX-TMP	vernier.com/gw-tmp	62
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	65

Standard Sensors

Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
Colorimeter	COL-BTA	vernier.com/col-bta	69
Conductivity Probes			
Conductivity Probe	CON-BTA	vernier.com/con-bta	68
Platinum-Cell Conductivity Probe	CONPT-BTA	vernier.com/conpt-bta	68
Current Probes			
Constant Current System	CCS-BTA	vernier.com/ccs-bta	—
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
Drop Counter	VDC-BTD	vernier.com/vdc-btd	69
Electrode Amplifier	EA-BTA	vernier.com/ea-bta	67
Gas Pressure Sensors			
Gas Pressure Sensor	GPS-BTA	vernier.com/gps-bta	68
Pressure Sensor 400	PS400-BTA	vernier.com/ps400-bta	68
Instrumentation Amplifier	INA-BTA	vernier.com/ina-bta	—
Melt Station	MLT-BTA	vernier.com/mlt-bta	75
Mini GC Plus Gas Chromatograph	GC2-MINI	vernier.com/gc2-mini	74
ORP Sensor	ORP-BTA	vernier.com/orp-bta	—
pH Sensors			
Glass-Body pH Electrode BNC†	GPH-BNC	vernier.com/gph-bnc	67
pH Sensor	PH-BTA	vernier.com/ph-bta	67
Tris-Compatible Flat pH Sensor	FPH-BTA	vernier.com/fph-bta	48
Polarimeter (Chemical)	CHEM-POL	vernier.com/chem-pol	75
Vernier Radiation Monitor	VRM-BTD	vernier.com/vrm-btd	137
Spectrometers*			
NEW Go Direct SpectroVis Plus	GDX-SVISPL	vernier.com/gdx-svispl	8
Vernier Emissions Spectrometer	VSP-EM	vernier.com/vsp-em	132
Vernier Flash Photolysis Spectrometer	VSP-FP	vernier.com/vsp-fp	73
NEW Vernier Fluorescence/UV-VIS Spectrophotometer	VSP-FUV	vernier.com/vsp-fuv	73
Vernier Spectrometer (Ocean Optics)	V-SPEC	vernier.com/v-spec	—
Vernier UV-VIS Spectrophotometer	VSP-UV	vernier.com/vsp-uv	72
Temperature Probes			
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	66
Surface Temperature Probe	STS-BTA	vernier.com/sts-bta	66
Thermocouple	TCA-BTA	vernier.com/tca-bta	66
Wide-Range Temperature Probe	WRT-BTA	vernier.com/wrt-bta	66
Voltage Probes			
Differential Voltage Probe	DVP-BTA	vernier.com/dvp-bta	136
Voltage Probe	VP-BTA	vernier.com/vp-bta	—

*Connect via USB directly to LabQuest or a computer †Requires an Electrode Amplifier

Chemistry Lab Books

Title	URL	Page
Chemistry with Vernier 4th Ed.	vernier.com/cwv	52
Vernier Chemistry Investigations for Use with AP‡ Chemistry 4th Ed.	vernier.com/apchem	54
Investigating Chemistry through Inquiry 4th Ed.	vernier.com/chem-i	56
Advanced Chemistry with Vernier 4th Ed.	vernier.com/chem-a	58
Organic Chemistry with Vernier	vernier.com/chem-o	60

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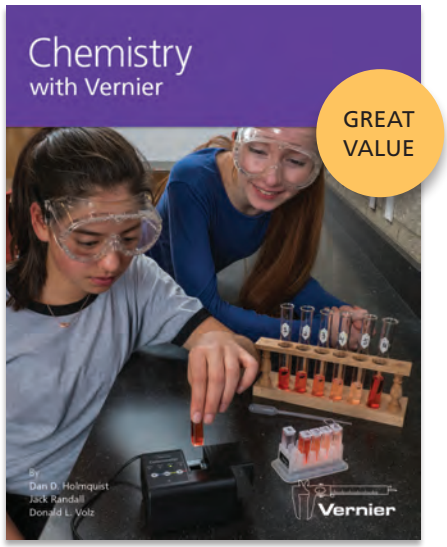


Chemistry with Vernier 4th Ed.

Appropriate for high school and college, this book explores a variety of chemistry topics. Vernier lab books are loaded with helpful experiment ideas, extensions and challenges, and more. The 4th edition is updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

More Online
Learn more about the experiments in *Chemistry with Vernier* at www.vernier.com/cwv

Electronic Version

CWV-E

When you buy the electronic version you receive

- 36 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Graphical Analysis 4 software, Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

CWV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Chemistry with Vernier contains the following experiments:

Ⓢ Ⓓ Using Temperature Probes
- Endothermic and Exothermic Reactions
- Freezing and Melting of Water
- Another Look at Freezing Temperature
- Heat of Fusion of Ice
- Pressure-Temperature Relationships
- Fractional Distillation
- Evaporation and Intermolecular Attractions
- Vapor Pressure of Liquids
- Effect of Temperature on Solubility
- Finding Molecular Weight
- Energy Content of Foods
- Energy Content of Fuels
- Hess's Law
- Heat of Combustion: Magnesium

Ⓢ Ⓓ Using a pH Sensor
- Household Acids and Bases
- Acid Rain
- Titration Curves of Acids and Bases
- ▶ Acid-Base Titration
- Titration of a Diprotic Acid
- Acid Dissociation Constant, K_a
- Time-Released Vitamin C Tablet
- The Buffer in Lemonade
- Phosphoric Acid Content in Soft Drinks
- Microscale Acid-Base Titration

Ⓢ Ⓓ Using a Voltage Probe
- Micro-Voltaic Cells
- Lead Storage Batteries

Ⓢ Ⓓ Using a Gas Pressure Sensor
- Boyle's Law: Gas Pressure and Volume
- Pressure-Temperature Relationship
- Vapor Pressure of Liquids

Ⓓ Using a Colorimeter
- ▶ Beer's Law
- Finding an Equilibrium Constant, K_c
- ▶ Rate Law Determination of the Crystal Violet Reaction
- Chlorine Content of Swimming Pool Water
- Quantity of Iron in a Vitamin Tablet

Ⓓ Using a Conductivity Probe
- Electrolytes and Non-Electrolytes
- The Effect of Concentration
- Using Conductivity to Find an Equivalence Point

Ⓓ Using a Drop Counter (optional)
- ▶ Acid-Base Titration
- Titration of a Diprotic Acid
- Using Conductivity to Find an Equivalence Point

No Sensor Used
- Find the Relationship: An Exercise in Graphical Analysis

Ⓢ Starter Package Ⓓ Deluxe Package ▶ Video Online

Products for *Chemistry with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Order Code	Ⓢ Starter Package LQ2-CH-ST	Ⓓ Deluxe Package LQ2-CH-DX
LabQuest 2 Interface	LABQ2	•	•
Stainless Steel Temperature Probe	TMP-BTA	•	•
pH Sensor	PH-BTA	•	•
Gas Pressure Sensor	GPS-BTA	•	•
Voltage Probe	VP-BTA	•	•
Conductivity Probe	CON-BTA	—	•
Colorimeter	COL-BTA	—	•
Drop Counter	VDC-BTD	—	•

Ⓢ *Starter Package*

Ⓓ *Deluxe Package*

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

OR

NEW Go Direct™ Sensors

Our new Go Direct sensors connect directly to a Chromebook,™ computer, or mobile device and require no additional interface.

Software needed for Go Direct sensors

FREE Graphical Analysis 4 software
See page 10.

Note: Logger *Pro* cannot be used to collect data with Go Direct sensors (except for Go Direct SpectroVis Plus).

This is a complete solution for all 36 experiments in *Chemistry with Vernier.*

Go Direct Temperature*

GDX-TMP

Go Direct pH

GDX-PH

Go Direct Gas Pressure

GDX-GP

Go Direct Voltage

GDX-VOLT

Go Direct Conductivity

GDX-CON

Go Direct Colorimeter

GDX-COL

Go Direct Drop Counter

GDX-DC

* You will need two Go Direct Temperature Probes for some experiments in *Chemistry with Vernier.*

More Online
Learn more about the experiments in *Vernier Chemistry Investigations for Use with AP* Chemistry* at www.vernier.com/apchem

Vernier Chemistry Investigations for Use with AP Chemistry* 4th Ed.

Appropriate for high school, this AP Chemistry lab book makes it easy for chemistry teachers to integrate Vernier data-collection technology into the curriculum. The 4th edition is updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

Electronic Version

APCHEM-E

When you buy the electronic version you receive

- Experiments aligned with the College Board's 16 AP Chemistry investigations
- Access to up-to-date versions of the experiments
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- A generous site license—buy one book and duplicate the experiments for your class
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Instructions for data collection with Graphical Analysis 4, Logger *Pro*, and LabQuest App.

Printed Lab Book

APCHEM

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Vernier Chemistry Investigations for Use with AP Chemistry* contains the following experiments:

Using a Conductivity Probe
- Investigating Water Hardness
- Investigating the Contents of an Unlabeled Container
- Investigating the Purity of a Mixture

Using a SpectroVis Plus
- Investigating Food Dyes in Sports Beverages
- Determining the Copper Content in Brass
- Separating Molecules
- Investigating the Kinetics of a Crystal Violet Reaction
- Investigating LeChatelier's Principle

Using a Gas Pressure Sensor
- The Effect of Acid Rain on a Marble Structure

Using a pH Sensor & Drop Counter
- The Acidity of Juice and Soft Drinks
- Investigating Acid-Base Titrations
- The Buffering Ability of Commercial Products
- Testing the Effectiveness of a Buffer

Using an ORP Sensor & Drop Counter
- Determining the Percent Peroxide in a Commercial Product

Using a Temperature Probe
- Investigating Commercial Hand Warmers

Using a Melt Station
- Investigating the Contents of an Unlabeled Container
- Investigating the Components of a Commercial Tablet

Video Online

*AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

Vernier & Flinn Scientific

FLINN SCIENTIFIC, INC

Since 1995, Vernier and Flinn Scientific, the leading provider of chemistry education products, have teamed up to provide you more time to do what you do best—teach.

Lengthy prep time is all but eliminated with Flinn's Advanced Inquiry Laboratory Kits for AP Chemistry. These budget-friendly kits are aligned with the inquiry investigations published by the College Board and provide you with all the chemical supplies needed to complete the experiment. These kits can be purchased individually or as a 16-kit bundle—one kit for each investigation.

For more information, visit www.flinnsci.com

Products for *Vernier Chemistry Investigations for Use with AP Chemistry*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Products	Order Code
Stainless Steel Temperature Probe	TMP-BTA
pH Sensor	PH-BTA
Go Direct SpectroVis Plus	GDX-SVISPL
Conductivity Probe	CON-BTA
ORP Sensor	ORP-BTA
Gas Pressure Sensor	GPS-BTA
Drop Counter	VDC-BTD
Melt Station	MLT-BTA

Software options

For computers

Logger *Pro* 3 (LP)
See page 20.

For Chromebook, mobile device, or computer

FREE Graphical Analysis 4
See page 10.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

OR

NEW Go Direct™ Sensors

Our new Go Direct sensors connect directly to a Chromebook,™ computer, or mobile device and require no additional interface.

Software needed for Go Direct sensors

FREE Graphical Analysis 4 software
See page 10.

FREE Vernier Spectral Analysis (for Go Direct SpectroVis Plus)
See page 71.

Note: Logger *Pro* cannot be used to collect data with Go Direct sensors (except for Go Direct SpectroVis Plus).

This is a complete solution for all 16 experiments in *Vernier Chemistry Investigations for Use with AP Chemistry.*

Go Direct Temperature

GDX-TMP

Go Direct pH

GDX-PH

Go Direct SpectroVis Plus

GDX-SVISPL

Go Direct Conductivity

GDX-CON

Go Direct ORP

GDX-ORP

Go Direct Gas Pressure

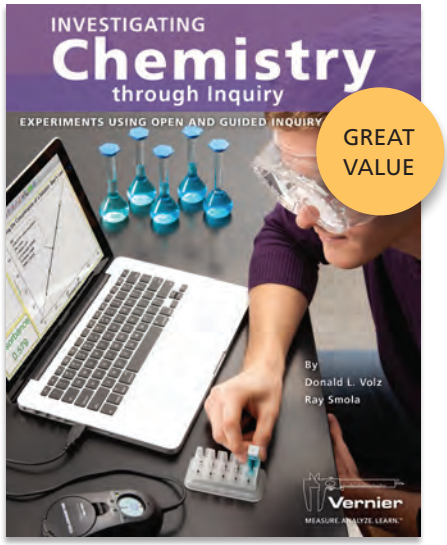
GDX-GP

Go Direct Drop Counter

GDX-DC

Go Direct Melt Station

GDX-MLT



More Online
Learn more about the experiments in *Investigating Chemistry through Inquiry* at www.vernier.com/chem-i

Investigating Chemistry through Inquiry 4th Ed.

Appropriate for high school and college, this lab book is loaded with teacher tips, sample graphs, and more. The 4th edition is updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

Electronic Version

CHEM-I-E

When you buy the electronic version you receive

- 25 inquiry-based, chemistry investigations
- Access to up-to-date versions of the experiments
- Essential teacher information for successful inquiry investigations
- Suggested researchable questions, sample data, and graphs
- A generous site license—buy one book and duplicate the labs for your class
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences

Printed Lab Book

CHEM-I

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

IB* Chemistry Teachers

The International Baccalaureate (IB) program has a complete set of objectives for an IB Chemistry class at the standard level (SL) and the higher level (HL). Many of the experiments in the *Investigating Chemistry through Inquiry* and *Advanced Chemistry with Vernier* lab books fit perfectly. We recommend that IB Chemistry teachers purchase both of these books. For a complete correlation of Vernier labs with IB Chemistry lab objectives, visit www.vernier.com/ib

*** The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.**

Investigating Chemistry through Inquiry contains the following investigations:

Using a Temperature Probe
- Physical Properties of Water
- Baking Soda and Vinegar Investigations
- An Investigation of Urea-Containing Cold Packs
- Identifying a Pure Substance
- Investigating the Energy Content of Foods
- Investigating the Energy Content of Fuels
- Evaporation and Intermolecular Attractions
- Enthalpy Changes
- Reaction Stoichiometry
- Colligative Properties of Solutions
- Long Term Water Monitoring
- Vapor Pressure and Heat of Vaporization Investigations
- The Effect of Acid Deposition on Aqueous Systems
- Baking Soda and Vinegar Investigations Revisited
- Reaction Rates
- Enzyme Activity
- Sugar Fermentation by Yeast

Using a Gas Pressure Sensor
- Vapor Pressure and Heat of Vaporization Investigations
- Baking Soda and Vinegar Investigations Revisited
- Reaction Rates
- Enzyme Activity
- Sugar Fermentation by Yeast

Using a pH Sensor
- Long Term Water Monitoring
- Acid-Base Properties of Household Products
- The Effect of Acid Deposition on Aqueous Systems

▶ Acid-Base Titrations

- Baking Soda and Vinegar Investigations Revisited

Using a Voltage Probe
- Investigating Voltaic Cells

Using a Conductivity Probe
- Conductivity of Aqueous Solutions
- Long Term Water Monitoring
- Conductimetric Titrations

Using a Colorimeter or SpectroVis Plus

▶ Beer's Law Investigations

Using an ORP Sensor
- Oxidation-Reduction Titrations

Using a Radiation Monitor
- Nuclear Radiation

▶ Video Online

Products for *Investigating Chemistry through Inquiry*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Products		Order Code
Stainless Steel Temperature Probe		TMP-BTA
pH Sensor		PH-BTA
Gas Pressure Sensor		GPS-BTA
Conductivity Probe		CON-BTA
ORP Sensor		ORP-BTA
Drop Counter		VDC-BTD
Choose one:	Colorimeter	COL-BTA
	Go Direct SpectroVis Plus	GDX-SVISPL

Software options

For computers

Logger *Pro* 3 (LP)
See page 20.

For Chromebook, mobile device, or computer

FREE Graphical Analysis 4
See page 10.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

OR

NEW Go Direct™ Sensors

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Software needed for Go Direct sensors

FREE Graphical Analysis 4 software
See page 10.

FREE Vernier Spectral Analysis (for Go Direct SpectroVis Plus)
See page 71.

Note: Logger *Pro* cannot be used to collect data with Go Direct sensors (except for Go Direct SpectroVis Plus).

This is a complete solution for all 25 experiments in *Investigating Chemistry through Inquiry.*

Go Direct Temperature†
GDX-TMP

Go Direct pH
GDX-PH

Go Direct Gas Pressure
GDX-GP

Go Direct Conductivity
GDX-CON

Go Direct Drop Counter
GDX-DC

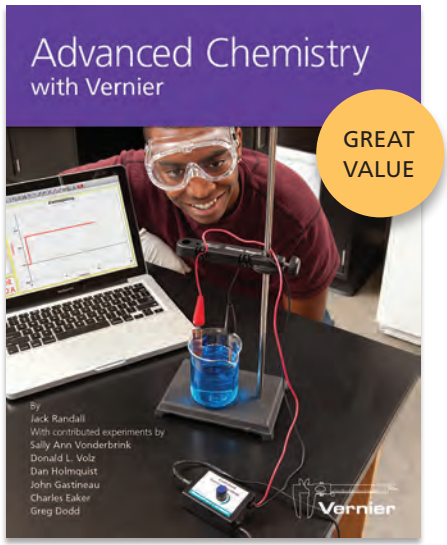
Go Direct ORP
GDX-ORP

Choose one:

Go Direct Colorimeter
GDX-COL

Go Direct SpectroVis Plus
GDX-SVISPL

† You will need two Go Direct Temperature Probes for some experiments in *Chemistry with Vernier.*



Advanced Chemistry with Vernier 4th Ed.

Appropriate for college and high school, this book explores a variety of advanced chemistry topics. Vernier lab books are loaded with helpful experiment ideas, extensions, and more. The 4th edition is updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

More Online
Learn more about the experiments in *Advanced Chemistry with Vernier* at www.vernier.com/chem-a

Electronic Version

CHEM-A-E

When you buy the electronic version you receive

- 35 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro* 3, LabQuest App, Graphical Analysis 4, and EasyData
- Essential teacher information for successful inquiry investigations
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

CHEM-A

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Advanced Chemistry with Vernier contains the following experiments:

Using a Temperature Probe
- Using Freezing-Point Depression to Find Molecular Weight
- The Molecular Mass of a Volatile Liquid
- Molar Volume of a Gas
- Vapor Pressure and Heat of Vaporization
- Rate Determination and Activation Energy
- Synthesis and Analysis of Aspirin
- Exploring the Properties of Gases
- Determining the Mole Ratios in a Chemical Reaction
- Determining the Enthalpy of a Chemical Reaction
- Synthesis and Analysis of Alum
- The Enthalpy of Neutralization of Phosphoric Acid

Using a pH Sensor
- Buffers
- Determining the K_{sp} of Calcium Hydroxide
- Determining K_a by the Half Titration of a Weak Acid

Using a pH Sensor and Drop Counter (optional)
▶ Acid-Base Titration
- Investigating Indicators
- Standardizing a Solution of Sodium Hydroxide

Using a Colorimeter or SpectroVis Plus
▶ The Determination of an Equilibrium Constant
- Determining the Concentration of a Solution: Beer's Law
- The Rate and Order of a Chemical Reaction
- The Synthesis and Analysis of Aspirin
- Rate Determination and Activation Energy

Using a Voltage Probe
- Electrochemistry: Voltaic Cells

Using a Gas Pressure Sensor
- The Decomposition of Hydrogen Peroxide
- The Molar Volume of a Gas
- Exploring the Properties of Gases
- Vapor Pressure and Heat of Vaporization

Using a Conductivity Probe & Drop Counter (optional)
- Conductimetric Titration and Gravimetric Determination

Using an ORP Sensor & Drop Counter
- An Oxidation-Reduction Titration: Fe^{2+} and Ce^{4+}
- Potentiometric Titration of Hydrogen Peroxide

Constant Current System
- Electroplating
- Avogadro's Number

Using a Radiation Monitor
- Alpha, Beta, and Gamma
- Radiation Shielding
- Half-Life Determination

Using a Platinum-Cell Conductivity Probe*
- The Base Hydrolysis of Ethyl Acetate

No Sensor Used
- The Determination of a Chemical Formula
- The Determination of the Percent Water in a Compound
- Separation and Qualitative Analysis of Cations
- Liquid Chromatography

▶ Video Online

*Platinum-Cell Conductivity Probe is not included in package.

Products for *Advanced Chemistry with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.*

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Order Code	LQ2-CHMA-SV
LabQuest 2	LABQ2	•
Stainless Steel Temperature Probe	TMP-BTA	•
pH Sensor	PH-BTA	•
Gas Pressure Sensor	GPS-BTA	•
Voltage Probe	VP-BTA	•
Conductivity Probe	CON-BTA	•
Drop Counter	VDC-BTD	•
Constant Current System	CCS-BTA	•
ORP Sensor	ORP-BTA	•
Go Direct SpectoVis Plus	GDX-SVISPL	•

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

OR

NEW Go Direct™ Sensors

Our new Go Direct sensors connect directly to a Chromebook,™ computer, or mobile device and require no additional interface.

Software needed for Go Direct sensors

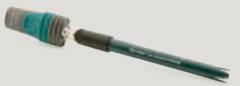
FREE Graphical Analysis 4 software
See page 10.

FREE Vernier Spectral Analysis (for Go Direct SpectroVis Plus)
See page 71.

Note: Logger *Pro* cannot be used to collect data with Go Direct sensors (except for Go Direct SpectroVis Plus).

This is a complete solution for all 35 experiments in *Advanced Chemistry with Vernier.**

Go Direct Temperature
GDX-TMP



Go Direct pH
GDX-PH

Go Direct Gas Pressure
GDX-GP

Go Direct Voltage
GDX-VOLT

Go Direct Conductivity
GDX-CON

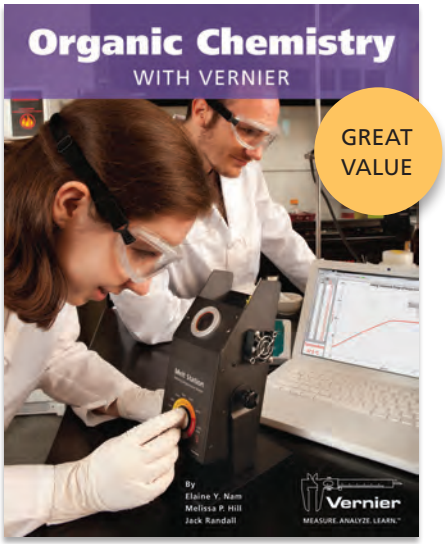
Go Direct Drop Counter
GDX-DC

Go Direct Constant Current System
GDX-CCS

Go Direct ORP
GDX-ORP

Go Direct SpectroVis Plus
GDX-SVISPL

*Experiment 29 requires the Platinum-Cell Conductivity Probe (CONPT-BTA). See page 68.



Organic Chemistry with Vernier

Appropriate for college, this lab book makes it easy for organic chemistry instructors to integrate Vernier data-collection technology into the organic chemistry lab curriculum.

More Online
Learn more about the experiments in *Organic Chemistry with Vernier* at www.vernier.com/chem-o

Electronic Version

CHEM-O-E

When you buy the electronic version you receive

- Complete student experiments with materials list, step-by-step instructions, data tables, and questions
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro* and LabQuest App
- Instructor Information section for each experiment with directions for setting up experiments, helpful hints, and sample graphs and data
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Generous site license—buy one book and duplicate experiments for your class
- Complete equipment and chemicals list

Printed Lab Book

CHEM-O

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Organic Chemistry with Vernier contains the following experiments:

Using a Melt Station

- Determining Melting Temperature
- Recrystallization of Benzoic Acid and Aspirin
- Identifying an Unknown Analgesic by Melting Temperature and Thin-Layer Chromatography
- Separation of Organic Compounds by Acid-Base Extraction Techniques
- The Synthesis and Analysis of Aspirin
- Synthesis of Dibenzalacetone by Aldol Condensation
- The Diels-Alder Reaction of Anthracene with Maleic Anhydride
- Friedel-Crafts Acylation of Ferrocene

Using a Mini Gas Chromatograph

- Fractional Distillation of Esters
- Investigating Gas Chromatography
- Understanding Intermolecular Forces Using a Gas Chromatograph: Enthalpy of Vaporization
- Investigating Thermodynamic Relationships of Substituted Hydrocarbons
- Synthesizing Ethyl Acetate by Fisher Esterification
- Using a Gas Chromatograph: Identifying an Unknown Compound
- S_N1: Synthesis of *t*-butyl chloride
- S_N2: Synthesis of 1-bromobutane

Using a SpectroVis Plus

- Extraction of Spinach Pigments and Analysis by Electronic Absorption Spectroscopy
- The Synthesis and Analysis of Aspirin
- Grignard Formation of Crystal Violet
- Synthesis of Fluorescein
- Synthesis of Methyl Orange and Its Application to Textiles

Using a Polarimeter

- Understanding Polarimetry
- Identification of Organic Unknowns Using Polarimetry
- Observing the Reaction Kinetics of Sucrose with Polarimetry
- Isolation and Epoxidation of a Natural Product: Limonene
- Analysis of Natural Products

Using a Wide-Range Temperature Probe

- Determination of a Boiling Point: Simple and Fractional Distillation
- Fractional Distillation of Esters
- The Synthesis and Analysis of Aspirin
- Isolation and Epoxidation of a Natural Product: Limonene
- Synthesis of Dibenzalacetone by Aldol Condensation
- The Diels-Alder Reaction of Anthracene with Maleic Anhydride
- Friedel-Crafts Acylation of Ferrocene
- Synthesis of Fluorescein

Products for *Organic Chemistry with Vernier*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Products	Order Code
Wide-Range Temperature Probe	WRT-BTA
Melt Station	MLT-BTA
Polarimeter (Chemical)	CHEM-POL
Go Direct SpectroVis Plus	GDX-SVISPL
Mini GC Plus	GC2-MINI

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

What Vernier Technology is Available for Biochemistry?

If you teach biochemistry, you will find numerous Vernier experiments and products that can fit into your curriculum. Common experiments performed in introductory biochemistry labs include acid/base chemistry and buffer preparation, protein and enzyme purification, enzyme activity assays, analysis of carbohydrates and lipids, and gel electrophoresis. Experiments that cover many topics, such as the examples in the following table, are found in the these lab books: *Advanced Biology with Vernier, Advanced Chemistry with Vernier,* and *Organic Chemistry with Vernier.*

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

Topic	Vernier Equipment		Order Code	Experiment
Acid/base chemistry and buffer preparation	pH sensor		PH-BTA	Experiment 19 from *Advanced Chemistry with Vernier*, "Buffers"
Gel electrophoresis	Vernier Blue Digital Bioimaging System		BL-DBS	Experiment 6B from *Advanced Biology with Vernier*, "Analysis of Precut Lambda DNA"
Enzyme activity assays	Vernier UV-VIS Spectrophotometer		VSP-UV	"Malate Dehydrogenase Enzyme Assay," available for free download at www.vernier.com/vsp-uv
DNA investigations	Fluorescence/UV-VIS Spectrophotometer		VSP-FUV	"Determination of DNA-Ligand Binding Using Fluorescence Spectroscopy," available for free download at www.vernier.com/vsp-fuv

NEW Go Direct™

The Complete Chemistry Solution

More than just wireless sensors, our Go Direct sensors are supported by free, comprehensive Graphical Analysis™ 4 software, digital access to over 100 experiments, and our commitment to Stellar Service.

Go Direct Sensors

Our 13 Go Direct sensors for chemistry offer complete versatility. Students can easily collect and stream data on any device via Bluetooth or USB—no interface required.

Graphical Analysis 4 Software

Our free Graphical Analysis 4 software offers complete sensor support for chemistry analysis and is compatible with Windows, macOS, Chromebook,™ Android,™ and iOS.

Electronic Lab Book Download

Our popular lab books have been updated for use with Graphical Analysis 4 software and are now available electronically.

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

Stellar Service

Our priority is to provide science educators with unparalleled customer service, technical support, and resources so that you are always supported when integrating our technology.

For more information, visit www.vernier.com/stellar-service

NEW Go Direct Temperature

GDX-TMP

With Go Direct Temperature, students can monitor temperatures from –40°C to 125°C. Conduct endothermic and exothermic reactions, determine the physical properties of water, measure the energy content of foods, or investigate intermolecular forces.

Go Direct Temperature Teacher Pack

GDX-TMP-TP

Includes eight Go Direct Temperature Probes and a Charging Station.

NEW Go Direct pH

GDX-PH

Go Direct pH is an important and versatile sensor for lab and field activities alike. Conduct acid-base titrations, monitor pH change during chemical reactions, test the pH and alkalinity of bodies of water, investigate household acids and bases, or examine the cause and effect of acid rain.

Go Direct pH Teacher Pack

GDX-PH-TP

Includes eight Go Direct pH Sensors and a Charging Station.

NEW Go Direct Gas Pressure

GDX-GP

Monitor the pressure of a gas (up to 400 kPa) throughout various chemistry experiments. Explore the properties of gas, determine reaction rates, investigate pressure-volume or temperature-pressure relationships and more. Includes a syringe, tubing, and stoppers to ease setup for experiments, such as Boyle's law.

NEW Go Direct Radiation Monitor

GDX-RAD

Explore radiation statistics, measure the rate of nuclear decay, and monitor radon progeny. This easy-to-use sensor detects alpha, beta, gamma, and X-ray radiation, and it includes LED and audible indicators for each detection.

NEW Go Direct Conductivity

GDX-CON

Investigate the difference between ionic and molecular compounds or measure Total Dissolved Solids (TDS). Our Go Direct Conductivity determines the ionic content of an aqueous solution by measuring its electrical conductivity (up to 20,000 µS/cm). It features a built-in temperature sensor to simultaneously read conductivity and temperature. Automatic temperature compensation allows students to calibrate the probe in the lab and then make measurements outdoors without temperature changes affecting data.

Conducting an acid-base titration using Go Direct pH, Go Direct Drop Counter, and Stir Station

NEW Go Direct Drop Counter

GDX-DC

Conducting a titration has never been easier. Our Go Direct Drop Counter precisely records the number of drops of titrant added during a titration and then automatically converts it to volume. Use in conjunction with our other Go Direct sensors, such as Go Direct pH, Go Direct Conductivity, or Go Direct ORP to perform acid-base, conductometric, or potentiometric titrations.

NEW Go Direct Colorimeter

GDX-COL

Use this sensor to explore absorbance and percent transmittance in a variety of experiments including: Beer's law (absorbance *vs.* concentration) and kinetic studies (concentration *vs.* time). Students select between four wavelengths (430 nm, 470 nm, 565 nm, 635 nm) to set up their experiment.

NEW Go Direct SpectroVis® Plus

GDX-SVISPL

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus. With a range of 380 to 950 nm, students can easily collect a full wavelength spectrum (absorbance, percent transmission, fluorescence, or intensity) in less than one second. Different modes of data collection make it easy to study absorbance *vs.* concentration (Beer's law) or monitor rates of reaction (kinetics). To collect data with Go Direct SpectroVis Plus on computers, Chromebooks,™ and mobile devices, download our free Vernier Spectral Analysis software. Students may also connect to LabQuest or to a computer running Logger *Pro* 3 to perform analysis.

NEW Go Direct Voltage

GDX-VOLT

Go Direct Voltage combines a wide input voltage range (±15 V) and high precision, making it an excellent choice for lab investigations of electrochemistry. Use this probe to study basic principles of electrochemical cells.

NEW Go Direct Constant Current System

GDX-CCS

Determine Avogadro's number and perform various electroplating and electrolysis experiments. This system combines a DC power source with a built-in current sensor to eliminate the need for a separate power supply. It can deliver up to 0.6 A at 5 V DC.

NEW Go Direct Melt Station

GDX-MLT

Teach students the visual detection capillary method of melting point determination with Go Direct Melt Station. It accurately measures melting temperatures of a solid (up to 260°C), and the real-time graphing provides a unique perspective of the melting process. A wide-angle observation and magnification window, LED-lit heater block, and adjustable tilt base, allow students a clear view of the substance as they witness the state change.

NEW Go Direct ORP

GDX-ORP

Go Direct ORP (Oxidation-Reduction Potential) measures the ability of a solution to act as an oxidizing or reducing agent. Determine the equivalence point of an oxidation-reduction titration, measure the oxidizing ability of chlorine in swimming pools, or investigate the amount of hydrogen peroxide in a commercial product.

Go Direct ORP consists of a Go Direct Electrode Amplifier and an ORP Electrode. Go Direct Electrode Amplifier (GDX-EA) can also be purchased separately for use with other electrodes.

Standard Sensors

Our standard sensors require an interface, such as LabQuest 2, LabQuest Stream,® or LabQuest Mini. The interface sends information from the sensor to the data-collection and analysis software on a device such as a computer, Chromebook,™ or mobile device.

For more information on available interfaces, see pp. 12–27.

