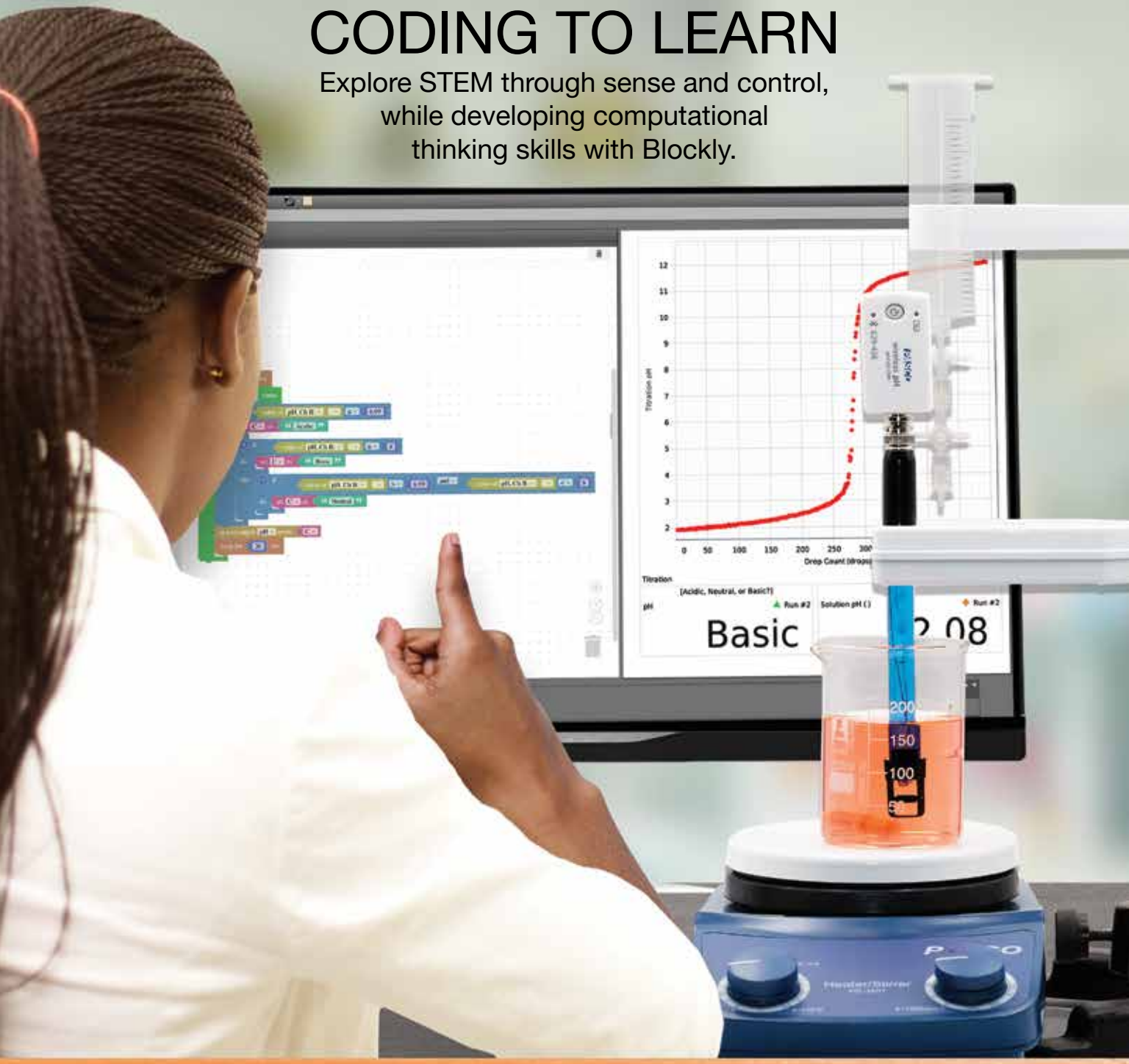
PASCO Science Technology

Biology, Chemistry, Environmental & Physics

2020

CODING TO LEARN

Explore STEM through sense and control, while developing computational thinking skills with Blockly.



Discover classroom-ready technology and explore STEM with interactive sensors, live data, coding, and more.

STEM Solutions

portable

RUGGED

19 environmental measurements

WEATHER-RESISTANT

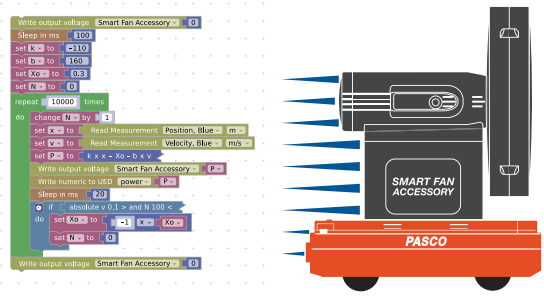
Wireless Weather Sensor with GPS
Collect real-time data or log data over time, including GPS location. Analyze and interpret trends and patterns to construct explanations (see page 61).

SPARKvue 4

Now with Blockly Coding

Redesigned features include Welcome screen, Lab templates, Quick Start labs, and Live Data Bar.

- One click to start a new activity, open a saved experiment, or explore PASCO lab activities
- Save data and camera images to device and cloud
- Explore sense and control with Blockly



Visit Our Brand New Website!

Quickly and easily find the products you want, and order them with ease.

- More resources for teachers
- Enhanced search and product catalog
- New and improved shopping experience

Table of Contents

Discover classroom-ready technology for the exploration of **STEM**. See page 160 for upcoming events in your area.

- Hear and discuss STEM best practices
- Tips for integrating STEM into your school or lab
- Get hands-on with PASCO STEM solutions


wireless temperature
wireless pH
wireless temperature
wireless CO2
wireless conductivity
wireless CO2
CO2 Concentration (ppm)
Temperature (°C)
Periodic: 20 Hz
Start

COMPLETE SCIENCE AND STEM SOLUTIONS

Standards-Based Curricula and Labs
These support K-8 Science, Biology, Chemistry, Physical Science, and Physics, as well as AP® Biology, AP® Chemistry, AP® Environmental Science, and AP® Physics.

Probeware and Sensing Technology Our innovative sensors, including our award-winning wireless sensors, are low-cost, rugged, and easy to use. PASCO now offers more than 25 wireless sensors.

Data Collection Software on Your Devices
Intuitive SPARKvue® works on iOS, Android™, and Chrome™, as well as Mac® and Windows® computers. And SPARKvue now has block-based coding (by Blockly), for sense and control investigations.

Lab Equipment and Apparatus PASCO is the premier developer of tools for your science lab, including our award-winning Smart Cart, EcoZone, EcoChamber, Modular Circuits, Structures bridge kits, our Signature Series Physics apparatus, and more.

Professional Development Our PD is relevant for teachers at all grade levels, is fully customizable, and includes ongoing teacher support. You can also take advantage of a wealth of training videos at pasco.com.

SPARKvue® 4 Software

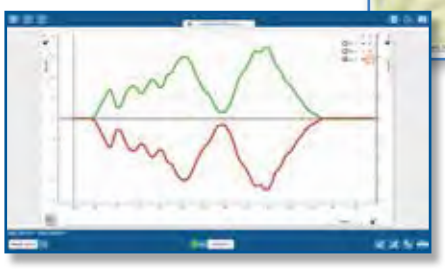
Award-winning data collection and analysis software for any platform

SPARKvue's intuitive design has made it an award-winning tool for collecting and analyzing experimental data. The user-friendly platform optimizes data collection and provides tools for in-depth analysis to provide students with a compact, yet powerful workspace. With the recent release of SPARKvue 4, we've added new features, including a new Welcome screen and Blockly coding. Now, students can use block-based code to sense and control PASCO devices, including any of our wireless sensors.

Designed for All Sciences

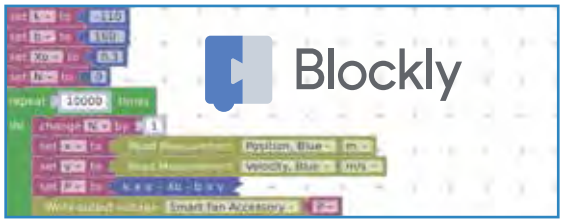
Collect data in real time using PASPORT or wireless sensors.

SPARKvue comes installed on every SPARK LXi.



SPARKvue includes interactive data displays that are specific to your activity.

Data Collection:

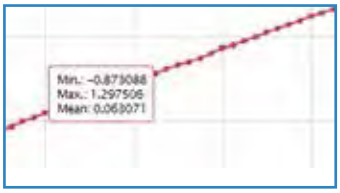


- **Live Data Bar:** See sensor readings before recording
- **Periodic sampling:** Automatic sampling at a fixed rate
- **Manual sampling:** Saves data only when a user specifies
- **Blockly:** Adds coding plus sense and control functions
- **Collaborate:** Start a shared session and stream results in real-time

Data Displays:

- Graph displays with multiple plot areas and axes
- Digits
- Meter
- Data tables
- FFT
- Map Display
- Weather Dashboard
- Oscilloscope

Tools for Data Analysis:



- **Scale-to-fit:** Adjust axis for optimal data view
- **Data Selection:** Easily select a portion of data for analysis
- **Prediction Tool:** Visualize a prediction alongside the data
- **Smart Tool:** Find data coordinates & calculate delta values
- **Calculation Tools for Statistics:** Easily obtain statistics such as minimum, maximum, mean values and more
- **Slope Tool:** Find the slope of a curve at a specific point
- **Curve Fits:** Various curve fits with goodness of fit values
- **User Annotation:** Easily add text notes to runs or points
- **Axes:** Add another *y*-axis or a new plot with one button

SPARKvue Resources:

- Video Library: 330+ free videos featuring SPARKvue
- PASCO Blog: Dozens of fun applications for SPARKvue
- Experiment Library: 80+ free and downloadable SPARKvue labs
- FREE webinar training from PASCO professionals on our website
- On-site Workshops: Personalized professional development
- Visit **www.pasco.com/training-and-events** for more information

Try SPARKvue software for FREE. Get Started Today!

The complete version of SPARKvue is now available as a FREE app for iPad® and Android™ tablets, Chromebook™, as well as free apps for iPhone and Android phones.

Download on the App Store | Available in the Chrome Web Store | ANDROID APP ON Google play

We also offer free 60-day trials for Windows™ and Mac®*.
Visit www.pasco.com/downloads

Cross-Platform Compatibility

SPARKvue (single user license)

PS-2401 PS-2401-DIG

Windows® and Mac®

SPARKvue (site license)

PS-2400 PS-2400-DIG

Windows® and Mac®

Essential Chemistry and *Essential Physics*

Complete Curriculum Solutions

The *Essential* curriculums are the only curricular solutions that include a Student Textbook, an e-Book, Teacher e-Resources, and award-winning equipment kits. These 3-D STEM curriculums include a full year of curricular core topics for both General and Honors courses. Each program is dynamically designed to be used as a primary curricular source, or it can be integrated into your existing curriculum.

Essential lessons follow the 5E model and include tools for ELL students, as well as tools for students with different learning styles. The programs include animations, videos, interactive equations and simulations, and more tools that increase student engagement and understanding. *Essential Chemistry* features innovative learning tools such as a chemical equation solver, 3-D molecular modeling, and interactive simulations. Similarly, *Essential Physics* includes specialized learning tools including sensor-based lab activities, embedded animations and simulations, and more than 30 videos.

Essential curricular solutions engage students through interactive learning tools and hands-on investigations that reinforce connections to NGSS and state standards. Contact your local PASCO representative to discover how an *Essential* curriculum can change your classroom.

Essential Chemistry

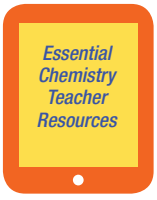
Student Textbook

EC-6350

Student e-Book

5-year access
EC-6350-EB5

1-year access
EC-6350-EB1

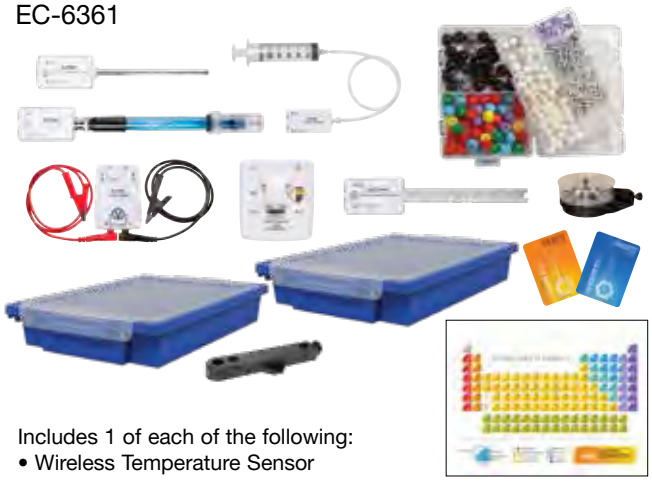


Teacher Resources

EC-6351-DIG
(digital only)

Essential Chemistry Standard Equipment Kit

EC-6361



Includes 1 of each of the following:

- Wireless Temperature Sensor
- Wireless pH Sensor
- Wireless Conductivity Sensor
- Wireless Pressure Sensor
- Wireless Voltage Sensor
- Wireless Colorimeter and Turbidity Sensor
- Molecular Model Set
- Electrode Support
- Condenser
- Periodic Trend Cards
- Spectrum Cards
- Periodic Table
- Gratnells® Storage Case (2)

This equipment kit supports 47 labs. The other labs in the textbook can be performed using typical equipment found in your chemistry lab.

See pages 36-41 for more *Essential Chemistry* information.

Essential Physics

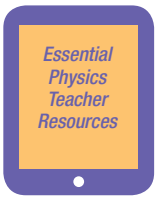
Student Textbook

EP-6323

Student e-Book

5-year access
EP-6323-EB5

1-year access
EP-6323-EB1



Teacher Resources

EP-6324-DIG
(digital only)

Comprehensive Physics Equipment Kit

EP-6490A

This comprehensive kit includes:

- Forces & Motion Kit
- Simple Machines Engineering Kit
- Oscillations, Waves & Sound Kit
- Light, Color & Optics Kit
- Essential Physics Modular Circuits Kit
- Additional Red Smart Cart
- Mini Launcher, Clamp & Rod
- One 1.2 m Metal Dynamics Track
- Two Tripod Stands

Each kit includes a Gratnells® Storage Tray.

Also available:

Standard Physics Equipment Kit EP-3567A

Includes:

Forces and Motion Kit:

- Wireless Smart Cart
- 1.2 m Track
- Dynamics Accessories

Modular Circuits Kit:

- Wireless Current Module
- Wireless Voltage Sensor
- Circuits Modules
- Circuits Accessories

See pages 72-77 for more *Essential Physics* information.

Call your PASCO Education Specialist for more info:
800-772-8700 (inside US) or **916-462-8383** (outside US).

SPARK LXi

PASCO's NEXT GEN SCIENCE DATALOGGER for the lab and field

Thls innovative science handheld device blends PASCO probeware with SPARKvue data collection and analysis software. It is durable, splash-proof, and works seamlessly with our PASPORT and wireless sensors.

- Ruggedized case for indoor/outdoor and wet/dry lab use
- 8.0" full-color touchscreen
- Simultaneously connects up to 5 wireless sensors
- Includes 2 PASPORT ports
- Includes Voltage Probe and port
- Includes Temp Probe and port
- Can connect more PASPORT sensors with the AirLink, SPARKlink Air, and 550 Universal Interface
- Installed software: PASCO SPARKvue, MatchGraph!, Spectrometry, Microsoft Office Suite, Google Suite
- Hands-free stand

SPARK LXi

PS-3600A

Use with wired and wireless sensors, the SPARK LXi can simultaneously accommodate up to five wireless sensors. It also includes two ports for blue PASPORT sensors, plus two ports for the included Fast Response Temp Probe and the Voltage Probe.

SPARK LXi Charging Station

PS-3602

This convenient charging station has a wire rack to hold the dataloggers and multiple charging cables, so a complete set of six SPARK LXi dataloggers can be charged from one power connection to the wall. The charging station is built into a Gratnells® case (size F3).

Dimensions:
312 x 427 x 300 mm

PASCO's Hands-on Solutions for K–8 Science

At PASCO, we develop STEM solutions so simple and accessible that even the youngest scientists can use them. Our wireless sensors and experiment solutions are the perfect way to introduce K–8 students to inquiry-based discovery learning, without overwhelming them. With our NGSS-based solutions, students of all ages are engaged in the active learning process as they navigate their way through hands-on exercises that form lasting STEM foundations.

K–8 Index

Essential K–5 Science Teacher Lab Manual

This teacher lab manual contains 10 labs that introduce students to the world of science using data collection and analysis and PASCO sensors. The labs cover topics such as heat, temperature, the greenhouse effect, and more. This manual is available in an all-digital version and a print version.

Essential K–5 Science Teacher Lab Manual

PS-6333-DIG (digital)

PS-6333 (print)

Includes lab prep instructions, expected answers/results, and editable student files. Manual is available in eco-friendly digital format or in print.

Essential K–5 Science Labs and Sensors Used

Lab Title	Temperature	Light	Weather with GPS
1. Physical and Chemical Changes	●		
2. Conservation of Mass	●		
3. Thermal Insulators and Conductors	●		
4. How a Greenhouse Works: Heat	●		
5. Can Plants Survive Without Light and Water?		●	
6. How a Greenhouse Works: Light		●	
7. Weather: Investigating Humidity			●
8. Weather: Investigating Barometric Pressure			●
9. Weather Station Creation			●
10. What Is a Meteorologist?			●

Elementary School Sensor Bundle

PS-3308C

1. Wireless Temperature PS-3201
2. Wireless Light PS-3213
3. Wireless Weather with GPS PS-3209

Wireless Temperature Sensor

winner! 2016 AWARDS OF EXCELLENCE TECH & LEARNING

Use this sensor to investigate:

- Heating and cooling
- What is the temperature?
- Phase changes
- Insulators and conductors

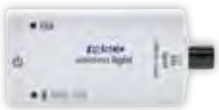
This wireless sensor is long-lasting and easy to use. Use it to explore temperature changes, to observe the property of temperature, and to learn that temperature is a measure of how hot or cold something is compared to a standard scale.

Wireless Temperature Sensor

PS-3201

Includes 1 coin cell battery.

Wireless Light Sensor



Students can use this durable and easy-to-use light sensor to compare how organisms, including humans, are able to see. Then they can compare that information to what an electronic light sensor can detect.

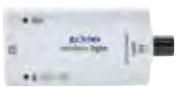
Use this sensor to investigate:

- Properties of light
- Light and heat
- Night and day
- Seasons

Wireless Light Sensor

PS-3213

Includes 1 coin cell battery.



See all our FREE Elementary Science labs in the PASCO Digital Library at pasco.com

Wireless Weather Sensor with GPS

Use this sensor to investigate:

- Water cycle
- Weather
- Humidity
- Barometric pressure

Students can use this durable and easy-to-use weather sensor to show that clouds in the sky have properties that can be observed and described. Then they learn to associate cloud formations with specific weather conditions such as temperature and humidity.

Wireless Weather Sensor with GPS

PS-3209

Includes USB charging cable.

Also available:

Weather Vane Accessory
PS-3553

Wireless Motion Sensor + FREE MatchGraph! Software

Use this sensor to investigate:

- Position and velocity graphing in real time using MatchGraph software
- Kinematics, conservation of momentum, and kinetic energy using dynamics carts
- Ocean-floor mapping
- Objects in freefall
- Oscillations

PASCO's Wireless Motion Sensor is an excellent tool to use to measure motion, and it is compatible with all PASCO dynamics tracks!

MatchGraph!™

Download the free app

for Mac®, Android™, and Windows® computers at pasco.com. Or download the free iPad app on the App Store.

Download on the App Store

Wireless Motion Sensor

PS-3219

Recommended:

MatchGraph! Software

Essential Middle School Science Teacher Lab Manual

This teacher lab manual contains 15 labs for Middle School Science that will introduce students to the world of science using data collection and analysis and PASCO sensors. The labs cover life, earth, and physical science topics such as ecosystems, water quality, pressure and volume, and more. This manual is available in an all-digital version and a print version.

Essential Middle School Science Labs and Sensors Used

Lab Title	Temperature	pH	CO_2	Weather with GPS	Smart Cart
1. Describing Ecosystems		●		●	
2. Photosynthesis			●	●	
3. Exercise and the Body			●		
4. Carbon Cycle			●		
5. Waste and Composting	●		●		
6. The Living Atmosphere*			●	●	
7. Night and Day				●	
8. The Changing Seasons	●			●	
9. Water Quality	●	●	●		
10. The Greenhouse Effect	●		●		
11. Keeping Cool	●				
12. Inertia					●
13. Energy's Changing Forms					●
14. Pressure and Volume				●	
15. Acid Rain		●			

**Also requires Wireless O_2 Sensor, below.*

Essential Middle School Science Teacher Lab Manual

PS-6332-DIG
(digital)

PS-6332
(print)

Includes lab prep instructions, expected answers/results, and editable student files. Manual is available in eco-friendly digital format or in print.

Wireless Middle School Science Sensor Bundle

PS-3307C

1. Wireless Temperature PS-3201
2. Wireless pH PS-3204
3. Wireless CO_2 PS-3208
4. Wireless Weather with GPS PS-3209
5. Wireless Smart Cart ME-1240

More Wireless Sensors for Middle School Science

Wireless Force Acceleration Sensor

PS-3202

Includes 1 eye bolt, 1 thumb screw, 1 bumper, a lithium-ion battery, and a USB connector.

Capable of measuring force, acceleration, and rotation, this sensor is ideal for experiments involving Newton's Laws. The wireless design offers improved measurements without a cable affecting experiment outcome. Finger-holes support handheld applications, or mount it onto a cart or rod.

Wireless Oxygen Gas Sensor

PS-3217

Includes USB charging cable, 250-mL sampling bottle

The Wireless Oxygen Gas Sensor is accurate and easy to use, which makes it the perfect sensor to study photosynthesis, respiration, and oxygen cycling in the environment. With remote logging, simultaneous measurement of humidity and temperature experiments can go beyond the lab period and easily give students hours or days of data for analysis.

Wireless Hand-Grip Heart Rate Sensor

Using the new wireless Hand-Grip Heart Rate Sensor, it's easier than ever before to conduct physiology labs on homeostasis or the cardiovascular system. Use this sensor for a quick and easy way to acquire wireless measurement for either continuous monitoring or initial vs. final data points. When the activity requires students to use their hands, the Wireless Exercise Heart Rate Sensor has a chest strap and will transmit data wirelessly up to 10 m away!

Wireless Hand-Grip Heart Rate Sensor

PS-3206

Includes hand-grips and Bluetooth® Heart Rate Module with one coin-cell battery.

Wireless Light Sensor

Makes all these measurements:

- Illuminance (lux)
- UVA, UVB, and UV Index
- RGB color detection

This wireless sensor is a great tool for explorations in Earth, Life, and Physical sciences. With its ambient light detector for illuminance and UV, and its directional detector for colors, your students can explore the electromagnetic spectrum, model planetary motion, and relate photosynthesis to light color and intensity.

Wireless Light Sensor

PS-3213

Includes 1 coin cell battery.

Wireless Colorimeter and Turbidity

The Wireless Colorimeter can measure absorbance and transmittance at six different wavelengths. Each wavelength represents a region of the ROYGBV color wheel. Measure the colors of a solution to introduce the principles of spectroscopy, relate absorbance to concentration, and study reaction rates. The colorimeter also functions as a turbidimeter for water quality analysis by measuring the scattering effect of suspended particles.

Wireless Colorimeter and Turbidity

PS-3215

Includes 10 cuvettes, 1 turbidity calibration standard (100 NTU), 2 cuvette racks, and USB charging cable.

