

# Vernier

## 2019

CATALOGUE

Pioneering Technologies for STEM Education Since 1981

Chemistry  
Physics  
Biology  
Middle School Science  
Elementary Science

Human Physiology  
Environmental Science  
Water Quality  
Earth Science  
Agricultural Science

Engineering  
Coding & Robotics  
Mathematics  
Physical Science



# Welcome

## Go Direct with Vernier

We introduced our first Go Direct sensors in 2017. We have added new sensors every few months since then, and we are excited to say that there are now over 40 Go Direct sensors! We now have a fairly complete set of sensors for all subject areas, including physics and human physiology. More Go Direct sensors are coming soon, and the free Graphical Analysis 4 app to use with them keeps gaining more new features. Graphical Analysis 4 is available for Windows and macOS computers, Chromebooks, and iOS and Android devices. The user interface is the same on all platforms, so one set of experiment instructions works for all devices.

Speaking of experiment instructions, we have revised most of our popular lab books so that they now include instructions for our Go Direct sensors or our LabQuest sensors with Graphical Analysis 4.

Since the early days of this company, we have promoted the idea of students learning how to code through project-based learning. In 1984 we released *How to Build a Better Mousetrap and 13 Other Science Projects for the Apple II*, a book that incorporated coding in electronics projects. This year, we introduce several new products specifically aimed at teaching engineering and coding.

If you visit the Portland, Oregon, area, we encourage you to drop by for a tour of our building. We also hold a series of workshops in the summer at our office. Summer is a great time to visit the Pacific Northwest!

[www.vernier.com/workshops](http://www.vernier.com/workshops)

We encourage you to give our products a try on a 30-day (or longer) preview basis. Feel free to contact any of us personally at any time.



**John Wheeler**

CEO

[jwheeler@vernier.com](mailto:jwheeler@vernier.com)



**Dave and Christine Vernier**

Co-Presidents

[dvernier@vernier.com](mailto:dvernier@vernier.com) and [cvernier@vernier.com](mailto:cvernier@vernier.com)

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

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 18 years.



2018 Best Companies to Work For in Oregon



2018 Healthiest Employers of Oregon



2018 Best Green Companies in Oregon



2018 Corporate Philanthropy Award



### On the Cover

Students measure dissolved oxygen concentration in water using Go Direct Optical Dissolved Oxygen connected wirelessly to LabQuest 2.

[www.vernier.com/gdx-odo](http://www.vernier.com/gdx-odo)

# Vernier 2019 Catalog

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WHAT'S NEW 2–3

---

ADVANTAGES OF USING VERNIER  
PROBEWARE 4–5

---

A GUIDE TO VERNIER  
DATA COLLECTION 6–7

---

DATA LOGGING 8–17

Go Direct® Data Logging 8–9

Interface Data Logging 10–17

---

SOFTWARE 18–23

Graphical Analysis™ 4 18–19

Vernier Spectral Analysis® 20

LabQuest Viewer® 21

Video Physics™ 21

Logger Pro® 3 22–23

---

LAB BOOKS 24–27

---

BIOLOGY 28–43

---

CHEMISTRY 44–63

---

EARTH SCIENCE 64–67

---

ELEMENTARY SCIENCE 68–71

---

ENGINEERING, CODING, AND  
ROBOTICS 72–81

---

ENVIRONMENTAL SCIENCE 82–93

---

MIDDLE SCHOOL SCIENCE 94–101

---

PHYSICAL SCIENCE 102–105

---

PHYSICS 106–131

---

STEM WITH VERNIER 132–133

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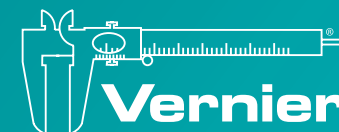
SENSORS AND ACCESSORIES 134–137

Sensor List 134–135

Accessories and Replacement  
Parts 136–137

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GENERAL INFO AND INDEX 138–144





# What's New

## Go Direct® Sensors

We've added 11 new sensors to our popular Go Direct sensor family. These affordable sensors connect directly to your Chromebook™, mobile device, computer, or LabQuest 2 via Bluetooth® wireless technology or USB—there is no need for additional equipment. Data are collected and analyzed using our free Graphical Analysis™ 4 app.

Go Direct sensors are backed by Stellar Service from Vernier, which means that you will have award-winning technical support, hands-on workshops, personalized on-line training, and a community that provides best practices.

**See page 134.**

[www.vernier.com/go-direct](http://www.vernier.com/go-direct)



Go Direct  
Sound



Go Direct  
Photogate



Go Direct  
Projectile Launcher



Go Direct  
Hand Dynamometer



Go Direct  
Ethanol Vapor



Go Direct Ion-Selective  
Electrode Amplifier



Go Direct Ammonium  
Ion-Selective Electrode



Go Direct Calcium  
Ion-Selective Electrode



Go Direct Chloride  
Ion-Selective Electrode



Go Direct Nitrate  
Ion-Selective Electrode



Go Direct Potassium  
Ion-Selective Electrode



## Physiology with Go Direct

Encourage students to explore the physiology of various human organ systems with our new lab book, *Human Physiology Experiments*, and the latest additions to our Go Direct family of sensors:

- Go Direct EKG
- Go Direct Surface Temperature
- Go Direct Respiration Belt
- Go Direct O<sub>2</sub> Gas
- Go Direct Hand Dynamometer
- Go Wireless Heart Rate
- Go Direct Force and Acceleration with the Reflex Hammer Accessory Kit

See pp. 32–33.

[www.vernier.com/physiology](http://www.vernier.com/physiology)

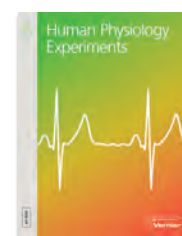


## Human Physiology Experiments

The experiments in *Human Physiology Experiments* encourage students to investigate the physiology of the cardiac, muscular, respiratory, vascular, and nervous systems.

See page 43.

[www.vernier.com/hsb-hp](http://www.vernier.com/hsb-hp)



## Pivot Interactives Adds Chemistry Topics

Pivot Interactives provides students with instant access to a collection of more than 160 real-world, browser-based, interactive video exercises. This year, more than 25 new interactive chemistry activities provide students with real-world data to complement your hands-on experiments and lectures.

Sign up for a 30-day free trial.  
[www.vernier.com/pivot](http://www.vernier.com/pivot)



## Coding with Vernier

Coding in the classroom has become an important way to introduce problem solving, nurture creativity, increase critical thinking, and build confidence, all while learning a new language.

Vernier offers a range of coding solutions, from entry-level block-based languages to advanced instrument-control programming. With Vernier technology and an appropriate coding application, students can create code to control robots, incorporate sensor input, and create sensor-controlled projects.

See page 74.

[www.vernier.com/coding](http://www.vernier.com/coding)

```
18 gdx.open(use_ble=False, use_usb=True)
19 gdx.select_sensors(1,2) #select the sensors
20 gdx.start(period=500) #set the measurement period
21 info = gdx.info() #returns the description of the sensors
22 print(info)
23
24 for i in range(0,10):
25     measurements = gdx.read() #return the current measurements
26     if measurements == None: #if the sensor is not connected
27         break
28     print(measurements)
29
30 gdx.stop() #stop data collection
31 gdx.close() #disconnect from the blue
```



## Middle School Lab Books

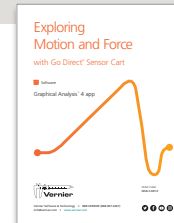
Enhance your middle school curriculum with our new lab books. Explore solar and wind energy and motion and force. Apply learned knowledge in culminating engineering design projects. These new lab books are available as electronic downloads only.

### Topics Include

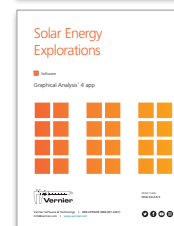
- Solar energy
- Wind energy
- Engineering design
- Motion and force

See page 101.

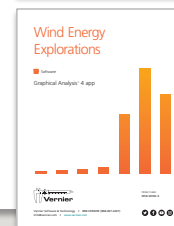
[www.vernier.com/middle-school-science](http://www.vernier.com/middle-school-science)



*Exploring Motion and Force with Go Direct Sensor Cart*



*Solar Energy Explorations*



*Wind Energy Explorations*

# Advantages of Using Vernier Probeware



## 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 for students, as evidenced in student test scores in science (National Center for Education Statistics, 2002, 2012; Schneider et al., 2002).

Get details at [www.vernier.com/whitepaper](http://www.vernier.com/whitepaper)



## Creates a deeper understanding

Vernier technology-based solutions enhance STEM education, increase learning, build students' critical thinking skills, and support the Science and Engineering Practices.



## Supports standards

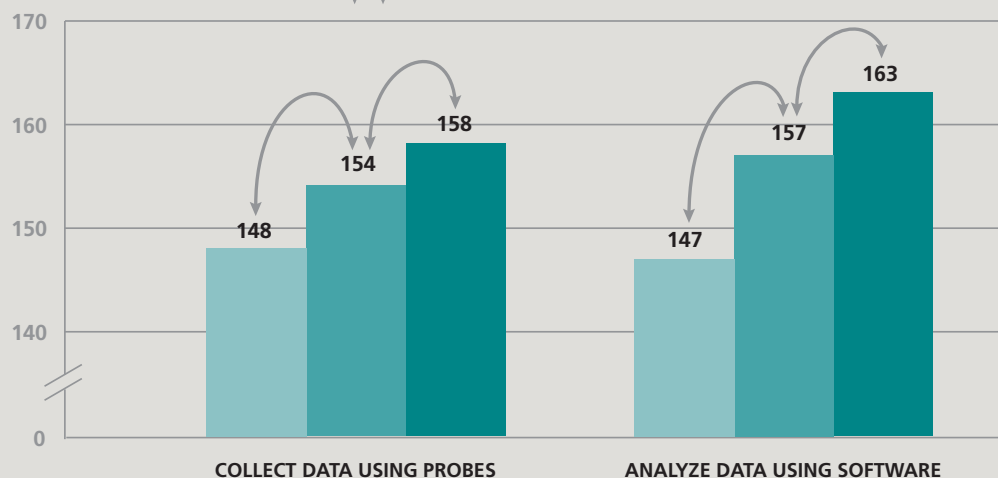
Student hands-on use of technology tools for data collection, analysis, and visualization is recommended in guidelines and requirements from influential national organizations, such as Next Generation Science Standards (NGSS) and state standards.

### Average Science Scores

#### 12th Grade Students Using Data-Collection Technology

NOT USING PROBEWARE    USING PROBEWARE LESS THAN ONCE A MONTH    USING PROBEWARE 1-2 TIMES A MONTH

Significantly different average scores.



*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. Source: 2000 NAEP Science Assessment*



## Frees class time

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.



## Builds student interest

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



## 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.



## Backed by 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.



## Download Our Free White Paper

### ***What the Research Says About the Value of Probeware for Science Instruction***

In-depth research in our white paper, *What the Research Says About the Value of Probeware for Science Instruction*, supports the following findings:

- Data-collection technology can provide a learning advantage to students.
- Probeware can help deepen student understanding of science concepts.
- Hands-on use of technology tools is recommended in guidelines from influential, national organizations such as ISTE, ASTE, and others.

In addition to the research, the paper provides a detailed bibliography to support your grant-writing efforts.

Download *What the Research Says About the Value of Probeware for Science Instruction* for free.



Download our free white paper on probeware and student performance [www.vernier.com/whitepaper](http://www.vernier.com/whitepaper)



# Getting Started with Go Direct Sensors

## Why Choose Go Direct Sensors?

With over 40 sensors to choose from, our Go Direct family of sensors offers an affordable solution that includes free software. Go Direct sensors are easy to use—just connect and start collecting data with your device.

### Go Direct Sensors

See page 134.

### Software

See pp. 18–19.

### Lab Books

See pp. 26–27.



## What You Need to Get Started

### A Go Direct Sensor

These versatile sensors connect to your device via Bluetooth® wireless technology or USB.

### B Device

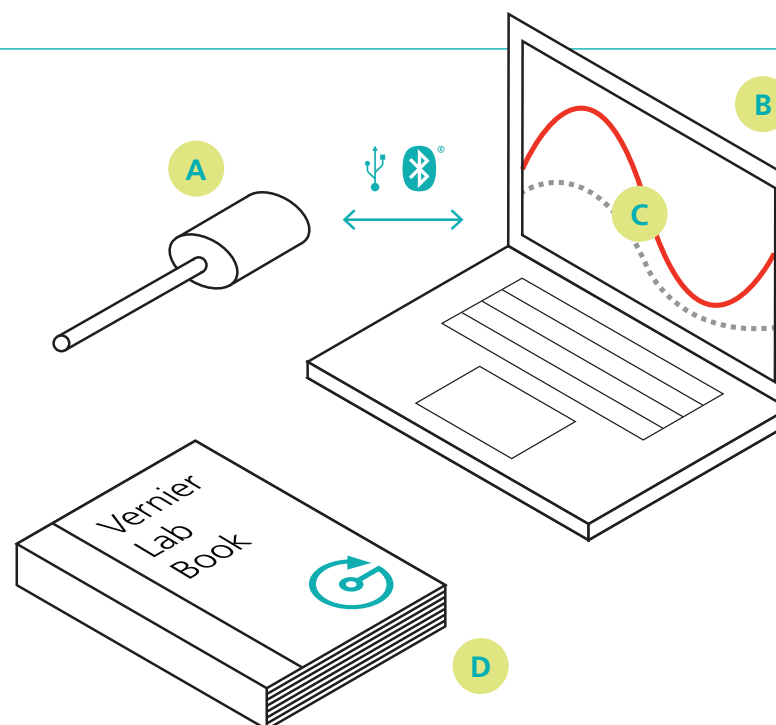
Go Direct sensors connect to a wide variety of devices commonly used in classrooms and laboratories, including Chromebooks, computers, mobile devices, and LabQuest 2.

### C Graphical Analysis™ 4 app

Our free data-collection app facilitates student understanding with real-time graphs of experimental data. No additional software purchase is necessary.

### D Lab Book

Step-by-step instructions at your fingertips save valuable time when integrating probeware into your curriculum. Many of our lab books provide updated support for Go Direct sensors and the Graphical Analysis 4 app.



# Getting Started with LabQuest Sensors

## Why Choose LabQuest Sensors?

With over 80 sensors to choose from, our LabQuest family of sensors offers the widest variety of experiments to integrate into your existing curriculum. Connect LabQuest sensors with an interface to your device, or use LabQuest 2 as a standalone device in the field or on the benchtop. With LabQuest 2, you can also transfer data wirelessly via Wi-Fi to one or more devices.

### LabQuest Sensors

See page 135.

### Interfaces

See pp. 10–17.

### Software

See pp. 18–19, 22–23.

### Lab Books

See pp. 26–27.

## LABQUEST®

### What You Need to Get Started

#### A LabQuest Sensor

LabQuest sensors share data with your device via a wired connection (BTA/BTD) to an interface from the LabQuest family.

#### B Interface

An interface sends information from the sensor to the data-collection and analysis software. The LabQuest family includes LabQuest 2, LabQuest Stream®, and LabQuest Mini.

#### C Device

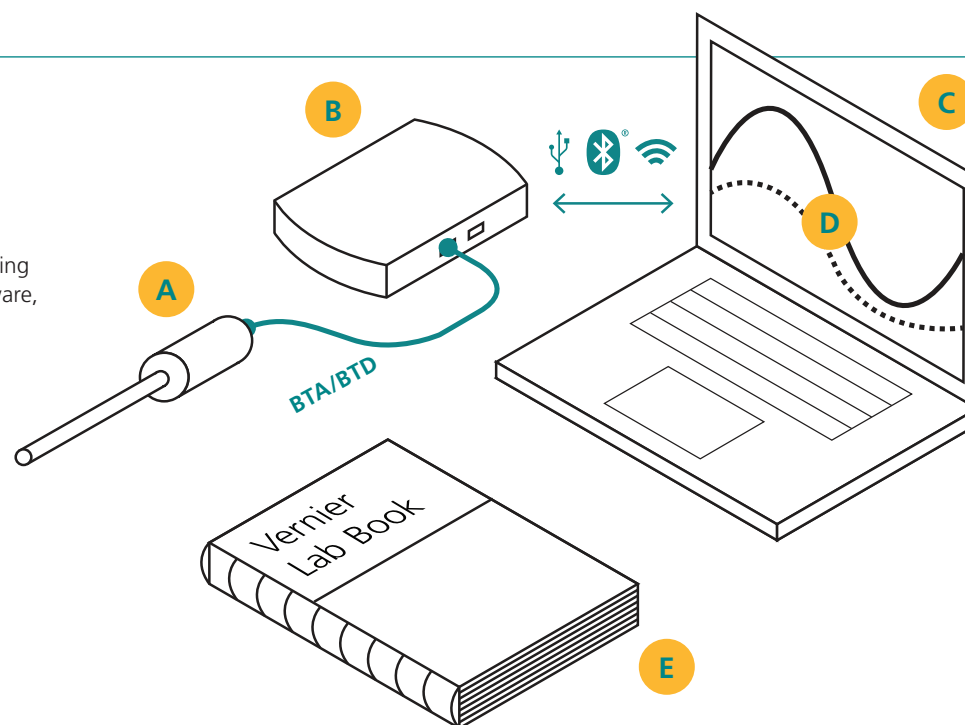
LabQuest sensors connect to computers, Chromebooks, and mobile devices through a LabQuest interface.

#### D Software

Our LabQuest family of interfaces are supported by our award-winning data-collection and analysis software, including Graphical Analysis 4, Logger Pro® 3, and Logger Lite®.

#### E Lab Book

Our popular, award-winning lab books provide hundreds of well-tested, customizable experiments.



# Go Direct Data Logging

[www.vernier.com/go-direct](http://www.vernier.com/go-direct)



## A complete sensing solution in each sensor— collect and directly stream data to your device.

These sensors connect directly with computers, Chromebook, LabQuest 2, and iOS and Android devices via Bluetooth wireless technology or USB.

### 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 app
- Over 40 Go Direct sensors available, with more to be released throughout this year
- Backed by Stellar Service from Vernier

## Go Direct<sup>®</sup> Sensors

### Connection



Connects directly via USB or Bluetooth<sup>®</sup> wireless technology to your device



Computer



Chromebook<sup>™</sup>



LabQuest<sup>®</sup> 2

### Compatible Platforms



iOS device



Android<sup>™</sup> device

### Software



FREE Graphical Analysis<sup>™</sup> 4,  
LabQuest App (LabQuest 2 only)



## Go Direct Sensor

	Biology	Chemistry	Earth Science	Elementary Science	Environmental Science	Middle School Science	Physical Science	Physics
Go Direct 3-Axis Magnetic Field								
Go Direct Acceleration								
Go Direct CO <sub>2</sub> Gas								
Go Direct Colorimeter								
Go Direct Conductivity								
Go Direct Constant Current System								
Go Direct Current								
Go Direct Drop Counter								
Go Direct EKG								
Go Direct Electrode Amplifier								
Go Direct Energy								
<b>NEW</b> Go Direct Ethanol Vapor								
Go Direct Force and Acceleration								
Go Direct Gas Pressure								
<b>NEW</b> Go Direct Hand Dynamometer								
Go Wireless Heart Rate								
<b>NEW</b> Go Direct Ion-Selective Electrodes								

## Go Direct Sensor

	Biology	Chemistry	Earth Science	Elementary Science	Environmental Science	Middle School Science	Physical Science	Physics
Go Direct Light and Color								
Go Direct Melt Station								
Go Direct Motion								
Go Direct O <sub>2</sub> Gas								
Go Direct Optical Dissolved Oxygen								
Go Direct ORP								
Go Direct pH Sensors								
<b>NEW</b> Go Direct Photogate								
<b>NEW</b> Go Direct Projectile Launcher								
Go Direct Radiation Monitor								
Go Direct Respiration Belt								
Go Direct Rotary Motion								
Go Direct Sensor Carts								
<b>NEW</b> Go Direct Sound								
Go Direct SpectroVis® Plus								
Go Direct Temperature Probes								
Go Direct Voltage								

For more information on our Go Direct sensors, visit [www.vernier.com/go-direct](http://www.vernier.com/go-direct)

# Interface Data Logging

[www.vernier.com/interfaces](http://www.vernier.com/interfaces)

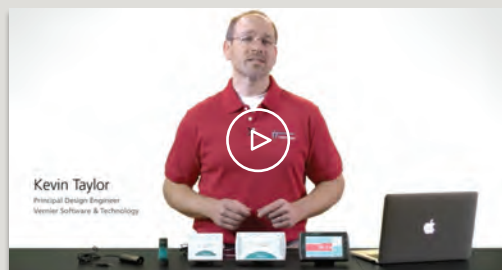


**Connect a LabQuest® sensor to a Vernier interface to collect and analyze data on your device.**

LabQuest sensors require an interface from the LabQuest family to send data to computers, Chromebooks, and iOS and Android™ devices. Our interfaces are supported by our award-winning data-collection software, including Graphical Analysis™ 4, Logger Pro® 3, and Logger Lite®.

**Need help deciding which Vernier interface is right for you?**

Watch our video overview for a comparison at [www.vernier.com/interfaces](http://www.vernier.com/interfaces)



## Interface Comparison

Interface	Order Code	Connection	Compatible Platforms				Software				Page
			Computer	Chromebook	iOS Device	Android Device	LabQuest App	Graphical Analysis 4	Logger Pro 3	Logger Lite	
		Standalone					•				
LabQuest 2	LABQ2	USB	•	•				•	•	•	12–15
		Wi-Fi	•	•	•	•		•			
LabQuest Stream®	LQ-STREAM	USB	•	•				•	•	•	16
		Bluetooth® Wireless Technology	•		•	•		•	•		
LabQuest Mini	LQ-MINI	USB	•	•				•	•	•	17
Go! Link*	GO-LINK	USB	•	•				•	•	•	web

\* Limited sensor support. See [www.vernier.com/go-link](http://www.vernier.com/go-link) for supported sensors.

LabQuest Sensor	Biology	Chemistry	Earth Science	Elementary Science	Environmental Science	Middle School Science	Physical Science	Physics
Accelerometers	●						●	●
Anemometer			●		●			
Barometer			●		●	●		
Blood Pressure Sensor	●							
Charge Sensor								●
CO <sub>2</sub> Gas Sensor	●		●		●			
Colorimeter	●	●			●			
Conductivity Probes	●	●	●		●	●	●	
Constant Current System		●						
Current Probes		●	●		●	●	●	●
Diffraction Apparatus								●
Dissolved Oxygen Probes	●		●		●	●		
Drop Counter		●			●			
EKG Sensor	●							
Electrode Amplifier		●						
Energy Sensor			●	●	●	●	●	
Ethanol Sensor	●							
Flow Rate Sensor			●		●			
Force Sensors				●		●	●	●
Gas Pressure Sensors	●	●		●		●	●	●
Goniometer	●							
Hand Dynamometer	●					●		
Heart Rate Monitors	●					●		
Instrumentation Amplifier		●						●
Ion-Selective Electrodes		●			●			
Light Sensor			●	●	●	●	●	●

LabQuest Sensor	Biology	Chemistry	Earth Science	Elementary Science	Environmental Science	Middle School Science	Physical Science	Physics
Magnetic Field Sensor			●	●		●	●	●
Melt Station		●						
Microphone							●	●
Motion Detectors			●	●		●	●	●
O <sub>2</sub> Gas Sensor	●		●		●			
ORP Sensor		●						
PAR Sensor	●				●			
pH Sensors	●	●	●		●	●	●	
Photogate							●	●
Polarimeter (Chemical)		●						
Power Amplifier								●
Projectile Launcher							●	●
Pyranometer					●			
Radiation Monitor		●						●
Relative Humidity Sensor			●		●			
Respiration Monitor Belt	●							
Rotary Motion Sensor								●
Salinity Sensor					●			
Soil Moisture Sensor					●			
Sound Level Sensor						●	●	●
Spirometer	●							
Structures & Materials Tester						●	●	●
Temperature Probes	●	●	●	●	●	●	●	●
Turbidity Sensor					●			
UV Sensors					●	●		
Voltage Probes		●	●	●	●	●	●	●

For more information on our LabQuest sensors, visit [www.vernier.com/labquest-sensors](http://www.vernier.com/labquest-sensors)



## Data Collection with LabQuest 2

The most engaging and effective approach to science is hands on, with students collecting and analyzing data to understand and apply core concepts. 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.

## Award-Winning



## LabQuest® 2

The freedom to inquire. The technology to excel.

- Use as a standalone device with all Vernier sensors.
- Connect to a Windows® or macOS® computer for use with Logger Pro® 3, Logger Lite®, or Graphical Analysis™ 4.
- Transfer data wirelessly to iOS and Android™ devices, Chromebooks, and computers running Graphical Analysis 4.

LABQ2

## 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, and stylus tether

## Features

### Full sensor support

Compatible with all Vernier sensors

### 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

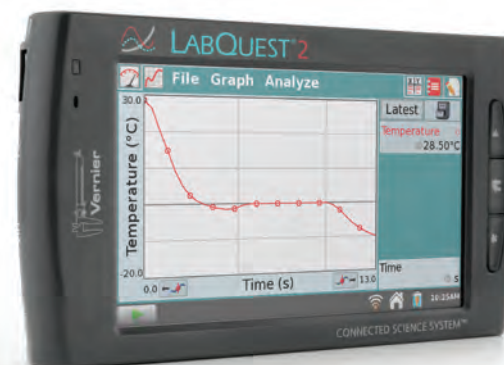
### Powerful analysis tools

Statistics, curve fits, integral function, and modeling

### High-capacity, lithium-ion rechargeable battery

### Wireless connectivity

- Wi-Fi
- Bluetooth® wireless technology



## 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<sub>2</sub> 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

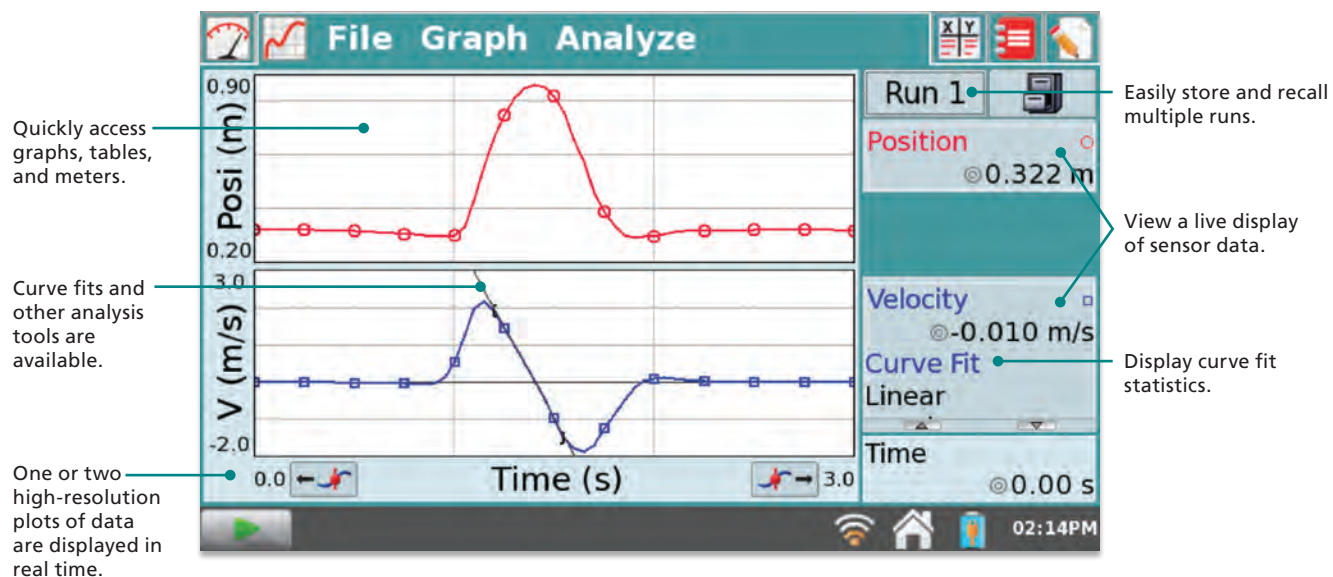
- Perform curve fits.
- View graphs in landscape and portrait orientations.
- Use built-in sensors—GPS, microphone, accelerometers, relative light sensor, and temperature.
- Draw a prediction before collecting data.
- Display two graphs at once.
- Display a tangent line on the graph.
- Use the Integral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

### Built-in Applications

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

### Other Great Features

- Transfer data wirelessly (using Wi-Fi) to computers, Chromebooks, and iOS and Android devices running Graphical Analysis 4.
- Export data to Logger Pro 3.
- 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 annotations with internal microphone.
- Find slopes, fit a line to a portion of your data, and display position data and its derivatives.



## One-Touch Simplicity

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.

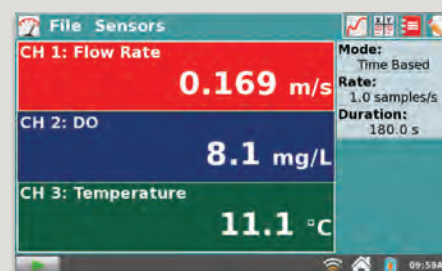
File Table

Data Set

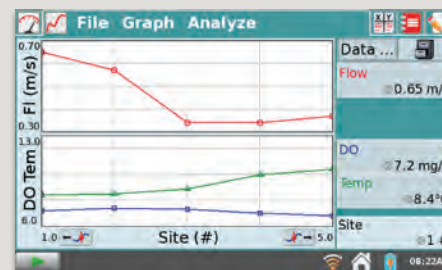
Site (#)	Flow (m/s)	DO (mg/L)	Temp (°C)
1	0.65	7.2	8.4
2	0.57	7.4	8.5
3	0.34	7.3	8.9
4	0.34	7.0	10.0
5	0.37	6.8	10.4
6	0.32	6.6	10.9
7	0.30	6.5	11.5

09:36AM

Data Table



Meter

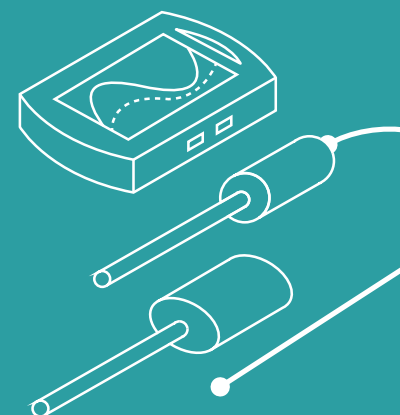


Graph

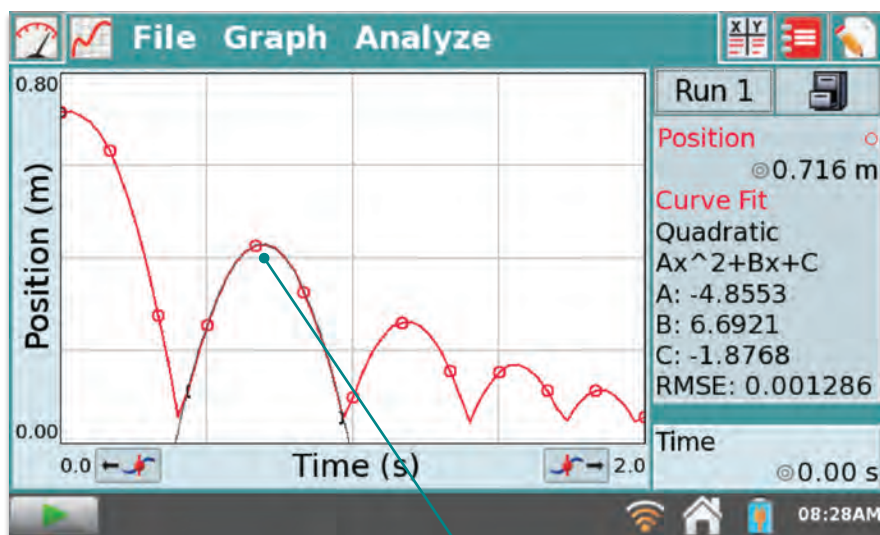
## Compatible Sensors

LabQuest 2 works with all of our sensors—both LabQuest and Go Direct.

[www.vernier.com/labquest2](http://www.vernier.com/labquest2)

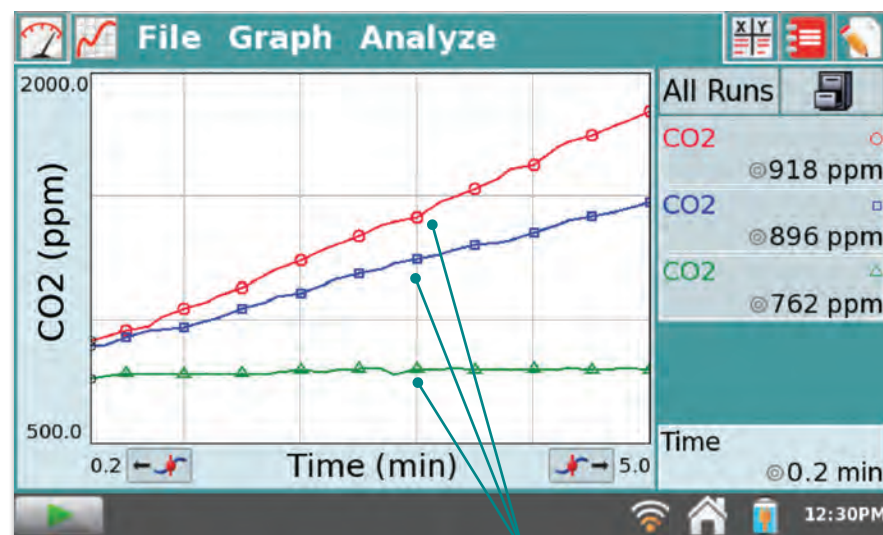


## Data Analysis at Your Fingertips



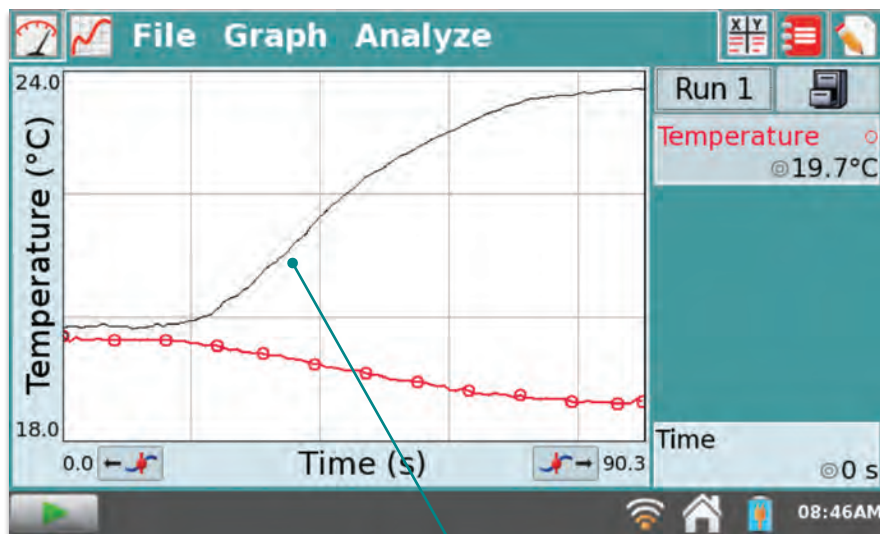
Position vs. time graph of a bouncing ball

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



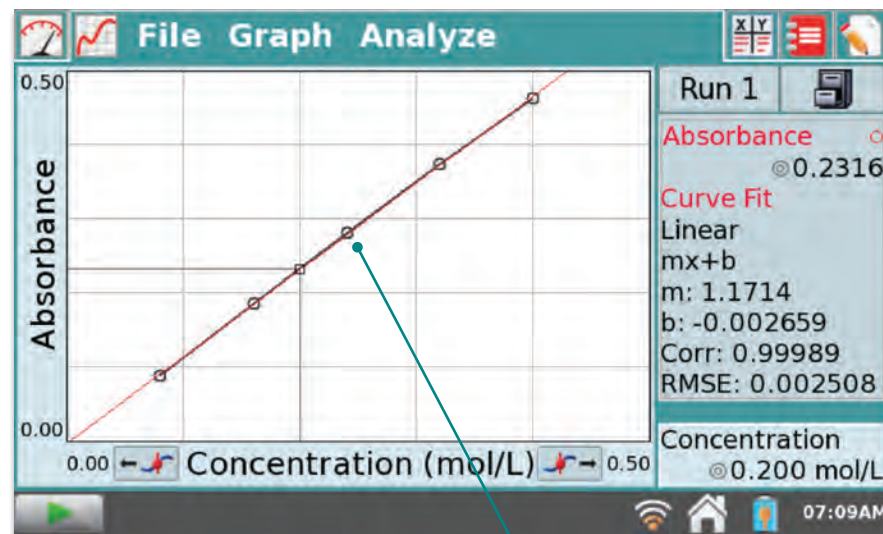
Investigating the rate of cellular respiration at different temperatures

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 address preconceptions.



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

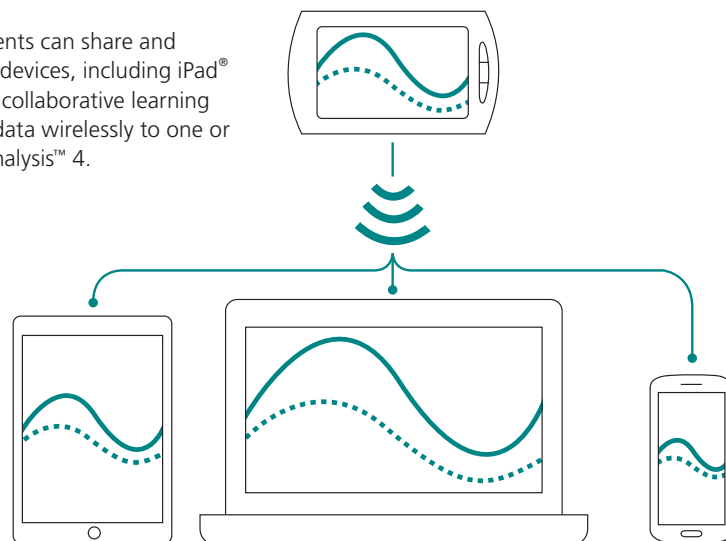
Use the analyze tools to determine the concentration of an unknown.



## Wirelessly Transfer Data to Chromebooks, Computers, and iOS and Android™ Devices

With Data Sharing and LabQuest® 2, students can share and analyze real-time data on multiple mobile devices, including iPad® and Android tablets, 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](http://www.vernier.com/data-sharing)



## LabQuest Charge Station

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

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

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



## LabQuest 2 Accessories and Replacement Parts

Part Name	Order Code
LabQuest Charge Station	LQ2-CRG
LabQuest 2 Lab Armor	LQ2-ARMOR
LabQuest 2 Stand	LQ2-STN
LabQuest Power Supply	LQ-PS
LabQuest Stylus 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
Vernier USB Type C to Mini USB Cable	CB-USB-C-MINI

Can't find the accessory you need? Check our complete list of accessories (including pictures) at [www.vernier.com/lq2-accessories](http://www.vernier.com/lq2-accessories)

## LabQuest 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 or computer using Bluetooth® wireless technology rather than Wi-Fi. This is 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.

LQ-STREAM

### Technical Specifications

Software Requirements	<ul style="list-style-type: none"> <li>Graphical Analysis™ 4</li> <li>Logger Pro® 3</li> <li>Logger Lite®</li> </ul>
Analog Inputs	3
Digital Inputs	2
Bluetooth Sampling Rate	10,000 samples per second
Wired Sampling Rate	100,000 samples per second

### 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 75 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

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



Power port for AC power or to recharge the built-in battery



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



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<sub>2</sub> sensors

## LabQuest® 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 or Chromebook, LabQuest Mini interfaces with Graphical Analysis 4, Logger Lite, and Logger Pro 3 software.

LQ-MINI

### Technical Specifications

Dimensions	10.5 cm × 8.5 cm × 2.6 cm
Computer Connection	USB 2.0 Full Speed
Software Requirements	<ul style="list-style-type: none"> <li>Graphical Analysis 4</li> <li>Logger Pro 3</li> <li>Logger Lite</li> </ul>
Analog Inputs	3
Digital Inputs	2
Maximum Sampling Rate	100,000 samples per second

### Features

- A maximum sampling rate of 100,000 per second gives you the unrivaled power of LabQuest.
- Five sensor ports give you the flexibility to choose from over 75 compatible sensors.

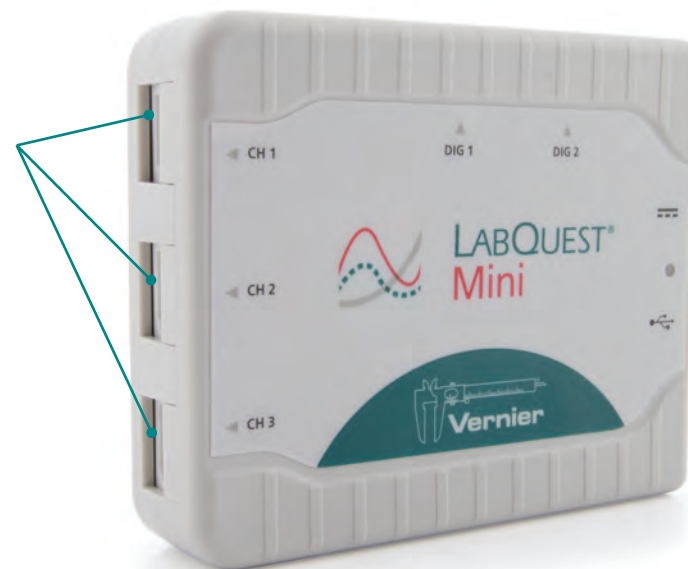
### Award-Winning



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

— Tech & Learning

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.



Auxiliary power port

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

# Software

[www.vernier.com/software](http://www.vernier.com/software)



FREE

## GRAPHICAL ANALYSIS 4

### Graphical Analysis™ 4

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

Using Graphical Analysis 4, you can collect data from nearly all Vernier devices including

- Go Direct sensors
- LabQuest sensors connected to a compatible interface
- LabQuest 2 or Logger Pro® 3 Data Sharing source

### Go Direct® Sensors

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

See page 134 for Go Direct sensors.

### LabQuest® Sensors

Use Graphical Analysis 4 with more than 75 Vernier LabQuest sensors. Connect LabQuest sensors to an interface from the LabQuest family, including LabQuest Mini, LabQuest Stream®, or LabQuest 2.

See page 135 for LabQuest sensors.

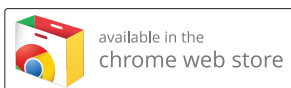
See page 10 for interface options.