Temperature Probe Comparison

Temperature Sensor	Range	Accuracy	Features
Stainless Steel Temperature Probe TMP-BTA	–40 to 135°C	±0.2°C at 0°C ±0.5°C at 100°C	• Use in organic liquids, salt solutions, dilute acids, and dilute bases • Durable and versatile so you can use it as you would use a thermometer for a wide range of experiments and subject areas
Surface Temperature Probe STS-BTA	–25 to 125°C	±0.2°C at 0°C ±0.5°C at 100°C	• Use in air or water only • Exposed thermistor and flexibility allows for a rapid response time
Wide-Range Temperature Probe WRT-BTA	–20 to 330°C	±0.5°C at 0°C ±0.3°C at 100°C	• Offers a wider temperature range than the Stainless Steel Temperature Probe • Diameter of the body of the probe is designed to match a thermometer, making it easy to use with existing glassware and equipment
Thermocouple TCA-BTA	–200 to 1400°C	±5°C at –200 to 0°C ±2.2°C at 0 to 900°C ±15°C at 900 to 1400°C	• Measure flame temperatures as high as 1400°C or liquid nitrogen temperatures as low as –196°C • Internal ice-point compensation means you do not need to place a reference wire in an ice-water bath during use

pH Sensors

pH Sensor

PH-BTA

Use the pH Sensor just as you would a traditional pH meter with the additional advantages of automated data collection, graphing, and data analysis. This single junction pH electrode and amplifier are designed as a single unit.

The pH Buffer Capsules Kit (PH-BUFCAP) is a convenient set of three vials containing capsules to make pH 4, pH 7, and pH 10 buffer standards for calibrating pH sensors. Included with the set is one vial of Hydrion® Color Key Buffer Preservative.

Conducting an acid-base titration using a pH Sensor, Drop Counter, and Stir Station

pH Electrodes		Features	Connects to
pH Electrode BNC PH-BNC		• Single-junction electrode best for general purpose aqueous solutions • Comparable applications as the Vernier pH Sensor	Electrode Amplifier EA-BTA 
Tris-Compatible Flat pH Electrode BNC FPH-BNC		• Double-junction electrode allows measurement of the pH of solutions containing proteins, sulfides, or Tris buffers • Flat shape of the sensor tip makes it easy to clean, allows for smaller sample sizes, and measurement of pH of semisolids (e.g., food or soil slurries)	The versatility of the Electrode Amplifier allows for the option of using a variety of electrodes with a BNC connector. Select a BNC electrode, attach the Electrode Amplifier, and connect to a Vernier interface to collect data. This includes electrodes from Vernier or third-party electrodes. For more information, visit vernier.com/ea-bta
Glass-Body pH Electrode BNC GPH-BNC		• Measure the pH of aqueous and non-aqueous solutions • Can be used in solutions containing organic solvents and in highly concentrated acids or bases	

Gas Pressure Sensor

GPS-BTA

The Gas Pressure Sensor measures the absolute pressure of a gas. It has sufficient resolution and range to work for many chemistry experiments.

- Wide enough range for Boyle's law experiments
- Sufficient resolution for vapor-pressure or pressure-temperature experiments

Includes the Pressure Sensor Accessories Kit. For replacement parts, see page 30.

Range 0 to 210 kPa
(0 to 2.1 atm or 0 to 1600 mmHg)

Conductivity Probe

CON-BTA

The Conductivity Probe determines the ionic content of an aqueous solution by measuring its electrical conductivity. It has three ranges, providing optimal precision in any given range. Students can quickly investigate the difference between ionic and molecular compounds, strong and weak acids, or ionic compounds that yield different ratios of ions.

Additional Features

- Fast response time—reaches 98% of full value in less than 5 seconds
- Quick and easy calibration using our software
- Built-in temperature compensation allows you to calibrate the probe in the lab and then make measurements outdoors without temperature changes affecting data
- Alternating current at its electrodes prevents polarization and electrolysis, reducing contamination of solutions
- Epoxy-body graphite electrode eliminates worry about corrosion of metal electrodes

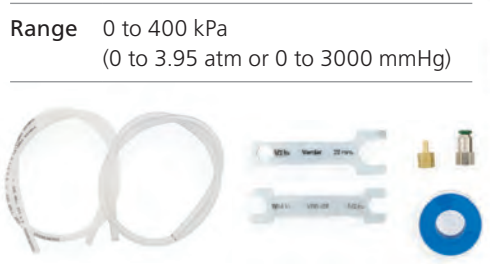
Pressure Sensor 400

PS400-BTA

Developed for University/College Educators

The Pressure Sensor 400 is the optimal sensor for conducting physical and analytical chemistry experiments, such as approximating the adiabatic expansion of a gas, Charles' law experiments, and ideal gas law investigations. It operates with excellent accuracy over a wide temperature range. The robust metal fittings and included accessories allow for a tight, leakproof seal to your reaction apparatus.

Range 0 to 400 kPa
(0 to 3.95 atm or 0 to 3000 mmHg)



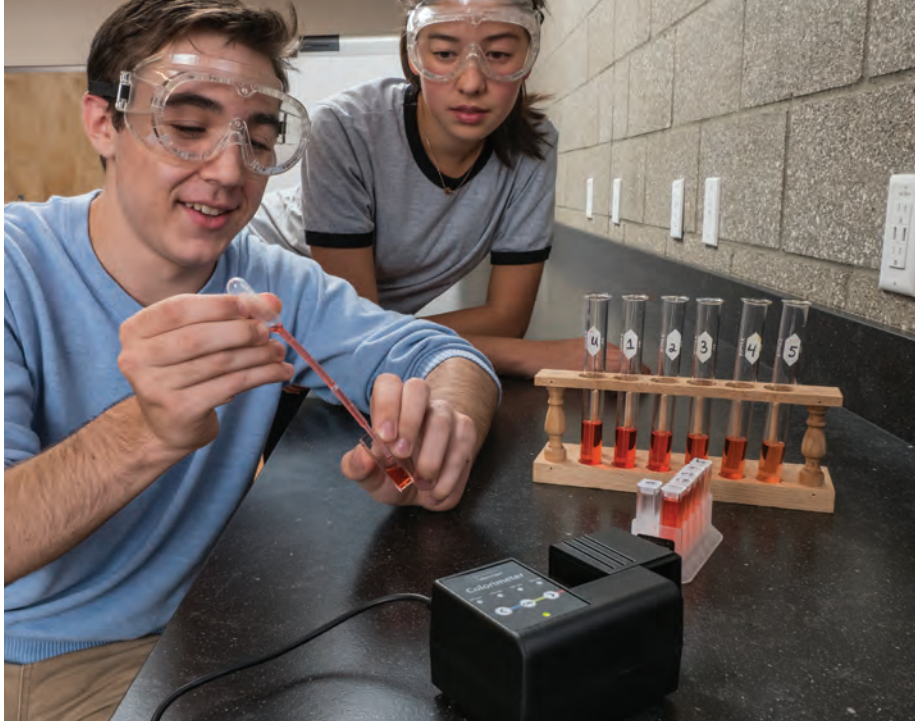
Accessories kit that comes with the sensor

Platinum-Cell Conductivity Probe

CONPT-BTA

Developed for University/College Educators

The 2-cell platinum sensing element and epoxy body of this electrode ensure greater chemical compatibility and accuracy when measuring the conductivity of stronger acids and bases and non-aqueous solutions. The Platinum-Cell Conductivity Probe allows students to explore the dependence of conductivity on temperature with the option of aqueous temperature compensation (2%) or no temperature compensation.



Investigating Beer's law using the Colorimeter

Colorimeter

COL-BTA

Use this sensor to explore absorbance and percent transmittance in a variety of experiments including: analyzing Beer's law (absorbance *vs.* concentration) and kinetic studies (concentration *vs.* time). This 4-wavelength Colorimeter (430 nm, 470 nm, 565 nm, and 635 nm) measures the amount of light transmitted through a sample at a user-selectable wavelength in order to determine the concentration of a solution. Includes 15 cuvettes. Additional cuvettes may be purchased in a package of 100 (CUV).

NEW OHAUS Scout® Balances

It is easy to collect mass data from an OHAUS balance using our popular Logger *Pro* software or LabQuest 2. Simply connect a supported balance to the USB port using the OHAUS Scout USB Cable, start the software, and collect real-time data as if the OHAUS balance were just another Vernier sensor!

For more information, please visit www.vernier.com/OHAUS

OHAUS Scout 120 g
0.001 g precision

OHS-123

OHAUS Scout 220 g
0.01 g precision

OHS-222

OHAUS Scout 420 g
0.01 g precision

OHS-422

All three balances require an OHAUS Scout USB Cable for data collection.

OHAUS Scout USB Cable

OHS-USB

Drop Counter

VDC-BTD

The Drop Counter precisely records the number of drops of titrant added during a titration, which is automatically converted into volume. It may be used in conjunction with other sensors, such as a pH Sensor, Conductivity Probe, or ORP Sensor to perform acid-base, conductometric, or potentiometric titrations.

Stir Station

STIR

The Stir Station is a high-quality, multi-function magnetic stirrer and ring stand. It has a stirring capacity of 800 mL in a 1 L beaker. It works efficiently with beakers with a volume as small as 50 mL and with a wide range of sizes and shapes of magnetic stirring bars. Includes Stir Station, Vernier Microstirrer, magnetic stirring bar, AC power adapter, and removable ring-stand post. Can be used with AC power (included) or four C batteries (not included).

Spectrometers

	NEW Go Direct SpectroVis Plus Spectrophotometer	Vernier UV-VIS Spectrophotometer	Vernier Fluorescence/UV-VIS Spectrophotometer
	GDX-SVISPL	VSP-UV	VSP-FUV
			
Wavelength (Absorbance)	380 to 950 nm	220 to 850 nm	220 to 850 nm
Excitation light source (Fluorescence)	Two fixed LEDs: 405 nm and 500 nm	N/A	Three exchangeable LED cartridges: • 375 nm, 450 nm, 525 nm (included) • 280 nm, 350 nm, 400 nm, 500 nm (sold separately)
Light source	Visible: LED-boosted tungsten Fluorescence: built-in LEDs	Visible: LED-boosted tungsten UV: Deuterium	Visible: LED-boosted tungsten UV: Deuterium Fluorescence: exchangeable LEDs
Sample holder (Pathlength)	Standard 1 cm cuvette	Standard 1 cm cuvette	Standard 1 cm cuvette
Items included	• Spectrophotometer • 15 plastic cuvettes with lids • USB cable	• Spectrophotometer • Two Quartz cuvettes with lids • USB cable • AC power supply	• Spectrophotometer • One UV Fluorescence Quartz cuvette with lid • Three exchangeable LED cartridges: 375 nm, 450 nm, 525 nm • USB cable • AC power supply
Warranty	5 years (tungsten light source: 3 years)	5 years (tungsten light source: 3 years; deuterium light source: 1 year)	5 years (tungsten light source: 3 years; deuterium light source: 1 year; included fluorescence LEDs: 1 year)

*** Determined with holmium oxide NIST standard**

NEW Go Direct SpectroVis® Plus

GDX-SVISPL

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus Spectrophotometer. Capable of connecting wirelessly or via USB, this device can collect a full wavelength spectrum (absorbance, percent transmission, or intensity) in less than one second. Once the peak wavelength is determined, you can establish the concentration of a solution (Beer's law) or monitor rates of reactions. A low light path allows Go Direct SpectroVis Plus to be used for microscale labs and biochemistry applications with micro and semi-micro cuvettes.

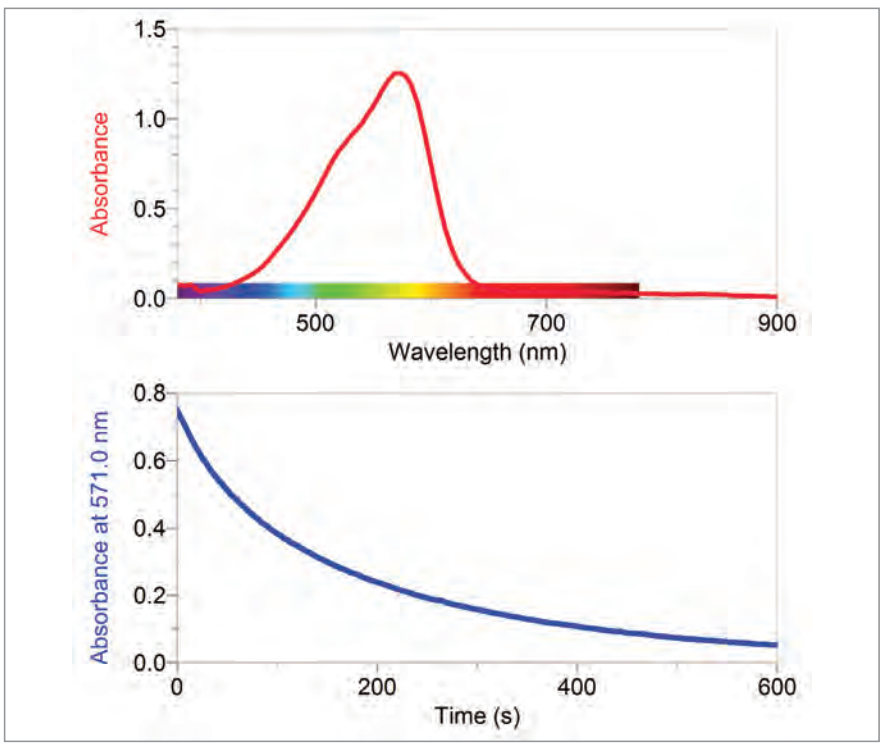
To collect data with Go Direct SpectroVis Plus on computers, Chromebooks™, and mobile devices, download our free Vernier Spectral Analysis software. Students may also connect to LabQuest or to a computer running Logger *Pro* 3 to perform analysis.

For detailed information on software compatibility, visit www.vernier.com/gdx-svispl

Product Specifications	
Wavelength range	380 to 950 nm (VIS-NIR)
Wavelength reporting interval	~1 nm
Light source	Incandescent and LEDs
Fluorescence	Two excitation sources centered at 405 nm and 500 nm

Use the **Spectrophotometer Optical Fiber** (VSP-FIBER) to measure light emissions of LEDs, fluorescent bulbs, or incandescent lights. For spectrum tube emissions, we recommend the Vernier Emissions Spectrometer on page 132.

Determining the concentration of an solution using Beer's law



Absorbance spectrum of crystal violet and kinetic trace of the reaction with NaOH

Accessories

Plastic Cuvettes*

(visible range, package of 100)

CUV

* Each Go Direct SpectroVis Plus comes with 15 visible range, plastic cuvettes.

Vernier UV-VIS Spectrophotometer

VSP-UV

Developed for University/College Educators

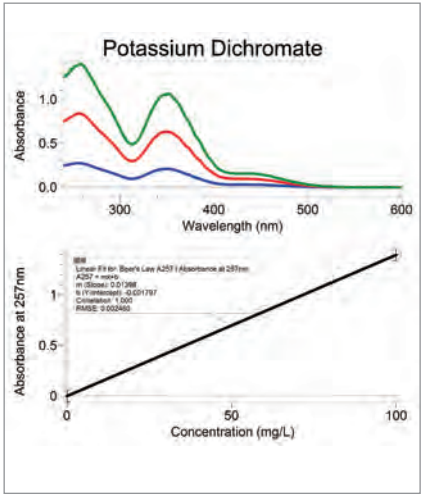
Students can easily and accurately measure the absorbance spectra of various chemical and biochemical compounds with the Vernier UV-VIS Spectrophotometer. The addition of an optical fiber (VSP-FIBER) allows this ultraviolet/visible light spectrophotometer to also be used for emission spectrum experiments. It connects via USB to your computer or LabQuest for easy data collection. Includes two Quartz cuvettes, power supply, and USB cable.

Product Specifications	
Wavelength range	220 to 850 nm
Wavelength reporting interval	~1 nm
Photometric accuracy†	±5.0%
Wavelength accuracy‡	±2.0 nm
Light source	deuterium (UV) and incandescent (VIS)

† As determined with potassium dichromate NIST standards
‡ As determined with holmium oxide NIST standard

More Online
Downloadable experiments are available for free at
www.vernier.com/vsp-uv

Examining the absorbance spectrum of potassium dichromate using the Vernier UV-VIS Spectrophotometer and LabQuest 2



Beer's law plot of potassium dichromate

Accessories

Quartz Cuvettes (package of 2)

CUV-QUARTZ*

* Each UV-VIS Spectrophotometer comes with two quartz cuvettes.

Spectrophotometer Optical Fiber

VSP-FIBER

NEW Vernier Fluorescence/UV-VIS Spectrophotometer

VSP-FUV

Developed for University/College Educators

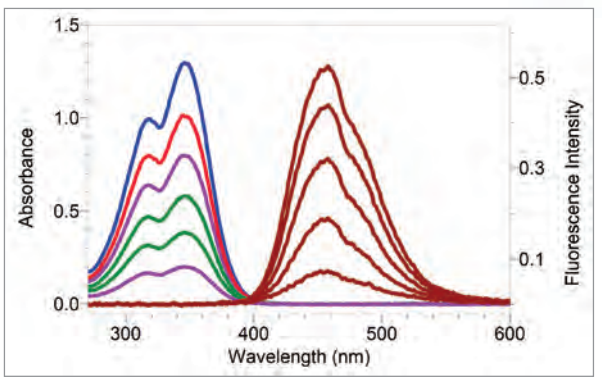
Our affordable Fluorescence/UV-VIS Spectrophotometer, designed specifically for upper-level college chemistry courses, allows students to easily and accurately conduct quinine sulfate, DAPI, GFP, and tryptophan fluorescence experiments. Exchangeable LEDs ensure you get the exact excitation wavelength needed for your experiment. Simply attach an optical fiber accessory (VSP-FIBER) to conduct emission spectra experiments.

The Fluorescence/UV-VIS Spectrophotometer connects directly to a computer or LabQuest. Data can be collected and analyzed using our Logger *Pro* software.

What's Included

- Three exchangeable LED cartridges: 375 nm, 450 nm, 525 nm
- One Fluorescence/UV Quartz Cuvette
- USB cable
- AC power supply
- Carrying case

Replacement Fluorescence/UV Quartz Cuvette (CUV-QUARTZ-FUV)



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

Accessories

Spectrophotometer Optical Fiber

VSP-FIBER

More Online

Free downloadable experiments are available at www.vernier.com/vsp-fuv

Vernier Flash Photolysis Spectrometer

VSP-FP

Developed for University/College Educators

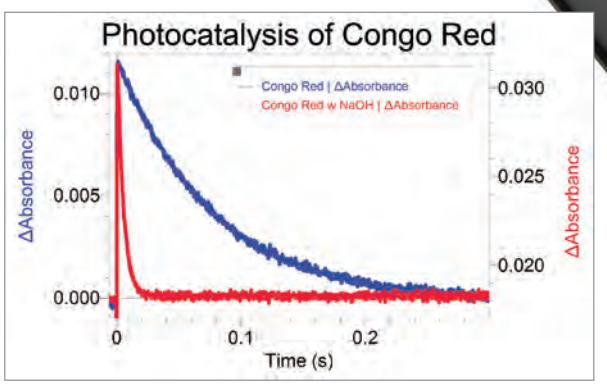
Photochemical reactions often proceed quickly and, as a result, require fast reaction techniques to analyze. The Vernier Flash Photolysis Spectrometer is a simple, user-friendly device for teaching the fundamental principles of these types of reactions. Some experiment ideas include:

- Excited-state dynamics
- Triplet-decay analysis
- Time-resolved fluorescence
- Phosphorescence-quenching kinetics
- Isomerization
- Reactive free radicals
- Photocatalysis

What's Included

- One fluorescence quartz cuvette
- Empty filter housing (fits standard third party filters)
- 600 nm filter in filter housing
- USB cable
- AC power supply

Replacement Fluorescence/UV Quartz Cuvette (CUV-QUARTZ-FUV)



Kinetic trace at 600 nm for photocatalyzed cis-trans isomerization of Congo red with and without NaOH *after importing the data into Logger* Pro

More Online

The Vernier Flash Photolysis Spectrometer connects directly to a computer via USB. The software is provided as a free download at www.vernier.com/vsp-fp

Vernier Mini GC® Plus

GC2-MINI

Developed for University/College Educators

The Mini GC Plus allows students to separate, analyze, and identify organic substances in a liquid sample. This desktop gas chromatograph utilizes MEMS chip detector technology. This permits room air to be used as a carrier gas and provides valid and reliable results with microliter volumes of samples.

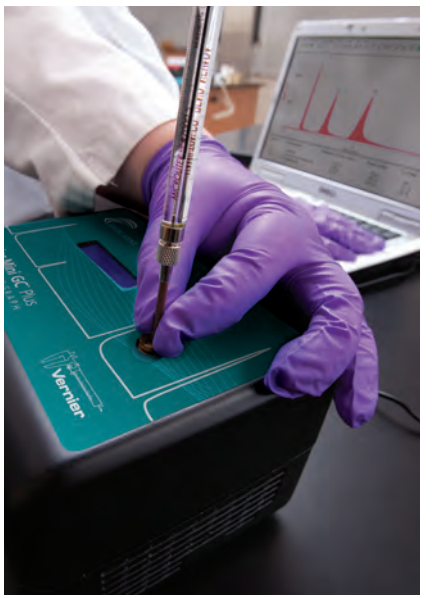
The Mini GC Plus can detect a variety of compounds. The features that make this possible include

- A maximum column temperature of 160°C, offering flexibility in designing temperature profiles
- A MEMS chip sensor that can be set at either of two levels of sensitivity
  - Standard sensitivity mode works well for polar compounds, such as ketones, alcohols, and esters.
  - High sensitivity mode works well for compounds such as halogenated alkanes and substituted aromatics, as well as mixtures with one or more compound of low concentration.

Includes free lab ebook—Features five experiments suitable for college organic chemistry or advanced high school chemistry.

The Mini GC Plus is covered by a two-year warranty (syringe, column, detector, and septa excluded).

Analyzing ketones using the Vernier Mini GC Plus and LabQuest 2



Analyzing ketones using the Vernier Mini GC Plus and a computer running Logger Pro

Accessories*

GC Septa (package of 4)

GC-SEP

GC Syringe, 1 µL Hamilton

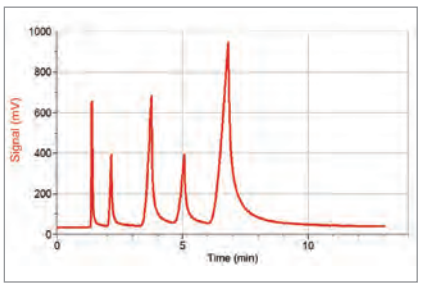
GC-SYR-MIC

* Each Mini GC Plus comes with three septa and a 1 µL syringe.

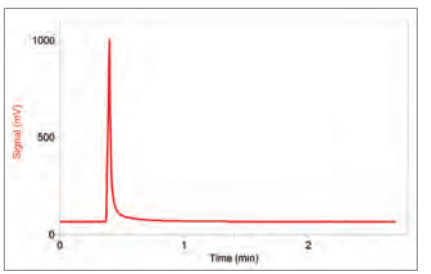
More Online

For more information about the Mini GC Plus, visit www.vernier.com/gc2-mini

See training video at www.vernier.com/videos



Mini GC Plus chromatogram of a ketone mixture



Mini GC Plus chromatogram of 1-chlorobutane

Chemical Polarimeter

CHEM-POL

Developed for University/College Educators

Help students master stereochemistry with the Chemical Polarimeter. The Chemical Polarimeter teaches students about the handedness of molecules by determining the optical rotation of a compound (R or S, + or –, right-handed or left-handed). This vertical polarimeter uses a 589 nm LED, a fixed polarizer, and a manually rotated polarizer to detect changes in rotation of plane-polarized light in the presence of an optically active compound.

Activities and experiments that can be performed using this instrument

- Determine the purity of optically active solutions such as sugars, amino acids, and more
- Characterize the purity of organic and inorganic syntheses yielding chiral products
- Determine the enantiometric purity of optically active compounds
- Study the kinetics of stereoisomers
- Explore the optical activity of amino acids

Product Specifications	
Accuracy	±1°
Analyzer resolution	0.25°
Light source	LED
Wavelength	589 nm

Accessories

Polarimeter Sample Cells*

CELLS-POL

Includes four additional sample cells with a screen-printed ruler

* Each Polarimeter comes with one sample cell.

Understanding Polarimetry

This introductory experiment for polarimetry uses sucrose to explore Biot's law: $\alpha = [\alpha] \ell c$ where α is the observed optical rotation in units of degrees, $[\alpha]$ is the specific rotation in units of degrees (the formal unit for specific rotation is degrees dm^{-1} mL g^{-1}, but scientific literature uses just degrees), ℓ is the length of the cell in units of dm, and c is the sample concentration in units of grams per milliliter.

Download this experiment and more at www.vernier.com/chem-pol

Melt Station

MLT-BTA

Developed for University/College Educators

Teach students the visual detection capillary method of melting point determination with the Melt Station. The Melt Station accurately measures melting temperatures of a solid over a wide temperature range.

A built-in RTD sensor accurately measures a temperature range of 30 to 260°C. Use the adjustable tilt feature and 6× viewing lens for a clear observation of samples. Internal cooling fans reduce the waiting time between sample testing. Also included is an important safety feature that will automatically power down the heating block after 60 minutes with no change to the control knob.

Accessories

Standard Capillary Tubes* (package of 100)

MLT-TUBE

* Each Melt Station comes with 100 standard capillary tubes.

Investigating the relationship between the angle of insolation and temperature change

Earth Science

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

NEW

Go Direct Sensors

Complete sensing solution in each sensor—collect and stream data directly to your device.

Sensor	Order Code	URL	Page
NEW Go Direct 3-Axis Magnetic Field	GDX-3MG	vernier.com/gdx-3mg	139
NEW Go Direct Conductivity	GDX-CON	vernier.com/gdx-con	63
NEW Go Direct Light and Color	GDX-LC	vernier.com/gdx-lc	139
NEW Go Direct Motion	GDX-MD	vernier.com/gdx-md	139
NEW Go Direct pH	GDX-PH	vernier.com/gdx-ph	62
NEW Go Direct Temperature	GDX-TMP	vernier.com/gdx-tmp	62
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	65

Standard Sensors

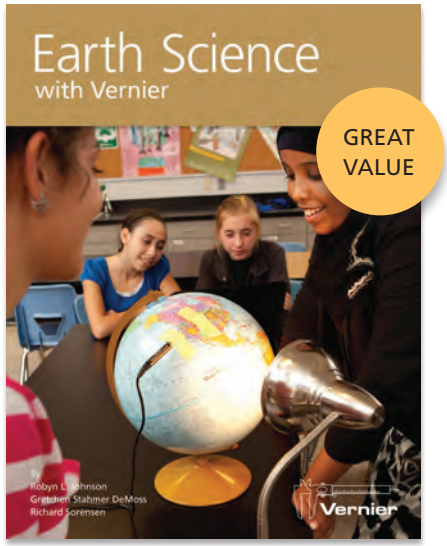
Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
Anemometer	ANM-BTA	vernier.com/anm-bta	111
Barometer	BAR-BTA	vernier.com/bar-bta	—
CO_2 Gas Sensor	CO2-BTA	vernier.com/co2-bta	46
Conductivity Probe	CON-BTA	vernier.com/con-bta	68
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
Vernier Optical DO Probe	ODO-BTA	vernier.com/odo-bta	47
Energy Sensor	VES-BTA	vernier.com/ves-bta	102
Flow Rate Sensor	FLO-BTA	vernier.com/flo-bta	97
Gas Pressure Sensor	GPS-BTA	vernier.com/gps-bta	68
Light Sensor	LS-BTA	vernier.com/ls-bta	—
Magnetic Field Sensor	MG-BTA	vernier.com/mg-bta	—
Mass (OHAUS® Balances)*	Varies by model	vernier.com/ohaus	69
Motion Detectors			
Motion Detector	MD-BTD	vernier.com/md-btd	138
Go! Motion*	GO-MOT	vernier.com/go-mot	109
O_2 Gas Sensor	O2-BTA	vernier.com/o2-bta	46
pH Sensors			
pH Sensor	PH-BTA	vernier.com/ph-bta	67
Tris-Compatible Flat pH Sensor	FPH-BTA	vernier.com/fph-bta	48
Pyranometer	PYR-BTA	vernier.com/pyr-bta	103
Relative Humidity Sensor	RH-BTA	vernier.com/rh-bta	—
Rotary Motion Sensor	RMV-BTD	vernier.com/rmv-btd	130
Salinity Sensor	SAL-BTA	vernier.com/sal-bta	—
Soil Moisture Sensor	SMS-BTA	vernier.com/sms-bta	48
Temperature Probes			
Extra-Long Temperature Probe	TPL-BTA	vernier.com/tpl-bta	97
Go!Temp*	GO-TEMP	vernier.com/go-temp	109
Infrared Thermometer	IRT-BTA	vernier.com/irt-bta	—
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	66
Surface Temperature Sensor	STS-BTA	vernier.com/sts-bta	66
Turbidity Sensor	TRB-BTA	vernier.com/trb-bta	—
UV Sensors			
UVA Sensor	UVA-BTA	vernier.com/uva-bta	—
UVB Sensor	UVB-BTA	vernier.com/uvb-bta	—
Voltage Probe	VP-BTA	vernier.com/vp-bta	—

*** USB sensor, no interface required**

Earth Science Lab Book

Title	URL	Page
Earth Science with Vernier	vernier.com/esv	78



Earth Science with Vernier

Appropriate for high school or middle school, this book explores a variety of Earth science topics. Vernier lab books are loaded with great experiment ideas, extensions, challenges, and more.

More Online
Learn more about the experiments in *Earth Science with Vernier* at www.vernier.com/esv

Electronic Version

ESV-E

When you buy the electronic version you receive

- 33 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

ESV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Earth Science with Vernier contains the following experiments:

Using a Temperature Probe
- Introduction to Data Collection
- Soil Temperature*
- Water Quality–Temperature
- Freezing of Ocean Water
- Reflection and Absorption of Light
- The Greenhouse Effect†
- Land and Sea Breezes†
- Relative Humidity†
- Dew Point
- Wind Chill†
- Seasons and Angle of Insolation
- Fossil Fuels
- Solar Homes†

Using a Light Sensor
- Reflection and Absorption of Light
- Photovoltaic Cells

Using a pH Sensor
- Soil pH
- Soil and Acid Rain
- Water Quality–pH
- Water Treatment
- Acid Rain and Its Effect on Surface Water

Using a Motion Detector
- Mapping the Ocean Floor

Using a UVB Sensor
- Are All Sunglasses Created Equal?
- Comparing Sunscreens
- UV Light and Clothing

Using a Conductivity Probe
- Soil Salinity
- Water Quality–Total Dissolved Solids
- Water Treatment
- Salinity of Ocean Water
- Desalination

Using a Turbidity Sensor
- Water Quality–Turbidity
- Water Treatment

Using a Magnetic Field Sensor
- Exploring Magnetism
- Where IS North?
- Searching for Iron Ore
- Sea Floor Spreading

Using Current and Voltage Probes
- Photovoltaic Cells
- Wind Power

Video Online

* Requires three temperature probes
† Requires two temperature probes

Sensors for *Earth Science with Vernier*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Sensors	Order Code
Stainless Steel Temperature Probe	TMP-BTA
Light Sensor	LS-BTA
pH Sensor	PH-BTA
UVB Sensor	UVB-BTA
Magnetic Field Sensor	MG-BTA
Conductivity Probe	CON-BTA
Voltage Probe	VP-BTA
Current Probe	DCP-BTA
Turbidity Sensor	TRB-BTA
Motion Detector	MD-BTD

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

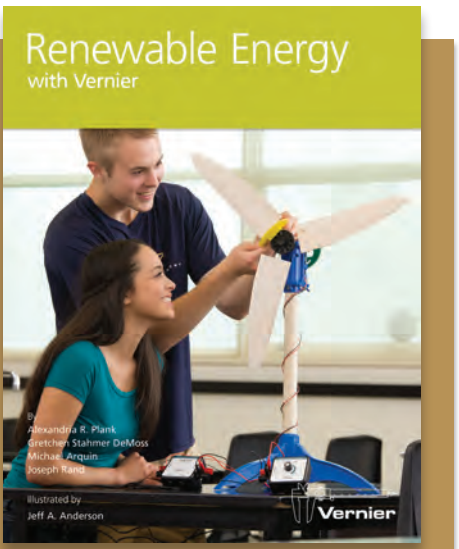
* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

Did you know?

Vernier offers a variety of lab books that can be used to supplement an Earth science course. To more deeply explore the topics of renewable energy, water quality, or environmental science, consider these related lab books.

See page 94.

See page 96.

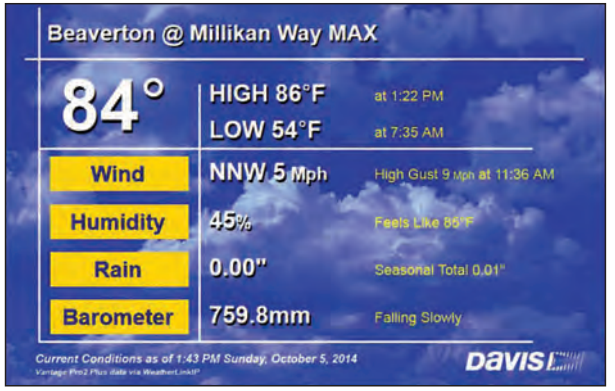


See page 98.

Davis® Weather Stations

Because they are accurate, economical, easy to use, and well built, Davis Weather Stations are a perfect choice for your school. The Davis Vantage Vue weather station is rugged, accurate, reliable, and very affordable. If you want customizable, professional units, the Vantage Pro2 and Vantage Pro2 Plus are excellent choices. All versions are wireless.