Also available:

Spectrometer/Colorimeter Cuvettes SE-8739

Wireless Pressure Sensor

Using a Wireless Pressure Sensor, students can create a model lung by attaching a syringe to the Metabolism Chamber. Pushing or pulling on the syringe changes the volume of the model's "chest cavity." Students can then measure the changes in air pressure inside the model "lung" and create a graph of their results to fully explore how we breathe.

Wireless Pressure Sensor

PS-3203

Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barbed luer locks, 1 female barbed luer lock, 1 60cc syringe, a lithium-ion battery, and a USB connector.

Building Better Bridges Kit

Middle School science students learn engineering concepts when they use this complete STEM bridge-building kit.

Now is the perfect time for your students to learn about bridge-building and how bridges really work. This complete STEM kit allows students to learn and apply engineering design concepts. They can use the I-Beams to build bridges and structures that behave like the real thing! And with the included new Wireless Load Cell, students can measure forces under tension or compression anywhere on their structures.

Students can perform the following lab investigations using PASCO's Building Better Bridges Kit.

- Measuring Forces
- Equilibrium of Forces
- Equilibrium of Rotation
- Forces in Trusses
- Forces in Bridges

Kit is compatible with PASCO Structures System.

Building Better Bridges Kit

ME-3581

Includes Lab Activities, Wireless Load Cell (with Bluetooth® Low Energy), I-Beams (various sizes), Connectors, Truss Screws, Weight Set, a Gratnells® Case and more

Want another Load Cell?

Wireless Load Cell PS-3216

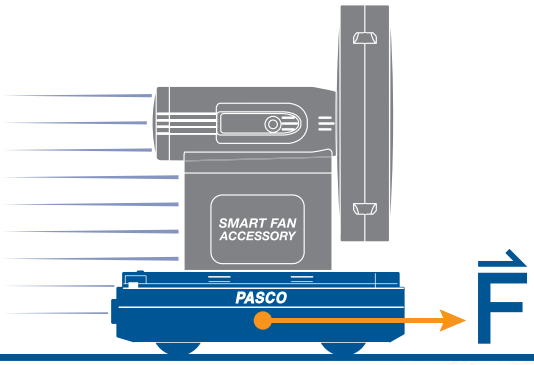
Blockly Coding Helps Middle School Students Develop Computational Thinking Skills

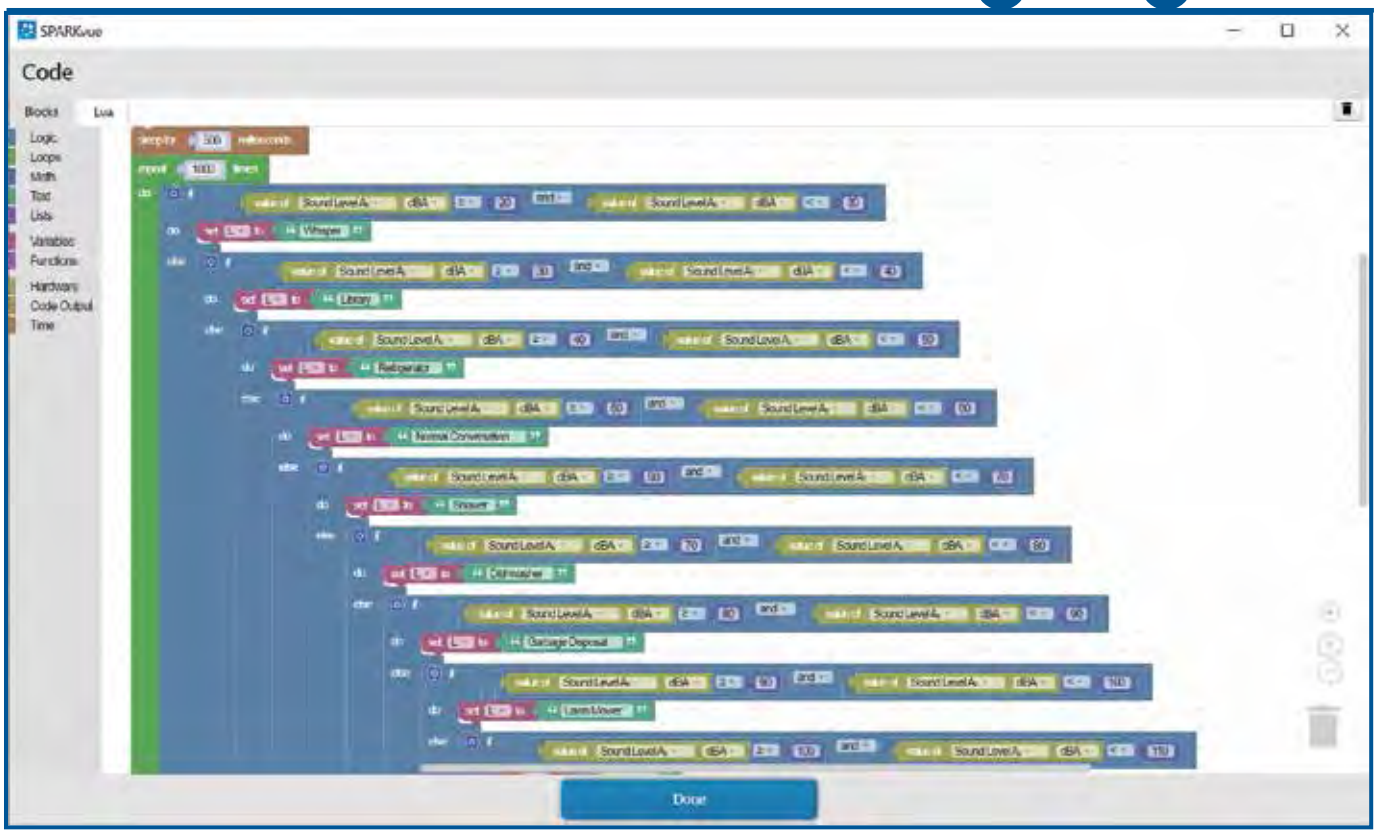
Introducing students to coding and computer-controlled outcomes is easier than ever before with Blockly coding. Included in the latest update of SPARKvue, Blockly gives students a new world of experimental opportunities that focus on computational thinking and data visualization. Blockly's visual coding environment is intuitively designed to facilitate the success of new coders, while strengthening the skills of more advanced students.

Blockly's colored coding blocks provide students with a visual method for developing critical coding foundations. The user-friendly design allows students to simply drag and connect coding blocks that correlate with syntactically correct coding elements such as variables, commands, and loops. Students can use Blockly to control PASCO output devices, determine data outputs, and monitor their code execution in real time. Using their own code, students can maneuver a Smart Cart, set data collection parameters for a Wireless CO_2 Sensor, or design and execute their own experiment.

With Blockly and SPARKvue in your lab, you and your students can:

- Apply coding concepts to your labs
- Design sense and control experiments
- Create whatever experiment you can dream up!





PASCO's Hands-on Solutions for Your Biology Lab

PASCO offers dynamic educational solutions for General, AP®, IB®, and Honors Biology courses. Our Wireless Sensors facilitate hands-on engagement and help students develop data analysis skills, while our labs provide inquiry-based planning support. Using PASCO's SPARKvue software, sensors, and lab experiments, students can deeply explore topics such as photosynthesis, cellular respiration, enzyme reactions, human physiology, spectrometry, and more.

Biology Index

World Class Support & Professional Development

Committed to Your Success

We want you to have all the support, guidance, and training you need. Just let us know how we can help.

For more details, see page 158.

CONTACT US TODAY
pasco.com

The latest sensors for Biology!

Wireless CO_2 Sensor

PS-3208 *(page 21)*

Includes 250-ml sampling bottle and USB charging cable.

Use this wireless sensor to measure the concentration of CO_2 gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO_2 data can be logged directly on the device for long-term life science and environmental science studies.

Wireless Weather Sensor with GPS

PS-3209 *(page 22)*

Includes USB charging cable.

Use this multimeasure sensor to monitor 19 different measurements including common weather, location, and light. Study microclimates, monitor environmental conditions during indoor or outdoor labs, or place the sensor outside for extended monitoring, because of its durable, water-resistant design and internal memory.

Wireless Optical Dissolved Oxygen Sensor

PS-3224 *(page 27)*

Includes USB charging cable

The Wireless Optical Dissolved Oxygen (DO) Sensor is the perfect solution to monitor DO in the lab or the field. Optical technology is accurate, fast, and does not require flow or calibration. With built-in memory, you can log data for hours or days to capture day/night nutrient cycles and changes in metabolic processes. With the included cover, the sensor has a fully waterproof design and is submersible to 10 m.

Wireless Oxygen Gas Sensor

PS-3217 *(page 28)*

Includes USB charging cable, 250-mL sampling bottle

The Wireless Oxygen Gas Sensor is accurate and easy to use, which makes it the perfect sensor to study photosynthesis, respiration, and oxygen cycling in the environment. With remote logging, simultaneous measurement of humidity and temperature experiments can go beyond the lab period and easily give students hours or days of data for analysis.

Wireless pH Sensor

PS-3204 *(page 23)*

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Instantly collect pH data with this wireless sensor. Use the probe to test household solutions, perform high-resolution acid-base titrations, investigate the chemistry of buffers, or study water quality.

Wireless Pressure Sensor

PS-3203 *(page 24)*

Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barbed luer locks, 1 female barbed luer lock, 1 60cc syringe, a lithium-ion battery, and a USB cable.

With the Wireless Pressure Sensor you can make accurate and consistent measurements of gas pressure, and explore transpiration, enzyme activity, osmosis and more!

Advanced Biology Through Inquiry Labs for AP® & IB®

PASCO's award-winning Advanced Biology through Inquiry Teacher Guide is newly revised and contains 18 labs that have been specifically designed to support student inquiry, as well as AP® and IB® curriculum*. This manual is available in a print version and an all-digital version.

- Most labs can be completed in one lab session with readily available materials, including the Biology Extension Bundle on the opposite page.
- Easy and meaningful data collection leads to increased time for data analysis and open inquiry.
- Labs integrate high-order analysis and synthesis questions.
- Includes sample data for investigations and inquiry, answers to analysis and synthesis questions, an assessment rubric, teacher tips and lab preparation information, and more.
- The flexible format provides guided-inquiry opportunities and scaffolding, so students can create their own experiments.

  Structured format includes step-by-step procedure, questions, and analysis.

  Guided format presents a set of questions that help students design a lab and organize their planning process.

  Open format includes Student Experiment Planning worksheet to organize, plan, and enable quick teacher assessment.

Advanced Biology Through Inquiry Labs and Sensors Used

Lab Title	Starter Bundle				Extension Bundle				AP® Big Ideas*	IB® Standards**
	Temp Link	CO_2	Pressure	pH	Weather with GPS	Conductivity	Colorimeter	EcoChamber		
1A. Enzyme Activity			●						1, 2, 4	2.5
1B. Enzyme Activity**									1, 2, 4	2.5
1C. Enzyme Activity***									1, 2, 4	2.5
2. Diffusion				●					2	1.4, 10.3
3. Osmosis							●		2, 3	1.4
4. Plasmolysis						●			2	1.4
5. Cell Size						●			1, 2	1.1
6. Homeostasis	●								3, 4	N/A
7. Cellular Respiration		●							1, 2, 4	2.8
8. Photosynthesis		●							2, 4	2.9
9. Plant Pigments***							●		2, 4	2.9
10. Transpiration			●		●				2, 4	9.1
11. Mitosis	*No sensors required.*								3	1.6
12. Meiosis									3	3.3, 10.1
13. Energy Dynamics		●						●	2, 4	4.2
14. Artificial Selection	*No sensors required.*								1	N/A
15. BLAST Bioinformatics									1	3.1, B.5
16. Population Genetics									1	10.3
17. Mathematical Modeling of Evolution									1	10.3
18. Animal Behavior									2, 4	A.4

*AP is a registered trademark of the College Board, which was not involved in the production of, and does not endorse, this product. IB is a registered trademark of the International Baccalaureate Organization, which was not involved in the production of, and does not endorse, this product.

**Requires Wireless O_2 Sensor; see page 28.

***Requires the Wireless Spectrometer; see page 26.

Advanced Biology Through Inquiry Teacher Lab Manual

PS-2852A-DIG (digital)

PS-2852A (print)

Includes lab prep instructions, expected answers/ results, and editable student files. Manual is available in eco-friendly digital format or in print.

Biology Solutions

The tools you need to teach your Biology classes, including AP® and IB®

Biology Starter Bundle

PS-7614A

1. Wireless CO_2 PS-3208
2. Wireless Temp Link PS-3222
3. Wireless pH PS-3204
4. Wireless Pressure PS-3203

Biology Extension Bundle

PS-7615B

1. Wireless Weather with GPS PS-3209
2. Wireless Optical Dissolved Oxygen Sensor PS-3224
3. Wireless Conductivity PS-3210
4. Wireless Colorimeter and Turbidity PS-3215*
5. EcoChamber ME-6667

* **WARNING!** This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Physiology Extension Bundle

PS-2935C

1. AirLink PS-3200
2. Wireless Hand-Grip Heart Rate PS-3206
3. EKG Sensor PS-2111
4. Spirometer PS-2152
5. Spirometer Mouth Pieces PS-2522
6. Wireless Blood Pressure PS-3218

Essential Biology Teacher Lab Manual

The 23 labs in this new manual support student inquiry. Most labs in this collection can be completed in one class session with readily available materials and the sensors below. The manual covers general biology topics such as respiration, photosynthesis, transpiration, water quality, and more. This new lab manual has been designed to optimize wireless sensor technology. It is available in both a print version and an all-digital version.

Essential Biology Through Inquiry Labs and Sensors Used

Lab Title	Starter Bundle				Extension Bundle					Physiology Extension Bundle				
	Temp Link	CO_2	Pressure	pH	Weather with GPS	Optical Dissolved Oxygen	Conductivity	Colorimeter	EcoChamber	Hand-Grip Heart Rate	EKG	Spirometer	Blood Pressure	AirLink
1A. Enzyme Action (Oxygen)*														
1B. Enzyme Action (Pressure)			●											
2. Membrane Permeability				●										
3. Organisms and pH				●										
4. Osmosis			●											
5. Plant Respiration and Photosynthesis		●												
6. Respiration of Germinating Seeds		●												
7. Buffers in Biological Systems				●										
8. Acid Rain				●										
9. Cellular Respiration in Yeast	●					●								
10. Energy Content of Food	●													
11. Metabolism of Yeast		●												
12. Photosynthesis of Aquatic Plants**						●								
13. Soil pH				●										
14. Transpiration			●											
15. Water and pH				●			●							
16. Water Purification				●			●							
17. Weather in a Terrarium					●									
18. EKG: Factors That Affect the Heart											●			●
19. Exercise and Heart Rate										●				
20. Exercise and Blood Pressure													●	
21. Muscle Fatigue			●											
22. Regulation of Body Heat	●													
23. Volume of Breath												●		●

*Requires Wireless O_2 Sensor; see page 28.

**Also requires the Photosynthesis Tank; see page 29.

Essential Biology Teacher Lab Manual

EB-6331-DIG (digital)

EB-6331 (print)

Includes lab prep instructions, expected answers/results, and editable student files. Manual is available in eco-friendly digital format or in print.

Sensor Bundles *(see previous page)*

Biology Starter Bundle
PS-7614A

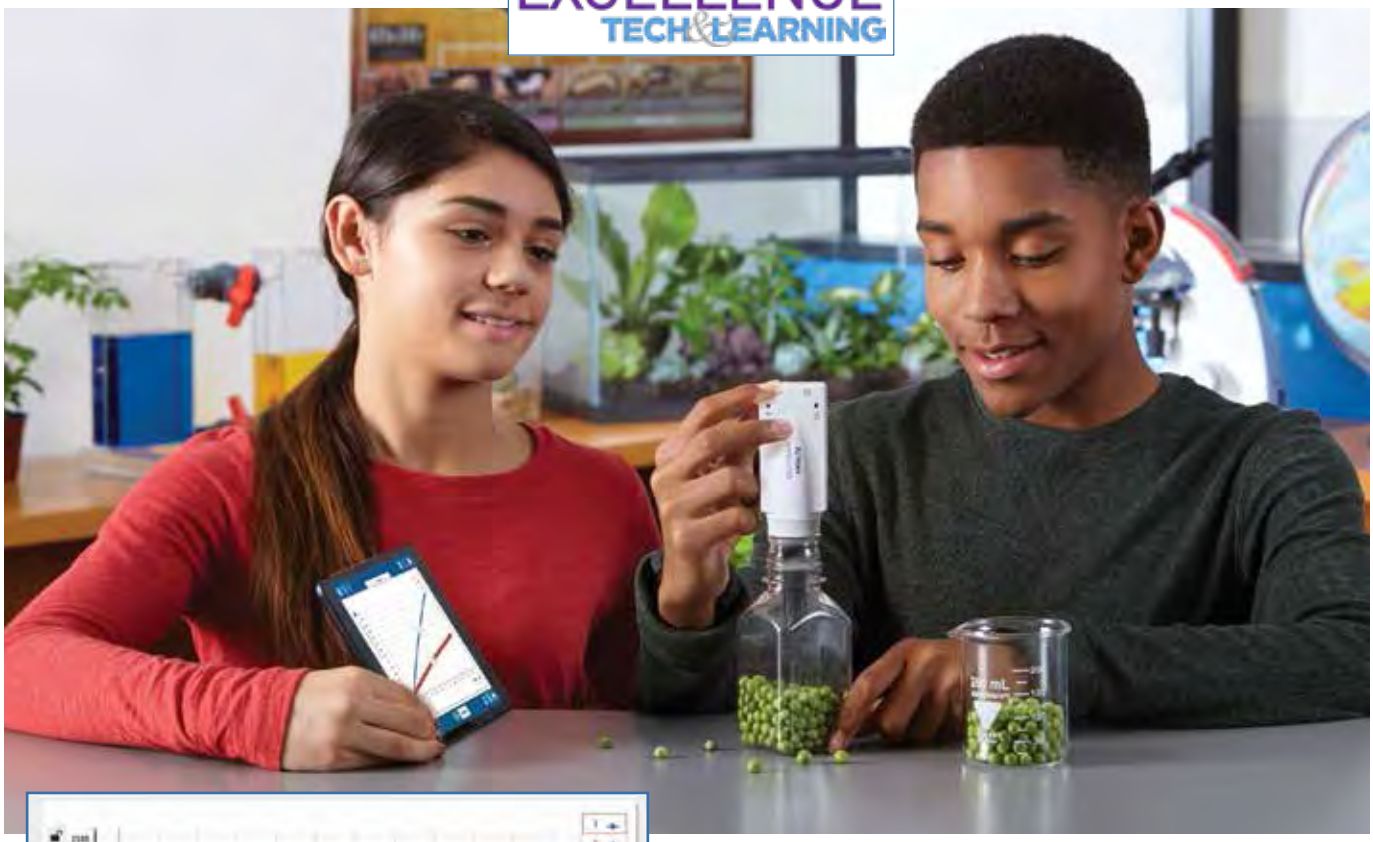
Biology Extension Bundle
PS-7615B

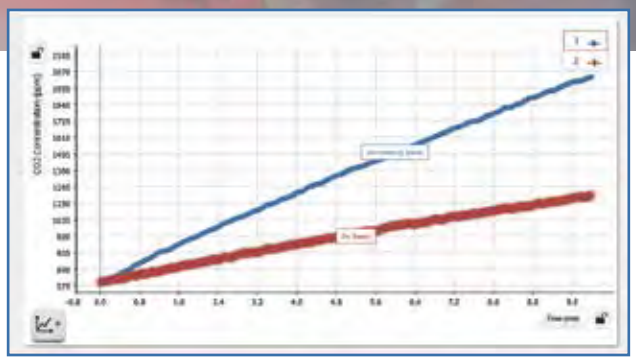
Physiology Extension Bundle
PS-2935C

800.772.8700 (inside US) +1 916.786.3800 (outside US)

Wireless CO_2 Sensor

2017 AWARDS of EXCELLENCE TECH & LEARNING





Compare the respiration rate of germinating and dry seeds.

Use this wireless sensor to measure the concentration of CO_2 gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile sensor. CO_2 data can be logged directly on the device for long-term studies and monitoring.

Wireless CO_2 Sensor

PS-3208

Includes 250-ml sampling bottle and USB charging cable.

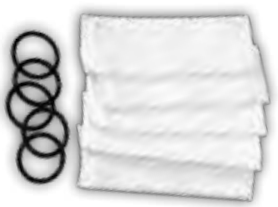
Dissolved CO_2 Waterproof Sleeve

The Wireless CO_2 Sensor can be equipped for aqueous measurements using this semipermeable sleeve. The sleeve is waterproof but allows CO_2 gas to pass through the membrane, creating a headspace around the sensor. Monitor photosynthesis and respiration of aquatic plants or animals with the sample bottle or with other chambers. (Please note: Improper use will void sensor warranty.)

Dissolved CO_2 Waterproof Sleeve

PS-3545

Includes 5 sleeves and 5 O-rings



Wireless Weather Sensor with GPS

Here is an all-in-one instrument for monitoring environmental conditions. By incorporating several sensing elements into a single unit, this wireless sensor provides up to **19 different measurements!** Use it in logging mode with the Weather Vane Accessory for long-term monitoring, or use it as a handheld instrument to study microclimates and record ambient conditions relevant to many biological and environmental phenomena.

Measurements

Weather
1. Ambient Temperature
2. Barometric Pressure
3. Wind Speed
4. Wind Direction (true)
5. Relative Humidity
6. Absolute Humidity
7. Dew Point
8. Wind Chill
9. Heat Stress Index

Light
10. Ambient Light (lux)
11. UV Index
12. PAR
13. Irradiance

GPS
14. Latitude
15. Longitude
16. Altitude
17. Speed
18. Magnetic Direction
19. True Direction

Specifications:
Battery: Rechargeable lithium polymer
Please see pasco.com for detailed specifications.

Weather Vane Accessory

Includes tripod, tripod adapter, and weather vane.

Equip your Wireless Weather Sensor for extended environmental monitoring with the Weather Vane Accessory. Once deployed the sensor will freely rotate to capture wind speed and direction, whether you are monitoring data in real time or using the sensor in logging mode to capture hours (or days!) of data for later analysis.

Wireless Weather Sensor with GPS

PS-3209

Includes USB charging cable.

Weather Vane Accessory

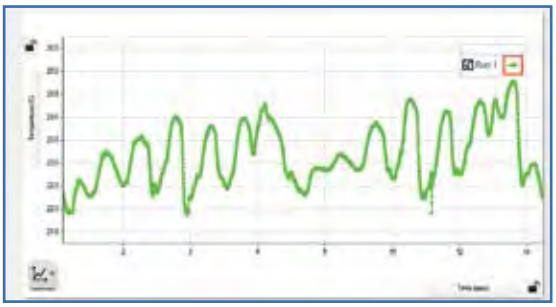
PS-3553

Includes tripod, tripod adapter, and weather vane.

Wireless Temperature Sensor

Welcome to the modern thermometer. With its waterproof, rugged design, this sensor functions in the lab or out in the field. Study evaporative cooling, homeostasis, monitor a water bath, or store weeks of environmental data on the sensor with this one device.

The versatile Wireless Temperature Sensor works well, both in the lab and out of doors.



Monitoring ambient temperature in a classroom terrarium over two weeks with datalogging

Specifications:
Range: -40°C to 125°C
Resolution: 0.05°C
Accuracy: 0.5°C
Waterproof: IP-X7 (1 m for 30 min)
Battery: Coin cell (expected life >1 yr)

Wireless Temperature Sensor

PS-3201

Includes 1 coin cell battery.

Wireless Colorimeter and Turbidity Sensor

The Wireless Colorimeter simultaneously measures the absorbance and transmittance of six different wavelengths. The sensor can be used to study enzyme activity, photosynthesis, and the rates of chemical reactions.

By using the accessory cuvettes and a calibration standard, the colorimeter also functions as a turbidimeter for water quality analysis.