### Data Sharing

Students can work together in a lab group to collect data on either LabQuest 2 or a computer running Logger Pro 3 software and share the data over a network. Each lab group member will then receive the same data to analyze separately on any platform with Graphical Analysis 4.

See how Data Sharing works at [www.vernier.com/data-sharing](http://www.vernier.com/data-sharing)

### Download Graphical Analysis 4



Download for Windows and macOS at [www.vernier.com/graphical-analysis](http://www.vernier.com/graphical-analysis)



### Award Winning



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

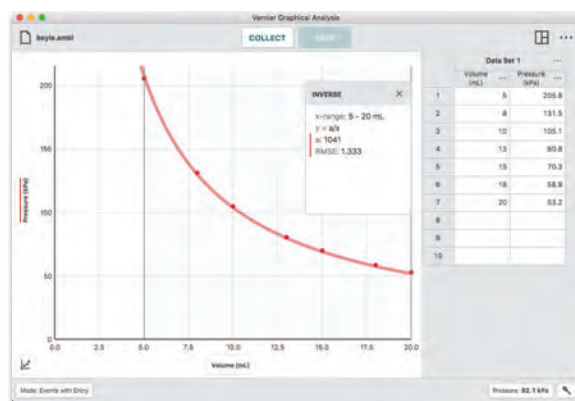


*BESSIE Award for best educational software for multi-level/data analysis*

## Key Features

### Data Collection

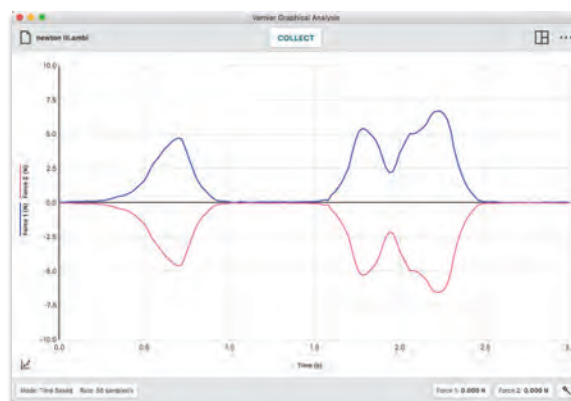
- Collect data from multiple sensors simultaneously, either with a multiple-channel interface such as LabQuest Stream or by using multiple Go Direct sensors. Use Data Sharing to retrieve data from just about every Vernier sensor.
- Select time-based or event-based data collection, including events with 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.



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

### 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 a calculated data set based on sensor data. Use this to linearize a graph, or perform other analysis.
- View data in a table.
- Highlight and read values from a graph.
- Interpolate and extrapolate using graphed data.



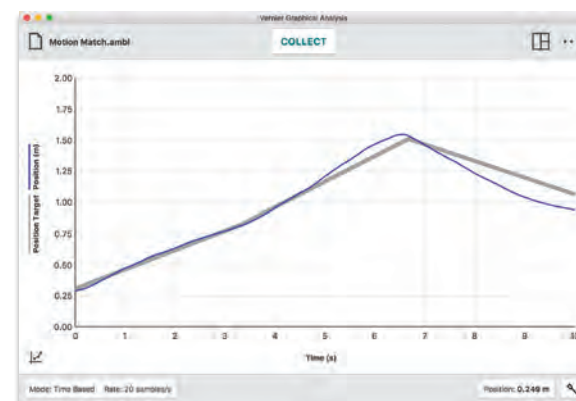
Collect data from multiple sensors simultaneously. Use two force sensors to demonstrate Newton's third law.

### Data Sharing

- Receive data shared from LabQuest 2 or a computer running Logger Pro 3 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 for use in Logger Pro 3.



Perform a graph match exercise with a motion detector and Graphical Analysis 4.





## Vernier Spectral Analysis®

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

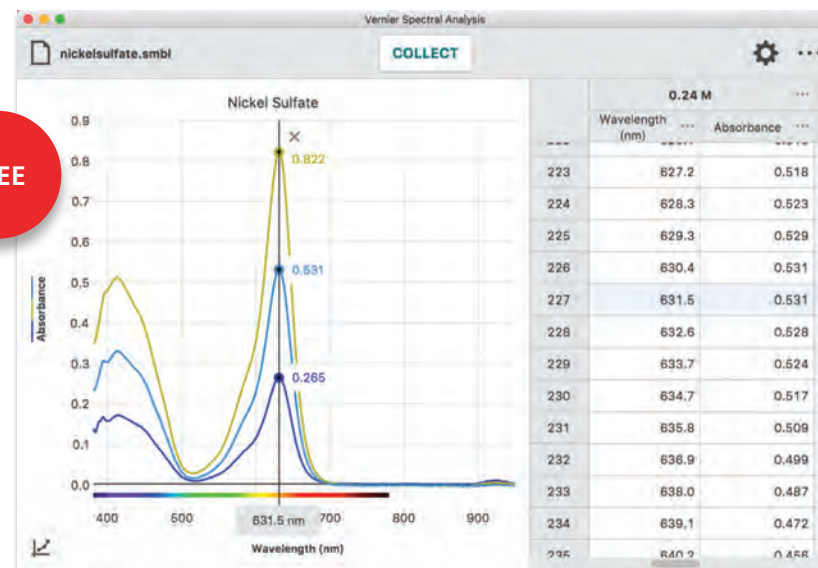
Our free Spectral Analysis app makes it easy to incorporate spectroscopy into your biology, chemistry, and physics experiments. Using the app, students can collect a full spectrum and explore topics such as Beer's law, enzyme kinetics, and plant pigments.

The user-friendly software includes analysis features such as curve fitting and data interpolation.

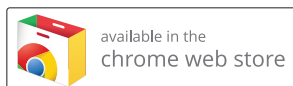
### Features

- Follow on-screen instructions for simplified Beer's law or kinetics data collection.
- Collect full spectrum absorbance or % transmittance data in less than one second.
- Analyze data with built-in analysis tools, including data interpolation and curve fittings.
- Determine the order of kinetics reaction with the calculated columns function.
- Understand color transmission using the color strip shown on full spectrum graphs.
- View a full spectrum of your sample while collecting data for Beer's law or kinetic experiments.
- View spectral lines by collecting intensity vs. wavelength data.

FREE

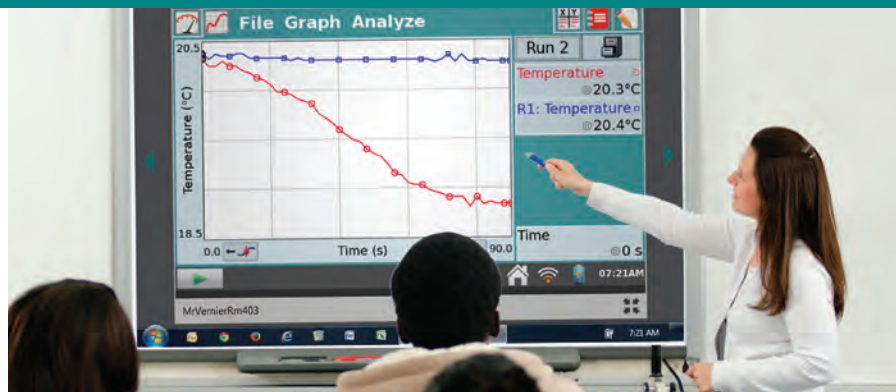


Download  
Spectral Analysis



Download for Windows and macOS at  
[www.vernier.com/spectral-analysis](http://www.vernier.com/spectral-analysis)





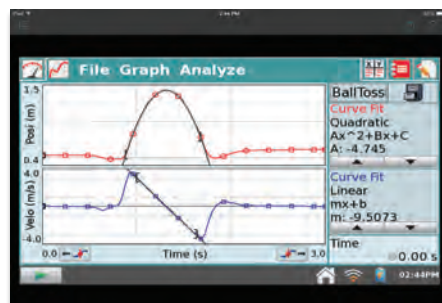
## LabQuest Viewer® Software

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 macOS and Windows computers.

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

For more information, visit [www.vernier.com/lq-view](http://www.vernier.com/lq-view)

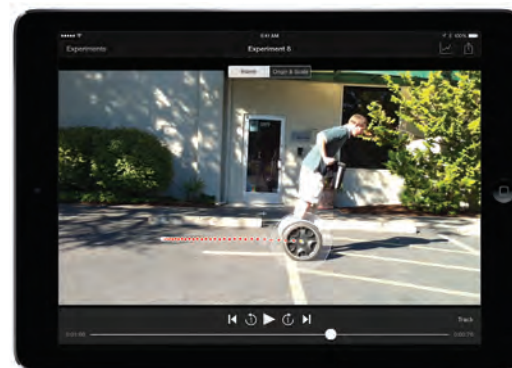
LQ-VIEW



## LabQuest Viewer for iPad

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

For more information, visit [www.vernier.com/lq-view-ipad](http://www.vernier.com/lq-view-ipad)



Video analysis of an accelerating Segway®

## Video Physics™

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

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

### Ways to use Video Physics in the classroom

- 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, position, and velocity.
- Export video with points.
- Email the video and data for further analysis in Vernier Logger Pro® 3 software for macOS and Windows.
- Open data files directly in our Graphical Analysis™ 4 software.

For more information, visit [www.vernier.com/video-physics](http://www.vernier.com/video-physics)





## Real-Time Graphing and Powerful Analytical Tools

Logger Pro 3 is our flagship data-collection and analysis software for Windows® and macOS® computers. With a complete suite of data-collection and analysis tools, Logger Pro 3 is suitable for all students, from beginning to advanced.

- One program does it all—for all of your computers AND your students' personal computers.
- Think of Logger Pro 3 as the digital data hub of your classroom and lab. It can gather data from a variety of sources, including LabQuest® 2, LabQuest Mini, LabQuest Stream®, Go! Link, OHAUS® balances, compatible TI graphing calculators, and spectrometers.

## Logger Pro® 3

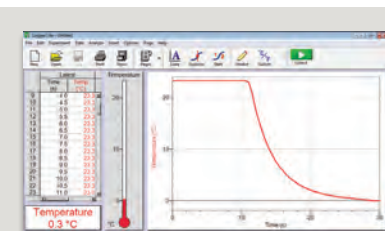
- Logger Pro 3 includes a site license for your entire school or college department.
  - Site license includes home computers of faculty.
  - Site license includes home computers of students—let them take it home!
- Logger Pro 3 updates are free.
- Logger Pro 3 Data Sharing
  - Supports Graphical Analysis™ 4 for iOS, Android, Chrome™, and computers
  - Streams data to multiple devices, allowing for individualized learning in lab groups and classrooms

with manual and CD

LP

electronic download\*

LP-E



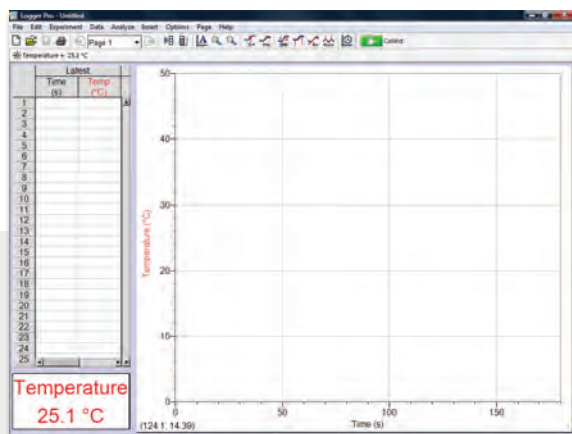
## Logger Lite®

**Don't need all this power or working with younger students?**

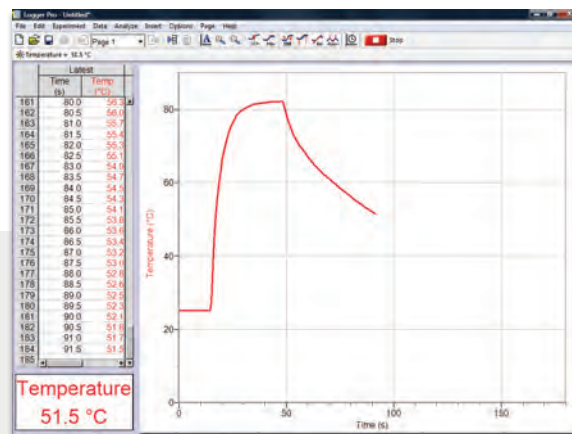
Logger Lite, a streamlined subset of Logger Pro 3, is available at no charge for use with LabQuest 2, LabQuest Mini, Go! Link, Go!Temp, and Go! Motion.

[www.vernier.com/logger-lite](http://www.vernier.com/logger-lite)

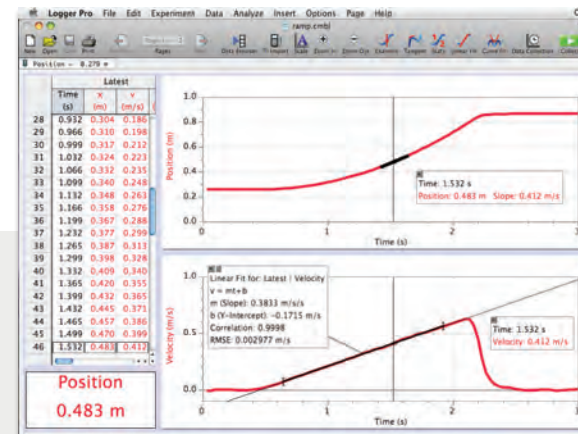
## Award-Winning



Start Logger Pro 3 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 3 draws the graph in real time, and the data table and digital meter update continuously.



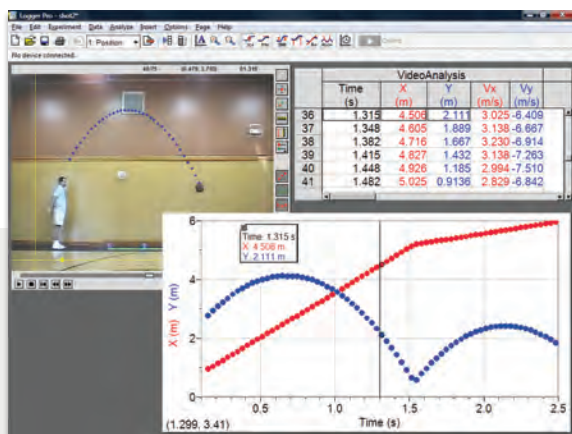
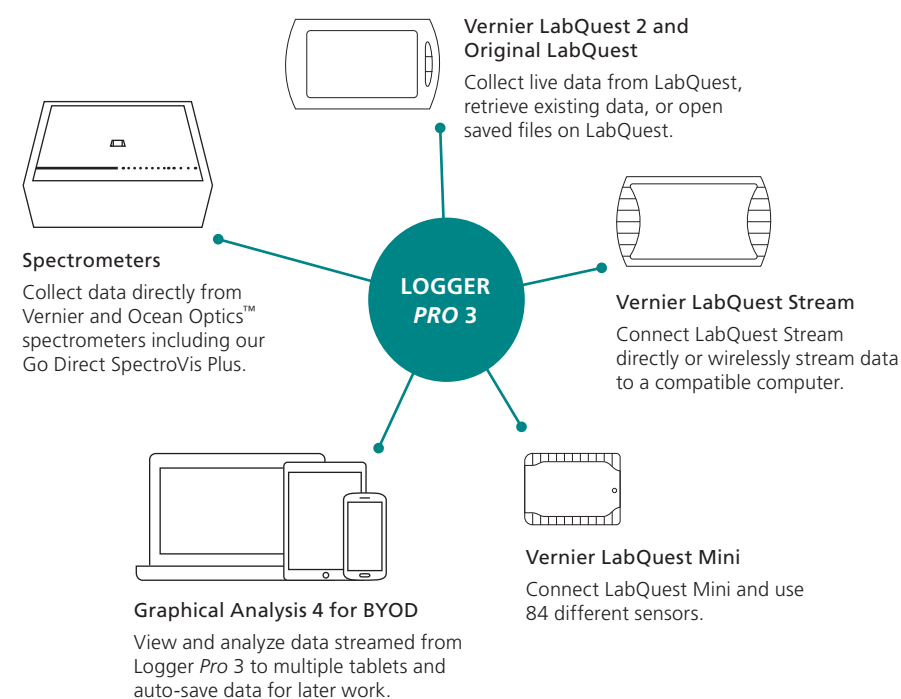
Draw tangent lines to find local slopes and fit lines to selected regions—the analysis tools you need are at your fingertips in Logger Pro 3.

## Logger Pro® 3 Features

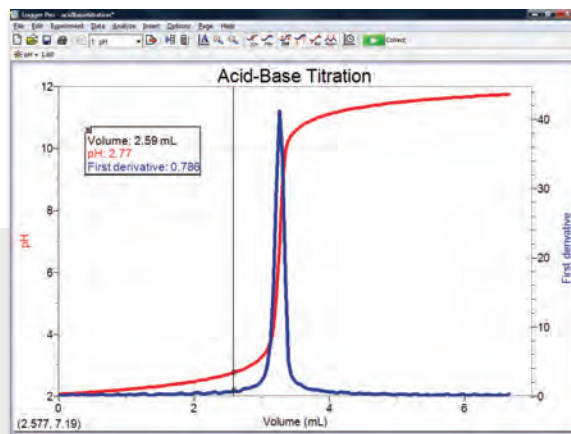
- Auto-ID sensors make setup effortless—simply connect a sensor, open Logger Pro 3, and click Collect.
- Collect live data from more than 100 different sensors and devices.
- Draw predictions on a graph before collecting data.
- Use a variety of data-collection modes for your experiment: time-based data, 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.
- Create calculated columns to graph new quantities, such as kinetic energy.
- Perform GC (gas chromatograph) peak analysis.

Note: Logger Pro 3 cannot be used to collect data with our Go Direct® sensors (other than Go Direct SpectroVis® Plus).

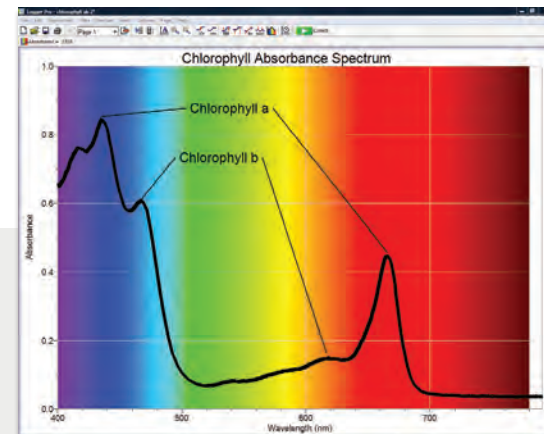
## What Can I Do with Logger Pro 3?



Analyze videos to study the motion of individual or multiple objects. This feature alone is worth the price of Logger Pro 3!



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.



# Lab Books

[www.vernier.com/books](http://www.vernier.com/books)



## E-Version and Printed Books—The Choice is Yours

Many of our popular, award-winning lab books are available in both e-version and printed formats. When you purchase either format, you receive

- Access to the most up-to-date versions of experiments on all supported software including Graphical Analysis™ 4, Vernier Spectral Analysis®, LabQuest® App, Logger Pro® 3, and EasyData® through your Vernier account
- 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

If you love having the physical book in your hands, simply purchase the printed book when available. The printed book also includes access to the e-version.

**NGSS  
ALIGNED**

To learn about the Next Generation Science Standards and Vernier, visit [www.vernier.com/ngss](http://www.vernier.com/ngss)





## 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® 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.

\* 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.

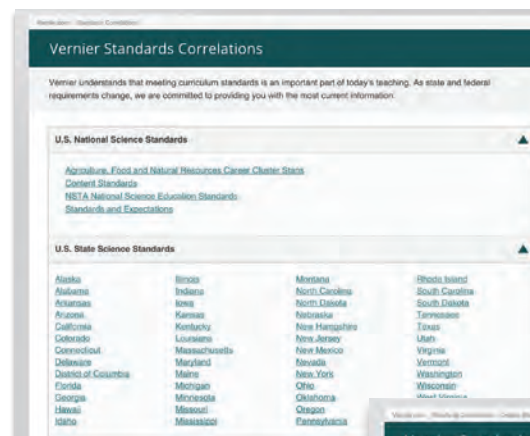
† The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

## Helping You Meet Content Standards

Vernier understands that meeting curriculum standards is an important part of teaching. As state and federal requirements change, we are committed to providing you with the most current information. You will find alignments to the following standards for all lab books published by Vernier at [www.vernier.com/standards](http://www.vernier.com/standards)

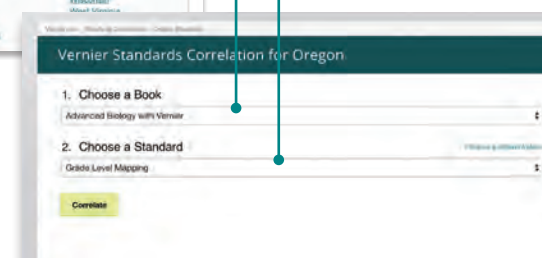
- Science standards for all 50 U.S. states
- NGSS (Next Generation Science Standards)
- NSES (National Science Education Standards)
- AP\* and IB†
- NCTM (National Council for Teachers of Mathematics)
- ISTE (International Society for Technology Educators)

## Vernier Standards Correlation for Your State














Choose the book you'd like to correlate.

Choose the standard to which you'd like to correlate.



For more information,  
visit [www.vernier.com/standards](http://www.vernier.com/standards)

## Lab Books by Subject

Lab Books by Subject	Appropriate for				Order Code		Page
	Elementary	Middle School	High School	College	Electronic	Printed	
Biology							
Biology with Vernier 	—	—	●	●	BWV-E	BWV	41
<b>UPDATED</b> Investigating Biology through Inquiry* 	—	—	●	●	BIO-I-E	BIO-I	42
Advanced Biology with Vernier	—	—	●	●	BIO-A-E	BIO-A	42
<b>NEW</b> Human Physiology Experiments 	—	—	●	●	HSB-HP-E	HSB-HP	43
Agricultural Science with Vernier	—	—	●	—	AWV-E	AWV	43
Chemistry							
Chemistry with Vernier 	—	—	●	●	CWV-E	CWV	61
Vernier Chemistry Investigations for Use with AP* Chemistry 	—	—	●	—	APCHEM-E	APCHEM	62
Investigating Chemistry through Inquiry 	—	—	●	●	CHEM-I-E	CHEM-I	63
Advanced Chemistry with Vernier 	—	—	●	●	CHEM-A-E	CHEM-A	62
<b>UPDATED</b> Organic Chemistry with Vernier	—	—	—	●	CHEM-O-E	CHEM-O	63
Forensics with Vernier	—	—	●	—	FWV-E	FWV	<a href="#">web</a>
Earth Science							
Earth Science with Vernier	—	●	●	—	ESV-E	ESV	67
Elementary Science							
Elementary Science with Vernier 	●	—	—	—	EWV-E	EWV	71
<b>UPDATED</b> Investigating Solar Energy 	●	—	—	—	ELB-SOLAR-E	ELB-SOLAR	71
<b>UPDATED</b> Investigating Wind Energy 	●	—	—	—	ELB-WIND-E	ELB-WIND	71
<b>UPDATED</b> Investigating Temperature 	●	—	—	—	ELB-TEMP-E	ELB-TEMP	<a href="#">web</a>
Engineering							
Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3	—	●	●	—	EP-EV3-E	—	75
Engineering Projects with NI LabVIEW™ and Vernier	—	—	●	●	EPV-E	—	79
<b>NEW</b> Coding with mBot: Self-Driving Vehicles	●	●	●	—	MBOT-MSDV-E	—	77
<b>NEW</b> Coding with Codey Rocky: Mission to Mars	●	—	—	—	MBCR-M2M-E	—	76



Supports Go Direct® sensors with Graphical Analysis™ 4 app

Complete list of supported software titles available on the corresponding page for each book

Lab Books by Subject	Appropriate for				Order Code		Page
	Elementary	Middle School	High School	College	Electronic	Printed	
Environmental Science							
<i>Investigating Environmental Science through Inquiry*</i>	—	—	●	●	ESI-E	ESI	92
<i>Water Quality with Vernier</i>	—	●	●	●	WQV-E	WQV	93
<b>UPDATED</b> <i>Renewable Energy with Vernier</i>	—	●	●	●	REV-E	REV	93
Middle School Science							
<i>Middle School Science with Vernier</i>	—	●	—	—	MSV-E	MSV	100
<b>NEW</b> <i>Exploring Motion and Force with Go Direct Sensor Cart</i>	—	●	—	—	MSB-CART-E	—	101
<b>NEW</b> <i>Solar Energy Explorations</i>	—	●	—	—	MSB-SOLAR-E	—	101
<b>NEW</b> <i>Wind Energy Explorations</i>	—	●	—	—	MSB-WIND-E	—	101
Physical Science							
<i>Physical Science with Vernier</i>	—	●	●	—	PSV-E	PSV	105
Physics							
<i>Physics with Vernier</i>	—	—	●	●	PWV-E	PWV	129
<i>Physics Explorations and Projects</i>	—	—	●	●	PEP-E	PEP	130
<i>Advanced Physics with Vernier—Mechanics*</i>	—	—	●	●	PHYS-AM-E	PHYS-AM	130
<i>Advanced Physics with Vernier—Beyond Mechanics*</i>	—	—	●	●	PHYS-ABM-E	PHYS-ABM	131
<i>Physics with Video Analysis</i>	—	—	●	●	PVA-E	PVA	131
Mathematics							
<i>Real-World Math with Vernier</i>	—	—	●	—	RWV-E	RWV	<a href="#">web</a>
Spanish Language Lab Books							
<i>Química con Vernier</i> <a href="http://www.vernier.com/cwv-es">www.vernier.com/cwv-es</a>	—	—	●	●	CWV-ES-E	CWV-ES	61
<i>Física con Vernier</i> <a href="http://www.vernier.com/pwv-es">www.vernier.com/pwv-es</a>	—	—	●	●	PWV-ES-E	PWV-ES	129
<i>Ciencias con lo Mejor de Vernier</i> <a href="http://www.vernier.com/cmv-lp">www.vernier.com/cmv-lp</a>	—	—	●	—	CMV-LP-E	CMV-LP	<a href="#">web</a>
<i>Energía Renovable con Vernier</i> <a href="http://www.vernier.com/rev-es">www.vernier.com/rev-es</a>	—	●	●	●	REV-ES-E	REV-ES	93
<i>Ciencia en la Primaria con Vernier</i> <a href="http://www.vernier.com/cpv">www.vernier.com/cpv</a>	●	—	—	—	CPV-E	CPV	71

\* Designed to support the AP curriculum framework published by the College Board. 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.

Investigating respiration  
and photosynthesis using  
spinach leaves



# Biology

[www.vernier.com/biology](http://www.vernier.com/biology)





## PACKAGES

Go Direct® and LabQuest® Packages pp. 30–33

### GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct Acceleration	GDX-ACC	111
Go Direct CO <sub>2</sub> Gas	GDX-CO2	34
Go Direct Colorimeter	GDX-COL	50
Go Direct Conductivity	GDX-CON	36
Go Direct EKG	GDX-EKG	35
<b>NEW</b> Go Direct Ethanol Vapor	GDX-ETOH	36
Go Direct Force and Acceleration	GDX-FOR	35
Go Direct Gas Pressure	GDX-GP	36
<b>NEW</b> Go Direct Hand Dynamometer	GDX-HD	35
Heart Rate Monitors		
Go Wireless Exercise Heart Rate	GW-EHR	<a href="#">web</a>
Go Wireless Heart Rate	GW-HR	35
Go Direct O <sub>2</sub> Gas	GDX-O2	34
Go Direct Optical Dissolved Oxygen	GDX-ODO	34
pH Sensors		
Go Direct pH	GDX-PH	52
Go Direct Tris-Compatible Flat pH	GDX-FPH	36
Go Direct Respiration Belt	GDX-RB	35
Go Direct SpectroVis Plus	GDX-SVISPL	36
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	35
Go Direct Temperature	GDX-TMP	36

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
25-g Accelerometer	ACC-BTA	118
Blood Pressure Sensor	BPS-BTA	<a href="#">web</a>
CO <sub>2</sub> Gas Sensor	CO2-BTA	37
Colorimeter	COL-BTA	54
Conductivity Probe	CON-BTA	54
EKG Sensor	EKG-BTA	<a href="#">web</a>
Ethanol Sensor	ETH-BTA	38
Gas Pressure Sensor	GPS-BTA	55
Goniometer	GNM-BTA	<a href="#">web</a>
Hand Dynamometer	HD-BTA	38
Heart Rate Monitors		
Exercise Heart Rate Monitor	EHR-BTA	<a href="#">web</a>
Hand-Grip Heart Rate Monitor	HGH-BTA	38
O <sub>2</sub> Gas Sensor	O2-BTA	37
Optical DO Probe	ODO-BTA	37
PAR Sensor	PAR-BTA	38
pH Sensors		
pH Sensor	PH-BTA	56
Tris-Compatible Flat pH Sensor	FPH-BTA	38
Qubit Sensors		
Qubit EKG/EMG Sensor	Q-S207	<a href="#">web</a>
Qubit GSR Sensor	Q-S222	<a href="#">web</a>
Respiration Monitor Belt (requires Gas Pressure Sensor)	RMB	<a href="#">web</a>
Soil Moisture Sensor	SMS-BTA	87
Spirometer	SPR-BTA	38
Temperature Probes		
Stainless Steel Temperature Probe	TMP-BTA	38
Surface Temperature Sensor	STS-BTA	57




## SPECTROPHOTOMETERS

Equipment	Order Code	Page
Go Direct SpectroVis® Plus	GDX-SVISPL	39
Vernier Fluorescence/UV-VIS Spectrophotometer	VSP-FUV	59
Vernier UV-VIS Spectrophotometer	VSP-UV	39

## DIGITAL MICROSCOPES

Equipment	Order Code	Page
Celestron® Digital Microscope Imager	CS-DMI	40
ProScope™ 5MP Microscope Camera	BD-PS-MC5UW	40
USB Digital Microscope	BD-EDU-100	40
ProScope Digital Microscopes	varies	<a href="#">web</a>

## LAB BOOKS

Title	Page
<i>Biology with Vernier</i> 	41
<b>UPDATED</b> <i>Investigating Biology through Inquiry</i> 	42
<i>Advanced Biology with Vernier</i>	42
<b>NEW</b> <i>Human Physiology Experiments</i> 	43
<i>Human Physiology with Vernier</i>	<a href="#">web</a>
<i>Agricultural Science with Vernier</i>	43

## RELATED CONTENT

Environmental Science	pp. 82–93
Water Quality with Vernier	page 93



## Go Direct Biology Packages

Life Science, High School Biology, AP Biology, IB Biology, and College Biology

Go Direct® sensors are perfect for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks and mobile devices



Connect Directly via USB or Bluetooth® Wireless Technology



Works with Your Existing Devices



2–4 Students per Package



Collect Data with the FREE Graphical Analysis™ 4 App

### Starter Package (4 Products)

GDP-BIO-ST



Go Direct Temperature



Go Wireless Heart Rate



Go Direct Gas Pressure



Go Direct CO<sub>2</sub> Gas



Go Direct Colorimeter



Go Direct Optical Dissolved Oxygen



Go Direct EKG



BioChamber 250

### Deluxe Package (13 Products)

GDP-BIO-ODX



Go Direct O<sub>2</sub> Gas



Go Direct Conductivity



Go Direct pH



BioChamber 2000



Go Direct Respiration Belt

### Related Lab Books



Many of the experiments in these books use sensors found in the Go Direct Biology Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see pp. 41–42.

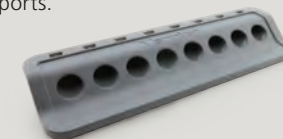
### You May Also Want

#### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



Additional recommendations available at [www.vernier.com/packages/biology](http://www.vernier.com/packages/biology)

## LabQuest Biology Packages

Life Science, High School Biology, AP Biology, IB Biology, and College Biology

Use LabQuest® 2 as a Standalone Device

LabQuest 2 works with all Vernier sensors and built-in LabQuest App.

OR

Wireless (One-to-Many)

Transfer LabQuest 2 data wirelessly via Wi-Fi to one or more devices running Graphical Analysis 4 app.

OR

Wired (One-to-One)

LabQuest 2 works with Chromebooks and Windows® and macOS® computers.



Sensors Connect to a LabQuest 2 Interface



2–4 Students per Package

### Starter Package (5 Products)

LQ2-BIO-ST



LabQuest 2



Stainless Steel Temperature Probe



Go Wireless Heart Rate



Go Direct Gas Pressure



Go Direct CO<sub>2</sub> Gas



Go Direct Conductivity



Go Direct pH



Go Direct Optical Dissolved Oxygen



Colorimeter



Go Direct EKG

### Deluxe Package (14 Products)

LQ2-BIO-ODX



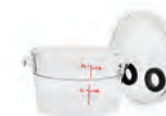
Go Direct O<sub>2</sub> Gas



BioChamber 250



Go Direct Respiration Belt



BioChamber 2000

### Related Lab Books



Many of the experiments in these books use sensors found in the LabQuest Biology Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see pp. 41–42.

### You May Also Want

#### LabQuest Charge Station

Easily charge and store your LabQuest 2 interfaces with the LabQuest Charge Station.

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

#### LabQuest Viewer® Software

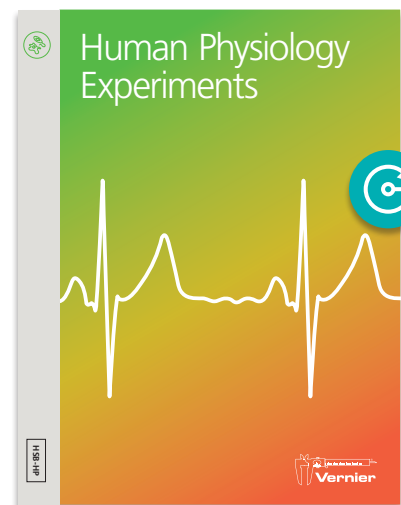
Teach your students how to use LabQuest by projecting your LabQuest screen. Display live images of your LabQuest units to monitor student progress.

See page 21.

LQ-VIEW



Additional recommendations available at [www.vernier.com/packages/biology](http://www.vernier.com/packages/biology)



## **NEW** *Human Physiology Experiments*

The experiments in the *Human Physiology Experiments* lab book encourage students to investigate the physiology of the cardiac, muscular, respiratory, vascular, and nervous systems. Setup is minimal, with students collecting data in minutes.

See page 43.



## **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 incorporating hands-on, project-based learning.

## **Project Lead The Way Biomedical Science**

Students in PLTW Biomedical Science courses (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.

For more information on Project Lead The Way, visit [www.pltw.org](http://www.pltw.org)

## Go Direct Human Physiology Package

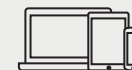
Anatomy and Physiology

Go Direct® sensors are perfect for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks and mobile devices



Connect Directly via USB or Bluetooth® Wireless Technology



Works with Your Existing Devices



2–4 Students per Package



Collect Data with the FREE Graphical Analysis™ 4 App

## Deluxe Package (9 Products)

GDP-HP-DX



Go Direct EKG



Go Direct O<sub>2</sub> Gas



Go Wireless® Heart Rate



BioChamber 250



Go Direct Surface Temperature



Go Direct Force and Acceleration



Go Direct Hand Dynamometer



Reflex Hammer Accessory Kit



Go Direct Respiration Belt

## Related Lab Book



The experiments in this book use sensors found in the Go Direct Human Physiology Package. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see page 43.

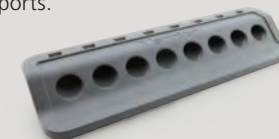
## You May Also Want

### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

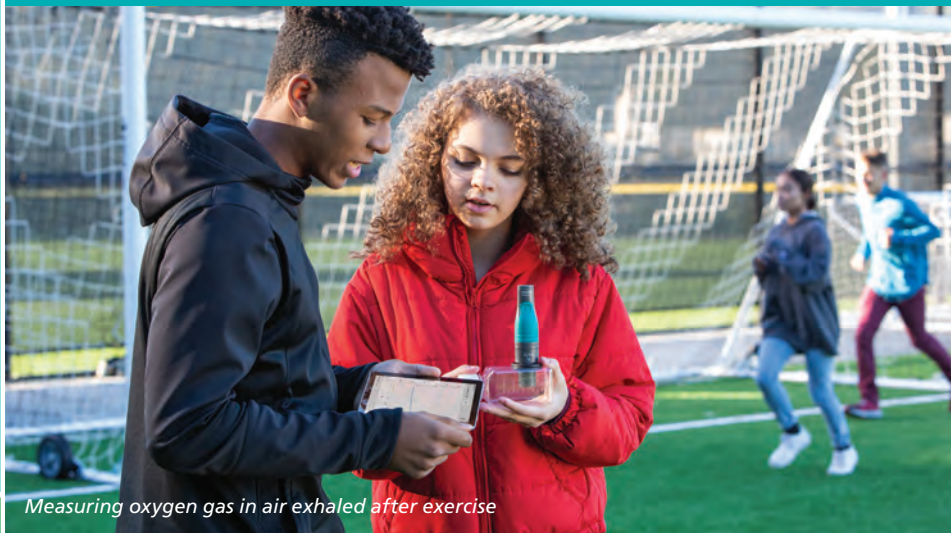
[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



Additional recommendations available at [www.vernier.com/packages/physiology](http://www.vernier.com/packages/physiology)





Measuring oxygen gas in air exhaled after exercise

## Go Direct® Sensors

### Connection



Connects directly via USB or Bluetooth® wireless technology to your device

### Compatible Platforms



Computer



Chromebook™



LabQuest® 2



iOS device



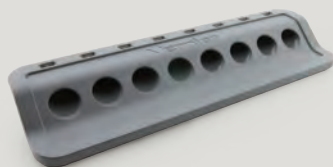
Android™ device

### Software



FREE Graphical Analysis™ 4,  
LabQuest App (LabQuest 2 only)

## You May Also Want



### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## Go Direct CO<sub>2</sub> Gas

Monitor changes in carbon dioxide, temperature, and relative humidity easily with Go Direct CO<sub>2</sub> Gas. This sensor includes built-in temperature compensation and humidity protection. A 250 mL respiration chamber is included for running controlled experiments with small plants and animals.

[www.vernier.com/gdx-co2](http://www.vernier.com/gdx-co2)

GDX-CO2



## Go Direct O<sub>2</sub> Gas

Go Direct O<sub>2</sub> Gas measures gaseous oxygen concentration and air temperature. This sensor has a wide measurement range, which is ideal for studying human and cellular respiration. A 250 mL respiration chamber is included for running controlled experiments with small plants and animals.

[www.vernier.com/gdx-o2](http://www.vernier.com/gdx-o2)

GDX-O2



## Go Direct Optical Dissolved Oxygen

Go Direct Optical Dissolved Oxygen combines the power of multiple sensors to measure dissolved oxygen, water temperature, and atmospheric pressure. Ideal for experiments in biology, ecology, and environmental science courses, this probe uses luminescent technology to provide fast, easy, and accurate results.

[www.vernier.com/gdx-odo](http://www.vernier.com/gdx-odo)

GDX-ODO



**NEW Go Direct Hand Dynamometer**

Go Direct Hand Dynamometer can be used to measure grip and pinch strength and to perform muscle fatigue studies. Students can correlate muscle strength and fatigue when they pair Go Direct Hand Dynamometer and Go Direct EKG.

[www.vernier.com/gdx-hd](http://www.vernier.com/gdx-hd)

GDX-HD

**Go Direct Force and Acceleration**

Use Go Direct Force and Acceleration in combination with the Reflex Hammer Accessory Kit to capture the strike of a reflex hammer.

[www.vernier.com/gdx-for](http://www.vernier.com/gdx-for)

GDX-FOR

**NEW Reflex Hammer Accessory Kit**

This accessory kit converts your Vernier force sensor into a reflex hammer. Utilizing this conversion kit, students can use a Vernier force sensor to capture the strike of a reflex hammer and, in combination with an EKG sensor, measure EMGs.

[www.vernier.com/rfx-acc](http://www.vernier.com/rfx-acc)

RFX-ACC

**Go Direct EKG**

Go Direct EKG measures electrical activity in the heart and electrical signals produced during muscle contractions. This sensor provides two separate outputs: one optimized for standard 3-lead EKG tracings and one optimized for surface EMG recordings.

[www.vernier.com/gdx-ekg](http://www.vernier.com/gdx-ekg)

GDX-EKG

**Go Direct Respiration Belt**

Go Direct Respiration Belt uses a force sensor and an adjustable nylon strap around the chest to measure respiration effort and respiration rate. Respiration rate is reported in the data-collection software, which makes it easy to do comparison studies between subjects or experiments.

[www.vernier.com/gdx-rb](http://www.vernier.com/gdx-rb)

GDX-RB

**Go Wireless® Heart Rate**

The Vernier Go Wireless Heart Rate is ideal for continuously monitoring heart rate before, during, and after exercise or while a person is stationary. Data are wirelessly transmitted to LabQuest 2, Chromebooks, iOS devices, or Android devices.

[www.vernier.com/gw-hr](http://www.vernier.com/gw-hr)

GW-HR

**Exercise Heart Rate Strap**

[www.vernier.com/hr-strap](http://www.vernier.com/hr-strap)

HR-STRAP

**Go Direct Surface Temperature**

Designed for use in situations in which low thermal mass or flexibility is required, Go Direct Surface Temperature has an exposed thermistor that results in an extremely rapid response time. This design allows for use in air and water.

[www.vernier.com/gdx-st](http://www.vernier.com/gdx-st)

GDX-ST



## Go Direct Temperature

Unlike a traditional thermometer, with Go Direct Temperature students can collect real-time temperature measurements of a single instance or over a period of time.

[www.vernier.com/gdx-tmp](http://www.vernier.com/gdx-tmp)

GDX-TMP



## Go Direct Tris-Compatible Flat pH

Go Direct Tris-Compatible Flat pH is a double-junction electrode for measuring pH in Tris buffers and solutions containing proteins or sulfides. The flat glass shape makes it easy to clean and useful for measuring the pH of semisolids such as soil slurries and certain foods.

[www.vernier.com/gdx-fph](http://www.vernier.com/gdx-fph)

GDX-FPH



## Go Direct Conductivity

Go Direct Conductivity determines the ionic content of an aqueous solution by measuring its electrical conductivity. With automatic temperature compensation, students can calibrate the probe in the lab and then make measurements outdoors without temperature changes affecting data.

[www.vernier.com/gdx-con](http://www.vernier.com/gdx-con)

GDX-CON



## Go Direct Gas Pressure

Monitor the pressure of a gas (up to 400 kPa) throughout various experiments. Determine reaction rates, investigate transpiration, study cell respiration, and more. Includes a syringe, tubing, and stoppers to simplify setup for experiments.