For further information about Davis Weather Station products, including computer software and hardware mounting options, see www.vernier.com/weather



Weather at the Vernier office using WeatherLinkIP

Davis WeatherLinkIP™

DWLINK-IP

Post Davis Weather Station data directly to the Internet using the Davis WeatherLinkIP. Simply plug the data logger into the back of your console and connect the cable to your cable/DSL router. Within minutes, you'll be able to see your weather data live on the Internet.

- View data on your Internet-connected computer, tablet, or smart phone.
- Easily upload data to third-party weather sites such as Weather Underground or Citizen Weather Observer Program (CWOP).
- Receive email alerts for current weather or alarm conditions.

Additional Console/Receivers

By purchasing additional Console/Receivers, you can set up multiple monitoring stations in other classrooms throughout your school.

Davis Vantage Vue Console/Receiver

DWVUE-CR

For use with Vantage Vue

Davis Vantage Pro2 Console/Receiver

DCR

For use with Vantage Pro2 and Vantage Pro2 Plus

All Davis products carry a one-year warranty.

Vantage Vue®

DWVUE

The Vantage Vue weather station includes a console with AC power adapter and a self-contained, easy-to-install sensor system. The console displays current data along with the ability to view graphs—all without a computer!

The integrated sensor suite combines a rain collector, temperature sensor, humidity sensor, wind direction, and anemometer in one package. Vantage Vue provides all of the following:

- Barometric pressure
- Rain rate
- Inside and outside humidity
- Rainfall totals
- Inside and outside temperature
- Wind chill
- Wind speed and direction
- Heat index
- Dew point
- Moon phase
- Local forecast
- Time of sunrise and sunset at your location
- Highs and lows for most weather variables

Vantage Pro2™

DWVP

The Vantage Pro2 includes all of the features of Vantage Vue, and you can add professional features such as a fan-aspirated radiation shield and other sensors.

Vantage Pro2™ Plus

DWPLUS

The Vantage Pro2 Plus includes all of the features of Vantage Pro2, plus a UV sensor, solar radiation sensor, and a sensor mounting shelf.

NEW Kestrel® DROP Wireless Data Loggers

Kestrel DROP Wireless Data Loggers are small, rugged, and accurate environmental data loggers. Collect temperature, relative humidity, and pressure data on the Kestrel LiNK app for iOS and Android™ devices.

Kestrel DROP Wireless Data Loggers	DROP D1 KES-D1	DROP D2 KES-D2	DROP D3 KES-D3
Temperature	●	●	●
Humidity		●	●
Heat index		●	●
Dew point temperature		●	●
Station pressure			●
Density altitude			●
Pressure trend			●

Features

- View, graph, record, and monitor environmental conditions
- Provides real-time, wireless, graphing functionality
- Log options: 2 s, 5 s, 10 s, 20 s, 30 s, 1 min, 2 min, 5 min, 10 min, 20 min, 30 min, 1 hr, 2 hr, 6 hr, 12 hr
- Connects only to the free Kestrel LiNK app, downloaded directly from the App Store® or Google Play™
- Battery life of 6 months to 1 year depending on user settings and logging rate

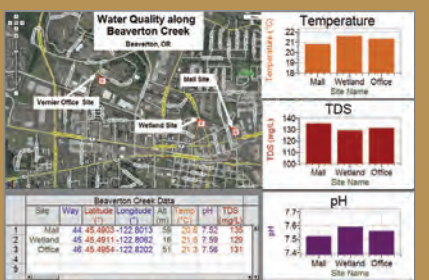
For more information, visit www.vernier.com/kestrel

Geotag data collected on LabQuest 2

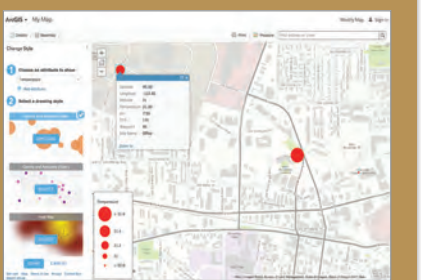
Did you know?

The built-in GPS in LabQuest 2 makes it easy to add location information to your field data. When finished, simply transfer the data to Logger *Pro* and then export to Google Maps™ or in a GIS-compatible format.

Using Geographic Information System (GIS) software to map data can be a very effective tool for analysis. The steep learning curve with some GIS software can be intimidating. Fortunately, the free online version of ArcGIS from Esri is easy to use with data collected on LabQuest 2.



Water quality data, including an imported Google Maps image, in Logger Pro



ArcGIS Online provides a variety of tools for data analysis

Visit www.vernier.com/til/2802

Applying engineering design processes to evaluate structure failure and improve design

View a Tech Tip video of engineering experiments at www.vernier.com/videos

Engineering

Engineering Solutions

Whether you are integrating engineering into your science curriculum, teaching an engineering course using popular robotics and programming-hardware, or adopting the engineering curriculum created by Project Lead The Way, Vernier provides a perfect solution.

Engineering for Science Classrooms

Vernier Engineering Activities, Build Your Own Sensor, and Engineering Projects can enhance your science classroom and help meet key state and national standards.

Programming and Robotics

Lab books, tutorials, and sample code make it easy to use Vernier sensors and interfaces with LabVIEW, LEGO® MINDSTORMS,® Scratch, and Arduino.™

Project Lead The Way (PLTW)

PLTW provides rigorous and innovative Science, Technology, Engineering, Mathematics (STEM) education curricular programs used by over 9,000 K–12 schools.

Engineering Products

Product	Order Code	URL	Page
Engineering for Science Classrooms			
Vernier Structures & Materials Tester	VSMT	vernier.com/vsmt	84
Truss Tester Accessory	VSMT-TRUSS	vernier.com/vsmt-truss	84
Digital Control Unit	DCU-BTD	vernier.com/dcu-btd	86
Vernier Analog Breadboard Cable	BB-BTA	vernier.com/bb-bta	89
Vernier Digital Breadboard Cable	BB-BTD	vernier.com/bb-btd	89
Programming and Robotics			
Scratch Programming		vernier.com/scratch	86
Go! Motion	GO-MOT	vernier.com/go-mot	109
Go!Temp	GO-TEMP	vernier.com/go-temp	109
LEGO®			
NXT Sensor Adapter for EV3 and NXT	BTA-NXT	vernier.com/bta-nxt	85
Arduino			
SparkFun RedBoard	ARD-RED	vernier.com/ard-red	87
Vernier Arduino Interface Shield	BT-ARD	vernier.com/bt-ard	87
LabVIEW			
SensorDAQ®	SDAQ	vernier.com/sdaq	89
Vernier myDAQ Adapter	BT-MDAQ	vernier.com/bt-mdaq	89
Analog Protoboard Adapter	BTA-ELV	vernier.com/bta-elv	89
Digital Protoboard Adapter	BTD-ELV	vernier.com/btd-elv	89
Project Lead The Way			
K–12 Engineering Curriculum			88

Engineering Lab Books

Title	URL	Page
Vernier Engineering Projects with LEGO® MINDSTORMS® Education NXT	vernier.com/ep-nxt	85
Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3	vernier.com/ep-ev3	85
Engineering Projects with NI LabVIEW™ and Vernier	vernier.com/epv	90
Hands-On Introduction to NI LabVIEW™ with Vernier	vernier.com/lwv	91

Related Content

Renewable Energy

See pp. 98–99.

Renewable Energy with Vernier

See page 98.

Vernier Structures & Materials Tester

VSMT *

The Vernier Structures & Materials Tester (VSMT) is the perfect device for all project-based STEM and engineering classrooms. Use the VSMT, along with the engineering design method, to design, build, and test structures, conduct bridge competitions, and investigate and analyze beam designs and material properties.

The top support crossbars of the VSMT are designed to easily slide and lock into position. Ruled markings on the VSMT allow you to accurately position the support beams for center or off-center loading.

The VSMT is equipped with a load cell and a displacement sensor. Using both sensors, maximum breaking loads, as well as load/displacement characteristics, can be recorded, enabling students to evaluate stress and strain. Use Logger *Pro* video analysis in conjunction with sensor measurements to see how and when things bend and break.

Product Specifications	
Load cell	0 to 1000 N
Displacement sensor	0.1 mm resolution
Maximum travel	7.5 cm

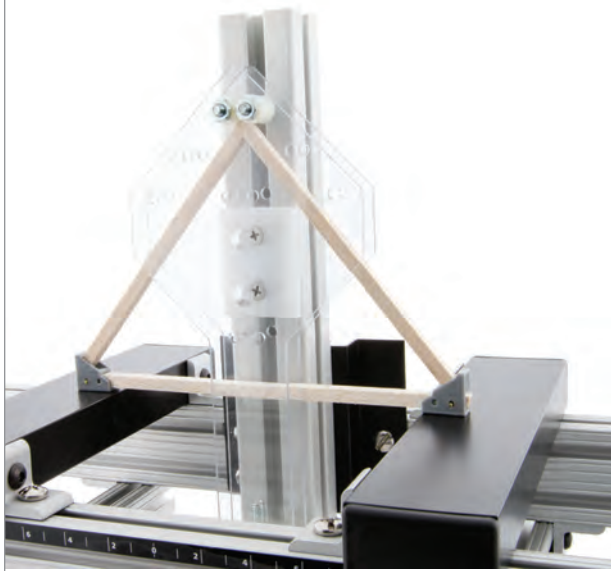
What's Included

The VSMT ships with a well-outfitted VSMT Tackle Kit that includes two aluminum load plates (50 × 50 × 6 mm and 50 × 80 × 6 mm), a chain, rods, U-bolts, and other accessories to make it easy to load bridges, materials, beams, and structures of varying sizes and shapes.

***Additional shipping charges may apply due to weight.**

Truss Tester Accessory

VSMT-TRUSS



The Truss Tester Accessory attaches to the Vernier Structures & Materials Tester (VSMT) to measure the force and deflection of trusses. The Truss Tester Accessory holds a single truss upright and allows the load to be applied in a variety of locations. Students can design their own investigations to determine how trusses fail and how truss performance can be improved.

The accessory attaches quickly and securely to the VSMT frame and load cell. It is designed for trusses built with ¼" square balsa wood sticks with a 20 cm base and a maximum height of 18 cm. Trusses can be top loaded, bottom loaded, or loaded on the slope of the truss structure. Use with truss brackets for quick and consistent truss construction. A 3-D printer file of truss brackets is available at www.thingiverse.com/thing:1047008

Package for *Engineering Projects with LEGO® MINDSTORMS® and Vernier*

LEGO® Engineering Project Package

This package includes two Vernier NXT Sensor Adapters and all the sensors needed to perform the activities in the books below.

Note: Both LEGO® MINDSTORMS® EV3 and NXT robotic systems are supported by the Vernier NXT Sensor Adapter (BTA-NXT).

Package Includes	Order Code	LEGO® Engineering Project Package LEGO-EP
NXT Sensor Adapter	BTA-NXT	•
Hand Dynamometer	HD-BTA	•
Stainless Steel Temperature Probe	TMP-BTA	•
pH Sensor	PH-BTA	•
UVB Sensor	UVB-BTA	•
Soil Moisture Sensor	SMS-BTA	•
Magnetic Field Sensor	MG-BTA	•
Differential Voltage Probe	DVP-BTA	•
Dual-Range Force Sensor	DFS-BTA	•
Gas Pressure Sensor	GPS-BTA	•

You may also need

LEGO® MINDSTORMS® Robotics Kit* (NXT or EV3)

LEGO® MINDSTORMS® Education Software* (NXT or EV3)

*Sold through LEGO® Education

For Use with the LEGO® Engineering Project Package

Perfect for high school and upper middle school students, these books contain student challenges to build and program robots to test batteries, locate "land mines," automate plant watering, and more. All the sensors needed to complete these challenges are included in the LEGO® Engineering Project Package.

These two books have virtually the same activities. The only difference is that one is written for the EV3 and the other for the NXT. Choose the book based on which LEGO® robotics kit you are using.

Vernier Engineering Projects with LEGO® MINDSTORMS® Education NXT

Electronic Version: EP-NXT-E

Printed: EP-NXT

This book contains 12 engineering challenges to build and program robots using the LEGO® MINDSTORMS® Education NXT Base Set, MINDSTORMS® Education NXT Software v2, and Vernier sensors.

For a complete list of projects, see www.vernier.com/ep-nxt

Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3

Electronic Version: EP-EV3-E

Printed: EP-EV3

This book contains 13 engineering challenges to build and program robots using the LEGO® MINDSTORMS® Education EV3 Core Set, MINDSTORMS® EV3 Software, and Vernier sensors.

For a complete list of projects, see www.vernier.com/ep-ev3

Digital Control Unit

DCU-BTD

Using a Digital Control Unit (DCU) with your standard Vernier sensors is a perfect way to explore hands-on STEM and engineering projects or implement Next Generation Science Standards (NGSS) in the classroom. The DCU provides the ability to use our sensors to control output devices such as motors, buzzers, pumps, and LEDs with your Logger *Pro* software or LabQuest 2. This is a great entry point for programming and engineering design.

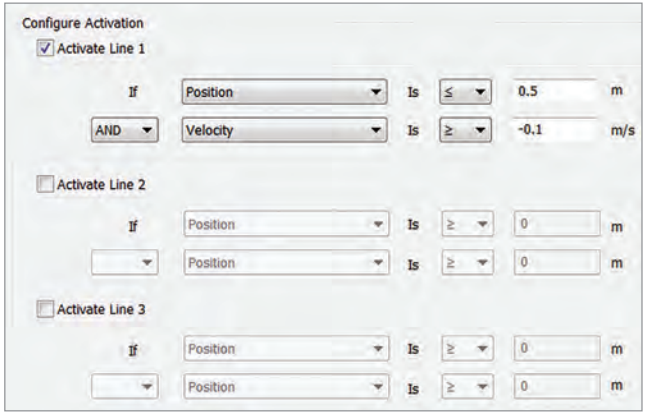
The connector on the DCU provides two easy ways to connect your electrical device: connect the device to the DCU header pins or screw the electrical device's wires into the detachable screw terminal on the DCU.

Once the electrical device is connected to the DCU, an external power supply, such as the LabQuest or LabPro power supply (not included, LQ-PS, or IPS), is required to power the device.

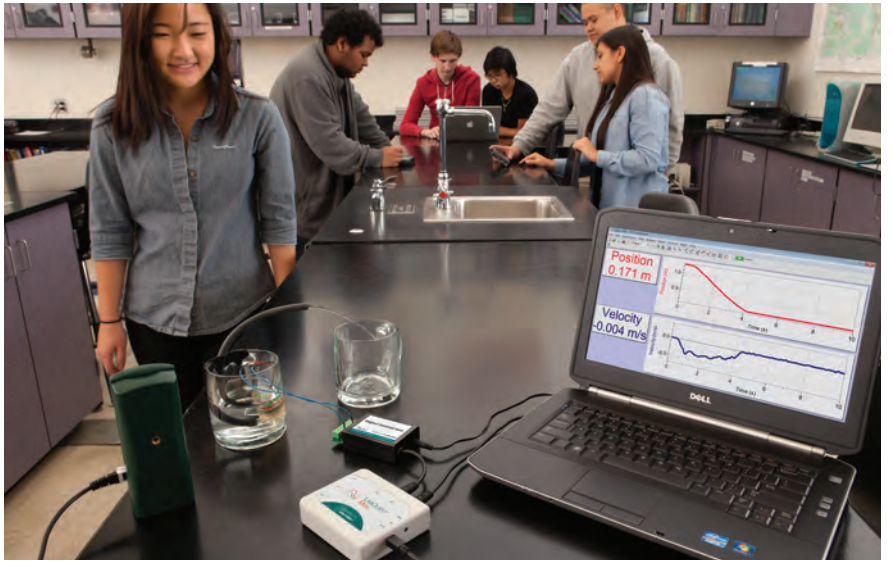
The DCU is easy to use with Logger *Pro* or LabQuest 2. In addition, the DCU can be connected to an Arduino™ (see page 87), NI myDAQ (see page 89), or SensorDAQ® (see page 89).

Easy Steps for Controlling DCU Output in Logger *Pro* or LabQuest 2

1. Connect an output device (e.g., a pump) to the DCU.
2. Select the DCU line or lines you want to activate.
3. Build a logic statement to activate the line when the statement is true. Choose AND, UNTIL, or OR to create a compound statement.



Creating a logic statement in Logger Pro *or LabQuest 2 to turn on DCU line 1 when the position measurement is less than 0.5 meters AND the velocity measurement is greater than –0.1 m/s*



Turning on a "drinking fountain" based on position and velocity measurements from a Motion Detector

Learn to Code with Scratch and Vernier

Scratch is a free, browser-based programming language that is designed for students ages 8 to 16 and supported by an active community of millions of users. Students can use Scratch to create music videos, animations, and video games, while learning the fundamentals of coding.

Our free Scratch extension brings real-world data from either a Go!Temp or Go! Motion into your Scratch project. Have the Scratch Cat move in response to the position data from a Go! Motion or change costumes when the temperature measured by the Go!Temp increases. Our extension adds a new way for students to interact with code.

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

Using Arduino with Vernier Sensors

Vernier Software & Technology has always supported hands-on, do-it-yourself projects for students (and teachers). The availability of very inexpensive, easy-to-program microcomputers, like the Arduino, make projects easy and affordable.

We have created an online guide for using Vernier sensors with Arduino. This guide helps you connect, program, and calibrate our sensors. It includes many Arduino sketches (programs) that can be used as a starting point for your projects. These sketches were intentionally kept simple, so that you can follow along without getting overwhelmed with complex details.

In addition, you will find some entertaining and educational project ideas, such as

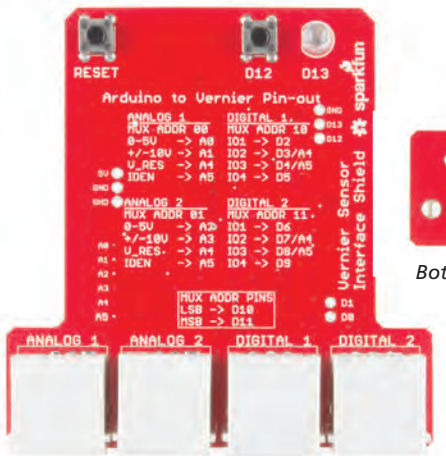
- Produce a Tone Out that Depends on Sensor Reading
- Control an RGB LED with a 3-Axis Accelerometer
- Control a Mousetrap with a Photogate
- Control a Laser Pointer with a Motion Detector
- Add a Display For Temperature Readings
- Drive a Pendulum
- Explore PID Control

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

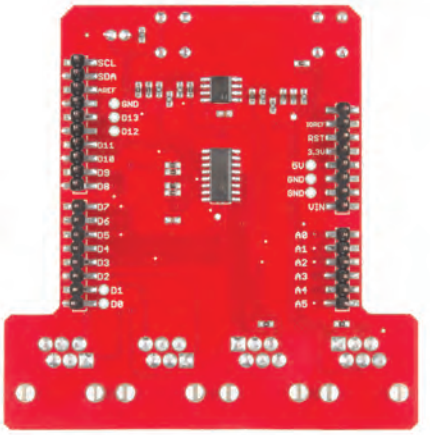
Vernier Arduino™ Interface Shield

BT-ARD

The Vernier Arduino Interface Shield plugs directly on top of the Arduino and adds two BTA (analog) and two BTD (digital) sockets. This shield was developed to be used with the SparkFun Arduino RedBoard but will work with the Arduino UNO and other UNO equivalents, such as the Leonardo and Mega Arduino boards.



Top



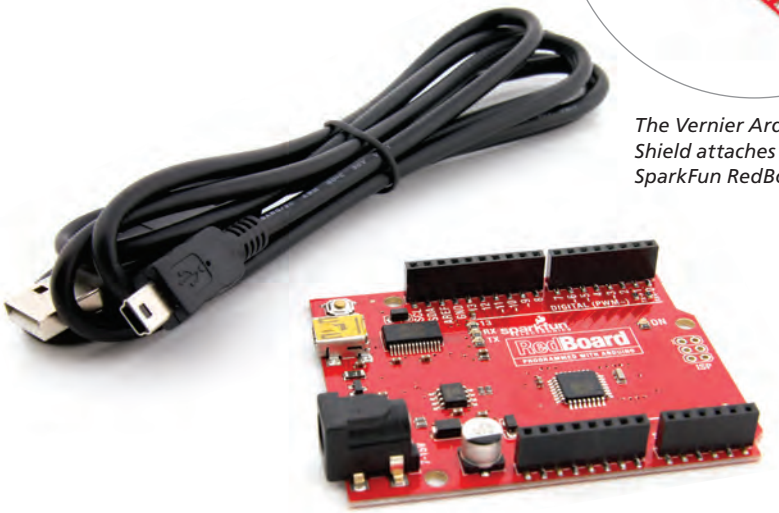
Bottom

The Vernier Arduino Interface Shield attaches directly to the SparkFun RedBoard.

SparkFun® RedBoard with Cable

ARD-RED

The SparkFun RedBoard is a surface-mount board that is pin-for-pin compatible with the Arduino UNO R3 layout. The key difference between the RedBoard and most Arduino boards is that it uses a mini-B USB connector instead of a full-size, type-B USB connector. The RedBoard can supply 5 V, which is the operating voltage of most Vernier sensors. You can power the RedBoard either with the USB cable (included) or with a 7 to 15 V barrel jack power supply (not included).



Project Lead The Way and Vernier

Over the years, Vernier has developed a strong partnership with Project Lead The Way (PLTW). We value their mission to empower students to thrive in an evolving world.

By providing a comprehensive curriculum package based on national standards, focusing on teacher training, and integrating Vernier technology, PLTW programs are extremely valuable for schools integrating hands-on, project-based learning.

About Project Lead The Way

Project Lead The Way is a nonprofit organization that provides a transformative learning experience for K–12 students and teachers across the United States. PLTW empowers students to develop in-demand, transportable knowledge and skills through pathways in computer science, engineering, and biomedical science. PLTW's teacher training and resources support teachers as they engage their students in real-world learning. More than 9,000 elementary, middle, and high schools in all 50 states and the District of Columbia offer PLTW programs. For more information on Project Lead The Way, visit www.pltw.org

Determining the effect of heart rate and exercise in the PLTW Biomedical Sciences Program

PLTW Programs

PLTW Gateway

Middle School

PLTW Gateway sparks a joy of discovery and illuminates the range of paths and possibilities students can look forward to in high school and beyond. By tackling challenges like designing tires for a moon rover, cleaning up an oil spill, or solving a medical mystery, students in grades 6–8 learn to test their limits and question what's possible.

PLTW Biomedical Science

High School

PLTW Biomedical Science students in grades 9–12 step into the roles of medical investigators, surgeons, and biomedical engineers. The program's collaborative, hands-on explorations inspire students to make an impact on the lives of those around them while preparing them with the knowledge and skills they need to thrive.

PLTW Engineering

High School

PLTW Engineering engages students in grades 9–12 in collaborative, real-world activities like designing a home, programming electronic devices or robotic arms, or exploring algae as a biofuel source. By pushing themselves to rework and refine their projects, students learn that both failed attempts and perseverance are key to learning and innovation.

National Instruments LabVIEW™ Software and Vernier

Introduce your students to a programming language used throughout the engineering disciplines. We have sample LabVIEW programs (VIs) for the LabQuest, SensorDAQ, and other Vernier hardware.

For more information on LabVIEW software and to download our sample LabVIEW VIs, go to www.vernier.com/ni-labview

SensorDAQ®

SDAQ

Designed by NI & Vernier for Engineering Education

SensorDAQ is perfect for teaching NI LabVIEW or for building sensor-controlled student projects using NI LabVIEW software.

Compatible with 71 standard Vernier sensors. Go to www.vernier.com/sdaq

- Use with NI LabVIEW software. Not compatible with Logger *Pro* or Logger Lite software.
- Works on Windows only.

What's Included

SensorDAQ, Voltage Probe, and USB cable

SensorDAQ carries a one-year warranty.

Engineering for Science Classrooms

Science experiments traditionally focus on a particular principle and specify which tools to use in the investigation. Engineering activities, on the other hand, typically present a problem and challenge students to solve it by applying creativity, scientific principles, and whatever tools are at their disposal. Including engineering activities in your science curriculum increases student engagement, provides context for science learning, offers an alternative form of assessment, and teaches problem-solving skills.

Whether you teach physics, chemistry, or biology, we have a number of ways that you can include engineering activities in your curriculum.

For a complete list of activities, visit www.vernier.com/engineering/science

Vernier Breadboard Cables

These cables make it easy for students to build their own sensor circuitry and input the signal into a Vernier interface for data acquisition.

Analog

BB-BTA

Digital

BB-BTD

Protoboard Adapters

Use these adapters to connect Vernier sensors to a non-Vernier interface. The connector fits into a standard prototyping board or National Instruments' ELVIS prototyping board, providing easy access to the sensor lines.

Analog

BTA-ELV

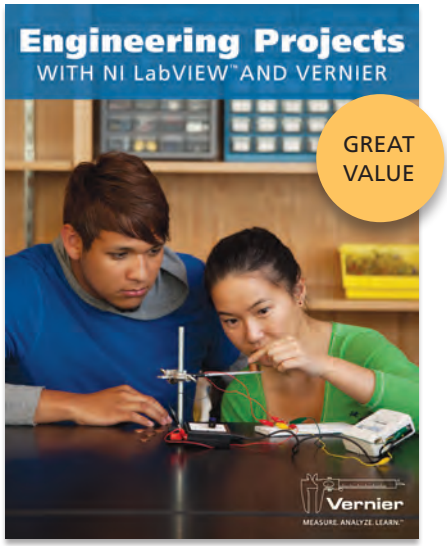
Digital

BTD-ELV

Vernier myDAQ Adapter

BT-MDAQ

The Vernier myDAQ Adapter can be used to perform data acquisition with over 60 Vernier sensors and the NI myDAQ interface (sold separately). In addition to connecting Vernier sensors, the adapter provides access to two myDAQ analog output terminals and three digital terminals (including the frequency and pulse width modulation [PWM] outputs). Designed for use with NI LabVIEW software.



Engineering Projects with NI LabVIEW™ and Vernier

This lab book contains engaging, hands-on projects for SensorDAQ or LabQuest interfaces. It introduces engineering concepts and programming with NI LabVIEW software. An introductory knowledge of NI LabVIEW programming is assumed (see our *Hands-On Introduction to NI LabVIEW* lab book).

More Online
Learn more about the experiments in *Engineering Projects with NI LabVIEW™ and Vernier* at www.vernier.com/epv

Electronic Version

EPV-E

When you buy the electronic version you receive

- 12 ready-to-use student projects with challenge exercises
- Access to up-to-date versions of the experiments
- Essential instructor information including construction and programming tips and extensions
- Word-processing files of the student sections, so you can edit the files to match your teaching preferences
- NI LabVIEW sample programs for all projects and challenges
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

EPV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Engineering Projects with NI LabVIEW™ and Vernier contains the following projects:

- Build a Temperature Sensor
- Digital Control Systems
- LED Color Mixer
- Hot Wire Anemometer
- DC Motor Control
- Light Intensity & Stepper Motors
- Servo Motor
- Analyzing the Heart with EKG
- Blood Pressure
- Strain Gage Measurements
- Propeller-Powered Pendulum
- PID Ping-Pong® Ball Levitation

Video Online

A Great Way to Teach STEM

This book introduces many important science and engineering concepts, including

- Analog and digital input
- Sensors and how they are calibrated
- Feedback and control
- Analog and digital output
- Servo and stepper motors
- PID control
- Pulse-width modulation
- Voltage dividers
- Wheatstone bridges

Videos of many of these projects are available at www.vernier.com/epv-videos

Package for *Engineering Projects with NI LabVIEW™ and Vernier*

SensorDAQ Package

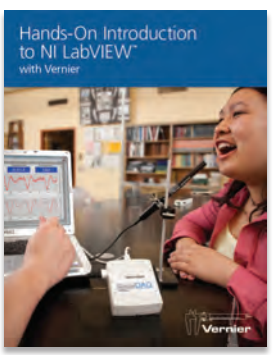
This package includes a SensorDAQ and all the sensors needed to perform the activities in the *Engineering Projects with NI LabVIEW™ and Vernier*.

Package Includes	Order Code	Engineering Projects with NI LabVIEW Package SD-EP-DX
SensorDAQ	SDAQ	•
Surface Temperature Sensor	STS-BTA	•
Digital Control Unit	DCU-BTD	•
Breadboard Cable	BB-BTA	•
Instrumentation Amplifier	INA-BTA	•
Light Sensor	LS-BTA	•
EKG Sensor	EKG-BTA	•
Analog Protoboard Adapter	BTA-ELV	•
Digital Protoboard Adapter	BTD-ELV	•
Power Amplifier	PAMP	•
Blood Pressure Sensor	BPS-BTA	•
Motion Detector	MD-BTD	•
Rotary Motion Sensor	RMV-BTD	•
Photogate	VPG-BTD	•

You may also need

NI LabVIEW software
See page 89.

Additional Resource



Hands-On Introduction to NI LabVIEW™ with Vernier

Electronic Version: LWV-E

Printed: LWV

Besides learning the basics of NI LabVIEW programming, your students will be introduced to collecting and analyzing data. This enhances the learning experience and helps students move to the stage of creating their own custom programs and independent projects. The exercises in this book can be done with the Vernier SensorDAQ or LabQuest interfaces and require a Temperature Probe, Voltage Probe, and Microphone. The printed version of this book includes the same electronic resources as the electronic version, plus a printed copy of the book.

Measuring temperature and dissolved oxygen concentration of river water

Environmental Science

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

NEW

Go Direct Sensors

Complete sensing solution in each sensor—collect and stream data directly to your device.

Sensor	Order Code	URL	Page
NEW Go Direct Colorimeter	GDX-COL	vernier.com/gdx-col	64
NEW Go Direct Conductivity	GDX-CON	vernier.com/gdx-con	63
NEW Go Direct Light and Color	GDX-LC	vernier.com/gdx-lc	139
NEW Go Direct pH	GDX-PH	vernier.com/gdx-ph	62
NEW Go Direct SpectroVis Plus	GDX-SVISPL	vernier.com/gdx-svispl	64
NEW Go Direct Temperature	GDX-TMP	vernier.com/gdx-tmp	62
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	65

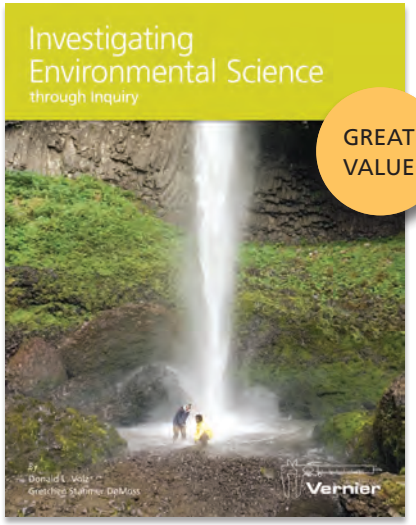
Standard Sensors

Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
Anemometer	ANM-BTA	vernier.com/anm-bta	111
Barometer	BAR-BTA	vernier.com/bar-bta	—
CO_2 Gas Sensor	CO2-BTA	vernier.com/co2-bta	46
Colorimeter	COL-BTA	vernier.com/col-bta	69
Conductivity Probe	CON-BTA	vernier.com/con-bta	68
Current Probes			
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
High Current Sensor	HCS-BTA	vernier.com/hcs-bta	—
Energy Sensor	VES-BTA	vernier.com/ves-bta	102
Flow Rate Sensor	FLO-BTA	vernier.com/flo-bta	97
Ion-Selective Electrode			
Ammonium Ion-Selective Electrode	NH4-BTA	vernier.com/nh4-bta	—
Calcium Ion-Selective Electrode	CA-BTA	vernier.com/ca-bta	—
Chloride Ion-Selective Electrode	CL-BTA	vernier.com/cl-bta	—
Nitrate Ion-Selective Electrode	NO3-BTA	vernier.com/no3-bta	—
Potassium Ion-Selective Electrode	K-BTA	vernier.com/k-bta	—
Light Sensor	LS-BTA	vernier.com/ls-bta	—
O_2 Gas Sensor	O2-BTA	vernier.com/q2-bta	46
PAR Sensor	PAR-BTA	vernier.com/par-bta	43
pH Sensors			
pH Sensor	PH-BTA	vernier.com/ph-bta	67
Tris-Compatible Flat pH Sensor	FPH-BTA	vernier.com/fph-bta	48
Pyranometer	PYR-BTA	vernier.com/pyr-bta	103
Relative Humidity Sensor	RH-BTA	vernier.com/rh-bta	—
Salinity Sensor	SAL-BTA	vernier.com/sal-bta	—
Soil Moisture Sensor	SMS-BTA	vernier.com/sms-bta	48
Temperature Probes			
Extra-Long Temperature Probe	TPL-BTA	vernier.com/tpl-bta	97
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	66
Surface Temperature Sensor	STS-BTA	vernier.com/sts-bta	66
Turbidity Sensor	TRB-BTA	vernier.com/trb-bta	—
UV Sensors			
UVA Sensor	UVA-BTA	vernier.com/uva-bta	—
UVB Sensor	UVB-BTA	vernier.com/uvb-bta	—
Vernier Optical DO Probe	ODO-BTA	vernier.com/odo-bta	47
Voltage Probes			
30-Volt Voltage Probe	30V-BTA	vernier.com/30v-bta	—
Differential Voltage Probe	DVP-BTA	vernier.com/dvp-bta	136
Voltage Probe	VP-BTA	vernier.com/vp-bta	—

Environmental Science Lab Books

Title	URL	Page
Investigating Environmental Science through Inquiry	vernier.com/esi	94
Water Quality with Vernier	vernier.com/wqv	96
Renewable Energy with Vernier	vernier.com/rev	98
Investigating Wind Energy	vernier.com/elb-wind	110
Investigating Solar Energy	vernier.com/elb-solar	112



Investigating Environmental Science through Inquiry

Appropriate for high school, this book explores a variety of environmental science topics. Vernier lab books are loaded with teacher tips, sample graphs, and more.