Specifications:

Color detection/peak wavelengths detected: 650 nm (red), 600 nm (orange), 570 nm (yellow), 550 nm (green), 500 nm (blue), 450 nm (violet)
Detector ranges: ±25 nm from peak
Absorbance: 0-3 Abs units; useful range (0.05 -1.5 Abs)
Transmittance: 0-100%
Turbidity range: 0-400 NTU
Accuracy: ±5% NTU

Wireless Colorimeter and Turbidity

PS-3215

Includes USB charging cable, 9 cuvettes, 2 cuvette racks, and one 100 NTU calibration cuvette.

WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Cuvette Rack

EC-3590

A small rack that is used to hold the 3.5 mL cuvettes used with the Wireless Colorimeter and Turbidity. Avoid spills and messes and help organize activities using multiple samples.

Cuvettes and Caps

SE-8739

A set of 100 identical 3.5 mL polystyrene cuvettes (with two clear sides) and caps. Replacement Cuvettes and Caps for the Wireless Colorimeter. Includes 100 cuvettes and 100 caps.

Wireless pH Sensor

Here's the best tool for measuring pH since litmus paper. Students can quickly obtain accurate pH readings but also log data to their connected device and even program the sensor to collect data autonomously for hours or weeks. Use the sensor to study water quality, environmental monitoring, test solutions, and monitor chemical reactions.

Measure the pH in the lab or field.

Specifications:

Range: 0-14 pH units
Resolution: 0.02 pH
Accuracy: 0.1 pH units
Water-resistance: IP-X7 (1 m for 30 min)
Battery: Coin cell (expected life >1 yr)

With the Wireless pH Sensor, students can collect data anywhere!

Wireless pH Sensor

PS-3204

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Electrode Support

PS-3505

Wireless Conductivity Sensor

Use the Wireless Conductivity Sensor to measure the electrical conductivity or Total Dissolved Solids (TDS) of a solution. Investigate diffusion, osmosis, chemical reactions, and monitor water quality.

Specifications:
Range: 0 to 20,000 µS/cm
Accuracy: ±10% of value from 200 µS/cm to 20,000 µS/cm
Resolution: 0.1 µS/cm
Battery: Coin cell (expected life >1 yr)
Waterproof: IP-X7 (1 m for 30 min)
Temperature compensated

Wireless Conductivity Sensor

PS-3210

Includes 1 coin cell battery.

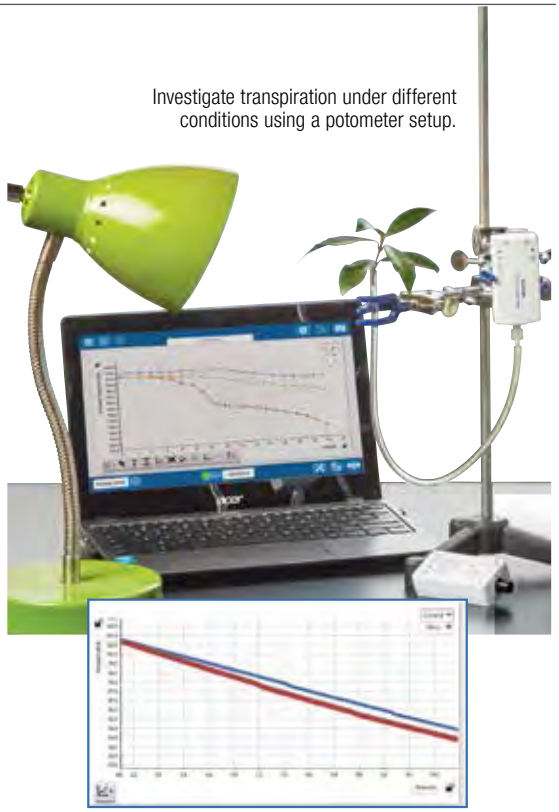
Wireless Pressure Sensor

With the new Wireless Pressure Sensor you can make accurate and consistent measurements of gas pressure, and explore transpiration, enzyme activity, osmosis and more!

Features
- Measures pressure even when the pressure within the system drops below ambient pressure.
- Supports common units (kPa, atm, psi, mmHg, or N/m2) for many applications.
- Features Bluetooth® wireless connectivity and long-lasting rechargeable battery.

Specifications:
Range: 0-400 kPa
Resolution: 0.1 kPa
Accuracy: 2 kPa
Battery: Rechargeable

Investigate transpiration under different conditions using a potometer setup.



Wireless Pressure Sensor

PS-3203

Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barbed luer locks, 1 female barbed luer lock, 1 60cc syringe, a lithium-ion battery, and a USB cable.

Wireless Light Sensor

The Wireless Light Sensor is a great addition to any biology lab to study the relationship between light intensity or color and photosynthetic activity, transpiration, or investigate UV radiation. This single sensor has two different detectors for a variety of applications and measurements: Spot Detector (measures red, green, blue, and white relative intensities) and Ambient Detector (measures Illuminance/lux, UVA, UVB, UV Index, solar PAR, and solar irradiance).

Specifications:

Spectral response: 300 nm to 1100 nm
Range: 0–130,000 lux
Battery: Coin cell (expected life >1 yr)

Monitor light conditions when investigating photosynthesis, transpiration, and more!

Wireless Light Sensor

PS-3213

Includes 1 coin cell battery.

Wireless Hand-Grip Heart Rate and Exercise Heart Rate Sensors

Using the new wireless Hand-Grip Heart Rate Sensor, it's easier than ever before to conduct physiology labs on the cardiovascular system or homeostasis. Use this sensor for a quick and easy way to acquire wireless measurement for either continuous monitoring or initial vs. final data points. When the activity requires students to use their hands, the Wireless Exercise Heart Rate Sensor has a chest strap and will transmit data wirelessly up to 10 m away!

Wireless Hand-Grip Heart Rate Sensor

PS-3206

Includes hand-grips and Bluetooth® Heart Rate Module with one coin-cell battery.

Wireless Exercise Heart Rate Sensor

PS-3207

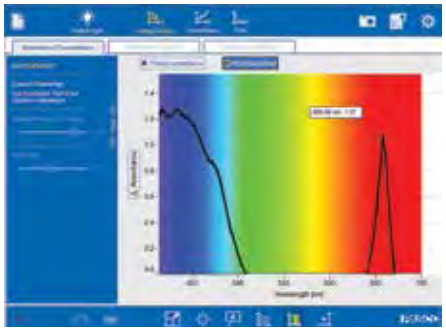
Includes Bluetooth® Heart Rate Module with one coin-cell battery and chest strap (M-XXL).

Award-Winning Wireless Spectrometry

for iOS®, Android™, Chrome*, Windows®, and Mac®

Wirelessly measure intensity, absorbance, transmittance, and fluorescence. The Bluetooth® and USB connectivity enable use with your tablets and computers, which makes this a powerful and intuitive tool for your spectrometry needs.

*Go to **pasco.com/spectrometer** to see our ever-expanding list of supported Chromebooks™.



Absorbance spectrum of chlorophyll

Perform these labs with the PASCO Spectrometer:

- Photosynthesis with DPIP
- Absorption spectra of plant pigments
- Concentration of proteins in solution
- Rate of an enzyme-catalyzed reaction
- Growth of a cell culture

Specifications:

- Bluetooth® and USB connectivity
- 2–3 nm FWHM resolution
- 380–950 nm range
- 2 fluorescence excitation wavelengths at 405 nm and 500 nm
- LED-boosted tungsten light source

winner! 2016 AWARDS of EXCELLENCE TECH & LEARNING

//CODiE// 2017 SIIA CODiE WINNER

bett AWARDS 2017 FINALIST

The Wireless Spectrometer comes with **PASCO's award-winning spectrometry software.**

- Free software for iOS, Android™, and Mac®.
- Will run on Chromebooks™ with Google Play store.
- Designed specifically for introductory spectrometry experiments.

Wireless Spectrometer

PS-2600

Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:

Optional Fiber Optic Cable
PS-2601

Cuvettes & Caps
SE-8739

Cuvette Rack
EC-3590

Wireless Optical Dissolved Oxygen Sensor

The Wireless Optical Dissolved Oxygen (DO) Sensor is the perfect solution to monitor DO in the lab or the field. Optical technology is accurate, fast, and does not require flow or calibration. With built-in memory, you can log data for hours or days to capture day/night nutrient cycles and changes in metabolic processes. With the included cover, the sensor has a fully waterproof design and is submersible to 10 m.

Perform these labs with the sensor:

- Photosynthesis, respiration, and fermentation
- Monitor water quality
- Measure net primary productivity
- Model ecosystems

Specifications:

Bluetooth® and USB connectivity

Response Time: 90% in 25 sec

Operating Temperature: 0–50°C

Range: 0–20 mg/L or 0–300% saturation
Reports solution temperature and ambient pressure

Accuracy: ±0.2 mg/L or 1% (whichever is greater) with user calibration; ±0.5 mg/L or 3% (whichever is greater without user calibration; >200% saturation ±10%

Wireless Optical Dissolved Oxygen Sensor

PS-3224

Includes USB charging cable

Wireless Optical Dissolved Oxygen Metal Guard

PS-3604

This stainless steel metal guard has been designed to protect the sensor cap and make the sensor sink. It threads easily onto the Wireless Optical Dissolved Oxygen Sensor, can withstand use in marine environments, and is strongly recommended for field applications. *(This metal guard is not compatible with our PASPORT Optical Dissolved O_2 sensor.)*

Wireless Optical Dissolved Oxygen Sensor Cap

PS-3605

Here is a replacement sensor cap for the Wireless Optical Dissolved Oxygen Sensor. It includes a calibration coefficient. *(This sensor cap is not compatible with our PASPORT Optical Dissolved O_2 sensor.)*

Wireless Temp/pH/Conductivity Sensor Storage Trays

Make lab management easy and efficient with PASCO's Wireless Sensor Storage Trays. Each Gratnells® tray stores up to 10 wireless sensors; sensors sold separately.

Wireless Sensor Storage Trays for:

Temperature/pH/Conductivity Sensors
PS-3585

Pressure Sensors
PS-3586

Colorimeter & Turbidity Sensors
PS-3587

Voltage & Current Sensors
PS-3588

Each storage tray holds up to ten sensors; sensors sold separately.

Also available:
See our complete line of Storage Trays and Rolling Carts on page 148.

Using Gas Sensors to Study Photosynthesis and Respiration

The Wireless CO_2 Sensor (on page 15) and the Wireless Oxygen Gas Sensor are ideal for photosynthesis experiments, respiration, and fermentation. Both provide high resolution and accuracy and are simple to use, not only with the Metabolism Chamber, but also with the EcoZone™ System or your own enclosure.

The study of cellular respiration becomes richer when students directly measure both carbon dioxide gas and oxygen gas data and see the relationship graphed in real time.

See all the details about the Wireless CO_2 Sensor on page 15.

Wireless Oxygen Gas Sensor

The Wireless Oxygen Gas Sensor is accurate and easy to use, which makes it the perfect sensor to study photosynthesis, respiration, and oxygen cycling in the environment. With remote logging, simultaneous measurement of humidity and temperature experiments can go beyond the lab period and easily give students hours or days of data for analysis.

Wireless Oxygen Gas Sensor

PS-3217

Includes USB charging cable, 250-mL sampling bottle

Also available:

Wireless O_2 Replacement Sensor PS-3606

Wireless CO_2 Sensor

PS-3208

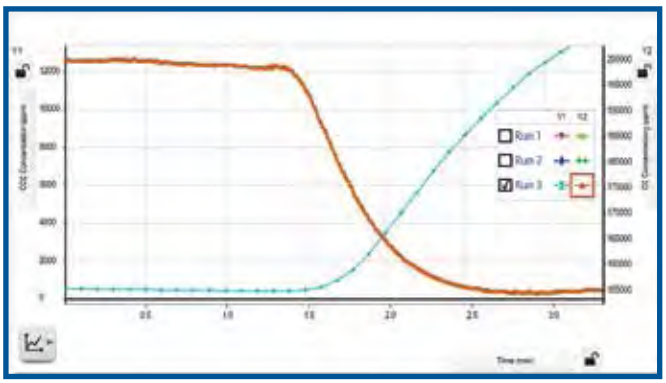
Includes 250-ml sampling bottle and USB charging cable.

Also available:

Dissolved CO_2 Waterproof Sleeve PS-3545

Get the full picture on cellular respiration.

Because of their small size, germinating peas are ideal to use to study cellular respiration. To give a full representation of the activity of the peas, both a CO_2 Sensor and an Oxygen Gas Sensor will be used. The resulting graphs will be analyzed by students who can then explain the changes in the concentrations of each gas.



Use the Metabolism Chamber to study cellular respiration and monitor CO_2 and O_2 simultaneously.

Ethanol Sensor

PS-2194

Includes PTFE tape for membrane replacement.

Make all your sensors wireless.

AirLink

PS-3200

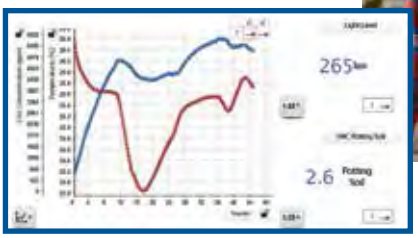
Includes one PASPORT sensor port, USB and Bluetooth connectivity, and USB cable.

EcoZone™ System

Create and monitor your own ecosystems.

The PASCO EcoZone™ System consists of three chambers that can be interconnected or used independently. Because the system remains closed and is designed to accommodate PASCO sensors, students will collect accurate data with minimal impact on the ecosystem.

Use the traditional terrestrial, aquatic, and decomposition arrangement to create your unique ecosystem and collect the data you want. The openings within the chambers allow air to circulate between the chambers, and the included cord efficiently wicks water and ions between the chambers.



Students observe carbon cycling in the EcoZone, which is taking place through photosynthesis, decomposition, and respiration.

Features

- Connect three chambers to model interactions between environments (e.g., terrestrial, aquatic, and decomposition chamber).
- Add small animals such as insects or annelids to see how nutrient cycling is altered.
- Outfit each chamber with three (or more!) sensors.
- Here's an excellent way to model nutrient and energy cycling and engage students in inquiry.

EcoZone™ System

ME-6668

Includes 3 EcoChambers, tray, rubber stoppers, syringe, plastic tubing and wicking cord.

Photosynthesis Tank

With this tank, students can measure the dissolved oxygen content in the environment of an aquatic plant, thereby directly measuring its photosynthetic activity. Water in the outer tank is used to control fluctuations. Turning the light on and off creates an easily analyzed graph in real-time, showing the relationship between light and the rate of oxygen production. Students can further their understanding of photosynthetic rates by adding dyes as colored filters.

Photosynthesis Tank

PS-2521B

Includes Photosynthesis Tank, large #14 stopper with sensor ports, and 2 small #3 stoppers.

EcoChamber

The sturdy design of PASCO's EcoChamber makes it a versatile, easy-to-use, easy-to-clean science learning tool. It is an acrylic chamber specially designed to accommodate up to three PASCO sensors so that students can model and understand the workings of an ecosystem. In addition to being used as a fermentation chamber, it can serve to conduct larger scale photosynthesis and respiration experiments.

Metabolism Chamber

ME-6936

Includes 250 mL sampling bottle with cap.

Also available:

250 mL Sample Bottles
4-pack
SE-6938

Includes four 250 mL sampling bottles with caps.

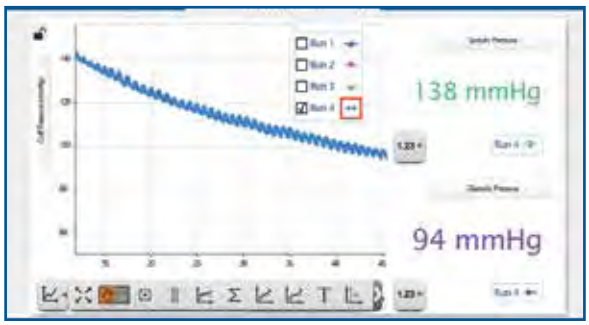
EcoChamber

ME-6667

Includes EcoChamber tank with lid, 7 stoppers of various sizes, 5 probe stoppers, syringe and plastic tubing with connector.

Wireless Blood Pressure Sensor

PASCO's new Wireless Blood Pressure Sensor has all the features of our PASPORT Blood Pressure Sensor, with the added convenience of collecting data wirelessly. With this sensor, students can quickly and easily measure both systolic and diastolic arterial blood pressure (mmHg) as well as heart rate (pulse in bpm). Students gain a contextual understanding of the physiology of blood pressure, as they compare the digits display for systolic and diastolic pressure with the display of blood pressure from the real-time graph.



A clear and easy way to observe heart rate plus systolic and diastolic blood pressure.

Typical Applications

- Determine the effects of exercise on blood pressure and heart rate
- Compare the blood pressure and heart rate of different students in the class
- Explore the effects of body position on blood pressure and heart rate

Not only can students quickly measure systolic and diastolic pressure, but they learn the actual concepts behind blood pressure measurement.

Wireless Blood Pressure Sensor

PS-3218

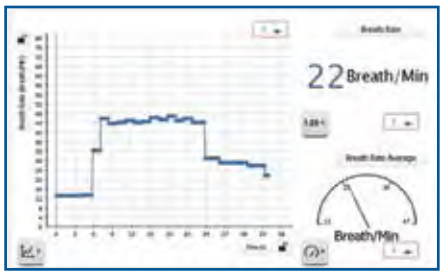
Includes Blood Pressure Sensor, standard-size arm cuff, bladder and pressure release valve.

Also available:

Small Blood Pressure Cuff
PS-3591
Standard Blood Pressure Cuff
PS-3592
Large Blood Pressure Cuff
PS-3593

Breath Rate Sensor

The Breath Rate Sensor measures breathing rate by detecting the air pressure in a mask worn by the student and measuring the time between exhalations. The sensor has two modes: one reading for every breath, and one for a running average over the last four breaths.



Student's breath rate before, during, and after exercise

With the Breath Rate Sensor, students can use a sensor instead of simply counting the number of breaths per minute.

Breath Rate Sensor

PS-2187

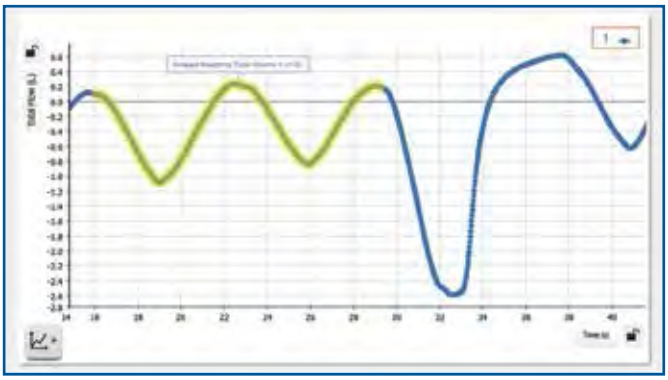
Includes 10 masks and 10 clips

Also available:

Replacement Masks (10 pack)
PS-2567
Replacement Clips (10 pack)
PS-2568

Spirometer Sensor... test your lung power and learn about the respiratory system.

With the Spirometer Sensor students can collect accurate airflow data from a pulmonary function test and create graphs to measure airflow, pressure, duration, and lung volume. The mouth piece and sensor are designed for safely and accurately measuring both airflow out (expiration) and airflow in (inspiration). Compare airflow before and after exercise or even determine total lung capacity.



The volume of the lungs increases when inhaling air into the lungs.

A student uses the spirometer to measure his lung volume. He observes the difference in the volume of his lungs when breathing normally vs. forced breathing.

Spirometer

PS-2152

Includes 2 disposable mouth pieces

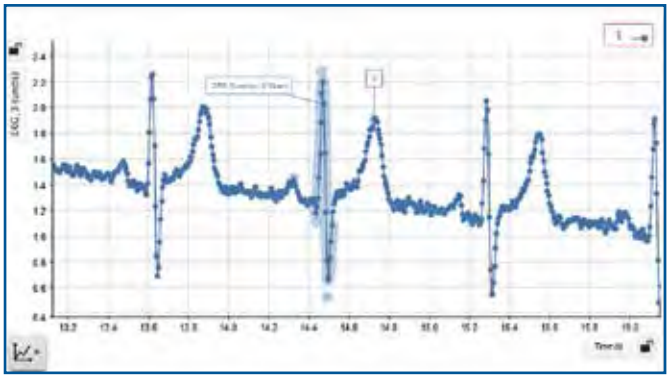
Also available:
Replacement Mouth Pieces (10)
PS-2522

Measure EKG in a heartbeat

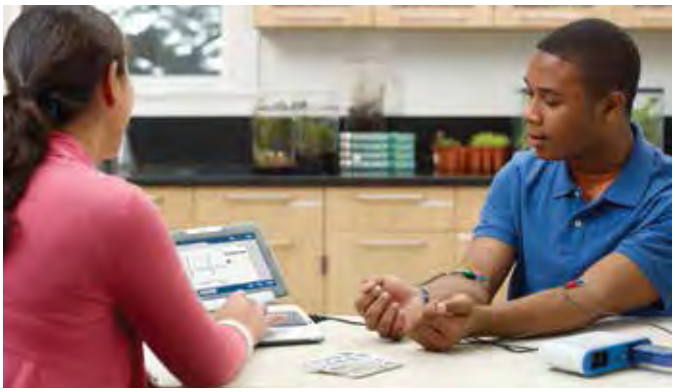
Take the mystery out of an EKG test by letting students measure and record the electrical signals produced by the heart. Students can use this sensor measure their heart rate, and then explore the effects mild exercise has on heart rate.

The Teaching Advantage

- Three-electrode design is easy to use.
- Electrodes are contained in disposable stick-on pads, eliminating the need for messy gels.



Clear data helps students better understand the electrical signals of the heart.



Easy setup and quick data collection make it possible for students to see their heartbeat in a class period.

EKG Sensor

PS-2111

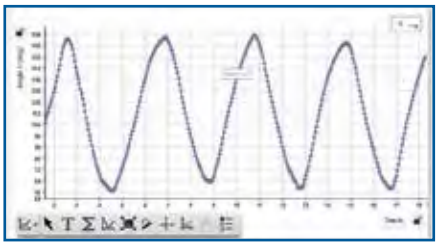
Includes 100 self-adhesive electrode patches.

Also available:
EKG Sensor Electrode Patches (100-pack; one-year shelf life)
CI-6620

Goniometer Sensor

Use the Goniometer Sensor to study how arms and legs move. Compare normal motion to that of moderate exercise and athletic activity. Use it with a force sensor to analyze energy expenditure when lifting weights or climbing stairs. Sensor simply straps on with Velcro®, making it easy to put on and take off.

See every flex and extension as your students become part of the experiment.



Measure the extent of movement and changes in velocity during normal actions.

Goniometer Sensor

PS-2137

Includes an Angle Sensor and 1 Goniometer Probe with Velcro® connection kit.

Measure two joints simultaneously. Just add an additional probe:

Goniometer Probe PS-2138

Includes probe and Velcro® connection kit.

Human Arm Model

The Human Arm Model simulates the muscles and motion of an actual human arm. To activate the arm motion, students pull on the cord with a Force Sensor. Changes in position are measured at the shoulder and elbow using the two built-in potentiometers plugged into one Angle Sensor (PS-2139), included with PS-2611.

Human Arm Model

PS-2611

Includes Human Arm Model and Angle Sensor PS-2139

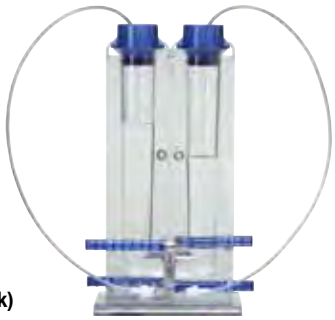
Diffusion/Osmosis Kit

While every biology student has seen a U-shaped tube with a permeable membrane separating a hypotonic and hypertonic solution, few have actually used this simple and elegant design for lab work. The Diffusion/Osmosis Kit contains the apparatus and a Dual Pressure Sensor that allow students to explore the rate of water movement. Students can quantify pressure changes accurately and easily compare solute concentration at the end of the experiment.