[www.vernier.com/gdx-gp](http://www.vernier.com/gdx-gp)

GDX-GP

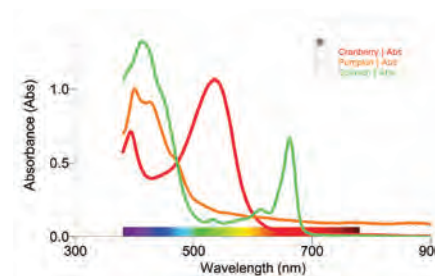


## NEW Go Direct Ethanol Vapor

Go Direct Ethanol Vapor measures the concentration of ethanol in the air above an aqueous sample. This sensor can be used in a wide variety of experiments in biological, agricultural, food, and environmental studies.

[www.vernier.com/gdx-etoh](http://www.vernier.com/gdx-etoh)

GDX-ETOH



Plant pigments spectra

## Go Direct<sup>®</sup> SpectroVis<sup>®</sup> Plus

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus. Students can easily collect a full wavelength spectrum (absorbance, percent transmission, fluorescence, or intensity), study absorbance vs. concentration (standard curve), or monitor enzyme activity (enzyme kinetics). Collect and analyze data using Vernier Spectral Analysis<sup>®</sup> app, LabQuest App, or Logger Pro 3.

Wavelength Range 380 to 950 nm

[www.vernier.com/gdx-svispl](http://www.vernier.com/gdx-svispl)

GDX-SVISPL



Investigating primary productivity using the Vernier Optical DO Probe



## LabQuest® Sensors

Connection



BTA or BTD, plus a LabQuest interface

Required LabQuest Interface Options



LabQuest Mini



LabQuest Stream®



LabQuest 2

Compatible Platforms



Computer



Chromebook™



iOS device



Android™ device

Software



LabQuest App, Logger Pro® 3, Graphical Analysis™ 4

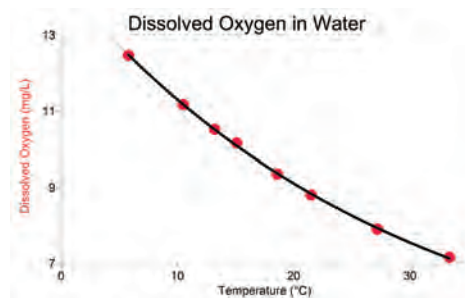
## Vernier Optical DO Probe

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

[www.vernier.com/odo-bta](http://www.vernier.com/odo-bta)

ODO-BTA



Saturated dissolved oxygen at various temperatures



## CO<sub>2</sub> Gas Sensor

The CO<sub>2</sub> Gas Sensor measures gaseous carbon dioxide and supports cellular respiration and photosynthetic metabolism studies as well as investigations into human respiratory changes in CO<sub>2</sub> based on exercise. Includes a 250 mL respiration chamber.

[www.vernier.com/co2-bta](http://www.vernier.com/co2-bta)

CO2-BTA



## O<sub>2</sub> Gas Sensor

The O<sub>2</sub> Gas Sensor measures oxygen concentration in air and can be used to study human and cellular respiration. Includes a 250 mL respiration chamber.

[www.vernier.com/o2-bta](http://www.vernier.com/o2-bta)

O2-BTA





## Hand-Grip Heart Rate Monitor

The Hand-Grip Heart Rate Monitor makes it easy to monitor heart rate before, during, and after exercise. Data from the hand grips are wirelessly transmitted to the data-collection device via Bluetooth® wireless technology or by using the included receiver.

[www.vernier.com/hgh-bta](http://www.vernier.com/hgh-bta)

HGH-BTA



## Exercise Heart Rate Strap

HR-STRAP

[www.vernier.com/hr-strap](http://www.vernier.com/hr-strap)

## Spirometer

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 makes it easy to clean and sterilize.

[www.vernier.com/spr-bta](http://www.vernier.com/spr-bta)

SPR-BTA



For Spirometer replacement parts, see page 137.

## Tris-Compatible Flat pH Sensor

This sensor is compatible with Tris buffers and solutions containing proteins. The flat glass shape makes it easy to clean and useful for measuring the pH of semisolids such as soil slurries and certain foods.

[www.vernier.com/fph-bta](http://www.vernier.com/fph-bta)

FPH-BTA



## Stainless Steel Temperature Probe

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

[www.vernier.com/tmp-bta](http://www.vernier.com/tmp-bta)

TMP-BTA



## PAR Sensor

The PAR (Photosynthetically Active Radiation) Sensor reports the power of electromagnetic radiation in the spectral range that is used by plants for photosynthesis. The waterproof sensor head makes it ideal for agricultural and environmental science investigations related to photosynthesis and primary productivity.

[www.vernier.com/par-bta](http://www.vernier.com/par-bta)

PAR-BTA



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

## Ethanol Sensor

Use the Ethanol Sensor to measure the concentration of ethanol in air above an aqueous sample.

[www.vernier.com/eth-bta](http://www.vernier.com/eth-bta)

ETH-BTA



## Hand Dynamometer

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

[www.vernier.com/hd-bta](http://www.vernier.com/hd-bta)

HD-BTA





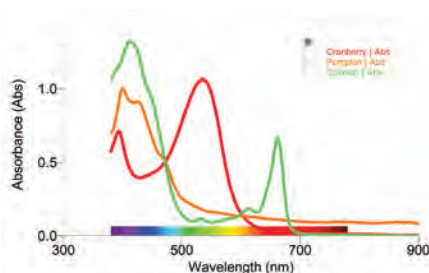
## Go Direct<sup>®</sup> SpectroVis<sup>®</sup> Plus

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus. Students can easily collect a full wavelength spectrum (absorbance, percent transmission, fluorescence, or intensity), study absorbance vs. concentration (standard curve), or monitor enzyme activity (enzyme kinetics). Collect and analyze data using Vernier Spectral Analysis<sup>®</sup> app, LabQuest<sup>®</sup> App, or Logger Pro<sup>®</sup> 3.

Wavelength Range 380 to 950 nm

[www.vernier.com/gdx-svispl](http://www.vernier.com/gdx-svispl)

GDX-SVISPL



Plant pigments spectra



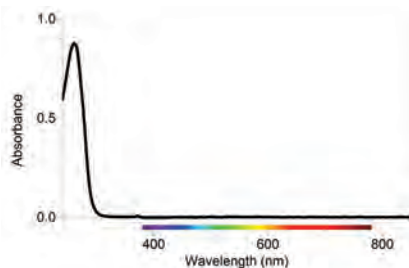
## Vernier UV-VIS Spectrophotometer

The Vernier UV-VIS Spectrophotometer is a portable ultraviolet and visible light spectrophotometer. It is ideal for measuring the absorbance spectra of various biochemical compounds, including DNA and proteins. Use it for kinetics studies such as enzyme assays as well.

Wavelength Range 220 to 850 nm

[www.vernier.com/vsp-uv](http://www.vernier.com/vsp-uv)

VSP-UV



Starna<sup>®</sup> DNaCON 260/280 reference standard

## What Vernier products are available for biotechnology?

In introductory biotechnology labs, students commonly study a broad range of topics:

- Acid/base chemistry and buffer preparation
- Protein and enzyme purification
- Enzyme activity assays
- Analysis of carbohydrates and lipids
- Gel electrophoresis

Several experiments that cover these topics are available as free downloads on our website. Additional experiments can be found in the following lab books: *Advanced Biology with Vernier* (BIO-A), *Advanced Chemistry with Vernier* (CHEM-A), and *Organic Chemistry with Vernier* (CHEM-O).

[www.vernier.com/biotechnology](http://www.vernier.com/biotechnology)

## Did you know?

Bio-Rad<sup>®</sup> 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 Vernier and Bio-Rad at [www.vernier.com/bio-rad-kits](http://www.vernier.com/bio-rad-kits)

**BIO-RAD**



Topic	Gel electrophoresis
Equipment	Blue View Transilluminator
Learn More	<a href="http://vernier.com/blue-view">vernier.com/blue-view</a>



Topic	Enzyme assays, Bradford assay, etc.
Equipment	Go Direct SpectroVis Plus Spectrophotometer
Learn More	<a href="http://vernier.com/gdx-svispl">vernier.com/gdx-svispl</a>



Topic	Enzyme assays, DNA, protein content
Equipment	Vernier UV-VIS Spectrophotometer
Learn More	<a href="http://vernier.com/vsp-uv">vernier.com/vsp-uv</a>



Topic	Enzyme assays, DNA and protein content, fluorescence assays
Equipment	Fluorescence/UV-VIS Spectrophotometer
Learn More	<a href="http://vernier.com/vsp-fuv">vernier.com/vsp-fuv</a>

## Recommended platforms



Chromebook™



Computer (macOS® and Windows®)

## Recommended platforms



iOS Device



Android™ Device

## USB Digital Microscope

This 5 megapixel USB Digital Microscope connects to a computer or Chromebook. 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.\*

[www.vernier.com/bd-edu-100](http://www.vernier.com/bd-edu-100)

BD-EDU-100



## Celestron® Digital Microscope Imager

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

[www.vernier.com/cs-dmi](http://www.vernier.com/cs-dmi)

CS-DMI

CS-5MP

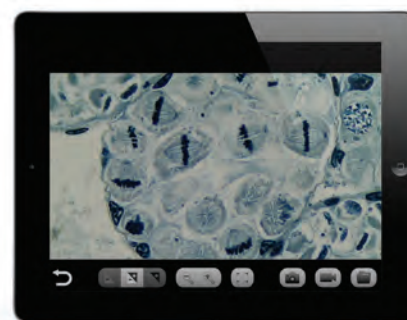


## ProScope™ 5MP Microscope Camera

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.

[www.vernier.com/bd-ps-mc5uw](http://www.vernier.com/bd-ps-mc5uw)

BD-PS-MC5UW



For more information about digital microscopes, visit [www.vernier.com/digital-microscopes](http://www.vernier.com/digital-microscopes)

## 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. You will have access to the most up-to-date versions of the experiments through your Vernier account.

- Download word-processing files to customize the experiments to fit your curricular needs.
- Electronic versions include a generous site license—purchase once and share files with other instructors in your school or college department.

### Biology Lab Books

Subjects	<i>Biology with Vernier</i>	<i>Investigating Biology through Inquiry</i>	<i>Advanced Biology with Vernier</i>	<i>Human Physiology Experiments</i>	<i>Agricultural Science with Vernier</i>
High School Biology	●	●			
AP* Biology	●	●	●		
IB† Biology	●	●	●		
Agricultural Science					●
Anatomy and Physiology				●	
College Biology	●	●	●		

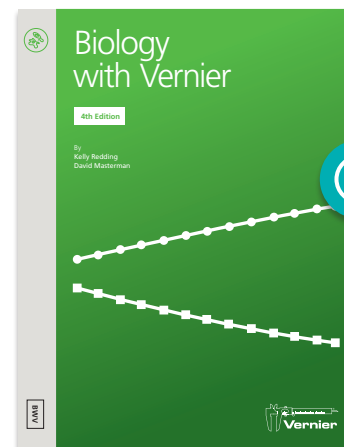
\* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† 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.

## Biology with Vernier

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

BWV-E

Printed + Electronic Lab Book

BWV

### Topics Include

- Cellular respiration
- Photosynthesis
- Enzymes
- Environmental science
- Human physiology

For a complete list of all 31 experiments, visit [www.vernier.com/bwv](http://www.vernier.com/bwv)

### Sensors Used

Sensor	Page
Temperature	36, 38
Heart Rate	35, 38
Gas Pressure	36, 55
CO <sub>2</sub> Gas	34, 37
O <sub>2</sub> Gas	34, 37
Conductivity	36, 54
pH	52, 56
Colorimeter	50, 54
Dissolved Oxygen	34, 37
EKG	35, <a href="http://www.vernier.com/ekg-bta">www.vernier.com/ekg-bta</a>
Respiration Belt	35, <a href="http://www.vernier.com/rmb">www.vernier.com/rmb</a>

### Additional Products

Equipment	Page
BioChamber 250	136
BioChamber 2000	136
Stir Station	58
Primary Productivity Kit	<a href="http://www.vernier.com/ppk">www.vernier.com/ppk</a>
Water Quality Bottles	<a href="http://www.vernier.com/wq-bot">www.vernier.com/wq-bot</a>

### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19
Spectral Analysis	20
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>



## UPDATED Investigating Biology through Inquiry

HIGH SCHOOL

COLLEGE

Electronic  
Lab Book Only

BIO-I-E

Printed + Electronic  
Lab Book

BIO-I

### Topics Include

- Cellular respiration
- Photosynthesis
- Enzyme action
- Evolution
- Ecology
- Human physiology

For a complete list of all 22 investigations, visit [www.vernier.com/bio-i](http://www.vernier.com/bio-i)

### Sensors Used

Sensor	Page
Temperature	36, 38
Gas Pressure	36, 55
Spectrometer	39
CO <sub>2</sub> Gas	34, 37
Conductivity	36, 54
Dissolved Oxygen	34, 37
O <sub>2</sub> Gas	34, 37
Heart Rate	35, 38
pH	52, 56

### Additional Products

Equipment	Page
Primary Productivity Kit <a href="http://www.vernier.com/ppk">www.vernier.com/ppk</a>	
Stir Station	58

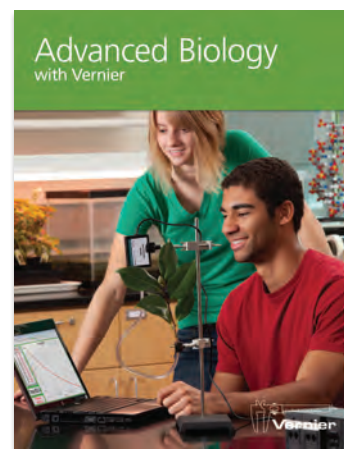
### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19
Spectral Analysis	20

## Advanced Biology with Vernier

HIGH SCHOOL

COLLEGE

Electronic  
Lab Book Only

BIO-A-E

Printed + Electronic  
Lab Book

BIO-A

### Topics Include

- Cellular respiration
- Photosynthesis
- Enzymes
- Biotechnology
- Environmental science
- Human physiology

For a complete list of all 17 experiments, visit [www.vernier.com/bio-a](http://www.vernier.com/bio-a)

### Sensors Used

Sensor	Page
Temperature	36, 38
Gas Pressure	36, 55
Conductivity	36, 54
CO <sub>2</sub> Gas	34, 37
O <sub>2</sub> Gas	34, 37
Dissolved Oxygen	34, 37
Heart Rate	35, 38
Blood Pressure <a href="http://www.vernier.com/bps-bta">www.vernier.com/bps-bta</a>	
Spectrometer	39

### Additional Products

Equipment	Page
BioChamber 250	136
BlueView Transilluminator <a href="http://www.vernier.com/blue-view">www.vernier.com/blue-view</a>	
Primary Productivity Kit <a href="http://www.vernier.com/ppk">www.vernier.com/ppk</a>	

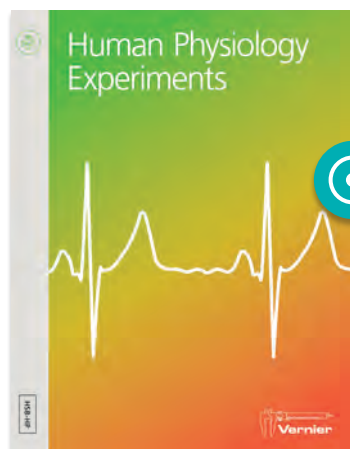
### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14
EasyData® <a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>	

## NEW Human Physiology Experiments

HIGH SCHOOL

COLLEGE


**Electronic  
Lab Book Only**

HSB-HP-E

**Printed + Electronic  
Lab Book**

HSB-HP

### Topics Include

- Heart rate and EKG
- Control of respiration
- Muscle action and EMG
- Reflexes
- Aerobic metabolism

For a complete list of all 14 experiments, visit [www.vernier.com/hsb-hp](http://www.vernier.com/hsb-hp)

### Sensors Used

Sensor	Page
Go Direct EKG	35
Go Wireless Heart Rate	35
Go Direct Surface Temperature	35
Go Direct Hand Dynamometer	35
Go Direct O <sub>2</sub> Gas	34
Go Direct Force and Acceleration	35
Go Direct Respiration Belt	35

### Additional Products

Equipment	Page
Reflex Hammer Accessory Kit	35

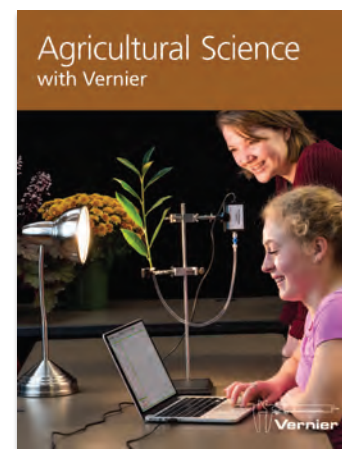
### Supported Software

Software	Page
Graphical Analysis 4	18–19

## Agricultural Science with Vernier

HIGH SCHOOL

COLLEGE


**Electronic  
Lab Book Only**

AWV-E

**Printed + Electronic  
Lab Book**

AWV

### Topics Include

- Fundamentals of agriculture
- Plant and soil science
- Animal science
- Energy and electricity

For a complete list of all 29 experiments, visit [www.vernier.com/awv](http://www.vernier.com/awv)

### Sensors Used

Sensor	Page
Temperature	36, 38
Tris-Compatible pH	36, 38
Conductivity	36, 54
CO <sub>2</sub> Gas	34, 37
Ethanol	36, 38
Dissolved Oxygen	34, 37
Go Direct Current	113, 122
Gas Pressure	36, 55
O <sub>2</sub> Gas	34, 37
Light	112, 125
Soil Moisture	87

### Additional Products

Equipment	Page
BioChamber 250	136
BioChamber 2000	136

### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13, 14
EasyData	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>

## Performing an acid-base titration



View our Tech Tips instructional video at  
[www.vernier.com/videos](http://www.vernier.com/videos)



# Chemistry

[www.vernier.com/chemistry](http://www.vernier.com/chemistry)



## PACKAGES

Go Direct® and LabQuest® packages pp. 46–49

## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct Colorimeter	GDX-COL	50
Go Direct Conductivity	GDX-CON	50
Go Direct Constant Current System	GDX-CCS	51
Go Direct Current	GDX-CUR	113
Go Direct Drop Counter	GDX-DC	51
Go Direct Electrode Amplifier	GDX-EA	51
Go Direct Gas Pressure	GDX-GP	51
Go Direct Melt Station	GDX-MLT	51
Go Direct ORP	GDX-ORP	52
pH Sensors		
Go Direct Glass-Body pH	GDX-GPH	52
Go Direct pH	GDX-PH	52
Go Direct Tris-Compatible Flat pH	GDX-FPH	52
Go Direct Radiation Monitor	GDX-RAD	113
Go Direct SpectroVis® Plus	GDX-SVISPL	53
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	53
Go Direct Temperature	GDX-TMP	53
Go Direct Wide-Range Temperature	GDX-WRT	53
Go Direct Voltage	GDX-VOLT	53

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Colorimeter	COL-BTA	54
Conductivity Probes		
Conductivity Probe	CON-BTA	54
Platinum-Cell Conductivity Probe	CONPT-BTA	54
Current Probes		
Constant Current System	CCS-BTA	55
Current Probe	DCP-BTA	55
Drop Counter	VDC-BTD	55
Electrode Amplifier	EA-BTA	55
Gas Pressure Sensors		
Gas Pressure Sensor	GPS-BTA	55
Pressure Sensor 400	PS400-BTA	55
Instrumentation Amplifier	INA-BTA	55
Melt Station	MLT-BTA	56
ORP Sensor	ORP-BTA	56
pH Sensors		
Glass-Body pH Electrode BNC (requires Electrode Amplifier)	GPH-BNC	56
pH Sensor	PH-BTA	56
Tris-Compatible Flat pH Sensor	FPH-BTA	38
Polarimeter (Chemical)	CHEM-POL	56
Radiation Monitor	VRM-BTD	127
Temperature Probes		
Stainless Steel Temperature Probe	TMP-BTA	57
Surface Temperature Sensor	STS-BTA	57
Thermocouple	TCA-BTA	57
Wide-Range Temperature Probe	WRT-BTA	57
Voltage Probes		
Differential Voltage Probe	DVP-BTA	57
Voltage Probe	VP-BTA	57

## BALANCES

Balances	Order Code	Page
OHAUS Scout® (120 g)	OHS-123	58
OHAUS Scout (220 g)	OHS-222	58
OHAUS Scout (420 g)	OHS-422	58

## GAS CHROMATOGRAPH

Gas Chromatograph	Order Code	Page
Mini GC Plus Gas Chromatograph	GC2-MINI	58

## LAB EQUIPMENT

Equipment	Order Code	Page
Electrode Support	ESUP	58
Stir Station	STIR	58

## SPECTROMETERS

Spectrometers	Order Code	Page
Go Direct SpectroVis Plus	GDX-SVISPL	59
Vernier Emissions Spectrometer	VSP-EM	59
Vernier Flash Photolysis Spectrometer	VSP-FP	59
Vernier Fluorescence/UV-VIS Spectrophotometer	VSP-FUV	59
Vernier Spectrometer (Ocean Optics™)	V-SPEC	<a href="#">web</a>
Vernier UV-VIS Spectrophotometer	VSP-UV	59

## LAB BOOKS

Title	Page
<i>Chemistry with Vernier</i>	61
<i>Advanced Chemistry with Vernier</i>	62
<i>Vernier Chemistry Investigations for Use with AP Chemistry</i>	62
<i>Investigating Chemistry through Inquiry</i>	63
<b>UPDATED</b> <i>Organic Chemistry with Vernier</i>	63
<i>Química con Vernier</i>	61



## Go Direct Chemistry Packages

High School Chemistry,  
AP Chemistry, IB Chemistry,  
and General Chemistry

Go Direct® sensors are perfect  
for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks  
and mobile devices



Connect Directly  
via USB or Bluetooth®  
Wireless Technology



Works with Your  
Existing Devices



2–4 Students  
per Package



Collect Data with the FREE  
Graphical Analysis™ 4 App

### Starter Package (4 Products)

GDP-CH-ST



Go Direct  
Temperature (x2)



Go Direct  
pH



Go Direct  
Gas Pressure

### Deluxe Package (8 Products)

GDP-CH-DX



Go Direct  
Voltage



Go Direct  
Conductivity

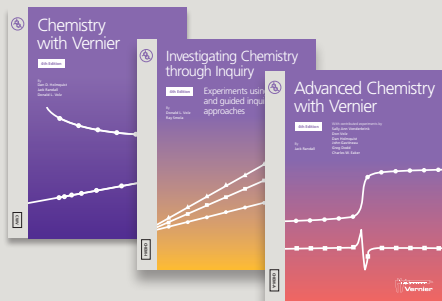


Go Direct  
Colorimeter



Go Direct  
Drop Counter

### Related Lab Books



Many of the experiments in these books use  
sensors found in the Go Direct Chemistry  
Packages. Vernier lab books include student  
instructions, teacher tips, and sample data.

For more details, see pp. 61–63.

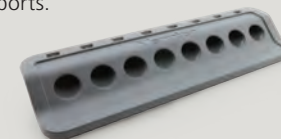
### You May Also Want

#### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging  
your Go Direct sensors. Each charge station has sixteen charging  
ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



Additional recommendations available at [www.vernier.com/packages/chemistry](http://www.vernier.com/packages/chemistry)

## LabQuest Chemistry Packages

High School Chemistry,  
AP Chemistry, IB Chemistry,  
and General Chemistry

Use LabQuest® 2 as a  
Standalone Device

LabQuest 2 works with  
all Vernier sensors and  
built-in LabQuest App.

OR

Wireless  
(One-to-Many)

Transfer LabQuest 2 data  
wirelessly via Wi-Fi to one  
or more devices running  
Graphical Analysis 4 app.

OR

Wired  
(One-to-One)

LabQuest 2 works with  
Chromebooks and Windows®  
and macOS® computers.



Sensors Connect to a  
LabQuest 2 Interface



2–4 Students  
per Package

### Starter Package (5 Products)

LQ2-CH-ST



LabQuest 2



Stainless Steel  
Temperature Probe  
(x2)



Go Direct  
pH



Go Direct  
Gas Pressure

### Deluxe Package (9 Products)

LQ2-CH-DX



Voltage  
Probe



Go Direct  
Conductivity

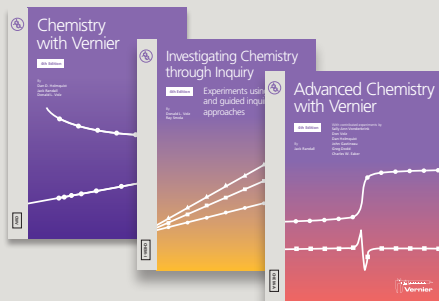


Colorimeter



Drop Counter

## Related Lab Books



Many of the experiments in  
these books use sensors found  
in the LabQuest Chemistry  
Packages. Vernier lab books  
include student instructions,  
teacher tips, and sample data.

For more details, see pp. 61–63.

## You May Also Want

### LabQuest Charge Station

Easily charge and store your  
LabQuest 2 interfaces with the  
LabQuest Charge Station.

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

### LabQuest Viewer® Software

Teach your students how to use LabQuest by  
projecting your LabQuest screen. Display live images  
of your LabQuest units to monitor student progress.

See page 21.

LQ-VIEW



Additional recommendations available at [www.vernier.com/packages/chemistry](http://www.vernier.com/packages/chemistry)

## Go Direct Advanced Chemistry Packages

AP Chemistry, IB Chemistry, and General Chemistry

Go Direct® sensors are perfect for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks and mobile devices



Connect Directly via USB or Bluetooth® Wireless Technology



Works with Your Existing Devices



2–4 Students per Package



Collect Data with the FREE Graphical Analysis™ 4 App

## Deluxe Package (9 Products)

GDP-CHMA-SV



Go Direct Temperature



Go Direct pH



Go Direct Gas Pressure



Go Direct Voltage



Go Direct Conductivity



Go Direct Drop Counter



Go Direct Constant Current System

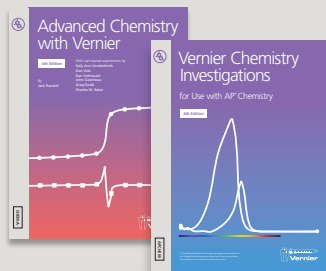


Go Direct ORP



Go Direct SpectroVis® Plus

## Related Lab Books



Many of the experiments in these books use sensors found in the Go Direct Advanced Chemistry Package. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see page 62.

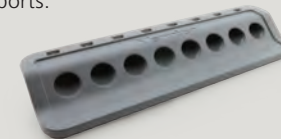
## You May Also Want

### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



Additional recommendations available at [www.vernier.com/packages/chemistry](http://www.vernier.com/packages/chemistry)

## LabQuest Advanced Chemistry Packages

AP Chemistry, IB Chemistry, and General Chemistry

Use LabQuest® 2 as a Standalone Device

LabQuest 2 works with all Vernier sensors and built-in LabQuest App.

OR

Wireless (One-to-Many)

Transfer LabQuest 2 data wirelessly via Wi-Fi to one or more devices running Graphical Analysis 4 app.

OR

Wired (One-to-One)

LabQuest 2 works with Chromebooks and Windows® and macOS® computers.



Sensors Connect to a LabQuest 2 Interface



2–4 Students per Package

## Deluxe Package (10 Products)

LQ2-CHMA-SV



LabQuest 2



Stainless Steel Temperature Probe



Go Direct pH



Go Direct Gas Pressure



Voltage Probe



Go Direct Conductivity



Drop Counter



Constant Current System

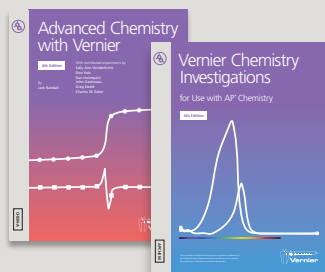


ORP Sensor



Go Direct SpectroVis Plus

## Related Lab Books



Many of the experiments in these books use sensors found in the LabQuest Advanced Chemistry Package. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see page 62.

## You May Also Want

### LabQuest Charge Station

Easily charge and store your LabQuest 2 interfaces with the LabQuest Charge Station.

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

### LabQuest Viewer® Software

Teach your students how to use LabQuest by projecting your LabQuest screen. Display live images of your LabQuest units to monitor student progress.

See page 21.

LQ-VIEW



Additional recommendations available at [www.vernier.com/packages/chemistry](http://www.vernier.com/packages/chemistry)



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

## Go Direct Colorimeter

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, and 635 nm) to set up their experiment.

Includes 15 cuvettes. Additional cuvettes may be purchased in a package of 100. See page 136.

[www.vernier.com/gdx-col](http://www.vernier.com/gdx-col)



GDX-COL

## Go Direct® Sensors

### Connection



Connects directly via USB or Bluetooth® wireless technology to your device

### Compatible Platforms



Computer



Chromebook™



LabQuest® 2



iOS device



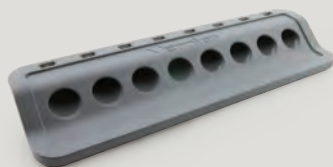
Android™ device

### Software



FREE Graphical Analysis™ 4, LabQuest App (LabQuest 2 only)

## You May Also Want



### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## Go Direct Conductivity

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  $\mu\text{S}/\text{cm}$ ). The sensor includes automatic temperature compensation for general use that can be turned off to perform conductivity studies as a function of temperature.

[www.vernier.com/gdx-con](http://www.vernier.com/gdx-con)

GDX-CON



## Go Direct Constant Current System

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.

[www.vernier.com/gdx-ccs](http://www.vernier.com/gdx-ccs)

GDX-CCS



## Go Direct Drop Counter

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 Go Direct pH, Go Direct Conductivity, or Go Direct ORP to perform acid-base, conductometric, or potentiometric titrations.

[www.vernier.com/gdx-dc](http://www.vernier.com/gdx-dc)

GDX-DC



## Go Direct Electrode Amplifier

The versatility of the Electrode Amplifier makes it possible to collect data from electrodes that have a BNC connector.

[www.vernier.com/gdx-ea](http://www.vernier.com/gdx-ea)

GDX-EA



## Go Direct Gas Pressure

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. Go Direct Gas Pressure includes a syringe, tubing, and stoppers to simplify setup for experiments, such as Boyle's law.

[www.vernier.com/gdx-gp](http://www.vernier.com/gdx-gp)

GDX-GP



## Go Direct Melt Station

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.

[www.vernier.com/gdx-mlt](http://www.vernier.com/gdx-mlt)

GDX-MLT



## Go Direct ORP

Use Go Direct ORP (Oxidation-Reduction Potential) to measure 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.

[www.vernier.com/gdx-orp](http://www.vernier.com/gdx-orp)

GDX-ORP



## Go Direct Radiation Monitor

Explore radiation statistics, measure the rate of nuclear decay, and monitor radon progeny. Go Direct Radiation Monitor detects alpha, beta, gamma, and X-ray radiation, and features LED and audible indicators.

[www.vernier.com/gdx-rad](http://www.vernier.com/gdx-rad)

GDX-RAD



## pH Sensors

[www.vernier.com/ph-sensors](http://www.vernier.com/ph-sensors)

### Sensor

#### Go Direct pH

GDX-PH



### Features

#### Recommended for General Use

Go Direct pH is an important and versatile sensor for lab and field activities alike. Conduct acid-base titrations, monitor pH changes during chemical reactions, and investigate household acids and bases. The wireless connection makes it easier to do field-based studies such as testing the pH of surface water.

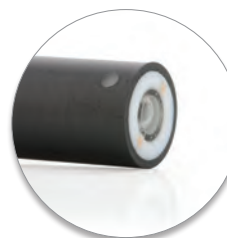
#### Go Direct pH Teacher Pack

GDX-PH-TP

Go Direct pH Teacher Pack includes eight Go Direct pH Sensors and a Go Direct Charge Station.

#### Go Direct Tris-Compatible Flat pH

GDX-FPH



Go Direct Tris-Compatible Flat pH is a double-junction electrode for measuring pH in Tris buffers and solutions containing proteins or sulfides. The flat glass shape makes it easy to clean and useful for measuring the pH of semisolids such as soil slurries and certain foods.

#### Go Direct Glass-Body pH

GDX-GPH



Go Direct Glass-Body pH can be used with non-aqueous solutions and solutions containing solvents, strong acids, and strong bases.

## Temperature Probes

[www.vernier.com/temperature-sensors](http://www.vernier.com/temperature-sensors)

### Sensor

### Range

### Features and Applications

#### Go Direct Temperature

GDX-TMP



−40°C to 125°C

#### Recommended for General Use

- Conduct endothermic and exothermic reactions.
- Determine the physical properties of water.
- Measure the energy content of foods.
- Investigate intermolecular forces.
- Use in situations in which low thermal mass or flexibility is required.
- The exposed thermistor provides an extremely rapid response to temperature changes.
- Use this sensor in air and water only.
- Determine the melting point of caffeine or the boiling point of different vegetable oils.
- RTD (Resistance Temperature Detector) technology establishes a  $\pm 0.5^\circ\text{C}$  accuracy.

#### Go Direct Surface Temperature

GDX-ST



−25°C to 125°C

#### Go Direct Wide-Range Temperature

GDX-WRT



−20°C to 330°C



Collecting temperature data during the freezing and melting of water

#### Go Direct Temperature Teacher Pack

GDX-TMP-TP

Includes eight Go Direct Temperature Probes and a Go Direct Charge Station.

## Go Direct® SpectroVis® Plus

Introduce your students to spectroscopy with the affordable Go Direct SpectroVis Plus Spectrophotometer. With a range of 380 to 950 nm, students can easily collect a full wavelength spectrum (absorbance, percent transmission, fluorescence, or intensity), study absorbance vs. concentration (Beer's law), or monitor rates of reaction (kinetics). Collect and analyze data using Vernier Spectral Analysis®, LabQuest® App, or Logger Pro® 3.

[www.vernier.com/gdx-svispl](http://www.vernier.com/gdx-svispl)

GDX-SVISPL

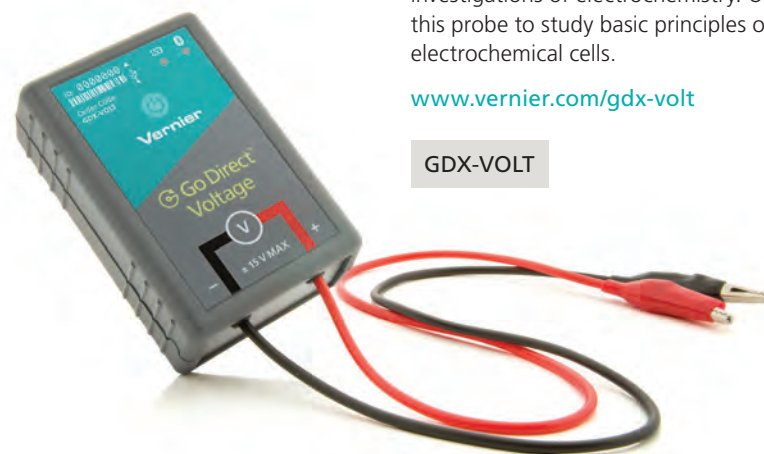


## Go Direct Voltage

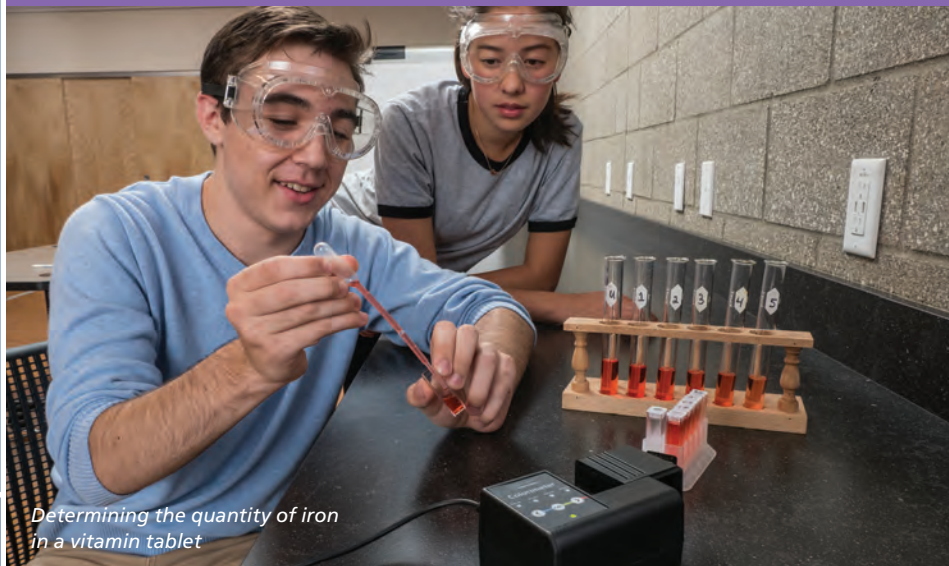
Go Direct Voltage combines a wide input voltage range (20 V) with high precision, making it an excellent choice for lab investigations of electrochemistry. Use this probe to study basic principles of electrochemical cells.

[www.vernier.com/gdx-volt](http://www.vernier.com/gdx-volt)

GDX-VOLT







Determining the quantity of iron in a vitamin tablet

## LabQuest® Sensors

Connection



BTA or BTB, plus a LabQuest interface

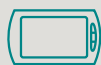
Required LabQuest Interface Options



LabQuest Mini



LabQuest Stream®



LabQuest 2

Compatible Platforms



Computer



Chromebook™



iOS device



Android™ device

Software



LabQuest App, Logger Pro® 3, Graphical Analysis™ 4

## Colorimeter

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, and 635 nm) to set up their experiments.

Includes 15 cuvettes. Additional cuvettes may be purchased in a package of 100. See page 136.

[www.vernier.com/col-bta](http://www.vernier.com/col-bta)

COL-BTA



## Conductivity Probes

[www.vernier.com/conductivity-probes](http://www.vernier.com/conductivity-probes)

Sensor

Features

### Conductivity Probe

CON-BTA



#### Recommended for General Use

The Conductivity Probe determines the ionic content of an aqueous solution by measuring its electrical conductivity. Students can quickly investigate the difference between ionic and molecular compounds, strong and weak acids, or ionic compounds that yield different ratios of ions.

### 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 non-aqueous solutions and strong acids and bases. The Platinum-Cell Conductivity Probe features automatic temperature compensation (2%) for aqueous solutions; turn off temperature compensation so students can explore the dependence of conductivity on temperature.

## Current Probes

[www.vernier.com/current-sensors](http://www.vernier.com/current-sensors)

Sensor

Current Range

Features

## Current Probe

 $\pm 0.6$  A

Measures currents in low-voltage AC and DC circuits or for electrochemistry experiments

DCP-BTA



## Constant Current System

0–0.6 A

DC power source with a built-in current probe designed for use in electrochemistry experiments

CCS-BTA



## Drop Counter

By precisely recording the number of drops of titrant during a titration, the Drop Counter makes it possible for students to successfully conduct titrations quickly and easily. The drop number is automatically converted to volume by the data-collection software, saving valuable time. Use the Drop Counter in conjunction with other sensors, such as a pH Sensor, Conductivity Probe, or ORP Sensor to perform acid-base, conductometric, or potentiometric titrations.

[www.vernier.com/vdc-btd](http://www.vernier.com/vdc-btd)

VDC-BTD



## Electrode Amplifier

The versatility of the Electrode Amplifier makes it possible to collect data from electrodes that have a BNC connector, including several Vernier electrodes and a variety of third-party electrodes. To get started, connect an electrode, such as our Glass-Body pH Electrode BNC, to the Electrode Amplifier, and then connect the Electrode Amplifier to a Vernier interface.

[www.vernier.com/ea-bta](http://www.vernier.com/ea-bta)

EA-BTA



## Gas Pressure Sensors

[www.vernier.com/pressure-sensors](http://www.vernier.com/pressure-sensors)

## Gas Pressure Sensor

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

The Gas Pressure Sensor includes the Pressure Sensor Accessories Kit. For replacement parts, see page 60.

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

GPS-BTA



## Pressure Sensor 400

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. 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)

PS400-BTA



## Instrumentation Amplifier

The Instrumentation Amplifier monitors voltages from 20 mV to 1 V (DC or AC). It is typically used to amplify the chart recorder or analog output of any instrument, such as a third-party gas chromatograph.

[www.vernier.com/ina-bta](http://www.vernier.com/ina-bta)

INA-BTA



## Melt Station

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 up to 260°C.

[www.vernier.com/mlt-bta](http://www.vernier.com/mlt-bta)

MLT-BTA



## ORP Sensor

The Oxidation-Reduction Potential (ORP) Sensor lets you measure the ability of a solution to act as an oxidizing or reducing agent.

[www.vernier.com/orp-bta](http://www.vernier.com/orp-bta)

ORP-BTA



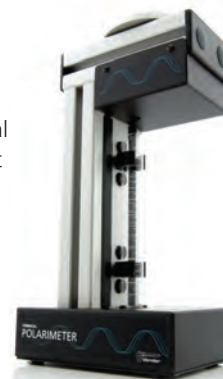
## Chemical Polarimeter

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).

[www.vernier.com/chem-pol](http://www.vernier.com/chem-pol)

CHEM-POL



## pH Sensor

Recommended for General Use

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

[www.vernier.com/ph-bta](http://www.vernier.com/ph-bta)

PH-BTA



## pH Electrodes

(Electrode Amplifier required; see page 55)

[www.vernier.com/ph-sensors](http://www.vernier.com/ph-sensors)

Sensor

Features

### pH Electrode BNC

PH-BNC



- Single-junction electrode for general purpose aqueous solutions
- Comparable applications as the Vernier pH Sensor

### Tris-Compatible Flat pH Electrode BNC

FPH-BNC



- Double-junction electrode allows for measurement of the pH of solutions containing proteins, sulfides, or Tris buffers
- Flat shape of the sensor tip makes it easy to clean and allows for smaller sample sizes and measurement of pH of semisolids (e.g., food or soil slurries)

### Glass-Body pH Electrode BNC





GPH-BNC



- Measures the pH of aqueous and non-aqueous solutions
- Can be used in solutions containing organic solvents and in highly concentrated acids or bases



## Temperature Sensors

Sensor		Range	Features
<b>Stainless Steel Temperature Probe</b> TMP-BTA		-40 to 135°C	<b>Recommended for General Use</b> <ul style="list-style-type: none"> <li>For use in organic liquids, salt solutions, dilute acids, and dilute bases</li> <li>Durable and versatile so you can use it as you would use a thermometer for a wide range of experiments and subject areas</li> </ul>
<b>Surface Temperature Probe</b> STS-BTA		-25 to 125°C	<ul style="list-style-type: none"> <li>For use in air or water only</li> <li>Exposed thermistor and flexibility facilitates a rapid response time</li> </ul>
<b>Thermocouple</b> TCA-BTA		-200 to 1400°C	<ul style="list-style-type: none"> <li>Can measure flame temperatures as high as 1400°C or liquid nitrogen temperatures as low as -196°C</li> <li>Internal ice-point compensation means you do not need to place a reference wire in an ice-water bath during use</li> </ul>
<b>Wide-Range Temperature Probe</b> WRT-BTA		-20 to 330°C	<ul style="list-style-type: none"> <li>Offers a wider temperature range than the Stainless Steel Temperature Probe</li> <li>Diameter of the body of the probe is designed to match a thermometer, making it easy to use with existing glassware and equipment</li> </ul>

## Voltage Probes

[www.vernier.com/voltage-probes](http://www.vernier.com/voltage-probes)

### Differential Voltage Probe

The Differential Voltage Probe reports the potential difference between its two leads. Multiple probes can be used at one time on a single circuit.