More Online
Learn more about the experiments in *Investigating Environmental Science through Inquiry* at www.vernier.com/esi

Electronic Version

ESI-E

When you buy the electronic version you receive

- 34 inquiry-based, environmental science investigations
- Access to up-to-date versions of the experiments
- Essential teacher information for successful inquiry investigations
- Suggested researchable questions, sample data, and graphs
- A generous site license—buy one book and duplicate experiments for your class
- Word-processing files of the student investigations, so you can edit the files to match your teaching preferences

Printed Lab Book

ESI

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Investigating Environmental Science through Inquiry contains the following inquiry investigations:

Ⓢ Ⓓ Using a Temperature Probe
- Seasons and Angle of Insolation
- A Local Weather Study
- Water Quality
- Long Term Water Monitoring
- Soil Temperature
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- Global Warming
- Insulation Study
- Fossil Fuel Energy
- Energy Conversion
- An Investigation of Passive Solar Heating
- A Pollution Study

Ⓢ Ⓓ Using a Turbidity Sensor
- Water Quality
- Long Term Water Monitoring
- Water Treatment
- A Pollution Study

Ⓢ Ⓓ Using a pH Sensor
- Water Quality
- Long Term Water Monitoring
- Water Treatment
- Soil pH
- Soil and Acid Precipitation
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- The Effect of Acid Deposition on Aquatic Ecosystems
- A Pollution Study

Ⓢ Ⓓ Using a Conductivity Probe
- Water Quality
- Long Term Water Monitoring
- Water Treatment
- Investigating Salinity
- Soil Salinity
- Water Cycle Column Investigations
- Ecocolumn Investigations
- The Effect of Acid Deposition on Aquatic Ecosystems
- A Pollution Study

Ⓢ Ⓓ Using a Soil Moisture Sensor
- Soil Moisture
- Managing Garden Soil Moisture
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Ecocolumn Investigations
- A Pollution Study

Ⓢ Ⓓ Using an Optical DO Probe
- Investigating Dissolved Oxygen
- Water Quality
- Long Term Water Monitoring
- Biochemical Oxygen Demand
- Primary Productivity
- A Pollution Study

Ⓓ Using a UV Sensor
- A Local Weather Study
- UV Investigations
- ▶ Sunscreen Comparison

Ⓓ Using Voltage & Current Probes
- Wind Energy
- Solar Energy: Photovoltaic Cells

Ⓓ Using a Relative Humidity Sensor
- A Local Weather Study
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- A Pollution Study

Ⓓ Using a Light Sensor
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- Measuring Particulates
- Energy Conversions

Ⓓ Using a CO_2 Gas Sensor
- ▶ Cell Respiration
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- Investigating Indoor Carbon Dioxide Concentrations
- A Pollution Study

Ⓢ Starter Package Ⓓ Deluxe Package ▶ Video Online

Products for *Investigating Environmental Science through Inquiry*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Order Code	Ⓢ Starter Package LQ2-EV-OST	Ⓓ Deluxe Package LQ2-EV-ODX
LabQuest 2 Interface	LABQ2	•	•
Stainless Steel Temperature Probe	TMP-BTA	•	•
pH Sensor	PH-BTA	•	•
Conductivity Probe	CON-BTA	•	•
Vernier Optical DO Probe	ODO-BTA	•	•
Soil Moisture Sensor	SMS-BTA	•	•
Turbidity Sensor	TRB-BTA	•	•
Relative Humidity Sensor	RH-BTA	—	•
UVB Sensor	UVB-BTA	—	•
CO_2 Gas Sensor	CO2-BTA	—	•
Voltage Probe	VP-BTA	—	•
Current Probe	DCP-BTA	—	•
Light Sensor	LS-BTA	—	•

Ⓓ *Deluxe Package*

Ⓢ *Starter Package*

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

NEW Kestrel® DROP Wireless Data Loggers

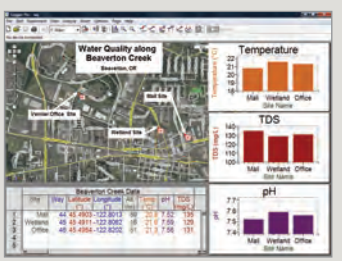
Kestrel DROP Wireless Data Loggers are small, rugged, and accurate environmental data loggers. Collect temperature, relative humidity, or pressure data on the Kestrel LiNK app for iOS and Android™ devices.

For a comparison chart, see page 81.

Kestrel DROP D3	KES-D3
Kestrel DROP D2	KES-D2
Kestrel DROP D1	KES-D1

Built-In GPS

The built-in GPS in LabQuest 2 makes it easy to add location information to your field data. When finished, simply transfer the data to Logger *Pro* and then export to Google Maps™ or GIS software.



Did you know?

AP* Environmental Studies program and the IB† Environmental Systems and Societies programs both recommend a strong laboratory and field investigation component. The *Investigating Environmental Science through Inquiry* lab book includes experiments correlated to both AP and IB standards. For correlations of Vernier labs to AP/IB objectives, visit www.vernier.com/environmental

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Water Quality with Vernier

Appropriate for high school, this book includes a variety of water quality tests. Vernier lab books are loaded with helpful experiment ideas, extensions, and more.

More Online
Learn more about the experiments in *Water Quality with Vernier* at www.vernier.com/wqv

Electronic Version

WQV-E

When you buy the electronic version you receive

- 18 water quality tests and investigations
- Access to up-to-date versions of the experiments
- Instructions for data collection with LabQuest App, Logger *Pro*, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

WQV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Water Quality with Vernier contains the following tests and experiments:

Experiment		Sensors Used
1	Temperature	Stainless Steel Temperature Probe
2	pH	pH Sensor
3	Turbidity	Turbidity Sensor
4	Total Solids	—
5	Dissolved Oxygen	Vernier Optical DO Probe
6	Biochemical Oxygen Demand	Vernier Optical DO Probe
7	Phosphates	Colorimeter
8	Nitrate	Nitrate Ion-Selective Electrode *or* Colorimeter
9	Bacterial Concentration	—
10	Ammonium Nitrogen	Ammonium Ion-Selective Electrode
11	Alkalinity	pH Sensor
12	Total Dissolved Solids	Conductivity Probe
13	Calcium and Water Hardness	Calcium Ion-Selective Electrode
14	Total Water Hardness	—
15	Chloride and Salinity	Chloride Ion-Selective Electrode *or* Conductivity Probe *or* Salinity Sensor
16	Stream Flow	Flow Rate Sensor
17	Physical Profile of a Lake	Conductivity Probe, Vernier Optical DO Probe, pH Sensor, and Extra-Long Temperature Probe
18	PAR Attenuation in Water	PAR Sensor

AP

Many of the experiments in our Water Quality with Vernier *lab book are the perfect complement to labs for AP* Environmental Science. See www.vernier.com/ap*

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

GLOBE® & Vernier

The GLOBE Program is an international science and education program that provides students and the public worldwide with the opportunity to participate in data collection and the scientific process, and contribute meaningfully to our understanding of the Earth system and global environment. Use Vernier sensors to collect GLOBE data.

To learn more about Vernier and GLOBE, see www.vernier.com/globe

Products for *Water Quality with Vernier*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

		Order Code
Sensors	Stainless Steel Temperature Probe	TMP-BTA
	pH Sensor	PH-BTA
	Turbidity Sensor	TRB-BTA
	Vernier Optical DO Probe	ODO-BTA
	Colorimeter	COL-BTA
	Ammonium Ion-Selective Electrode	NH4-BTA
	Calcium Ion-Selective Electrode	CA-BTA
	Chloride Ion-Selective Electrode	CL-BTA
	Nitrate Ion-Selective Electrode	NO3-BTA
	Conductivity Probe	CON-BTA
	Salinity Sensor	SAL-BTA
	Flow Rate Sensor	FLO-BTA
	Extra-Long Temperature Probe	TPL-BTA
	PAR Sensor	PAR-BTA
Lab Equipment	Water Depth Sampler	WDS
	Water Quality Bottles	WQ-BOT

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

*** You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.**

Vernier Optical DO Probe

ODO-BTA

Students can now measure the concentration of dissolved oxygen in water quickly and easily with the Vernier Optical DO Probe. Use it to determine changes in dissolved oxygen levels, one of the primary indicators of the quality of an aquatic environment.

- Plug-and-play technology—no filling solution, warm-up time, calibration, or stirring necessary
- Built-in temperature and pressure compensation
- Easy maintenance
- Switch setting allows units of mg/L or % saturation

Range	0 to 20 mg/L 0 to 300% saturation

For more details, see page 47.

Extra-Long Temperature Probe

TPL-BTA

This probe is designed for outdoor temperature sensing or for measuring temperature at various depths in lakes and streams. It has a 30 m (100 ft) cable.

Range	–50 to 150°C

Renewable Energy with Vernier

winner! 2015 AWARDS of EXCELLENCE TECH&LEARNING

Appropriate for high school, this book includes experiments and projects about wind and solar energy. Vernier lab books are loaded with teacher tips, sample graphs, and more.

More Online
Learn more about the experiments in *Renewable Energy with Vernier* at www.vernier.com/rev

Electronic Version

REV-E

When you buy the electronic version you receive

- EQuIP rubric friendly experiments—each shows connections to NGSS
- 26 experiments and engineering projects in wind and solar energy
- Access to up-to-date versions of the experiments
- Essential teacher information for successful experiments and projects
- Instructions for data collection with LabQuest App and Logger *Pro*
- A generous site license—buy one book and duplicate labs for your class
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences

Printed Lab Book

REV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Renewable Energy with Vernier contains the following experiments and engineering projects:

Experiment		Sensors Used	Lab Equipment Used
1	Renewable Energy: Why is it So Important?	Light Sensor	—
2	What is Energy?	Surface Temperature Sensor	—
3	Project: Energy Audit	Surface Temperature Sensor	—
4	Voltage and Circuits	Vernier Energy Sensor	Vernier Variable Load
5	Current and Resistors	Vernier Energy Sensor	—
6	Mechanical Power	—	KidWind Advanced Wind Experiment Kit
7	Generators	Vernier Energy Sensor	KidWind simpleGEN
8	Exploring Wind Turbines	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
9	Effect of Load on Wind Turbine Output	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
10	Blade Variables and Power Output	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
11	Solidity (computer only)	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
12	Turbine Efficiency	Vernier Energy Sensor, Anemometer	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
13	Power Curves	Vernier Energy Sensor, Anemometer	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
14	Power and Energy	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
15	Project: Maximum Energy Output	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
16	Project: Build a Wind Farm	Vernier Energy Sensor	Vernier Variable Load, KidWind Advanced Wind Experiment Kit
17	Exploring Solar Panels	Vernier Energy Sensor	Vernier Variable Load, KidWind 2V/400mA Solar Panel
18	Effect of Load on Solar Panel Output	Vernier Energy Sensor	Vernier Variable Load, KidWind 2V/400mA Solar Panel
19	Variables Affecting Solar Panel Output	Vernier Energy Sensor, Light Sensor (optional)	Vernier Variable Load, KidWind 2V/400mA Solar Panel
20	Effect of Temperature on Solar Panel Output	Vernier Energy Sensor, Surface Temperature Sensor	Vernier Variable Load, KidWind 2V/400mA Solar Panel
21	Project: Build a Solar Charger	Vernier Energy Sensor	Vernier Variable Load, KidWind 2V/400mA Solar Panel
22	Exploring Passive Solar Heating	Surface Temperature Sensor	—
23	Variables Affecting Passive Solar Heating	Surface Temperature Sensor (2)	—
24	Exploring Solar Collectors	Surface Temperature Sensor, Light Sensor	KidWind Solar Thermal Exploration Kit
25	Variables Affecting Solar Collectors	Surface Temperature Sensor	KidWind Solar Thermal Exploration Kit
26	Project: Solar Cooker	Surface Temperature Sensor	—

Products for *Renewable Energy with Vernier*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

		Order Code
Sensors	Vernier Energy Sensor	VES-BTA
	Surface Temperature Sensor	STS-BTA
	Light Sensor	LS-BTA
	Anemometer	ANM-BTA
Lab Equipment	Vernier Variable Load	VES-VL
	KidWind Advanced Wind Experiment Kit	KW-AWX
	KidWind 2V/400mA Solar Panel	KW-SP2V
	KidWind simpleGEN Kit	KW-SGEN
	KidWind Solar Thermal Exploration Kit	KW-STXK

Software option

For computers

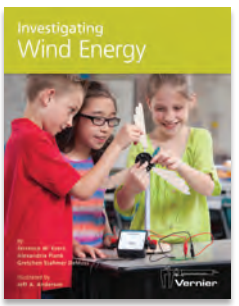
Logger *Pro* 3 (LP)
See page 20.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

KidWind by Vernier

KidWind and Vernier have teamed up to bring you the latest in renewable energy education. For over a decade, KidWind has been a leader in renewable energy education and the delivery of STEM education. KidWind's standards-based educational tools explore the science and technology of wind, solar, and other forms of renewable energy and their impact on the environment.

Through KidWind's extensive training network, teacher trainings, and student wind turbine design competitions, KidWind brings hands-on applications of their materials to teachers and students worldwide.

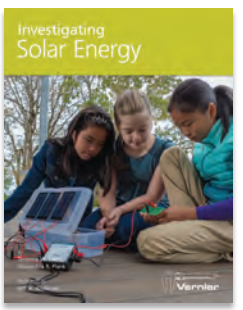


Investigating Wind Energy

Electronic Version Printed

ELB-WIND-E ELB-WIND

Appropriate for grades 4–6 and aligned to NGSS, this book contains 10 hands-on, engaging wind energy experiments for elementary students and a culminating wind energy engineering project. Students explore wind energy through the use of KidWind MINI Wind Turbines and the Vernier Energy Sensor. Topics such as energy transfer, basic electric circuits, and blade variables, including pitch, shape, quantity, mass, and material, are covered. See page 110.



Investigating Solar Energy

winner! 2016 AWARDS of EXCELLENCE TECH & LEARNING

Electronic Version Printed

ELB-SOLAR-E ELB-SOLAR

Appropriate for grades 4–6 and aligned to NGSS, this book contains nine experiments and two engineering projects. Students learn about solar energy and apply their knowledge to develop solutions to real-world problems. Students use the KidWind Solar Energy Exploration Kit, the Vernier Energy Sensor, and the Surface Temperature Sensor to explore solar energy, energy transfer, series and parallel circuits, and variables that affect solar panel output. This book is for data collection using computers and LabQuest only. See page 112.

KidWind Advanced Wind Experiment Kit

KW-AWX

Discover advanced concepts of wind turbine technology, including gearboxes and generator construction (with the simpleGEN add-on). Students can use the blades they design to generate electricity, lift weights, and pump water. This kit is recommended for use with our lab book, *Renewable Energy with Vernier*.

KidWind Advanced Wind Experiment Kit Classroom Pack

KW-AWXC

The classroom pack option includes three turbine towers and bases, three nacelles, three generator sets, eight hubs, and blade consumables for eight groups of 2 to 4 students.

KidWind Basic Wind Experiment Kit

KW-BWX

Explore wind energy affordably and easily. This kit, one of our most popular, allows young scientists to test a variety of blade designs, generate electricity (0.5–3 V range), and lift weights. The Basic Wind Experiment Kit has all the materials you need to get started with wind power. Great for classrooms as well as individual science fair projects.

KidWind Basic Wind Experiment Kit Classroom Pack

KW-BWXC

The classroom pack option includes three turbine towers and bases, three nacelles, three generators, eight hubs, and blade consumables for eight groups of 2 to 4 students.

Additional shipping charges may apply to KidWind products due to weight.

Recommended Classroom Setup

3 Setups

6–10 Groups of 2–4 Students

We recommend three setups for a classroom with 6 to 10 groups of 2 to 4 students.

Each setup should have
- Box fan
- Wind turbine tower and base
- Vernier interface
- Vernier Energy Sensor (VES-BTA)
- Either a Vernier Variable Load (VES-VL) or a Vernier Resistor Board (VES-RB)

Each group needs
- Blade Pitch Protractor
- Wind Turbine Hub
- Blade consumables

Which KidWind Kit Should I Buy?

I Teach	I Should Buy
K–3	MINI Wind Turbine
4–5	MINI Wind Turbine with Blade Design
6–8	Basic Wind Experiment Kit
High School	Advanced Wind Experiment Kit
University	Advanced Wind Experiment Kit with GENPack or simpleGEN

I Want to	I Should Buy
Lift weight	Basic Wind Experiment Kit
	Advanced Wind Experiment Kit
Light an LED	MINI Wind Turbine
	MINI Wind Turbine with Blade Design
	Basic Wind Experiment Kit
	Advanced Wind Experiment Kit
Make a sound	MINI Wind Turbine
	MINI Wind Turbine with Blade Design
Pump water	Advanced Wind Experiment Kit
Build a wind farm	Advanced Wind Experiment Kit
Use the *Renewable Energy with Vernier* lab book	Advanced Wind Experiment Kit
Use the *Investigating Wind Energy* lab book	MINI Wind Turbine with Blade Design

Students investigate wind energy through engineering blade design

KidWind MINI Wind Turbine

KW-MWT

Demonstrate the power of the wind with an affordable and rugged wind turbine. This easy-to-build turbine can light an LED or play a tune on the Sound and Light Board (included). The highly efficient blades produce plenty of power.

KidWind MINI Wind Turbine with Blade Design

KW-MWTBD

The MINI Wind Turbine with Blade Design allows students to perform basic blade experiments on a desk using a small house fan. This kit is recommended for use with our lab book, *Investigating Wind Energy*.

KidWind simpleGEN

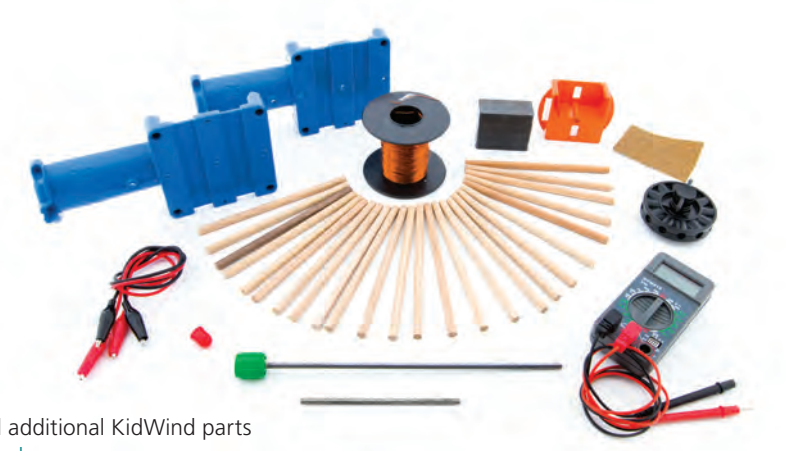
KW-SGEN

The simpleGEN is an easy-to-build AC generator for exploring the basics of electrical generator design. Demonstrate Faraday's law, light LEDs, and perform experiments that explore how coils, magnets, and rotation affect power generation. Convert your generator to a simple motor and explore additional variables. Take your experiments to the next level by converting your simpleGEN into a wind turbine nacelle.

KidWind simpleGEN Classroom Pack

KW-SGENC

The simpleGEN Classroom Pack has enough materials to build 10 generators.



KidWind Accessories, Consumables, and Replacement Parts

Part Name	Order Code
Basic Turbine Building Parts	KW-BTPART
Basic Turbine Building Parts (10 Pack)	KW-BTPART10
Wind Turbine Hub (3 Pack)	KW-WTH3
Wind Turbine Hub (10 Pack)	KW-WTH10
Blade Design Consumables Classroom Pack	KW-BDC
Dowels (25 Pack)	KW-D25
Dowels (100 Pack)	KW-D100
Wind Turbine Generator (10 Pack)	KW-GEN10
Blade Pitch Protractor	KW-BPP

For information on complete kit contents and additional KidWind parts and accessories, visit www.vernier.com/kidwind

Vernier Energy Sensor

VES-BTA

The Vernier Energy Sensor offers an easy way to quantify voltage, current, power, and energy output of small wind turbines and solar panels. The Energy Sensor measures the current and voltage of the system. Our data-collection and analysis software then calculates the power and energy output.

Source input potential range	±30 V
Source input current range	±1000 mA

Vernier Variable Load

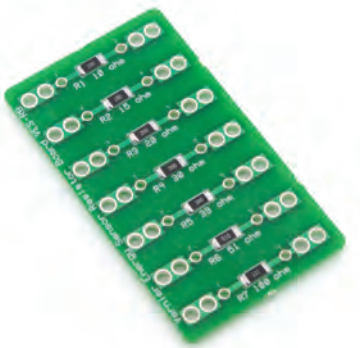
VES-VL

The Vernier Variable Load is used in conjunction with the Vernier Energy Sensor to provide a range of resistive loads for projects with wind turbines or solar panels. This load is used in our *Renewable Energy with Vernier* lab book.

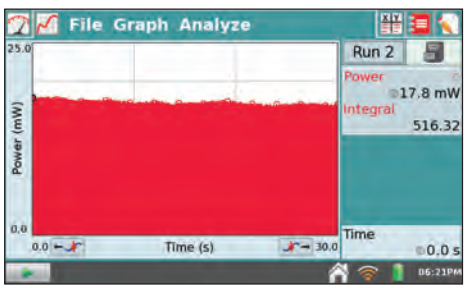
Vernier Resistor Board

VES-RB

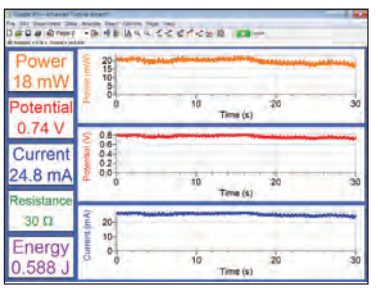
The Vernier Resistor Board provides a set of seven different load resistors for KidWind wind turbines and solar panels. This board is used in our *Investigating Wind Energy* and *Investigating Solar Energy* lab books.



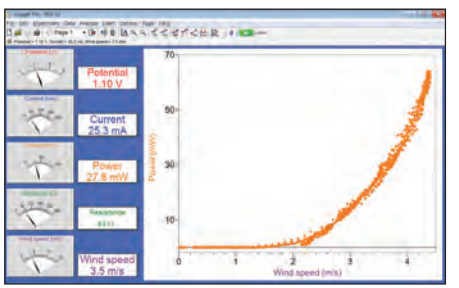
Measuring power produced by a solar panel



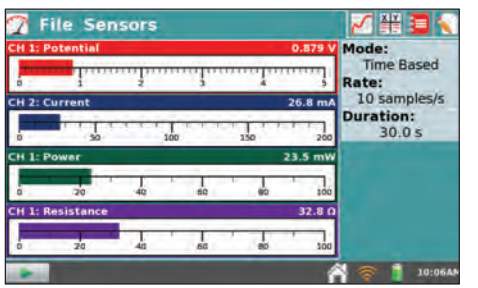
Measuring energy produced over 30 seconds by a student wind turbine



Logger Pro *used to graph potential, current, and power* vs. *time*



Power produced by a wind turbine as a function of wind speed

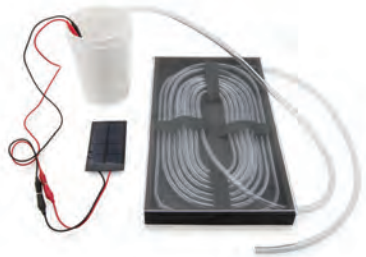


When the Energy Sensor is connected to LabQuest 2, four meters are displayed automatically.

Solar Thermal Exploration Kit

KW-STXK

The Solar Thermal Exploration Kit is modeled after a domestic solar water-heating system. Explore variables such as box color, light intensity, tube design, and rate of water pumping. Learn about what makes a solar water heating system more or less efficient.



2V/400mA Solar Panel

KW-SP2V

This high-quality solar panel is great for demonstrations and experiments. External screw terminals and attached clip cords make the panels easy to use.

Solar Energy Exploration Kit

KW-SEEK

winner! 2016 AWARDS of EXCELLENCE TECH & LEARNING

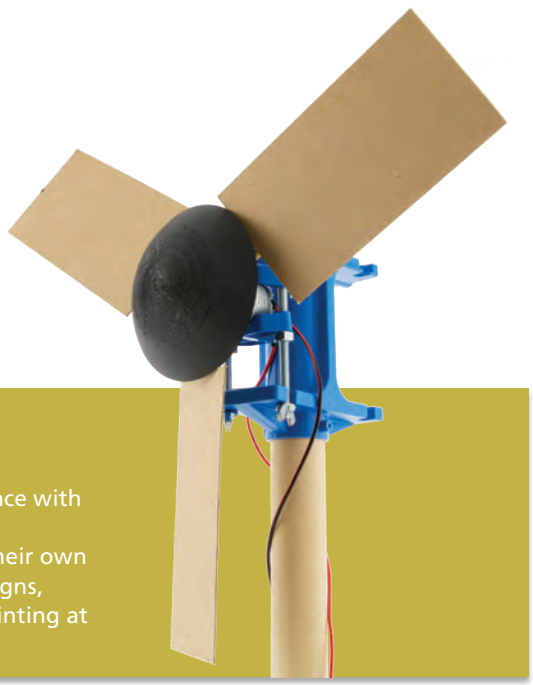
Explore solar energy with this innovative science kit designed to help students investigate energy transformations. Discover how the angle of photovoltaic panels relative to the sun affects power output. Experiment with basic circuits and learn about important factors in photovoltaic systems.

Pyranometer

PYR-BTA

The Vernier Pyranometer measures the power of electromagnetic radiation in watts per square meter. It is sensitive to the near infrared, visible, and UV ranges, where nearly all of the solar energy is concentrated. It is great for experiments with solar cells and calculating their efficiency. The sensor is weatherproof and has a dome-shaped top to allow it to work with a wide range of sun angles. The Pyranometer has a 6 m cable.

Irradiance range	0 to 1100 W/m^2



Did you know?

If your students have experience with CAD software and access to a 3-D printer, they can design their own nose cones or modify our designs, which are available for 3-D printing at www.thingiverse.com/vernier

Primary Science

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

NEW

Go Direct Sensors

Complete sensing solution in each sensor—collect and stream data directly to your device.

Sensor	Order Code	URL	Page
NEW Go Direct 3-Axis Magnetic Field	GDX-3MG	vernier.com/gdx-3mg	8
NEW Go Direct Conductivity	GDX-CON	vernier.com/gdx-con	9
NEW Go Direct Force and Acceleration	GDX-FOR	vernier.com/gdx-for	7
NEW Go Direct Gas Pressure	GDX-GP	vernier.com/gdx-gp	8
NEW Go Direct Light and Color	GDX-LC	vernier.com/gdx-lc	8
NEW Go Direct Motion	GDX-MD	vernier.com/gdx-md	7
NEW Go Direct pH	GDX-PH	vernier.com/gdx-ph	7
NEW Go Direct Temperature	GDX-TMP	vernier.com/gdx-tmp	7
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	9

Standard Sensors

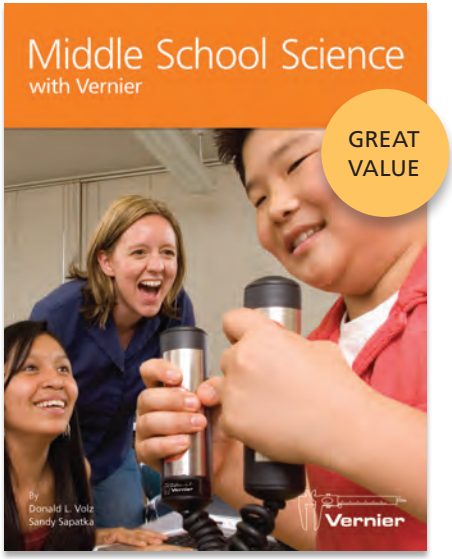
Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
Anemometer	ANM-BTA	vernier.com/anm-bta	111
Barometer	BAR-BTA	vernier.com/bar-bta	—
Conductivity Probe	CON-BTA	vernier.com/con-bta	68
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
Vernier Optical DO Probe	ODO-BTA	vernier.com/odo-bta	47
Energy Sensor	VES-BTA	vernier.com/ves-bta	102
Force Sensors			
Dual-Range Force Sensor	DFS-BTA	vernier.com/dfs-bta	109
Force Plate	FP-BTA	vernier.com/fp-bta	109
Gas Pressure Sensor	GPS-BTA	vernier.com/gps-bta	68
Hand Dynamometer	HD-BTA	vernier.com/hd-bta	47
Heart Rate Monitors			
Go Wireless Heart Rate	GW-HR	vernier.com/gw-hr	46
Hand-Grip Heart Rate Monitor	HGH-BTA	vernier.com/hgh-bta	46
Light Sensor	LS-BTA	vernier.com/ls-bta	—
Magnetic Field Sensor	MG-BTA	vernier.com/mg-bta	—
Mass (OHAUS® Balances)*	Varies by model	vernier.com/ohaus	69
Motion Detectors			
Motion Detector	MD-BTD	vernier.com/md-btd	138
Go! Motion*	GO-MOT	vernier.com/go-mot	109
pH Sensors			
pH Sensor	PH-BTA	vernier.com/ph-bta	67
Tris-Compatible Flat pH Sensor	FPH-BTA	vernier.com/fph-bta	48
Pyranometer	PYR-BTA	vernier.com/pyr-bta	103
Relative Humidity Sensor	RH-BTA	vernier.com/rh-bta	—
Salinity Sensor	SAL-BTA	vernier.com/sal-bta	—
Soil Moisture Sensor	SMS-BTA	vernier.com/sms-bta	48
Sound Level Sensor	SLS-BTA	vernier.com/sls-bta	109
Structures & Materials Tester	VSMT	vernier.com/vsmt	84
Temperature Probes			
Extra-Long Temperature Probe	TPL-BTA	vernier.com/tpl-bta	97
Go!Temp*	GO-TEMP	vernier.com/go-temp	109
Infrared Thermometer	IRT-BTA	vernier.com/irt-bta	—
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	66
Surface Temperature Sensor	STS-BTA	vernier.com/sts-bta	66
Thermocouple	TCA-BTA	vernier.com/tca-bta	66
UV Sensors			
UVA Sensor	UVA-BTA	vernier.com/uva-bta	—
UVB Sensor	UVB-BTA	vernier.com/uvb-bta	—
Voltage Probes			
Differential Voltage Probe	DVP-BTA	vernier.com/dvp-bta	136
Voltage Probe	VP-BTA	vernier.com/vp-bta	—

*** USB sensor, no interface required**

Primary Science Lab Books

Title	URL	Page
Middle School Science with Vernier 4th Ed.	vernier.com/msv	106
Elementary Science with Vernier	vernier.com/ewv	108
Let's Go! Investigating Temperature	vernier.com/elb-temp	109
Investigating Wind Energy	vernier.com/elb-wind	110
Investigating Solar Energy	vernier.com/elb-solar	112



Middle School Science with Vernier 4th Ed.

Appropriate for middle school, this book explores various science topics. Vernier lab books are loaded with great experiment ideas, projects and challenges, and more. The 4th edition is updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

More Online
Learn more about the experiments in *Middle School Science with Vernier* at www.vernier.com/msv

Electronic Version

MSV-E

When you buy the electronic version you receive

- 38 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Graphical Analysis 4, Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

MSV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Middle School Science with Vernier 4th Ed. contains the following experiments:

Ⓢ Ⓓ Using Temperature Probes
- A Hot Hand
- Heating of Land and Water
- The Greenhouse Effect
- Relative Humidity
- Absorption of Radiant Energy
- Schoolyard Study
- A Good Sock
- What Causes the Seasons?
- Solar Homes
- Boiling Temperature of Water
- Freezing Temperature of Water
- How Low Can You Go?
- A Good Cold Pack
- A Water Field Study
- Cooling Rates: Shaq *vs.* Susie

Ⓢ Ⓓ Using a pH Sensor
- Soil Study
- A Water Field Study

Ⓢ Ⓓ Using a Voltage Probe
- Lemon "Juice"

Ⓢ Ⓓ Using a Motion Detector
- Ocean Floor Mapping
- Graphing Your Motion
- Speeding Up
- A Speedy Slide
- The Indy 100
- A Crash Lesson
- Falling Objects

Ⓢ Ⓓ Using a Light Sensor
- Reflectivity of Light
- Schoolyard Study

Ⓓ Using a Force Sensor
- Friction
- First-Class Levers
- Pulleys
- Buoyancy

Ⓓ Using a Conductivity Probe
- Water Hardness Study
- Diffusion: How Fast?
- A Water Field Study

Ⓓ Using a Gas Pressure Sensor
- Get a Grip!
- Fun with Pressure
- Yeast Beasts in Action

Ⓓ Using a Heart Rate Monitor
- Heart Rate and Body Position
- Heart Rate and Exercise

Ⓓ Using a Magnetic Field Sensor
- Mapping a Magnetic Field
- Electromagnets

Ⓢ Starter Package

Ⓓ Deluxe Package

Products for *Middle School Science with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Order Code	Ⓢ Starter Package LQ2-MS-ST	Ⓓ Deluxe Package LQ2-MS-DX
LabQuest 2 Interface	LABQ2	•	•
Motion Detector	MD-BTD	•	•
pH Sensor	PH-BTA	•	•
Voltage Probe	VP-BTA	•	•
Stainless Steel Temperature Probe	TMP-BTA	•	•
Light Sensor	LS-BTA	•	•
Dual-Range Force Sensor	DFS-BTA	—	•
Gas Pressure Sensor	GPS-BTA	—	•
Hand-Grip Heart Rate Monitor	HGH-BTA	—	•
Conductivity Probe	CON-BTA	—	•
Magnetic Field Sensor	MG-BTA	—	•

Ⓓ Deluxe Package

Ⓢ Starter Package

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

FREE Logger Lite
Download at
vernier.com/logger-lite

OR

NEW Go Direct™ Sensors

Our new Go Direct sensors connect directly to a Chromebook,™ computer, or mobile device and require no additional interface.