Diffusion/Osmosis Kit

ME-6942

Includes Diffusion/Osmosis Apparatus (20 membranes and mounting stud), Dual Pressure Sensor PS-2181, tubing and connectors.



Also available:

Diffusion/Osmosis Apparatus (no sensor) ME-6940

Replacement Membranes (20-pack) ME-6941

Wireless Temperature Link

PS-3222

Includes Fast Response Temperature Probe

The Wireless Temperature Link enables wireless connection for any PASCO temperature probe with a 3.5 mm connection. The link comes with a Fast Response Temperature Probe, but it can also connect to the Stainless Steel Temperature Probe, Skin/Surface Temperature Probe, the Absolute Zero Sphere, and the Ideal Gas Law Apparatus.

Microscope Cameras & Microscopes

PASCO's excited to provide a new line of microscopy equipment for your classroom or lab. With the addition of several new products, we've got a solution to meet your needs, whether you're looking to upgrade existing equipment or add digital microscopes.

Moticam X3 with WiFi

SE-6205

The Moticam X3 is a WiFi camera that can connect to any platform for maximum portability and flexibility.

Moticam 3+ USB

SE-6204

The Moticam 3+ provides high-resolution options with a USB connection for Windows, Mac, and Chromebook.

LED Microscope with Detachable Tablet

SE-6203

The LED microscope with detachable tablet provides 40–1000x magnification with a built-in 7 in tablet that can wirelessly share images with other devices. Here's the perfect solution for general biology lab stations and teacher demos.

For more microscope information, go to ***pasco.com/microscopes***

SPARKvue 4!

SPARKvue is PASCO's award-winning data collection and analysis software. New features include:

- The new Welcome screen allows you to start a new activity or open an experiment, with one click.
- Jump right into most common labs using Templates and Quick Start labs.
- Monitor sensor data without recording using the Live Data Bar.
- Configure, calibrate, and edit sensor properties with new Hardware Setup button.
- Share experiment files directly to Cloud services such as Google Drive.

SPARKvue's digital imaging capabilities support a wide variety of USB imaging devices including webcams and **Moticam digital** microscopes. Use with your Mac®, Windows®, iOS, Android™ and Chromebook™ devices and get all the advantages of digital microscopy. No need for your students to learn a new software just for microscopy. They can collect sensor data and capture and analyze images, all in SPARKvue.

- Make measurements right on the screen.
- Use digital zoom for even more magnification.
- Add labels using the text tool.
- Annotate, highlight, and more!

Award-winning SPARKvue is available for download at pasco.com/sparkvue or ***get the app for free:***

Download on the App Store | ANDROID APP ON Google play | Available in the Chrome Web Store

SPARKvue (single user license)

PS-2401
PS-2401-DIG
For Mac® and Windows®

SPARKvue (site license)

PS-2400
PS-2400-DIG
For Mac® and Windows®

See the latest SPARKvue 4 features on pp. 96-97.

Award-Winning Solutions for Your Chemistry Lab

PASCO provides chemistry educators with the most complete and innovative classroom solutions on the market. Our goal is to provide teachers with affordable, turnkey STEM solutions that combine versatile sensor technology with interactive, NGSS-based curriculum. Using SPARKvue® software and our wireless sensors, students can see real-time data collection and analysis on their own devices. And our *Essential Chemistry* textbook and interactive e-book reinforce student engagement at home and in the classroom.

Chemistry Index

Essentials for Chemistry you can't do without!

Wireless pH Sensor

PS-3204 (page 44)

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Instantly collect pH data with this wireless sensor. Use the probe to test household solutions, perform high-resolution acid-base titrations, or study water quality.

Perform these labs with the Wireless pH Sensor:

- **Explore acid-base titrations**
- **Investigate the chemistry of buffers**
- **Monitor water quality**

Wireless Colorimeter and Turbidity

PS-3215 (page 46)

Includes USB charging cable, 9 cuvettes, 1 Turbidity Calibration Standard, and 2 cuvette racks.

The Wireless Colorimeter and Turbidity Sensor simultaneously measures the absorbance and transmittance of six different wavelengths. The colorimeter can be used to study colored solutions, concentrations, and the rates of chemical reactions. The colorimeter can also function as a turbidimeter for water quality analysis.

WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Wireless Drop Counter

PS-3214 (page 45)

Includes Wireless Drop Counter, Stopcock Valves (2), 60 cc Drop Dispenser Syringe with Tip, and Syringe Holder. Included but not shown: Micro Stir Bar and Micro USB Cable (1 m.)

Use the new Wireless Drop Counter for more efficient and accurate titration data. Conducting a titration has never been easier!

Wireless Temperature Sensor

PS-3201 (page 48)

Includes 1 coin cell battery.

This durable, high-resolution sensor covers many temperature experiments. From chemical changes to thermochemistry, this is a lab essential. Real-time temperature measurements can be tracked in a graph, table, or digits display.

Perform these labs with the Wireless Temperature Sensor:

- **Explore heats of reaction and solution**
- **Study the evidence of a chemical reaction**
- **Investigate varying reaction rates**

winner! 2016 AWARDS EXCELLENCE TECH&LEARNING

See PASCO's New *Essential Chemistry* Curriculum on pages 36-39.

Essential Chemistry Curriculum

This complete chemistry solution includes Textbook, e-Book, Lab Manual, Digital Teacher Resources, and Equipment!

Essential Chemistry is a comprehensive, full-color textbook paired with PASCO equipment. It is the first interactive e-book for chemistry on the market. The program includes over 100 interactive visualizations and tools that increase student engagement and understanding. *Essential Chemistry* is focused on practical applications that connect students to the chemistry of nature as well as technology.

About the program:

- Rigorous yet accessible design
- Interactive simulations and equations
- Lessons follow the 5E design
- Strong mathematics scaffolding
- Formative and summative assessment tools
- Tools for students with different learning styles
- Works with your LMS and Google Classroom
- Includes 24/7 online access

Essential Chemistry is multiplatform: iOS, Android™, Chrome™, Windows®, and Mac®!

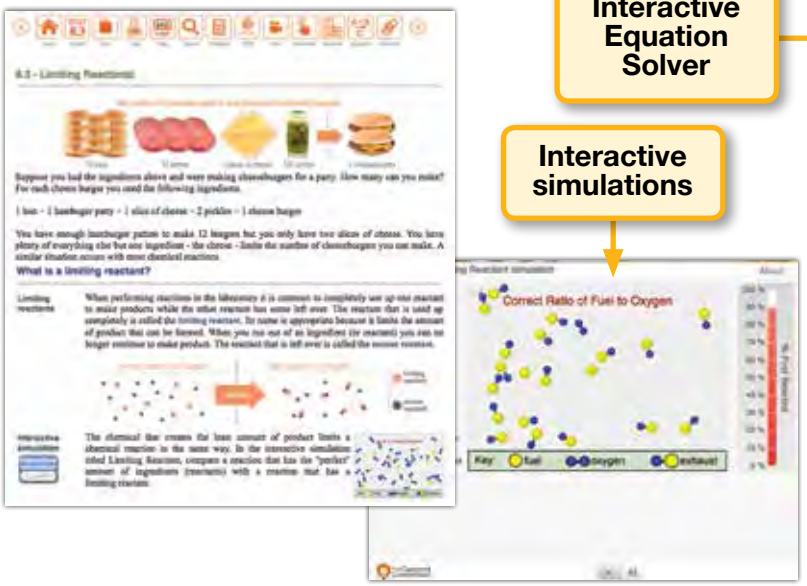
A textbook and an e-book for all your students

What sets *Essential Chemistry* apart is the complete and interactive e-book. Simulations, visualizations, and interactive equations bring concepts to life for students in ways that text and static images cannot. Combined with a rich array of digital resources for teachers, formative and summative assessment, and equipment for lab investigations, *Essential Chemistry* forms a seamless learning system for mastering chemistry.

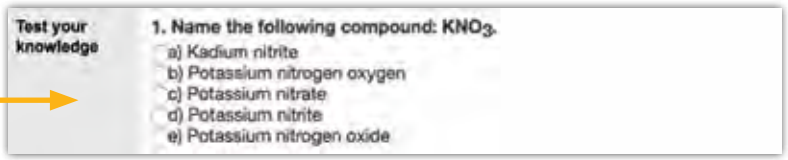
Interactive tools include:

Interactive Equation Solver

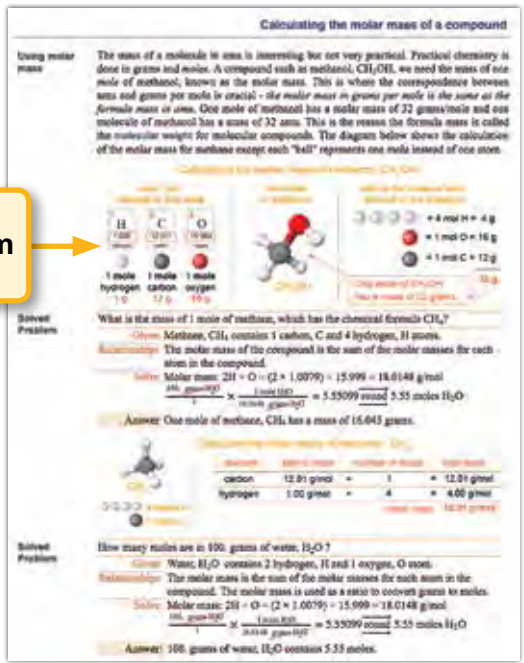
Interactive simulations



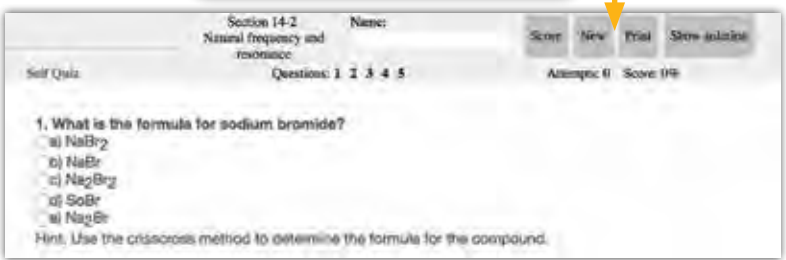
Formative assessment



Embedded solved problem with practice



Summative assessment: The Infinite Test Bank



Essential Chemistry meets your standards and supports STEM and NGSS!

The Digital Teacher Resources include lesson plans, slide presentations, student work, and answer keys, all at point-of-use.

Easily Accessible Resources

Teaching resources
Section 4.1

Temperature

Prepare the Lesson:		
Lesson Plan	PDF	DOCX
Slide Presentation	PDF	PPTX
Slide Notes	PDF	
Student Assignments:		
4_1_Temperature	PDF	DOCX
Section 1 Vocabulary (crossword)	PDF	DOCX
Section 1 Vocabulary (fill-in)	PDF	DOCX
Section 1 Review and Take a Quiz	Go to section review page	
Answer Keys:		
Answers: Temperature Assignment	PDF	DOCX
Answers: Section 1 Vocabulary (crossword)	PDF	DOCX
Answers: Section 1 Vocabulary (fill-in)	PDF	DOCX
Answers to Section 1 Review and Take a Quiz are located on the section review page		

Lesson Plans

LESSON PLAN

Chapter 4 Section 1: Temperature

Learning Objectives

Prior Knowledge

Teaching Tools

Electronic Resources

Student Work

Sample Assessment Questions

Lesson Plan Segments

Slide Presentations

Chapter 4:
Temperature and Heat

Section 1: Temperature

essential CHEMISTRY

PASCO

Student Work

NAME

Chapter 4 Section 1 Assignment: Temperature

Answer Keys

Analysis - Temperature

Table 1 - Temperature

	Cold water temperature (°C)	Hot water temperature (°C)
Initial	2.5	44.6
Prediction	I predict the temperature will increase by at least 10 degrees Celsius.	I predict the temperature will decrease by at least 10 degrees Celsius.
Final	4.6	42.5

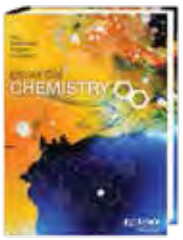
1. Did the temperature change as you predicted? Explain your answer.

Essential Chemistry Solutions

Essential Chemistry Student Textbook

EC-6350

Hardbound student textbook



Essential Chemistry Student e-Book

EC-6350-EB5 (5-yr license)

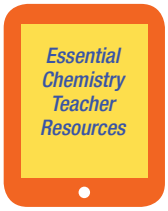
EC-6350-EB1 (1-yr license)

Includes: e-Book with 24/7 online access

Essential Chemistry Teacher Resources

EC-6351-DIG

Includes: Standards alignment guide for your state; Essential Chemistry Teacher User Guide; Teacher e-Book with five-year license; Student e-Book with five-year license; SPARKvue software



Call the PASCO Customer Service Team for pricing information: 800-772-8700.

Standard Equipment Kit *42 labs are designed to use this equipment set.*

EC-6361

Includes 1 of each of the following:

- Wireless Temperature Sensor, PS-3201
- Wireless pH Sensor, PS-3204
- Wireless Conductivity Sensor, PS-3210
- Wireless Pressure Sensor, PS-3203
- Wireless Voltage Sensor, PS-3211
- Wireless Colorimeter and Turbidity, PS-3215*
- Molecular Model Kit, PS-3400
- Electrode Support, PS-3505
- Gratnells® Storage Tray
- Periodic Trend Cards, EC-3405
- Periodic Table, EC-3404
- Spectrum Cards, EC-3403
- Condenser, PS-3402

* **WARNING!** This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Essential Chemistry Student Lab Manual

Are you looking for more hands-on chemistry labs? The Essential Chemistry Student Lab Manual is a student-consumable book that includes 73 labs, activities, and writing and design projects. Labs are completely integrated with PASCO sensors, equipment, and software, including our Standard Equipment Kit (on the opposite page).

EC-6352

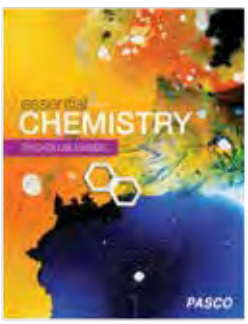
The investigations and activities in the lab manual cover these topics:

- Experimental Variables
- Investigating the Temperature Scale
- Density of a Solid
- Density of a Liquid
- Chemical Formula
- Pure Substances and Mixtures
- Physical or Chemical Change
- Temperature and Thermal Energy
- Specific Heat
- Energy from Food
- Heat of Fusion
- Project: Design an Insulator
- Research Presentation:
- Insulators in the Home
- Patterns and Trends
- Naming Ionic Compounds
- Store Labels and Models
- Counting by Weighing
- Molar Mass
- Percent Composition of a Hydrate
- Empirical Formula of Magnesium Oxide
- Balancing Chemical Equations
- Chemical Reactions
- Solubility Rules
- Conservation of Mass
- Percent Yield
- Modeling Limiting Reactants
- Determining Limiting Reactants
- Project: Design an Airbag
- Research Enhancement:
- Airbags and Consumers
- Isotopic Composition
- What Is a Wave?
- Light Energy
- Flame Tests
- Types of Bonding
- Lewis Structures and VSEPR
- Surface Tension
- Evaporative Cooling
- State Changes
- Hess's Law
- Volume of a Gas
- Boyle's Law
- Charles' Law
- Electrolytes
- Solution Concentration
- Colored Solutions
- Project: Design a Purification Process
- Writing Enhancement: Water Purification
- Optimum Conditions
- Catalysts
- Reaction Equilibrium
- Le Châtelier's Principle
- What Is pH?
- Titration of an Unknown Acid
- Antacids: An Inquiry Study
- Vitamin C Titration
- Electrochemical Cells
- Electroplating
- Lemon Battery
- Project: Design a Galvanic Cell
- Writing Enhancement: Galvanic Cell
- Half-Lives
- Bonding and Organic Chemistry
- Distilling Aromatic Compounds
- Fragrant Esters
- Polymers
- Amino Acids
- Chlorophyll Extraction
- Respiration and Energy
- Greenhouse Gases
- The Water Cycle
- Ocean Currents
- Ocean Acidification
- Spectroscopy

Essential Chemistry Teacher Lab Manual

EC-6330 + EC-6330-DIG

This Teacher Lab Manual comes in two formats: print, which includes the full student version with answer keys; and the all-digital version, which is the same content as the print version but in electronic format.

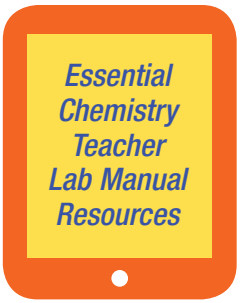


Essential Chemistry Teacher Lab Manual Resources

EC-6353-DIG

These rich all-digital teacher resources include:

- Editable documents
- PowerPoint presentations
- Answer keys
- Video lab assistance
- And more…



Essential Chemistry Solutions

Essential Chemistry Student Lab Manual

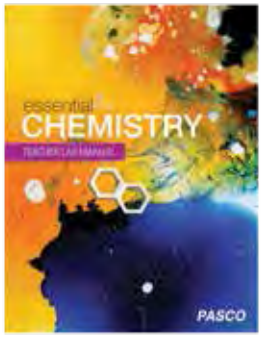
EC-6352 (print)

Essential Chemistry Teacher Lab Manual

EC-6330-DIG (digital)

EC-6330 (print)

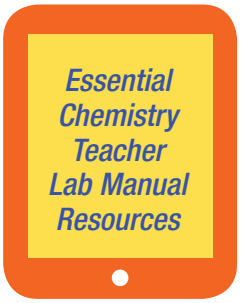
Includes lab prep instructions, expected answers/ results, and editable student files. Manual is available in eco-friendly digital format or in print.



Essential Chemistry Teacher Lab Manual Resources

EC-6353-DIG (digital)

Includes editable documents, PowerPoint presentations, answer keys, video lab assistance, and more…



Essential Chemistry Standard Equipment Kit *42 labs are designed to use this equipment set.*

EC-6361

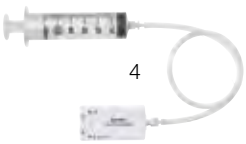
Includes 1 of each of the following:

1. Wireless Temperature Sensor, PS-3201
2. Wireless pH Sensor, PS-3204
3. Wireless Conductivity Sensor, PS-3210
4. Wireless Pressure Sensor, PS-3203
5. Wireless Voltage Sensor, PS-3211
6. Wireless Colorimeter and Turbidity, PS-3215*
7. Molecular Model Kit, PS-3400
8. Electrode Support, PS-3505
9. Condenser, PS-3402
10. Periodic Trend Cards, EC-3405
11. Spectrum Cards, EC-3403
12. Periodic Table, EC-3404
13. Gratnells® Storage Tray


1


2


3


4


5


6

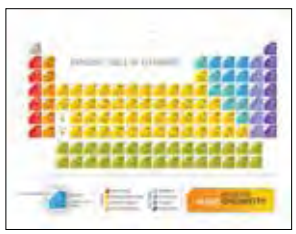

7

* **WARNING!** This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.


8


9


10 11


12


13

Also available:

Essential Chemistry Basic Equipment Kit EC-6360

Includes: Wireless Temperature Sensor (PS-3201), Wireless pH Sensor (PS-3204), Wireless Conductivity Sensor (PS-3210), Molecular Model Set (PS-3400), Electrode Support (PS-3505), Condenser (PS-3402), Periodic Trends Cards (EC-3405), Spectrum Cards (EC-3403), Periodic Table (EC-3404), Storage Case

Advanced Chemistry Through Inquiry Labs for AP® & IB®

PASCO's Advanced Chemistry through Inquiry Teacher Guide is newly revised and contains 16 labs that have been specifically designed to support student inquiry, as well as AP® and IB® curriculum*. This manual is available in both a print version and an all-digital version.

- Most labs can be completed in one lab session with readily available materials, including the sensor bundles on the opposite page.
- The flexible format provides guided-inquiry opportunities and scaffolding, so students can create their own experiments.
- Easy and meaningful data collection leads to increased time for data analysis and open inquiry.
- Labs integrate high-order analysis and synthesis questions.
- Includes sample data for investigations and inquiry, answers to analysis and synthesis questions, an assessment rubric, teacher tips and lab preparation information, and more.

Structured format includes step-by-step procedure, questions, and analysis.

Guided format presents a set of questions that help students design a lab and organize their planning process.

Open format includes Student Experiment Planning worksheet to organize, plan, and enable quick teacher assessment.

Advanced Chemistry Through Inquiry Labs and Sensors Used

Lab Title	Starter Bundle: Temperature	Starter Bundle: Pressure	Starter Bundle: pH	Starter Bundle: Conductivity	Extension Bundle: Colorimeter	Extension Bundle: ORP Probe	Extension Bundle: Drop Counter	AP® Big Ideas*	IB® Standards**
1. Analyzing Food Dyes in Sports Drinks					●			1.3, 11.2, 11.3	1.15, 1.16
2. Investigating the Copper Content of Brass**					●			1.2, 11.2, 11.3, 12.1	1.16, 3.4
3. How Hard Is Your Tap Water?			●	●				1.2, 1.3	1.19, 2.10, 3.2, 3.3
4. How Much Acid Is in Your Fruit Juice?			●				●	1.3, 8.1-8.4, 18.2, 18.3	1.20, 3.3
5. Separating Food Dyes Using Chromatography**					●			1.1, 4.4	1.20, 2.3
6. A Chemistry Mystery: Name That Unknown!				●				1.1, 4.1, 4.4	2.22, 2.24, 2.32
7. Stoichiometry in Solutions	●			●			●	1.2, 1.3	1.5, 3.3
8. Percentage of H_2O_2 in Your Drugstore Hydrogen Peroxide						●	●	9.1	3.9, 1.20, 3.3
9. Investigating the Physical and Chemical Changes of Matter	●	●	●	●				1.1, 4.1, 4.4	2.3, 2.5, 3.1, 3.10, 5.10
10. What Does Acid Rain Do to Coral Reefs?		●						6.1	4.1, 4.2
11. Kinetics of Crystal Violet Fading					●			16.1	4.2, 4.1
12. Building a Better Hand Warmer	●							5.1, 5.3	5.6, 5.7
13. Applications of Le Chatelier's Principle**	●				●			7.1, 17.1	6.9, 6.10
14. Investigation of Acid-Base Titrations			●				●	1.3, 8.1-8.4, 18.2, 18.3	1.20, 6.11, 6.12, 6.13
15. Introduction to Buffers			●				●	18.3	6.20, 1.20
16. Evaluating Lemonade as a Buffer			●				●	18.3	6.18, 1.4

*AP is a registered trademark of the College Board, which was not involved in the production of, and does not endorse, this product.
IB is a registered trademark of the International Baccalaureate Organization, which was not involved in the production of, and does not endorse, this product.

**Requires the Wireless Spectrometer; see below.

Wireless Spectrometer

PS-2600

Includes Spectrometer and 10 cuvettes.

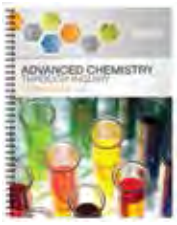
See page 54 for complete information.

Advanced Chemistry Through Inquiry Teacher Lab Manual

PS-2828A-DIG (digital)

PS-2828A (print)

Includes lab prep instructions, expected answers/results, and editable student files. Manual is available in eco-friendly digital format or in print.



Chemistry Solutions

The tools you need to teach your Chemistry classes, including AP® and IB®

Chemistry Starter Bundle

PS-3302

1. Wireless pH PS-3204
2. Wireless Temperature PS-3201
3. Wireless Pressure PS-3203
4. Wireless Voltage PS-3211
5. Wireless Conductivity PS-3210


1


2


3


4


5

Chemistry Extension Bundle

PS-3303C

1. Wireless Drop Counter PS-3214
2. Wireless Colorimeter and Turbidity PS-3215*
3. ORP Probe PS-3515

* **WARNING!** This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.