Voltage Range  $\pm 6$  V

DVP-BTA

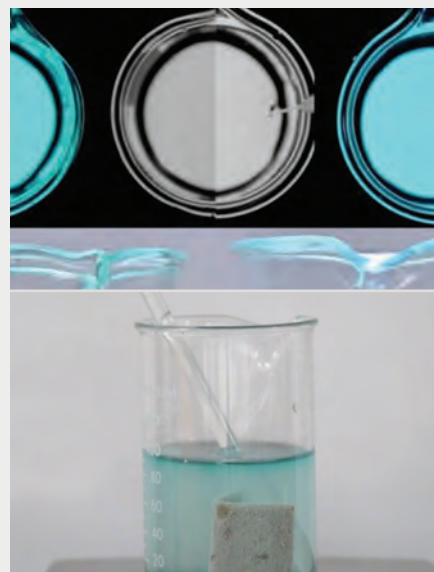


### Voltage Probe

Measure voltages developed in a variety of electrochemical (voltaic) cells with the Voltage Probe. This probe can be used to measure the potential in AC and DC circuits.

Voltage Range  $\pm 10$  V

VP-BTA



**Pivot Interactives is a subscription-based, online supplement to hands-on experimentation in chemistry.**

Each activity consists of student-controlled videos that allow variation of experimental parameters one at a time. Students use embedded tools to directly measure, analyze, and interpret real-world scientific phenomena.

Sign up for a free trial at [www.vernier.com/pivot](http://www.vernier.com/pivot)



## OHAUS Scout® Balances

[www.vernier.com/ohaus](http://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

It is easy to collect mass data from an OHAUS balance using our popular Logger Pro® 3 software or LabQuest® App. Simply connect a supported balance to the USB Cable, start the software, and collect real-time data as if the OHAUS balance were just another Vernier sensor!



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

## OHAUS Scout USB Cable

OHS-USB

## LAB EQUIPMENT

## Electrode Support

Our Electrode Support is a great complement to the Vernier Stir Station, as well as a perfect holder for many sensors. It is built to connect to all standard ring-stand posts; its large-handled locking nut keeps your sensors firmly in place.

[www.vernier.com/esup](http://www.vernier.com/esup)

ESUP

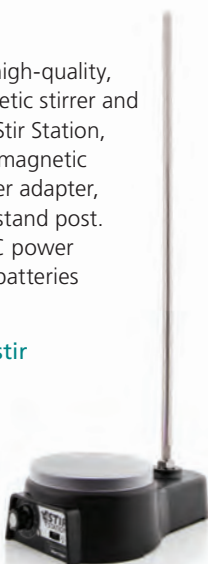


## Stir Station

The Stir Station is a high-quality, multi-function magnetic stirrer and ring stand. 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).

[www.vernier.com/stir](http://www.vernier.com/stir)

STIR



## Vernier Mini GC® Plus

Developed for  
University/College Educators

With the Mini GC Plus, students can separate, analyze, and identify organic substances in a liquid sample. This desktop gas chromatograph utilizes a MEMS chip sensor that 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.

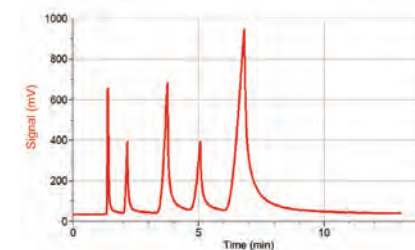
The Mini GC Plus is covered by a two-year warranty (syringe, column, detector, and septa excluded).

[www.vernier.com/gc2-mini](http://www.vernier.com/gc2-mini)

GC2-MINI




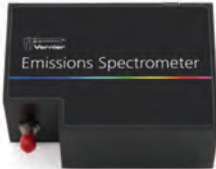



Analyzing ketones using the Vernier Mini GC Plus and LabQuest 2



Mini GC Plus chromatogram of a ketone mixture

# SPECTROMETERS

Spectrometer	Go Direct® SpectroVis® Plus Spectrophotometer	Vernier UV-VIS Spectrophotometer	Vernier Fluorescence/UV-VIS Spectrophotometer	Vernier Emissions Spectrometer	Vernier Flash Photolysis Spectrometer
					
<b>Description</b>	The Go Direct SpectroVis Plus Spectrophotometer quickly measures a full wavelength spectrum. It directly connects via Bluetooth® wireless technology or wired via USB to your device.	The Vernier UV-VIS Spectrophotometer generates a full spectrum, Beer's law graph, and kinetics traces of ultraviolet and visible-absorbing samples such as aspirin, DNA, proteins, and NADH.	The Fluorescence/UV-VIS Spectrophotometer measures the fluorescence and absorbance spectra of ultraviolet and visible samples such as quinine sulfate, fluorescein, rhodamine, and DAPI.	The perfect tool to conduct emissions analysis, the Vernier Emissions Spectrometer enables you to instantly collect emissions spectra from light bulbs, gas discharge tubes, or the sun.	The Vernier Flash Photolysis Spectrometer is perfect for students to explore the fundamental principles of photochemical reactions. It measures the absorption and emission changes of a photoexcited sample with microsecond resolution.
<b>Wavelength Range</b>	380 to 950 nm	220 to 850 nm	220 to 850 nm	350 to 900 nm	450 to 750 nm
<b>Light Source</b>	Visible: LED-boosted tungsten Fluorescence: built-in LEDs for excitation at 405 nm and 500 nm	Visible: LED-boosted tungsten UV: Deuterium	Visible: LED-boosted tungsten UV: Deuterium Fluorescence: exchangeable LEDs for excitation at 375 nm, 450 nm, and 525 nm (additional wavelengths sold separately)	N/A	Xenon flashlamp (pump) white LED (probe)
<b>Warranty</b>	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)	5 years	5 years
<b>More Information</b>	Innovative use ideas available at <a href="http://www.vernier.com/gdx-svispl">www.vernier.com/gdx-svispl</a>	Download free experiments at <a href="http://www.vernier.com/vsp-uv">www.vernier.com/vsp-uv</a>	Download free experiments at <a href="http://www.vernier.com/vsp-fuv">www.vernier.com/vsp-fuv</a>	Innovative use ideas available at <a href="http://www.vernier.com/vsp-em">www.vernier.com/vsp-em</a>	Download free experiments at <a href="http://www.vernier.com/vsp-fp">www.vernier.com/vsp-fp</a>
<b>Order Code</b>	GDX-SVISPL	VSP-UV	VSP-FUV	VSP-EM	VSP-FP

## What Vernier Technology is Available for Biochemistry?

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.

Several experiments that cover these topics are available as free downloads on our website. Additional experiments can be found in these lab books: *Advanced Biology with Vernier* (BIO-A), *Advanced Chemistry with Vernier* (CHEM-A), and *Organic Chemistry with Vernier* (CHEM-O).



Topic	Acid/base chemistry and buffer preparation
Equipment	pH Sensor
Lab Book	CHEM-A



Topic	Gel electrophoresis
Equipment	Vernier Blue Digital Bioimaging System
Lab Book	BIO-A



Topic	Enzyme activity assays
Equipment	Vernier UV-VIS Spectrophotometer
Learn More	<a href="http://vernier.com/vsp-uv">vernier.com/vsp-uv</a>



Topic	DNA investigations
Equipment	Fluorescence/UV-VIS Spectrophotometer
Learn More	<a href="http://vernier.com/vsp-fuv">vernier.com/vsp-fuv</a>

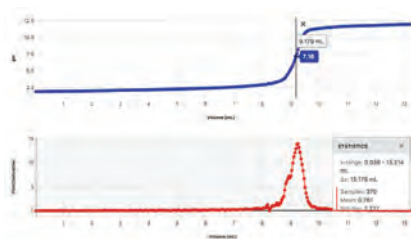
[www.vernier.com/biochemistry](http://www.vernier.com/biochemistry)

## Recommended Products

Outfitting a lab for a specific chemistry course? Our integrated solution helps students collect accurate data, visualize trends and relationships, and explore different hypotheses for both conventional and innovative experiments.

### Analytical Chemistry

- pH Sensor
- Wide-Range Temperature Probe
- Vernier Fluorescence/UV-VIS Spectrophotometer
- ORP Sensor
- Chemical Polarimeter
- Drop Counter
- Vernier UV-VIS Spectrophotometer
- Conductivity Probe
- Vernier Mini GC Plus

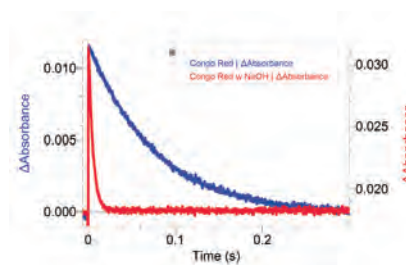


Complete an acid-base titration with our pH probes that have 0.1 pH unit accuracy and a drop counter that accurately converts drops to volume.

To get started, see the recommendations at [www.vernier.com/analytical-chemistry](http://www.vernier.com/analytical-chemistry)

### Physical Chemistry

- Pressure Sensor 400
- Wide-Range Temperature Probe
- Chemical Polarimeter
- Tris-Compatible Flat pH Sensor
- Vernier Mini GC Plus
- Vernier Fluorescence/UV-VIS Spectrophotometer
- Vernier Flash Photolysis Spectrometer
- Thermocouple
- Platinum-Cell Conductivity Probe
- Voltage Probe
- Drop Counter
- Vernier UV-VIS Spectrophotometer

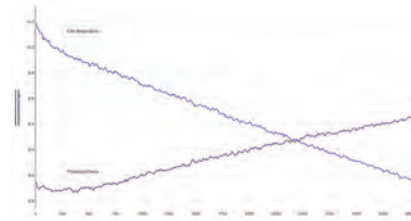


The Vernier Flash Photolysis Spectrometer has 100  $\mu$ s resolution, enabling your students to investigate rate constants of fast photochemical reactions, including the base quenching of Congo Red.

To get started, see the recommendations at [www.vernier.com/physical-chemistry](http://www.vernier.com/physical-chemistry)

### Environmental Chemistry

- Go Direct Tris-Compatible Flat pH
- Go Direct Nitrate Ion-Selective Electrode
- Go Direct Chloride Ion-Selective Electrode
- Go Direct Ammonium Ion-Selective Electrode
- Go Direct SpectroVis Plus Spectrophotometer
- Go Direct Optical Dissolved Oxygen
- Go Direct Calcium Ion-Selective Electrode
- Go Direct Potassium Ion-Selective Electrode
- Go Direct Conductivity
- Go Direct Temperature



Cell respiration and photosynthesis of aquatic plants

To get started, see the recommendations at [www.vernier.com/env-chemistry](http://www.vernier.com/env-chemistry)

## 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. You will have access to the most up-to-date versions of the experiments through your Vernier account.

- Download word-processing files to customize the experiments to fit your curricular needs.
- Electronic versions include a generous site license—purchase once and share files with other instructors in your school or college department.

### Chemistry Lab Books

Subjects	<i>Chemistry with Vernier</i>	<i>Advanced Chemistry with Vernier</i>	<i>Vernier Chemistry Investigations for Use with AP* Chemistry</i>	<i>Investigating Chemistry through Inquiry</i>	<i>Organic Chemistry with Vernier</i>
High School Chemistry	•	•		•	
AP* Chemistry	•	•	•	•	
IB <sup>†</sup> Chemistry	•	•		•	
General Chemistry	•	•		•	
Organic Chemistry					•

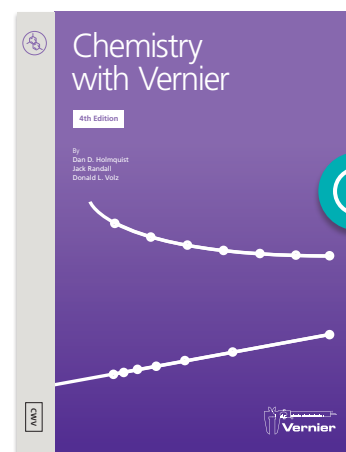
\* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

† 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.

## Chemistry with Vernier

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

CWV-E

Printed + Electronic Lab Book

CWV

### Topics include

- Stoichiometry
- Gas laws
- Acid-base titrations
- Calorimetry

For a complete list of all 36 experiments, visit [www.vernier.com/cwv](http://www.vernier.com/cwv)

### Sensors Used

Sensor	Page
Temperature	53, 57
pH	52, 56
Gas Pressure	51, 55
Conductivity	50, 54
Drop Counter	51, 55
Voltage	53, 57
Choose one:	
Colorimeter	50, 54
SpectroVis® Plus	59

### Additional Products

Equipment	Page
Stir Station	58
Electrode Support	58

### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19
Spectral Analysis	20
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>

### Química Con Vernier



*Química con Vernier* is the Spanish-language version of *Chemistry with Vernier*.

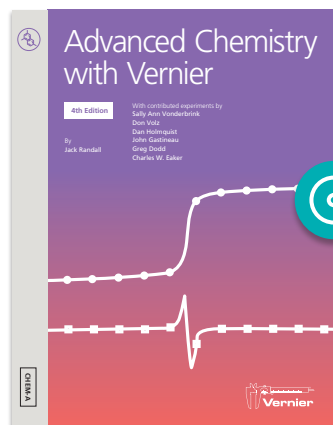
[www.vernier.com/cwv-es](http://www.vernier.com/cwv-es)



## Advanced Chemistry with Vernier

HIGH SCHOOL

COLLEGE


**Electronic  
Lab Book Only**

CHEM-A-E

**Printed + Electronic  
Lab Book**

CHEM-A

### Topics include

- Stoichiometry and the mole
- Redox reactions
- Electrochemistry
- Chemical kinetics
- Spectroscopy

For a complete list of all 35 experiments, visit [www.vernier.com/chem-a](http://www.vernier.com/chem-a)

### Sensors Used

Sensor	Page
Temperature	53, 57
pH	52, 56
Gas Pressure	51, 55
Choose one: Conductivity	50, 54
Platinum-Cell Conductivity	54
Drop Counter	51, 55
Voltage	53, 57
Choose one: Colorimeter	50, 54
SpectroVis® Plus	59
ORP	52, 56
Choose one: Constant Current	51, 55
Current Probe	55, 113
Radiation Monitor	113, 127

### Additional Products

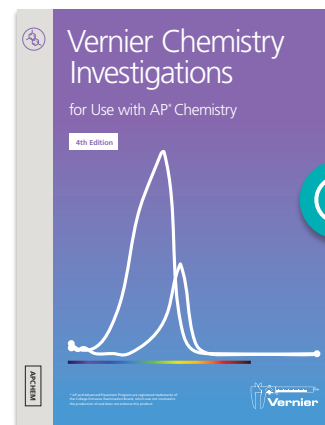
Equipment	Page
Stir Station	58
Electrode Support	58

### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19
Spectral Analysis	20

## Vernier Chemistry Investigations for Use with AP\* Chemistry

HIGH SCHOOL


**Electronic  
Lab Book Only**

APCHEM-E

**Printed + Electronic  
Lab Book**

APCHEM

Includes inquiry-based laboratory investigations aligned with the 16 investigations published by The College Board

### Topics include

- Spectroscopy
- Titrations
- Chemical kinetics
- Equilibrium
- Calorimetry

For a complete list of all 16 investigations, visit [www.vernier.com/apchem](http://www.vernier.com/apchem)

### Sensors Used

Sensor	Page
Temperature	53, 57
pH	52, 56
Gas Pressure	51, 55
Conductivity	50, 54
Drop Counter	51, 55
SpectroVis Plus	59
ORP	52, 56
Melt Station	51, 56

### Additional Products

Equipment	Page
Stir Station	58
Electrode Support	58

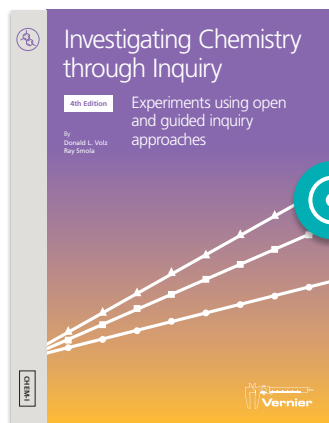
### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14
Graphical Analysis 4	18–19
Spectral Analysis	20

## Investigating Chemistry through Inquiry

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

CHEM-I-E

Printed + Electronic Lab Book

CHEM-I

### Topics include

- Chemical bonding and structure
- Energetics/thermochemistry
- Atomic structure
- Chemical kinetics

For a complete list of all 25 investigations, visit [www.vernier.com/chem-i](http://www.vernier.com/chem-i)

### Sensors Used

Sensor	Page
Temperature	53, 57
pH	52, 56
Gas Pressure	51, 55
Conductivity	50, 54
Voltage	53, 57
Choose one:	
Colorimeter	50, 54
SpectroVis Plus	59
ORP	52, 56
Radiation Monitor	113, 127

### Additional Products

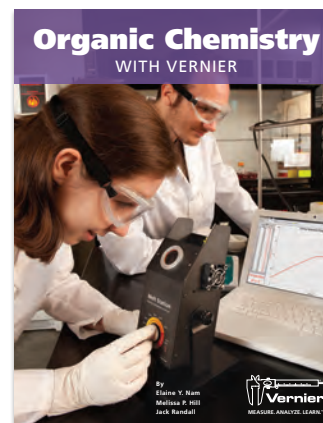
Equipment	Page
Stir Station	58
Electrode Support	58

### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14
Graphical Analysis 4	18–19
Spectral Analysis	20
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>

## UPDATED Organic Chemistry with Vernier

COLLEGE



Electronic Lab Book Only

CHEM-O-E

Printed + Electronic Lab Book

CHEM-O

### Topics include

- Synthesis
- Isolation and purification
- Distillation
- Chromatography
- Spectroscopy

For a complete list of all 26 experiments, visit [www.vernier.com/chem-o](http://www.vernier.com/chem-o)

### Sensors Used

Sensor	Page
Wide-Range Temperature	53, 57
Polarimeter	56
Melt Station	56
Mini GC Plus	58
Choose one:	
Go Direct SpectroVis Plus	59
Vernier UV-VIS Spectrophotometer	59
Vernier Fluorescence/UV-VIS Spectrophotometer	59

### Additional Products

Equipment	Page
Stir Station	58
Electrode Support	58

### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14

Studying the relationship between  
the angle of insolation and  
temperature change



# Earth Science

[www.vernier.com/earth-science](http://www.vernier.com/earth-science)



## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct 3-Axis Magnetic Field	GDX-3MG	66
Go Direct CO <sub>2</sub> Gas	GDX-CO2	34
Go Direct Conductivity	GDX-CON	66
Go Direct Current	GDX-CUR	113
Go Direct Energy	GDX-NRG	88
Go Direct Light and Color	GDX-LC	66
Go Direct Motion	GDX-MD	98
Go Direct O <sub>2</sub> Gas	GDX-O2	34
Go Direct Optical Dissolved Oxygen	GDX-ODO	34
pH Sensors		
Go Direct pH	GDX-PH	52
Go Direct Tris-Compatible Flat pH	GDX-FPH	66
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	53
Go Direct Temperature	GDX-TMP	53
Go Direct Voltage	GDX-VOLT	113

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Anemometer	ANM-BTA	<a href="#">web</a>
Barometer	BAR-BTA	<a href="#">web</a>
CO <sub>2</sub> Gas Sensor	CO2-BTA	37
Conductivity Probe	CON-BTA	54
Current Probe	DCP-BTA	122
Energy Sensor	VES-BTA	<a href="#">web</a>
Flow Rate Sensor	FLO-BTA	<a href="#">web</a>
Gas Pressure Sensor	GPS-BTA	55
Light Sensor	LS-BTA	125
Magnetic Field Sensor	MG-BTA	123
Motion Detector	MD-BTD	66
O <sub>2</sub> Gas Sensor	O2-BTA	37
Optical DO Probe	ODO-BTA	37
pH Sensors		
pH Sensor	PH-BTA	56
Tris-Compatible Flat pH Sensor	FPH-BTA	38
Pyranometer	PYR-BTA	<a href="#">web</a>
Relative Humidity Sensor	RH-BTA	<a href="#">web</a>
Salinity Sensor	SAL-BTA	<a href="#">web</a>
Soil Moisture Sensor	SMS-BTA	87
Temperature Probes		
Extra-Long Temperature Probe	TPL-BTA	<a href="#">web</a>
Stainless Steel Temperature Probe	TMP-BTA	66
Surface Temperature Sensor	STS-BTA	57
Turbidity Sensor	TRB-BTA	66
UV Sensors		
UVA Sensor	UVA-BTA	<a href="#">web</a>
UVB Sensor	UVB-BTA	66
Voltage Probe	VP-BTA	57

## WEATHER STATIONS

Equipment	Order Code	Page
Davis WeatherLinkIP™	DWLINK-IP	<a href="#">web</a>
Vantage Pro2™	DWVVP	<a href="#">web</a>
Vantage Pro2™ Plus	DWPLUS	<a href="#">web</a>
Vantage Vue®	DWVUE	67
Kestrel® DROP D1	KES-D1	<a href="#">web</a>
Kestrel DROP D2	KES-D2	<a href="#">web</a>
Kestrel DROP D3	KES-D3	<a href="#">web</a>




## ADDITIONAL PRODUCTS

Product	Order Code	Page
Electrode Support	ESUP	58
KidWind 2V/400mA Solar Panel	KW-SP2V	91
KidWind Basic Wind Experiment Kit	KW-BWX	89
KidWind MINI Wind Turbine with Blade Design	KW-MWTBD	90
Solar Energy Exploration Kit	KW-SEEK	91
Vernier Resistor Board	VES-RB	88

## LAB BOOKS

Title	Page
<i>Earth Science with Vernier</i>	67

## RELATED CONTENT

<b>UPDATED</b> <i>Renewable Energy with Vernier</i> 	page 93
<i>Water Quality with Vernier</i>	page 93
<b>NEW</b> <i>Solar Energy Explorations</i> 	page 101
<b>NEW</b> <i>Wind Energy Explorations</i> 	page 101



## Go Direct Conductivity

Simultaneously read conductivity and temperature with Go Direct® Conductivity. Sample total dissolved solids (TDS), measure the salinity of soil, and more.

[www.vernier.com/gdx-con](http://www.vernier.com/gdx-con)

GDX-CON



## Go Direct Light and Color

Go Direct Light and Color combines the power of multiple sensors to measure light intensity in the visible range and UV portions of the electromagnetic spectrum.

[www.vernier.com/gdx-lc](http://www.vernier.com/gdx-lc)

GDX-LC



## Go Direct Tris-Compatible Flat pH

The flat glass shape of Go Direct Tris-Compatible Flat pH makes it easy to clean and useful for measuring the pH of semisolids such as soil slurries and certain foods.

[www.vernier.com/gdx-fph](http://www.vernier.com/gdx-fph)

GDX-FPH



## Go Direct 3-Axis Magnetic Field

Go Direct 3-Axis Magnetic Field measures the components of the magnetic field along three orthogonal axes. This makes it possible to determine the magnitude and direction of the magnetic field at any point in space.

[www.vernier.com/gdx-3mg](http://www.vernier.com/gdx-3mg)

GDX-3MG



## Motion Detector

Oceanographers use echo sounders to investigate objects below the surfaces of bodies of water. Use the Motion Detector in a similar manner to map objects on a simulated ocean floor.

[www.vernier.com/md-btd](http://www.vernier.com/md-btd)

MD-BTD



## Stainless Steel Temperature Probe

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

Range -40 to 135°C

[www.vernier.com/tmp-bta](http://www.vernier.com/tmp-bta)

TMP-BTA



## Turbidity Sensor

Measure the turbidity of freshwater or seawater samples and determine water quality. Simple setup and calibration make it easy to use at the collection site or when you return to the classroom.

[www.vernier.com/trb-bta](http://www.vernier.com/trb-bta)

TRB-BTA



## UVB Sensor

The UVB Sensor is an ultraviolet light sensor that responds primarily to UVB radiation (approximately 290 to 320 nm). It is ideal for experiments using sunlight as your UV source.

[www.vernier.com/uvb-bta](http://www.vernier.com/uvb-bta)

UVB-BTA



## Davis® Vantage Vue® Weather Station

The Vantage Vue weather station includes a console with an 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!

For additional Davis weather stations and supporting products, including computer software and hardware mounting options, see [www.vernier.com/weather](http://www.vernier.com/weather)

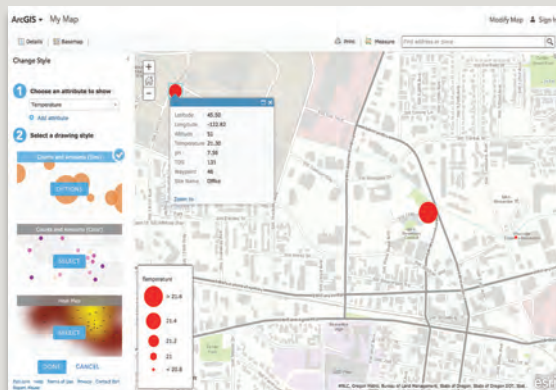


DWVUE

## 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® 3 and then export to a GIS-compatible format.

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



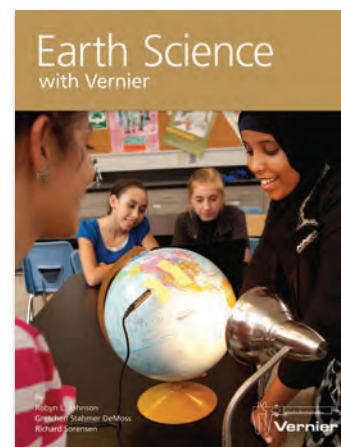
*ArcGIS Online provides a variety of tools for data analysis.*

Visit [www.vernier.com/til/2802](http://www.vernier.com/til/2802)

## Earth Science with Vernier

MIDDLE SCHOOL

HIGH SCHOOL



Electronic  
Lab Book Only

Printed + Electronic  
Lab Book

ESV-E

ESV

### Topics Include

- Geology/soil analysis
- Water quality
- Hydrology/oceanography
- Meteorology
- Renewable energy

For a complete list of all 33 experiments, visit [www.vernier.com/esv](http://www.vernier.com/esv)

### Sensors Used

Sensor	Page
Temperature	66
Light	125
pH	56
Motion Detector	66
UVB	66
Magnetic Field	123
Conductivity	54
Turbidity	66
Current	122
Voltage	57

### Additional Products

Equipment	Page
Electrode Support	58
Davis Weather Station <a href="http://www.vernier.com/weather">www.vernier.com/weather</a>	
KidWind 2V/400mA Solar Panel	91
KidWind MINI Wind Turbine	90
Stir Station	58
Water Depth Sampler <a href="http://www.vernier.com/wds">www.vernier.com/wds</a>	
Water Quality Bottles <a href="http://www.vernier.com/wq-bot">www.vernier.com/wq-bot</a>	

### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14
EasyData® <a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>	

Exploring blade design



# Elementary Science

[www.vernier.com/elementary-science](http://www.vernier.com/elementary-science)



## PACKAGES

Go Direct® Packages page 70

LabQuest® 2 Packages [www.vernier.com/ewv-lq2](http://www.vernier.com/ewv-lq2)

## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct 3-Axis Magnetic Field	GDX-3MG	66
Go Direct Energy	GDX-NRG	70
Go Direct Force and Acceleration	GDX-FOR	104
Go Direct Gas Pressure	GDX-GP	51
Go Direct Light and Color	GDX-LC	66
Go Direct Motion	GDX-MD	98
Go Direct Sound	GDX-SND	98
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	53
Go Direct Temperature	GDX-TMP	98
Go Direct Voltage	GDX-VOLT	105

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Anemometer	ANM-BTA	<a href="#">web</a>
Barometer	BAR-BTA	<a href="#">web</a>
Dual-Range Force Sensor	DFS-BTA	119
Energy Sensor	VES-BTA	<a href="#">web</a>
Force Plate	FP-BTA	119
Gas Pressure Sensor	GPS-BTA	55
Light Sensor	LS-BTA	125
Magnetic Field Sensor	MG-BTA	123
Motion Detector	MD-BTD	117
Relative Humidity Sensor	RH-BTA	<a href="#">web</a>
Sound Level Sensor	SLS-BTA	121
Temperature Probes		
Go!Temp (USB Sensor)	GO-TEMP	<a href="#">web</a>
Stainless Steel Temperature Probe	TMP-BTA	57
Surface Temperature Sensor	STS-BTA	57
Voltage Probe	VP-BTA	57

## ADDITIONAL PRODUCTS

Product	Order Code	Page
Davis® Weather Station	DWVUE	67
Digital Microscopes	varies	40
KidWind MINI Wind Turbine with Blade Design	KW-MWTBD	70
KidWind Solar Energy Exploration Kit	KW-SEEK	91
Vernier Resistor Board	VES-RB	88

## LAB BOOKS

Title	Page
<i>Elementary Science with Vernier</i>	71
<b>UPDATED</b> <i>Investigating Solar Energy</i>	71
<b>UPDATED</b> <i>Investigating Wind Energy</i>	71
<b>UPDATED</b> <i>Investigating Temperature</i>	<a href="#">web</a>
<i>Ciencia en la Primaria con Vernier</i>	71

*“Out of the textbook and into their hands! Vernier software takes student experiments to a new level. Thank you for bringing relevance and rigor to the classroom!”*

—Keli Iwamoto,  
Creston School, Portland, Oregon, USA



## Go Direct Elementary Science Packages

Go Direct® sensors are perfect for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks and mobile devices



Connect Directly via USB or Bluetooth® Wireless Technology



Works with Your Existing Devices



2–4 Students per Package



Collect Data with the FREE Graphical Analysis™ 4 App

### Starter Package (3 Products)

GDP-EL-ST



Go Direct Temperature



Go Direct Light and Color



Go Direct Motion

### Deluxe Package (7 Products)

GDP-EL-DX



Go Direct Gas Pressure



Go Direct 3-Axis Magnetic Field



Go Direct Voltage



Go Direct Force and Acceleration

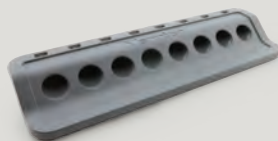
### You May Also Want

#### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



### Related Lab Book



Many of the experiments in this book use sensors found in the Go Direct Elementary Science packages. Vernier lab books include student instructions, teacher tips, and sample data.

See page 71.

## KidWind MINI Wind Turbine with Blade Design

Students can use the MINI Wind Turbine with Blade Design to perform basic blade experiments on a desk while also using a small house fan (not included). This kit is recommended for use with our lab book *Investigating Wind Energy*.

[www.vernier.com/kw-mwtbd](http://www.vernier.com/kw-mwtbd)

KW-MWTBD



## NEW Go Direct Energy

Simpler to use than a multimeter, Go Direct Energy measures the voltage and current of a renewable energy system. Connect a source, such as a small wind turbine or solar panel, and our free Graphical Analysis 4 app calculates the power and energy output.

[www.vernier.com/gdx-nrg](http://www.vernier.com/gdx-nrg)

GDX-NRG



Additional recommendations available at [www.vernier.com/packages/ewv](http://www.vernier.com/packages/ewv)

**UPDATED Investigating Wind Energy**

ELEMENTARY

**Electronic  
Lab Book Only**

ELB-WIND-E

**Printed + Electronic  
Lab Book**

ELB-WIND

**Products Used**

Product	Page
KidWind MINI Wind Turbine with Blade Design	90
Energy Sensor 88, <a href="http://www.vernier.com/ves-bta">www.vernier.com/ves-bta</a>	
Vernier Resistor Board	88

**Supported Software**

Graphical Analysis 4	pp. 18–19
LabQuest® App	pp. 13–14

**Topics Include**

- Energy
- Renewable energy
- Engineering design

For a complete list of all 11 experiments, see [www.vernier.com/elb-wind](http://www.vernier.com/elb-wind)

Logger Lite® [www.vernier.com/logger-lite](http://www.vernier.com/logger-lite)

**UPDATED Investigating Solar Energy**

ELEMENTARY

**Electronic  
Lab Book Only**

ELB-SOLAR-E

**Printed + Electronic  
Lab Book**

ELB-SOLAR

**Products Used**

Product	Page
KidWind Solar Energy Exploration Kit	91
Energy Sensor 88, <a href="http://www.vernier.com/ves-bta">www.vernier.com/ves-bta</a>	
Surface Temperature	53
Vernier Resistor Board	88

**Supported Software**

Graphical Analysis 4	pp. 18–19
LabQuest App	pp. 13–14

**Topics Include**

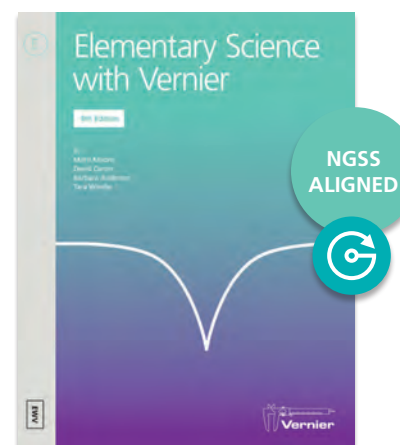
- Energy
- Renewable energy
- Engineering design

For a complete list of all 11 experiments, see [www.vernier.com/elb-solar](http://www.vernier.com/elb-solar)

Logger Lite [www.vernier.com/logger-lite](http://www.vernier.com/logger-lite)

**Elementary Science with Vernier**

ELEMENTARY

**Electronic  
Lab Book Only**

EWV-E

**Printed + Electronic  
Lab Book**

EWV

**Topics Include**

- Properties of matter
- Forces and interactions
- Electricity

For a complete list of all 43 experiments, see [www.vernier.com/ewv](http://www.vernier.com/ewv)

**Sensors Used**

Sensor	Page
Temperature	57, 98
Light	66, 125
Motion Detector	98, 117
Gas Pressure	51, 55
Magnetic Field	98, 123
Voltage	57, 113
Force	104, 119

**Supported Software**

Software	Page
Graphical Analysis 4	18–19
LabQuest App	13–14
Logger Lite <a href="http://www.vernier.com/logger-lite">www.vernier.com/logger-lite</a>	

**Ciencia en la Primaria con Vernier**

Ciencia en la Primaria con Vernier is the Spanish-language version of *Elementary Science with Vernier*.

[www.vernier.com/cpv](http://www.vernier.com/cpv)



Applying engineering design processes to evaluate structure failure and improve design



View a Tech Tip video of engineering experiments at [www.vernier.com/videos](http://www.vernier.com/videos)



# Engineering, Coding, and Robotics

[www.vernier.com/engineering](http://www.vernier.com/engineering)

## CODING

Product	Page
Block-Based Coding	
LEGO® MINDSTORMS®	75
Scratch	74
Instrument-Control Coding	
Arduino®	74
LabVIEW™	74
Text-Based Coding	
JavaScript™	74
Python®	74

## ROBOTICS

Product	Order Code	Page
LEGO® MINDSTORMS® Robotics		
NXT Sensor Adapter for EV3 and NXT	BTA-NXT	75

## RENEWABLE ENERGY

Product	Order Code	Page
Go Direct® Energy Sensor	GDX-NRG	76
KidWind® simpleGEN	KW-SGEN	77
Solar Kits		
Solar Energy Exploration Kit	KW-SEEK	76
Solar Thermal Exploration Kit	KW-STXK	76
Wind Kits		
KidWind Advanced Wind Experiment Kit	KW-AWX	77
KidWind Basic Wind Experiment Kit	KW-BWX	77
KidWind MINI Wind Turbine with Blade Design	KW-MWTBD	77

## ARDUINO

Product	Order Code	Page
Arduino Interface Shield	BT-ARD	78
Digital Control Unit	DCU-BTD	78
ProtoBoard Adapters		
Analog ProtoBoard Adapter	BTA-ELV	78
Digital ProtoBoard Adapter	BTD-ELV	78
SparkFun® RedBoard	ARD-RED	78

## LABVIEW

Product	Order Code	Page
myDAQ Adapter	BT-MDAQ	79
SensorDAQ®	SDAQ	79

## ENGINEERING AND CODING LAB BOOKS

Product	Order Code	Page
Engineering Projects with NI LabVIEW™ and Vernier	EPV	79
Hands-On Introduction to NI LabVIEW™ with Vernier	Free Download	79

## ROBOTICS AND CODING LAB BOOKS

Product	Order Code	Page
LEGO® Robotics		
Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3	EP-EV3-E	75
Vernier Engineering Projects with LEGO® MINDSTORMS® Education NXT	Free Download	<a href="#">web</a>

## BRIDGE AND STRUCTURE TESTING

Product	Order Code	Page
Vernier Structures & Materials Tester	VSMT	81
Truss Tester Accessory	VSMT-TRUSS	<a href="#">web</a>

*“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



## Coding with Vernier

Coding in the classroom has become an important way to introduce problem solving, nurture creativity, increase critical thinking, and build confidence, all while learning a new language.

Vernier offers a range of coding solutions from entry-level block-based languages to advanced instrument-control programming. With Vernier technology and an appropriate coding application, students can create code to control robots, incorporate sensor input, and create sensor-controlled projects.



### Entry-Level Programming

Colorful and modularized drag-and-drop graphical blocks make it easy for beginning programmers to learn to code.

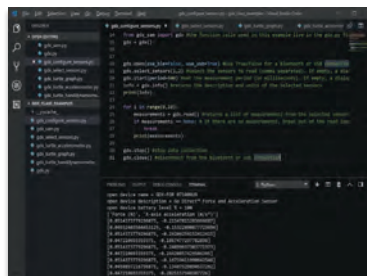
- **LEGO® MINDSTORMS®**  
Program your LEGO® MINDSTORMS® EV3 robots.  
See page 75.
- **Scratch**  
Create unique Scratch code using your Vernier sensors.



### Intermediate Programming Languages

Text-based coding allows students to build on their coding knowledge while learning new skills and solving more complex problems. Vernier code libraries and sample code provide support for Go Direct® sensors using the following intermediate programming languages:

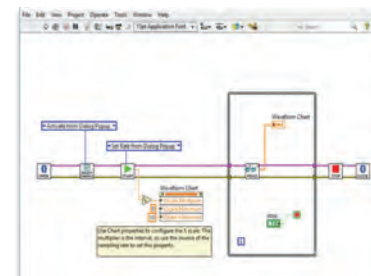
- **Python®**
- **JavaScript™**



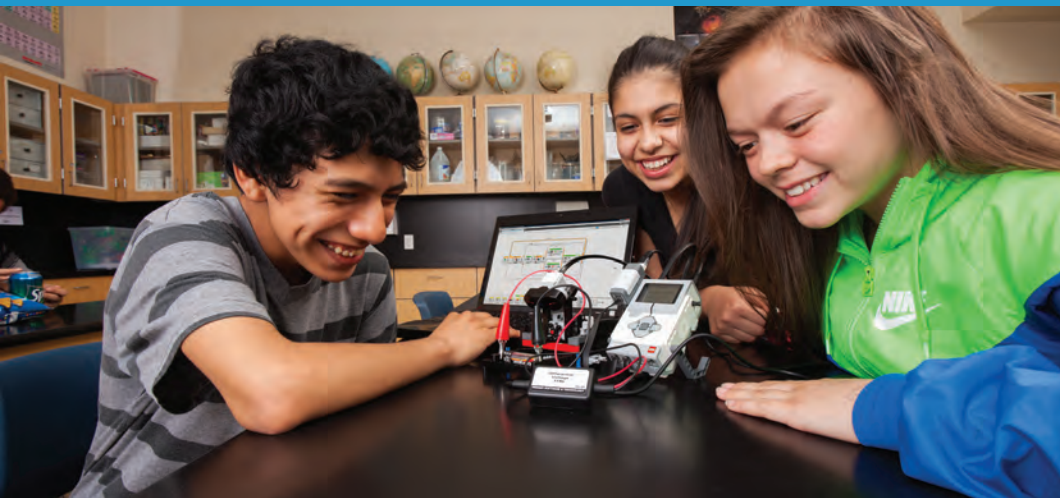
### Advanced Programming Languages Used in University, Research, and Industry

Programming languages used by researchers and professional engineers introduce students to automation, advanced analysis, and sensor-controlled projects.

- **Arduino® IDE**  
Connect Vernier sensors to an Arduino microcontroller.  
See page 78.
- **National Instruments' LabVIEW™**  
Incorporate Vernier sensor input into LabVIEW VIs.  
See page 79.



Learn more at [www.vernier.com/coding](http://www.vernier.com/coding)



## LEGO® MINDSTORMS® Robotics

Program your EV3 robots in the fastest, smartest, and most fun way possible. Simply drag and drop the programming blocks onto the programming canvas, click “Play”, and see how your robot reacts. Each programming block will make your robot respond in a specific way, and by combining them you can make your robot walk, talk, grab, or do whatever you can imagine.

Get more out of LEGO’s robotics platform, LEGO® MINDSTORMS® EV3, by connecting Vernier sensors for exciting robotics projects. Our Sensor Adapter, MINDSTORMS® EV3 software Sensor Block, and robotics activities make it easy to give your students interesting robotics projects. The LEGO® MINDSTORMS® EV3 system (sold separately) is appropriate for middle and high school students.

## NXT Sensor Adapter for EV3 and NXT

The Vernier NXT Sensor Adapter allows certain Vernier LabQuest® sensors to work on the LEGO® MINDSTORMS® EV3 and LEGO® MINDSTORMS® NXT robotics systems. Enhance your robots and with sensors for measuring everything from temperature to force, light level, UV level, pH, and more.

[www.vernier.com/bta-nxt](http://www.vernier.com/bta-nxt)

BTA-NXT



## Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3

MIDDLE SCHOOL

HIGH SCHOOL

Electronic Lab Book Only

EP-EV3-E



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](http://www.vernier.com/ep-ev3)

## Vernier Mars Challenge with LEGO® MINDSTORMS® Education EV3

MIDDLE SCHOOL

Electronic Lab Book Only

FREE DOWNLOAD



This curriculum guide offers an opportunity to introduce students to the physical concepts of electricity and magnetism through exciting hands-on robotics activities. By coupling robotics design with NASA’s space program, students gain an understanding of scientific principles in real-world applications.