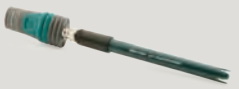
Software needed for Go Direct sensors

FREE Graphical Analysis 4 software
See page 10.

Note: Logger *Pro* cannot be used to collect data with Go Direct sensors.

This is a complete solution for all 35 experiments in *Middle School Science with Vernier.*

Go Direct Motion
GDX-MD



Go Direct pH
GDX-PH

Go Direct Voltage
GDX-VOLT

Go Direct Temperature*
GDX-TMP

Go Direct Light and Color
GDX-LC

Go Direct Force and Acceleration
GDX-FOR

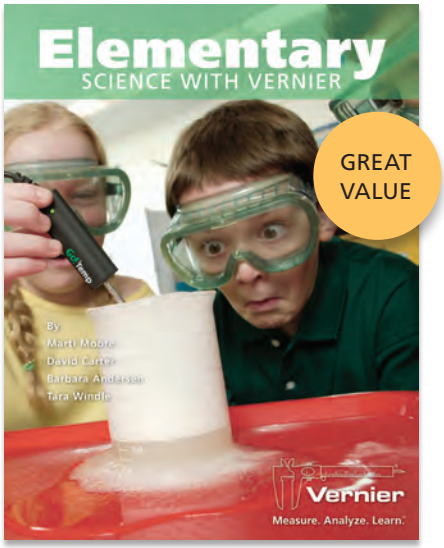
Go Direct Gas Pressure
GDX-GP

Go Direct Conductivity
GDX-CON

Go Direct 3-Axis Magnetic Field
GDX-3MG

Go Wireless Heart Rate†
GW-HR

* You will need two Go Direct Temperature Probes for some experiments in *Middle School with Vernier.*
† Wireless only. See www.vernier.com/gw-hr for compatibility requirements.



Elementary Science with Vernier

Appropriate for elementary school, this book explores various science topics. Vernier lab books are loaded with great experiment ideas, projects and challenges, and more.

More Online
Learn more about the experiments in *Elementary Science with Vernier* at www.vernier.com/ewv

Electronic Version

EWV-E

When you buy the electronic version you receive

- 43 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger Lite and LabQuest App
- Essential instructor information including teaching tips, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

EWV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Elementary Science with Vernier contains the following experiments:

Ⓢ Ⓓ Using a Temperature Probe
- Learning to Use Go!Temp
- How Do Mittens Keep You Warm?
- Baggie Mittens
- The Sole Purpose
- ▶ Cool Reaction!
- Cold as Ice
- Are We Cool or What?
- Why Do We Need Thermometers?
- Celsius or Fahrenheit. What's the Difference?
- Getting it *Just* Right!
- Go!Temp Spends the Night
- Hold Everything! Comparing Insulators
- Keepin' it Cool! Design Your Own Thermos
- I'm Melting! Water Changes States
- Solid, Liquid, Gas: Water Can Do it All!

Ⓢ Ⓓ Using a Light Probe
- Learning to Use the Light Probe
- Distance From the Sun
- Sunshine on My Shoulders
- Summer and Winter
- Reflectivity of Light

Ⓢ Ⓓ Using a Motion Detector
- Learning to Use Go! Motion
- ▶ e-Motion
- Batty About Science
- Spring into Action!
- Air Ball!
- Driving with Energy
- Weigh Station: All Trucks Stop!

Ⓓ Using a Gas Pressure Sensor
- Learning to Use the Pressure Sensor
- Get a Grip!
- Under Pressure
- ▶ Bubbles in Your Bread

Ⓓ Using a Magnetic Field Sensor
- Learning to Use the Magnetic Field Sensor
- Exploring the Poles
- ▶ Making Magnets
- Electromagnets

Ⓓ Using a Voltage Probe
- Learning to Use the Voltage Probe
- Are All Batteries the Same?
- Stacked Batteries
- All Worn Out!

Ⓓ Using a Force Sensor
- Learning to Use the Force Sensor
- Lift the Load
- ▶ What a Drag!
- Oh! My Aching Back! How Ramps Make Lifting Easier

Ⓢ Starter Package

Ⓓ Deluxe Package

▶ Video Online

Products for *Elementary Science with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Package Includes	Order Code	Ⓢ Starter Package LQ2-EL-ST	Ⓓ Deluxe Package LQ2-EL-DX
LabQuest 2 Interface	LABQ2	•	•
Stainless Steel Temperature Probe	TMP-BTA	•	•
TI Light Probe	TILT-BTA	•	•
Motion Detector	MD-BTD	•	•
Magnetic Field Sensor	MG-BTA	—	•
Gas Pressure Sensor	GPS-BTA	—	•
Differential Voltage Probe	DVP-BTA	—	•
Dual-Range Force Sensor	DFS-BTA	—	•

Ⓓ Deluxe Package

Ⓢ Starter Package

You may also want

FREE Logger Lite
Download at
vernier.com/logger-lite

LabQuest Viewer (LQ-VIEW)
See page 17.

Go!Temp

GO-TEMP

Connect directly to the USB port on your computer or Chromebook™ to collect temperature data.

For more details, visit
www.vernier.com/go-temp

Let's Go! Investigating Temperature

ELB-TEMP-E

ELB-TEMP

A collection of 10 temperature experiments for computer or LabQuest. These experiments are also included in the *Elementary Science with Vernier* book.

Go! Motion

GO-MOT

Connect directly to the USB port on your computer or Chromebook to collect position, velocity, and acceleration data.

Go! Link

GO-LINK

Our low-cost USB sensor interface connects Vernier sensors to a computer or to a Chromebook.

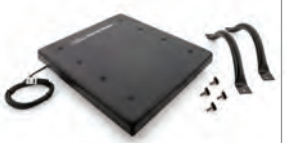
Dual-Range Force Sensor

DFS-BTA

Measure pushing and pulling forces with this versatile sensor.

Force Plate

FP-BTA

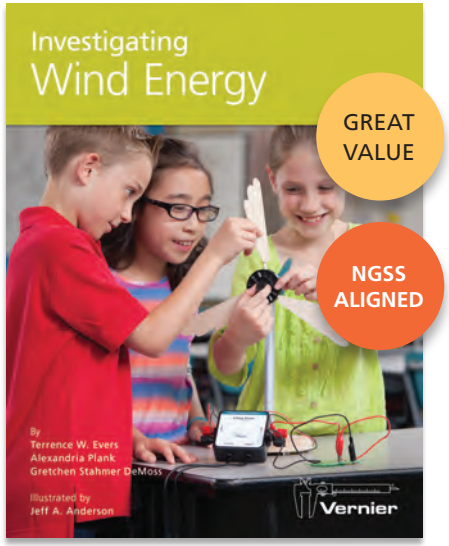


The Force Plate is a large force sensor that is tough enough to jump on. Two handles are included for pushing or pulling.

Sound Level Sensor

SLS-BTA

Easily measure sound level in decibels (dB) in many school settings.



Investigating Wind Energy

Appropriate for elementary and middle school, this book explores wind energy topics. Vernier lab books are loaded with great experiment ideas, projects and challenges, and more.

More Online
Learn more about the experiments in *Investigating Wind Energy* at www.vernier.com/elb-wind

Electronic Version

ELB-WIND-E

When you buy the electronic version you receive

- 10 ready-to-use student experiments and a culminating engineering project
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger Lite and LabQuest App
- Essential instructor information including teaching tips, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

ELB-WIND

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

PRIMARY SCIENCE

Investigating Wind Energy contains the following experiments:

Experiment	Sensors Used	Lab Equipment Used
1 Introduction to Wind Turbines	—	KidWind MINI Wind Turbine with Blade Design, KidWind Sound and Light Board*
2 Exploring Wind Energy	—	KidWind MINI Wind Turbine with Blade Design, KidWind Sound and Light Board*
3 Introduction to the Vernier Energy Sensor	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, KidWind Sound and Light Board*
4 Wind Turbine Output: The Effect of Load	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design
5 Exploring Wind Turbine Blades	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board
6 Blade Design: Pitch	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board
7 Blade Design: Area	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board
8 Blade Design: Quantity	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board
9 Blade Design: Mass	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board
10 Blade Design: Material	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board
11 Project: Power Up!	Vernier Energy Sensor	KidWind MINI Wind Turbine with Blade Design, Vernier Resistor Board

* Included with MINI Wind Turbine and MINI Wind Turbine with Blade Design

Did you know?

Integrating inquiry investigations and the engineering design method into your elementary STEM class is easy with the *Investigating Wind Energy* lab book. Aligned with the Next Generation Science Standards (NGSS), the experiments and project in this book encourage students to apply learned knowledge as they explore electric circuits and as they design, test, and refine a wind turbine blade set.

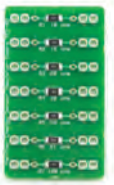
Products for *Investigating Wind Energy*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

		Order Code
Sensor & Lab Equipment	Vernier Energy Sensor	VES-BTA
	KidWind MINI Wind Turbine with Blade Design	KW-MWTBD
	Vernier Resistor Board	VES-RB



Software options

For computers

Logger *Pro* 3 (LP)
See page 20.

FREE Logger Lite
Download at
vernier.com/logger-lite

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

Vernier Energy Sensor

VES-BTA

Used in most of the experiments in the *Investigating Wind Energy* and the *Investigating Solar Energy* lab books, the Vernier Energy Sensor offers an easy way to quantify voltage, current, power, and energy output of small wind turbines and solar panels. Simply connect a small wind turbine or solar panel and the Vernier Resistor Board or Variable Load.

KidWind MINI Wind Turbine with Blade Design

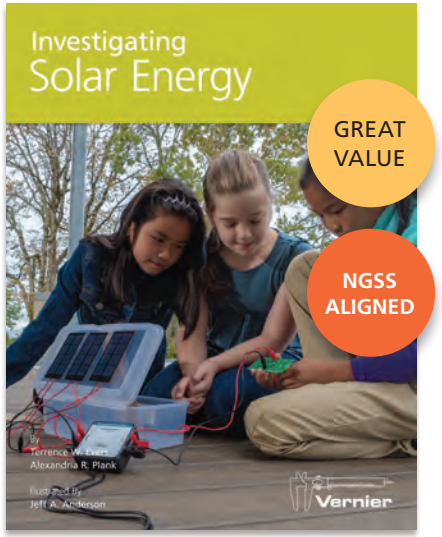
KW-MWTBD

The MINI Wind Turbine with Blade Design allows students to perform basic blade experiments on a desk using a small house fan. This kit is recommended for use with our *Investigating Wind Energy* lab book and includes the KidWind Sound and Light Board.

Anemometer

ANM-BTA

The Vernier Anemometer is an impeller-type anemometer that measures wind speed in the range of 0.5 to 30 m/s (1 to 67 mph). The Anemometer fits in your palm for wind study measurements in the field. A standard camera mount on the back and an accessory rod allow you to position it in wind tunnels or in front of fans for wind turbine experiments.



Investigating Solar Energy

winner! 2016 AWARDS of EXCELLENCE TECH & LEARNING

Appropriate for elementary and middle school, this book explores solar energy topics. Vernier lab books are loaded with great experiment ideas, projects and challenges, and more.

More Online
Learn more about the experiments in *Investigating Solar Energy* at www.vernier.com/elb-solar

Electronic Version

ELB-SOLAR-E

When you buy the electronic version you receive

- 9 ready-to-use student experiments and 2 engineering projects
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger Lite and LabQuest App
- Essential instructor information including teaching tips, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

ELB-SOLAR

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a spiral-bound printed copy of the book

PRIMARY SCIENCE

Investigating Solar Energy contains the following experiments:

	Experiment	Sensors Used	Lab Equipment Used
1	Introduction to Solar Panels	—	KidWind Solar Energy Exploration Kit
2	Exploring Solar Energy	—	KidWind Solar Energy Exploration Kit
3	Introduction to the Vernier Energy Sensor	Vernier Energy Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
4	Making Connections: Circuits	Vernier Energy Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
5	Solar Panel Output: Effect of Load	Vernier Energy Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
6	Solar Panel Output: Effect of Shade	Vernier Energy Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
7	Solar Panel Output: Effect of Angle	Vernier Energy Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
8	Pumping Water with Solar Energy	Vernier Energy Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
9	Exploring Surface Temperature	Surface Temperature Sensor	—
10	Project: Solar Homes	Vernier Energy Sensor, Surface Temperature Sensor	KidWind Solar Energy Exploration Kit, Vernier Resistor Board
11	Project: What's Cookin'?	Surface Temperature Sensor	—

Products for Solar Energy

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

		Order Code
Sensors & Lab Equipment	Vernier Energy Sensor	VES-BTA
	Surface Temperature Sensor	STS-BTA
	KidWind Solar Energy Exploration Kit	KW-SEEK
	Vernier Resistor Board	VES-RB

Software options

For computers

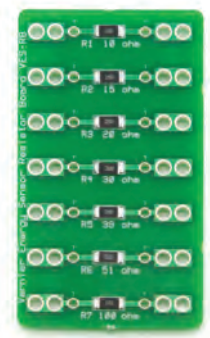
Logger 3 (LP)
See page 20.

FREE Logger Lite
Download at
vernier.com/logger-lite

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

Vernier Resistor Board

VES-RB



Used in most of the experiments in the *Investigating Solar Energy* and *Investigating Wind Energy* lab books, the Vernier Resistor Board has seven 1 W, 5% resistors mounted on a circuit board. Test clip holes on either side of the resistors allow for easy connections to clips on wire leads.

KidWind Solar Energy Exploration Kit

KW-SEEK

winner! 2016 AWARDS OF EXCELLENCE TECH & LEARNING

Explore solar energy with this innovative science kit designed to help students investigate energy transformations. Discover how the angle of photovoltaic panels relative to the sun affects power output. Experiment with basic circuits and learn about important factors in photovoltaic systems. Harness energy from the solar panels to pump water or power a small motor.

Vernier Energy Sensor

VES-BTA

The Vernier Energy Sensor offers an easy way to quantify voltage, current, power, and energy output of small wind turbines and solar panels. Simply connect a source, such as a small wind turbine or solar panel, and a load, such as the Vernier Resistor Board or Variable Load.

Investigating the force of friction

Physical Science

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

NEW

Go Direct Sensors

Complete sensing solution in each sensor—collect and stream data directly to your device.

Sensor	Order Code	URL	Page
NEW Go Direct 3-Axis Magnetic Field	GDX-3MG	vernier.com/gdx-3mg	139
NEW Go Direct Conductivity	GDX-CON	vernier.com/gdx-con	63
NEW Go Direct Force and Acceleration	GDX-FOR	vernier.com/gdx-for	139
NEW Go Direct Gas Pressure	GDX-GP	vernier.com/gdx-gp	63
NEW Go Direct Light and Color	GDX-LC	vernier.com/gdx-lc	139
NEW Go Direct Motion	GDX-MD	vernier.com/gdx-md	139
NEW Go Direct pH	GDX-PH	vernier.com/gdx-ph	62
NEW Go Direct Temperature	GDX-TMP	vernier.com/gdx-tmp	62
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	65

Standard Sensors

Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
Conductivity Probe	CON-BTA	vernier.com/con-bta	68
Current Probes			
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
High Current Sensor	HCS-BTA	vernier.com/hcs-bta	—
Energy Sensor	VES-BTA	vernier.com/ves-bta	102
Force Sensors			
Dual-Range Force Sensor	DFS-BTA	vernier.com/dfs-bta	138
Force Plate	FP-BTA	vernier.com/fp-bta	130
Gas Pressure Sensor	GPS-BTA	vernier.com/gps-bta	68
Light Sensor	LS-BTA	vernier.com/ls-bta	—
Magnetic Field Sensor	MG-BTA	vernier.com/mg-bta	—
Mass (OHAUS® Balances)*	Varies by model	vernier.com/ohaus	69
Microphone	MCA-BTA	vernier.com/mca-bta	138
Motion Detectors			
Motion Detector	MD-BTD	vernier.com/md-btd	138
Go! Motion*	GO-MOT	vernier.com/go-mot	109
pH Sensor	PH-BTA	vernier.com/ph-bta	67
Sound Level Sensor	SLS-BTA	vernier.com/sls-bta	138
Structures & Materials Tester	VSMT	vernier.com/vsmt	84
Temperature Probes			
Infrared Thermometer	IRT-BTA	vernier.com/irt-bta	—
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	66
Surface Temperature Sensor	STS-BTA	vernier.com/sts-bta	66
Thermocouple	TCA-BTA	vernier.com/tca-bta	66
Voltage Probes			
Differential Voltage Probe	DVP-BTA	vernier.com/dvp-bta	136
Voltage Probe	VP-BTA	vernier.com/vp-bta	—
30-Volt Voltage Probe	30V-BTA	vernier.com/30v-bta	—

*** USB sensor, no interface required**

Physical Science Lab Book

Title	URL	Page
Physical Science with Vernier 4th Ed.	vernier.com/psv	116

Physical Science with Vernier 4th Ed.

Appropriate for middle school or high school, this book explores a variety of physical science topics. Vernier lab books are loaded with great experiment ideas, extensions and challenges, and more. The 4th edition is updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

More Online
Learn more about the experiments in *Physical Science with Vernier* at www.vernier.com/psv

Electronic Version

PSV-E

When you buy the electronic version you receive

- 40 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Graphical Analysis 4 software, Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, instructions for preparing solutions, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

PSV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Physical Science with Vernier 4th Ed. contains the following experiments:

Using a Temperature Probe
- Temperature Probe Response Time
- Boiling Temperature of Water
- Freezing and Melting of Water
- Evaporation of Alcohols*
- Endothermic and Exothermic Reactions
- Neutralization Reactions
- Mixing Warm and Cold Water*
- Heat of Fusion
- Energy Content of Fuels
- Energy Content of Foods
- Absorption of Radiant Energy*
- An Insulated Cola Bottle*
- A Good Sock*
- Insolation Angle*
- Solar Homes and Heat Sinks*
- Gas Temperature and Pressure

Using a Motion Detector
- Speeding Up
- It's Race Day
- A Crash Lesson
- Newton's Second Law
- Graphing Your Motion
- Falling Objects

Using a pH Sensor
- Household Acids and Bases
- Acid Rain

Using a Voltage Probe
- Lemon "Juice"
- Simple Circuits

Using a Force Sensor
- Frictional Forces
- First-Class Levers
- Pulleys
- An Inclined Plane

Using a Light Sensor
- Reflectivity of Light
- Polaroid Filters
- How Bright is the Light?

Magnetic Field Sensor
- Electromagnets: Winding Things Up
- Magnetic Field Explorations

Using a Conductivity Probe
- Conducting Solutions
- Conductivity of Salt Water: The Effect of Concentration
- Acid Strengths
- Neutralization Reactions

Using a Gas Pressure Sensor
- Gas Pressure and Volume
- Gas Temperature and Pressure
- Fun with Pressure

Video Online

*** Requires two temperature probes**

Products for *Physical Science with Vernier*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)*
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

Sensors	Order Code
Motion Detector	MD-BTD
Dual-Range Force Sensor	DFS-BTA
pH Sensor	PH-BTA
Voltage Probe	VP-BTA
Stainless Steel Temperature Probe†	TMP-BTA
Light Sensor	LS-BTA
Conductivity Probe	CON-BTA
Magnetic Field Sensor	MG-BTA
Gas Pressure Sensor	GPS-BTA

Software options

For computers

Logger *Pro* 3 (LP)
See page 20.

For Chromebook, mobile device, or computer

FREE Graphical Analysis 4
See page 10.

* You may also be interested in LabQuest Viewer (LQ-VIEW). See page 17.

OR

NEW Go Direct™ Sensors

Our new Go Direct sensors connect directly to a Chromebook,™ computer, or mobile device and require no additional interface.

Software needed for Go Direct sensors

FREE Graphical Analysis 4 software
See page 10.

Note: Logger *Pro* cannot be used to collect data with Go Direct sensors..

This is a complete solution for all 40 experiments in *Physical Science with Vernier.*

Go Direct Motion
GDX-MD

Go Direct Force and Acceleration
GDX-FOR

Go Direct pH
GDX-PH

Go Direct Voltage
GDX-VOLT

Go Direct Temperature†
GDX-TMP

Go Direct Light and Color
GDX-LC

Go Direct Conductivity
GDX-CON

Go Direct 3-Axis Magnetic Field
GDX-3MG

Go Direct Gas Pressure
GDX-GP

† You will need two temperature probes for some experiments in *Physical Science with Vernier.*

Data collection with the
Motion Encoder

Physics

Outfit Your Lab

Vernier makes it easy to incorporate probeware into your experiments. We provide all the tools, training, and support needed to help you and your students succeed.

1

Select Your Experiments

Vernier lab books, aligned to state and national science standards, provide customizable handouts, teacher tips, sample graphs, and a license to duplicate the experiments for your class.

2

Choose Your Equipment

Vernier packages and lists of recommended products take the guess work out of equipment selection.

3

Add Software

Vernier software and apps take data collection to the next level. Real-time graphing and powerful analytical tools help students connect with science through hands-on learning.

Standard Sensors

Connect to a Vernier interface to collect and analyze data on your device.

Sensor	Order Code	URL	Page
Accelerometers			
3-Axis Accelerometer	3D-BTA	vernier.com/3d-bta	138
25-g Accelerometer	ACC-BTA	vernier.com/acc-bta	138
Low-g Accelerometer	LGA-BTA	vernier.com/lga-bta	138
Wireless Dynamics Sensor System	WDSS	vernier.com/wdss	129
Carts and Tracks			
Dynamics Cart and Track System with Motion Encoder	DTS-EC	vernier.com/dts-ec	127
Encoder Fan Cart	CART-FEC	vernier.com/cart-fec	128
Current Sensors			
Current Probe	DCP-BTA	vernier.com/dcp-bta	136
High Current Sensor	HCS-BTA	vernier.com/hcs-bta	—
Vernier Energy Sensor	VES-BTA	vernier.com/ves-bta	113
Electricity and Magnetism Sensors			
Charge Sensor	CRG-BTA	vernier.com/crg-bta	137
Magnetic Field Sensor	MG-BTA	vernier.com/mg-bta	—
Force Sensors			
Dual-Range Force Sensor	DFS-BTA	vernier.com/dfs-bta	138
Force Plate	FP-BTA	vernier.com/fp-bta	130
Wireless Dynamics Sensor System	WDSS	vernier.com/wdss	129
Light Sensors			
Diffraction Apparatus	DAK	vernier.com/dak	135
Light Sensor	LS-BTA	vernier.com/ls-bta	—
UVA Sensor	UVA-BTA	vernier.com/uva-bta	—
UVB Sensor	UVB-BTA	vernier.com/uvb-bta	—
Vernier Emissions Spectrometer	VSP-EM	vernier.com/vsp-em	132
Motion Detectors			
Go! Motion	GO-MOT	vernier.com/go-mot	109
Motion Detector	MD-BTD	vernier.com/md-btd	138
Photogate	VPG-BTD	vernier.com/vpg-btd	138
Power Amplifier	PAMP	vernier.com/pamp	130
Projectiles			
Projectile Launcher	VPL	vernier.com/vpl	131
Time of Flight Pad	TOF-VPL	vernier.com/tof-vpl	131
Radiation Monitor	VRM-BTD	vernier.com/vrm-btd	137
Rotary Motion Sensor	RMV-BTD	vernier.com/rmv-btd	130
Sound Sensors			
Microphone	MCA-BTA	vernier.com/mca-bta	138
Sound Level Meter	SLM-BTA	vernier.com/slm-bta	138
Sound Level Sensor	SLS-BTA	vernier.com/sls-bta	138
Temperature Sensors			
FLIR ONE™ Thermal Camera	FLIRONE-IOS	vernier.com/flirone-ios	133
Infrared Thermometer	IRT-BTA	vernier.com/irt-bta	—
Stainless Steel Temperature Probe	TMP-BTA	vernier.com/tmp-bta	66
Surface Temperature Sensor	STS-BTA	vernier.com/sts-bta	66
Voltage Probes			
30-Volt Voltage Probe	30V-BTA	vernier.com/30v-bta	—
Differential Voltage Probe	DVP-BTA	vernier.com/dvp-bta	136
Instrumentation Amplifier	INA-BTA	vernier.com/ina-bta	—
Voltage Probe	VP-BTA	vernier.com/vp-bta	—
Vernier Energy Sensor	VES-BTA	vernier.com/ves-bta	113

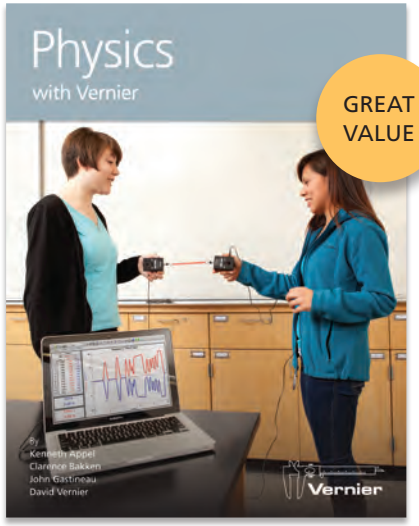
Go Direct Sensors

Complete sensing solution in each sensor—collect and stream data directly to your device.

Sensor	Order Code	URL	Page
NEW Go Direct 3-Axis Magnetic Field	GDX-3MG	vernier.com/gdx-3mg	139
NEW Go Direct Force and Acceleration	GDX-FOR	vernier.com/gdx-for	139
NEW Go Direct Light and Color	GDX-LC	vernier.com/gdx-lc	139
NEW Go Direct Motion	GDX-MD	vernier.com/gdx-md	139
NEW Go Direct Radiation Monitor	GDX-RAD	vernier.com/gdx-rad	139
NEW Go Direct Voltage	GDX-VOLT	vernier.com/gdx-volt	139

Physics Lab Books

Title	URL	Page
Physics with Vernier	vernier.com/pwv	120
Advanced Physics with Vernier—Mechanics	vernier.com/phys-am	122
Advanced Physics with Vernier—Beyond Mechanics	vernier.com/phys-abm	124
Physics with Video Analysis	vernier.com/pva	133
Amusement Park Physics	vernier.com/ampk	129



More Online
Learn more about the experiments in *Physics with Vernier* at www.vernier.com/pwv

Physics with Vernier

Appropriate for high school, this book explores a variety of physics topics. Vernier lab books are loaded with helpful experiment ideas, extensions, challenges, and more.

Electronic Version

PWV-E

When you buy the electronic version you receive

- 35 ready-to-use student experiments
- Access to up-to-date versions of the experiments
- Instructions for data collection with Logger *Pro*, LabQuest App, and EasyData
- Essential instructor information including teaching tips, suggested answers, and sample data and graphs
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Complete equipment and supplies list
- A generous site license—buy one book and duplicate the experiments for your class

Printed Lab Book

PWV

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Lab equipment for *Physics with Vernier*

- Dynamics Cart and Track System
- Picket Fence
- Springs Set
- Pulley Bracket
- Optics Expansion Kit
- Bumper and Launcher Kit
- Polarizer/Analyzer Set for Optics Expansion Kit
- Extech Digital DC Power Supply
- Friction Pad
- Independence of Motion Accessory
- Time of Flight Pad
- Vernier Circuit Board 2
- Projectile Launcher

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

Physics with Vernier contains the following experiments:

Ⓢ Ⓓ Using a Motion Detector
- Graph Matching
- Cart on a Ramp
- Determining *g* on an Incline
- Ball Toss

▶ Air Resistance
- Simple Harmonic Motion
- Energy of a Tossed Ball
- Energy in Simple Harmonic Motion
- Momentum, Energy, and Collisions
- Impulse and Momentum
- Back and Forth Motion
- Static and Kinetic Friction

Ⓢ Ⓓ Using a Force Sensor
- Newton's Second Law
- Newton's Third Law
- Static and Kinetic Friction
- Impulse and Momentum

Ⓢ Ⓓ Using a Microphone
- Sound Waves and Beats
- Tones, Vowels, and Telephones
- Mathematics of Music
- Speed of Sound

Ⓢ Ⓓ Using a Differential Voltage Probe
- Capacitors

Ⓓ Using Photogates
- Picket Fence Free Fall
- Projectile Motion
- Atwood's Machine
- Pendulum Periods

Ⓓ Using a Temperature Probe
- Newton's Law of Cooling

Ⓓ Using an Accelerometer

▶ Bungee Jump Accelerations
- Centripetal Accelerations on a Turntable
- Accelerations in the Real World
- Newton's Second Law

Ⓓ Using Current & Differential Voltage Probes
- Ohm's Law
- Series and Parallel Circuits
- Electrical Energy

Ⓓ Using a Magnetic Field Sensor
- The Magnetic Field in a Coil
- The Magnetic Field in a Slinky
- The Magnetic Field of a Permanent Magnet

Ⓓ Using a Light Sensor
- Polarization of Light
- Light, Brightness, and Distance

Ⓢ Starter Package Ⓓ Deluxe Package ▶ Video Online

LabQuest 2 and LabQuest Mini Packages for *Physics with Vernier*

LabQuest 2 Package

This package includes a LabQuest 2 interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest 2 with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.

Package Includes	Order Code	Ⓢ Starter Package LQ2-PHY-ST	Ⓓ Deluxe Package LQ2-PHY-DX
LabQuest 2 Interface	LABQ2	•	•
Motion Detector	MD-BTD	•	•
Dual-Range Force Sensor	DFS-BTA	•	•
Microphone	MCA-BTA	•	•
Differential Voltage Probe (×2)	DVP-BTA	•	•
Low-g Accelerometer	LGA-BTA	—	•
Light Sensor	LS-BTA	—	•
Vernier Photogates (×2)	VPG-BTD	—	•
Ultra Pulley Attachment	SPA	—	•
Picket Fence	PF	—	•
Stainless Steel Temperature Probe	TMP-BTA	—	•
Magnetic Field Sensor	MG-BTA	—	•
Current Probes (×2)	DCP-BTA	—	•

Ⓓ *Deluxe Package*

Ⓢ *Starter Package*

You may also want

Logger *Pro* 3 (LP)
See page 20.

LabQuest Viewer (LQ-VIEW)
See page 17.

LabQuest Mini Package

This package includes a LabQuest Mini interface and all sensors needed to conduct the experiments featured on the opposite page.

You may also replace LabQuest Mini with either of the following interfaces:

- LabQuest Stream (LQ-STREAM)
  See page 24.

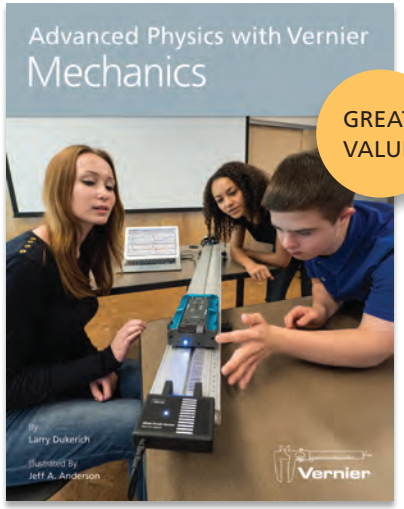
Package Includes	Order Code	Ⓢ Starter Package LM-PHY-ST	Ⓓ Deluxe Package LM-PHY-DX
LabQuest Mini Interface	LQ-MINI	•	•
Motion Detector	MD-BTD	•	•
Dual-Range Force Sensor	DFS-BTA	•	•
Microphone	MCA-BTA	•	•
Differential Voltage Probe (×2)	DVP-BTA	•	•
Low-g Accelerometer	LGA-BTA	—	•
Light Sensor	LS-BTA	—	•
Vernier Photogates (×2)	VPG-BTD	—	•
Ultra Pulley Attachment	SPA	—	•
Picket Fence	PF	—	•
Stainless Steel Temperature Probe	TMP-BTA	—	•
Magnetic Field Sensor	MG-BTA	—	•
Current Probes (×2)	DCP-BTA	—	•

Ⓓ *Deluxe Package*

Ⓢ *Starter Package*

You may also want

Logger *Pro* 3 (LP)
See page 20.



Advanced Physics with Vernier—Mechanics

Advanced Physics with Vernier—Mechanics is the first of a two-volume set of experiments for the more in-depth introductory physics course, such as college physics, AP* Physics, or IB† Physics.