1


2


3

Wireless pH Sensor

Using PASCO's Wireless pH Sensor, students can measure the pH of different juices without the hassle or mess of indicator solutions or pH paper. And the results are incredibly accurate and readable, making it easy to compare the acidity of different samples.

The advantage of using PASCO sensors and SPARKvue software is that the ease of data collection means that there's plenty of additional time for further investigation or classroom discussion.

Display pH in digits, graphs, tables, or bar charts, so your students can get the most out of their measurements.

Measure the pH of different juices using the Wireless pH Sensor.

Specifications

- Excellent accuracy (0.01 pH) and resolution (0.02 pH)
- Water-resistant (1 m for 30 min)
- Battery life >1 year
- Also connect ORP or ISE electrodes

Wireless pH Sensor

PS-3204

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Wireless Temp/pH/Conductivity Sensor Storage Trays

Make lab management easy and efficient with PASCO's Wireless Sensor Storage Trays. Each Gratnells® tray stores up to 10 wireless sensors; sensors sold separately.

Wireless Sensor Storage Trays for:

Temperature/pH/Conductivity Sensors
PS-3585

Pressure Sensors
PS-3586

Colorimeter & Turbidity Sensors
PS-3587

Voltage & Current Sensors
PS-3588

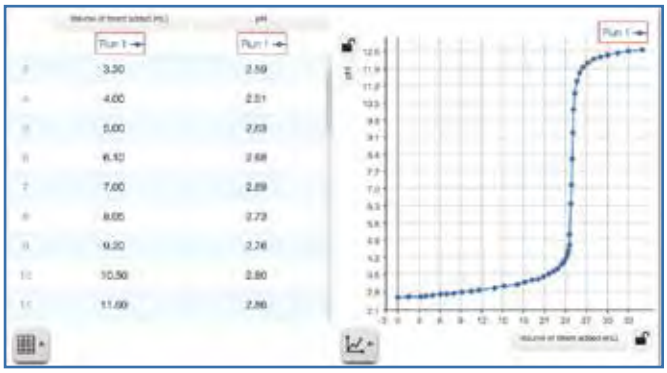
Each storage tray holds up to ten sensors; sensors sold separately.

Also available:
See our complete line of Storage Trays and Rolling Carts on page 148.

Get even more measurements out of the Wireless pH Sensor by using these ORP or ISE electrodes.

The Wireless pH Sensor: perform acid-base titrations and more!

Using the Wireless pH Sensor, students can easily create acid-base titration curves. They can incorporate the Wireless Drop Counter to collect more data in less time.



Easily perform pH titrations using the Wireless pH Sensor.

Wireless Drop Counter

PS-3214

Includes: Wireless Drop Counter, Stopcock Valves (2), 60 cc Drop Dispenser Syringe with Tip, and Syringe Holder. Included but not shown: Micro Stir Bar and Micro USB Cable (1 m.)

Also available:

Drop Dispenser PS-6935

Probes and Electrodes

Oxidation Reduction Potential Probe
PS-3515

Ammonium
PS-3516
Carbon Dioxide
PS-3517
Calcium
PS-3518
Chloride
PS-3519
Potassium
PS-3520
Nitrate
PS-3521

Requires one of these:

Wireless pH Sensor PS-3204
or
a PASPORT pH Amplifier

Also available:

Heater-Stirrer PS-3401

Electrode Support PS-3505

Wireless Colorimeter and Turbidity Sensor

The Wireless Colorimeter can measure absorbance and transmittance at six different wavelengths. Each wavelength represents a region of the ROYGBV color wheel. Measure the colors of a solution to introduce the principles of spectroscopy, relate absorbance to concentration, and study reaction rates. The colorimeter also functions as a turbidimeter for water quality analysis by measuring the scattering effect of suspended particles.

Specifications:

Color detection/peak wavelengths detected: 650 nm (red), 600 nm (orange), 570 nm (yellow), 550 nm (green), 500 nm (blue), 450 nm (violet)

Detector ranges: ±25 nm from peak

Absorbance: 0-3 Abs units; useful range (0.05 -1.5 Abs)

Transmittance: 0-100%

Turbidity range: 0-400 NTU

Accuracy: ±5% NTU

Wireless Colorimeter and Turbidity Sensor

PS-3215

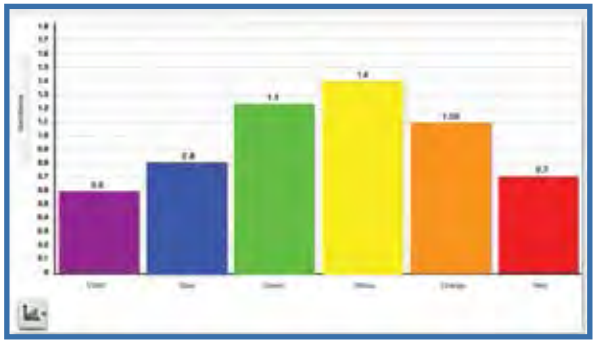
Includes USB charging cable, 9 cuvettes, 2 cuvette racks, and one 100 NTU calibration cuvette.

Also available:

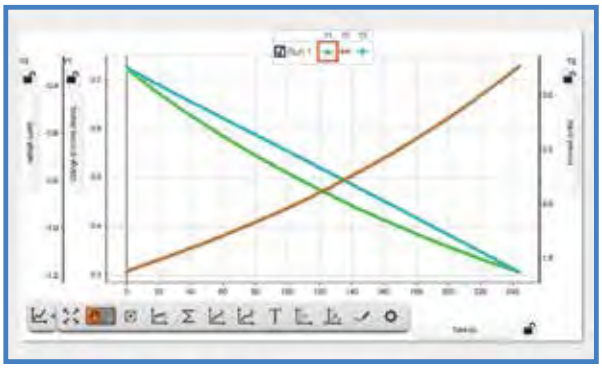
Cuvettes & Caps
SE-8739

Cuvette Rack
EC-3590

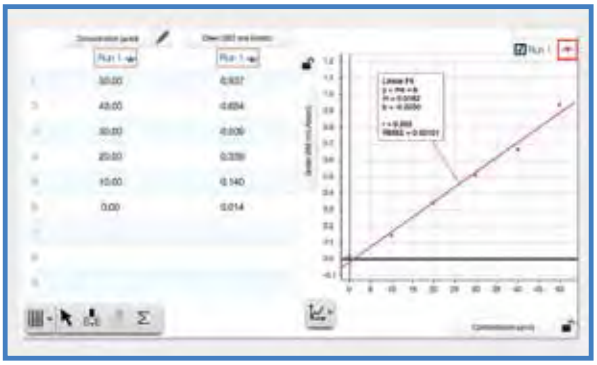
WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.



Measure the absorbance and transmittance of a solution at six different wavelengths... simultaneously!

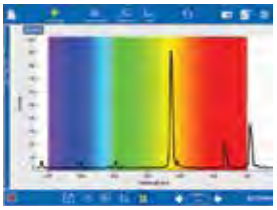


Graphically analyze how a reaction changes over time. Use SPARKvue to see multiple measurements on the same graph.



Create Beer's Law plots to help students understand the relationship between absorbance and concentration.

Need information about PASCO's Wireless Spectrometer? See page 54.



Wireless Temp/pH/Conductivity Sensor Storage Trays

Make lab management easy and efficient with PASCO's Wireless Sensor Storage Trays. Each Gratnells® tray stores up to 10 wireless sensors; sensors sold separately.

Wireless Sensor Storage Trays for:

Temperature/pH/Conductivity Sensors
PS-3585

Pressure Sensors
PS-3586

Colorimeter & Turbidity Sensors
PS-3587

Voltage & Current Sensors
PS-3588

Each storage tray holds up to ten sensors; sensors sold separately.

Gratnells Rolling Carts:

2 column
EP-3574

Stores up to 8 Gratnells F2 trays

Dimensions:
107 cm high, 70 cm wide, 43.5 cm deep

3 column
EP-3575

Stores up to 12 Gratnells F2 trays

Dimensions:
107 cm high, 102 cm wide, 43.5 cm deep

Also available:
See our complete line of Storage Trays and Rolling Carts on page 148.

Wireless Temperature Sensor

This durable, high-resolution sensor covers many temperature experiments. From chemical changes to thermochemistry, this is a lab essential. Real-time temperature measurements can be tracked in a graph, table, or digits display.

Specifications

- Range -40° to 125°C
- Leading resolution of 0.01°C
- Water-resistant (1 m for 30 min)

The Teaching Advantage

- Includes fast sampling rate for small temperature changes such as convection or skin temperature.
- No calibration required: just connect and measure.
- Features convenient Bluetooth® wireless connectivity and long-lasting coin cell battery.
- Logs temperature data directly onto the sensor for long-term experiments.

winner! 2016 AWARDS of EXCELLENCE TECH & LEARNING

Wireless Temperature Sensor

PS-3201

Includes 1 coin cell battery.

Wireless Temperature Link

PS-3222

Includes Fast Response Temperature Probe

The Wireless Temperature Link enables wireless connection for any PASCO temperature probe with a 3.5 mm connection. The link comes with a Fast Response Temperature Probe, but it can also connect to the Stainless Steel Temperature Probe, Skin/Surface Temperature Probe, the Absolute Zero Sphere, and the Ideal Gas Law Apparatus.

PASCO's 5-Year Educational Warranty

To withstand the rigors of student use, PASCO products are made of the highest quality materials. They are designed and manufactured by our team of education researchers and engineers in Roseville, California. And we back up our products with a 5-year warranty, so you can be completely confident about buying PASCO solutions.

PASCO 5 YEAR EDUCATIONAL WARRANTY

Use the change in temperature to determine specific heat capacity of a metal sample.

Have your students explore concepts ranging from specific heat capacity to heats of solution and Hess' Law. Using PASCO's Wireless Temperature Sensor, Calorimetry Cups, and Heater-Stirrer, your students will be outfitted with the necessary equipment to perform a wide range of thermochemistry experiments.

Heater-Stirrer:

This compact Heater-Stirrer is an essential for any lab! The white ceramic top is ideal for heating and for seeing color changes when mixing solutions. It has been designed to withstand spills. Its safety features include warning labels and indicator LEDs. The included rod makes it easy to support sensors.

Calorimetry Cups:

Includes set of six Styrofoam™ cups that are 7.5 cm inside diameter, 10 cm deep, with 1.3 cm thick walls for excellent thermal properties. The lids have a hole, which is ideal for inserting a temperature probe.

Heater-Stirrer

PS-3401

Includes support rod.

Calorimetry Cups

TD-8825A

Styrofoam calorimeter cups (7.5 cm inside diameter, 10 cm deep) have 1.3 cm thick walls for excellent thermal properties.

The lids have a hole for a temperature probe. Includes set of six cups with lids.

Ideal Gas Law Apparatus

The Ideal Gas Law Apparatus has a stable design that ensures consistently repeatable results and long-term reliability. When students use it, they will be able to quantitatively investigate the relationships between pressure, temperature, and volume of a gas.

The relationship between pressure, volume, and temperature can be dynamically visualized with the Ideal Gas Law Apparatus.

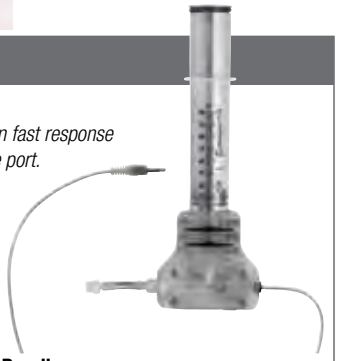
Ideal Gas Law Apparatus

TD-8596A

Includes Ideal Gas Law syringe, built-in fast response thermistor, and quick connect pressure port.

Required:

Wireless Pressure Sensor
PS-3203
Wireless Temperature Link
PS-3222



Also available:

Ideal Gas Law Apparatus Wireless Bundle
PS-3310
Includes the Ideal Gas Law Apparatus, the Wireless Pressure Sensor, and the Temp Link.

Absolute Zero Sphere

The Absolute Zero Sphere has a constant volume, which makes it perfect for determining absolute zero temperature. Students immerse the sphere in water baths of different temperatures, then observe the pressure and temperature changes in real time. Once the data is collected, they can use a linear fit to extrapolate the value of absolute zero.

Immerse the sphere in water baths of several different temperatures to see pressure and temperature changes in real-time.

Absolute Zero Sphere

TD-8595

Includes built-in Fast Response Thermistor Probe and quick-connect pressure port.

Required:

Wireless Pressure Sensor
PS-3203
Wireless Temperature Link
PS-3222

Also available:

Absolute Zero Sphere Wireless Bundle
PS-3309
Includes the Absolute Zero Sphere, the Wireless Pressure Sensor, and the Temp Link.

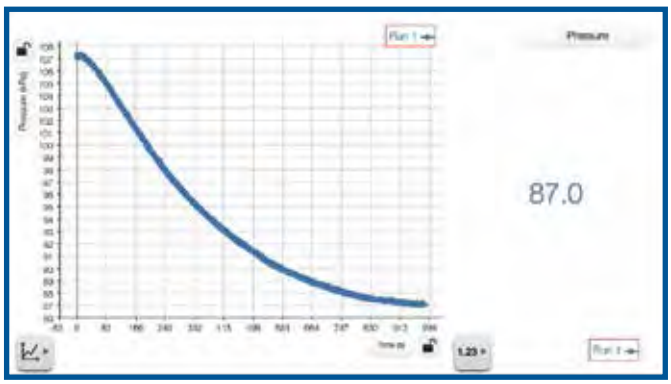
Wireless Pressure Sensor

With this wireless sensor you can make accurate and consistent measurements of gas pressure, and explore Gas Laws and chemical reactions.

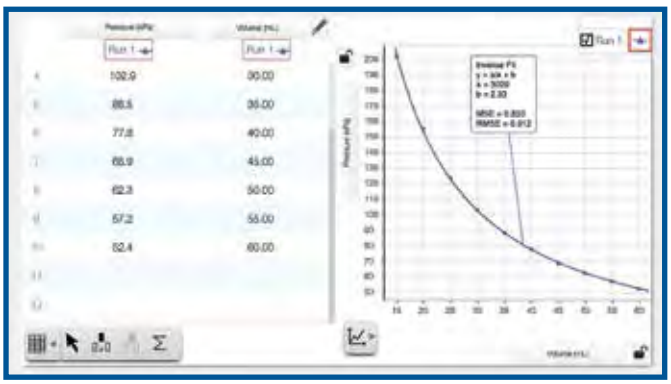
A test tube, piece of steel wool, and a Wireless Pressure Sensor are all your students need to calculate the amount of oxygen in the air.

Specifications

- Wide range 0-400 kPa for gas laws, reaction rates, osmosis, and more!
- Recharge battery just once a semester
- Includes syringe and tubing



Monitor the Pressure digit display while live data is graphed in real time as steel wool reacts with oxygen.



With the included syringe, your students can easily quantify the relationship between pressure and volume.

Wireless Pressure Sensor

PS-3203

Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barb connectors, 1 female barb connector, 1 60cc syringe, a lithium-ion battery, and a USB connector.

Wireless Conductivity Sensor

Use the Wireless Conductivity Sensor to measure the electrical conductivity of a water solution. With this wireless sensor you can investigate the properties of solutions, as well as model and measure water quality.

Compare the types of bonding or the concentration of electrolytes when measuring the conductivity of solutions.

The Wireless Conductivity Sensor can measure conductivity and total dissolved solids.

Measure the conductivity of water and other water-based solutions.

Specifications

- Measure both conductivity and total dissolved solids
- Automatic temperature compensation
- Water-resistant (1 meter for 30 minutes)
- Battery life >1 year

Wireless Conductivity Sensor

PS-3210

Includes 1 coin cell battery.

SPARKvue: Try our award-winning software for FREE!

you choose

reimagined
remarkably easy
redesigned

SPARKvue is the most intuitive educational software for data collection and analysis.

It has been designed for science learning for students of all ages. It is simple enough for elementary-level learners, but with features for advanced physics, chemistry, biology, or environmental science students.

- SPARKvue is multiplatform, so it works on your devices.
- Data collection features include Live Data Bar, Periodic and Manual Sampling, and Remote Logging.
- Using wired or wireless sensors, SPARKvue is plug-and-play.
- It includes multiple data displays and analysis tools.
- Share and export your data with SPARKvue.

Get Started Today!

The full and complete version of SPARKvue is available as a FREE app for iPad® and Android™ tablets and Chromebooks™, and there are free apps for iPhone® and Android™ phones.

Download on the App Store | ANDROID APP ON Google play | chrome web store

We also offer free 60-day trials for Windows® and Mac® at **pasco.com**

Electrochemistry made easy with the Wireless Current and Voltage Sensors

These wireless sensors provide the perfect solution for the electrochemistry portion of your curriculum. Using them during electrochemistry experiments, students will be able to measure voltage and current in voltaic and electrolytic cells.

Help your students reach their "potential" by measuring the voltage of electrochemical cells within different metal combinations.

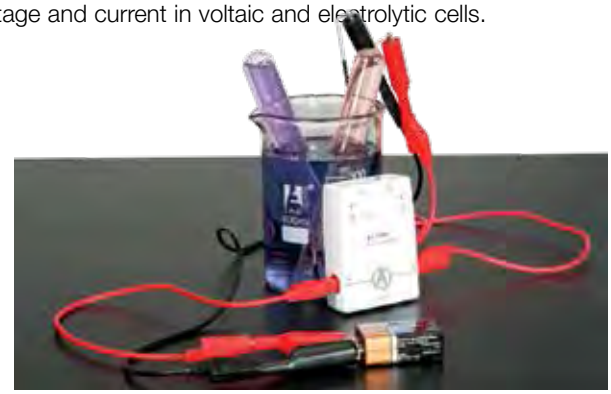
Specifications

- Range ±15 V
- Bluetooth® sampling rate of 1 kHz
- High-speed sampling via USB
- 100 kHz burst mode
- Recharge battery just once a semester

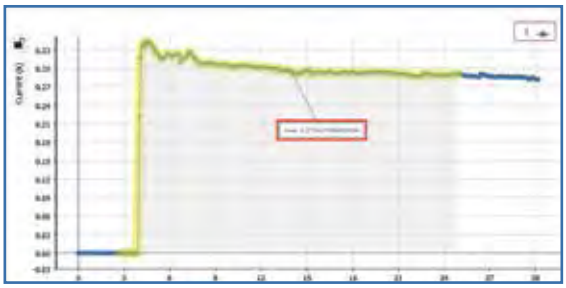
Wireless Voltage Sensor

PS-3211

Includes 1 coin cell battery.



SPARKvue's analysis tools allow you to determine the area under the curve, which is equal to the charge used in the electrolysis experiment featuring the Wireless Current Sensor.



Specifications

- Range ±1A
- Bluetooth® sampling rate of 1 kHz
- High-speed sampling via USB
- 100 kHz burst mode
- Recharge battery just once a semester

Wireless Current Sensor

PS-3212

Includes rechargeable battery and banana-clip cables.

Wireless Sensor Storage Trays for:

Voltage & Current Sensors

PS-3588

Each storage tray holds up to ten sensors; sensors sold separately.

Also available:
See our complete line of Storage Trays and Rolling Carts on page 148.

Molecular Model Set

The Molecular Model Set is the perfect tool to help students understand core science concepts such as the conservation of mass, chemical formulas, and balancing equations. Anything is possible for students, from creating simple water or carbon dioxide molecules to complex biochemicals such as amino acids, as they make models while they study Chemistry and Biochemistry.

Molecular Model Set

PS-3400

Includes 86 atoms and 153 bonds.

Two Density Sets from PASCO

The Discover Density Set (SE-9719) has 22 pieces and allows students to discover the relationship between density, volume, and dimensions.

The Density Set (ME-8569A) allows you to investigate irregular objects by water displacement and specific heat.

Discover Density Set

SE-9719A

Includes

Cylinders of same length and different diameters (4)

Cylinders of same diameter and different lengths (4)

Spheres with different diameters (4)

Rectangular shapes of various sizes and materials (10)

Instruction manual

Density Set

ME-8569A

Includes one irregular aluminum shape, two blocks, (aluminum and brass), three identically-sized cylinders (aluminum, brass and plastic).

Specific Heat Set

Comes with five different materials (aluminum, brass, stainless steel, zinc, and copper), each with a mass of 80 g. Each has a hole to tie a loop of string, so it can be suspended in a liquid.

Specific Heat Set

SE-6849

This specific heat set has five different materials, all having the same mass (80 g). Each has a hole to tie a loop of string to hang the samples in water.

Award-Winning Wireless Spectrometry for iOS®, Android™, Computers, and Chromebooks*

Measure intensity, absorbance, transmittance, and fluorescence.

This one apparatus allows you to measure these four parameters… all wirelessly. The Bluetooth® and USB connectivity enable use with your iPad, tablets, and computers, making this a powerful tool for your spectrometry needs.

Our list of compatible Chromebooks is expanding rapidly. Check **pasco.com/spectrometer for the latest updates.*

Now has the same functionality as the Spec 20, and more!

Spectrometer Specifications:

- Bluetooth and USB connectivity
- 2–3 nm FWHM resolution
- 380–950 nm range
- 2 fluorescence excitation wavelengths at 405 nm and 500 nm
- LED-boosted tungsten light source

You can perform these labs with the Wireless Spectrometer:

- Emission Spectra of Light
- Absorbance Spectra
- Beer's Law
- Kinetics
- Fluorescence

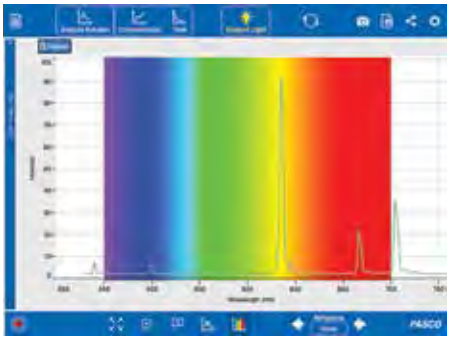
winner! 2016 AWARDS of EXCELLENCE TECH & LEARNING

//CODiE// 2017 SIIA CODiE WINNER

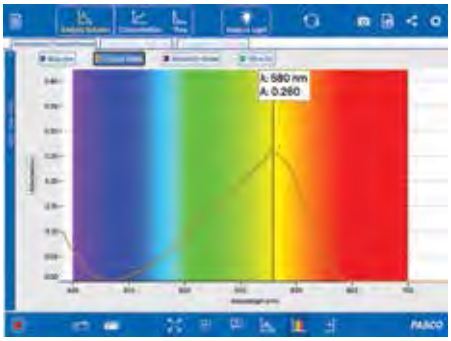
bett AWARDS 2017 FINALIST

The Wireless Spectrometer comes with **PASCO's award-winning spectrometry software.**

- Free software for iOS, Android™, and Mac®.
- Will run on Chromebooks™ with Google Play store.
- Designed specifically for introductory spectrometry experiments.



Analyze light sources with the optional Fiber Optic Cable. Easily compare the spectrum to known reference lines in the software.



Full visible spectrum analysis of solutions with a large digits display helps set the wavelength and see the absorbance.

Wireless Spectrometer

PS-2600

Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:

Optional Fiber Optic Cable
PS-2601

Cuvettes & Caps
SE-8739

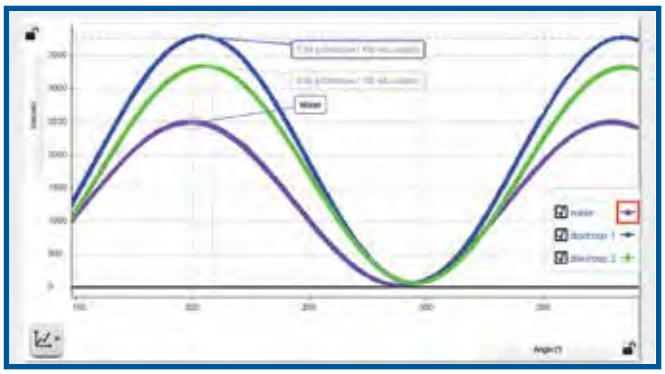
Cuvette Rack
EC-3590

PASCO Polarimeter for your Chromebook™, iPad®, Tablets, and Computers

Measure the optical rotation of chiral compounds.