For a complete list of projects, see [www.vernier.com/mars-ev3](http://www.vernier.com/mars-ev3)

## NEW Go Direct Energy

Use Go Direct<sup>®</sup> Energy with our free Graphical Analysis<sup>™</sup> 4 app on a computer, Chromebook,<sup>™</sup> or mobile device to determine the power output of a renewable energy system. Connect a source, such as KidWind<sup>®</sup> solar panels or wind turbines, and students can quantitatively evaluate the effects of their design changes.

[www.vernier.com/gdx-nrg](http://www.vernier.com/gdx-nrg)

GDX-NRG



## Vernier Variable Load

The Vernier Variable Load provides 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.

[www.vernier.com/ves-vl](http://www.vernier.com/ves-vl)

VES-VL



## Vernier Resistor Board

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 elementary and middle school renewable energy lab books.

[www.vernier.com/ves-rb](http://www.vernier.com/ves-rb)

VES-RB



## Solar Energy Exploration Kit

ALL GRADE  
LEVELS

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.

[www.vernier.com/kw-seek](http://www.vernier.com/kw-seek)

KW-SEEK



winner!  
2016 AWARDS  
of EXCELLENCE  
TECH & LEARNING

## Solar Thermal Exploration Kit

ALL GRADE  
LEVELS

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.

[www.vernier.com/kw-stxk](http://www.vernier.com/kw-stxk)

KW-STXK



## 2V/400mA Solar Panel

ALL GRADE  
LEVELS

This high-quality solar panel is great for demonstrations and experiments. External screw terminals and attached clip cords make the panels easy to use.

[www.vernier.com/kw-sp2v](http://www.vernier.com/kw-sp2v)

KW-SP2V





## KidWind MINI Wind Turbine with Blade Design

ELEMENTARY

Students can use the MINI Wind Turbine with Blade Design to perform basic blade experiments on a desk while also using a small house fan (not included). This kit is recommended for use with our lab book *Investigating Wind Energy*.

[www.vernier.com/kw-mwtbd](http://www.vernier.com/kw-mwtbd)

KW-MWTBD



## KidWind Advanced Wind Experiment Kit

HIGH SCHOOL

COLLEGE

Discover advanced concepts of wind turbine technology, including gearboxes and generator construction (with the simpleGEN add-on). Students 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*.

KW-AWX

### KidWind Advanced Wind Experiment Kit Classroom Pack

[www.vernier.com/kw-awx](http://www.vernier.com/kw-awx)

KW-AWXC



## KidWind simpleGEN

HIGH SCHOOL

COLLEGE

The simpleGEN is an easy-to-build AC generator that students can use to 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.

KW-SGEN

### KidWind simpleGEN Classroom Pack

The simpleGEN Classroom Pack includes enough materials to build 10 generators.

[www.vernier.com/kw-sgen](http://www.vernier.com/kw-sgen)

KW-SGENC



## KidWind Basic Wind Experiment Kit

MIDDLE SCHOOL

This kit allows experimentation with blade design for generating electricity and lifting weights. Experiments in our *Wind Energy Explorations* lab book use this kit.

KW-BWX

### KidWind Basic Wind Experiment Kit Classroom Pack

[www.vernier.com/kw-bwx](http://www.vernier.com/kw-bwx)

KW-BWXC



For information on complete kit contents and additional KidWind parts and accessories, visit [www.vernier.com/kidwind](http://www.vernier.com/kidwind)



## Arduino® and Vernier Programming Guide

We have created an online guide for using Vernier sensors with Arduino. This guide helps you connect, program, and calibrate our sensors. It includes a Vernier code library and sketches (programs) that can be used as a starting point for your projects.

[www.vernier.com/arduino](http://www.vernier.com/arduino)

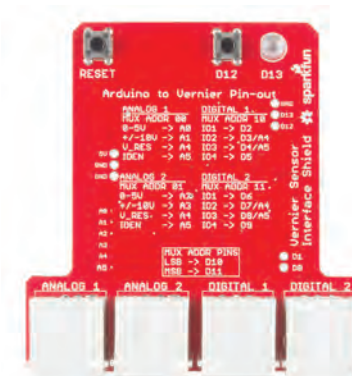


## Arduino Interface Shield

The Arduino Interface Shield plugs directly on top of the Arduino and adds two BTA (analog) and two BTD (digital) sockets, making it easy to connect over 80 Vernier LabQuest® sensors\*. This shield was developed to be used with the SparkFun Arduino RedBoard but will work with the Arduino UNO and other UNO equivalents.

[www.vernier.com/bt-ard](http://www.vernier.com/bt-ard)

BT-ARD



## Digital Control Unit

The Digital Control Unit (DCU) connects to a Vernier interface and allows you to control output devices such as motors, buzzers, pumps, and LEDs using Logger Pro® 3 software or LabQuest App†.

The DCU can also connect to an Arduino Interface Shield, myDAQ Adapter, and SensorDAQ. See page 79.

An external power supply, such as the LabQuest or LabPro power supply (not included), is required to power the device.

[www.vernier.com/dcu-btd](http://www.vernier.com/dcu-btd)

DCU-BTD



## Protoboard Adapters

Use these adapters to connect Vernier LabQuest sensors\* to a non-Vernier interface. The connector fits into a standard prototyping board.

[www.vernier.com/protoboard-adapters](http://www.vernier.com/protoboard-adapters)

Analog

BTA-ELV

Digital

BTD-ELV



## SparkFun® RedBoard with Cable

The SparkFun RedBoard is a surface-mount board that is pin-for-pin compatible with the Arduino UNO R3 layout. The RedBoard 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 LabQuest sensors\*.

[www.vernier.com/ard-red](http://www.vernier.com/ard-red)

ARD-RED



## National Instruments LabVIEW™ Software and Vernier

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

For more information on LabVIEW software and to download our sample LabVIEW VIs, visit [www.vernier.com/ni-labview](http://www.vernier.com/ni-labview)



## myDAQ Adapter

The myDAQ Adapter can be used to perform data acquisition with more than 60 Vernier LabQuest\* sensors and the NI myDAQ interface (sold separately). Designed for use with NI LabVIEW software.

[www.vernier.com/bt-mdaq](http://www.vernier.com/bt-mdaq)

BT-MDAQ



## SensorDAQ®

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

### Compatible with over 80 Vernier sensors

- Use with NI LabVIEW software. Not compatible with Logger Pro® 3 or Logger Lite® software.
- Use with LabQuest sensors. Not compatible with Go Direct® sensors.
- Works with Windows® only

[www.vernier.com/sdaq](http://www.vernier.com/sdaq)

SDAQ

Designed by National Instruments and Vernier for Engineering Education

SensorDAQ carries a one-year warranty.

### What's Included

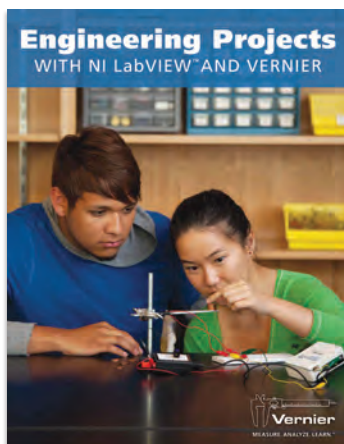
- SensorDAQ
- Voltage Probe
- USB cable



## Engineering Projects with NI LabVIEW™ and Vernier

HIGH SCHOOL

COLLEGE



### Electronic Lab Book Only

EPV-E

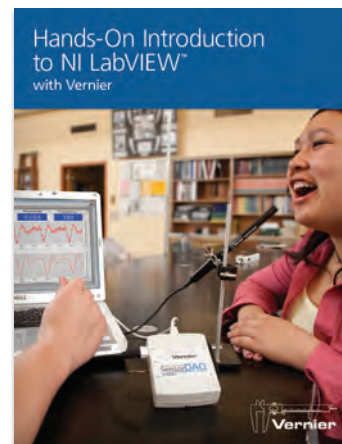
This lab book contains engaging, hands-on projects for SensorDAQ or LabQuest interfaces. It introduces engineering concepts and programming with NI LabVIEW software. An introductory knowledge of NI LabVIEW programming is assumed.

For a complete list of projects, see [www.vernier.com/epv](http://www.vernier.com/epv)

## Hands-On Introduction to NI LabVIEW™ and Vernier

HIGH SCHOOL

COLLEGE



### Electronic Lab Book Only

FREE DOWNLOAD

This free book introduces the basics of NI LabVIEW programming through a series of hands-on exercises using a Vernier temperature sensor, voltage probe, microphone, and Vernier SensorDAQ or LabQuest interface.

For a complete list of projects, see [www.vernier.com/lww](http://www.vernier.com/lww)



## 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 PreK–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, curriculum, and resources support teachers as they engage their students in real-world learning. More than 11,500 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](http://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 (6–8) sparks a joy of discovery and illuminates the range of paths and possibilities students can look forward to in high school and beyond as they apply knowledge and skills from a variety of disciplines.

### Computer Science

HIGH SCHOOL

PLTW Computer Science (9–12) engages students in real-world activities, projects, and problems that challenge them to apply computational thinking and logic to solve big problems.

### PLTW Engineering

HIGH SCHOOL

PLTW Engineering (9–12) empowers students to step into the role of an engineer and adopt a problem-solving mindset, inspiring students to believe in their own potential and see themselves in a career that improves communities.

### PLTW Biomedical Science

HIGH SCHOOL

PLTW Biomedical Science (9–12) inspires students to make an impact on others' lives and empowers them to pursue their life and career goals—whether it's a future in diagnosing, treating, or preventing disease.





Applying engineering processes to evaluate structure failure and improve design

## Structures & Materials Tester

Use the Vernier Structures & Materials Tester (VSMT), along with the engineering design method, to design, build, and test structures. You can also conduct bridge competitions, as well as investigate and analyze beam designs and material properties.

The VSMT is equipped with a load cell and a displacement sensor, which enables students to evaluate stress and strain. Use Logger Pro® 3 video analysis in conjunction with sensor measurements to see how and when things bend and break.

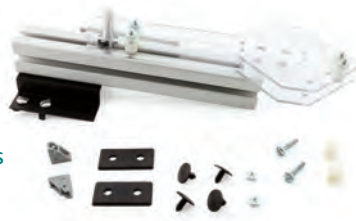
[www.vernier.com/vsmt](http://www.vernier.com/vsmt)

VSMT\*

## Truss Tester Accessory

[www.vernier.com/vsmt-truss](http://www.vernier.com/vsmt-truss)

VSMT-TRUSS



## Includes VSMT Tackle Kit

- Two aluminum load plates
  - 50 × 50 × 6 mm
  - 50 × 80 × 6 mm
- Chain
- Rods
- U-bolts



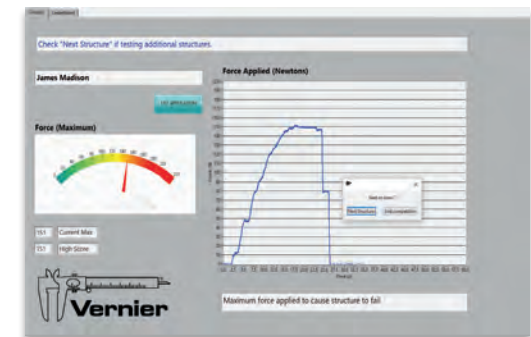
## Product Specifications

Load Cell	0 to 1000 N
Displacement Sensor	0.1 mm resolution
Maximum Travel	7.5 cm

## NEW Vernier Bridge Competition Software

This stand-alone application for Windows® and macOS® computers is a great resource to use for bridge competitions. The software provides visual representation of the force acting on the structure, as well as a comparison to previously tested structures.

[www.vernier.com/vbcs](http://www.vernier.com/vbcs)



\* Additional shipping charges may apply due to weight.



Measuring temperature and dissolved  
oxygen concentration of river water



# Environmental Science

[www.vernier.com/environmental-science](http://www.vernier.com/environmental-science)

## PACKAGES

LabQuest® Packages page 84

## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct® CO <sub>2</sub> Gas	GDX-CO2	34
Go Direct Colorimeter	GDX-COL	50
Go Direct Conductivity	GDX-CON	86
Go Direct Current	GDX-CUR	113
Go Direct Energy	GDX-NRG	88
Go Direct Ethanol Vapor	GDX-ETOH	36
Go Direct Light and Color	GDX-LC	86
Ion-Selective Electrodes*		
<b>NEW</b> Go Direct Ammonium Ion-Selective Electrode	GDX-NH4	<a href="#">web</a>
<b>NEW</b> Go Direct Calcium Ion-Selective Electrode	GDX-CA	<a href="#">web</a>
<b>NEW</b> Go Direct Chloride Ion-Selective Electrode	GDX-CL	<a href="#">web</a>
<b>NEW</b> Go Direct Nitrate Ion-Selective Electrode	GDX-NO3	<a href="#">web</a>
<b>NEW</b> Go Direct Potassium Ion-Selective Electrode	GDX-K	<a href="#">web</a>
Go Direct O <sub>2</sub> Gas	GDX-O2	34
Go Direct Optical Dissolved Oxygen	GDX-ODO	85
pH Sensors		
Go Direct pH	GDX-PH	86
Go Direct Tris-Compatible Flat pH	GDX-FPH	85
Go Direct SpectroVis® Plus	GDX-SVISPL	53
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	86
Go Direct Temperature	GDX-TMP	86
Go Direct Voltage	GDX-VOLT	113

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Anemometer	ANM-BTA	<a href="#">web</a>
Barometer	BAR-BTA	<a href="#">web</a>
CO <sub>2</sub> Gas Sensor	CO2-BTA	37
Colorimeter	COL-BTA	54
Conductivity Probe	CON-BTA	54
Current Probes		
Current Probe	DCP-BTA	122
High Current Sensor	HCS-BTA	<a href="#">web</a>
Energy Sensor	VES-BTA	<a href="#">web</a>
Flow Rate Sensor	FLO-BTA	<a href="#">web</a>
Ion-Selective Electrodes*		
Ammonium Ion-Selective Electrode	NH4-BTA	<a href="#">web</a>
Calcium Ion-Selective Electrode	CA-BTA	<a href="#">web</a>
Chloride Ion-Selective Electrode	CL-BTA	<a href="#">web</a>
Nitrate Ion-Selective Electrode	NO3-BTA	<a href="#">web</a>
Potassium Ion-Selective Electrode	K-BTA	<a href="#">web</a>
Light Sensor	LS-BTA	125
O <sub>2</sub> Gas Sensor	O2-BTA	37
Optical DO Probe	ODO-BTA	87
PAR Sensor	PAR-BTA	38
pH Sensors		
pH Sensor	PH-BTA	56
Tris-Compatible Flat pH Sensor	FPH-BTA	38
Pyranometer	PYR-BTA	<a href="#">web</a>
Relative Humidity Sensor	RH-BTA	<a href="#">web</a>
Salinity Sensor	SAL-BTA	<a href="#">web</a>
Soil Moisture Sensor	SMS-BTA	87
Temperature Probes		
Extra-Long Temperature Probe	TPL-BTA	<a href="#">web</a>
Stainless Steel Temperature Probe	TMP-BTA	57
Surface Temperature Sensor	STS-BTA	57
Turbidity Sensor	TRB-BTA	66

\* Ion-Selective Electrodes require excellent chemical technique and careful calibration to obtain accurate results; they are not recommended for middle school or elementary students.

## UV Sensors

UVA Sensor	UVA-BTA	<a href="#">web</a>
UVB Sensor	UVB-BTA	66

## Voltage Probes

30-Volt Voltage Probe	30V-BTA	<a href="#">web</a>
Differential Voltage Probe	DVP-BTA	57
Voltage Probe	VP-BTA	57






## DIGITAL MICROSCOPES

Equipment	Order Code	Page
Celestron® Digital Microscope Imager	CS-DMI	40
USB Digital Microscope	BD-EDU-100	40

## LAB EQUIPMENT

Equipment	Order Code	Page
KidWind Wind Energy Kits	varies	89–90
Primary Productivity Kit	PPK	<a href="#">web</a>
Solar Exploration Kits	varies	91
Water Depth Sampler	WDS	<a href="#">web</a>

## LAB BOOKS

Title	Page
<i>Investigating Environmental Science through Inquiry</i>	92
<i>Water Quality with Vernier</i>	93
<b>UPDATED</b> <i>Renewable Energy with Vernier</i> 	93
<b>UPDATED</b> <i>Investigating Wind Energy</i> 	71
<b>UPDATED</b> <i>Investigating Solar Energy</i> 	71
<b>NEW</b> <i>Solar Energy Explorations</i> 	101
<b>NEW</b> <i>Wind Energy Explorations</i> 	101

## LabQuest Environmental Science Packages

Appropriate for all levels of Environmental Science

Use LabQuest 2 as a Standalone Device

LabQuest 2 works with all Vernier sensors and built-in LabQuest App.

OR

Wireless (One-to-Many)

Transfer LabQuest 2 data wirelessly via Wi-Fi to one or more devices running Graphical Analysis 4 app.

OR

Wired (One-to-One)

LabQuest 2 works with Chromebooks and Windows® and macOS® computers.



Sensors Connect to a LabQuest 2 Interface



2–4 Students per Package

### Starter Package (7 Products)

LQ2-EV-OST



LabQuest 2



Stainless Steel Temperature Probe



pH Sensor



Conductivity Probe



Vernier Optical DO Probe



Soil Moisture Sensor



Turbidity Sensor

### Deluxe Package (13 Products)

LQ2-EV-ODX



Relative Humidity Sensor



UVB Sensor



CO<sub>2</sub> Gas Sensor



Voltage Probe



Current Probe



Light Sensor

### Related Lab Book



#### *Investigating Environmental Science through Inquiry*

Many of the experiments in this book use sensors found in the LabQuest Environmental Science Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see page 92.

### You May Also Want

#### LabQuest Charge Station

Easily charge and store your LabQuest 2 interfaces with the LabQuest Charge Station.

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

#### LabQuest Viewer® Software

Teach your students how to use LabQuest by projecting your LabQuest screen. Display live images of your LabQuest units to monitor student progress.

See page 21.

LQ-VIEW



See LabQuest Environmental Science Packages online at [www.vernier.com/packages/esi](http://www.vernier.com/packages/esi)





Monitoring the level of dissolved oxygen during photosynthesis

## Go Direct® Sensors

### Connection



Connects directly via USB or Bluetooth® wireless technology to your device



Computer



Chromebook™



LabQuest® 2

### Compatible platforms



iOS device



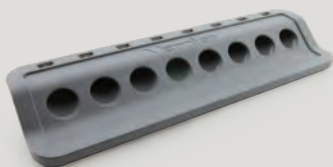
Android™ device

### Software



FREE Graphical Analysis™ 4,  
LabQuest App (LabQuest 2 only)

## You May Also Want



### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## Go Direct Optical Dissolved Oxygen

Measure biological/biochemical oxygen demand or monitor watersheds over time with Go Direct Optical Dissolved Oxygen.

- Combines the power of multiple sensors to measure dissolved oxygen, water temperature, and atmospheric pressure
- Ready to sample dissolved oxygen immediately without additional setup or the need to warm it up—so more class time can be spent on the investigation

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

[www.vernier.com/gdx-odo](http://www.vernier.com/gdx-odo)

GDX-ODO



## Go Direct Tris-Compatible Flat pH

The flat glass shape of Go Direct Tris-Compatible Flat pH makes it easy to clean and useful for measuring the pH of semisolids such as soil slurries and certain foods.

[www.vernier.com/gdx-fph](http://www.vernier.com/gdx-fph)

GDX-FPH





## Go Direct Light and Color

Go Direct® Light and Color combines the power of visible light, UV, 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.

[www.vernier.com/gdx-lc](http://www.vernier.com/gdx-lc)

GDX-LC



## Go Direct Conductivity

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  $\mu\text{S}/\text{cm}$ ). The sensor includes automatic temperature compensation for general use that can be turned off to perform conductivity studies as a function of temperature.

[www.vernier.com/gdx-con](http://www.vernier.com/gdx-con)

GDX-CON



## Go Direct pH

Use Go Direct pH to 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.

GDX-PH

## Go Direct pH Teacher Pack

Includes eight Go Direct pH Sensors and a Go Direct Charge Station.

[www.vernier.com/gdx-ph](http://www.vernier.com/gdx-ph)

GDX-PH-TP



## Temperature Probes

[www.vernier.com/temperature-sensors](http://www.vernier.com/temperature-sensors)

Sensor	Temperature Range	Features
Go Direct Temperature	-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.

GDX-TMP



## Go Direct Surface Temperature

-25°C to 125°C

GDX-ST



Designed for use in situations in which low thermal mass or flexibility is required, this sensor has an exposed thermistor that results in an extremely rapid response time. For use in air and water only.

## Go Direct Temperature Teacher Pack

Includes eight Go Direct Temperature Probes and a Go Direct Charge Station.

GDX-TMP-TP





Measuring water quality parameters of a lake

## LabQuest® Sensors

### Connection



BTA or BTD,  
plus a LabQuest interface

### Required LabQuest interface options



LabQuest  
Mini



LabQuest  
Stream®



LabQuest 2

### Compatible platforms



Computer



Chromebook™



iOS device



Android™ device

### Software



LabQuest App, Logger Pro® 3, Graphical Analysis™ 4

## Vernier Optical DO Probe

ODO-BTA

Students can measure the concentration of dissolved oxygen in water quickly and easily with the Vernier Optical DO Probe.

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

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

[www.vernier.com/odo-bta](http://www.vernier.com/odo-bta)



## Soil Moisture Sensor

The Soil Moisture Sensor uses capacitance to measure the water content of soil. Use it to conduct experiments in ecology, environmental science, agricultural science, horticulture, biology, and more.

Range 0 to 45% volumetric water content

[www.vernier.com/sms-bta](http://www.vernier.com/sms-bta)

SMS-BTA



## 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 as well as 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](http://www.vernier.com/globe)



## KidWind<sup>®</sup> PROJECT

*Competing in the ultimate hands-on wind turbine design competitions for students*

### KidWind Competitions—Putting the "E" in STEM

Challenge students to use creativity and apply engineering principles while designing, building, and testing a functional wind turbine. Students compete with peers in a supportive environment at local and national events.

Your students can also compete online in a variety of blade design challenges. For more information about KidWind competitions, visit [www.kidwindchallenge.org](http://www.kidwindchallenge.org)



To see our recommendations and to get started on the KidWind Challenge, visit [www.vernier.com/products/kidwind/challenges](http://www.vernier.com/products/kidwind/challenges)

### NEW Go Direct Energy

Simpler to use than a multimeter, Go Direct<sup>®</sup> Energy measures the voltage and current of a renewable energy system. Connect a source, such as a small wind turbine or solar panel, and our free Graphical Analysis™ 4 app calculates the power and energy output.

[www.vernier.com/gdx-nrg](http://www.vernier.com/gdx-nrg)

GDX-NRG



### Vernier Variable Load

The Vernier Variable Load provides 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.

[www.vernier.com/ves-vl](http://www.vernier.com/ves-vl)

VES-VL

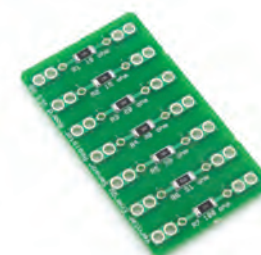


### Vernier Resistor Board

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 elementary and middle school renewable energy lab books.

[www.vernier.com/ves-rb](http://www.vernier.com/ves-rb)

VES-RB





## Recommended Classroom Setup



**3 Test Stations**



**6–10 Groups  
of 2–4 Students**

We recommend three test stations for a classroom with 6 to 10 groups of 2 to 4 students.

Each test station should have

- Box fan
- Wind turbine tower and base
- Go Direct Energy (GDX-NRG)
- 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
College	Advanced Wind Experiment Kit with GENPack or simpleGEN

## KidWind Advanced Wind Experiment Kit

Discover advanced concepts of wind turbine technology, including gearboxes and generator construction (with the simpleGEN add-on). Students 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*.

**KW-AWX**

### KidWind Advanced Wind Experiment Kit Classroom Pack

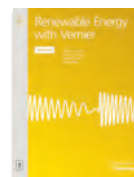
[www.vernier.com/kw-awx](http://www.vernier.com/kw-awx)

**KW-AWXC**



HIGH SCHOOL

COLLEGE



Use this kit for the experiments and engineering projects found in *Renewable Energy with Vernier*.

See page 93.

## KidWind Basic Wind Experiment Kit

This kit allows experimentation with blade design for generating electricity and lifting weights. Experiments in our *Wind Energy Explorations* lab book use this kit.

**KW-BWX**

### KidWind Basic Wind Experiment Kit Classroom Pack

[www.vernier.com/kw-bwx](http://www.vernier.com/kw-bwx)

**KW-BWXC**



MIDDLE SCHOOL



Use this kit for the experiments and engineering projects found in *Wind Energy Explorations*.

See page 101.

For information on complete kit contents and additional KidWind parts and accessories, visit [www.vernier.com/kidwind](http://www.vernier.com/kidwind)

Part Name	Order Code
Chipboard Sheets (50 Pack)	KW-CB50
Balsa Blade Sheets (100 Pack)	KW-BBS100
KidWind Airfoil Balsa Blade Sheets	KW-ABBS10
Blade Design Consumables Classroom Pack	KW-BDC
Blade Pitch Protractor	KW-BPP
Dowels (25 Pack)	KW-D25
Dowels (100 Pack)	KW-D100
Gear Set	KW-GEAR
GENPack	KW-GP
Power Output Board	KW-POBD
Basic Turbine Building Parts	KW-BTPART
Wind Turbine Generator (10 Pack)	KW-GEN10
High Torque Generator with Wires	KW-HIGEN
Wind Turbine Hub (10 Pack)	KW-WTH10



## WIND EXPERIMENT KITS



### KidWind MINI Wind Turbine with Blade Design

ELEMENTARY

#### Recommended

Students can use the MINI Wind Turbine with Blade Design to perform basic blade experiments on a desk while also using a small house fan (not included). This kit is recommended for use with our lab book *Investigating Wind Energy*.

[www.vernier.com/kw-mwtbd](http://www.vernier.com/kw-mwtbd)

KW-MWTBD



### KidWind MINI Wind Turbine

ELEMENTARY

The MINI Wind Turbine includes the wind turbine with Red Blade Set and Sound and Light Board.

[www.vernier.com/kw-mwt](http://www.vernier.com/kw-mwt)

KW-MWT



### KidWind simpleGEN

HIGH SCHOOL

COLLEGE

The simpleGEN is an easy-to-build AC generator that students can use to 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.

KW-SGEN



### KidWind simpleGEN Classroom Pack

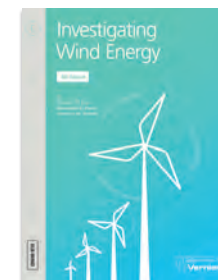
The simpleGEN Classroom Pack includes enough materials to build 10 generators.

[www.vernier.com/kw-sgen](http://www.vernier.com/kw-sgen)

KW-SGENC

### Teach Wind Energy Affordably and Easily

KidWind and Vernier offer a perfect solution for exploring renewable energy produced by wind turbine technology. Incorporate engineering design into your curriculum with our customizable experiments and projects.



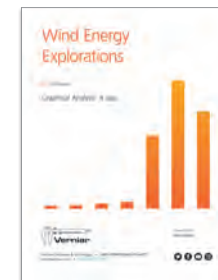
GRADES 4–6

#### Lab Book

*Investigating Wind Energy*

#### Equipment Used

KidWind MINI Wind Turbine with Blade Design



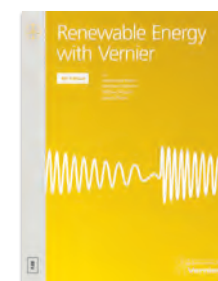
GRADES 6–8

#### Lab Book

*Wind Energy Explorations*

#### Equipment Used

KidWind Basic Wind Experiment Kit



HIGH SCHOOL & COLLEGE

#### Lab Book

*Renewable Energy with Vernier*

#### Equipment Used

KidWind Advanced Wind Experiment Kit with GENPack or simpleGEN

For more information, visit  
[www.vernier.com/wind-energy](http://www.vernier.com/wind-energy)

## Solar Energy Exploration Kit

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.

[www.vernier.com/kw-seek](http://www.vernier.com/kw-seek)

KW-SEEK



Go Direct® Energy makes it easy to measure power output.

See page 88.



winner!  
2016 AWARDS  
EXCELLENCE  
TECH LEARNING

## Solar Thermal Exploration Kit

ALL GRADE  
LEVELS

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.

[www.vernier.com/kw-stxk](http://www.vernier.com/kw-stxk)

KW-STXK



## 2V/400mA Solar Panel

ALL GRADE  
LEVELS

This high-quality solar panel is great for demonstrations and experiments. External screw terminals and attached clip cords make the panels easy to use.

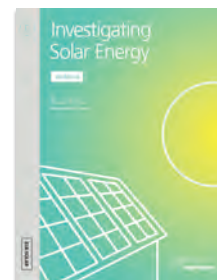
[www.vernier.com/kw-sp2v](http://www.vernier.com/kw-sp2v)

KW-SP2V



## Explore Solar Energy within Your Budget

Teach students how to build circuits to harness solar energy. Our technology is affordable, easy to use, and transports quickly in and out of the classroom or laboratory for outdoor investigations.



GRADES 4–6

**Lab Book**  
*Investigating Solar Energy*

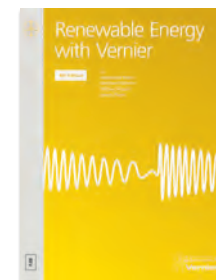
**Equipment Used**  
Solar Energy Exploration Kit



GRADES 6–8

**Lab Book**  
*Solar Energy Explorations*

**Equipment Used**  
Solar Energy Exploration Kit



HIGH SCHOOL & COLLEGE

**Lab Book**  
*Renewable Energy with Vernier*

**Equipment Used**  
Solar Thermal Exploration Kit and 2V/400mA Solar Panel

For more information, visit  
[www.vernier.com/solar-energy](http://www.vernier.com/solar-energy)

## 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. You will have access to the most up-to-date versions of the experiments through your Vernier account.

- Download word-processing files to customize the experiments to fit your curricular needs.
- Electronic versions include a generous site license—purchase once and share files with other instructors in your school or college department.

### Environmental Science Lab Books

Subjects	<i>Investigating Environmental Science through Inquiry</i>	<i>Water Quality with Vernier</i>	<i>Renewable Energy with Vernier</i>	<i>Solar Energy Explorations</i>	<i>Wind Energy Explorations</i>	<i>Investigating Solar Energy</i>	<i>Investigating Wind Energy</i>
Elementary Science/STEM						●	●
Middle School Science/STEM		●		●	●		
High School Science/STEM	●	●	●				
AP* Environmental Science	●	●	●				
IB† Environmental Systems and Societies	●	●	●				
College-Level Environmental/ Ecology	●	●	●				

\* 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

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

ESI-E

Printed + Electronic Lab Book

ESI

### Topics Include

- Acid deposition
- Water quality
- Climate change
- Weather
- Renewable energy

For a complete list of all 38 investigations, visit [www.vernier.com/esi](http://www.vernier.com/esi)

### Sensors Used

Sensor	Page
Temperature	57
pH	56
Conductivity	54
Dissolved Oxygen	87
Soil Moisture	87
Turbidity	66
Relative Humidity	<a href="http://www.vernier.com/rh-bta">www.vernier.com/rh-bta</a>
UVB	66
CO <sub>2</sub> Gas	37
Voltage	57
Current	122
Light	125

### Additional Products

Equipment	Page
Water Depth Sampler	<a href="http://www.vernier.com/wds">www.vernier.com/wds</a>
Primary Productivity Kit	<a href="http://www.vernier.com/ppk">www.vernier.com/ppk</a>
Stir Station	58

### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>



## Water Quality with Vernier

MIDDLE SCHOOL

HIGH SCHOOL

COLLEGE

Electronic  
Lab Book Only

WQV-E

Printed + Electronic  
Lab Book

WQV

### Topics Include

- Water turbidity
- Total Dissolved Solids (TDS)
- Biochemical oxygen demand

For a complete list of all 18 tests, visit [www.vernier.com/wqv](http://www.vernier.com/wqv)

### Sensors Used

Sensor	Page
Temperature	57
pH	56
Turbidity	66
Dissolved Oxygen	87
Colorimeter	54
Conductivity	54
Nitrate ISE <sup>‡</sup>	<a href="http://www.vernier.com/no3-bta">www.vernier.com/no3-bta</a>
Ammonium ISE <sup>‡</sup>	<a href="http://www.vernier.com/nh4-bta">www.vernier.com/nh4-bta</a>
Calcium ISE <sup>‡</sup>	<a href="http://www.vernier.com/ca-bta">www.vernier.com/ca-bta</a>
Chloride ISE <sup>‡</sup>	<a href="http://www.vernier.com/cl-bta">www.vernier.com/cl-bta</a>
Flow Rate	<a href="http://www.vernier.com/flo-bta">www.vernier.com/flo-bta</a>
PAR Sensor	38

### Additional Products

Equipment	Page
Water Depth Sampler	<a href="http://www.vernier.com/wds">www.vernier.com/wds</a>
Water Quality Bottles	<a href="http://www.vernier.com/wq-bot">www.vernier.com/wq-bot</a>

### Supported Software

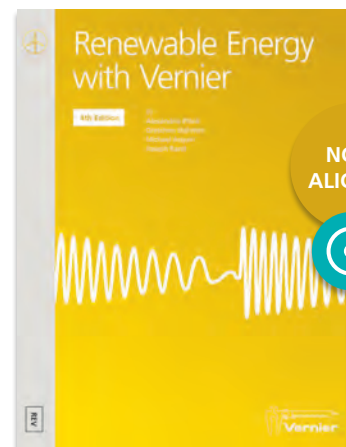
Software	Page
Logger Pro 3	22–23
LabQuest App	13–14
EasyData	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>

<sup>‡</sup> Ion-Selective Electrodes require excellent chemical technique and careful calibration to obtain accurate results; they are not recommended for middle school or elementary students.

## UPDATED Renewable Energy with Vernier

HIGH SCHOOL

COLLEGE

Electronic  
Lab Book Only

REV-E

Printed + Electronic  
Lab Book

REV

### Topics Include

- Renewable energy
- Wind power
- Solar power

For a complete list of all 26 experiments, visit [www.vernier.com/rev](http://www.vernier.com/rev)

winner!  
2015 AWARDS  
of EXCELLENCE  
TECH LEARNING

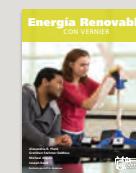
### Sensors Used

Sensor	Page
Energy	88, <a href="http://www.vernier.com/ves-bta">www.vernier.com/ves-bta</a>
Surface Temperature	57, 86
Light	86, 125
Anemometer	<a href="http://www.vernier.com/anm-bta">www.vernier.com/anm-bta</a>

### Additional Products

Equipment	Page
Vernier Variable Load	88
KidWind Advanced Wind Experiment Kit	89
KidWind Solar Panel	91
KidWind simpleGEN Kit	90
KidWind Solar Thermal Exploration Kit	91

### Energía Renovable con Vernier



*Energía Renovable con Vernier* is the Spanish-language version of *Renewable Energy with Vernier*.

[www.vernier.com/rev-es](http://www.vernier.com/rev-es)

### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14
Graphical Analysis 4	18–19

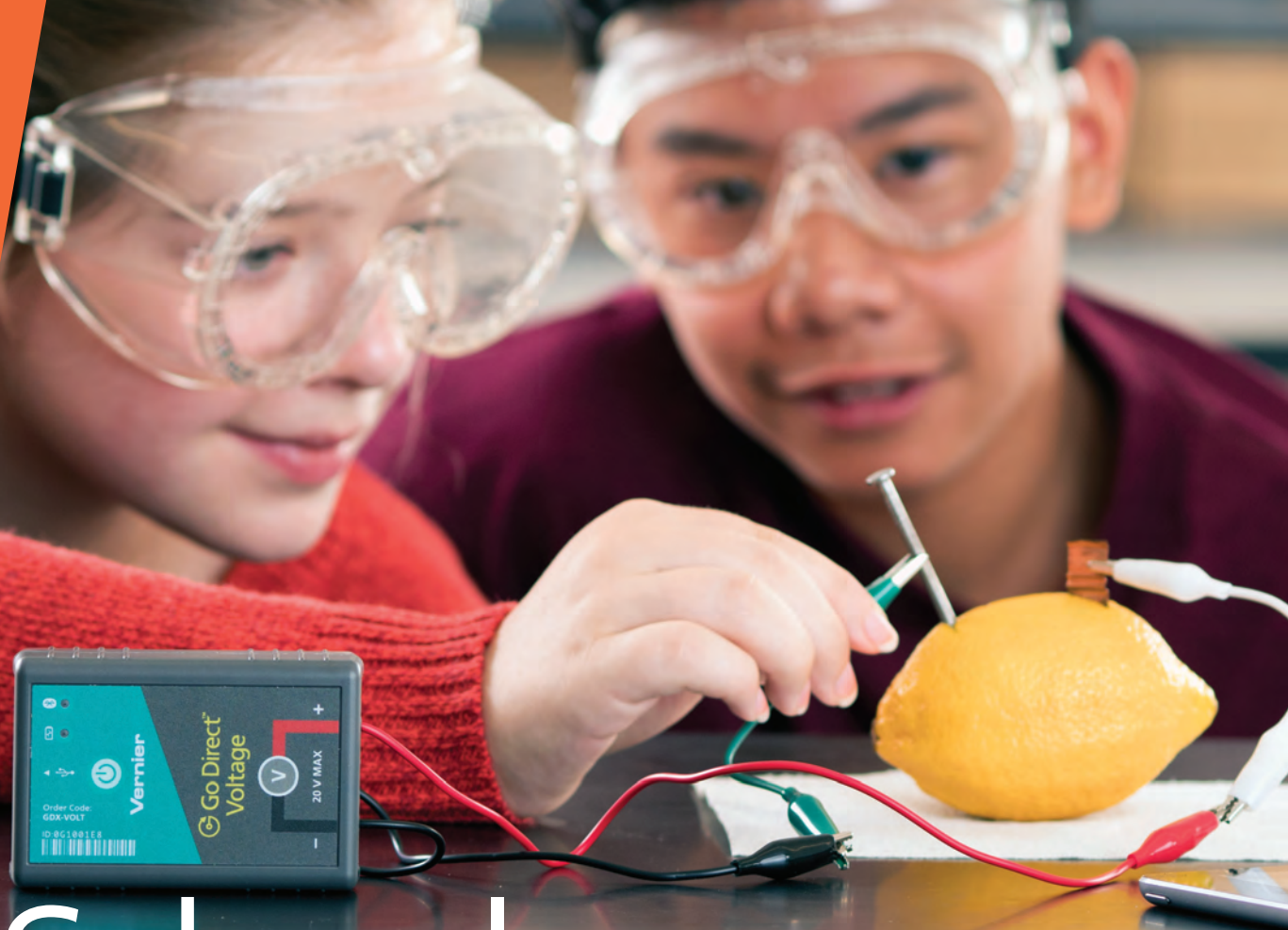


Measuring the potential  
developed by a lemon battery



# Middle School Science

[www.vernier.com/ms-science](http://www.vernier.com/ms-science)



## PACKAGES

Go Direct® and LabQuest® Packages pp. 96–97

## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct 3-Axis Magnetic Field	GDX-3MG	98
Carts and Tracks		
Dynamics Cart and Track System with Go Direct Sensor Carts	DTS-GDX	114
Go Direct Sensor Cart (Green)	GDX-CART-G	99
Go Direct Sensor Cart (Yellow)	GDX-CART-Y	99
Go Direct Conductivity	GDX-CON	50
Go Direct Current	GDX-CUR	113
Go Direct Energy	GDX-NRG	99
Go Direct Force and Acceleration	GDX-FOR	112
Go Direct Gas Pressure	GDX-GP	51
Heart Rate Monitors		
Go Wireless® Exercise Heart Rate	GW-EHR	web
Go Wireless Heart Rate	GW-HR	35
Go Direct Light and Color	GDX-LC	112
Go Direct Motion	GDX-MD	98
Go Direct Optical Dissolved Oxygen	GDX-ODO	34
pH Sensors		
Go Direct pH	GDX-PH	52
Go Direct Tris-Compatible Flat pH	GDX-FPH	52
Go Direct Sound	GDX-SND	98
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	53
Go Direct Temperature	GDX-TMP	98
Go Direct Voltage	GDX-VOLT	113

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Anemometer	ANM-BTA	web
Barometer	BAR-BTA	web
Conductivity Probe	CON-BTA	54
Current Probe	DCP-BTA	122
Energy Sensor	VES-BTA	web
Force Sensors		
Dual-Range Force Sensor	DFS-BTA	119
Force Plate	FP-BTA	119
Gas Pressure Sensor	GPS-BTA	55
Hand Dynamometer	HD-BTA	38
Hand-Grip Heart Rate Monitor	HGH-BTA	38
Light Sensor	LS-BTA	125
Magnetic Field Sensor	MG-BTA	123
Motion Detector	MD-BTD	117
Optical DO Probe	ODO-BTA	37
pH Sensors		
pH Sensor	PH-BTA	56
Tris-Compatible Flat pH Sensor	FPH-BTA	38
Pyranometer	PYR-BTA	web
Relative Humidity Sensor	RH-BTA	web
Salinity Sensor	SAL-BTA	web
Soil Moisture Sensor	SMS-BTA	87
Sound Level Sensor	SLS-BTA	121
Structures & Materials Tester	VSMT	81
Temperature Probes		
Extra-Long Temperature Probe	TPL-BTA	web
Go!Temp® (USB Sensor)	GO-TEMP	web
Stainless Steel Temperature Probe	TMP-BTA	57
Surface Temperature Sensor	STS-BTA	57
Thermocouple	TCA-BTA	57

## UV Sensors

UVA Sensor	UVA-BTA	web
UVB Sensor	UVB-BTA	66

## Voltage Probes

Differential Voltage Probe	DVP-BTA	57
Voltage Probe	VP-BTA	57

## ADDITIONAL PRODUCTS

Product	Order Code	Page
Dynamics Cart and Track System	DTS	116
OHAUS® Balances	varies	58
KidWind MINI Wind Turbine with Blade Design	KW-MWTBD	90
KidWind Basic Wind Experiment Kit	KW-BWX	99
Solar Energy Exploration Kit	KW-SEEK	99
Vernier Resistor Board	VES-RB	88

## LAB BOOKS

Title	Page
<i>Middle School Science with Vernier</i> 	100
<i>Earth Science with Vernier</i>	67
<b>NEW</b> <i>Solar Energy Explorations</i> 	101
<b>NEW</b> <i>Wind Energy Explorations</i> 	101
<i>Physical Science with Vernier</i> 	105
<b>NEW</b> <i>Exploring Motion and Force with Go Direct Sensor Cart</i> 	101

## Go Direct Middle School Packages

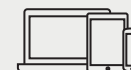
Physical Science, Life Science, Earth Science, and Renewable Energy

Go Direct® sensors are perfect for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks and mobile devices



Connect Directly via USB or Bluetooth® Wireless Technology



Works with Your Existing Devices



2–4 Students per Package



Collect Data with the FREE Graphical Analysis™ 4 App

### Starter Package (5 Products)

GDP-MS-ST



Go Direct Motion



Go Direct pH



Go Direct Temperature (×2)



Go Direct Light and Color

### Deluxe Package (11 Products)

GDP-MS-DX



Go Direct Force and Acceleration



Go Direct Gas Pressure



Go Direct Voltage



Go Direct Conductivity



Go Direct 3-Axis Magnetic Field



Go Wireless® Heart Rate

### Related Lab Book



#### Middle School Science with Vernier

Many of the experiments in this book use sensors found in the Go Direct Middle School Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see page 100.