More Online
Learn more about the experiments in *Advanced Physics with Vernier—Mechanics* at www.vernier.com/phys-am

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Electronic Version

PHYS-AM-E

When you buy the electronic version you receive

- Experiments designed for an interactive teaching style, with planned moments for instructor or student-led discussion
- Access to up-to-date versions of the experiments
- Essential instructor information including discussions about how to lead students to a successful activity
- Experiment extensions that challenge the most talented students
- Word-processing files of the student investigations so you can edit the files to match your teaching preferences
- A generous site license—buy one book and duplicate the experiments for your class
- Instructions for data collection with Logger *Pro* or LabQuest App

Printed Lab Book

PHYS-AM

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Advanced Physics with Vernier—Mechanics contains the following experiments:

Experiment		Sensors Used	Lab Equipment Used
1	Motion on an Incline	Motion Detector	Dynamics Cart and Track System
2	Error Analysis	Vernier Photogate	Picket Fence
3	Newton's First Law	Motion Detector	Dynamics Cart and Track System, Bumper and Launcher Kit, Friction Pad
4	Newton's Second Law	Vernier Photogate, Dual-Range Force Sensor	Dynamics Cart and Track System, Cart Picket Fence, Ultra Pulley and Bracket
5	Newton's Third Law	(2) Dual-Range Force Sensors	Dynamics Cart and Track System, Bumper and Launcher Kit
6	Projectile Motion	Video Analysis in Logger *Pro*	—
7	Energy Storage and Transfer (Elastic)	Dual-Range Force Sensor	Dynamics Cart and Track System, Bumper and Launcher Kit
8	Energy Storage and Transfer (Kinetic)	Vernier Photogate	Dynamics Cart and Track System, Bumper and Launcher Kit, Cart Picket Fence
9	Energy Storage and Transfer (Gravitational)	—	Dynamics Cart and Track System, Bumper and Launcher Kit
10A	Impulse and Momentum	Motion Detector, Dual-Range Force Sensor	Dynamics Cart and Track System, Bumper and Launcher Kit
10B	Impulse and Momentum	Vernier Photogate, Dual-Range Force Sensor	Dynamics Cart and Track System, Bumper and Launcher Kit, Cart Picket Fence
11A	Momentum and Collisions	(2) Motion Detectors	Dynamics Cart and Track System
11B	Momentum and Collisions	(2) Vernier Photogates	Dynamics Cart and Track System, (2) Cart Picket Fence
12A	Centripetal Acceleration	Vernier Photogate, Dual-Range Force Sensor	Centripetal Force Apparatus
12B	Centripetal Acceleration	Vernier Photogate, Dual-Range Force Sensor	—
13	Rotational Dynamics	Rotary Motion Sensor	Rotational Motion Accessory Kit
14	Conservation of Angular Momentum	Rotary Motion Sensor	Rotational Motion Accessory Kit
15	Simple Harmonic Motion - Mathematical Model	Motion Detector	Springs Set
16	Simple Harmonic Motion - Kinematics and Dynamics	Motion Detector, Dual-Range Force Sensor	Springs Set
17	Pendulum Periods	Rotary Motion Sensor	Rotational Motion Accessory Kit
18	Physical Pendulum	Rotary Motion Sensor	Rotational Motion Accessory Kit
19	Center of Mass	Video Analysis in Logger *Pro*	—

Products for *Advanced Physics with Vernier—Mechanics*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

			Order Code
Sensors	Motion Detector		MD-BTD
	Vernier Photogate		VPG-BTD
	Dual-Range Force Sensor		DFS-BTA
	Rotary Motion Sensor		RMV-BTD
Lab Equipment	*Choose one:*	Dynamics Cart and Track System	DTS
		Dynamics Cart and Track System with Motion Encoder	DTS-EC
	Bumper and Launcher Kit		BLK
	Cart Friction Pad for Dynamics Cart and Track System		DTS-PAD
	Picket Fence		PF
	Cart Picket Fences		PF-CART
	Rotational Motion Accessory Kit		AK-RMV
	Centripetal Force Apparatus		CFA
	Springs Set		SPRINGS

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

You may also want

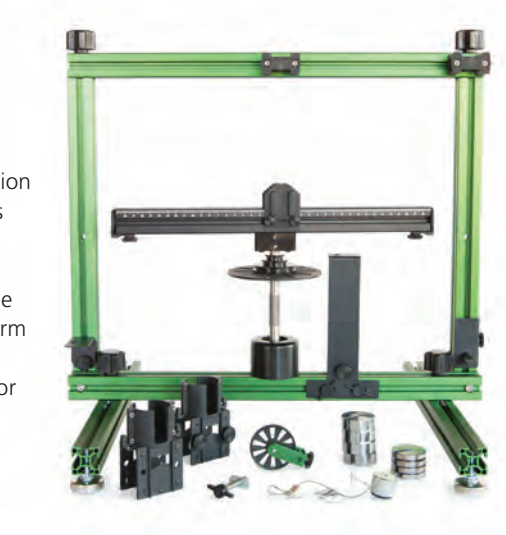
LabQuest Viewer (LQ-VIEW)
See page 17.

Centripetal Force Apparatus

CFA*

The Centripetal Force Apparatus allows you to investigate relationships between mass, radius, tension force, and angular velocity. A force sensor measures the tension force exerted on a mass as it moves in a circle. A photogate can be used to measure the angular speed. Different masses can be added to the platform and positioned at variable radii. The platform can be driven by a falling mass. The apparatus also accommodates the Vernier Wireless Dynamics Sensor System to measure force, which provides the best set of data. Sensors are sold separately. For more information, visit www.vernier.com/cfa

*Additional shipping charges may apply due to weight.



GREAT VALUE

Advanced Physics with Vernier—Beyond Mechanics

Advanced Physics with Vernier—Beyond Mechanics is the second of a two-volume set of experiments for the more in-depth introductory physics course, such as college physics, AP* Physics, or IB† Physics.

More Online
Learn more about the experiments in *Advanced Physics with Vernier—Beyond Mechanics* at www.vernier.com/phys-abm

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Electronic Version

PHYS-ABM-E

When you buy the electronic version you receive

- Complete student experiments with a materials list, instructions for data collection with Logger *Pro* or LabQuest App, data tables, and questions
- Access to up-to-date versions of the experiments
- Teacher Information section for each experiment with complete directions for setting up experiments, helpful hints, sample graphs, and data
- Word-processing files of the student experiments, so you can edit the files to match your teaching preferences
- Electronic support material including videos

Printed Lab Book

PHYS-ABM

When you buy the printed lab book you receive

- All of the resources listed for the electronic version, plus a printed copy of the book

Advanced Physics with Vernier—Beyond Mechanics contains the following experiments:

Experiment		Sensors Used	Lab Equipment Used
1	Behavior of a Gas	Gas Pressure Sensor, Stainless Steel Temperature Probe	—
2	Heat Engines	Gas Pressure Sensor, Stainless Steel Temperature Probe	—
3	Standing Waves on a String	Power Amplifier	Power Amplifier Accessory Speaker
4	Standing Waves in a Column of Air	Microphone	—
5	Doppler Effect with Water Waves	—	—
6	Electrostatics	Charge Sensor	Electrostatics Kit
7	Coulomb's Law	—	—
8	Mapping Electric Potential	Differential Voltage Probe	Power Amplifier or Power Supply
9	Factors Affecting Resistance	Instrumentation Amplifier, Current Probe‡	Power Amplifier or Power Supply, Resistivity Rod Set
10	Series and Parallel Circuits	Differential Voltage Probe, Current Probe	Vernier Circuit Board 2
11	Faraday's Law—Moving Magnet	Instrumentation Amplifier	—
12	Faraday's Law—Alternating Current	Instrumentation Amplifier	Power Amplifier
13	Capacitors and Inductors	Differential Voltage Probe, Current Probe	Vernier Circuit Board 2
14	RLC Circuits	Differential Voltage Probe, Current Probe	Power Amplifier, Vernier Circuit Board 2
15	Curved Mirrors and Images	—	Optics Expansion Kit, Mirror Set§
16	Thin Lenses and Real Images	—	Optics Expansion Kit§
17	Thin Lenses and Virtual Images	—	Optics Expansion Kit§
18	Aperture and Depth of Field	—	Optics Expansion Kit§
19	Interference	Diffraction Apparatus§	—
20	Diffraction	Diffraction Apparatus§	—
21	Spectrum of Atomic Hydrogen	Vernier Emission Spectrometer, Vernier Emissions Fiber	Emission Tubes, Spectrum Tube Power Supply (single tube or carousel)
22	Planck's Constant	Differential Voltage Probe, Current Probe	Power Amplifier

‡ Current Probe needed if using a conventional power supply. § These accessories require the Combination Track/Optics Bench (order code TRACK, page 132).

Products for *Advanced Physics with Vernier—Beyond Mechanics*

Standard Sensors

Use these sensors to conduct the experiments featured on the opposite page. Sensors connect to a LabQuest 2 or other compatible interface.

- LabQuest 2 (LABQ2)
  See page 14.
- LabQuest Stream (LQ-STREAM)
  See page 24.
- LabQuest Mini (LQ-MINI)
  See page 18.

		Order Code
Sensors	Gas Pressure Sensor	GPS-BTA
	Stainless Steel Temperature Probe	TMP-BTA
	Power Amplifier	PAMP
	Microphone	MCA-BTA
	Charge Sensor	CRG-BTA
	Differential Voltage Probe	DVP-BTA
	Current Probe	DCP-BTA
	Instrumentation Amplifier	INA-BTA
	Emissions Spectrometer	VSP-EM
	Vernier Emissions Fiber	VSP-EM-FIBER
	Diffraction Apparatus	DAK
Lab Equipment	Power Amplifier Accessory Speaker	PAAS-PAMP
	Electrostatics Kit	ESK-CRG
	Resistivity Rod Set	RRS
	Vernier Circuit Board 2	VCB2
	Optics Expansion Kit	OEK
	Mirror Set	M-OEK
	Spectrum Tube Single Power Supply	ST-SPS
	Hydrogen Spectrum Tube	ST-H

Software option

For computers

Logger *Pro* 3 (LP)
See page 20.

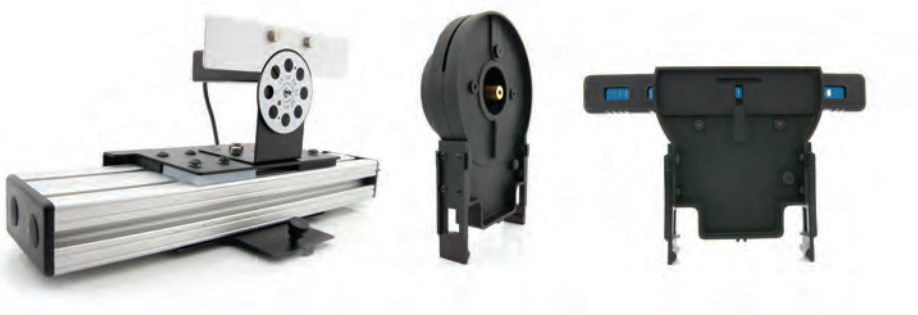
You may also want

LabQuest Viewer (LQ-VIEW)
See page 17.

Diffraction Apparatus

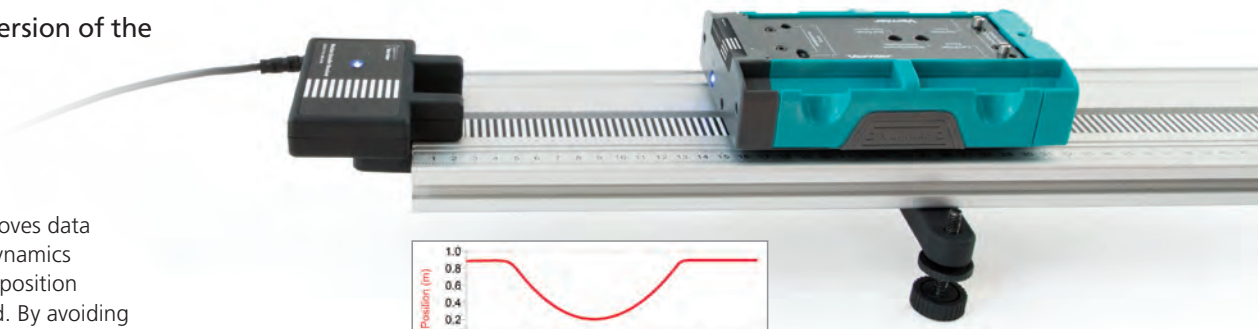
DAK

The Diffraction Apparatus consists of a laser light source, a collection of diffraction and interference slits, and a novel Linear Position Sensor and High Sensitivity Light Sensor. Map light intensity versus position for many slit geometries. Mounts on a Combination Track/Optics Bench (not included).



One Dynamics System; Two Ways to Collect Data

Purchase either the Motion Encoder or Motion Detector version of the Dynamics Cart and Track System.



VERNIER EXCLUSIVE
The Motion Encoder†

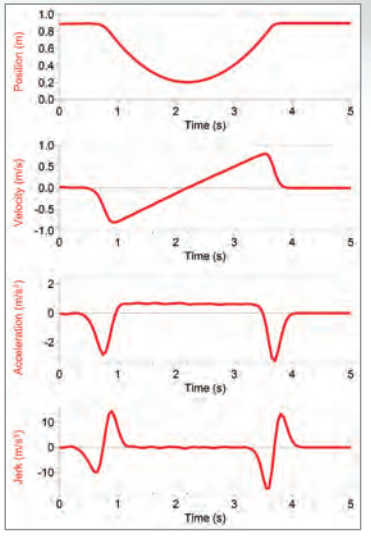
The Motion Encoder's innovative optical motion sensor dramatically improves data quality and simplifies experiment setup. An optical sensor beneath the dynamics cart senses the passage of the cart over a marked strip on the track. The position information is sent as an encoded IR signal to a receiver at the track's end. By avoiding the possibility of stray sound reflections, this optical-only system provides excellent, repeatable, and noise-resistant motion data.

Because the position information is relayed by a narrow IR beam, multiple Motion Encoder Carts can be used in a single lab. Two carts can even be used at the same time on a single track, allowing students to study collisions.

If you have ever been frustrated by the need to tweak the alignment of a motion detector, you will be pleased by the data your students collect using the Vernier Motion Encoder. Get the Motion Encoder version of the Dynamics Cart and Track System if you want the best possible cart motion data. For details, see page 127.

† U.S. Patent No. 9,488,503

worlddidac AWARD 2014



Motion encoder data are so pristine that you can usefully graph jerk vs time.

A Traditional Motion Detector

The Motion Detector is the classic method for collecting position data. Use a Motion Detector bracket to measure cart motion for the entire length of the track. You can even use two Motion Detectors at once to study cart collisions.

Unlike the Motion Encoder, the Motion Detector can be used with experiments other than cart on track experiments. Students can graph their own walking motion, study pendulums, or graph a ball toss with a Motion Detector. If you want to use a Motion Detector for all motion experiments, get the Dynamics Cart and Track System without the Motion Encoder. For details, see page 127.

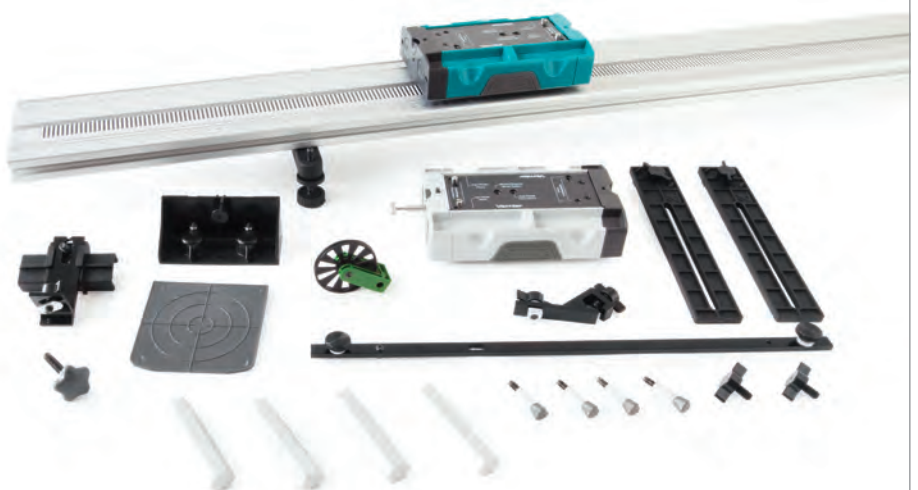
Dynamics Cart and Track System

DTS*

This cart and track system features the Combination 1.2 m Track/Optics Bench, two low-friction plastic carts (one standard and one with an adjustable plunger), and all of the necessary attachment accessories.

The Dynamics Cart and Track System includes

- Standard Cart with magnetic and hook-and-pile end caps
- Combination 1.2 m Track/Optics Bench
- Plunger Cart with magnetic and hook-and-pile end caps
- 4 hexagonal masses
- Mounting hardware for Dual-Range Force Sensor and accelerometers
- Adjustable End Stop
- 2 Adjustable Two-Foot Levelers
- Motion Detector Bracket
- Motion Detector Reflector Flag
- Rod Clamp
- 2 Photogate Brackets
- Ultra Pulley
- Pulley Bracket



Dynamics Cart and Track System with Motion Encoder

DTS-EC*

The Dynamics Cart and Track System with Motion Encoder is a revolutionary way for students to study dynamics. The Motion Encoder adds an optical position sensing system to record cart motion and eliminates the need for a motion detector for cart-on-track activities.

Dynamics Cart and Track System with Long Track

Both our Dynamics Cart and Track System and Dynamics Cart and Track System with Motion Encoder can be reconfigured to include a long track (2.2 m).

Dynamics Cart and Track System with Long Track

DTS-LONG*

Dynamics Cart and Track System with Motion Encoder and Long Track

DTS-EC-LONG*

Did you know?

The Dynamics Cart and Track System can be used year round. Simply add the Vernier Optics Expansion Kit to your Dynamics Cart and Track System to conduct optics experiments, such as image formation with lenses and light intensity *vs.* distance. You can even use the kit to build a basic telescope.

For more information, see page 134.

Motion Encoder Cart and Receiver

DTS-MEC

This kit includes a fully assembled Motion Encoder Cart, as well as the Motion Encoder Receiver and Motion Encoder Long Track Strip.

Tracks

Both of the Combination Dynamics Track and Optical Benches are anodized aluminum and include a metric scale. Extremely rigid, these tracks will not sag under use. The tracks include two adjustable two-foot levelers.

Combination 1.2 m Track/ Optics Bench

TRACK*

Combination 2.2 m Track/ Optics Bench

TRACK-LONG*

Friction Pad DTS

DTS-PAD

* Additional shipping charges may apply due to weight.

Fan Carts

The Fan Cart is a large fan on a lightweight cart. It offers students the ability to perform kinematics and dynamics experiments with constant acceleration, variable mass, variable thrust, and variable thrust angle.

The fan has three speeds for studying the effect of variable thrust. Two mass bars let you change the total mass of the cart to observe how mass affects acceleration. The fan turns on a protractor base, allowing the thrust to be directed at a known angle from the direction of travel. In this way, students can understand vector component applications.

A sail is included to perform the fan-on-a-sailboat experiment. The sail can be mounted in two positions to study the subtle effects of diverted airflow.

Although the cart can be used for qualitative experiments alone, most often it is used with sensors on a Dynamics Track.

Which fan cart is right for me?	
I collect data with the Vernier Motion Encoder System.	Buy the Encoder Fan Cart (CART-FEC).
I collect data with a Motion Detector.	Buy the Fan Cart (CART-F).
I have a Fan Cart but would like an Encoder Fan Cart.	Buy the Encoder Cart Upgrade Kit (FECT) to add to your existing Fan Cart. With a few minutes of work you can convert an existing cart to an Encoder Cart.

Fan Cart

CART-F

Use with a Motion Detector and the Vernier Dynamics System. The Fan Cart requires four AA batteries (not included).

Encoder Fan Cart

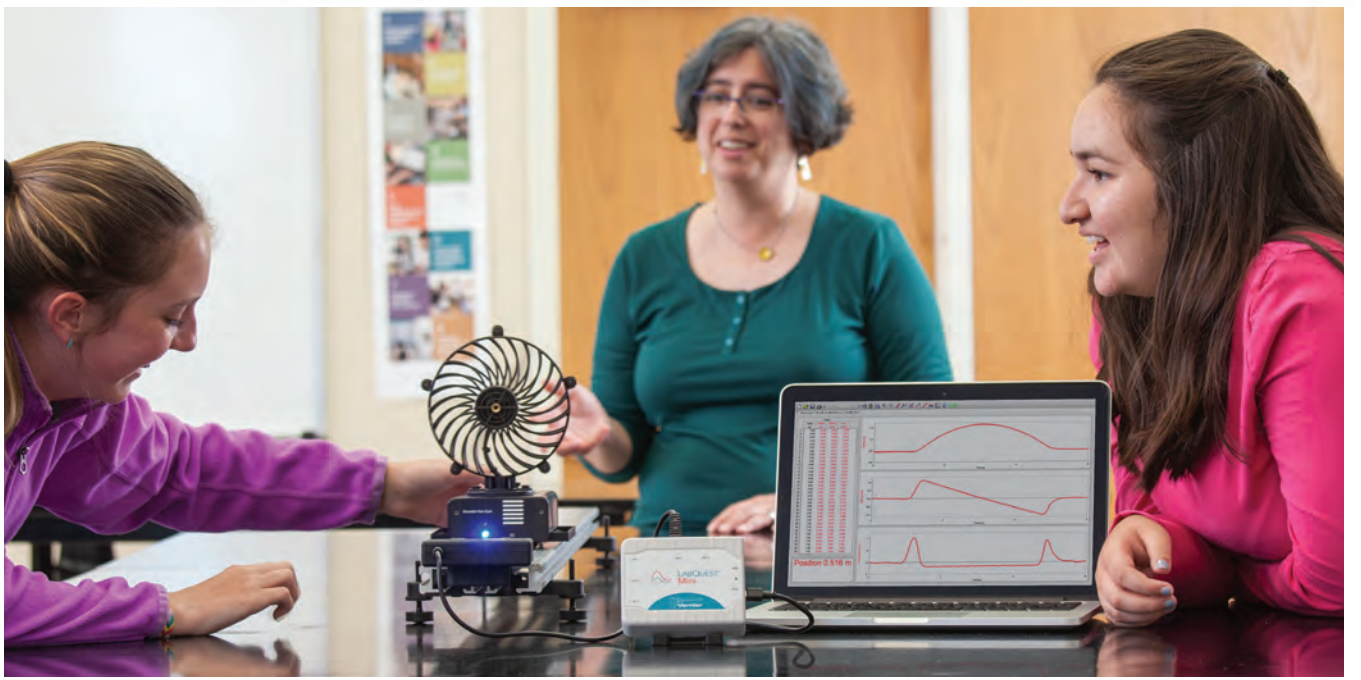
CART-FEC

Use with the Motion Encoder System. The Encoder Fan Cart requires four AA batteries (not included) and the Motion Encoder Transmitter requires two AAA batteries (not included).

Encoder Fan Cart Upgrade Kit

FECT

The Encoder Fan Cart Upgrade Kit is used to convert a Fan Cart to an Encoder Fan Cart. Two AAA batteries (not included) are required for the encoder transmitter.



Data collection with the Encoder Fan Cart

Bumper and Launcher Kit

BLK

The Bumper and Launcher Kit allows students to perform additional physics experiments using the Vernier Dual-Range Force Sensor, Vernier Wireless Dynamics Sensor System, and the Dynamics Cart and Track System. The kit includes

- Track bracket
- Dual-magnet bumper
- Force sensor mounting screw
- 2 magnetic bumpers
- 2 rubber bumpers
- 2 hoop bumpers
- 2 clay holders
- About 20 grams of clay

Track and Force Sensor not included.

Wireless Dynamics Sensor System

WDSS

The Wireless Dynamics Sensor System is the perfect tool for dozens of physics and physical science experiments such as collecting acceleration and altitude data on an amusement park ride.

The Wireless Dynamics Sensor System combines a 3-axis accelerometer, force sensor, and altimeter into one unit that communicates with your computer or LabQuest 2 via Bluetooth® wireless technology. You can also use it as a standalone data logger and retrieve the data into Logger *Pro* at a later time.

Includes a rechargeable battery* and charger, a bumper for collisions, hooks for mounting the unit in different positions, and mounting hardware for Vernier and other dynamics carts.

* The battery carries a one-year warranty.

You also need

Computer use

- Logger *Pro* 3 software
- Windows or macOS computer with compatible, built-in Bluetooth wireless technology *or* a Bluetooth USB Adapter

LabQuest use

- LabQuest 2 *or* original LabQuest with Bluetooth USB Adapter

This wireless sensor is not compatible with Graphical Analysis 4 software except when linked to a data sharing source.

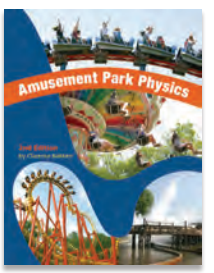
Students explore Newton's Second Law of Motion using the WDSS mounted on a dynamics cart.

Amusement Park Physics

AMPK

by Clarence Bakken

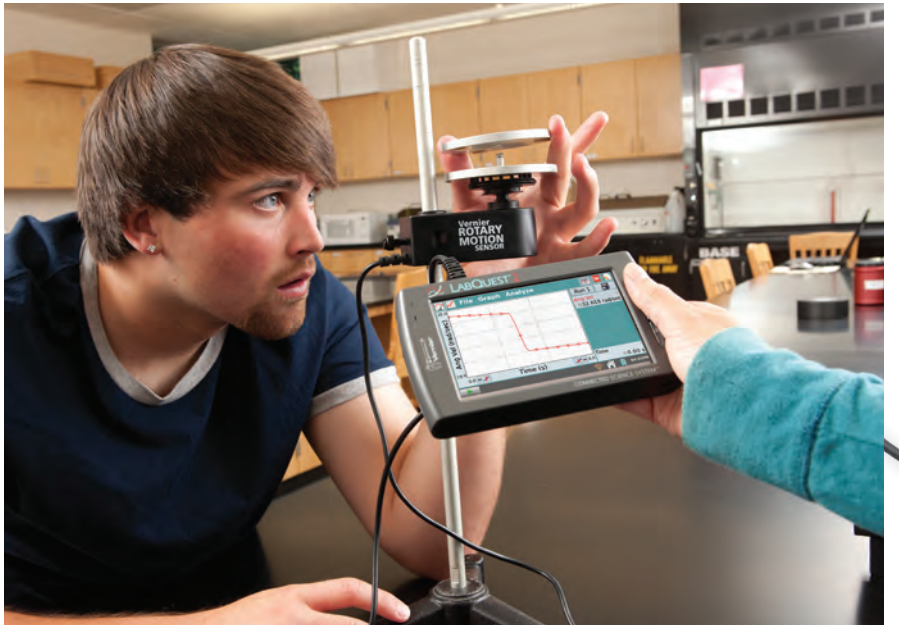
Amusement Park Physics is an excellent resource for teachers who want their students to connect their experiences at an amusement park to the physics concepts studied in class. The book explains how the instruments used to collect data, including electronic sensors, work on a conceptual level. A key portion of the book discusses taking your class to the amusement park and includes sample lab sheets and problem sets.



Data Vest

DV

The Data Vest makes hands-free data collection at an amusement park or playground easy. The vest has a front pouch for the LabQuest, CBL 2, or the Wireless Dynamics Sensor System. It has two inside pockets for the sensors and side straps to hold the vest in place.



Studying the Law of Conservation of Angular Momentum using the Rotary Motion Sensor and Rotational Motion Accessory Kit

Rotary Motion Sensor

RMV-BTD

Our Rotary Motion Sensor lets you monitor angular motion precisely and easily. It is direction sensitive and can be used to collect angular displacement, angular velocity, and angular acceleration data.

Power Amplifier Accessory Speaker

PAAS-PAMP

This kit includes a speaker and accessories that can be used with the Vernier Power Amplifier to study mechanical waves and springs. The speaker contains a lightweight metal disc glued to the speaker cone. A drive post attached to the metal plate allows you to drive elastic materials such as strings and springs.

Rotational Motion Accessory Kit

AK-RMV

This accessory kit is used to study the motion of a physical pendulum; the rotational inertia of disks, rings, and point masses; and the conservation of angular momentum.

Rotary Motion Motor Kit

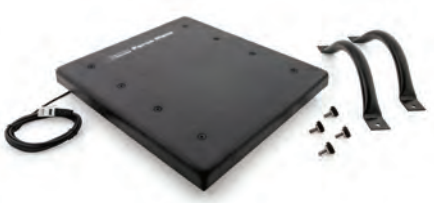
MK-RMV

The Rotary Motion Motor Kit includes a small electric motor with pulley, rubber band belt, motor clip, and mounting screw. The motor can be attached to the Rotary Motion Sensor and used as an analog tachometer or generator. You can also perform experiments that investigate motor efficiency in different conditions.

Force Plate

FP-BTA*

The Force Plate is a large force sensor—tough enough to jump on. About the size and shape of a bathroom scale, the Force Plate has two ranges: one reading up to 3500 N, and the other up to 800 N. Two handles are included for pushing or pulling. Additional pairs of handles are available (FP-HAN).



Power Amplifier

PAMP

The Vernier Power Amplifier allows you to drive loads with ±10 V and currents up to 1 A. It works with any waveform, including DC, sine, square, triangle, and sawtooth. The Power Amplifier can drive a variety of loads, including speakers, lamps, small DC motors, and RLC circuits.

Projectile Launcher

VPL*

Use the Vernier Projectile Launcher to investigate important concepts in two-dimensional kinematics. Launch steel balls at angles from 0 to 70° and up to a distance of 2.5 m. A unique pneumatic launching system provides excellent repeatability and allows you to adjust the launch speed. Built-in photogates and angle markings provide easy and accurate measurement of the ball's launch velocity, allowing for precise quantitative analysis of projectile motion.

Includes: launcher, six steel balls, hand pump, two pairs of goggles, level, roll of waxed marking paper, photogate cable

The Projectile Launcher and accessories are used in *Physics with Vernier* experiments.

More Online
For more information on the Projectile Launcher, visit www.vernier.com/vpl

Measuring the time of flight of a projectile

Projectile Stop

PS-VPL

The Projectile Stop has one job: to keep the projectiles from the Vernier Projectile Launcher from rolling out of sight. Place the Projectile Stop in the launch line, beyond the landing site, and it will catch the projectile.

Time of Flight Pad

TOF-VPL

The Time of Flight Pad is used to precisely measure how long a projectile has been in motion. Use it with the Vernier Projectile Launcher and a Vernier interface to determine the launch speed of a projectile, along with the time the projectile is in flight.

Independence of Motion Accessory

IOM-VPL

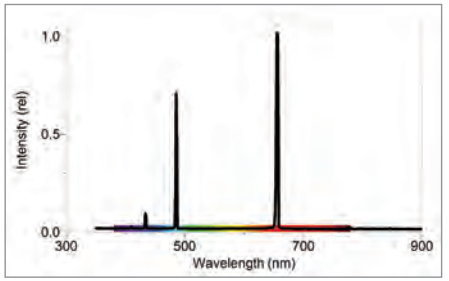
The Independence of Motion Accessory enables the Vernier Projectile Launcher to perform the classic experiment where one ball is dropped as another is projected horizontally. The balls strike the floor simultaneously.

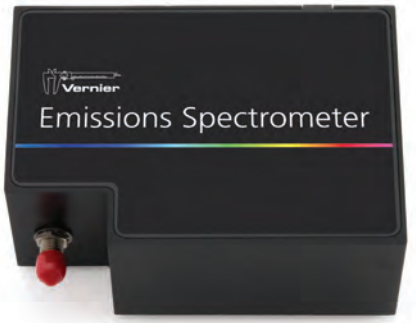
* Additional shipping charges may apply due to weight.

Vernier Emissions Spectrometer

VSP-EM

This is the perfect device to conduct emissions analysis. It connects directly to your computer or LabQuest with a standard USB cable (included) and gives precise measurements over a range of 350–900 nm. Use the Vernier Emissions Spectrometer with or without an optical fiber to examine spectra of light bulbs, spectrum tubes, or the sun.





Analyzing gas tube emission spectra

Spectrum Tube Carousel Power Supply

ST-CAR

The Spectrum Tube Carousel Power Supply features the same ultra-safe, patented design of the Spectrum Tube Single Power Supply version but holds eight gas spectrum tubes simultaneously. You can quickly switch from one gas to another without handling the tubes. Includes a Spectrum Tube Fiber Optic Holder.

Vernier Emissions Fiber

VSP-EM-FIBER

This 400 µm diameter optical fiber is used to pipe light from sources to a spectrometer. For a list of compatible spectrometers, see www.vernier.com/vsp-em-fiber

Spectrum Tube Single Power Supply

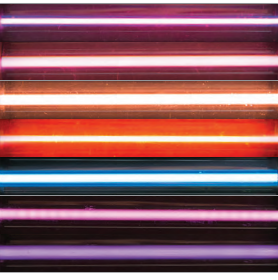
ST-SPS

The Spectrum Tube Single Power Supply provides an ultra-safe means of generating gas discharges. One tube is energized at a time, and there are storage slots for six more tubes. Includes a Spectrum Tube Fiber Optics Holder.