PASCO's Polarimeter has both Bluetooth® and USB connectivity, so it works on your iPad®, Chromebook™, tablets, and computers. It is ideal for introductory Organic and Biochemistry experiments with chiral compounds.

In this new device, plane polarized light is passed through a sample, which contains a chiral compound, to an analyzer and a detector. The degree of optical rotation of the plane polarized light is based on the type and amount of sample present. Determine the concentration of a sugar solution based on the optical rotation of plane polarized light.



Optical rotation of sucrose

Determine the concentration of a sugar solution based on the optical rotation of plane polarized light.

Specifications:

- Bluetooth® and USB connectivity
- 589 nm LED light source
- Accuracy = ± 0.09° optical rotation
- SPARKvue- and Capstone-compatible
- Industry-standard, horizontal polarimeter sample cell (100 mm)

Polarimeter

PS-2235

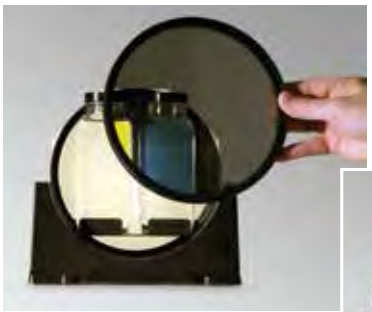
Includes 1 Sample Cell

Also available:

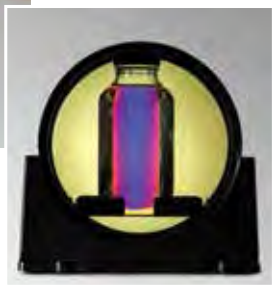
Polarimetry Sample Cell Replacement
PS-2234

Polarizer Demonstrator

OS-9477A



Introduce the concept of polarization with this colorful and meaningful demonstration.



Includes two round polarizer discs with stands.

Also available:

Polarizer Demonstrator Accessory
OS-8172

Linear Polarizer (2-pack) OS-8549

PASCO's Integrated Solutions for Environmental Science

Facilitate discovery-based environmental inquiry in your classroom with PASCO. We offer cutting-edge solutions for both general and advanced Environmental Science classes, as well as Ag Science. Using our award-winning wireless sensors and SPARKvue software, students can collect and analyze data and see their lab results, all in real time and on their own devices. Our wireless sensors are rugged, suitable for use inside or outside the classroom, and have a long battery life. These sensors are powerful tools for environmental monitoring and experimentation anytime, anywhere. And our free digital labs may provide the exact lab investigation you have been seeking!

Environmental Science Index

World Class Support & Professional Development
Committed to Your Success

For more details, see page 158.

CONTACT US TODAY
www.pasco.com

Wireless Optical Dissolved Oxygen Sensor

PS-3224 *(page 65)*

Includes USB charging cable

The Wireless Optical Dissolved Oxygen (DO) Sensor is the perfect solution to monitor DO in the lab or the field. Optical technology is accurate, fast, and does not require flow or calibration. With built-in memory, you can log data for hours or days to capture day/night nutrient cycles and changes in metabolic processes. With the included cover, the sensor has a fully waterproof design and is submersible to 10 m.

Wireless Weather Sensor with GPS

PS-3209 *(page 61)*

Use this multimeasure sensor to monitor 17 different measurements including common weather, location, and light. Study microclimates, monitor environmental conditions during indoor or outdoor labs, or place the sensor outside for extended monitoring, because of its durable, water-resistant design and internal memory.

Includes USB charging cable.

Wireless CO_2 Sensor

PS-3208 *(page 60)*

Use this wireless sensor to measure the concentration of CO_2 gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO_2 data can be logged directly on the device for long-term life science and environmental science studies.

Includes 250-ml sampling bottle and USB charging cable.

Wireless Temperature Sensor

PS-3201 *(page 62)*

Includes 1 coin cell battery.

Welcome to the modern thermometer. Students can access instant temperature readings but also continuously monitor, log, and plot temperature data in SPARKvue on nearly any connected device. When class-time ends but the experiment continues, students can set the sensor to log data autonomously for days or weeks and then download the data for analysis.

The versatile Wireless Temperature Sensor works well, both in the lab and out of doors.

Wireless pH Sensor

PS-3204 *(page 62)*

Wirelessly monitor pH in the field or lab with this durable, accurate sensor. Study water quality, pollution, and environmental monitoring with ease. Log data to the sensor for extended studies that can go for days or weeks before collecting your data (see page 68 for full details).

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Advanced Environmental Science Through Inquiry Labs for AP® & IB®

PASCO's Advanced Environmental Science Through Inquiry Teacher Lab Manual is newly revised and contains 20 labs that have been specifically designed to support student inquiry, as well as AP® and IB® curriculum*. This manual is available in both a print version and an all-digital version.

- Most labs can be completed in one lab session with readily available materials, including the sensor bundles on the opposite page.
- Easy and meaningful data collection leads to increased time for data analysis and open inquiry.
- Includes sample data for investigations and inquiry, answers to analysis and synthesis questions, an assessment rubric, teacher tips and lab preparation information, and more.
- Labs integrate high-order analysis and synthesis questions.
- The flexible format provides guided-inquiry opportunities and scaffolding, so students can create their own experiments.

  Structured format includes step-by-step procedure, questions, and analysis.

  Guided format presents a set of questions that help students design a lab and organize their planning process.

  Open format includes Student Experiment Planning worksheet to organize, plan, and enable quick teacher assessment.

Advanced Environmental Science Through Inquiry Labs and Sensors Used

Lab Title	Starter Bundle				Extension Bundle				AP® Big Ideas*	IB® Connections*
	Weather with GPS	Temperature	pH	Conductivity	Optical Dissolved Oxygen	CO_2	Colorimeter	EcoZone		
1. Determining Soil Quality			●	●		●			1.2	5.1, 5.2, 5.3
2. Insolation and the Seasons		●							1	1.2
3. Investigating Specific Heat		●							1	1.2, 2.3
4. Monitoring Microclimates	●								4	7.1, 7.2, 7.3
5. Sunlight Intensity and Reflectivity	●	●							1	2.3, 7.1-7.3
6. Tracking Weather	●								1	7.2, 7.3
7. Earth's Magnetic Field**									1	1.2
8. Radiation Energy Transfer		●							1	1.2, 2.3
9. Seafloor Spread Plate Tectonics**									1	1.2
10. Modeling an Ecosystem	●	●	●	●	●	●			2	1.2, 2.4, 2.5, 3.1
11. Photosynthesis and Primary Productivity					●				1, 2	1.1, 1.2, 2.3, 5.2
12. Photosynthesis and Cell Respiration		●				●			1, 2	1.1, 1.2, 2.3, 5.2
13. Cellular Respiration and Carbon Cycle						●			1	1.1, 1.2, 6.1, 6.2
14. Energy Content of Food		●							1	1.3, 2.3
15. Weather in a Terrarium	●								1, 2	1.1, 1.2, 7.2, 7.3
16. Yeast Respiration		●			●	●			1, 2	1.1, 1.2
17. Properties of Water		●							1	4.1, 4.2
18. Air Pollution and Acid Rain			●						4	6.1, 6.2, 6.3, 6.4
19. Monitoring Water Quality	●	●	●	●	●		●		4	4.1, 4.2, 4.4
20. Toxicology Using Yeast			●			●			2	1.1, 1.2
21. Water Treatment			●	●			●		4	4.1, 4.2, 4.4
22. Greenhouse Gases		●						●	4	6.1, 6.2, 6.3, 6.4

*AP is a registered trademark of the College Board, which was not involved in the production of, and does not endorse, this product. IB is a registered trademark of the International Baccalaureate Organization, which was not involved in the production of, and does not endorse, this product.

**Requires Wireless 3-Axis Magnetic Field Sensor; see opposite page.

Environmental Science Solutions

The tools you need to teach your Environmental Science classes, including AP® and IB®

Environmental Science Starter Bundle

PS-7616B

1. Wireless Weather with GPS PS-3209
2. Weather Vane Accessory PS-3553
3. Wireless Temperature PS-3201
4. Wireless pH PS-3204
5. Wireless Conductivity PS-3210

Environmental Science Extension Bundle

PS-7617C

1. Wireless Optical Dissolved Oxygen Sensor PS-3224
2. Wireless CO_2 PS-3208
3. Wireless Colorimeter & Turbidity Sensor PS-3215*
4. EcoZone ME-6668

* **WARNING!** This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Advanced Environmental Science Through Inquiry Teacher Lab Manual

PS-2979A-DIG (digital)

PS-2979A (print)

Includes lab prep instructions, expected answers/ results, and editable student files. Manual is available in eco-friendly digital format or in print.

Water Quality Field Guide

PS-2829A-DIG (digital)

PS-2829A (print)

Includes lab prep instructions, expected answers/ results, and editable student files. Manual is available in eco-friendly digital format or in print.

Wireless 3-Axis Magnetic Field Sensor

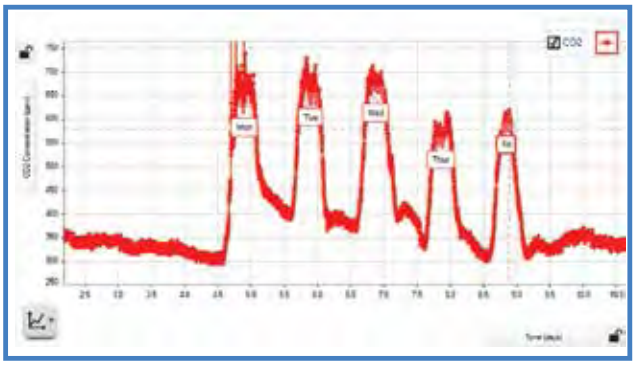
PS-3221

Recommended:
Zero Gauss Chamber
EM-8652

See our digital Ag Science Labs for Environmental Science on page 69.

Wireless CO_2 Sensor

Use this wireless sensor to measure the concentration of CO_2 gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO_2 data can be logged directly on the device for long-term life science and environmental science studies.



Using the logging function, CO_2 air quality was captured in PASCO offices for 24 days straight! When logging date for an entire work week, it's easy to see how the CO_2 levels increase as the days progress.

Wireless CO_2 Sensor

PS-3208

Includes 250-ml sampling bottle and USB charging cable.

Dissolved CO_2 Waterproof Sleeve

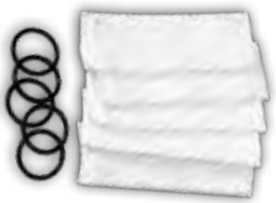
(shown with Wireless CO_2 Sensor; sold separately)

The Wireless CO_2 Sensor can be equipped for aqueous measurements using this semipermeable sleeve. The sleeve is waterproof but allows CO_2 gas to pass through the membrane, creating a headspace around the sensor. Monitor photosynthesis and respiration of aquatic plants or animals with the sample bottle or other chambers.
(***Please note***: Improper use will void sensor warranty.)

Dissolved CO_2 Waterproof Sleeve

PS-3545

Includes 5 sleeves and 5 O-rings



Wireless Sensor Storage Trays for:

Weather Sensor with GPS
PS-3596

CO_2 Sensor
PS-3598

Each storage tray holds up to ten sensors; sensors sold separately.

Also available:
See our complete line of Storage Trays and Rolling Carts on page 148.

Wireless Weather Sensor with GPS

The Wireless Weather Sensor is an all-in-one instrument for monitoring environmental conditions. By incorporating several sensing elements into a single unit, the sensor provides up to **19 different measurements!** Use the sensor in logging mode with the Weather Vane Accessory for long-term monitoring, or use it as a handheld instrument to study microclimates and record ambient conditions relevant to many biological and environmental phenomena.

Measurements

Weather
1. Ambient Temperature
2. Barometric Pressure
3. Wind Speed
4. Wind Direction (true)
5. Relative Humidity
6. Absolute Humidity
7. Dew Point
8. Wind Chill
9. Heat Stress Index

Light
10. Ambient Light (lux)
11. UV Index
12. PAR
13. Irradiance

GPS
14. Latitude
15. Longitude
16. Altitude
17. Speed
18. Magnetic Direction
19. True Direction

This sensor can measure latitude, longitude, and other GPS functions!

Specifications:
Battery: Rechargeable
Water-resistant
(Please see pasco.com for detailed specifications.)

Wireless Weather Sensor with GPS

PS-3209

Includes USB charging cable

Weather Vane Accessory

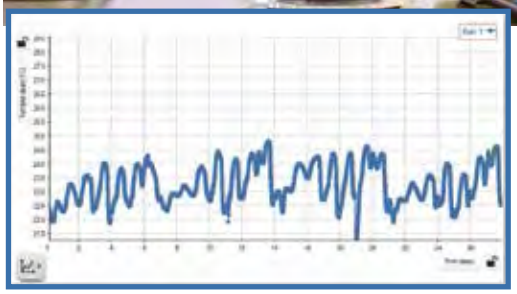
Equip your Wireless Weather Sensor for extended environmental monitoring with the Weather Vane Accessory. Once deployed the sensor will freely rotate to capture wind speed and direction, whether you are monitoring data in real time or using the sensor in logging mode to capture hours (or days!) of data for later analysis.

Weather Vane Accessory

PS-3553

Includes tripod, tripod adapter, and weather vane.

Wireless Temperature Sensor



The versatile Wireless Temperature Sensor works well, both in the lab and out of doors.

See more than 4 weeks of data stored on the sensor!

Welcome to the modern thermometer. Students can access instant temperature readings but also continuously monitor, log, and plot temperature data in SPARKvue on nearly any connected device. When class-time ends but the experiment continues, students can set the sensor to log data autonomously for days or weeks and then download the data for analysis.

Specifications:

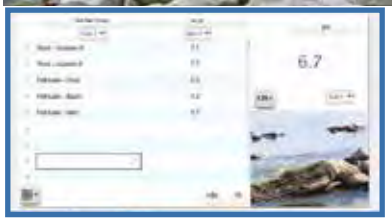
Range: -40°C to 125°C
Resolution: 0.05°C
Accuracy: 0.5°C
Battery: Coin cell (>500,000 samples)
Logging: Yes
Bluetooth: BT 4.0

Wireless Temperature Sensor

PS-3201

Includes 1 coin cell battery.

Wireless pH Sensor



Measure pH of water at different locations and annotate with text and images.

Here's the best tool for measuring pH since litmus paper. Students can quickly obtain accurate pH readings but also log data to their connected device and even program the sensor to collect data autonomously for hours or weeks. Use the sensor to study water quality, environmental monitoring, testing solutions, and chemical reactions.

With the Wireless pH Sensor, students can collect data anywhere!

Specifications:

Range: 0-14 pH units
Resolution: 0.02 pH
Accuracy: 0.1 pH units
Battery: Coin cell
Logging: Yes
Bluetooth: BT 4.0

Wireless pH Sensor

PS-3204

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Electrode Support

PS-3505

Wireless Conductivity Sensor

Compare conductivity and TDS of water samples to investigate water quality at different sites.

Use the Wireless Conductivity Sensor to measure the electrical conductivity or Total Dissolved Solids (TDS) of a solution. Investigate diffusion, osmosis, chemical reactions, and monitor water quality.

Specifications:

Range: 0–20,000 µS/cm
Accuracy: ±10% of value from 200–20,000 µS/cm
Resolution: 0.1 µS/cm
Battery: Coin cell (expected life >1 yr)
Waterproof: IP-X7 (1 m for 30 min)
Temperature compensated

Wireless Conductivity Sensor

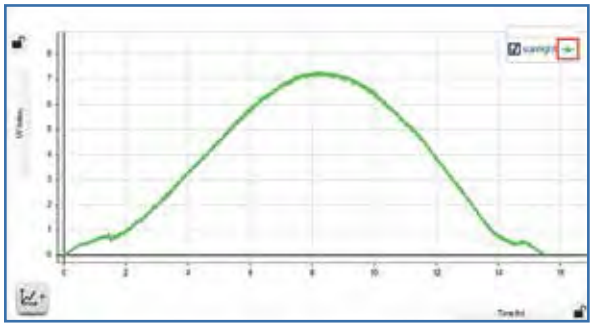
PS-3210

Wireless Light Sensor

The Wireless Light Sensor is a great tool for explorations of phenomena in Earth and Environmental Science. Study insolation and the seasons, solar panel efficiency, UV radiation, and the impact of light intensity on the greenhouse effect. This single sensor has two different detectors for a variety of applications and measurements: the Spot Detector measures red, green, blue, and white relative intensities; the Ambient Detector measures illuminance (lux), UVA, UVB, UV index, solar PAR, and solar irradiance.

Specifications:

Spectral response: 300 nm–1100 nm
Range: 0–130,000 lux
Battery: Coin cell (expected life >1 yr)



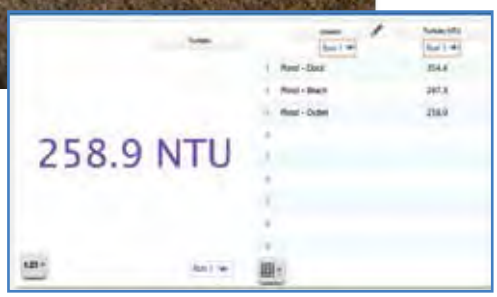
Monitor UV index over the course of a day using the sensor parallel to the horizon in logging mode. The same setup is a great way to compare daylight duration and intensity over the course of a year.

Wireless Light Sensor

PS-3213

Includes 1 coin cell battery.

Wireless Colorimeter and Turbidity Sensor



The Wireless Colorimeter simultaneously measures the absorbance and transmittance of six different wavelengths. The colorimeter can be used to study concentrations of solutions and the rates of chemical reactions. Using accessory cuvettes and a calibration standard, the colorimeter also functions as a turbidimeter for water quality analysis. With the wireless, rugged design, it's easy to take this instrument into the field or use it in the lab.

Specifications:

Color detection/peak wavelengths detected: 650 nm (red), 600 nm (orange), 570 nm (yellow), 550 nm (green), 500 nm (blue), 450 nm (violet)
Detector ranges: ±25 nm from peak
Absorbance: 0-3 Abs units; useful range (0.05 -1.5 Abs)
Transmittance: 0-100%
Turbidity range: 0-400 NTU
Accuracy: ±5% NTU

WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Wireless Colorimeter and Turbidity

PS-3215

Includes USB charging cable, 9 cuvettes, 2 cuvette racks, and one 100 NTU calibration cuvette.

Also available:

Cuvettes & Caps
SE-8739

Cuvette Rack
EC-3590

Wireless Temp/pH/Conductivity Sensor Storage Trays

Make lab management easy and efficient with PASCO's Wireless Sensor Storage Trays. Each Gratnells® tray stores up to 10 wireless sensors; sensors sold separately.

Wireless Sensor Storage Trays for:

Temperature/pH/Conductivity Sensors
PS-3585
Pressure Sensors
PS-3586
Colorimeter & Turbidity Sensors
PS-3587
Voltage & Current Sensors
PS-3588

Each storage tray holds up to ten sensors; sensors sold separately.

Also available:

See our complete line of Storage Trays and Rolling Carts on page 148.

Wireless Optical Dissolved Oxygen Sensor

(See page 27 for full details.)

The Wireless Optical Dissolved Oxygen (DO) Sensor is the perfect solution to monitor DO in the lab or the field. Optical technology is accurate, fast, and does not require flow or calibration. With built-in memory, you can log data for hours or days to capture day/night nutrient cycles and changes in metabolic processes. The sensor also reports qualitative measurement of oxygen gas concentration in air for use in a sample bottle or other high-humidity enclosures. With the included cover, the sensor has a fully waterproof design and is submersible to 10 m.

Specifications:

Bluetooth® and USB connectivity

Response Time: 90% in 25 sec

Operating Temperature: 0–50°C

Range: 0–20 mg/L or 0–300% saturation
Reports solution temperature and ambient pressure

Accuracy: ±0.2 mg/L or 1% (whichever is greater) with user calibration; ±0.5 mg/L or 3% (whichever is greater without user calibration; >200% saturation ±10%

Wireless Optical Dissolved Oxygen Sensor

PS-3224

Includes USB charging cable

Wireless Optical Dissolved Oxygen Metal Guard

PS-3604

This stainless steel metal guard has been designed to protect the sensor cap and make the sensor sink. It threads easily onto the Wireless Optical Dissolved Oxygen Sensor, can withstand use in marine environments, and is strongly recommended for field applications. *(This metal guard is not compatible with our PASPORT DO sensors.)*

Wireless Optical Dissolved Oxygen Sensor Cap

PS-3605

Here is a replacement sensor cap for the Wireless Optical Dissolved Oxygen Sensor. It includes a calibration coefficient. *(This sensor cap is not compatible with our PASPORT DO sensors.)*

Salinity Sensor

With PASCO's Salinity Sensor you now can explore your local coastal ecosystems. Study estuaries and even ocean and brine environments. Explore transition areas where fresh water and salt water mix — even map them for yourself using the GPS Position Sensor.

The Salinity Sensor is calibrated to global standards — once you have identified the salinity of your local ecosystem, you can compare your data to similar saltwater ecosystems around the world.

Salinity level of sample taken from a bay

Features

- Measures salinity, conductivity and temperature
- Automatically temperature-compensates based on Practical Salinity Standard

Salinity Sensor

PS-2195

Make all your sensors wireless!

AirLink

PS-3200

Includes one PASPORT sensor port, USB and Bluetooth connectivity, and USB cable.

Flow Rate/Temperature Sensor

PS-2130

Chemical Water Quality Testing in the Field

PASCO's ezSample water quality test kits simplify the chemical testing of water sources. Avoid the mess and difficulty of handling chemicals directly and get great results, even in the field.

Colorimetric Analysis

Conduct colorimetric tests in the field and avoid the mess and tedium of mixing chemicals. These ezSample Snap Vials contain a pre-formulated reagent to test a variety of water quality parameters. No more guessing at color variations—drop the vial into the Water Quality Colorimeter and read the concentration.


Snap tip of the vial and...

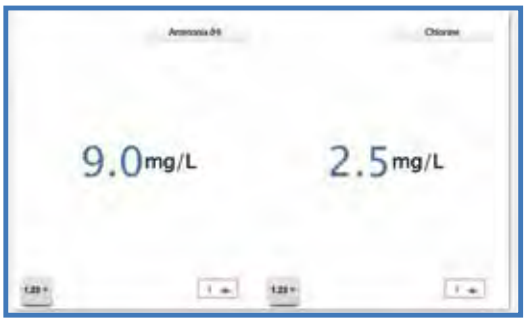

...sample instantly flows into tube, mixing with the reagent.


Place in Water Quality Colorimeter and read your results.

Water Quality Colorimeter

PS-2179

Includes Sensor Extension Cable.



Iron concentration using ezSample Snap Vial and Water Quality Colorimeter.

ezSample™ Snap Vial Kits

Ammonia EZ-2334A
Chlorine EZ-2339A
Iron EZ-2331
Nitrate EZ-2333B*
Phosphate EZ-2337

Each kit contains 30 tests.

Requires:

Water Quality Colorimeter PS-2179

* **WARNING!** This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm.
For more information go to www.P65Warnings.ca.gov.

ezSample™ Field Titrator Kits

Alkalinity EZ-2340
Carbon Dioxide EZ-2341*
Total Hardness EZ-2338

Each kit contains 30 tests.

* **WARNING!** This product can expose you to chemicals including phenolphthalein, which is known to the State of California to cause cancer, and methanol, which is known to the State of California to cause birth defects or other reproductive harm.
For more information go to www.P65Warnings.ca.gov.

PASCO Renewable Energy Kit

With the renewable energy kit students can investigate key concepts around energy transformation and factors that affect the efficiency of wind turbines and solar (photovoltaic) cells. The setup is easy and can be done in the classroom or lab for fast results.


Students study variables in blade design and configurations to create a turbine with maximum energy output for a target wind speed.