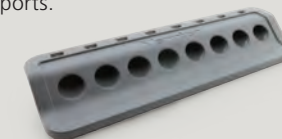
### You May Also Want

#### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



Additional recommendations available at [www.vernier.com/packages/msv](http://www.vernier.com/packages/msv)

## LabQuest Middle School Packages

Physical Science, Life Science, Earth Science, and Renewable Energy

Use LabQuest® 2 as a Standalone Device

LabQuest 2 works with all Vernier sensors and built-in LabQuest App.

OR

Wireless  
(One-to-Many)

Transfer LabQuest 2 data wirelessly via Wi-Fi to one or more devices running Graphical Analysis 4 app.

OR

Wired  
(One-to-One)

LabQuest 2 works with Chromebooks and Windows® and macOS® computers.



Sensors Connect to a LabQuest 2 Interface



2–4 Students per Package

### Starter Package (6 Products)

LQ2-MS-ST



LabQuest 2



Go Direct pH



Motion Detector



Stainless Steel Temperature Probes (x2)



Go Direct Light and Color

### Deluxe Package (12 Products)

LQ2-MS-DX



Go Direct Force and Acceleration



Gas Pressure Sensor



Go Wireless Heart Rate



Go Direct Conductivity



Go Direct 3-Axis Magnetic Field



Voltage Probe

### Related Lab Book



#### Middle School Science with Vernier

Many of the experiments in this book use sensors found in the LabQuest Middle School Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see page 100.

### You May Also Want

#### LabQuest Charge Station

Easily charge and store your LabQuest 2 interfaces with the LabQuest Charge Station.

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

#### LabQuest Viewer® Software

Teach your students how to use LabQuest by projecting your LabQuest screen. Display live images of your LabQuest units to monitor student progress.

See page 21.

LQ-VIEW



Additional recommendations available at [www.vernier.com/packages/msv](http://www.vernier.com/packages/msv)



Measuring mechanical advantage in a pulley system



## Go Direct® Sensors

### Connection



Connects directly via USB or Bluetooth® wireless technology to your device

### Compatible platforms



Computer



Chromebook™



LabQuest® 2



iOS device



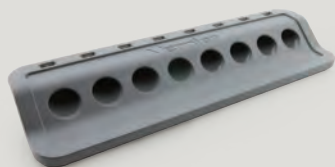
Android™ device

### Software



FREE Graphical Analysis™ 4, LabQuest App (LabQuest 2 only)

## You May Also Want



### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## Go Direct Temperature

With Go Direct Temperature, students can monitor temperatures from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , 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.

[www.vernier.com/gdx-tmp](http://www.vernier.com/gdx-tmp)



GDX-TMP

## Go Direct Temperature Teacher Pack

GDX-TMP-TP

Includes eight Go Direct Temperature Probes and a Go Direct Charge Station.

## NEW Go Direct Sound

Collect sound data wirelessly with the snap of your fingers. With sound-triggered data collection, Go Direct Sound provides students with an easy way to capture and evaluate waveforms. Measure wave amplitude and sound intensity level at the same time to investigate the decibel scale.

[www.vernier.com/gdx-snd](http://www.vernier.com/gdx-snd)

GDX-SND



## Go Direct Motion

Go Direct Motion accurately tracks objects as close as 15 cm and as far away as 3.5 m. The compact design and wireless capabilities of this motion detector eliminate the concern of a dangling cable getting in the way.

[www.vernier.com/gdx-md](http://www.vernier.com/gdx-md)

GDX-MD



## Go Direct 3-Axis Magnetic Field

Go Direct 3-Axis Magnetic Field measures the components of the magnetic field along one, two, or three orthogonal axes. This allows you to determine the magnitude and direction of the magnetic field at any point in space.

[www.vernier.com/gdx-3mg](http://www.vernier.com/gdx-3mg)

GDX-3MG



## NEW Go Direct Energy

Simpler to use than a multimeter, Go Direct Energy measures the voltage and current of a renewable energy system. Connect a source, such as a small wind turbine or solar panel, and our free Graphical Analysis 4 app calculates the power and energy output.

[www.vernier.com/gdx-nrg](http://www.vernier.com/gdx-nrg)

GDX-NRG

### Go Direct Energy Accessories

Vernier Resistor Board

VES-RB



## Go Direct Sensor Carts

We've added wireless sensors to our popular dynamics cart. Each cart includes an encoder wheel to report position, velocity, and acceleration; a 3-axis accelerometer to measure independent accelerations; and a  $\pm 50$  N force sensor to measure pushes and pulls. Conduct basic physics investigations with or without a track.

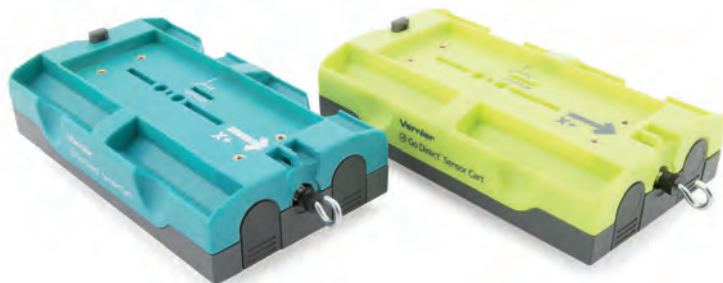
[www.vernier.com/gdx-cart](http://www.vernier.com/gdx-cart)

### Go Direct Sensor Cart (Green)

### Go Direct Sensor Cart (Yellow)

GDX-CART-G

GDX-CART-Y



## KidWind Basic Wind Experiment Kit

With this kit, student can experiment with blade design for generating electricity and lifting weights. Experiments in our *Wind Energy Explorations* lab book use this kit.

KW-BWX

### KidWind Basic Wind Experiment Kit Classroom Pack

[www.vernier.com/kw-bwx](http://www.vernier.com/kw-bwx)

KW-BWXC



For information on complete kit contents and additional KidWind parts and accessories, visit [www.vernier.com/kidwind](http://www.vernier.com/kidwind)

## Solar Energy Exploration Kit

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.

[www.vernier.com/kw-seek](http://www.vernier.com/kw-seek)

KW-SEEK



winner!  
2016 AWARDS  
EXCELLENCE  
TECH & LEARNING

## 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. You will have access to the most up-to-date versions of the experiments through your Vernier account.

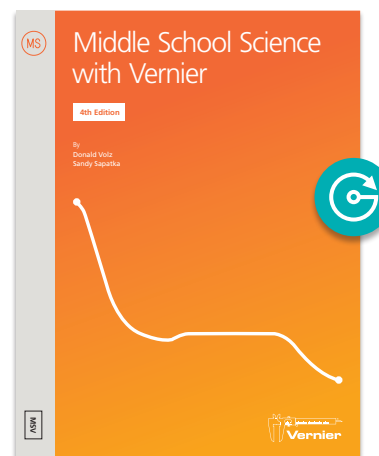
- Download word-processing files to customize the experiments to fit your curricular needs.
- Electronic versions include a generous site license—purchase once and share files with other teachers in your school.

### Middle School Lab Books

Subjects	<i>Middle School Science with Vernier</i>	<i>Physical Science with Vernier</i> (see page 105)	<i>Earth Science with Vernier</i> (see page 67)	<i>Wind Energy Explorations</i>	<i>Solar Energy Explorations</i>	<i>Exploring Motion and Force with Go Direct Sensor Cart</i>	<i>Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3</i> (see page 75)
Life Science	●						●
Earth and Space Science	●		●			●	●
Physical Science	●	●		●	●	●	●
Environmental Science	●			●	●		●
Engineering Education				●	●		●

## Middle School Science with Vernier

MIDDLE SCHOOL


**Electronic  
Lab Book Only**

MSV-E

**Printed + Electronic  
Lab Book**

MSV

### Topics Include

- Physical science
- Life science
- Earth science
- Renewable energy

For a complete list of all 38 experiments, visit [www.vernier.com/msv](http://www.vernier.com/msv)

### Sensors Used

Sensor	Page
Temperature	57, 98
pH	52, 56
Voltage	57, 113
Motion Detector	98, 117
Light	112, 125
Force	112, 119
Conductivity	50, 54
Gas Pressure	51, 55
Heart Rate	35, 38
Magnetic Field	98, 123

### Additional Products

Equipment	Page
Electrode Support	58
Stir Station	58

### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>



## NEW Wind Energy Explorations

MIDDLE SCHOOL

Electronic  
Lab Book Only

MSB-WIND-E

### Products Used

Product	Page
Go Direct Energy	88
KidWind Basic Wind Experiment Kit	89
Vernier Resistor Board	88

### Topics Include

- Renewable energy
- Wind power
- Engineering design

For a complete list of all 8 experiments, visit [www.vernier.com/msb-wind-e](http://www.vernier.com/msb-wind-e)

### Supported Software

Graphical Analysis 4	pp. 18–19
----------------------	-----------



## NEW Solar Energy Explorations

MIDDLE SCHOOL

Electronic  
Lab Book Only

MSB-SOLAR-E

### Products Used

Product	Page
Go Direct Energy	88
Go Direct Surface Temperature	86
Solar Energy Exploration Kit	91
Vernier Resistor Board	88

### Topics Include

- Renewable energy
- Solar power
- Engineering design

For a complete list of all 9 experiments, visit [www.vernier.com/msb-solar-e](http://www.vernier.com/msb-solar-e)

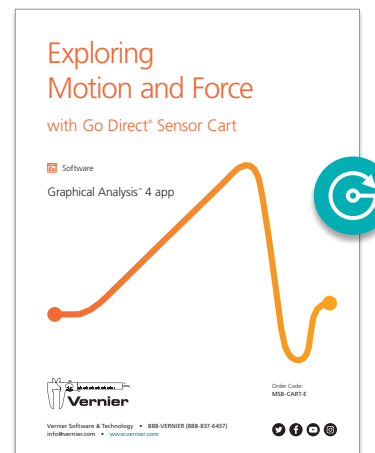
### Supported Software

Graphical Analysis 4	pp. 18–19
----------------------	-----------

## NEW Exploring Motion and Force with Go Direct Sensor Cart

MIDDLE SCHOOL

Students can explore the force of friction, aspects of motion, and simple machines such as the lever, ramp, and pulley, all using the Go Direct Sensor Cart and materials typically found in the classroom.



Electronic  
Lab Book Only

MSB-CART-E

### Topics Include

- Force of friction
- Motion
- Simple mechanics

For a complete list of all 7 experiments, visit [www.vernier.com/msb-cart-e](http://www.vernier.com/msb-cart-e)

### Sensors Used

Sensor	Page
Go Direct Sensor Cart	114

### Go Direct Sensor Cart (Green)

GDX-CART-G

### Go Direct Sensor Cart (Yellow)

GDX-CART-Y



### Supported Software

Software	Page
Graphical Analysis 4	18–19

### Additional Products

Equipment	Page
Mass for Carts	137
Dynamics Track	124



Measuring mechanical advantage  
in a pulley system



# Physical Science

[www.vernier.com/physical-science](http://www.vernier.com/physical-science)



## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct 3-Axis Magnetic Field	GDX-3MG	112
Go Direct Acceleration	GDX-ACC	111
Carts and Tracks		
Dynamics Cart and Track System with Go Direct Sensor Carts	DTS-GDX	114
Go Direct Sensor Cart (Green)	GDX-CART-G	114
Go Direct Sensor Cart (Yellow)	GDX-CART-Y	114
Go Direct Conductivity	GDX-CON	104
Go Direct Current	GDX-CUR	113
Go Direct Energy	GDX-NRG	88
Go Direct Force and Acceleration	GDX-FOR	104
Go Direct Gas Pressure	GDX-GP	51
Go Direct Light and Color	GDX-LC	112
Go Direct Motion	GDX-MD	104
Go Direct pH	GDX-PH	52
<b>NEW</b> Go Direct Photogate	GDX-VPG	110
<b>NEW</b> Go Direct Sound	GDX-SND	104
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	53
Go Direct Temperature	GDX-TMP	53
Go Direct Voltage	GDX-VOLT	113

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Accelerometers		
3-Axis Accelerometer	3D-BTA	118
25-g Accelerometer	ACC-BTA	118
Low-g Accelerometer	LGA-BTA	118
Conductivity Probe	CON-BTA	54
Current Probes		
Current Probe	DCP-BTA	122
High Current Sensor	HCS-BTA	<a href="#">web</a>
Energy Sensor	VES-BTA	<a href="#">web</a>
Force Sensors		
Dual-Range Force Sensor	DFS-BTA	119
Force Plate	FP-BTA	119
Gas Pressure Sensor	GPS-BTA	55
Light Sensor	LS-BTA	125
Magnetic Field Sensor	MG-BTA	123
Microphone	MCA-BTA	121
Motion Detector	MD-BTD	117
pH Sensor	PH-BTA	56
Photogate	VPG-BTD	118
Sound Level Sensor	SLS-BTA	121
Structures & Materials Tester	VSMT	81
Temperature Probes		
Go!Temp® (USB Sensor)	GO-TEMP	<a href="#">web</a>
Stainless Steel Temperature Probe	TMP-BTA	57
Surface Temperature Sensor	STS-BTA	57
Thermocouple	TCA-BTA	57
Voltage Probes		
30-Volt Voltage Probe	30V-BTA	<a href="#">web</a>
Differential Voltage Probe	DVP-BTA	57
Voltage Probe	VP-BTA	57



## BALANCES

Balances	Order Code	Page
OHAUS Scout® (120 g)	OHS-123	58
OHAUS Scout (220 g)	OHS-222	58
OHAUS Scout (420 g)	OHS-422	58

## ADDITIONAL PRODUCTS

Product	Order Code	Page
Dynamics Cart and Track System	DTS	116
Electrode Support	ESUP	58
Motion Detector Clamp	MD-CLAMP	<a href="#">web</a>
Stir Station	STIR	58
Vernier Circuit Board 2	VCB2	123

## LAB BOOKS

Title	Page
<i>Physical Science with Vernier</i> 	105
<b>NEW</b> <i>Exploring Motion and Force with Go Direct Sensor Cart</i> 	105



## Go Direct® Sensors

### Connection



Connects directly via USB or Bluetooth® wireless technology to your device



Computer



Chromebook™



LabQuest® 2

### Compatible platforms



iOS device



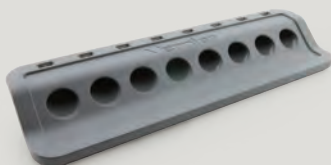
Android™ device

### Software



FREE Graphical Analysis™ 4,  
LabQuest App (LabQuest 2 only)

## You May Also Want



### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## Go Direct Motion

Go Direct Motion accurately tracks objects as close as 15 cm and as far away as 3.5 m. The compact design and wireless capability of this motion detector eliminate the concern of a dangling cable getting in the way.

The built-in temperature compensation of Go Direct Motion automatically adjusts for the difference in the speed of sound in cold and warm locations.

[www.vernier.com/gdx-md](http://www.vernier.com/gdx-md)

GDX-MD



## Go Direct Force and Acceleration

Go Direct Force and Acceleration includes a  $\pm 50$  N force sensor, a 3-axis accelerometer, and a 3-axis gyroscope. Take it on an amusement park ride, mount it on a dynamics cart, or attach a string and whirl it in a horizontal or vertical circle.

[www.vernier.com/gdx-for](http://www.vernier.com/gdx-for)

GDX-FOR



## NEW Go Direct Sound

Collect sound data wirelessly with the snap of your fingers. With sound-triggered data collection, Go Direct Sound provides students with an easy way to capture and evaluate waveforms. Measure wave amplitude and sound intensity level at the same time to investigate the decibel scale.

[www.vernier.com/gdx-snd](http://www.vernier.com/gdx-snd)

GDX-SND



## Go Direct Conductivity

Use Go Direct Conductivity to determine the ionic content of an aqueous solution by measuring its electrical conductivity (up to 20,000  $\mu\text{S}/\text{cm}$ ).

[www.vernier.com/gdx-con](http://www.vernier.com/gdx-con)

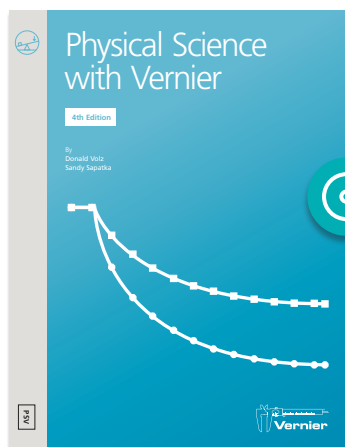
GDX-CON



**Physical Science with Vernier**

MIDDLE SCHOOL

HIGH SCHOOL

**Electronic  
Lab Book Only**

PSV-E

**Printed + Electronic  
Lab Book**

PSV

**Topics Include**

- Properties of matter
- Forces and interactions
- Electricity

For a complete list of all 40 experiments, visit [www.vernier.com/psv](http://www.vernier.com/psv)

**Sensors Used**

Sensor	Page
Temperature	53, 57
Motion Detector	104, 117
pH	52, 56
Voltage	57, 113
Force	104, 119
Light	112, 125
Magnetic Field	112, 123
Conductivity	54, 104
Gas Pressure	51, 55

**Additional Products**

Equipment	Page
Electrode Support	58
Vernier Circuit	123
Dynamics Cart and Track System	114–116
Motion Detector Clamp	<a href="http://www.vernier.com/md-clamp">www.vernier.com/md-clamp</a>

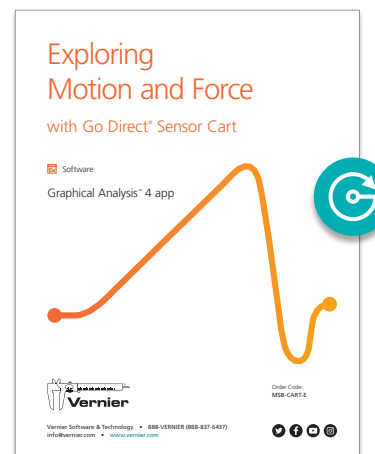
**Supported Software**

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis 4	18–19
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>

**NEW Exploring Motion and Force  
with Go Direct Sensor Cart**

MIDDLE SCHOOL

Students can explore the force of friction, aspects of motion, and simple machines such as a lever, ramp, or pulley, all using the Go Direct Sensor Cart and materials typically found in the classroom.

**Electronic  
Lab Book Only**

MSB-CART-E

**Topics Include**

- Force of friction
- Motion
- Simple mechanics

For a complete list of all 7 experiments, visit [www.vernier.com/msb-cart-e](http://www.vernier.com/msb-cart-e)

**Sensors Used**

Sensor	Page
Go Direct Sensor Cart	114

**Go Direct Sensor Cart (Green)**

GDX-CART-G

**Go Direct Sensor Cart (Yellow)**

GDX-CART-Y

**Supported Software**

Software	Page
Graphical Analysis 4	18–19

**Additional Products**

Equipment	Page
Mass for Carts	137
Dynamics Track	124



Investigating centripetal  
force and acceleration



# Physics

[www.vernier.com/physics](http://www.vernier.com/physics)

## PACKAGES

Go Direct® and LabQuest® Packages pp. 108–109

## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct 3-Axis Magnetic Field	GDX-3MG	112
Go Direct Acceleration	GDX-ACC	111
Carts and Tracks		
Dynamics Cart and Track System with Go Direct Sensor Carts	DTS-GDX	114
Go Direct Sensor Cart (Green)	GDX-CART-G	114
Go Direct Sensor Cart (Yellow)	GDX-CART-Y	114
Go Direct Current	GDX-CUR	113
Go Direct Force and Acceleration	GDX-FOR	104
Go Direct Gas Pressure	GDX-GP	112
Go Direct Light and Color	GDX-LC	112
Go Direct Motion	GDX-MD	110
<b>NEW</b> Go Direct Photogate	GDX-VPG	110
<b>NEW</b> Go Direct Projectile Launcher	GDX-PL	111
Go Direct Radiation Monitor	GDX-RAD	113
Go Direct Rotary Motion	GDX-RMS	111
<b>NEW</b> Go Direct Sound	GDX-SND	113
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	112
Go Direct Temperature	GDX-TMP	112
Go Direct Voltage	GDX-VOLT	113

**Go Direct Charge Station**  
GDX-CRG

See page 137.

## LABQUEST SENSORS

Sensor	Order Code	Page
Accelerometers		
3-Axis Accelerometer	3D-BTA	118
25-g Accelerometer	ACC-BTA	118
Low-g Accelerometer	LGA-BTA	118
Carts and Tracks		
Dynamics Cart and Track System with Motion Encoder	DTS-EC	116
Encoder Fan Cart	CART-FEC	117
Current Sensors		
Current Probe	DCP-BTA	122
High Current Sensor	HCS-BTA	<a href="#">web</a>
Electricity and Magnetism Sensors		
Charge Sensor	CRG-BTA	123
Magnetic Field Sensor	MG-BTA	123
Force Sensors		
Dual-Range Force Sensor	DFS-BTA	119
Force Plate	FP-BTA	119
Gas Pressure Sensor	GPS-BTA	126
Light Sensors		
Diffraction Apparatus	DAK	125
Light Sensor	LS-BTA	125
Motion Detectors		
Go! Motion® (USB sensor)	GO-MOT	<a href="#">web</a>
Motion Detector	MD-BTD	117
Photogate	VPG-BTD	118
Power Amplifier	PAMP	122
Projectiles		
Projectile Launcher	VPL	120
Time of Flight Pad	TOF-VPL	120
Radiation Monitor	VRM-BTD	127
Rotary Motion Sensor	RMV-BTD	119

## Sound Sensors

Microphone	MCA-BTA	121
Sound Level Sensor	SLS-BTA	121

## Temperature Probes

Stainless Steel Temperature Probe	TMP-BTA	126
Surface Temperature Sensor	STS-BTA	126

## Voltage Probes

30-Volt Voltage Probe	30V-BTA	<a href="#">web</a>
Differential Voltage Probe	DVP-BTA	122
Instrumentation Amplifier	INA-BTA	55
Voltage Probe	VP-BTA	57



## EMISSION SPECTROMETER

Emission Spectrometer	Order Code	Page
Vernier Emissions Spectrometer	VSP-EM	127

## INFRARED CAMERAS

FLIR ONE® Thermal Cameras page 126

## LAB BOOKS

Title	Page
<i>Physics with Vernier</i> 	129
<i>Physics Explorations and Projects</i> 	130
<i>Advanced Physics with Vernier—Mechanics</i>	130
<i>Advanced Physics with Vernier—Beyond Mechanics</i>	131
<i>Physics with Video Analysis</i>	131
<i>Física con Vernier</i>	129
Additional physics lab books	131



See page 128.

## Go Direct Physics Packages

Appropriate for all levels of physics

Go Direct® sensors are perfect for instructors who

- Are new to probeware
- Plan to equip a new school
- Are already using Chromebooks and mobile devices



Connect Directly via USB or Bluetooth® Wireless Technology



2–4 Students per Package



Works with Your Existing Devices



Collect Data with the FREE Graphical Analysis™ 4 App

### Starter Package (4 Products)

GDP-PHY-ST



Go Direct Motion



Go Direct Force and Acceleration



Go Direct Voltage



Go Direct Current

### Deluxe Package (12 Products)

GDP-PHY-DX



Go Direct Acceleration



Go Direct Photogate



Ultra Pulley Attachment



Picket Fence



Go Direct Current



Go Direct Sound

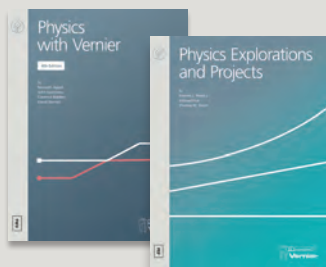


Go Direct Light and Color



Go Direct 3-Axis Magnetic Field

### Related Lab Books



Many of the experiments in these books use sensors found in the Go Direct Physics Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see pp. 129–130.

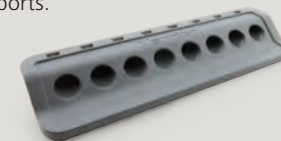
### You May Also Want

#### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG



Additional recommendations available at [www.vernier.com/packages/physics](http://www.vernier.com/packages/physics)

## LabQuest Physics Packages

Appropriate for all levels of physics

Use LabQuest® 2 as a Standalone Device

LabQuest 2 works with all Vernier sensors and built-in LabQuest App.

OR

Wireless (One-to-Many)

Transfer LabQuest 2 data wirelessly via Wi-Fi to one or more devices running Graphical Analysis 4 app.

OR

Wired (One-to-One)

LabQuest 2 works with Chromebooks and Windows® and macOS® computers.



Sensors Connect to a LabQuest 2 Interface



2–4 Students per Package

### Starter Package (5 Products)

LQ2-PHY-ST



LabQuest 2



Go Direct Force and Acceleration



Differential Voltage Probe



Motion Detector



Current Probe

### Deluxe Package (13 Products)

LQ2-PHY-DX



Go Direct Acceleration



Go Direct Photogate



Ultra Pulley Attachment



Picket Fence



Current Probe



Go Direct Sound

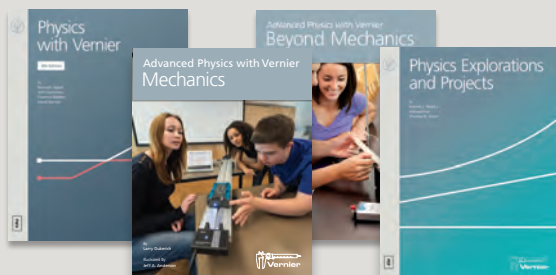


Light Sensor



Go Direct 3-Axis Magnetic Field

### Related Lab Books



Many of the experiments in these books use sensors found in the LabQuest Physics Packages. Vernier lab books include student instructions, teacher tips, and sample data.

For more details, see pp. 129–131.

### You May Also Want

#### LabQuest Charge Station

Easily charge and store your LabQuest 2 interfaces with the LabQuest Charge Station.

[www.vernier.com/lq2-crg](http://www.vernier.com/lq2-crg)

LQ2-CRG

#### LabQuest Viewer® Software

Teach your students how to use LabQuest by projecting your LabQuest screen. Display live images of your LabQuest units to monitor student progress.

See page 21.

LQ-VIEW



For packages that include the low-cost and powerful LabQuest Mini interface, see [www.vernier.com/lm-phy-dx](http://www.vernier.com/lm-phy-dx)





Investigating impulse and change in momentum with Go Direct Sensor Cart and Graphical Analysis 4

## Go Direct® Sensors

### Connection



Connects directly via USB or Bluetooth® wireless technology to your device



Computer



Chromebook™



LabQuest® 2

### Compatible platforms



iOS device



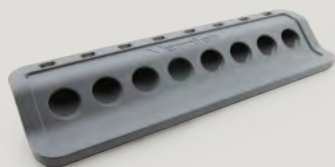
Android™ device

### Software



FREE Graphical Analysis™ 4, LabQuest App (LabQuest 2 only)

## You May Also Want



### Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## Go Direct Motion

Go Direct Motion accurately tracks objects as close as 15 cm and as far away as 3.5 m. The compact design rests on a surface or can be mounted by one of the two threaded holes—one on the bottom and one on the back.

[www.vernier.com/gdx-md](http://www.vernier.com/gdx-md)

GDX-MD



## NEW Go Direct Photogate

Go Direct Photogate is a double-gate sensor that includes two photogates built into the arms of the sensor, which accurately measures velocity and acceleration without needing to know anything about the geometry of the object.

Go Direct Photogate also includes a single laser gate for use with objects passing outside of the arms of the sensor (required visible light laser not included).

The sensor can be used to study free fall, rolling objects, collisions, and pendulums.

[www.vernier.com/gdx-vpg](http://www.vernier.com/gdx-vpg)

GDX-VPG



## Go Direct Acceleration

Collect acceleration, rotation, and altitude data in the classroom or in the field. This 3-axis acceleration sensor has two acceleration ranges plus an altimeter and a 3-axis gyroscope.

[www.vernier.com/gdx-acc](http://www.vernier.com/gdx-acc)

GDX-ACC



## NEW Go Direct Projectile Launcher

Use the Go Direct Projectile Launcher to investigate important concepts in two-dimensional kinematics. Its unique pneumatic launching system provides excellent repeatability, launching steel balls at angles between 0 and 90 degrees and over distances up to 2.5 m. Built-in photogates provide easy and accurate measurement of the ball's launch speed and built-in accelerometers report launch angle, allowing for precise quantitative analysis of projectile motion.

[www.vernier.com/gdx-pl](http://www.vernier.com/gdx-pl)

GDX-PL\*



### Projectile Launcher Accessories

Projectile Stop	page 120
Independence of Motion	page 120
Time of Flight Pad	page 120

## NEW Go Direct Centripetal Force Apparatus

When students use a Go Direct Centripetal Force Apparatus with Go Direct Force and Acceleration, they can conduct a variety of rotational dynamics investigations with a single experiment setup. This combination easily measures angular velocity, centripetal force, and angular acceleration without the hassle of wires.

[www.vernier.com/gdx-cfa](http://www.vernier.com/gdx-cfa)

GDX-CFA



### Centripetal Force Accessories

Moment of Inertia Kit	CFA-MIK
Motor Accessory Kit	GDX-CFA-MAK
CFA Sensor Bracket Kit	CFA-SBK

## Go Direct Rotary Motion

Measure angular displacement, angular velocity, and angular acceleration easily and precisely. For extra versatility, add the Rotational Motion Accessory Kit.

[www.vernier.com/gdx-rms](http://www.vernier.com/gdx-rms)

GDX-RMS

### Rotation Accessories

Rotary Motion Motor Kit  
[www.vernier.com/mk-rmv](http://www.vernier.com/mk-rmv)



## Rotational Motion Accessory Kit

This accessory kit is used with the Rotary Motion Sensor to study the motion of a physical pendulum; the rotational inertia of disks, rings, and point masses; and the conservation of angular momentum.

[www.vernier.com/ak-rmv](http://www.vernier.com/ak-rmv)

AK-RMV



\* Additional shipping charges may apply due to weight.

## Go Direct Force and Acceleration

Go Direct® Force and Acceleration includes a  $\pm 50$  N force sensor, a 3-axis accelerometer, and a 3-axis gyroscope. Take it on an amusement park ride, mount it on a dynamics cart, or attach a string and whirl it in a horizontal or vertical circle—in wireless mode, your imagination is the only limiting factor!

[www.vernier.com/gdx-for](http://www.vernier.com/gdx-for)

GDX-FOR

### Force Accessories

Bumper Launcher Kit page 117

Go Direct Centripetal Force Apparatus page 111



## Go Direct Light and Color

Go Direct Light and Color combines the power of visible light, UV, 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.

[www.vernier.com/gdx-lc](http://www.vernier.com/gdx-lc)

GDX-LC

### Light and Optics Accessories

Optics Accessories page 124



## MAGNETISM

### Go Direct 3-Axis Magnetic Field

This sensor measures the components of a magnetic field along three orthogonal axes. With its range, students can study the Earth's magnetic field or investigate magnetic fields of permanent magnets, electromagnets, and solenoids.

[www.vernier.com/gdx-3mg](http://www.vernier.com/gdx-3mg)

GDX-3MG



### Temperature Probes

[www.vernier.com/temperature-sensors](http://www.vernier.com/temperature-sensors)

#### Go Direct Temperature

Temperature Range  
-40°C to 125°C

GDX-TMP



#### Go Direct Surface Temperature

Temperature Range  
-40°C to 125°C

GDX-ST



## THERMODYNAMICS

### Go Direct Gas Pressure

Monitor the pressure of a gas (up to 400 kPa) while investigating heat engines or the kinetic theory of gases with Go Direct Gas Pressure. Includes a syringe, tubing, and stoppers to ease setup for experiments such as Boyle's law or the relationship between fluid pressure and depth. (The sensor cannot measure water pressure directly—only air pressure.)

[www.vernier.com/gdx-gp](http://www.vernier.com/gdx-gp)

GDX-GP



## Go Direct Voltage

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

[www.vernier.com/gdx-volt](http://www.vernier.com/gdx-volt)

GDX-VOLT



## Go Direct Current

Simplify your experiment setup with Go Direct Current. Capture small currents like those produced by a magnet falling through a coil. Use this sensor in combination with Go Direct Voltage to investigate Ohm's law or series and parallel circuits.

[www.vernier.com/gdx-cur](http://www.vernier.com/gdx-cur)

GDX-CUR



## Electricity Accessories

Vernier Circuit Board 2 page 123

Optional Breadboard Kit page 123

Extech® Digital DC Power Supply page 122

## SOUND

### NEW Go Direct Sound

Collect sound data wirelessly with the snap of your fingers. With sound-triggered data collection, Go Direct Sound provides students with an easy way to capture and evaluate waveforms. Measure wave amplitude and sound intensity level at the same time to investigate the decibel scale, or take the sensor outside the classroom to discover sounds in their natural environment.

[www.vernier.com/gdx-snd](http://www.vernier.com/gdx-snd)

GDX-SND



## MODERN PHYSICS

### Go Direct Radiation Monitor

Explore radiation statistics, measure the rate of nuclear decay, and monitor radon progeny. Go Direct Radiation Monitor detects alpha, beta, gamma, and X-ray radiation, and it includes LED and audible indicators.

[www.vernier.com/gdx-rad](http://www.vernier.com/gdx-rad)

GDX-RAD





Students test materials to reduce the force of a collision by increasing the time interval of the force.



## Go Direct® Sensor Carts

We've added wireless sensors to our popular dynamics cart. Each cart includes an encoder wheel to report position, velocity, and acceleration; a 3-axis accelerometer to measure independent accelerations; and a  $\pm 50$  N force sensor to measure pushes and pulls. Conduct basic physics investigations with or without a track.

[www.vernier.com/gdx-cart](http://www.vernier.com/gdx-cart)

### Go Direct Sensor Cart (Green)    Go Direct Sensor Cart (Yellow)

GDX-CART-G

GDX-CART-Y

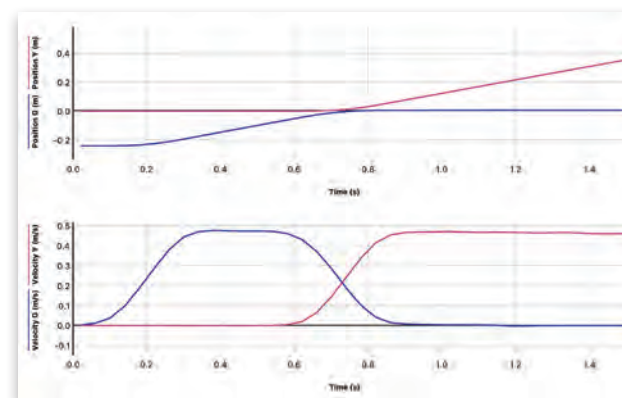


## Dynamics Cart and Track System with Go Direct Sensor Cart

The Dynamics Cart and Track System with Go Direct Sensor Cart includes essential laboratory equipment for teaching dynamics and kinematics. With our Go Direct Sensor Cart, students can explore force, position, velocity, and acceleration directly on their device using Bluetooth® wireless technology. There are no wires to create drag, and no additional equipment is required! Each cart features built-in sensors that simplify experiment setup and make this system the best choice for studying dynamics and kinematics.

[www.vernier.com/dts-gdx](http://www.vernier.com/dts-gdx)

DTS-GDX\*



## One Dynamics System—Three Ways to Collect Data

Depending on your budget and your needs, we offer three ways to collect motion data.

### 1 Go Direct Sensor Cart

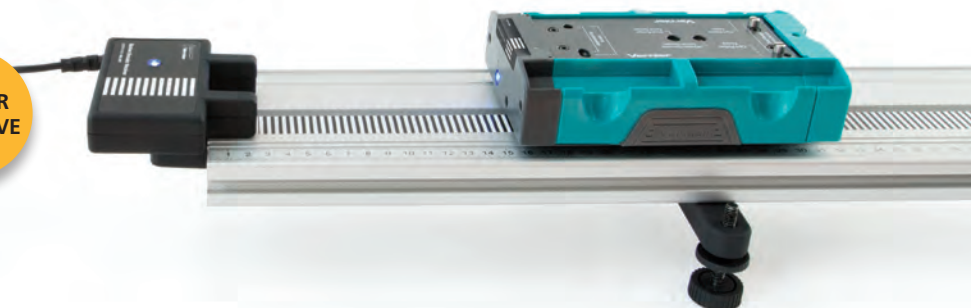
The wireless Go Direct Sensor Cart includes an optical encoder on a wheel to sense the displacement of the cart. No interface is needed to use this system with our free Graphical Analysis™ 4 app. Students can perform impulse and momentum experiments with the built-in force sensor, and the 3-axis accelerometer means you can take your Sensor Cart off campus to investigate accelerations on a swing or merry-go-round. For details, see page 114.



### 2 The Motion Encoder\*

For classrooms already equipped with data-collection interfaces, the Motion Encoder dramatically improves data quality and simplifies experiment setup over the traditional ultrasonic Motion Detector. An optical sensor under the dynamics cart senses the passage of the cart over a striped decal on the track. The displacement information is sent as an encoded IR signal to a receiver at the track's end. This optical-only system provides excellent, repeatable, and noise-resistant data. For details, see page 116.

VERNIER  
EXCLUSIVE



### 3 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 or Go Direct Sensor Cart, the Motion Detector can be used for dynamics experiments other than cart-on-track experiments. Students can graph their own walking motion, study a simple pendulum, 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 or Go Direct Sensor Cart. For details, see page 116.



## Dynamics Cart and Track System

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 attachment accessories.

[www.vernier.com/dts](http://www.vernier.com/dts)

DTS\*



## Dynamics Cart and Track System with Motion Encoder†

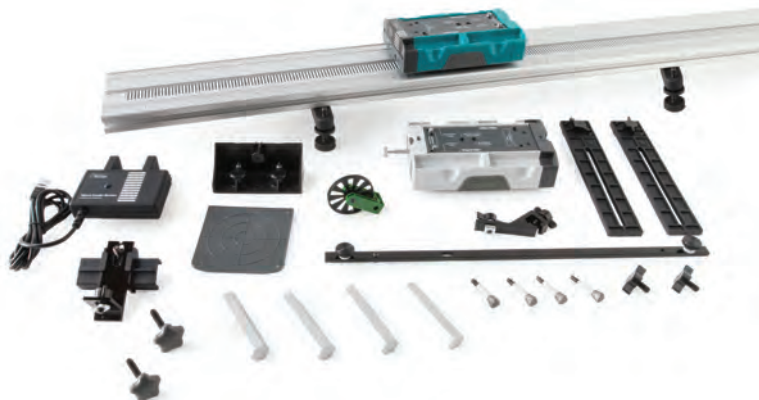
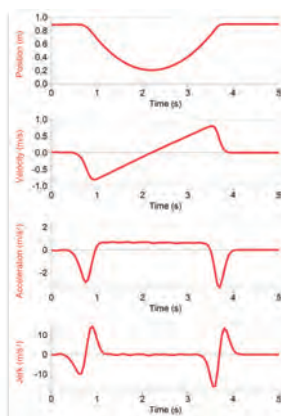
The Dynamics Cart and Track System with Motion Encoder adds an optical position sensing system to record cart motion.

[www.vernier.com/dts-ec](http://www.vernier.com/dts-ec)

DTS-EC\*

**worlddidac**  
A W A R D 2 0 1 4

*Motion encoder data are so pristine that you can usefully graph jerk vs. time.*



## Motion Encoder† Cart and Receiver

This kit includes a fully assembled Motion Encoder Cart, as well as the Motion Encoder Receiver and Motion Encoder Long Track Strip.

[www.vernier.com/dts-mec](http://www.vernier.com/dts-mec)

DTS-MEC



## Dynamics Cart and Track Systems with 2.2 Meter Tracks

### Dynamics Cart and Track System with Long Track

[www.vernier.com/dts-long](http://www.vernier.com/dts-long)

DTS-LONG\*

### Dynamics Cart and Track System with Motion Encoder and Long Track

[www.vernier.com/dts-ec-long](http://www.vernier.com/dts-ec-long)

DTS-EC-LONG\*

### Dynamics Cart and Track System with Go Direct® Sensor Cart and Long Track

[www.vernier.com/dts-gdx-long](http://www.vernier.com/dts-gdx-long)

DTS-GDX-LONG\*

## Friction Pad DTS

Add a Friction Pad to any of our plastic dynamics carts to study the effect of consistent friction on the motion of the cart.