Spectrum Tubes

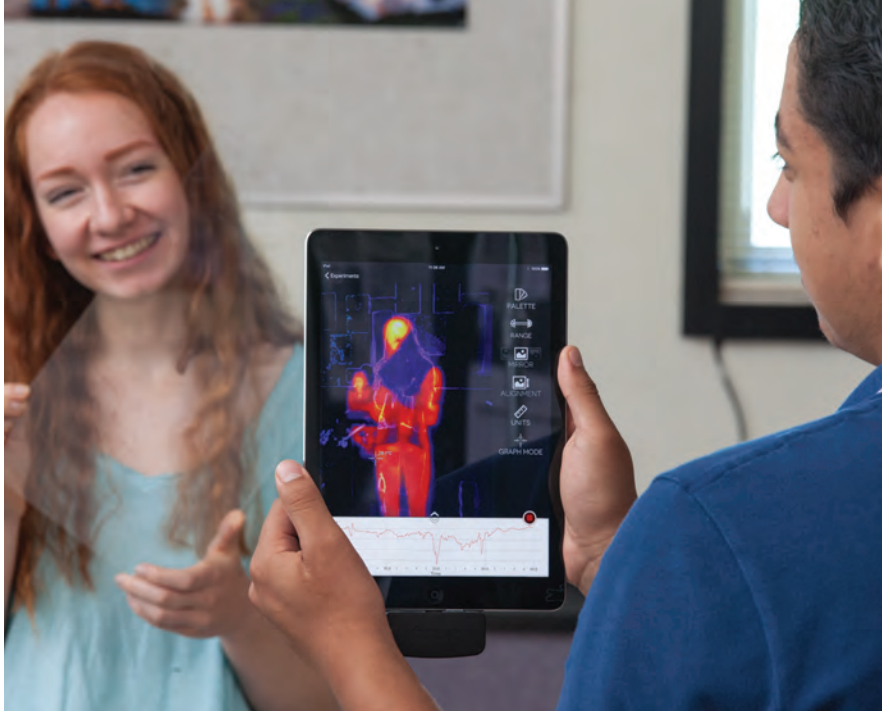
Spectrum Tubes are permanently enclosed in protective plastic carriers, with no exposed high voltage. There are no through-the-glass electrodes, so tubes are long lasting. All Spectrum Tubes are sold separately:

Hydrogen	ST-H
Nitrogen	ST-N
Helium	ST-HE
Neon	ST-NE
Carbon Dioxide	ST-CO2
Air	ST-AIR
Argon	ST-AR



Spectrum Tubes carry a two-year warranty.*

*** Two years or 40 hours, whichever comes first, on the hydrogen tube. Two years or 100 hours, whichever comes first, on all other gas tubes.**



Investigating transmission of infrared light using Thermal Analysis and the FLIR ONE Thermal Camera

Thermal Analysis App

Our free Thermal Analysis app offers students a fun and engaging way to study thermal energy. Using Thermal Analysis, students can observe temperature changes on the skin, illustrate convection, track heating due to friction, compare heat conduction in different materials, analyze the transparency of materials in infrared *vs.* visible light, and so much more.

Download on the App Store

FLIR ONE™ Thermal Camera

FLIRONE-IOS

FLIR ONE uses patented MSX technology for superior image quality. Every time you capture a thermal reading with the FLIR ONE, you are also taking a standard picture. This picture will provide physical detail to the raw thermal reading. FLIR ONE for iOS easily connects to an iPhone, iPad, or iPod touch with a Lightning® connector.

Video Physics™

Vernier Video Physics brings video analysis to iPad®, iPhone®, and iPod touch®. Track an object automatically, set the scale, and see graphs of trajectory, position, and velocity.

For more details, see page 26.

Download on the App Store

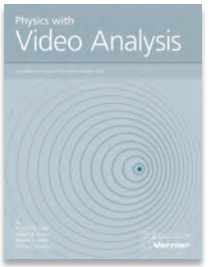
AWARDS of EXCELLENCE winner! TECH LEARNING

//CODiE// 2012 SIIA CODIE FINALIST

Physics with Video Analysis

PVA

by Priscilla Laws, Robert Teese, Maxine Willis, and Patrick Cooney



Physics with Video Analysis lab book contains a wide selection of Logger *Pro* video analysis activities for introductory physics at either the high school or college level. Topics include kinematics, dynamics, circuits, sound, electrostatics, and more. Includes professionally made videos, student activities, solutions, and Logger *Pro* setup files.

More Online

Free sample activities and videos are available on our website at www.vernier.com/pva

Additional Physics Books and Activities

For details on the following books, go to www.vernier.com/books and click Physics.

- *A Den of Inquiry Volume 1*
- *A Den of Inquiry Volume 2*
- *RealTime Physics Tools for Scientific Thinking*
- *RealTime Physics*
- *Workshop Physics*
- *Understanding Physics*
- *MBL Interactive Lecture Demonstrations*

Vernier Optics System

Expand the use of your Dynamics Cart and Track Systems by adding these optics products.

Optics Expansion Kit

OEK

Add the Optics Expansion Kit to your dynamics track to conduct optics experiments, such as image formation with lenses and light intensity *vs.* distance. You can even use the kit to build a basic telescope.

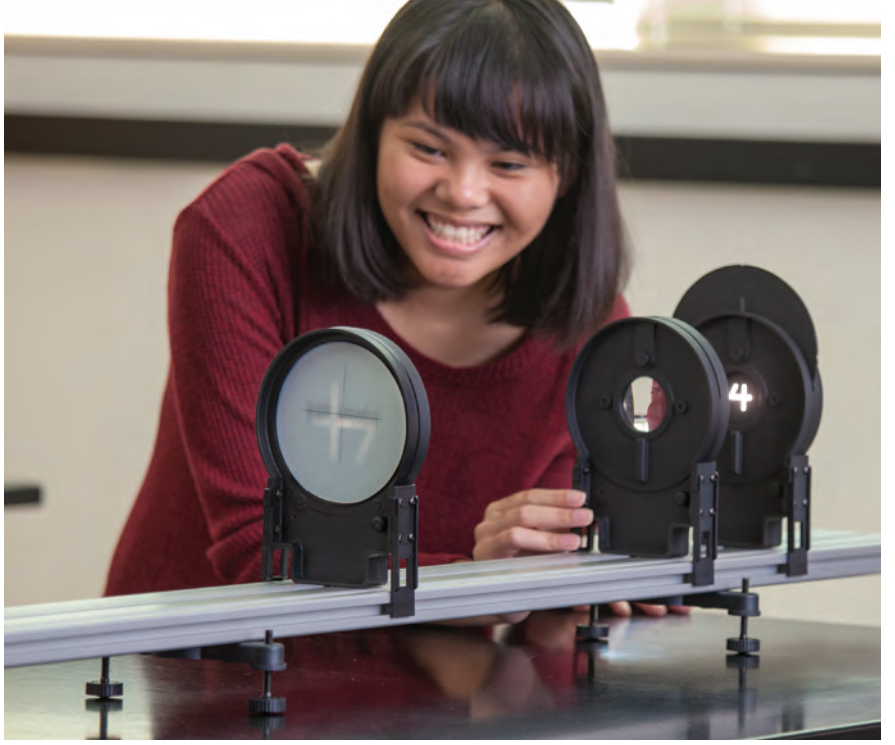
Vernier Optics Expansion Kit includes

- 3 lens holders with bases (100 mm converging lens, 200 mm converging lens, –150 mm diverging lens)
- Screen, holder, and base
- Combination luminous and point light source
- Light Sensor holder
- Aperture screen
- Power supply

The Optics Expansion Kit extends the capabilities of the Vernier dynamics system track (sold separately).

The Optics Expansion Kit is used in *Physics with Vernier* and *Advanced Physics with Vernier—Beyond Mechanics* experiments.

More Online
Download free sample experiments online at www.vernier.com/oek



Viewing an inverted image using a single thin lens from the Optics Expansion Kit mounted on the Combination 1.2 m Track/Optics Bench

Mirror Set

M-OEK

The Mirror Set for the Optics Expansion Kit extends the kit to allow students to easily study image formation by concave and convex mirrors. Includes a concave mirror, a convex mirror, and a half screen for viewing images formed by the mirrors. Requires components from the Optics Expansion Kit for use.

Combination 1.2 m Track/ Optics Bench

TRACK*

The Combination Dynamics Track/Optics Bench is anodized aluminum and includes a metric scale. Extremely rigid, this 1.2 m track will not sag under use. The track includes two adjustable levelers.

*Additional shipping charges may apply.

Diffraction Apparatus

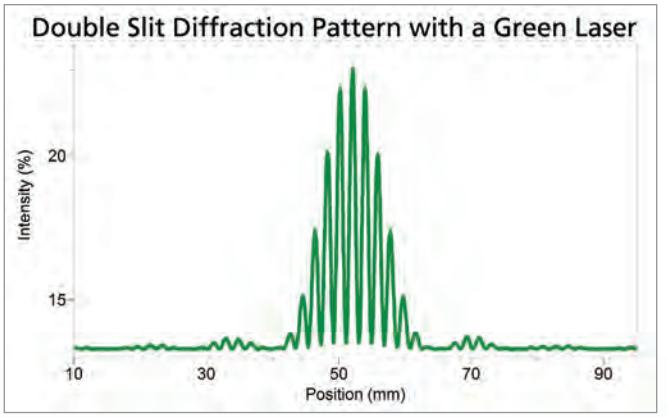
DAK

The Diffraction Apparatus lets students create, view, and measure diffraction and interference patterns. The included Red Diffraction Laser provides a clean monochromatic light source. High-precision slits with fully opaque blocking areas cast clear diffraction and interference patterns, which are ideal for quantitative analysis of intensity *vs.* position.

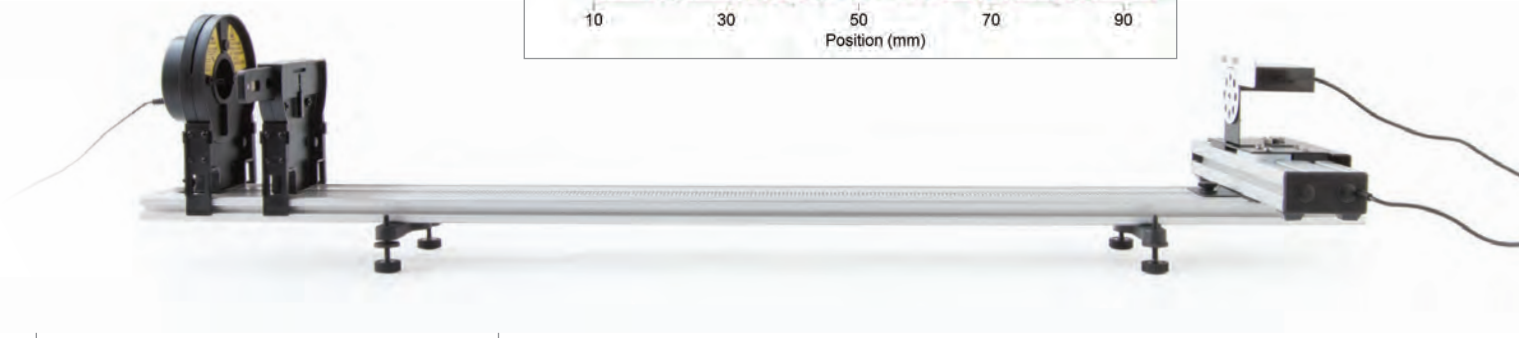
The High Sensitivity Light Sensor is mounted on a Linear Position Sensor, which uses a precision optical encoder to measure translation with better than a 50 µm resolution.

The Diffraction Apparatus requires a Combination 1.2 m Track/Optics Bench, which is available individually or as part of the Dynamics Cart and Track System. An optional Green Diffraction Laser is also available, so that the effect of wavelength on the pattern can be measured.

More Online
Visit www.vernier.com/dak



Double-slit diffraction pattern created with 0.04 mm slits separated by 0.25 mm and a 532 nm laser



Green Diffraction Laser

GDL-DAK

The Green Diffraction Laser is an optional accessory for the Diffraction Apparatus.

More Online
For more information, go to www.vernier.com/gdl-dak

Polarizer/Analyzer Set

PAK-OEK

The Polarizer/Analyzer Set allows students to study light polarization, doing experiments such as Malus's law. The set consists of three adjustable linear polarizers, one of which includes attachment points for the Vernier Rotary Motion Sensor.

The Polarizer/Analyzer Set is used in *Physics with Vernier* experiments.

More Online
See www.vernier.com/pak-oek

Color Mixer

CM-OEK

The Color Mixer accessory consists of a three-color LED source, a lens, and a screen. These all attach to a Combination Track/Optics Bench (sold separately) and can be used to study the mixing of red, blue, and green light by additive and subtractive mixing. These simple experiments show how modern computer and television displays work.

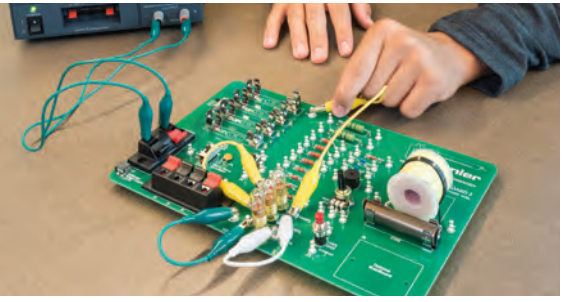
More Online
Download a free sample experiment at www.vernier.com/cm-oek

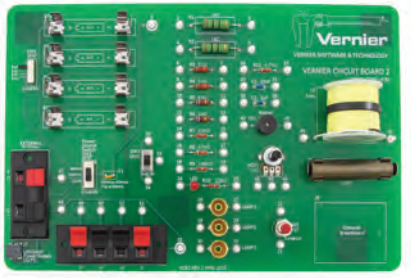
Vernier Circuit Board 2

VCB2

The Vernier Circuit Board 2 is a basic electricity lab on a board. The turret terminals for every component make it easy to connect basic series and parallel circuits, examine the behavior of different components, and investigate RLC circuits. The Vernier Circuit Board 2 includes 10 bulbs, a resettable fuse, three powering options, 10 alligator clip leads, terminal clips to add your own components, and pre-installed components.

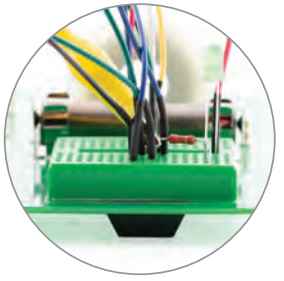
The Vernier Circuit Board is used in *Physics with Vernier* and *Advanced Physics with Vernier—Beyond Mechanics* experiments.





NEW Optional Breadboard Kit

VCB2-OBBK



Install this small breadboard to easily conduct experiments using additional electronic components not permanently mounted on the Vernier Circuit Board 2. The Optional Breadboard Kit contains various components to get you started.

With this kit, you can create blinking LED circuits with the 555 timer, introduce students to transistors, or make a simple light-sensing circuit. Included wires connect to both the breadboard and the Vernier Circuit Board 2 components. Additional jumper wires for breadboard use only are also provided.

Did you know?

Teach your students how to build a simple timer circuit using the Optional Breadboard Kit for the Vernier Circuit Board 2. For more information, visit www.vernier.com/innovate/build-a-simple-timer-circuit

Differential Voltage Probe

DVP-BTA

The Differential Voltage Probe is designed for exploring the basic principles of electricity. Use this probe to measure voltages in low voltage AC and DC circuits.

Current Probe

DCP-BTA

The Current Probe can be used to measure currents in low-voltage AC and DC circuits or for electrochemistry experiments.

Extech Digital DC Power Supply

EXPS*

The Extech® Digital DC Power Supply has three outputs: adjustable 0–30 V at 0–3 A, fixed 5 V, and fixed 12 V. It provides constant current or constant voltage modes and has overload and short circuit protection. Binding post terminals are provided for the variable supply. Easy snap terminals are provided for the 5 V and 12 V outputs. The front panel contains digital voltage and current meters for the variable output, so you won't need additional metering in a typical experiment. The Extech Digital DC Power Supply comes with a one-year warranty.

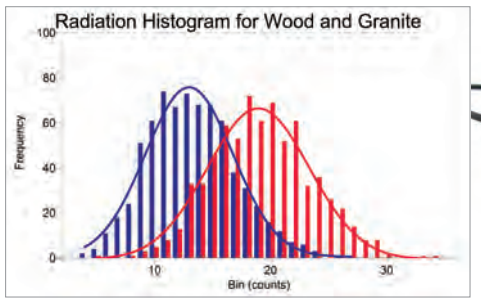
The Extech Digital DC Power Supply is used in *Physics with Vernier* and *Advanced Physics with Vernier—Beyond Mechanics* experiments.

* Additional shipping charges may apply due to weight.

Vernier Radiation Monitor

VRM-BTD

The Vernier Radiation Monitor detects alpha, beta, gamma, and X-ray radiation using a Geiger-Mueller tube. Use the Radiation Monitor for experiments in nuclear counting statistics, shielding, and decay rate measurements. Each new detection is indicated by a flashing red LED and can also include an optional audio signal. No battery is required, as the Radiation Monitor gets power from the interface, such as LabQuest 2.



Count histograms for wood (blue) and granite (red) countertops show the slight natural radioactivity of granite.

Charge Sensor

CRG-BTA

The Charge Sensor is used as an electronic electroscope. An extremely high impedance voltage sensor with a 0.01 µF input capacitor makes quantitative measurements possible in many electrostatics experiments. The sensor has three operating ranges and a zeroing switch to discharge the input capacitor. For more information, visit www.vernier.com/crg-bta

Electrostatics Kit

ESK-CRG

The Electrostatics Kit is an accessory for the Vernier Charge Sensor. This kit allows students to perform a range of experiments in electrostatics, including the use of Faraday's Pail, quantitative and qualitative measurement of charge, charging by friction, charging by contact, and charging by induction. The kit includes

- Faraday Pail and cage
- Grounding plane
- Grounding wires and wrist strap
- Charge producers and proof plane
- Wool, vinyl, nylon rod, and PVC rod
- Cotton cloth

High-Voltage Electrostatics Kit

HVEK-CRG

The High-Voltage Electrostatics Kit is an accessory for the Vernier Charge Sensor. Use it with a Faraday Pail and the Charge Sensor to investigate the distribution of charge on a sphere, transfer of charge on contact between two spheres, and charging by induction. The kit includes an electrostatics voltage source (output 750, 1500, 3000, 6000 VDC) and two conducting spheres. Extremely low output current makes this device safe for classroom use.

Accelerometers

Low-g Accelerometer

LGA-BTA

This is the best choice for most experiments. Use it for studying the one-dimensional motion of a car (real and toy), elevator, pendulum bob, or amusement park ride.

Range	±50 m/s^2

3-Axis Accelerometer

3D-BTA

Use this to study the complex motion of an amusement park ride, a bungee jump, or simply a toss in the air.

Range	±50 m/s^2

25-g Accelerometer

ACC-BTA

Choose this for studying one-dimensional collisions or any motion with larger accelerations.

Range	±250 m/s^2

Motion Detector

MD-BTD

The Motion Detector uses ultrasound to measure the position of carts, balls, people, and other objects.

- Measure objects as close as 15 cm and as far away as 6 m.
- Sensitivity switch reduces noise and produces higher quality data for studying dynamics carts on tracks.
- Attaches easily to the Vernier Dynamics System.
- Pivoting head allows for flexibility in the experimental setup.

Can be used with LabQuest, LabQuest 2, LabQuest Mini, LabPro, and CBL 2. Not supported with Go! Link or EasyLink.

Range	0.15 to 6 m
Resolution	1 mm

Dual-Range Force Sensor

DFS-BTA

Our Dual-Range Force Sensor can be easily mounted on a ring stand or dynamics cart or used as a replacement for a hand-held spring scale.

Ranges	±10 N, ±50 N
Resolution	0.01 N, 0.05 N

Microphone

MCA-BTA

Use our Microphone to display and study the waveforms of sounds from voices and musical instruments. It is also appropriate for speed of sound experiments.

Photogate

VPG-BTD

Use the Vernier Photogate to study free fall, rolling objects, collisions, and pendulums.

- Use the built-in laser detector to create a photogate through which you could drive a truck.
- Connect up to four gates in a chain.
- Includes an accessory rod for attachment to a ring stand or for adding the Ultra Pulley Attachment.

Sound Level Sensors

Sound Level Sensor

SLS-BTA

The Sound Level Sensor allows you to easily measure sound level in decibels (dB) in many school settings. It is A-weighted, meaning it responds to sound loudness the same way the human ear does. It measures sound level to within 3 dB along a single range from 55 to 110 dB, with no need to switch between ranges during an experiment. When used with a Vernier interface, you can monitor classroom sound levels, measure reverberation time, and investigate sound insulation.

If you are interested in collecting sound waveforms, use the Vernier Microphone.

Range	55 to 110 dB
Accuracy	±3 dB
Resolution	0.1 dB
Frequency range	30 to 10,000 Hz

Sound Level Meter

SLM-BTA

Measure sound level in decibels (dB) with our Sound Level Meter. A switch on the meter is used to select dBA or dBC weighting. The Sound Level Meter also has an LCD panel, which allows you to use it as a standalone device. Maximum Level Hold switch makes it possible to store the highest sound level in standalone mode.

Ranges	35 to 90 dB, 75 to 130 dB
Accuracy	±1.5 dB at 94 dB
Frequency range	31.5 to 8,000 Hz

NEW Go Direct™

Are Go Direct sensors right for you?

Our new Go Direct sensors offer total versatility. Students can easily collect and stream data on any device via Bluetooth® or USB—no interface required.

Our free Graphical Analysis 4 software supports our Go Direct sensors. This software is available for Windows, macOS, Chromebook,™ Android,™ and iOS. Full support for the typical physics curriculum in Graphical Analysis 4 will be available later in 2017.

Go Direct sensors are perfect for educators who

- Are just getting started with data collection, own a few sensors, and are doing only basic experiments in physics. Costs are lower since no interface is required.
- Have some standard Vernier sensors. Most standard sensors can be used alongside the new Go Direct Sensors in Graphical Analysis 4.

Give us a call, and we can help you think through the decision. Logger *Pro* has the full feature set that has made it popular, and Graphical Analysis 4 with Go Direct sensors, with its multi-platform support, is rapidly growing in capability. Either way, you will get the same Stellar Service from Vernier.

NEW Go Direct 3-Axis Magnetic Field

GDX-3MG

This sensor measures the components of the magnetic field along three orthogonal axes. Students can also measure the field along just two axes, or only one axis, choosing the direction that is best for the experiment. Its range allows students to study the Earth's magnetic field or investigate magnetic fields of permanent magnets, electromagnets, and solenoids.

NEW Go Direct Force and Acceleration

GDX-FOR

Go Direct Force and Acceleration includes a 3-axis accelerometer and 3-axis gyroscope. Take it on a roller coaster, swing, or slide. Suspend several Go Direct Force and Acceleration Sensors from the ceiling to perform a 3-D vector force experiment, or attach a string to the hook and whirl it in a horizontal or vertical circle. In wireless mode, your imagination is the only limiting factor!

NEW Go Direct Motion

GDX-MD

This sensor accurately measures distance to an object using ultrasonic pulses, and its built-in temperature compensation adjusts for the speed of sound in different environments. Students can use Go Direct Motion with graph matching to kinesthetically experience position and velocity. Explore concepts and studies in mechanics, such as position, velocity, acceleration, momentum, and simple harmonic motion. The wireless connection accommodates experimental setups for relative motion studies.

NEW Go Direct Light and Color

GDX-LC

Go Direct Light and Color combines the power of visible light, UVA/UVB, and RGB sensors to measure source emission, transmittance, and reflection of light in the visible light to ultraviolet electromagnetic spectrum. Explore light intensity as a function of distance, conduct polarized filter studies, observe the flicker of fluorescent lamps, perform reflectivity studies, and analyze RGB color contribution.

NEW Go Direct Voltage

GDX-VOLT

Go Direct Voltage combines a wide input voltage range (±15 V) and high precision, making it an excellent choice for lab investigations of both AC/DC circuits and electromagnetism. Use this probe to measure the voltage in simple circuits, to study basic principles of electrochemical cells, or to investigate the resistivity of different metals.

NEW Go Direct Radiation Monitor

GDX-RAD

Explore radiation statistics, measure the rate of nuclear decay, and monitor radon progeny. This easy-to-use sensor detects alpha, beta, gamma, and X-ray radiation, and it includes LED and audible indicators for each detection.

Discussing distillation data collected using Go Direct Temperature

Curriculum

Enhance Your Curriculum with Vernier Lab Books

Enhance your curriculum with our award-winning lab books, which are available as eco-friendly electronic downloads in addition to the traditional print format. Now you'll always have access to the most up-to-date versions of the experiments. You can also download word-processing files to customize the experiments to fit your curricular needs.

Advantages of E-Version Books

Our popular, award-winning lab books are now available as eco-friendly electronic downloads in addition to the traditional print format. When you purchase the electronic version of a lab book, you receive

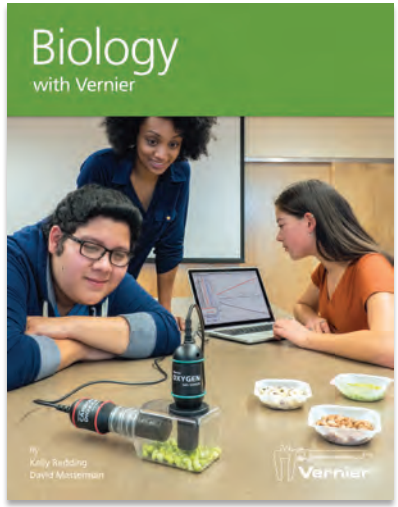
- Access to the most up-to-date versions of experiments on all supported software including Logger *Pro* 3, LabQuest App, Graphical Analysis 4‡, and EasyData‡
- Word-processing files of the student pages so you can edit the experiments to match your teaching style
- PDF files of all experiments for easy viewing on tablets and mobile devices
- Teacher information PDF files including sample data and graphs, a complete materials and supplies list, and other supplemental resources
- A searchable PDF of the entire book
- A generous site license—purchase once and share files with other instructors in your school or college department
- Easy access to all of the books you have purchased when signed in to your Vernier account

Additional benefits of the electronic versions of our lab books

- Save money by not paying for printing and shipping
- No need for a CD drive

If you love having the physical book in your hands, not to worry. Simply purchase the printed book. You will receive the book in addition to everything that comes with the electronic version.

‡ When available



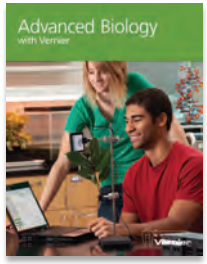
Biology with Vernier

Electronic: BWV-E

Printed: BWV

Appropriate for high school and introductory college courses for non-majors, this book contains 31 experiments in cell respiration, photosynthesis, membrane diffusion, osmosis, human physiology, transpiration, fermentation, and other important biology concepts.

See page 34.



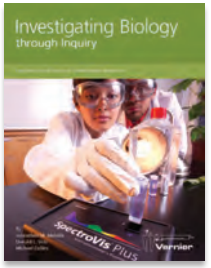
Advanced Biology with Vernier

Electronic: BIO-A-E

Printed: BIO-A

Appropriate for high school, this book contains 17 experiments including the 12 traditional AP* Biology labs. Additional advanced-level experiments make it appropriate for introductory college biology courses.

See page 38.



Investigating Biology through Inquiry

Electronic: BIO-I-E

Printed: BIO-I

Recommended for AP*, IB†, or college biology, this book, for data collection on computers and LabQuest only, will help you integrate inquiry into your high school or college biology curriculum. It provides many researchable questions for your students to investigate along with sample data for each investigation. See page 36.

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Agricultural Science with Vernier

Electronic AWV-E

Printed AWV

Appropriate for high school, this lab book contains experiments specifically chosen for teaching topics in agricultural science. Experiments range from testing soil pH, salinity, and moisture to comparing the energy content of different fuels and foods.

See page 42.

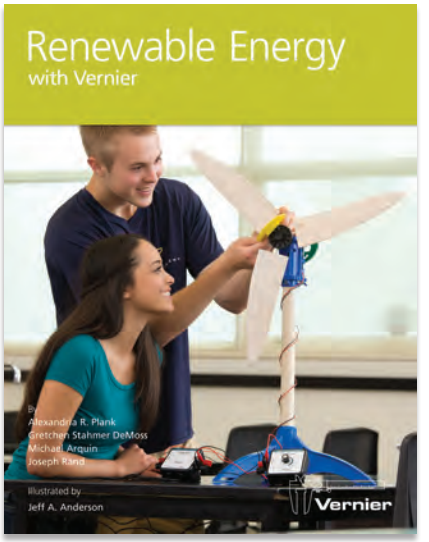
Water Quality with Vernier

Electronic WQV-E

Printed WQV

Appropriate for high school, this book takes advantage of the LabQuest Data Matrix mode and recently developed sensors, including the Optical DO Probe and PAR Sensor. Contains 16 tests, including temperature and pH. Two additional activities encourage student investigation.

See page 96.



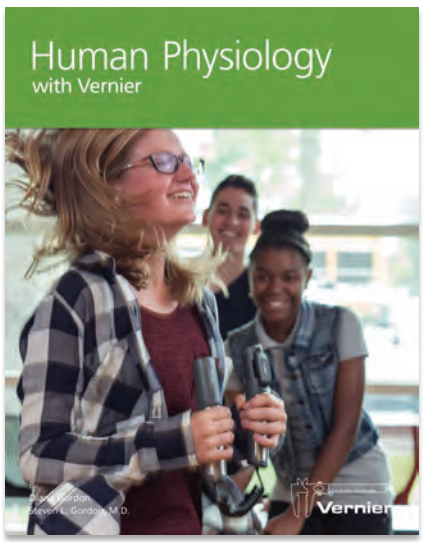
Renewable Energy with Vernier

Electronic REV-E

Printed REV

Appropriate for high school and perfect for teaching STEM, the *Renewable Energy with Vernier* lab book features 26 experiments in wind and solar energy. The lab book contains a combination of explorations, traditional experiments, inquiry investigations, and engineering projects—all of which are aligned to NGSS. This book is for data collection on computers and LabQuest only.

See page 98.



Human Physiology with Vernier

Electronic HP-A-E

Printed HP-A

Appropriate for high school and introductory college courses, this book, for data collection on computers and LabQuest only, contains 24 human physiology experiments. The experiments are designed to encourage students to think about the physiology of various human organ systems.

See page 40.

Investigating Environmental Science through Inquiry

Electronic ESI-E

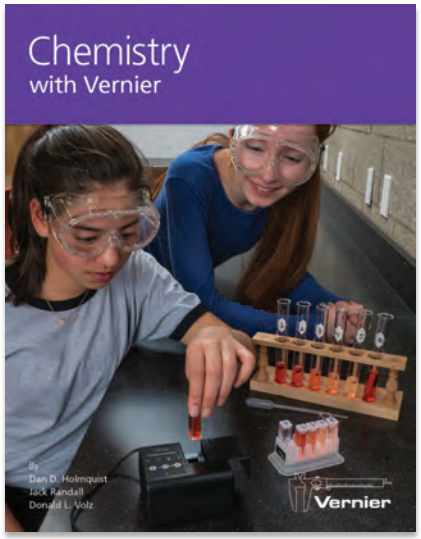
Printed ESI

Appropriate for high school, this book contains 34 inquiry-based investigations. It covers issues that prompt students' interest in the effects of anthropogenic environmental changes. Includes correlations for AP* and IB† environmental science. Student instructions are written so they can be used with all Vernier platforms.

See page 94.

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.



UPDATED

Chemistry with Vernier 4th Ed.

Electronic: CWV-E

Printed: CWV

Appropriate for high school and first-year college chemistry courses, this book contains 36 experiments in thermochemistry, gas laws, acid-base reactions, equilibrium, electrochemistry, electrolytes, states of matter, and more. Now updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

See page 52.

UPDATED

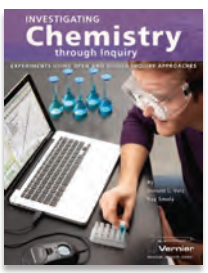
Vernier Chemistry Investigations for Use with AP Chemistry* 4th Ed.

Electronic: APCHEM-E

Printed: APCHEM

Recommended for AP* Chemistry courses, this book contains 16 inquiry investigations designed to support the AP Chemistry curriculum framework published by the College Board. Now updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

See page 54.



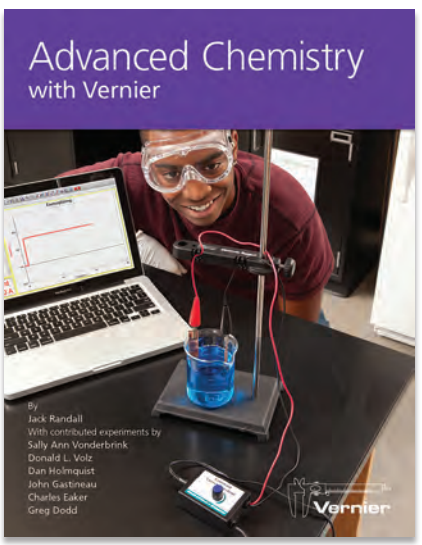
UPDATED

Investigating Chemistry through Inquiry 4th Ed.

Electronic: CHEM-I-E

Printed: CHEM-I

Appropriate for college and high school, this book contains 25 inquiry-based chemistry investigations in thermochemistry, acids and bases, stoichiometry, chemical kinetics, and properties of solutions. Now updated for data collection with Go Direct sensors and Graphical Analysis 4 software. See page 56.