PASCO Renewable Energy Kit

SE-7611

Kit includes 12 blades (2 different lengths), 6 STEM adapters for student designed blades, 2 towers, weighted base, nacelle with generator, 1W solar cell, LED, and 2 patch cords.

Custom-design blades and adapters at **pasco.com/DIY.**

EcoZone™ System

The EcoZone System is designed specifically to accommodate PASCO sensors for effective measurement of your model environment. Select from a wealth of sensor measurements for monitoring soil, oxygen, carbon dioxide, water quality, and ecosystem "weather"conditions. Even use the included syringe to extract water samples for chemical-based testing using the ezSample water quality test kits (see page 60).

EcoZone™ System

ME-6668

Includes 3 EcoChambers, tray, rubber stoppers, syringe, plastic tubing and wicking cord.

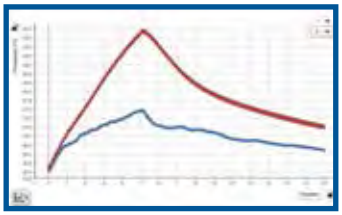
Easily create interconnected ecosystems (aquatic, terrestrial and decomposition) with live, continuous sensor monitoring. See pages 54-55 for more information on the Wireless CO_2, pH, Temperature, and Conductivity Sensors shown.

EcoChamber: Use it to build a greenhouse gas model.

Students create a model environment with the EcoChamber, which supports sensor-based measurement of a closed system. This environment is monitored by a Fast Response Temperature Probe as the lamp's "solar energy" is absorbed by the rocks, re-radiated into the chamber, and absorbed by the gas in the chamber.

Canned dust remover is an efficient greenhouse gas. By filling the EcoChamber, students can model the greenhouse effect caused by the earth/sun relationship.

Two trials – one control, one with greenhouse gas: The greenhouse-gas trial resulted in a higher temperature and a longer cooling-off period.



EcoChamber

ME-6667

Includes acrylic chamber, 7 stoppers of various sizes, 5 probe stoppers, 20 cc calibrated syringe and sample tube with connector.

Density Circulation Model

The PASCO Density Circulation Model helps students understand the complex density-driven circulation associated with heat transfer through convection. Specifically, students simulate vertical ocean currents driven by water bodies with density differences (the "ocean conveyor belt").

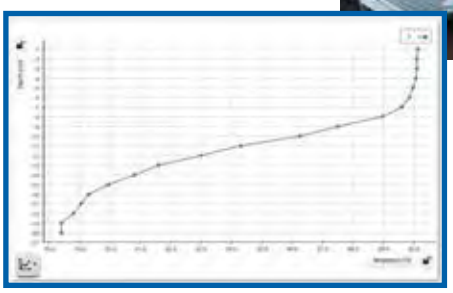
With the Density Circulation Model, students can investigate:

- Vertical ocean currents
- Tropical vs. polar water bodies
- Convection
- Upwelling
- Thermocline and haliocline
- Inversions

Density Circulation Model

ME-6816

The student data clearly shows that the water bodies are stratified by temperature (density), with a very rapid change of temperature at the boundary between the two (the small green area where mixing does occur).



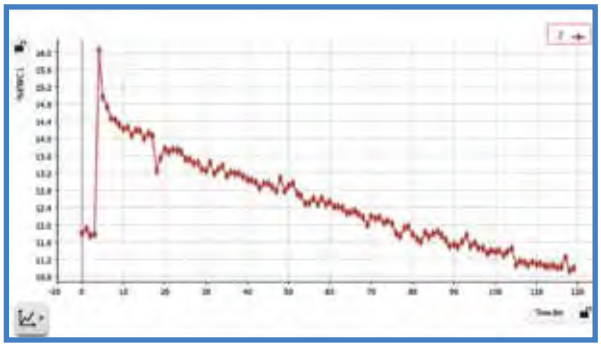
As students open the valves, convection-driven circulation begins and the water types begin to layer—even for very small temperature/density differences.

Investigate soil science

Soil moisture plays an important role in soil science, hydrology, and agriculture studies, since soil moisture is essential to plant growth and soil stability. The soil moisture for a given area is dependent on many factors, including the availability of water and the type and composition of the soil. Students can use the Soil Moisture Sensor in field measurements to help determine if a soil is a good candidate to support a certain crop or plant type. By comparing different soil types, students can construct a soil moisture map of the area and decide where the best location is for agriculture or for a building.

Students can also investigate the connection between soil moisture and transpiration. Under normal conditions the plants pull their moisture from the soil. With the Soil Moisture Sensor, students can investigate the rate at which moisture is removed from the soil in various conditions.

Study soil conditions in different settings to identify optimal environments for different plant species.



Soil moisture data over time.

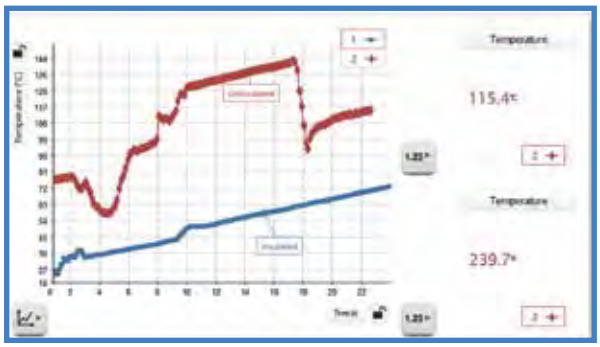
Soil Moisture Sensor

PS-2163

Non-Contact Temperature

The Non-Contact Temperature Sensor allows the measurement of surface temperatures without direct contact — for both safety and convenience. Investigate how different materials heat up under direct energy from the sun, or try to discern the inner structure of an exterior wall by measuring and mapping temperatures across its surface. Even compare surface temperatures at different locations on the body. Energy audits of home and school buildings are easy — create profiles of heat loss or heat absorption with just a scan.

Students can create a temperature profile of a surface or a building with the Non-Contact Temperature Sensor.



Investigate the surface temperature of different materials and their impact on building insulation and efficiency.

Non-Contact Temperature Sensor

PS-2197

Recommended:
Sensor Extension Cable PS-2500

FREE Ag Science Labs now in the PASCO Digital Library

Here are twelve labs that are designed to use wireless sensors and FREE to download. Each lab includes an editable student file and SPARKvue configuration file, which streamline data collection and enable students to spend more time on analysis and inquiry.

Experiments and Sensors Used	Wireless Sensors						
Experiments	CO_2 Gas	Temperature	pH	Conductivity	Colorimeter & Turbidity	Weather/GPS	Dissolved O_2
1. Determining Soil Quality	●						
2. Water Treatment			●	●	●		
3. Freshwater Quality Monitoring		●	●	●			●
4. Water and pH			●	●			
5. Respiration of Germinating Seeds	●						
6. Plant Pigments and Photosynthesis					●		
7. Plant Respiration and Photosynthesis	●						
8. Modeling an Ecosystem	●		●	●	●	●	●
9. Greenhouse Gases		●					
10. Energy Content of Food		●					
11. Diffusion			●	●	●		
12. Soil and pH			●				

Ag Science Starter Bundle

PS-7621A

1. Wireless pH PS-3204
2. Wireless Conductivity PS-3210
3. Wireless CO_2 PS-3208
4. Wireless Colorimeter PS-3215*
5. Wireless Temperature Sensor PS-3201

* **WARNING!** This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Ag Science Extension Bundle

PS-7622A

1. EcoZone ME-6668
2. Wireless Optical Dissolved O_2 Sensor PS-3224
3. Wireless Weather with GPS PS-3209
4. Weather Vane Accessory PS-3553

PASCO's Integrated Solutions for Physics

PASCO provides High School Physics educators with the most groundbreaking solutions on the market that incorporate wireless, cross-platform technology with inquiry-based, hands-on activities to foster active learning. Using our award-winning SPARKvue software, sensors, and *Essential Physics* curriculum, you can easily explore topics such as Mechanics; Electricity and Magnetism; Optics; Thermodynamics; Oscillations, Waves, and Sound; and much more. Whether you teach Honors, IB®, AP® Physics 1 or 2, or General Physics courses, we offer lab manuals, experiments, and textbooks for your curricular needs.

Physics Index

Are you receiving our Physics Catalog? It includes our full line of Physics equipment!

Go to pasco.com/downloads

Four essentials for Physics you can't do without!

Smart Carts

ME-1240 (red)

ME-1241 (blue)

(page 83)

It is the ultimate tool for your physics lab with built-in sensors that measure force, position, velocity, and acceleration. The Smart Cart can make these measurements on or off a dynamics track and transmit the data wirelessly over Bluetooth®.

U.S. Patent Number 10481173

Wireless Sound Sensor

NEW

PS-3227 *(page 91)*

This new Wireless Sound Sensor is really two sensors in one wireless device: a Sound Level Sensor with both dBA- and dBC-weighted scales, and a Sound Wave Sensor that can measure changes in relative sound pressure level as a function of time.

Smart Cart Demo Kits

NEW

ME-1272 (with red Smart Cart)

ME-1273 (with blue Smart Cart) *(page 83)*

These new kits contain one each of the following items… just what you need for your Smart Cart demos!

- Smart Cart (red *OR* blue)
- Smart Fan Accessory
- Sail
- Smart Cart Rod Stand Adapter
- Ballistic Cart Accessory
- Smart Cart Vector Display
- Gratnells Case (red *OR* blue)
- Demonstration Manual
- Two 250-g Cart Masses

Modular Circuits Wireless AC/DC Module

NEW

EM-3533 *(page 89)*

The new Wireless AC/DC Module is a ±3 V DC power supply and AC signal generator, rolled into one compact package that fits directly into PASCO's Modular Circuits system. It is rechargeable via USB, making it the perfect battery eliminator for Modular Circuits.

Use this new module to study:

- Series and Parallel Circuits
- Capacitor Charge and Discharge
- RC and LRC Circuits
- Ohm's Law

Most computing devices connect directly to PASCO Bluetooth® 4.0 wireless products. Go to pasco.com/compatibility to determine your direct-connect compatibility. PASCO offers the PS-3500 USB Bluetooth® Adapter for computing devices that do not support direct-connect.

USB Bluetooth® 4.0 Adapter
PS-3500

10-port USB Charging Station
PS-3501

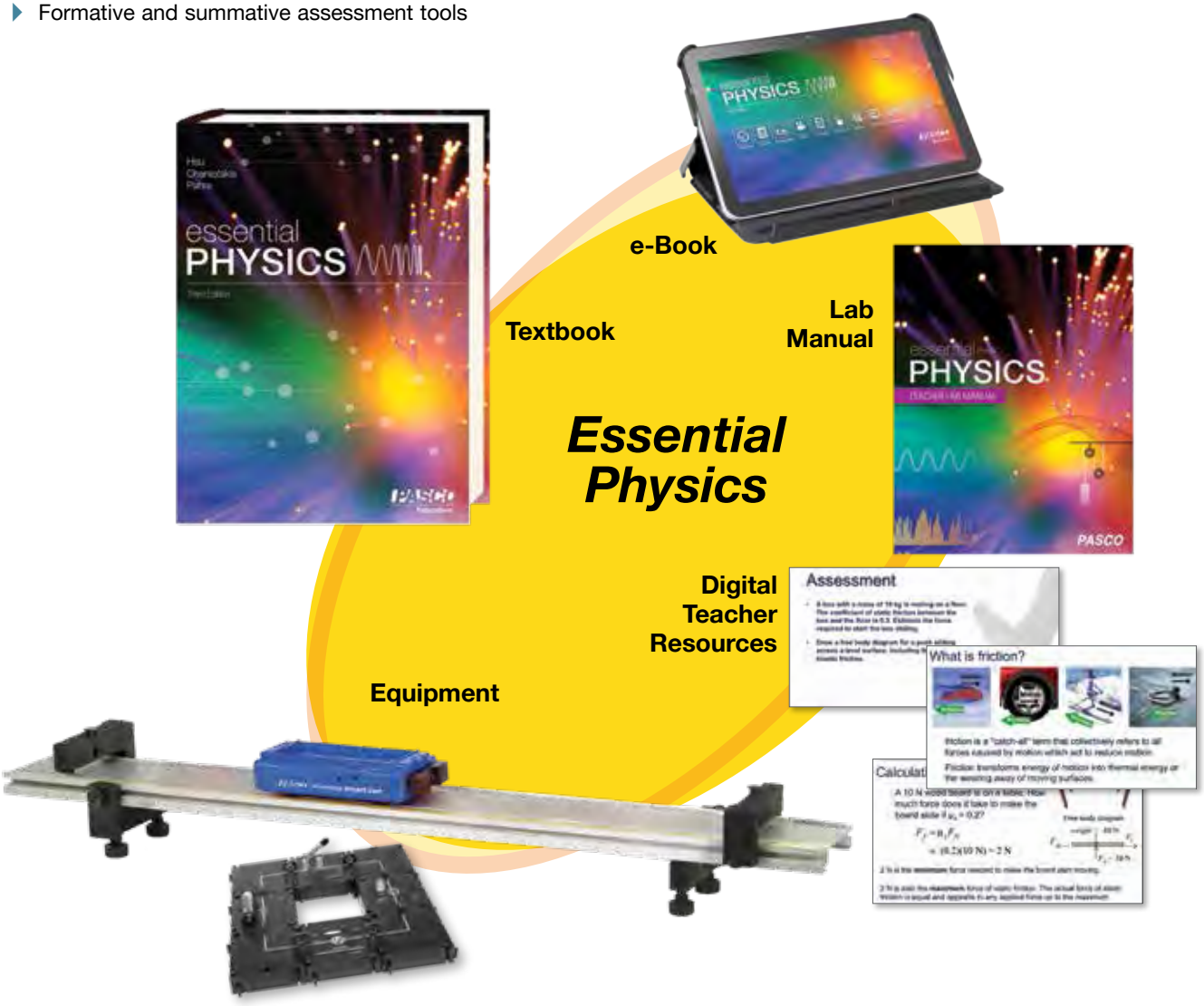
Essential Physics Curriculum

This complete physics solution includes Textbook, e-Book, Lab Manual, Digital Teacher Resources, and Equipment!

Essential Physics 3rd Edition is a comprehensive, full-color textbook paired with PASCO equipment. It is the first e-book for physics on the market. The program includes over 100 interactive tools that increase student engagement and understanding. *Essential Physics* is focused on practical applications that connect students to the physics of nature as well as technology.

About the program:

- Rigorous yet accessible design
- Interactive simulations and equations
- Lessons follow the 5E design
- Strong mathematics scaffolding
- Formative and summative assessment tools
- Tools for students with different learning styles
- Works with your LMS and Google Classroom
- Includes 24/7 online access



Essential Physics is multiplatform: iOS, Android™, Chrome™, Windows®, and Mac®!

A textbook and an e-book for all your students

What sets *Essential Physics* apart is the complete and interactive e-book. Animations, videos, and interactive equations and simulations bring concepts to life for students in ways that text and static images cannot. Combined with digital resources for teachers, formative and summative assessment, and equipment for lab investigations, *Essential Physics* forms a seamless learning system for mastering physics.

The interactive e-book tools include:

31 videos

84 embedded interactive equations

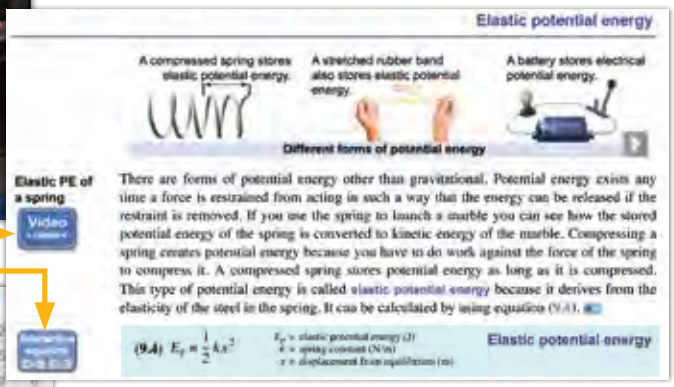
71 interactive simulations

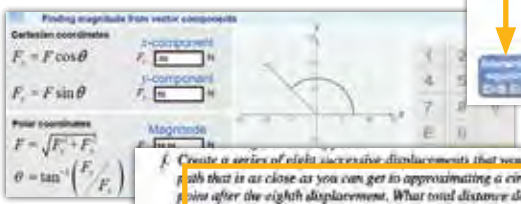
Full audio read

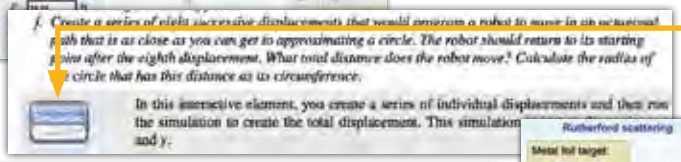
31 embedded animations

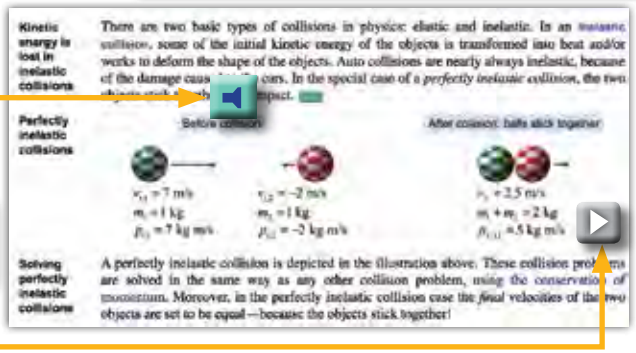
Summative assessment: The Infinite Test Bank

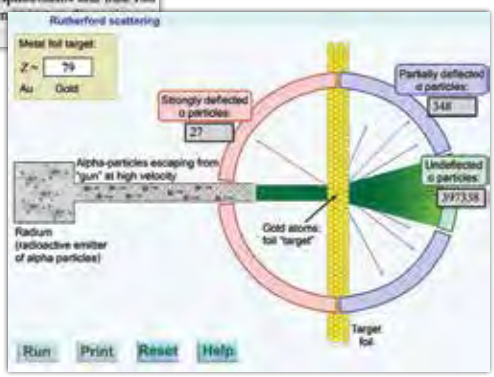
Formative assessment

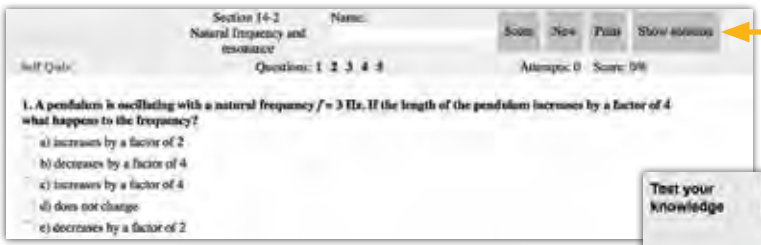


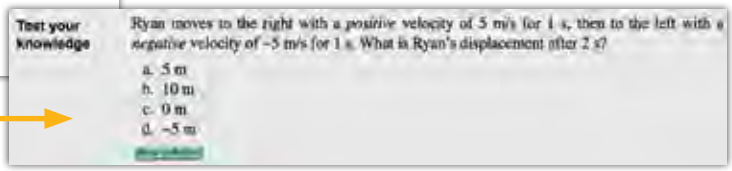






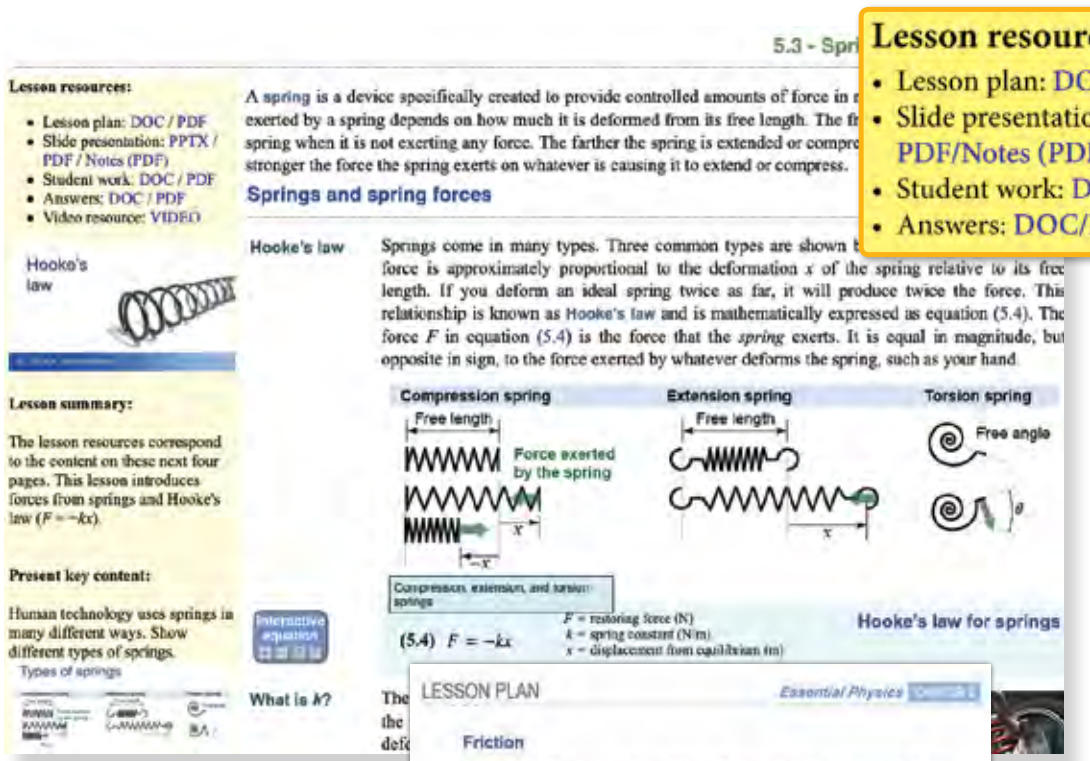




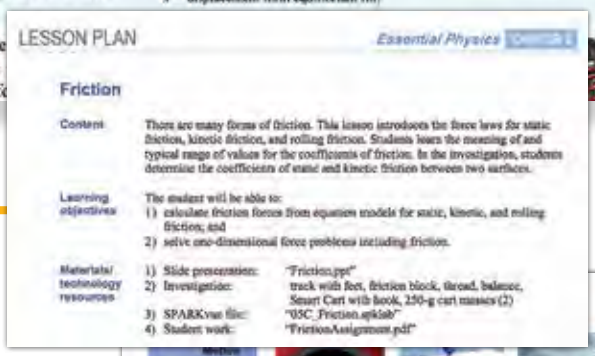


Essential Physics meets your state standards and supports STEM and NGSS!

The Digital Teacher Resources include lesson plans, slide presentations, student work, and answer keys, all at point-of-use.



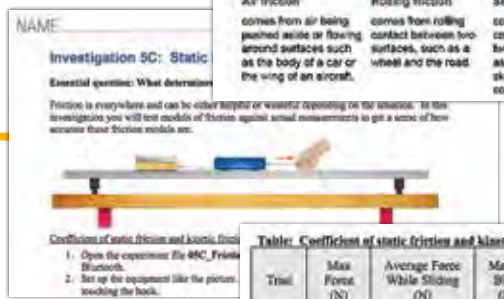
Lesson resources:
- Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF
- Answers: DOC/PDF

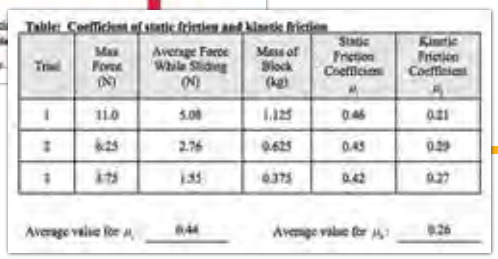


Lesson resources:
Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF
- Answers: DOC/PDF

Lesson resources:
- Lesson plan: DOC/PDF
Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF
- Answers: DOC/PDF

Lesson resources:
- Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)
Student work: DOC/PDF
- Answers: DOC/PDF





Lesson resources:
- Lesson plan: DOC/PDF
- Slide presentation: PPTX/ PDF/Notes (PDF)
- Student work: DOC/PDF
Answers: DOC/PDF

Get a textbook, an e-book, and equipment for the price of most textbooks!