[www.vernier.com/dts-pad](http://www.vernier.com/dts-pad)

DTS-PAD



## Eddy Current Brake

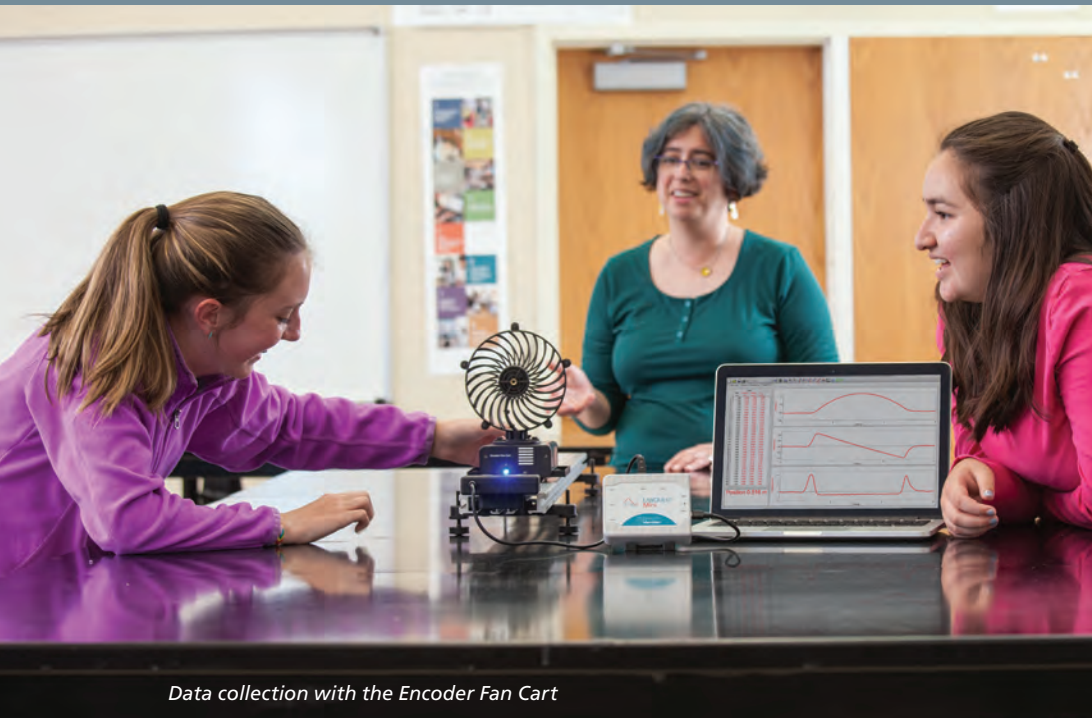
Eddy current brakes are used as a braking system for high-speed trains and roller coasters. Recreate this unusual braking system in your classroom or laboratory by installing our Eddy Current Brake into the end cap of a plastic Vernier dynamics cart. As the cart moves over the track, the magnets in the Eddy Current Brake create an electromagnetic drag on the cart that is proportional to the cart's speed.

[www.vernier.com/dts-ecb](http://www.vernier.com/dts-ecb)

DTS-ECB







Data collection with the Encoder Fan Cart

## Fan Carts

### Fan Cart

The Fan Cart works with a Motion Detector and the Vernier Dynamics System. Study Newton's second law using variable fan thrust and included mass bars.

[www.vernier.com/cart-f](http://www.vernier.com/cart-f)

CART-F



### Encoder Fan Cart

Use the Encoder Fan Cart with the Motion Encoder System. Study Newton's second law using variable fan thrust and included mass bars.

[www.vernier.com/cart-fec](http://www.vernier.com/cart-fec)

CART-FEC



## Bumper and Launcher Kit

The Bumper and Launcher Kit allows students to use the Dynamics Cart and Track System to perform Hooke's law experiments or to study momentum and impulse. The kit includes

- Track bracket
- Dual-magnet bumper
- Force sensor mounting screw
- 2 magnetic bumpers
- 2 rubber bumpers
- 2 hoop bumpers
- 2 clay holders and about 20 grams of clay

[www.vernier.com/blk](http://www.vernier.com/blk)

BLK



Track and Force Sensor not included

## MOTION

### Motion Detector

The Motion Detector uses ultrasound to measure the position of carts, balls, people, and other objects.

Can be used with interfaces from the LabQuest® family, LabPro®, and CBL 2™. Not supported with Go! Link® or EasyLink®.

Range 0.15 to 6 m

[www.vernier.com/md-btd](http://www.vernier.com/md-btd)

MD-BTD







Collecting position, velocity, and acceleration data using a Dynamics Cart and Track with Motion Encoder

## LabQuest® Sensors

### Connection



BTA or BTD,  
plus a LabQuest interface

### Required LabQuest interface options



LabQuest  
Mini



LabQuest  
Stream®



LabQuest 2

### Compatible platforms



Computer



Chromebook™



iOS device



Android™ device

### Software



LabQuest App, Logger Pro 3, Graphical Analysis™ 4

## Accelerometers

[www.vernier.com/accelerometers](http://www.vernier.com/accelerometers)

### Low-g Accelerometer

This is the best choice for most experiments. Use it for studying the one-dimensional motion of a car (real or toy), pendulum bob, an elevator, or an amusement park ride.

Range  $\pm 50 \text{ m/s}^2$

LGA-BTA



### 3-Axis Accelerometer

Use this to study the complex motion of an amusement park ride, a bungee jump, or simply a toss in the air.

Range  $\pm 50 \text{ m/s}^2$

3D-BTA



### 25-g Accelerometer

Choose this for studying one-dimensional collisions or any motion with larger accelerations.

Range  $\pm 250 \text{ m/s}^2$

ACC-BTA



## Photogate

Study free fall, rolling objects, collisions, and pendulums with the Vernier Photogate. Use the built-in laser detector to create a photogate through which you could drive a truck. Includes an accessory rod for attaching to a ring stand or for adding the Ultra Pulley Attachment (sold separately).

[www.vernier.com/vpg-btd](http://www.vernier.com/vpg-btd)

VPG-BTD



## Ultra Pulley Attachment

Add an Ultra Pulley to your Photogate to monitor motion as a string passes over the pulley, or as the pulley rolls along a table.

[www.vernier.com/spa](http://www.vernier.com/spa)

SPA



## Pulley Bracket

The Pulley Bracket attaches an Ultra Pulley and a Photogate to the end of a Vernier Dynamics Track, for an easy way to do a modified Atwood's machine experiment with a cart and a hanging mass.

[www.vernier.com/b-spa](http://www.vernier.com/b-spa)

B-SPA



## UPDATED Dual-Range Force Sensor

Using our Dual-Range Force Sensor, students can test Newton's third law of motion, explore Hooke's law, or graph the transition from static friction to kinetic friction.

Ranges  $\pm 10\text{ N}$ ,  $\pm 50\text{ N}$

[www.vernier.com/dfs-bta](http://www.vernier.com/dfs-bta)

DFS-BTA



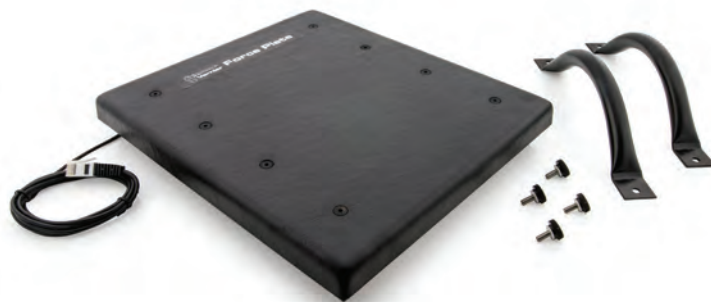
## Force Plate

The Force Plate—a force sensor about the size of a bathroom scale—is tough enough to jump on. Two handles are included for pushing or pulling. Additional pairs of handles are available (FP-HAN).

Ranges  $-850$  to  $+3500\text{ N}$   
 $-200$  to  $+850\text{ N}$

[www.vernier.com/fp-bta](http://www.vernier.com/fp-bta)

FP-BTA\*



## Rotary Motion Sensor

Our Rotary Motion Sensor lets you collect angular displacement, angular velocity, and angular acceleration data precisely and easily.

[www.vernier.com/rmv-btd](http://www.vernier.com/rmv-btd)

RMV-BTD



See website for replacement parts.

## Rotational Motion Accessory Kit

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.

[www.vernier.com/ak-rmv](http://www.vernier.com/ak-rmv)

AK-RMV



## CIRCULAR MOTION

## Centripetal Force Apparatus

The Centripetal Force Apparatus can be used to investigate relationships between mass, radius, tension force, and angular velocity. Requires a force sensor and a photogate (not included).

[www.vernier.com/cfa](http://www.vernier.com/cfa)

CFA\*

## Centripetal Force Accessories

Moment of Inertia Kit CFA-MIK

CFA Sensor Bracket Kit CFA-SBK



\* Additional shipping charges may apply due to weight.



## 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.

### Ways to use Video Physics in the Classroom

- 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, position, and velocity.
- Export video with points.
- Email the video and data for further analysis in Vernier Logger Pro® 3 software for macOS® and Windows®.
- Open data files directly in our Graphical Analysis™ 4 software.

### Awards



## Projectile Launcher

The Projectile Launcher and accessories are used to investigate concepts in two-dimensional kinematics, such as launch speed and launch angle. Its unique pneumatic launching system provides excellent repeatability at angles from 0 to 70° and up to a distance of 2.5 m.

Projectile Launcher includes

- Launcher
- Six steel balls
- Hand pump
- Two pairs of goggles
- Level
- Roll of waxed marking paper
- Photogate cable

[www.vernier.com/vpl](http://www.vernier.com/vpl)

VPL\*

See website for replacement parts.



## Independence of Motion Accessory

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.

[www.vernier.com/iom/iom-vpl](http://www.vernier.com/iom/iom-vpl)



IOM-VPL

## Time of Flight Pad

The Time of Flight Pad is used with a projectile launcher or photogate (not included) to precisely measure how long a projectile has been in motion.

[www.vernier.com/tof-vpl](http://www.vernier.com/tof-vpl)

TOF-VPL



## Projectile Stop

The Projectile Stop has one job: to keep the projectiles from the Vernier Projectile Launcher from rolling out of sight.

[www.vernier.com/ps-vpl](http://www.vernier.com/ps-vpl)

PS-VPL





## Microphone

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. If you are interested in measuring sound level, use our Sound Level Sensor.

[www.vernier.com/mca-bta](http://www.vernier.com/mca-bta)

MCA-BTA



## Sound Level Sensor

Use the Sound Level Sensor to easily measure sound level in decibels (dB) in a variety of experiments.

If you are interested in collecting sound waveforms, use the Vernier Microphone.

Range 55 to 110 dB

[www.vernier.com/sls-bta](http://www.vernier.com/sls-bta)

SLS-BTA



## Power Amplifier Accessory Speaker

This kit includes a speaker and accessories that can be used with the Vernier Power Amplifier to study mechanical waves on strings and springs.

[www.vernier.com/paas-pamp](http://www.vernier.com/paas-pamp)

PAAS-PAMP



*Investigating standing waves with the Power Amplifier Accessory Speaker*



## Differential Voltage Probe

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.

[www.vernier.com/dvp-bta](http://www.vernier.com/dvp-bta)

DVP-BTA



## Voltage Probes

Sensor	Voltage Range	URL
30-Volt Voltage Probe	$\pm 30$ V	<a href="http://www.vernier.com/30v-bta">www.vernier.com/30v-bta</a>
Differential Voltage Probe	$\pm 6$ V	<a href="http://www.vernier.com/dvp-bta">www.vernier.com/dvp-bta</a>
Instrumentation Amplifier	$\pm 1$ V	<a href="http://www.vernier.com/ina-bta">www.vernier.com/ina-bta</a>
Voltage Probe	$\pm 10$ V	<a href="http://www.vernier.com/vp-bta">www.vernier.com/vp-bta</a>

## Current Probe

The Current Probe is used to measure currents in low-voltage AC and DC circuits.

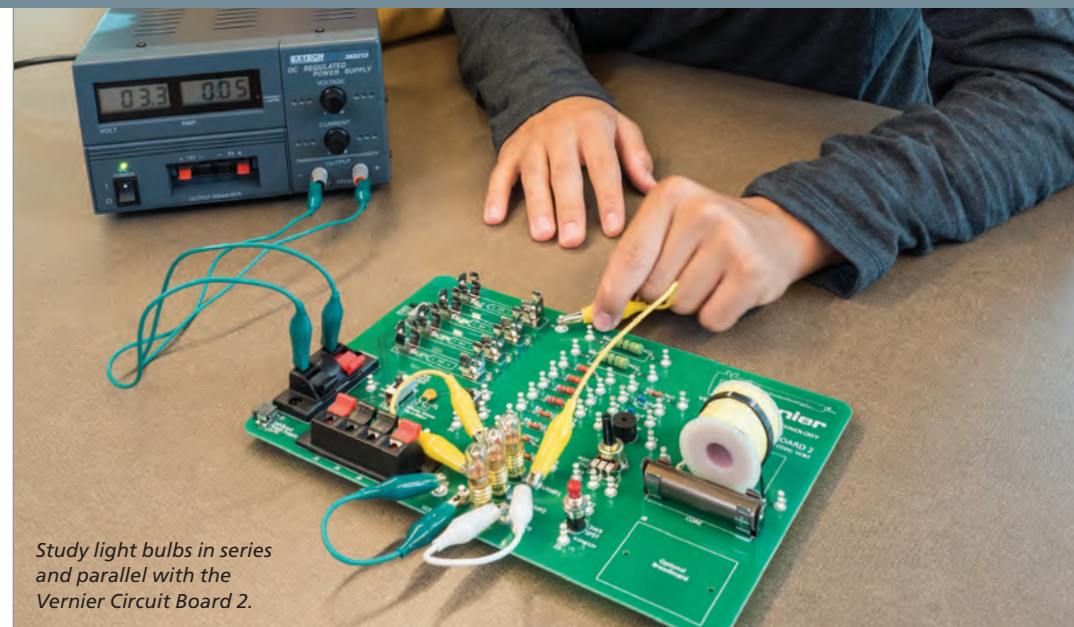
[www.vernier.com/dcp-bta](http://www.vernier.com/dcp-bta)

DCP-BTA



## Current Probes

Sensor	Current Range	URL
Current Probe	$\pm 0.6$ A	<a href="http://www.vernier.com/dcp-bta">www.vernier.com/dcp-bta</a>
High Current Sensor	$\pm 10$ A	<a href="http://www.vernier.com/hcs-bta">www.vernier.com/hcs-bta</a>



Study light bulbs in series and parallel with the Vernier Circuit Board 2.

## Extech Digital DC Power Supply

The Extech® Digital DC Power Supply provides constant current or constant voltage for physics activities that require DC power. This quality power supply has three outputs: adjustable 0–30 V at 0–3 A, fixed 5 V, and fixed 12 V.



The Extech Digital DC Power Supply is used in *Physics with Vernier* and *Advanced Physics with Vernier—Beyond Mechanics* experiments.

[www.vernier.com/exp5](http://www.vernier.com/exp5)

EXPS\*

## Power Amplifier

The Vernier Power Amplifier is used to drive loads with  $\pm 10$  V and currents up to 1 A. It works with any waveform, including DC, sine, square, triangle, and sawtooth.

[www.vernier.com/pamp](http://www.vernier.com/pamp)

PAMP



## Vernier Circuit Board 2

The Vernier Circuit Board 2 is a convenient platform for circuit experiments, from basic series and parallel circuits to RLC circuits. Many components are provided for experimentation, and additional components can be added to expand the capability of this useful board.

The Vernier Circuit Board is used with *Physics with Vernier*, *Physics Explorations and Projects*, and *Advanced Physics with Vernier—Beyond Mechanics* experiments.

[www.vernier.com/vcb2](http://www.vernier.com/vcb2)

VCB2



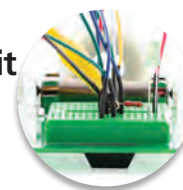
See website for replacement parts.

## Optional Breadboard Kit

Add this small breadboard to your Vernier Circuit Board 2 to conduct experiments using components not included on the circuit board. The kit includes a 555 timer, photocell, two transistors, and a tri-color LED.

[www.vernier.com/vcb2-obbk](http://www.vernier.com/vcb2-obbk)

VCB2-OBbk



## Magnetic Field Sensor

Use the Magnetic Field Sensor to study the field around permanent magnets, coils, and electrical devices. The sensor tip can be rotated 90° to measure fields that are perpendicular to the wand.

[www.vernier.com/mg-bta](http://www.vernier.com/mg-bta)

MG-BTA



## STATIC ELECTRICITY

### Charge Sensor

The Charge Sensor is an extremely high impedance voltage sensor with a 0.01  $\mu\text{F}$  input capacitor that can be used to make quantitative charge measurements in electrostatics experiments.

[www.vernier.com/crg-bta](http://www.vernier.com/crg-bta)

CRG-BTA



### Electrostatics Kit

With the Electrostatics Kit and the Vernier Charge Sensor (not included), students can perform a range of electrostatics experiments, including quantitative and qualitative measurement of charge as well as charging by friction, contact, and/or induction.

[www.vernier.com/esk-crg](http://www.vernier.com/esk-crg)

ESK-CRG



### High-Voltage Electrostatics Kit

Use the High-Voltage Electrostatics Kit with the Vernier Charge Sensor and Electrostatics Kit (each sold separately) to investigate the distribution of charge on a sphere, transfer of charge on contact between two spheres, and charging by induction. Extremely low output current makes this device safe for classroom use.

[www.vernier.com/hvek-crg](http://www.vernier.com/hvek-crg)

HVEK-CRG



## Optics Expansion Kit

Use the Optics Expansion Kit with your dynamics track (not included) 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.

Kit includes

- 3 lenses (100 mm converging lens, 200 mm converging lens, -150 mm diverging lens)
- Screen
- Combination luminous and point light source
- Light Sensor Holder\*
- Aperture screen
- Power supply



The Optics Expansion Kit is used in *Physics with Vernier* and *Advanced Physics with Vernier—Beyond Mechanics* experiments.

Download free sample experiments at [www.vernier.com/oek](http://www.vernier.com/oek)

OEK

See website for replacement parts.



## Mirror Set

The Mirror Set extends the Optics Expansion Kit so students can easily study image formation by concave and convex mirrors. Includes a concave mirror, a convex mirror, and a half screen. Requires components from the Optics Expansion Kit for use.

[www.vernier.com/m-oek](http://www.vernier.com/m-oek)

M-OEK



Light source not included.

## Polarizer/Analyzer Set

Using the Polarizer/Analyzer Set, students can study light polarization and do experiments such as Malus's law. The set consists of three adjustable linear polarizers, one of which includes attachment points for either of our Rotary Motion Sensors. Requires components from the Optics Expansion Kit and either a LabQuest® Light Sensor or the Go Direct® Light and Color Sensor for use.

[www.vernier.com/pak-oek](http://www.vernier.com/pak-oek)

PAK-OEK



**Do you have a Vernier Combination Dynamics Track/Optics Bench?**

**Combination 1.2 m Track/Optics Bench**

TRACK†

**Combination 2.2 m Track/Optics Bench**

TRACK-LONG†



## Light Sensor

The Light Sensor approximates the human eye in spectral response. Use it for inverse square law experiments or for studying polarizers, reflectivity, or solar energy.

[www.vernier.com/ls-bta](http://www.vernier.com/ls-bta)

LS-BTA

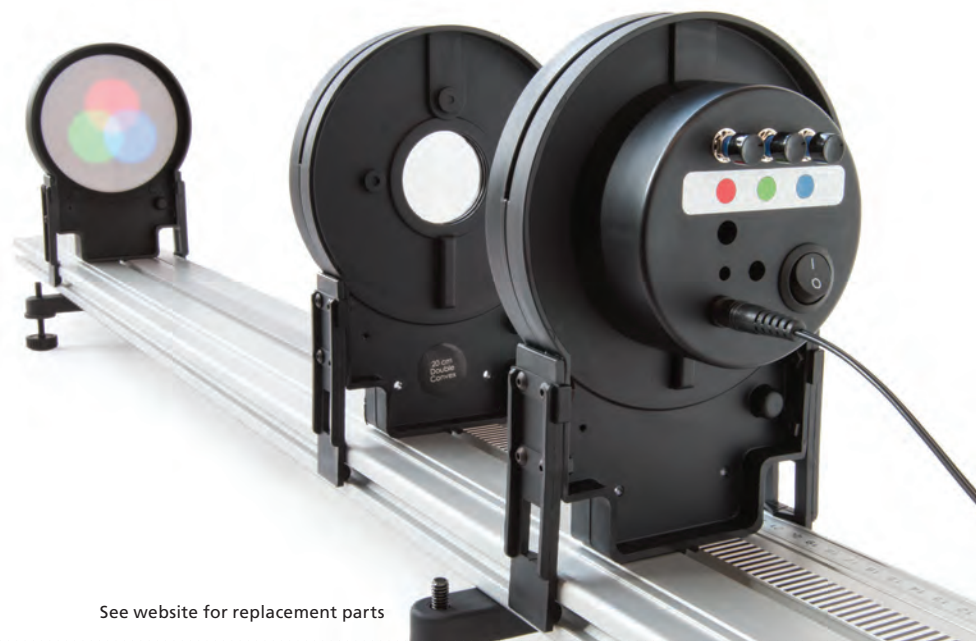


## Color Mixer

The Color Mixer accessory can be used to study the mixing of red, blue, and green light by additive and subtractive mixing. Requires a Combination Track/Optics Bench (not included).

Download a free sample experiment at [www.vernier.com/cm-oek](http://www.vernier.com/cm-oek)

CM-OEK



See website for replacement parts

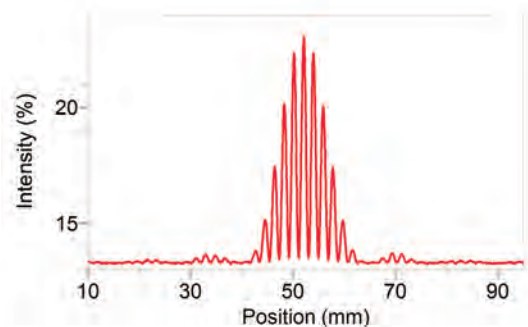
## Diffraction Apparatus

Using the Diffraction Apparatus, with its included Red Diffraction Laser, high-precision slits, and High Sensitivity Light Sensor, students can create, view, and measure diffraction and interference patterns.

The Diffraction Apparatus requires a Combination Track/Optics Bench (not included).

[www.vernier.com/dak](http://www.vernier.com/dak)

DAK



Double-slit diffraction pattern intensity data using the included Red Diffraction Laser

## Green Diffraction Laser

Add the Green Diffraction Laser to your Diffraction Apparatus (not included) to study the effect of wavelength on a diffraction pattern.

[www.vernier.com/gdl-dak](http://www.vernier.com/gdl-dak)

GDL-DAK





## FLIR ONE® Thermal Cameras

Using a FLIR ONE Thermal Camera, 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 compared to visible light, and so much more.

[www.vernier.com/flir](http://www.vernier.com/flir)

### FLIR ONE Pro

FLIRPRO-IO5



### NEW FLIR ONE Pro LT

FLIRLT-IO5



### FLIR ONE Gen 3

FLIRONE3-IO5



## Vernier Thermal Analysis® Plus App

The Vernier Thermal Analysis Plus app makes it possible to analyze temperatures of up to four spots or regions and collect temperature data as a function of time. Examine the in-app graph, select different points or regions to examine, collect time-lapse videos for longer experiments, or export data to Graphical Analysis GW or Logger Pro® 3 for further analysis.

[www.vernier.com/thermal-analysis](http://www.vernier.com/thermal-analysis)



## Gas Pressure Sensor

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

[www.vernier.com/gps-bta](http://www.vernier.com/gps-bta)

GPS-BTA



## Temperature Probes

[www.vernier.com/temperature-sensors](http://www.vernier.com/temperature-sensors)

### Stainless Steel Temperature Probe

Range -40 to 135°C

TMP-BTA



### Surface Temperature Sensor

Range -25 to 125°C

STS-BTA

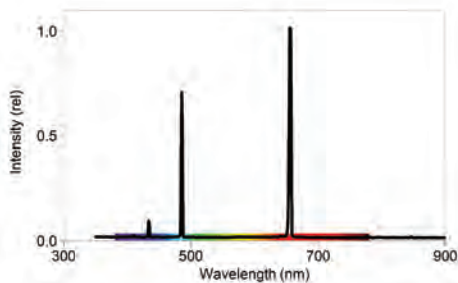


## Vernier Emissions Spectrometer

The Vernier Emissions Spectrometer gives precise measurements over a range of 350–900 nm. Use it with or without an optical fiber (not included) to examine spectra of light bulbs, spectrum tubes, or the sun.

[www.vernier.com/vsp-em](http://www.vernier.com/vsp-em)

VSP-EM



Hydrogen emission spectrum



Analyzing gas tube emission spectra

## Vernier Emissions Fiber

[www.vernier.com/vsp-em-fiber](http://www.vernier.com/vsp-em-fiber)

VSP-EM-FIBER



## Spectrum Tube Power Supplies

### Spectrum Tube Single Power Supply

These power supplies feature an ultra-safe design for electrifying spectrum tubes.

[www.vernier.com/st-sps](http://www.vernier.com/st-sps)

ST-SPS



### Spectrum Tube Carousel Power Supply

These power supplies hold eight gas spectrum tubes.

[www.vernier.com/st-car](http://www.vernier.com/st-car)

ST-CAR



### Spectrum Tubes

Spectrum Tubes are permanently enclosed in protective plastic carriers, with no exposed high voltage. 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.\*

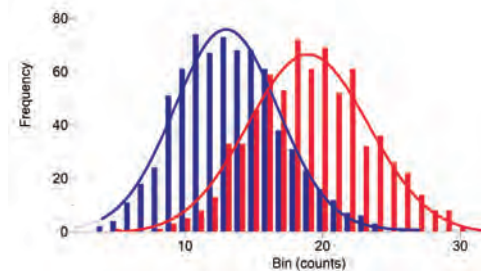
[www.vernier.com/spectrum-tubes](http://www.vernier.com/spectrum-tubes)

## Vernier Radiation Monitor

The Vernier Radiation Monitor detects alpha, beta, gamma, and X-ray radiation and can be used for experiments in nuclear counting statistics, shielding, and decay rate measurements.

[www.vernier.com/vrm-btd](http://www.vernier.com/vrm-btd)

VRM-BTD



Count histograms for wood (blue) and granite (red) countertops show the slight natural radioactivity of granite.

\* 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.



## Supplement your hands-on experiments in physics and chemistry with Pivot Interactives.

Pivot Interactives provides students with instant access to a collection of more than 160 real-world, interactive video exercises.

Each activity consists of student-controlled videos that allow variation of experimental parameters one at a time. Although the level of control is similar to a simulation, it is obvious to students that the events in the video are real. Students use embedded tools to directly measure, analyze, and interpret real-world scientific phenomena. Each video exercise challenges students to answer open-ended questions, collect their own data, and develop a mathematical model that describes the relationships between the variables.

Start your FREE trial today.

Visit [www.vernier.com/pivot](http://www.vernier.com/pivot)

### Features

- Classroom-ready experiments with teacher guides and grading/feedback tools
- Libraries (or matrices) of videos for each topic in introductory physics and chemistry
- High-production-quality videos of hard-to-replicate phenomena—not simulations
- Built-in, interactive measurement and analysis tools for use within each activity
- Teacher-customizable experiments
- Web-based access on computers, Chromebooks, and mobile devices

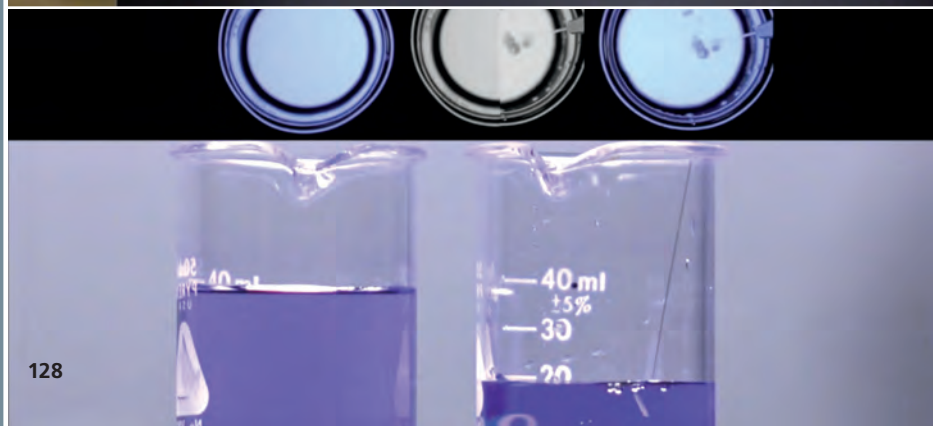
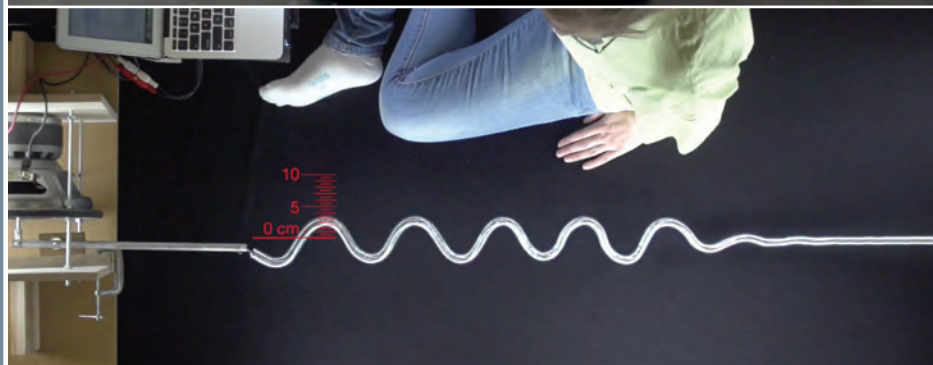
### Suggested Uses

- Pre-lab exercises
- Lab skills assessment
- Flipped classroom learning
- Post-lab assessment
- Substitute teacher days
- Credit recovery/homebound students



### Free Trial for Educators

Start a free 30-day, fully functioning trial of Pivot Interactives to use with your students. Access the entire library of videos, try new analysis tools, and more. Watch a short video of Pivot Interactives in action at [www.vernier.com/pivot](http://www.vernier.com/pivot)





## 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. You will have access to the most up-to-date versions of the experiments through your Vernier account.

- Download word-processing files to customize the experiments to fit your curricular needs.
- Electronic versions include a generous site license—purchase once and share files with other instructors in your school or college department.

### Physics Lab Books

Subjects	<i>Physics with Vernier</i>	<i>Physics Explorations and Projects</i>	<i>Advanced Physics with Vernier—Mechanics</i>	<i>Advanced Physics with Vernier—Beyond Mechanics</i>	<i>Physics with Video Analysis</i>
Physics First/Conceptual Physics	•	•			
Regular/Honors Physics	•	•			•
AP* Physics 1	•	•	•	•	•
AP* Physics 2	•	•		•	•
AP* Physics C Mechanics		•	•		•
AP* Physics C Electricity and Magnetism		•		•	•
IB† Physics			•	•	
College Physics (Algebra-Based)	•	•	•	•	•
College Physics (Calculus-Based)		•	•	•	•

\* 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.

## Physics with Vernier

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

PWV-E

Printed + Electronic Lab Book

PWV

### Topics Include

- Kinematics
- Newton's laws
- Momentum and energy
- Circuits
- Light and sound

For a complete list of all 35 experiments, visit [www.vernier.com/pwv](http://www.vernier.com/pwv)

### Sensors Used

Sensor	Page
Motion Detector	110, 117
Force	112, 119
Microphone	113, 121
Voltage	113, 122
Accelerometer	111, 118
Light	112, 125
Photogate	110, 118
Temperature	112, 126
Magnetic Field	112, 123
Current	113, 122

### Additional Products

Equipment	Page
Ultra Pulley Attachment	136
Picket Fence	136
Dynamics System	114, 116
Springs Set	136
Optics Expansion Kit	124
Bumper and Launcher Kit	117
Polarizer/Analyzer Set	124
Extech® Digital DC Power Supply	122
Friction Pad	116
Projectile Launcher	111, 120
Independence of Motion Accessory	120
Time of Flight Pad	120
Vernier Circuit Board 2	123



### Fisica con Vernier

This is the Spanish-language version of *Physics with Vernier* (3rd Edition).

[www.vernier.com/pwv-es](http://www.vernier.com/pwv-es)

### Supported Software

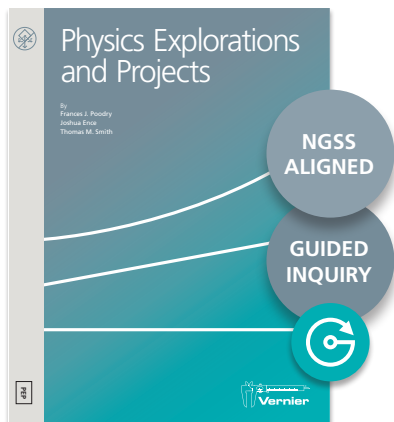
Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19
EasyData®	<a href="http://www.vernier.com/easydata">www.vernier.com/easydata</a>



## Physics Explorations and Projects

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

PEP-E

Printed + Electronic Lab Book

PEP

### Topics Include

- Planning and conducting investigations
- Science and engineering practices
- Newton's laws
- Momentum and energy
- Electricity and magnetism
- Waves

For a complete list of all 35 investigations, visit [www.vernier.com/pep](http://www.vernier.com/pep)

### Suggested Sensors

Sensor	Page
Motion detecting sensors/equipment	110–111, 114–118
Force	112, 119
Projectile Launcher	111, 120
Magnetic Field	112, 123
Voltage	113, 122
Current	113, 122
Charge Sensor	123
Microphone	113, 121
Diffraction Apparatus	125
Temperature/FLIR Camera	112, 126

### Additional Products

Equipment	Page
Centripetal Force Apparatus	111, 119
Bumper and Launcher Kit	117
Electrostatics Kit	123
Vernier Circuit Board 2	123
KidWind simpleGEN	90
KidWind 2V Solar Panel	91

### Supported Software

Software	Page
Logger Pro® 3	22–23
LabQuest® App	13–14
Graphical Analysis™ 4	18–19

## Advanced Physics with Vernier—Mechanics

HIGH SCHOOL

COLLEGE



Electronic Lab Book Only

PHYS-AM-E

Printed + Electronic Lab Book

PHYS-AM

### Topics Include

- Newton's laws
- Momentum
- Energy
- Rotation
- Simple harmonic motion

For a complete list of all 16 experiments, visit [www.vernier.com/phys-am](http://www.vernier.com/phys-am)

### Sensors Used

Sensor	Page
Force	119
Motion Detector	117
Photogate	118
Rotary Motion	119

### Supported Software

Software	Page
Logger Pro 3	22–23
LabQuest App	13–14

### Additional Products

Equipment	Page
Dynamics System	116
Bumper and Launcher Kit	117
Friction Pad	116
Picket Fence	136
Cart Picket Fence	136
Rotational Motion Accessory Kit	119
Centripetal Force Apparatus	119
Springs Set	136

## Advanced Physics with Vernier— Beyond Mechanics

HIGH SCHOOL

COLLEGE

Electronic  
Lab Book Only

PHYS-ABM-E

Printed + Electronic  
Lab Book

PHYS-ABM

### Topics Include

- Mechanical waves
- Electricity
- Magnetism
- RC and RLC circuits
- Optics
- Electromagnetic waves

For a complete list of all 22 experiments, visit [www.vernier.com/phys-abm](http://www.vernier.com/phys-abm)

### Sensors Used

Sensor	Page
Gas Pressure	126
Temperature	126
Microphone	121
Charge Sensor	123
Voltage	122
Current	122
Instrumentation Amplifier	55
Emissions Spectrometer	127
Diffraction Apparatus	125

### Supported Software

Software	Page
Logger Pro 3	22–23

### Additional Products

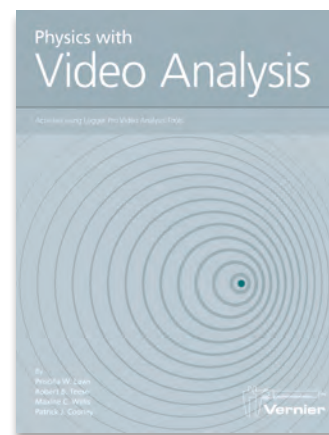
Equipment	Page
Power Amplifier	122
Power Amplifier Accessory Speaker	121
Electrostatics Kit	123
Resistivity Rod Set	137
Vernier Circuit Board 2	123
Optics Expansion Kit	124
Mirror Set	124
Emissions Optical Fiber	127
Spectrum Tube Power Supply	127
Hydrogen Spectrum Tube	127

LabQuest App	13–14
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## Physics with Video Analysis

HIGH SCHOOL

COLLEGE

Electronic  
Lab Book Only

PVA-E

Printed + Electronic  
Lab Book

PVA

Requires Logger Pro 3 software for macOS® and Windows® computers

### Topics Include

- Mechanical waves
- Electricity
- Magnetism
- RC and RLC circuits
- Optics
- Electromagnetic waves

For a complete list of all 33 activities, visit [www.vernier.com/pva](http://www.vernier.com/pva)

### Supported Software

Software	Page
Logger Pro 3	22–23

## Additional Physics Books and Activities

For details on the following books, go to [www.vernier.com/books](http://www.vernier.com/books) and expand Physics.

### Tools for Scientific Thinking

David R. Sokoloff  
Ronald K. Thornton

### Activity Based Physics

David R. Sokoloff  
Ronald K. Thornton  
Priscilla W. Laws

### Interactive Lecture Demonstrations

David R. Sokoloff  
Ronald K. Thornton

### RealTime Physics

David R. Sokoloff  
Ronald K. Thornton  
Priscilla W. Laws



## Science

Vernier technology is used in more than 135 countries in biology, biotechnology, chemistry, Earth science, environmental science, physical science, physics, and water quality courses. From elementary schools to graduate studies, you can rely on Vernier technology for hands-on learning when science is the key focus of your STEM program.

### Using Vernier technology, students

- Ask questions and define problems to investigate
- Plan and carry out investigations
- Decide what data to gather and how much data are needed to produce reliable results
- Analyze and interpret data

## Technology

All Vernier technology—from sensors used in hands-on experiments to technology to test design solutions—supports a robust, engaging STEM education.

### What other educators are saying

*“The range of compatible sensors is 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 provides more teaching time without taking the practical element of the sciences away. The LabQuest 2 allows us to carry out meaningful experiments that we have not been able to do before.”*

—Chris Jessop, AKS School, Lytham, United Kingdom



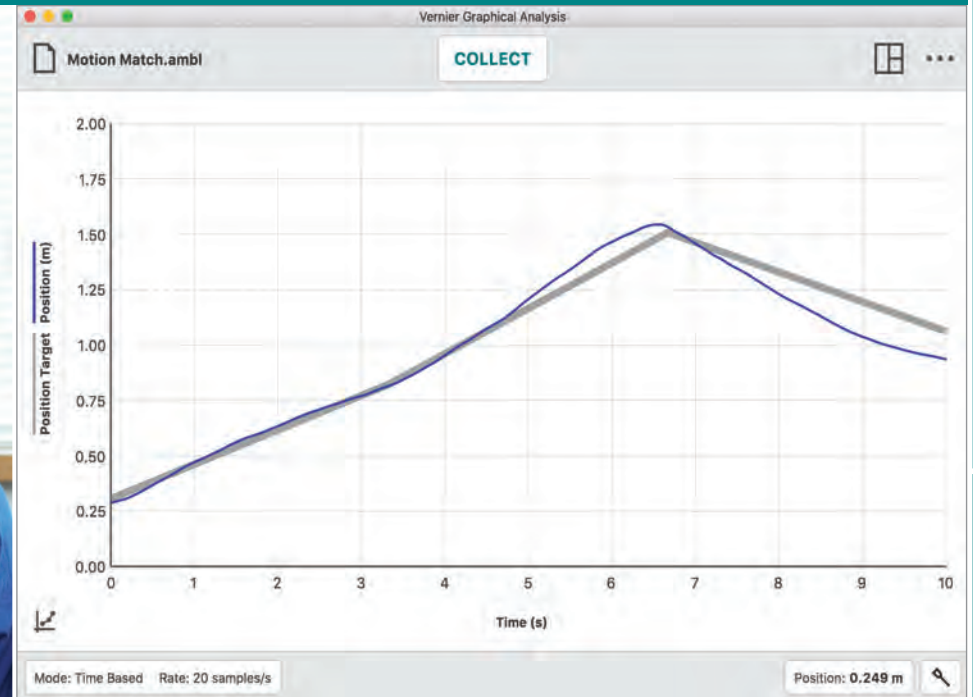


## Engineering

The practices of engineering, when combined with Vernier sensors, allow students to identify problems, design solutions, and test those solutions using sensor data.

### Vernier supports hands-on engineering activities:

- Engineering design projects
- Feedback and control projects
- Bridge testing and contests
- Structures and materials testing
- Wind and solar energy investigations and design challenges



## Math

Computational thinking, visualizing data, and recognizing patterns are all part of scientific investigations and engineering activities using Vernier sensors and software.

### Vernier technology engages student and helps them

- Understand grade-level appropriate mathematics and statistics when analyzing data
- Visualize data using a variety of analytical tools to show relationships



## The Vernier Sensor Advantage

### Outstanding Performance

With 38 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.

### Go Direct® Sensors

Our Go Direct sensors connect directly to a computer, Chromebook™, or a mobile device via Bluetooth® wireless technology or USB connection. Most sensors include a rechargeable battery to power the sensor when used as a wireless sensor.