UPDATED

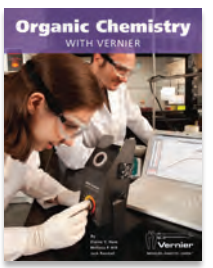
Advanced Chemistry with Vernier 4th Ed.

Electronic: CHEM-A-E

Printed: CHEM-A

Appropriate for college and advanced high school courses, this book contains 35 advanced chemistry experiments appropriate for second-year high school and college chemistry courses. Several experiments in this lab book can be used to supplement the AP Chemistry laboratory curriculum. Now updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

See page 58.



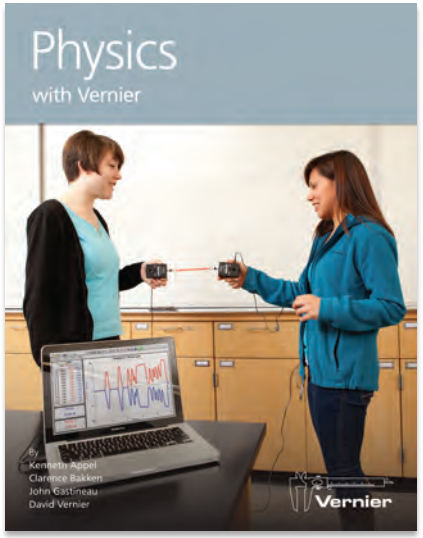
Organic Chemistry with Vernier

Electronic: CHEM-O-E

Printed: CHEM-O

Experiments in this book cover a broad range of topics, including compound identification, synthesis, chromatography, optical rotation, and spectroscopy for college organic chemistry courses.

See page 60.



Physics with Vernier

Electronic: PWV-E

Printed: PWV

Appropriate for an introductory physics course, this book contains 35 experiments in mechanics, sound, light, electricity, and magnetism.

See page 120.

Advanced Physics with Vernier – Mechanics

Electronic: PHYS-AM-E

Printed: PHYS-AM

Appropriate for second-year high school and college physics courses, this is the first of a two-volume set of experiments for the more in-depth introductory physics course.

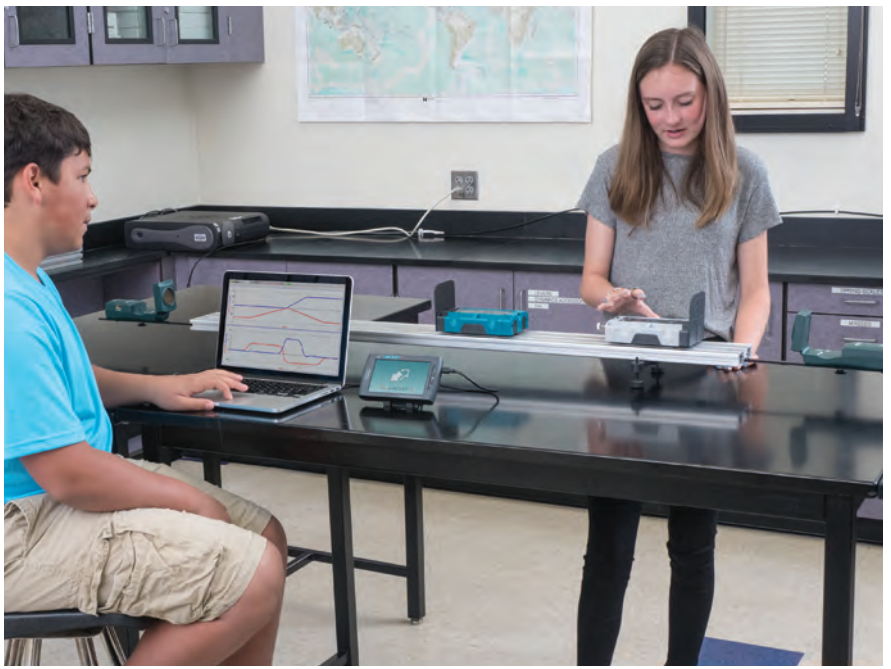
See page 122.

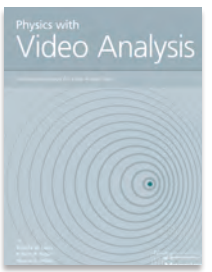
Advanced Physics with Vernier – Beyond Mechanics

Electronic: PHYS-ABM-E

Printed: PHYS-ABM

Appropriate for second-year high school and college physics courses, this is the second of a two-volume set of experiments for the more in-depth introductory physics course. This lab book contains 22 activities that explore real-world applications of math concepts from algebra through calculus. See page 124.





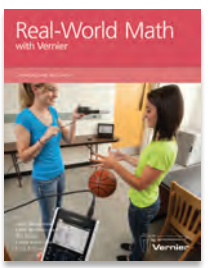
Physics with Video Analysis

Electronic: PVA-E

Printed: PVA

Appropriate for introductory high school or college physics courses, this book contains a wide selection of video analysis activities using Logger *Pro* for introductory physics.

See page 133.



Real-World Math with Vernier

Electronic: RWV-E

Printed: RWV

This lab book contains 32 activities that explore real-world applications of math concepts from algebra through calculus. Activities cover topics such as linear, quadratic, and periodic functions; statistics; systems of equations; and many more. This book is for data collection on computers and calculators only.

See page 151.

Elementary Science with Vernier

Electronic: EWV-E

Printed: EWV

This book contains 43 fun and engaging experiments for elementary students. Activities investigate temperature, motion, force, magnetism, light, electricity, and pressure. This book is for data collection on computers and LabQuest only.

See page 108.

UPDATED *Middle School Science with Vernier* 4th Ed.

Electronic: MSV-E

Printed: MSV

This book is written specifically for students in grades 6–8. It contains 38 experiments in Earth science, life science, and physical science. Now updated for data collection with Go Direct sensors and Graphical Analysis 4 software.

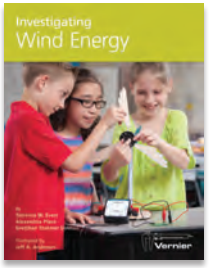
See page 106.

UPDATED *Physical Science with Vernier* 4th Ed.

Electronic: PSV-E

Printed: PSV

This book contains 40 experiments for physical science. These experiments are perfect for introductory physical science and integrated science classes (middle school through grade 10). Now updated for data collection with Go Direct sensors and Graphical Analysis 4 software. See page 116.



Investigating Wind Energy

Electronic: ELB-WIND-E

Printed: ELB-WIND

Appropriate for upper-elementary and middle school, this book contains 10 hands-on, engaging wind energy experiments plus a culminating wind energy engineering project—all of which are aligned with NGSS. Topics such as energy transfer, basic electric circuits, and blade variables are covered. This book is for data collection on computers and LabQuest only. See page 99.

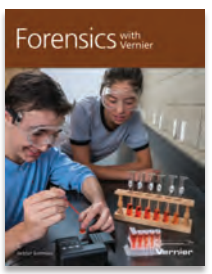
Earth Science with Vernier

Electronic: ESV-E

Printed: ESV

Appropriate for high school or middle school, this book contains 33 experiments and six projects. Topics include geology, soil analysis, water quality, hydrology, oceanography, meteorology, and energy.

See page 78.



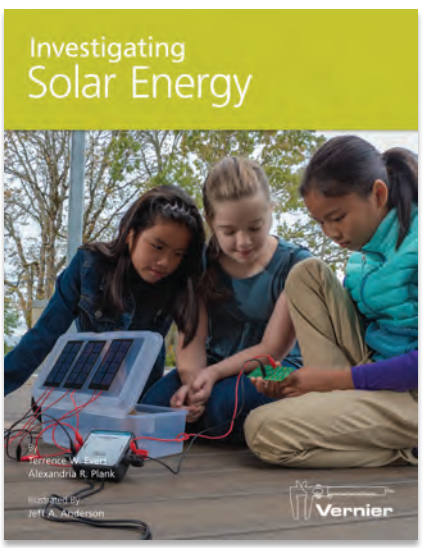
Forensics with Vernier

Electronic: FWV-E

Printed: FWV

This book is for teachers at the high school level who wish to introduce their students to forensics using engaging and realistic laboratory activities with Vernier probeware. The book contains 14 lab activities for computer and LabQuest only.

See www.vernier.com/fwv



Investigating Solar Energy

Electronic: ELB-SOLAR-E

Printed: ELB-SOLAR

In the nine experiments and two engineering projects in this book—all of which are aligned with NGSS—students learn about solar energy and apply their knowledge to develop solutions to real-world problems. Students explore solar energy, energy transfer, series and parallel circuits, and variables that affect solar panel output. This book, appropriate for upper-elementary and middle school, is for data collection using computers and LabQuest only.

See page 99.

Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3

Electronic: EP-EV3-E

Printed: EP-EV3

This book contains 13 engineering projects to challenge upper middle school and high school students to build and program robots for testing batteries, locating "land mines," automating plant watering, and more.

See page 85.

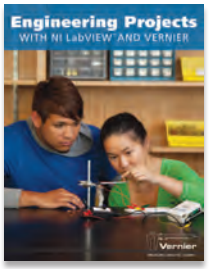
Vernier Engineering Projects with LEGO® MINDSTORMS® Education NXT

Electronic: EP-NXT-E

Printed: EP-NXT

Appropriate for upper middle school and high school, this book contains 12 engineering challenges. Challenges include aquarium monitoring, sunscreen testing, and more. Not compatible with the EV3 system.

See page 85.

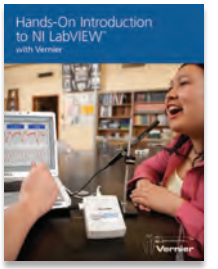


Engineering Projects with NI LabVIEW™ and Vernier

Electronic: EPV-E

Printed: EPV

This book includes 12 engaging, hands-on projects that introduce engineering concepts and programming with NI LabVIEW software and SensorDAQ, LabQuest, LabQuest 2, or LabQuest Mini. Topics include analog and digital input and output, feedback and control, servo and stepper motors, PID control, and pulse-width modulation. See page 90.



Hands-On Introduction to NI LabVIEW™ with Vernier

Electronic: LWV-E

Printed: LWV

This book introduces NI LabVIEW programming through a series of hands-on exercises using Vernier sensors and SensorDAQ, LabQuest, LabQuest 2, or LabQuest Mini.

See page 91.

NEW *Quimica con Vernier*

Electronic: CWV-ES-E

Printed: CWV-ES

This book includes 36 experiments for high school and first-year college chemistry courses taught in Spanish or for students who prefer instructions in Spanish.

For more information, visit
www.vernier.com/cwv-es

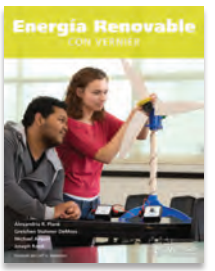
Ciencias con lo Mejor de Vernier

Electronic: CMV-LP-E

Printed: CMV-LP

This book includes 42 experiments from five subject areas for courses taught in Spanish or for students who prefer instructions in Spanish.

For more information, visit
www.vernier.com/cmv-lp



Energía Renovable con Vernier

Electronic: REV-ES-E

Printed: REV-ES

This book features 26 experiments in wind and solar energy for courses taught in Spanish or for students who prefer instructions in Spanish. For data collection on computers and LabQuest only.

For more information, visit
www.vernier.com/rev-es

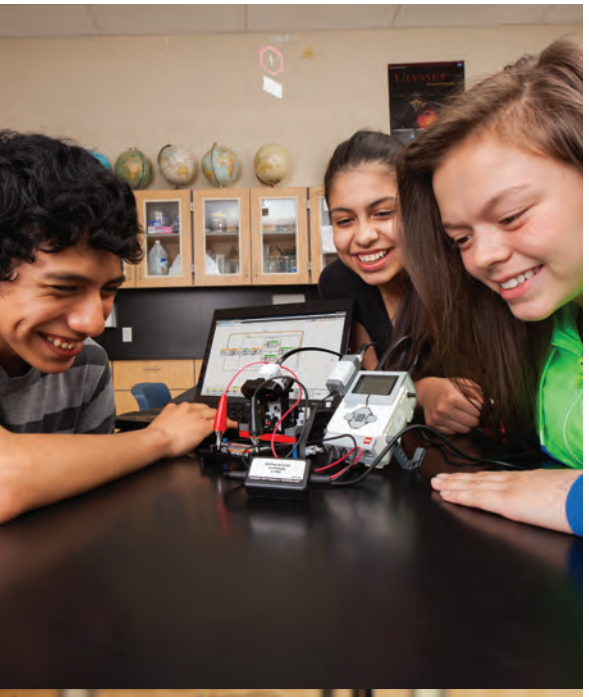
Ciencia en la Primaria con Vernier

Electronic: CPV-E

Printed: CPV

This book includes 43 ready-to-use activities for courses taught in Spanish or for students who prefer instructions in Spanish.

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



Next Generation Science Standards* and Vernier

Teach the next generation of scientists and engineers using Vernier technology

Vernier lab books encourage students to investigate natural phenomena and solve real-world problems using the eight science and engineering practices identified in the Next Generation Science Standards (NGSS). These science and engineering practices are the foundation of our lab books and include

- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Hands-on learning has been at the core of our mission for 36 years, and as we create new products—whether it is hardware, software, or written investigations—we work to align to NGSS, making it easy for teachers and science supervisors to help students meet these standards.

* Next Generation Science Standards is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, these products.

Why Use Probeware?

Research in our white paper, *What the Research Says About the Value of Probeware for Science Instruction,* supports the following findings:

- Use of data-collection technology can provide a learning advantage to students.
- Probeware can help to deepen student understanding of science concepts.
- Use of technology tools for data collection, analysis, and visualization in a context of student scientific investigations can provide experiences with core scientific practices for students.

To learn more about the research that links student use of probeware in the classroom to higher performance and test scores, request a copy of our white paper at www.vernier.com/whitepaper

Vernier Lab Books and NGSS

The following books were written specifically to support the integration of NGSS into your classroom:

- *Renewable Energy with Vernier*—recommended for high school
- *Investigating Wind Energy*—recommended for upper-elementary school
- *Investigating Solar Energy*—recommended for upper-elementary school

Inquiry-Based Lab Books

Our inquiry-based lab books promote hands-on learning, reinforce science and engineering practices, and help students learn the twenty-first century skills promoted by NGSS. Many of the experiments help teachers directly address the three-dimensional learning recommended by the NGSS, including Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas.

- *Investigating Chemistry through Inquiry*—recommended for college and high school
- *Investigating Biology through Inquiry*—recommended for college and high school
- *Investigating Environmental Science through Inquiry*—recommended for high school

STEM Engineering Lab Books

Vernier also publishes a number of STEM-specific lab books with projects and activities that promote engineering education and cover topics such as mechanics, pressure, and electricity.

- *Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3*
- *Vernier Engineering Projects with LEGO® MINDSTORMS® Education NXT*
- *Engineering Projects with NI LabVIEW™ and Vernier*
- STEM extensions for popular experiments are available at www.vernier.com/extensions

How do I edit Vernier experiments in Google Docs™?

Have you ever wanted to edit Vernier experiments in Google Docs? You can easily edit Microsoft® Word® .docx files in Google Docs:

1. In Google Drive,™ click the gear icon (Settings).
2. Choose Settings from the menu, and then select "Convert uploaded files to Google Docs editor format." Click Done.
3. Drag and drop Word files into Google Drive. Files will automatically start to upload and convert to Google Doc format (in Google Drive the file name will include .docx).

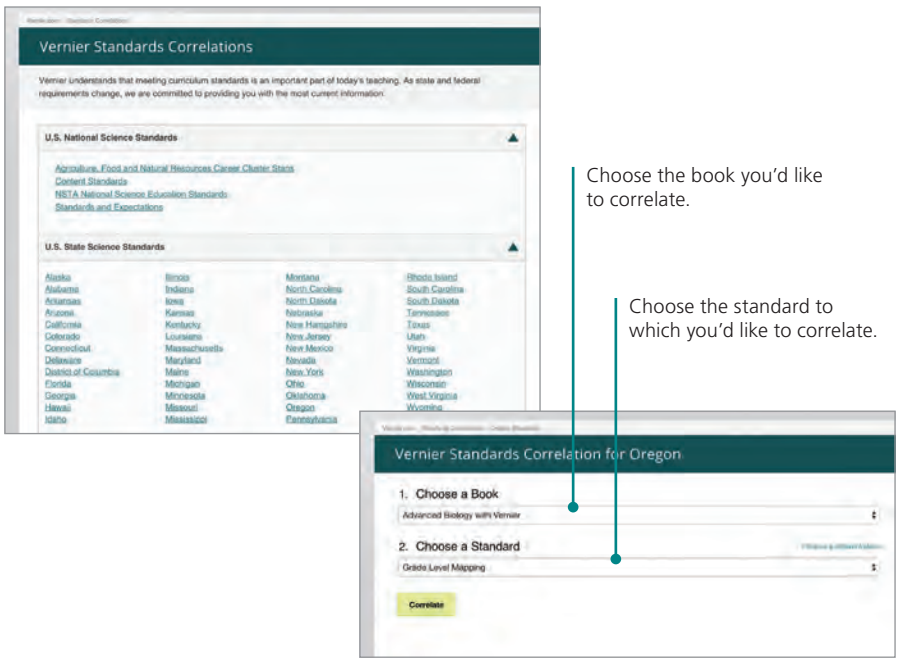
Note: This process works very well for files with a .docx extension. Files with a .doc extension will open cleanly most of the time. However, if there is text wrapping around a figure, the figure may not appear in the Google Doc. In this situation, convert the .doc file to a .docx file before adding it to Google Drive.

Helping You Meet Content Standards

Vernier understands that meeting curriculum standards is an important part of today's teaching. As state and federal requirements change, we are committed to providing you with the most current information. You will find the following alignments to standards on our website for all lab books published by Vernier at www.vernier.com/standards

- Science standards for all 50 U.S. states
- Provincial standards for Canada
- NCTM (National Council for Teachers of Mathematics)
- AP and IB
- NSES (National Science Education Standards)
- ISTE (International Society for Technology Educators)

Vernier Standards Correlation for Your State



More Online
For more information, go to www.vernier.com/standards

CURRICULUM

Your Complete Solution for AP* and IB† Science

Curriculum

- Correlations to AP and IB standards for biology, chemistry, physics, and environmental science
- Word-processing files for all student pages, so you can customize the labs to meet your standards
- ICT support for the IB Group 4 sciences
- Questions promote higher-order thinking skills
- Lab extensions encourage inquiry investigations

Data-Collection Packages

Additional information on data-collection packages for AP and IB science can be found on the following pages:

Biology
For Inquiry, see page 37.
For AP/Advanced, see page 39.

Chemistry
For AP, see page 55.
For IB, see page 59.

Physics
See pages 121 and 123.

Environmental Science
See pages 95 and 99.

Software

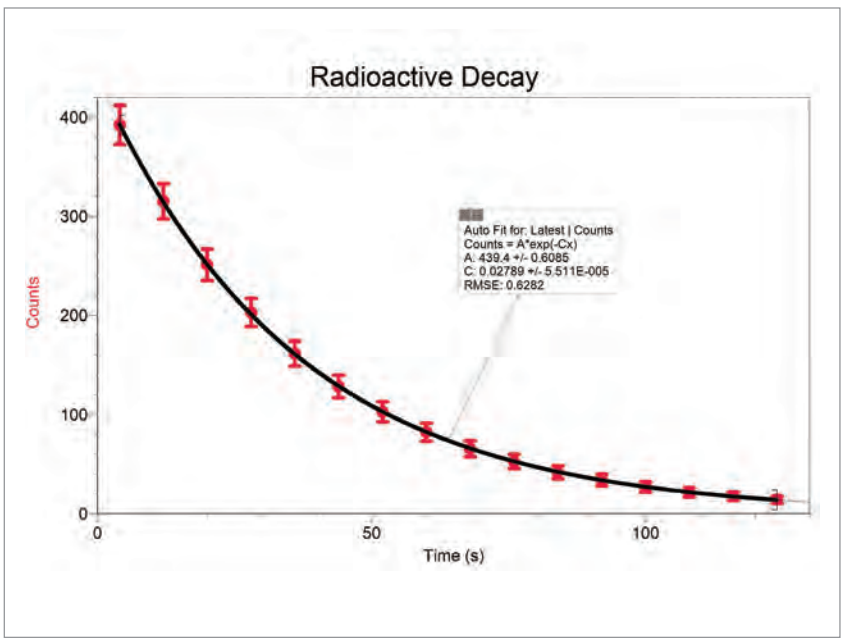
Logger *Pro* 3

with CD	electronic download‡
LP	LP-E

For macOS and Windows

- Error bars
- Log and semi-log graphs
- Modeling
- Custom curve fits
- Double y-graphs
- Gel analysis
- Peak integration on GC data
- Export data to Google™ Maps or GIS
- Spectrometer data analysis
- Video analysis
- Optional manual configuration mode allows students to set all data-collection parameters

For more details, see pp. 20–21.



IB Standards

All IB Group 4 experimental science courses require students to use sensors for data logging in an experiment and software for graph plotting.

For IB correlations, visit www.vernier.com/ib

CURRICULUM

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

‡ Provide an email address to which we will send download information.

TI

Data Collection

TI-84 Plus Graphing Calculators

TI graphing calculators are valuable tools in math and science. We recommend the TI-84 or the TI-Nspire™ (see page 152) family of calculators. These calculators can be purchased individually or in convenient teacher packs of 10 calculators.

Which TI-84 calculator is right for me?

		Order Code	Data-Collection Support	Features
TI-84 Plus CE		TI-84PCE	• Software: EasyData App v5.2 • USB sensors: CBR2 and EasyTemp • Interface: EasyLink	• Sleek, slim design • Full-color, backlit display • Rechargeable battery • Expanded RAM Memory • Expanded Archive Memory • Import photos & overlay graphs
TI-84 Plus		TI-84PL	• Software: EasyData App v2.4 • USB sensors: CBR2 and EasyTemp • Interfaces: EasyLink/CBL 2 • Collect data from multiple sensors simultaneously with LabPro or CBL 2	• Grayscale display • Powered by four AAA batteries (included)

TI-84 Plus CE

TI-84PCE

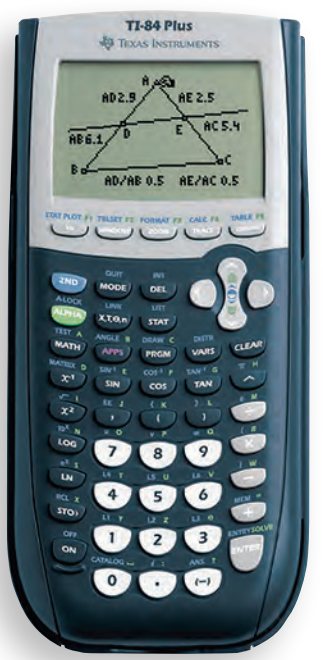
The TI-84 Plus CE has a full-color, high-resolution, backlit screen, making it easy to read. The calculator comes with a rechargeable battery, so there is never a need to buy AAA batteries. Import real-world images as a graph background for analysis of features in the image. (Comes with Vernier EasyData app for data collection. Works with 65 Vernier sensors to investigate concepts in math and science, when used with an EasyLink sensor interface.)

Includes TI-84 Plus CE calculator, rechargeable battery, and AC wall adapter.

TI-84 Plus CE Teacher Pack

TI-84PCE-TPK

Includes 10 EZ Spot calculators, 10 rechargeable batteries, and a 10-unit charging station.



TI-84 Plus

TI-84PL

The TI-84 Plus is a lower-price alternative to the TI-84 Plus CE calculator. It comes with over 10 preloaded Apps, including EasyData and Cabri™ Jr. The TI-84 Plus supports data collection with 78 Vernier sensors, including microphones, photogates, and drop counters, when used with a CBL 2 sensor interface.

TI-84 EZ Spot Teacher Pack

TI-84SPOTTP

Includes 10 EZ Spot calculators and 40 AAA batteries.

Real-World Math with Vernier

Electronic Version

RWV-E

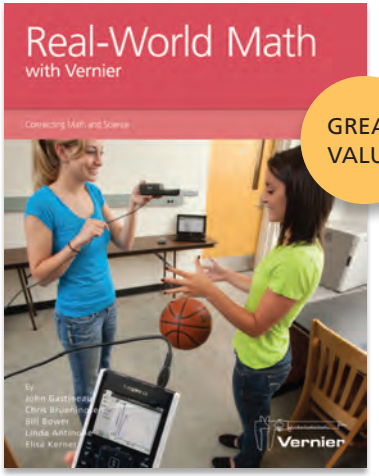
Printed Lab Book

RWV

This lab book supports TI-Nspire, TI-84 Plus, TI-73, TI-89, and more!

Investigate the following:

- Linear functions
- Proportional relationships
- Quadratic functions
- Exponential functions
- Sinusoidal functions



More Online
Learn more about the experiments in *Real-World Math with Vernier* at www.vernier.com/rwv

CBR 2

CBR2

If you teach math, physical science, or physics, consider the CBR 2. The CBR 2 collects distance, velocity, and acceleration data. It connects directly to a TI calculator. When the CBR 2 is connected to the USB port of a TI-84 Plus calculator or TI-Nspire handheld, the data-collection application automatically launches, and you are ready to collect data.

Vernier EasyTemp

EZ-TMP

EasyTemp is an inexpensive and easy-to-use temperature probe designed for use with TI calculators. Plug EasyTemp into the USB port on a TI-84 Plus calculator or TI-Nspire handheld. The data-collection application automatically launches, and you are ready to collect data. This stainless steel probe is durable enough for classroom use and has a temperature range of –20 to 115°C.

TI-SmartView™ CX Emulator Software

TI-SV*

TI-SmartView lets you project an interactive representation of a TI-84 Plus calculator to your entire class. You can use TI-SmartView to project multiple representations simultaneously (graphs, window settings, tables), display key press history, and capture multiple screenshots.

*** Single-user license. For lower-price, multi-user licenses of TI-SmartView software, go to www.vernier.com/ti-smartview**

CBL 2

CBL2

The CBL 2 System includes the CBL 2 interface, a Stainless Steel Temperature Probe, TI Light Probe, Voltage Probe, calculator cradle, link cable, batteries, and user's guide. More than 70 Vernier sensors can be used with the CBL 2.

The CBL 2 can be used with TI-73 Explorer, TI-83 Plus, TI-84 Plus, and TI-84 Plus C Silver Edition calculators.

The CBL 2 cannot be used with TI-84 Plus CE or TI-Nspire handhelds.

Vernier EasyLink

EZ-LINK

EasyLink is an easy, affordable way to get started with calculator-based data collection.

EasyLink is a single-channel interface that plugs into the USB port of a TI-84 Plus graphing calculator or TI-Nspire handheld. It supports any one of over 60 Vernier sensors.

TI-Nspire™ CX Handheld

TI-NSCX

TI-Nspire CX handheld is the latest in learning technology from TI, creating a dynamic dimension for students to visualize concepts and take an engaging, interactive role in their learning. The screen is a full-color, back-lit display that is easy to read, even in low-light situations. The handheld includes an easy-glide Touchpad that works more like a computer with a mouse. The TI-Nspire CX is recommended for students taking algebra, geometry, trigonometry, and precalculus.

Includes TI-Nspire CX handheld, rechargeable battery, and AC wall adapter.

TI-Nspire CX School Pack

TI-NSCX-TPK

Includes 10 TI-Nspire CX EZ Spot handhelds with the words "School Property" on the keypad, 10 rechargeable batteries, and a 10-unit docking station.

TI-Nspire™ CX CAS Handheld

TI-NSCXCAS

The TI-Nspire CX CAS handheld has all the features of the TI-Nspire CX handheld plus a built-in Computer Algebra System (CAS) for working with mathematical expressions in symbolic form. Examples of CAS functionality include factoring and expanding expressions, solving for common denominators, and performing symbolic calculations. The TI-Nspire CX CAS is recommended for students taking geometry, trigonometry, precalculus, and calculus.

Includes TI-Nspire CX CAS handheld, rechargeable battery, and AC wall adapter.

TI-Nspire CX CAS School Pack

TI-NSCXCAS-TPK

Includes 10 TI-Nspire CX CAS handhelds, 10 rechargeable batteries, and a 10-unit docking station.

Calculator Products

Product		Order Code
Calculators	TI-84 Plus CE	TI-84PCE
	TI-84 Plus CE Teacher Pack (10 calculators & charging station)	TI-84PCE-TPK
	TI-84 Plus Calculator	TI-84PL
	TI-84 Plus EZ Spot Teacher Pack	TI-84SPOTTP
	TI-Nspire CX Handheld	TI-NSCX
	TI-Nspire CX School Pack (10 handhelds & docking station)	TI-NSCX-TPK
	TI-Nspire CX CAS Handheld	TI-NSCXCAS
	TI-Nspire CX CAS School Pack (10 handhelds & docking station)	TI-NSCXCAS-TPK
Charging/Docking Stations	TI-84 Plus CE Charging Station	TI-84PCE-CS
	TI-Nspire CX Docking Station	TI-NSCX-DS
Emulator/Computer Software	TI-SmartView Emulator software for TI-84 (single-user license)*	TI-SV
	TI-Nspire Teacher Software (single license numeric & CAS Software)*	TI-N2TX-SP-KT
Miscellaneous Accessories	TI USB Connectivity Kit (cannot be used with TI-84 Plus CE or TI-Nspire Handhelds)	GLC-USB
TI Navigator System	30-User TI-Nspire CX Navigator System	TI-NAV-CX30
	15-User TI-Nspire CX Navigator System	TI-NAV-CX15
	5-User TI-Nspire CX Navigator Add-on†	TI-NAV-CX5

* Lower-price, multi-user license software also available. See www.vernier.com/ti-software

† Requires purchase of a Navigator system.

TI products purchased in the USA are covered by a one-year warranty based on the date of purchase. Units are warranted against defective materials or workmanship.

Looking for training on Texas Instruments products?

Go to http://education.ti.com/us/pd

Data Collection with TI-Nspire™ Technology

TI-Nspire Lab Cradle

TI-NSLABC

The TI-Nspire Lab Cradle from Texas Instruments is a multi-channel, data-collection interface for use with TI-Nspire technology (sold separately). The Lab Cradle has five sensor ports for use with 80 Vernier sensors. Collect data at rates up to 100,000 samples per second. The Lab Cradle is compatible with TI-Nspire computer software and handhelds running software version 3.0 or newer. The Lab Cradle includes a rechargeable battery and an AC adapter.

TI-Nspire Lab Cradle Bundle

TI-NSLABC-5

Includes 5 TI-Nspire Lab Cradles with rechargeable batteries and a 5-unit charging bay.

For a list of compatible sensors, see www.vernier.com/ti-nslabc

TI-Nspire™ CX Teacher Software

TI-N2TX-SP-KT *

TI-Nspire CX Teacher Software is perfect for classroom presentations. The computer emulation software has the same functionality as the TI-Nspire handhelds. Teacher software includes license for both TI-Nspire CX and TI-Nspire CX CAS teacher software.

* Single-user license. For lower-price, multi-user licenses, go to www.vernier.com/ti-software

Looking for TI-Nspire or TI-Nspire CAS student software? See www.vernier.com/ti-software

TI-Navigator™ Classroom Learning Systems

The TI-Navigator is a classroom learning system that combines Texas Instruments graphing technology and your classroom computer to create a wireless classroom network. Teachers can assess understanding of key concepts, monitor student progress, and differentiate instruction. The included software supports automatically grading and archiving student work. Learn more at www.vernier.com/ti-navigator

For TI-Nspire CX or TI-Nspire CX CAS Users†

30-User TI-Nspire CX Navigator System

TI-NAV-CX30

15-User TI-Nspire CX Navigator System

TI-NAV-CX15

5-User TI-Nspire CX Navigator Add-on‡

TI-NAV-CX5

TI-Nspire Navigator Teacher Software Add-on‡

TI-NAVX-SP-KT

† This system is for use with TI-Nspire CX handhelds only and will not work with older clickpad or touchpad units.

‡ Add-on pieces require the purchase of a 30-User or 15-User TI-Nspire Navigator system.

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Vernier and the Environment

A strong commitment to the environment is central to our mission. Here are just a few examples of our practices:

- **Solar panels**—We have installed 17,000 watts of solar panels.
- **Alternative transportation**—All employees are provided with free transit passes and are encouraged to walk, bike, carpool, or take public transport to work.
- **Recycling**—We recycle everything we can: paper, plastic, aluminum, cardboard, electronics, batteries, and more.
- **Worm bin composting**—Vernier employees compost food scraps and yard clippings using a colony of red wiggler worms.
- **Electric car charging stations**—10% of Vernier employees own hybrid, plug-in hybrid, or pure electric vehicles.
- **Packing materials**—Employees use boxes and packing materials over and over again.
- **Lighting**—We've installed energy-saving LED bulbs in our fixtures.
- **LEED-EB Gold rating**—In 2006, and again in 2016, our building qualified for the second highest rating possible from the U.S. Green Building Council.
- **Green Company Award**—We have been named one of the *100 Best Green Companies to Work For in Oregon* for seven years.
- **Printing**—This catalog was produced by a local printer using 100% Wind Energy and printed with vegetable-based inks on 30% PCW paper stock.

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When you call Vernier, you'll speak with people devoted to science education—scientists, educators, and engineers who are passionate about working with teachers and helping students succeed.

Outside of work, our team members enjoy a variety of hobbies including music, soccer, beekeeping, kayaking, snowboarding, travel, and baseball.

To learn more about what they do for fun, visit www.vernier.com/team

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