### LabQuest® Sensors

Our LabQuest sensors require an interface from the LabQuest family, 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](http://www.vernier.com/sensors)

### Generous Warranty

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

## GO DIRECT SENSORS

Sensor	Order Code	Page
Go Direct 3-Axis Magnetic Field	GDX-3MG	112
Go Direct Acceleration	GDX-ACC	111
Carts and Tracks		
Dynamics Cart and Track System with Go Direct Sensor Carts	DTS-GDX	114
Go Direct Sensor Cart (Green)	GDX-CART-G	114
Go Direct Sensor Cart (Yellow)	GDX-CART-Y	114
Go Direct CO <sub>2</sub> Gas	GDX-CO2	34
Go Direct Colorimeter	GDX-COL	50
Go Direct Conductivity	GDX-CON	50
Go Direct Constant Current System	GDX-CCS	51
Go Direct Current	GDX-CUR	113
Go Direct Drop Counter	GDX-DC	51
Go Direct EKG	GDX-EKG	35
Go Direct Electrode Amplifier	GDX-EA	51
Go Direct Energy	GDX-NRG	88
<b>NEW</b> Go Direct Ethanol Vapor	GDX-ETOH	36
Go Direct Force and Acceleration	GDX-FOR	112
Go Direct Gas Pressure	GDX-GP	51
<b>NEW</b> Go Direct Hand Dynamometer	GDX-HD	35
Heart Rate Monitors		
Go Wireless Exercise Heart Rate	GW-EHR	<a href="#">web</a>
Go Wireless Heart Rate	GW-HR	35
<b>NEW</b> Go Direct Ion-Selective Electrode Amplifier	GDX-ISEA	<a href="#">web</a>
Ion-Selective Electrodes (ISE)*		
<b>NEW</b> Go Direct Ammonium ISE	GDX-NH4	<a href="#">web</a>
<b>NEW</b> Go Direct Calcium ISE	GDX-CA	<a href="#">web</a>
<b>NEW</b> Go Direct Chloride ISE	GDX-CL	<a href="#">web</a>
<b>NEW</b> Go Direct Nitrate ISE	GDX-NO3	<a href="#">web</a>
<b>NEW</b> Go Direct Potassium ISE	GDX-K	<a href="#">web</a>
Go Direct Light and Color	GDX-LC	112
Go Direct Melt Station	GDX-MLT	51

Go Direct Motion	GDX-MD	110
Go Direct O <sub>2</sub> Gas	GDX-O2	34
Go Direct Optical Dissolved Oxygen	GDX-ODO	34
Go Direct ORP	GDX-ORP	52
pH Sensors		
Go Direct Glass-Body pH	GDX-GPH	52
Go Direct pH	GDX-PH	52
Go Direct Tris-Compatible Flat pH	GDX-FPH	52
<b>NEW</b> Go Direct Photogate	GDX-VPG	110
<b>NEW</b> Go Direct Projectile Launcher	GDX-PL	111
Go Direct Radiation Monitor	GDX-RAD	113
Go Direct Respiration Belt	GDX-RB	35
Go Direct Rotary Motion	GDX-RMS	111
<b>NEW</b> Go Direct Sound	GDX-SND	113
Go Direct SpectroVis Plus	GDX-SVISPL	53
Temperature Probes		
Go Direct Surface Temperature	GDX-ST	53
Go Direct Temperature	GDX-TMP	53
Go Direct Wide-Range Temperature	GDX-WRT	53
Go Direct Voltage	GDX-VOLT	113

### Featured Accessories



**Go Direct Charge Station**  
GDX-CRG  
See page 137.



**NEW Go Direct Centripetal Force Apparatus**  
GDX-CFA  
See page 111.



**NEW Reflex Hammer Accessory Kit**  
RFX-ACC  
See page 35.

## LABQUEST SENSORS

Sensor	Order Code	Page
<b>Accelerometers</b>		
3-Axis Accelerometer	3D-BTA	118
25-g Accelerometer	ACC-BTA	118
Low-g Accelerometer	LGA-BTA	118
Anemometer	ANM-BTA	<a href="#">web</a>
Barometer	BAR-BTA	<a href="#">web</a>
Blood Pressure Sensor	BPS-BTA	<a href="#">web</a>
Charge Sensor	CRG-BTA	123
CO <sub>2</sub> Gas Sensor	CO2-BTA	37
Colorimeter	COL-BTA	54
<b>Conductivity Probes</b>		
Conductivity Probe	CON-BTA	54
Platinum-Cell Conductivity Probe	CONPT-BTA	54
Constant Current System	CCS-BTA	55
<b>Current Probes</b>		
Current Probe	DCP-BTA	122
High Current Sensor	HCS-BTA	<a href="#">web</a>
Diffraction Apparatus	DAK	125
Digital Control Unit	DCU-BTD	78
<b>Dissolved Oxygen Probes</b>		
Dissolved Oxygen Probe	DO-BTA	<a href="#">web</a>
Optical DO Probe	ODO-BTA	37
Drop Counter	VDC-BTD	55
EKG Sensor	EKG-BTA	<a href="#">web</a>
Electrode Amplifier	EA-BTA	55
Energy Sensor	VES-BTA	<a href="#">web</a>
Ethanol Sensor	ETH-BTA	38
Flow Rate Sensor	FLO-BTA	<a href="#">web</a>
<b>Force Sensors</b>		
Dual-Range Force Sensor	DFS-BTA	119
Force Plate	FP-BTA	119
<b>Gas Pressure Sensors</b>		
Gas Pressure Sensor	GPS-BTA	55
Pressure Sensor 400	PS400-BTA	55
Goniometer	GNM-BTA	<a href="#">web</a>

Hand Dynamometer	HD-BTA	38
<b>Heart Rate Monitors</b>		
Exercise Heart Rate Monitor	EHR-BTA	<a href="#">web</a>
Hand-Grip Heart Rate Monitor	HGH-BTA	38
Instrumentation Amplifier	INA-BTA	55
<b>Ion-Selective Electrodes (ISE)*</b>		
Ammonium ISE	NH4-BTA	<a href="#">web</a>
Calcium ISE	CA-BTA	<a href="#">web</a>
Chloride ISE	CL-BTA	<a href="#">web</a>
Nitrate ISE	NO3-BTA	<a href="#">web</a>
Potassium ISE	K-BTA	<a href="#">web</a>
Light Sensor	LS-BTA	125
Magnetic Field Sensor	MG-BTA	123
Melt Station	MLT-BTA	56
Microphone	MCA-BTA	121
<b>Motion Detectors</b>		
Dynamics Cart and Track System with Motion Encoder	DTS-EC	116
Motion Detector	MD-BTD	117
O <sub>2</sub> Gas Sensor	O2-BTA	37
ORP Sensor	ORP-BTA	56
PAR Sensor	PAR-BTA	38
<b>pH Sensors</b>		
Glass-Body pH Electrode BNC (requires Electrode Amplifier)	GPH-BNC	56
pH Sensor	PH-BTA	56
Tris-Compatible Flat pH Sensor	FPH-BTA	38
Photogate	VPB-BTD	118
Polarimeter (Chemical)	CHEM-POL	56
Power Amplifier	PAMP	122
Projectile Launcher	VPL	120
Pyranometer	PYR-BTA	<a href="#">web</a>
Qubit Sensors	varies	<a href="#">web</a>
Radiation Monitor	VRM-BTD	127
Relative Humidity Sensor	RH-BTA	<a href="#">web</a>
Respiration Monitor Belt (requires Gas Pressure Sensor)	RMB	<a href="#">web</a>
Rotary Motion Sensor	RMV-BTD	119
Salinity Sensor	SAL-BTA	<a href="#">web</a>

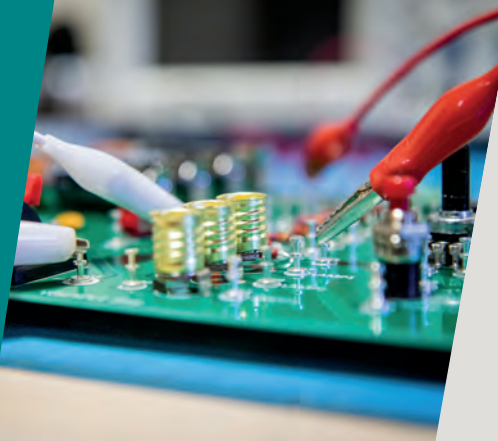
Soil Moisture Sensor	SMS-BTA	87
Sound Level Sensor	SLS-BTA	121
Spirometer	SPR-BTA	38
Structures & Materials Tester	VSMT	81
<b>Temperature Probes</b>		
Extra-Long Temperature Probe	TPL-BTA	<a href="#">web</a>
Stainless Steel Temperature Probe	TMP-BTA	57
Surface Temperature Sensor	STS-BTA	57
Thermocouple	TCA-BTA	57
Wide-Range Temperature Probe	WRT-BTA	57
Turbidity Sensor	TRB-BTA	66
<b>UV Sensors</b>		
UVA Sensor	UVA-BTA	<a href="#">web</a>
UVB Sensor	UVB-BTA	66
<b>Voltage Probes</b>		
30-Volt Voltage Probe	30V-BTA	<a href="#">web</a>
Differential Voltage Probe	DVP-BTA	122
Voltage Probe	VP-BTA	57

## USB-ONLY SENSORS

Sensor	Order Code	Page
<b>Go! and Easy Sensors</b>		
EasyTemp (for calculators)	EZ-TMP	<a href="#">web</a>
Go! Motion	GO-MOT	<a href="#">web</a>
Go!Temp	GO-TEMP	<a href="#">web</a>
Mini GC Plus Gas Chromatograph	GC2-MINI	58
OHAUS Balances	varies	58
<b>Spectrometers</b>		
Go Direct SpectroVis Plus (USB and Wireless)	GDX-SVISPL	59
Vernier Emissions Spectrometer	VSP-EM	127
Vernier Flash Photolysis Spectrometer	VSP-FP	59
Vernier Fluorescence/UV-VIS Spectrophotometer	VSP-FUV	59
Vernier Spectrometer (Ocean Optics)	V-SPEC	<a href="#">web</a>
Vernier UV-VIS Spectrophotometer	VSP-UV	59

\* Ion-Selective Electrodes require excellent chemical technique and careful calibration to obtain accurate results; they are not recommended for elementary or middle school students.

# Accessories & Replacement Parts



## SENSORS

Part Name	Order Code
<b>Blood Pressure Sensors</b>	
Small Blood Pressure Cuff	CUFF-SM
Large Blood Pressure Cuff	CUFF-LG
<b>CO<sub>2</sub> and/or O<sub>2</sub> Gas Sensors</b>	
250 mL Nalgene Bottle (1 opening)	CO2-BTL
BioChamber 250 (250 mL) (2 openings)	BC-250
BioChamber 2000 (2000 mL) (2 openings)	BC-2000
<b>Colorimeters</b>	
Cuvette Rack	CUV-RACK
Plastic Cuvettes (Visible Range) (pkg. of 100)	CUV
<b>Conductivity Probes</b>	
Conductivity Low Standard (500 mL)	CON-LST
Conductivity Middle Standard (500 mL)	CON-MST
Conductivity High Standard (500 mL)	CON-HST
<b>Dissolved Oxygen Probe (Optical, order code GDX-ODO)</b>	
Go Direct Optical Dissolved Oxygen Replacement Cap	GDX-ODO-CAP
<b>Dissolved Oxygen Probe (Optical, order code ODO-BTA)</b>	
Optical DO Probe Metal Guard	ODO-GRD
Optical DO Probe Replacement Cap	ODO-CAP
<b>Dissolved Oxygen Probe (Original, order code DO-BTA)</b>	
DO Calibration Solution (60 mL)	DO-CAL
DO Filling Solution (130 mL)	FS
DO Polishing Strips	PS
DO Probe Membrane Cap	MEM
<b>Drop Counters</b>	
Microstirrer	MSTIR
Reagent Reservoir, 2 Valves, and Tip	VDC-RR
Stopper Stem	PS-STEM
Plastic 2-Way Valve	PS-2WAY
<b>EKG Sensors</b>	
EKG Electrodes (100)	ELEC

<b>Electrode Amplifier (for Go Direct Sensors, order code GDX-EA)</b>	
Go Direct pH Electrode BNC	GDX-PH-BNC
Go Direct Glass-Body pH Electrode BNC	GDX-GPH-BNC
Go Direct Flat pH Electrode BNC	GDX-FPH-BNC
Go Direct ORP Electrode BNC	GDX-ORP-BNC
<b>Electrode Amplifier (for LabQuest Sensors, order code EA-BTA)</b>	
pH Electrode BNC	PH-BNC
Glass-Body pH Electrode BNC	GPH-BNC
Flat pH Electrode BNC	FPH-BNC
ORP Electrode BNC	ORP-BNC
<b>Ethanol Sensors</b>	
Ethanol Cap Assemblies (pkg. of 3)	ETH-CAPS
Ethanol Stopper	ETH-STOP
Ethanol Tape	ETH-TAPE
<b>Force Sensors</b>	
Replacement Accessory Rod	ACC-ROD
Springs Set	SPRINGS
Dual-Range Force Sensor Replacement Parts Kit	DFS-RPK
Bumper Launcher Kit	BLK
Hoop Bumpers for Bumper and Launcher Kit	HOOPS-BLK
<b>Gas Chromatograph</b>	
GC Septa (pkg. of 4)	GC-SEP
GC Syringe, 1 µL Hamilton	GC-SYR-MIC
<b>Gas Pressure Sensors</b>	
Gas Pressure Sensor Bulb (set of 4)	GPS-BULB4
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

<b>Gas Pressure Sensors (cont.)</b>	
Stopper Stem	PS-STEM
Syringe (20 mL, plastic)	PS-SYR
Syringe (20 mL, plastic) (pkg. of 10)	PS-SYR10
<b>Heart Rate Sensors</b>	
Heart Rate Hand Grips	HR-GRIP
Exercise Heart Rate Strap	HR-STRAP
<b>Ion-Selective Electrodes</b>	
ISE Ammonium Replacement Module <sup>†</sup>	NH4-MOD
ISE Calcium Replacement Module <sup>†</sup>	CA-MOD
ISE Nitrate Replacement Module <sup>†</sup>	NO3-MOD
ISE Potassium Replacement Module <sup>†</sup>	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
<b>Melt Stations</b>	
Melt Station Capillary Tubes (pkg. of 100)	MLT-TUBE
<b>Motion Detectors</b>	
Go! Motion to Computer Cable	GMC-USB
Motion Detector Cable	MDC-BTD
Motion Detector Clamp	MD-CLAMP
<b>pH and ORP Sensors</b>	
Microstirrer	MSTIR
pH Buffer Capsules (10 each of pH 4, 7, 10)	PH-BUFCAP
pH Storage Bottles (pkg. of 5)	BTL
pH Storage Solution (500 mL)	PH-SS
<b>Photogates</b>	
Cart Picket Fence	PF-CART
<b>NEW</b> Go Direct Photogate Timing Cable	VPG-CB-GDX
<b>NEW</b> Go Direct Time of Flight Pad Cable	TOF-CB-GDX
Laser Pointer	LASER
Laser Pointer Stand	STAND
Photogate Bar Tape Kit	TAPE-VPG
Picket Fence	PF
Pulley Bracket	B-SPA
Ultra Pulley Attachment	SPA
<b>Polarimeters (Chemical)</b>	
Polarimeter Sample Cells (pkg. of 4)	CELLS-POL
<b>Power Amplifier</b>	
Accessory Speaker	PAAS-PAMP

<sup>†</sup> 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.

## Projectile Launchers

Goggles (set of 2)	GGL-VPL
Time of Flight Pad	TOF-VPL
Steel Balls (set of 6)	STB-VPL
Projectile Stop	PS-VPL
Independence of Motion Accessory	IOM-VPL
Wax Tape (300 ft.)	WXT-VPL

## Rotary Motion Sensors

Rotational Motion Accessory Kit	AK-RMV
Rotary Motion Motor Kit	MK-RMV
Rotary Motion Sensor Replacement Pulley	RMV-PULLEY
Rotary Motion Sensor Replacement Parts Kit	RMV-RPK

## Salinity Sensors

Salinity Standard (500 mL)	SAL-ST
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## Spectrophotometers/Spectrometers

Cuvette Rack	CUV-RACK
Plastic Cuvettes (visible) (pkg. of 100)	CUV
Plastic Cuvettes (UV-VIS) (pkg. of 100)	CUV-UV
Quartz Cuvettes (pkg. of 2)	CUV-QUARTZ
Fluorescence/UV Quartz Cuvette (1)	CUV-QUARTZ-FUV
Spectrophotometer Optical Fiber (for GDX-SVISPL, VSP-UV, VSP-FUV)	VSP-FIBER
Vernier Emissions Fiber (for VSP-EM)	VSP-EM-FIBER

## Spirometers

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 <sub>2</sub> Gas Sensor to Spirometer Adapter	O2-SPR
Spirometer Flow Head	SPR-FLOW

## Turbidity Sensors

Turbidity Accessories Replacement Kit	TRB-ACC
Turbidity Bottles (pkg. of 6)	TRB-BOT

## Vernier Structures & Materials Tester

Truss Tester Accessory	VSMT-TRUSS
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## Voltage and Current Probes

Inductor	IND
Miniature Alligator Clips for Vernier Circuit Board	VCB-GATOR
Optional Breadboard Kit for the Vernier Circuit Board 2	VCB2-OBK
Replacement Lamps for Vernier Circuit Board	VCB-BULB
Resistivity Rods	RRS
Vernier Circuit Board 2	VCB2

## DYNAMICS CART AND TRACK SYSTEM

Part Name	Order Code
For any Cart and Track System	
Adjustable Two Foot Leveler	AL-VDS
Adjustable End Stop	AS-VDS
Anti-Roll Pegs	VDS-ARP10
Axles and Wheels for Cart	WHEELS-VDS
Cart Picket Fence	PF-CART
Cart - Plunger Cart (plastic)	DTS-CART-P
Cart - Standard Cart (plastic)	DTS-CART-S
Motion Detector Bracket	DTS-MDB
Optics Accessories	pages 114–115
Photogate Bracket	PGB-VDS
Pulley Bracket	B-SPA
Vernier Dynamics System Replacement Parts Kit	VDS-RPK

## For Dynamics Cart and Track Systems Only (Plastic Carts)

DFS/Accelerometer Fasteners	DTS-ACC
Eddy Current Brake	DTS-ECB
Friction Pad DTS (for plastic carts)	DTS-PAD
Mass DTS (hexagonal bars)	DTS-MASS
Motion Detector Reflector Flag	DTS-FLAG

## For Vernier Dynamics Systems Only (Metal Carts)

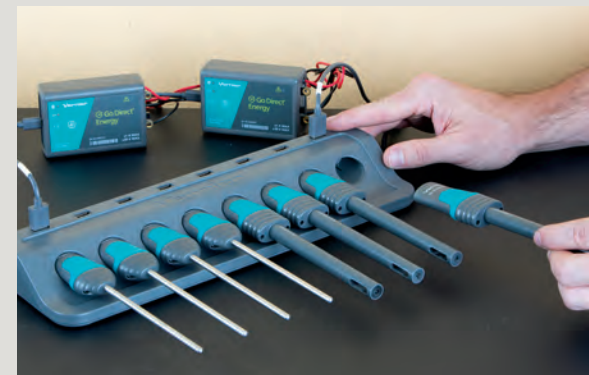
Friction Pad (for metal carts)	PAD-VDS
Mass for Dynamics Carts (500 g block)	MASS

## MISC. CABLES/ADAPTERS/POWER SUPPLIES

Part Name	Order Code
BTA/BTD Cables	
Analog Bare Wire Cable	CB-BTA
Digital Bare Wire Cable	CB-BTD
Analog Breadboard Cable	BB-BTA
Digital Breadboard Cable	BB-BTD
Analog Sensor Extension Cable (2 m)	EXT-BTA
Digital Sensor Extension Cable (2 m)	EXT-BTD
For LabPro	
AC Adapter (for LabPro, CBL 2, or DCU)	IPS
LabPro USB Cable	CB-USB

## GO DIRECT AND GO WIRELESS

Part Name	Order Code
Go Direct Charge Station	GDX-CRG
Go Wireless USB Radio	GW-RADIO
Vernier Micro USB Cable	CB-USB-MICRO
Vernier USB Type C to Micro USB Cable	CB-USB-C-MICRO



## Go Direct Charge Station

Go Direct Charge Station is the perfect solution for charging your Go Direct® sensors. Each charge station has sixteen charging ports—eight USB and eight wand-style sensor ports.

[www.vernier.com/gdx-crg](http://www.vernier.com/gdx-crg)

GDX-CRG

## LABQUEST 2 AND ORIGINAL LABQUEST

Part Name	Order Code
For LabQuest 2 and Original LabQuest	
LabQuest Charge Station	LQ2-CRG
LabQuest Power Supply	LQ-PS
LabQuest Tether (pkg. of 5)	LQ-TETH-5
LabQuest Lanyard	LQ-LAN
LabQuest Battery Boost 2	LQ-BOOST2
LabQuest SD Card	LQ-SD
Vernier Mini USB Cable	CB-USB-MINI
Vernier USB Type C to Mini USB Cable	CB-USB-C-MINI
For LabQuest 2 Only	
LabQuest 2 Lab Armor	LQ2-ARMOR
LabQuest 2 Stand	LQ2-STN
LabQuest 2 Battery	LQ2-BAT
LabQuest 2 Stylus (pkg. of 5)	LQ2-STYL-5
For Original LabQuest Only	
Original LabQuest Battery	LQ-BAT
Original LabQuest Stylus (pkg. of 5)	LQ-STYL-5



# Index



## A

Accelerometers  
 3-Axis Accelerometer 118  
 25-g Accelerometer 118  
 Go Direct Acceleration 111  
 Go Direct Force and Acceleration 112  
 Low-g Accelerometer 118  
 Accessories and replacement parts 136–137  
 Adapters [vernier.com/adapters](http://vernier.com/adapters)  
*Advanced Biology with Vernier* 42  
*Advanced Chemistry with Vernier* 62  
*Advanced Physics with Vernier—Beyond Mechanics* 131  
*Advanced Physics with Vernier—Mechanics* 100  
*Agricultural Science with Vernier* 43  
 Ammonium Ion-Selective Electrodes  
 Ammonium ISE [vernier.com/nh4-bta](http://vernier.com/nh4-bta)  
 Go Direct Ammonium ISE  
[vernier.com/gdx-nh4](http://vernier.com/gdx-nh4)  
 Analytical Chemistry 60  
 Anemometer [vernier.com/anm-bta](http://vernier.com/anm-bta)  
 Arduino™ products 78

## B

Balances 58  
 Barometer [vernier.com/bar-bta](http://vernier.com/bar-bta)  
 BioChambers 136  
 Biochemistry 60  
*Biology with Vernier* 41  
 Biotechnology 39  
 Blood Pressure Sensor [vernier.com/bps-bta](http://vernier.com/bps-bta)  
 BNC electrodes 56  
 BlueView Transilluminator  
[vernier.com/blue-view](http://vernier.com/blue-view)  
 Bumper and Launcher Kit 117

## C

Cables 137  
 Calcium Ion-Selective Electrodes  
 Calcium ISE [vernier.com/ca-bta](http://vernier.com/ca-bta)  
 Go Direct Calcium ISE  
[vernier.com/gdx-ca](http://vernier.com/gdx-ca)  
 Calibration standards 136–137  
 Canadian sales 142  
 Celestron® Digital Microscope Imager 40  
 Centripetal Force Apparatuses  
 Centripetal Force Apparatus 119  
 Go Direct Centripetal Force Apparatus 111  
 Charge Sensor 123  
 Charging stations  
 Go Direct 137  
 LabQuest 15  
 Chemical Polarimeter 56  
*Chemistry with Vernier* 61  
 Chloride Ion-Selective Electrodes  
 Chloride ISE [vernier.com/cl-bta](http://vernier.com/cl-bta)  
 Go Direct Chloride ISE  
[vernier.com/gdx-cl](http://vernier.com/gdx-cl)  
*Ciencia en la Primaria con Vernier*  
[vernier.com/cpv](http://vernier.com/cpv)  
*Ciencias con lo Mejor de Vernier*  
[vernier.com/cmv-lp](http://vernier.com/cmv-lp)  
 CO<sub>2</sub> gas sensors  
 CO<sub>2</sub> Gas Sensor 37  
 Go Direct CO<sub>2</sub> Gas 34  
 Coding 74  
 Color Mixer Kit 125  
 Colorimeters  
 Colorimeter 54  
 Go Direct Colorimeter 50  
 Conductivity probes  
 Conductivity Probe 54

Go Direct Conductivity 50  
 Platinum-Cell Conductivity Probe 54  
 Constant current systems  
 Constant Current System 55  
 Go Direct Constant Current System 51  
 Current sensors  
 Current Probe 122  
 Go Direct Current 113  
 High Current Sensor  
[vernier.com/hcs-bta](http://vernier.com/hcs-bta)  
 Cuvette Rack 137  
 Cuvettes 137

## D

Davis® weather stations 67  
 Differential Voltage Probe 122  
 Diffraction Apparatus 125  
 Digital Control Unit (DCU) 78  
 Digital microscopes 40  
 Dissolved oxygen probes  
 Dissolved Oxygen Probe  
[vernier.com/do-bta](http://vernier.com/do-bta)  
 Go Direct Optical Dissolved Oxygen 34  
 Optical DO Probe 37  
 Drop counters  
 Drop Counter 55  
 Go Direct Drop Counter 51  
 Dual-Range Force Sensor 119  
 Dynamics systems 114–116

## E

*Earth Science with Vernier* 67  
 EasyLink [vernier.com/ez-link](http://vernier.com/ez-link)  
 EasyTemp [vernier.com/ez-tmp](http://vernier.com/ez-tmp)  
 EKG electrodes 136

EKG sensors  
 EKG Sensor [vernier.com/ekg-bta](http://vernier.com/ekg-bta)  
 Go Direct EKG 35

Electrode amplifiers  
 Electrode Amplifier 55  
 Go Direct Electrode Amplifier 51  
 Ion-Selective Electrode Amplifier  
[vernier.com/gdx-isea](http://vernier.com/gdx-isea)

Electrode Support 58  
 Electronic lab books 24  
 Electrostatics kits 123  
*Elementary Science with Vernier* 71  
 ELVIS adapters 78  
 Emissions Spectrometer 127  
*Energia Renewable con Vernier*  
[vernier.com/rev-es](http://vernier.com/rev-es)

Energy sensors  
 Energy Sensor [vernier.com/ves-bta](http://vernier.com/ves-bta)  
 Go Direct Energy 88  
*Engineering Projects with NI LabVIEW™ and Vernier* 79

Environmental Chemistry 60  
 Equipment return 142

Ethanol Sensors  
 Ethanol Sensor 38  
 Go Direct Ethanol Vapor 36

Exercise Heart Rate Monitor  
[vernier.com/ehr-bta](http://vernier.com/ehr-bta)

*Exploring Motion and Force with Go Direct Sensor Cart* 101

Extech® Power Supply 122  
 Extra-Long Temperature Probe  
[vernier.com/tpl-bta](http://vernier.com/tpl-bta)

## F

Fan carts 117  
*Física con Vernier* [vernier.com/pwv-es](http://vernier.com/pwv-es)  
 Flash Photolysis Spectrometer 59  
 FLIR ONE® Thermal Cameras 126  
 Flow Rate Sensor [vernier.com/flo-bta](http://vernier.com/flo-bta)  
 Fluorescence UV/VIS Spectrophotometer 59  
 Force sensors  
 Dual-Range Force Sensor 119  
 Force Plate 119  
 Go Direct Force and Acceleration 112  
*Forensics with Vernier* [vernier.com/fwv](http://vernier.com/fwv)  
 Friction Pad 116

# G

Gas chromatograph 58  
 Gas pressure sensors  
   Gas Pressure Sensor 55  
   Go Direct Gas Pressure 51  
   Pressure Sensor 400 55  
 Glass-Body pH Electrode BNC 56  
 Go Direct Charge Station 137  
 Go Direct sensors  
   Go Direct 3-Axis Magnetic Field 112  
   Go Direct Acceleration 111  
   Go Direct Ammonium Ion-Selective Electrode [vernier.com/gdx-nh4](http://vernier.com/gdx-nh4)  
   Go Direct Calcium Ion-Selective Electrode [vernier.com/gdx-ca](http://vernier.com/gdx-ca)  
   Go Direct Chloride Ion-Selective Electrode [vernier.com/gdx-cl](http://vernier.com/gdx-cl)  
   Go Direct CO<sub>2</sub> Gas 34  
   Go Direct Colorimeter 50  
   Go Direct Conductivity 50  
   Go Direct Constant Current System 51  
   Go Direct Current 113  
   Go Direct Drop Counter 51  
   Go Direct EKG 35  
   Go Direct Electrode Amplifier 51  
   Go Direct Energy 88  
   Go Direct Ethanol Vapor 36  
   Go Direct Force and Acceleration 112  
   Go Direct Gas Pressure 51  
   Go Direct Glass-Body pH 52  
   Go Direct Ion-Selective Electrode Amplifier [vernier.com/gdx-isea](http://vernier.com/gdx-isea)  
   Go Direct Light and Color 112  
   Go Direct Melt Station 51  
   Go Direct Motion Detector 110  
   Go Direct Nitrate Ion-Selective Electrode [vernier.com/gdx-no3](http://vernier.com/gdx-no3)  
   Go Direct O<sub>2</sub> Gas 34  
   Go Direct Optical Dissolved Oxygen 34  
   Go Direct ORP 52  
   Go Direct pH 52  
   Go Direct Photogate 110  
   Go Direct Projectile Launcher 111  
   Go Direct Radiation 113  
   Go Direct Respiration Monitor Belt 35  
   Go Direct Sensor Carts (Green and Yellow) 114  
   Go Direct Sound 113  
   Go Direct SpectroVis Plus Spectrophotometer 53

Go Direct Surface Temperature 53  
 Go Direct Tris-Compatible Flat pH 52  
 Go Direct Temperature 53  
 Go Direct Voltage 113  
 Go Direct Wide-Range Temperature 53  
 Go! Link [vernier.com/go-link](http://vernier.com/go-link)  
 Go! Motion [vernier.com/go-mot](http://vernier.com/go-mot)  
 Go!Temp [vernier.com/go-temp](http://vernier.com/go-temp)  
 Goniometer [vernier.com/gnm-bta](http://vernier.com/gnm-bta)  
 Go Wireless Exercise Heart Rate [vernier.com/gw-ehr](http://vernier.com/gw-ehr)  
 Go Wireless Heart Rate 35  
 Grants [vernier.com/grants](http://vernier.com/grants)  
 Graphical Analysis 4 app 18–19  
 Green Diffraction Laser 125

# H

Hand Dynamometer 38  
 Heart rate monitors  
   Exercise Heart Rate Monitor [vernier.com/ehr-bta](http://vernier.com/ehr-bta)  
   Go Wireless Exercise Heart Rate [vernier.com/gw-ehr](http://vernier.com/gw-ehr)  
   Go Wireless Heart Rate 35  
   Hand-Grip Heart Rate Monitor 38  
 High Current Sensor [vernier.com/hcs-bta](http://vernier.com/hcs-bta)  
 High-Voltage Electrostatics Kit 123  
*Human Physiology Experiments* 43  
*Human Physiology with Vernier* [vernier.com/hp-a](http://vernier.com/hp-a)

# I

Independence of Motion Accessory 120  
 Instrumentation Amplifier 55  
 Interfaces for LabQuest sensors  
   EasyLink [vernier.com/ez-link](http://vernier.com/ez-link)  
   Go! Link [vernier.com/go-link](http://vernier.com/go-link)  
   LabQuest 2 12–14  
   LabQuest Mini 17  
   LabQuest Stream 16  
   NXT/EV3 Adapter 75  
   SensorDAQ 79  
 International sales 142  
*Investigating Biology through Inquiry* 42  
*Investigating Chemistry through Inquiry* 63  
*Investigating Environmental Science through Inquiry* 92  
*Investigating Temperature* [vernier.com/elb-temp](http://vernier.com/elb-temp)  
*Investigating Solar Energy* 71

*Investigating Wind Energy* 71  
 Ion-Selective Electrodes (ISE) [vernier.com/ise](http://vernier.com/ise)  
 ISE standards 136

# K

Kestrel® DROP Wireless Data Loggers [vernier.com/kes-d3](http://vernier.com/kes-d3)  
 KidWind products 88–91

# L

LabQuest 2 12–14  
 LabQuest accessories 15  
 LabQuest Mini 17  
 LabQuest Stream 16  
 LabQuest Viewer 21  
 LEGO® MINDSTORMS® robotics 75  
 Light sensors  
   Go Direct Light and Color 112  
   Light Sensor 125  
 Logger Lite software [vernier.com/logger-lite](http://vernier.com/logger-lite)  
 Logger Pro 3 software 22–23

# M

Magnetic field sensors  
   Go Direct 3-Axis Magnetic Field 112  
   Magnetic Field Sensor 123  
 Melt Stations  
   Go Direct Melt Station 51  
   Melt Station 56  
 Microscopes (Digital) 40  
 Microphone 121  
*Middle School Science with Vernier* 100  
 Mini GC Plus 58  
 Mirror Set 124  
 Moment of Inertia Kit [vernier.com/cfa-mik](http://vernier.com/cfa-mik)  
 Motion detectors  
   Go Direct Motion Detector 110  
   Go! Motion [vernier.com/go-mot](http://vernier.com/go-mot)  
   Motion Detector 117  
 Motion Encoder  
   Dynamics Cart and Track Systems 116  
   Fan Cart 117  
 MyDAQ Adapter 79

# N

NABT/Environmental Science Teaching Award [vernier.com/grants/nabt](http://vernier.com/grants/nabt)  
 Nitrate Ion-Selective Electrodes  
   Go Direct Nitrate ISE [vernier.com/gdx-no3](http://vernier.com/gdx-no3)  
   Nitrate ISE [vernier.com/no3-bta](http://vernier.com/no3-bta)  
 NXT/EV3 Adapter 75

# O

O<sub>2</sub> gas sensors  
   Go Direct O<sub>2</sub> Gas 34  
   O<sub>2</sub> Gas Sensor 37  
 OHAUS® Balances 58  
 Optical DO probes  
   Go Direct Optical Dissolved Oxygen 34  
   Optical DO Probe 37  
 Optical fibers 137  
 Optics accessories 124–125  
*Organic Chemistry with Vernier* 63  
 ORP sensors  
   Go Direct ORP 52  
   ORP Sensor 56

# P

Packages [vernier.com/packages](http://vernier.com/packages)  
 PAR Sensor 38  
 pH Buffer Capsules 136  
 pH sensors  
   Glass-Body pH Electrode BNC 56  
   Go Direct Glass-Body pH 52  
   Go Direct pH 52  
   Go Direct Tris-Compatible Flat pH 52  
   pH sensor 56  
   Tris-Compatible Flat pH Sensor 38  
 pH Storage Solution 136  
 Photogates  
   Go Direct Photogate 110  
   Photogate 118  
 Physical Chemistry 60  
*Physical Science with Vernier* 105  
*Physics Explorations and Projects* 130  
*Physics with Vernier* 129  
*Physics with Video Analysis* 131  
 Picket Fence 136  
 Pivot Interactives 128  
 Platinum-Cell Conductivity Probe 54  
 PLTW 80  
 Polarimeter (Chemical) 56  
 Polarizer/Analyzer Set 124  
 Potassium Ion-Selective Electrodes  
   Go Direct Potassium ISE [vernier.com/gdx-k](http://vernier.com/gdx-k)  
   Potassium ISE [vernier.com/k-bta](http://vernier.com/k-bta)  
 Power Amplifier 112  
 Power Amplifier Accessory Speaker 121  
 Power (AC) adapters 137

Pressure sensors  
 Go Direct Gas Pressure 51  
 Gas Pressure Sensor 55  
 Pressure Sensor 400 55  
 Primary Productivity Kit [vernier.com/ppk](http://vernier.com/ppk)  
 Professional development  
[vernier.com/workshops](http://vernier.com/workshops)  
 Projectile Launchers  
 Go Direct Projectile Launcher 111  
 Projectile Launcher 120  
 ProScope 5MP Microscope Camera 40  
 ProScope microscopes [vernier.com/proscope](http://vernier.com/proscope)  
 Protoboard adapters 78  
 Pyranometer [vernier.com/pyr-bta](http://vernier.com/pyr-bta)

## Q

Qubit biosystems sensors [vernier.com/qubit](http://vernier.com/qubit)  
*Química con Vernier* [vernier.com/cwv-es](http://vernier.com/cwv-es)

## R

Radiation monitors  
 Go Direct Radiation Monitor 113  
 Vernier Radiation Monitor 127  
*Real-World Math with Vernier* [vernier.com/rwv](http://vernier.com/rwv)  
 Relative Humidity Sensor [vernier.com/rh-bta](http://vernier.com/rh-bta)  
 Renewable energy products 89–91  
*Renewable Energy with Vernier* 93  
 Respiration monitors  
 Go Direct Respiration Belt 35  
 Respiration Monitor Belt [vernier.com/rmb](http://vernier.com/rmb)  
 Returns 142  
 Robotics 75–77  
 Rotary Motion Sensors  
 Go Direct Rotary Motion Sensor 111  
 Rotary Motion Sensor 119  
 Rotary Motion Motor Kit [vernier.com/mk-rmv](http://vernier.com/mk-rmv)  
 Rotational Motion Accessory Kit 119

## S

Salinity Sensor [vernier.com/sal-bta](http://vernier.com/sal-bta)  
 SensorDAQ 79  
 Sensor Carts 114  
 Site license policy 143  
 Software  
 Graphical Analysis 4 app 18–19  
 LabQuest App 13–14  
 LabQuest Viewer 21  
 Logger Lite [vernier.com/logger-lite](http://vernier.com/logger-lite)  
 Logger Pro 3 22–23  
 Spectral Analysis app 20

Thermal Analysis Plus app 126  
 Vernier Structure Class Competition Software 81  
 Video Physics app 21  
 Soil Moisture Sensor 87  
 Solar Energy Exploration Kit 91  
*Solar Energy Explorations* 101  
 Solar panel 91  
 Solar Thermal Exploration Kit 91  
 Sound level sensors  
 Go Direct Sound 113  
 Sound Level Sensor 121  
 Spanish language lab books 27  
 SparkFun RedBoard 78  
 Spectrometers/Spectrophotometers  
 Emissions Spectrometer 127  
 Flash Photolysis Spectrometer 59  
 Fluorescence/UV-VIS Spectrometer 59  
 Go Direct SpectroVis Plus 59  
 Vernier Spectrometer [vernier.com/v-spec](http://vernier.com/v-spec)  
 UV-VIS Spectrometer 59  
 Spectrum Tube Power Supplies 127  
 Spectrum tubes 127  
 Spirometer 38  
 Spirometer accessories 137  
 Stainless Steel Temperature Probe 57  
 STEM with Vernier 132–133  
 Stir Station 58  
 Structures & Materials Tester 81  
 Surface Temperature Sensors  
 Go Direct Surface Temperature Sensors 53  
 Surface Temperature Sensor 57

## T

Technical specifications  
 LabQuest 2 12  
 LabQuest Mini 17  
 LabQuest Stream 16  
 Vernier sensors [vernier.com/manuals](http://vernier.com/manuals)  
 Temperature probes  
 EasyTemp [vernier.com/ez-temp](http://vernier.com/ez-temp)  
 Extra-Long Temperature Probe [vernier.com/tpl-bta](http://vernier.com/tpl-bta)  
 Go!Temp [vernier.com/go-temp](http://vernier.com/go-temp)  
 Go Direct Surface Temperature 53  
 Go Direct Temperature 53  
 Go Direct Wide-Range Temperature 53  
 Stainless Steel Temperature Probe 57  
 Surface Temperature Probe 57

Thermocouple 57  
 Wide-Range Temperature Probe 57  
 Thermocouple 57  
 Time of Flight Pad 120  
 Track/Optics Benches 124  
 Training [vernier.com/training](http://vernier.com/training)  
 Transilluminator [vernier.com/blue-view](http://vernier.com/blue-view)  
 Tris-Compatible pH sensors  
 Go Direct Tris-Compatible Flat pH Sensor 52  
 Tris-Compatible Flat pH Sensor 38  
 Truss Tester Accessory [vernier.com/vsmt-truss](http://vernier.com/vsmt-truss)  
 Turbidity sensor [vernier.com/trb-bta](http://vernier.com/trb-bta)

## U

Ultra Pulley Attachment 136  
 USB Adapters  
 Easy to Go! [vernier.com/mini-usb](http://vernier.com/mini-usb)  
 Go! to Easy [vernier.com/usb-mini](http://vernier.com/usb-mini)  
 USB cables 137  
 USB Digital Microscope 40  
 UV sensors  
 Go Direct Light and Color 112  
 UVA Sensor [vernier.com/uva-bta](http://vernier.com/uva-bta)  
 UVB Sensor 66  
 UV-VIS Spectrophotometer 59

## V

*Vernier Chemistry Investigations for Use with AP Chemistry* 62  
 Vernier Circuit Board 2 123  
 Vernier Dynamics Cart and Track Systems 114–116  
 Vernier Emissions Spectrometer 127  
 Vernier Energy Sensor [vernier.com/ves-bta](http://vernier.com/ves-bta)  
 Vernier Engineering Contest  
[vernier.com/grants/engineering](http://vernier.com/grants/engineering)  
*Vernier Engineering Projects with LEGO® MINDSTORMS® Education EV3* 75  
 Vernier Fluorescence/UV-VIS Spectrometer 59  
*Vernier Mars Challenge with LEGO® MINDSTORMS® Education EV3* 75  
 Vernier Mini GC Plus 58  
 Vernier Radiation Monitor 127  
 Vernier Resistor Board 88  
 Vernier Spectrometer [vernier.com/v-spec](http://vernier.com/v-spec)  
 Vernier Structures & Materials Tester 81  
 Vernier/NSTA Technology Awards  
[vernier.com/grants/nsta](http://vernier.com/grants/nsta)  
 Vernier UV-VIS Spectrophotometer 59  
 Vernier Variable Load 88

Video Physics app 21  
 Video Training Library [vernier.com/videos](http://vernier.com/videos)  
 Voltage probes  
 30-Volt Voltage Probe [vernier.com/30v-bta](http://vernier.com/30v-bta)  
 Differential Voltage Probe 122  
 Go Direct Voltage 113  
 Instrumentation Amplifier 55  
 Voltage Probe 57

## W

Warranty information 142  
 Water Depth Sampler [vernier.com/wds](http://vernier.com/wds)  
 Water quality bottles [vernier.com/wq-bot](http://vernier.com/wq-bot)  
*Water Quality with Vernier* 93  
 Weather stations 67  
 Webinars [vernier.com/webinars](http://vernier.com/webinars)  
 White paper 5  
 Wide-Range Temperature Probe 57  
*Wind Energy Explorations* 101  
 Workshops [vernier.com/workshops](http://vernier.com/workshops)





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Co-President and Co-Founder



**Verle Walters**

Educational Technology Product Owner and Partnership Manager



# Vernier



## Stellar Service Makes a Measurable Difference

When you're teaching students to collect and analyze scientific data, count on Vernier.

Founded by a science teacher, our company puts student understanding and teacher support first. So when you use Vernier data-collection technology, you always get educator-developed solutions, resources, and support. From professional development and personalized customer service to grant opportunities, online training videos, and more, you'll always find what you need for hands-on experiments and learning.

When science teachers succeed, students succeed—and that makes all the difference.



Innovative  
Technology



Experiments



Technical Support  
Team



Technical  
Information Library



Webinars



Grants



Workshops



Innovative Uses



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Research



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Tech Tip Videos

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*"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."*

—Chris Jessop,  
AKS School, Lytham, United Kingdom

## STEM with Vernier

Digital tools, such as Vernier sensors and graphing and analysis software, enhance STEM curriculum by integrating technology that helps students to visualize data and build critical thinking skills.

### Science

Vernier technology is used in more than 135 countries in biology, biotechnology, chemistry, Earth science, environmental science, physical science, physics, and water quality courses.

### Technology

All Vernier technology—from sensors used in hands-on experiments to technology to test design solutions—supports a robust, engaging STEM education.

### Engineering

The practices of engineering, when combined with Vernier sensors, allow students to identify problems, design solutions, and test those solutions using sensor data.

### Math

Computational thinking, visualizing data, and recognizing patterns are all part of scientific investigations and engineering activities using Vernier sensors and software.

## NEW Human Physiology Solution

The experiments in our new *Human Physiology Experiments* lab book encourage students to think about the physiology of various human organ systems.

### Topics include

- Heart rate and EKG
- Control of respiration
- Muscle action and EMG
- Reflexes
- Aerobic metabolism

See page 43.



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