Essential Physics 3rd Edition Student Textbook

EP-6323

Hardbound student textbook

Essential Physics 3rd Edition Student e-Book only

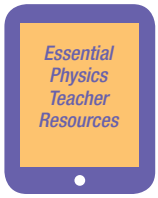
EP-6323-EB1 (1-year license)
EP-6323-EB5 (5-year license)

Includes e-Book with 24/7 online access

Essential Physics Teacher Resources

EP-6324-DIG

Includes Standards alignment for your state; Essential Physics Teacher User Guide; Teacher e-Book with five-year license; Student e-Book with five-year license; SPARKvue software



For complete pricing information call the PASCO Customer Service Team at 800-772-8700.

Comprehensive Equipment Kit *43 labs are designed to use this equipment set.*

EP-6490A

- Forces & Motion Kit
- Simple Machines Engineering Kit
- Oscillations, Waves & Sound Kit
- Light, Color & Optics Kit
- Essential Physics Modular Circuits Kit
- Additional Red Smart Cart
- Mini Launcher, Clamp & Rod
- One 1.2m Metal Dynamics Track
- Two Tripod Stands

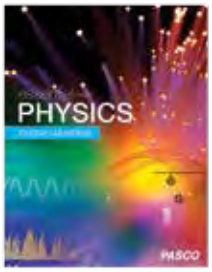
Each kit includes a Gratnells® Storage Tray.

Standard Equipment Kit *23 labs are designed to use this equipment set.*

EP-3567A

Includes 1 of each of the following:

- Smart Cart (Blue), ME-1241
- Friction Block, ME-9807
- PAScar Cart Mass (set of 2), ME-6757A
- Angle Indicator, ME-9495A
- Track End Stop (set of 2), ME-8971
- Super Pulley with Clamp, ME-9448B
- 1.2m Dynamics Track, ME-9493
- Track Feet (set of 2), ME-8972
- Weights
- Modular Circuits
- Wireless Current Module
- Wireless Voltage Sensor
- Gratnells® Storage Tray



Essential Physics Student Lab Manual

EP-6326

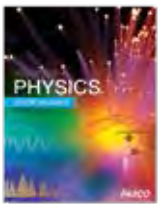
The *Essential Physics* Student Lab Manual is a student-consumable print book. In the manual there are 46 labs that cover a full year of instruction. Best of all, the labs are completely integrated with PASCO equipment and software.

Investigations and activities in the student lab manual cover topics such as:

- Graphs of Motion
- Motion Graphs
- Acceleration
- A Model for Accelerated Motion
- Newton's Second Law
- Hooke's Law
- Static and Kinetic Friction
- Projectile Motion
- Acceleration on an Inclined Plane
- Static Equilibrium
- Work and the Force vs. Distance Graph
- Inclined Plane and the Conservation of Energy
- Work and Energy
- Springs and the Conservation of Energy
- Work Done by Friction
- Design a Crash Barrier
- Conservation of Momentum
- Inelastic Collisions
- Elastic Collisions
- Levers
- Pulleys
- Ramps and Inclined Planes
- Gear Ratios
- Designing Gear Machines
- Torque
- Mechanical Advantage of Gears
- Oscillators
- Resonance
- Waves
- Interference
- Resonance and Sound
- Design a Musical Instrument
- Electricity and Circuits
- Voltage and Batteries
- Design a Lemon Battery
- Resistors and Ohm's Law
- Series and Parallel Resistances
- Electrical Power
- Compound Circuits
- Magnification of Mirrors and Lenses
- Reflection in a Plane Mirror
- Refraction of Light
- Creating Real and Virtual Images with Lenses
- Image Formation for a
- Convex Lens
- Build a Microscope and Telescope
- Phosphorescence

Essential Physics Student Lab Manual

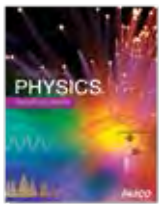
EP-6326 (student-consumable)



Essential Physics Teacher Lab Manual

EP-6329-DIG (digital)

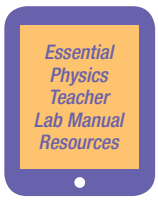
EP-6329 (print)



Essential Physics Teacher Lab Manual Resources

EP-6328-DIG (digital)

Includes editable documents, PowerPoint presentations, answer keys, and video lab assistance.



All the Physics Equipment You Need...

Comprehensive Equipment Kit *43 labs are designed to use this equipment set.*

EP-6490A

- Forces & Motion Kit
- Simple Machines Engineering Kit
- Oscillations, Waves & Sound Kit
- Light, Color & Optics Kit
- Essential Physics Modular Circuits Kit
- Additional Red Smart Cart
- Mini Launcher, Clamp & Rod
- One 1.2 m Metal Dynamics Track
- Two Tripod Stands

Each kit includes a Gratnells® Storage Tray.

Choose the Kits You Need...

Forces & Motion Kit

EP-3576

Forces + Motion Labs

- Graphs of Motion
- Motion Graphs
- Acceleration
- A Model for Accelerated Motion
- Newton's Second Law
- Hooke's Law
- Static and Kinetic Friction
- Projectile Motion
- Acceleration on an Inclined Plane
- Work and the Force vs. Distance Graph
- Inclined Plane and the Conservation of Energy
- Work and Energy
- Springs and the Conservation of Energy
- Work Done by Friction
- Design a Crash Barrier
- Conservation of Momentum
- Inelastic Collisions
- Elastic Collisions
- Ramps and Inclined Planes

Go to **pasco.com** enter **EP-3576** for complete kit contents

Essential Physics Modular Circuits Kit

EM-3536

Modular Circuits Labs

- Electricity and Circuits
- Voltage and Batteries
- Design a Lemon Battery
- Resistors and Ohm's Law
- Series and Parallel Resistances
- Electrical Power
- Compound Circuits

Go to **pasco.com** enter **EM-3536** for complete kit contents

Simple Machines Engineering Kit

EP-3577

Simple Machines Labs

- Static Equilibrium
- Levers
- Pulleys
- Gear Ratios
- Designing Gear Machines
- Torque
- Mechanical Advantage of Gears

Go to **pasco.com** enter **EP-3577** for complete kit contents

Light, Color & Optics Kit

EP-3558

Light, Color & Optics Labs

- Magnification of Mirrors and Lenses
- Reflection in a Plane Mirror
- Refraction of Light
- Creating Real and Virtual Images with Lenses
- Image Formation for a Convex Lens
- Build a Microscope and Telescope
- Phosphorescence

Go to **pasco.com** enter **EP-3558** for complete kit contents

Oscillations, Waves & Sound Kit

EP-3578

Oscillations, Waves & Sound Labs

- Oscillators
- Resonance
- Waves
- Interference
- Resonance and Sound
- Design a Musical Instrument

Go to **pasco.com** enter **EP-3578** for complete kit contents

Advanced Physics 1 Lab Manual

PS-3812-DIG (digital) PS-3812 (print)

This experiment guide covers the latest standards for College Board Advanced Placement Physics 1.

- Every lab is based on the College Board Learning Objectives.
- Data Analysis and Assessment Questions are designed to prepare students for the AP® Physics 1 exam.
- Every lab employs the same strategies found in free response questions on the AP® exam.
- Includes editable student handouts.

Prepare your students for inquiry investigations in the physics lab. Each lab is presented three ways:

- Structured
- Guided inquiry
- Student designed

You decide which level of inquiry is appropriate for each lab.

Each lab includes teacher resources:

- Pre-lab discussion and questions
- Procedural overview
- Teacher tips
- Sample data
- Assessment and synthesis questions
- Extended inquiry suggestions

ADV PHYSICS 1 EXPERIMENTS	EQUIPMENT		ALIGNMENT	
LAB	Perform these labs with the PS-3813 Equipment Kit	Add the PS-3814 Expansion Kit to perform all these labs	IB® Standards*	AP® 1 Standards**
1. Graphical Analysis: Motion	✔	✔	2.1	3.A.1.1, 2, 3
2. Newton's Second Law	✔	✔	2.2	3.B.1.1, 2, 3, 3.B.2.1
3. Atwood's Machine	✔	✔	2.2	3.B.1.1, 2
4. Coefficients of Friction	✔	✔	2.2	3.C.4.1,2
5. Two Dimensional Motion: Projectiles		✔	1.3, 2.1	3.E.1.3, 4
6. Conservation of Mechanical Energy	✔	✔	2.3	5.B.4.1,2
7. Work and Kinetic Energy	✔	✔	2.3	4.C.2.1, 2
8. Conservation of Momentum		✔	2.4	5.D.1.3,5.D.2.2, 4
9. Momentum and Impulse	✔	✔	2.4	3.D.2.3, 4
10. Rotational Dynamics		✔	B.1	3.F.2.1, 2, 3.A.1.3
11. Rotational Statics		✔	B.1	3.F.1.1, 2, 3, 4, 5
12. Periodic Motion: Mass and Spring	✔	✔	4.1, 9.1	3.B.3.1, 2, 3, 4
13. Simple Pendulum	✔	✔	4.1, 9.1	3.B.3.1, 2, 3
14. Resonance and Standing Waves		✔	4.5, B.4	6.D.3.4, 6.D.4.1, 2
15. DC Circuits		✔	5.1, 5.2	1.B.1.2, 5.B.9.2, 3, 5.C.3.1

Each experiment guide includes video support!

How-to videos are included with the manual, on the PASCO web site and on YouTube, and can be installed on your own computers.

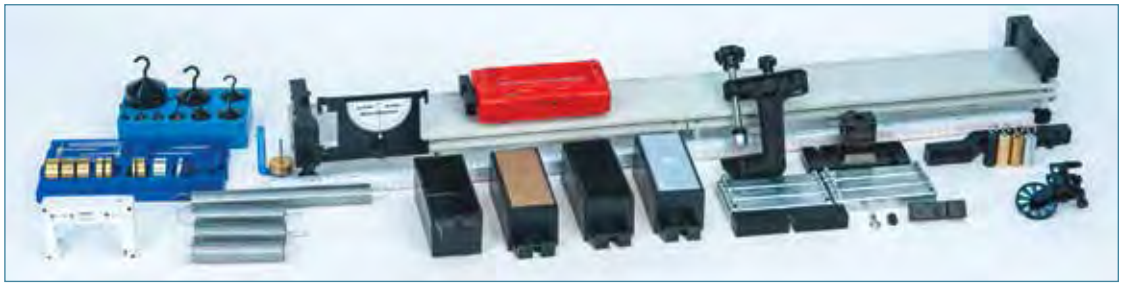
Try It!

* IB is a registered trademark of the International Baccalaureate Organization, which was not involved in the production of, and does not endorse, this product.
** AP is a trademark registered and/or owned by the College Board, which was not involved in the production of, and does not endorse, this product.

Advanced Physics 1 Equipment Kit

PS-3813

Equipment	Part #	Qty
Smart Cart (red)	ME-1240	1
PAStrack	ME-6960	1
Dynamics Track End Stop (2 pack)	ME-8971	1
Four Scale Meter Stick	SE-8695	1
250-g Compact Cart Mass	ME-6755	2
Mass & Hanger Set	ME-8979	1
Super Pulley Kit	ME-9433	1
Thread	ME-9875	1
60-cm Stainless Steel Rod	ME-8977	1
Aluminum Table Clamp	ME-8995	1
Wireless Smart Gate	PS-3225	1
Right Angle Clamp	SE-9444	1
250-g Cart Mass (set of 2)	ME-6757A	3
Discover Friction Accessory Tray	ME-8574	1
45-cm Stainless Steel Rod	ME-8736	1
Angle Indicator	ME-9495A	1
Dynamics Track Rod Clamp	ME-9836	1
Bumper Accessory Set	ME-9884	1
Smart Cart Rod Stand Adapter	ME-1244	1
90-cm Stainless Steel Rod	ME-8738	1
Demonstration Spring Set	ME-9866	1
Hooked Mass Set	SE-8759	1
Photogate Pendulum Set	ME-8752	1
Pendulum Clamp	ME-9506	1



Advanced Physics 1 Expansion Kit

PS-3814

Equipment	Part #	Qty
Smart Cart (blue)	ME-1241	1
Pendulum Accessory	ME-8969	1
Aluminum Table Clamp	ME-8995	1
Wireless Rotary Motion Sensor	PS-3220	1
Stainless Steel Calipers	SF-8711	1
Tension Protractor	ME-6855	2
60-cm Stainless Steel Rod	ME-8977	1
Aluminum Table Clamp	ME-8995	1
Tuning Fork Set	SE-7342	1
Resonance Air Column	WA-9606	1
AC/DC Electronics Lab Kit	EM-8656	1
Wireless Voltage Sensor	PS-3211	1
Wireless Current Sensor	PS-3212	1
Photogate Mounting Bracket	ME-6821A	1
Mini Launcher	ME-6825B	1
Carbon Paper	SE-8693	1

Advanced Physics Sensor Bundle

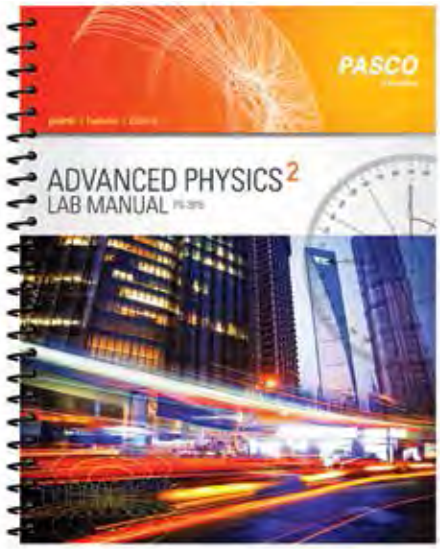
Just need sensors?

PS-3818

Equipment	Part #	Qty
1. Smart Cart (red)	ME-1240	1
2. Wireless Smart Gate	PS-3225	1
3. Smart Cart (blue)	ME-1241	1
4. Wireless Rotary Motion Sensor	PS-3220	1
5. Wireless Voltage Sensor	PS-3211	1
6. Wireless Current Sensor	PS-3212	1
7. Wireless Pressure Sensor	PS-3203	1
8. Wireless Magnetic Field Sensor	PS-3221	1

Advanced Physics 2 Lab Manual

PS-3815-DIG (digital) PS-3815 (print)



This experiment guide covers the latest standards for College Board Advanced Placement Physics 1.

- Every lab is based on the College Board Learning Objectives.
- Data Analysis and Assessment Questions are designed to prepare students for the AP® Physics 1 exam.
- Every lab employs the same strategies found in free response questions on the AP® exam.
- Includes editable student handouts.

Prepare your students for inquiry investigations in the physics lab. Each lab is presented three ways:

- Structured
- Guided inquiry
- Student designed

You decide which level of inquiry is appropriate for each lab.

Each lab includes teacher resources:

- Pre-lab discussion and questions
- Procedural overview
- Teacher tips
- Sample data
- Assessment and synthesis questions
- Extended inquiry suggestions

ADV PHYSICS 2 EXPERIMENTS	EQUIPMENT		ALIGNMENT	
LAB	Perform these labs with the PS-3816 Equipment Kit	Add the PS-3817 Expansion Kit to perform all these labs	IB® Standards*	AP® 2 Standards**
1. Hydrostatic Pressure	✔	✔	B.3	3.C.4.1, 3.C.4.2
2. Buoyant Force		✔	B.3	1.E.1.2, 3.A.3.1, 3.C.4.2
3. Fluid Dynamics	✔	✔	B.3	5.B.10.1, 5.B.10.3, 5.B.10.4
4. Boyle's Law	✔	✔	3.2	5.B.7.2, 7.A.3.2, 7.A.3.3
5. Spherical Mirror Reflection	✔	✔	C.1	6.E.4.1, 6.E.4.2
6. Snell's Law	✔	✔	4.4	6.E.3.2, 6.E.3.3
7. Focal Length of a Converging Lens	✔	✔	C.1	6.E.5.1, 6.E.5.2
8. Interference and Diffraction	✔	✔	4.4, 9.2, 9.3	6.C.3.1
9. Electric Field Mapping		✔	5.1, 10.1	2.E.2.1
10. Magnetic Fields		✔	5.4	2.D.2.1, 2.D.3.1, 2.D.4.1
11. Magnetic Field Strength		✔	5.4	2.D.2.1
12. Electromagnetic Induction	✔	✔	11.1	4.E.2.1
13. Capacitor Fundamentals		✔	11.3	4.E.4.2, 4.E.4.3
14. Series and Parallel Capacitors		✔	11.3	4.E.5.3, 5.B.9.5
15. RC Circuits		✔	11.3	4.E.5.1, 4.E.5.2, 4.E.5.3
16. Planck's Constant		✔	12.1	6.F.3.1, 6.F.4.1

Each experiment guide includes video support!

How-to videos are included with the manual, on the PASCO web site and on YouTube, and can be installed on your own computers.

Try It!

* IB is a registered trademark of the International Baccalaureate Organization, which was not involved in the production of, and does not endorse, this product.
** AP is a trademark registered and/or owned by the College Board, which was not involved in the production of, and does not endorse, this product.

Advanced Physics 2 Equipment Kit

PS-3816

Equipment	Part #	Qty
Water Reservoir	ME-8594	1
Wireless Pressure Sensor	PS-3203	1
Four-Scale Meter Stick	SE-8695	1
Concave Mirror Accessory	OS-8457	1
Basic Optics Light Source	OS-8470	1
Optics Track, 1.2 m	OS-8508	1
Basic Optics Ray Table	OS-8465	1
Basic Optics Viewing Screen	OS-8460	1
Converging Lens, 50-mm diam.	OS-8466A	1
Adjustable Lens Holder	OS-8474	1
Diffraction Plate	OS-8850	1
Rod, 45-cm	ME-8736	2
Aluminum Table Clamp	ME-8995	2
Stainless Steel Calipers	SE-8710	1
Three-finger Clamp	SE-9445	2
Laser Pointer (with known wavelength)	SE-9716B/C	1
Wireless Voltage Sensor	PS-3211	1
Not Pictured: .539 ID Plastic Tube, 12”		1
Magnet or Enameled Wire, 22-gauge		1

Advanced Physics 2 Expansion Kit

PS-3817

Equipment	Part #	Qty
Smart Cart (red)	ME-1240	1
Aluminum Table Clamp	ME-8995	1
Thread	ME-9875	1
Overflow Can	SE-8568	1
Right Angle Clamp	SE-9444	1
Field Mapper Kit	PK-9023	1
Student Power Supply, 18 VDC, 3 A	SE-8828	1

Equipment	Part #	Qty
Digital Multimeter	SE-9786A	1
Neodymium Magnets, solid (16 pack)	EM-8648B	1
AC/DC Electronics Lab Kit	EM-8656	1
Magnaprobe™ Wand	SE-7390	1
4-mm Banana Plug Patch Cord (5 pack)	SE-9750	2
Wireless 3-Axis Magnetic Field Sensor	PS-3221	1
Wireless Current Sensor	PS-3212	1

Not Pictured:	Qty
Aluminum Cylinder	1
Brass Cylinder	1
Magnet or Enameled Wire, 22-gauge	1
Capacitor, 100-µF	5
Blue LED (450–500 nm)	1
Green LED (501–565 nm)	1
Yellow/Amber LED (566–620 nm)	1
Red LED (621–750 nm)	1

Advanced Physics Sensor Bundle

Just need sensors?

PS-3818

Equipment	Part #	Qty
1. Smart Cart (red)	ME-1240	1
2. Wireless Smart Gate	PS-3225	1
3. Smart Cart (blue)	ME-1241	1
4. Wireless Rotary Motion Sensor	PS-3220	1
5. Wireless Voltage Sensor	PS-3211	1
6. Wireless Current Sensor	PS-3212	1
7. Wireless Pressure Sensor	PS-3203	1
8. Wireless Magnetic Field Sensor	PS-3221	1

MatchGraph!™ FREE App

for Windows®, Mac®, iPad® and Android™

Now works with PASCO Motion Sensors and the Wireless Smart Cart!

FREE motion-graphing software

Engage your students with a student-centered experience as they study motion graphs. Give them a deeper understanding of interpreting motion graphs, while they see their own motion graphed in real time!

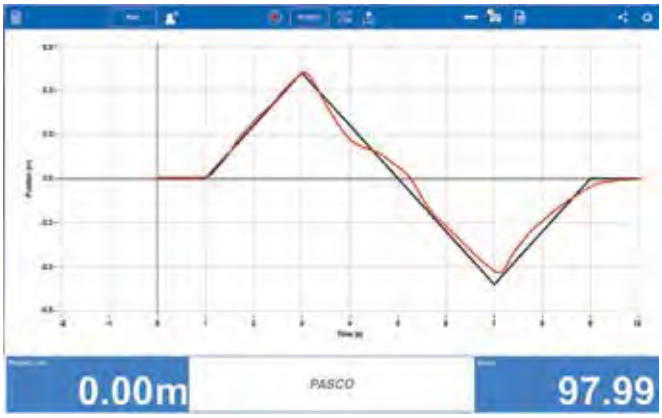
MatchGraph!™

MatchGraph features:

- **Students choose from position and velocity profiles** as they learn to relate motion to the graphs they make.
- **Their journals can capture images of matches**, which can be used in their lab reports.
- **Students can export their data** into SPARKvue® or PASCO Capstone™ for even more analysis.
- **Students can export images** of MatchGraph data into their lab reports.

This interactive game teaches students these motion-graphing basics:

- Position
- Velocity graph
- Acceleration
- Slope and rate of change
- Frame of reference



Wireless Motion Sensor

PS-3219

Includes rod clamp

Use with MatchGraph software to study position and velocity graphing in real time. Investigate ocean-floor mapping. Study objects in freefall. Measure dynamics carts to study kinematics, conservation of momentum, and kinetic energy.

Download the Free *MatchGraph!* App

for Mac®, Android™, and Windows® computers at **pasco.com/downloads.** Download the free iPad® or Android™ app on the App Store or Google Play.

ANDROID APP ON Google play

Download on the App Store

Wireless Smart Cart

Game changer for the physics lab!

The patent-pending Wireless Smart Cart greatly simplifies many physics lab activities and opens up new possibilities with its integrated suite of wireless sensors! The Smart Cart can make measurements of force, position, velocity and acceleration, on or off a dynamics track, while transmitting data wirelessly over Bluetooth®.

U.S. Patent Number 10481173

Smart Cart Features:

- Magnetic bumper
- **Sealed wheel encoder sensor**
- Force sensor hook and rubber bumper
- ±100 N force sensor
- 3-axis acceleration/gyro sensor
- 3-position plunger
- Mass tray
- Velcro® tabs
- Rechargeable battery
- Bluetooth connectivity
- Available in red and blue

Smart Cart Demo Kits

NEW

Here are two new Smart Cart Demo Kits. Each kit contains one of the following:

- Smart Cart (red *OR* blue)
- Smart Fan Accessory
- Two 250-g Cart Masses
- Smart Cart Rod Stand Adapter
- Ballistic Cart Accessory
- Smart Cart Vector Display
- Gratnells Case (red *OR* blue)
- Demonstration Manual
- Sail

Smart Cart Demo Kits

ME-1272 (with red cart)

ME-1273 (with blue cart)

Read the review from *The Physics Teacher*

The PASCO Wireless Smart Cart: A Game Changer in the Undergraduate Physics Laboratory

Asif Shakur and Ismor Gomez, Salisbury University, Salisbury, MD

With the introduction of the Wireless Smart Cart by PASCO scientific in April 2016, we expect a paradigm shift in undergraduate physics laboratory instruction. We have evaluated the feasibility of using the smart cart by carrying out experiments that are usually performed using traditional PASCO equipment. The simplicity, convenience, and cost-saving achieved by replacing a plethora of traditional laboratory sensors, wires, and equipment clutter with the smart cart are reported here.

Inelastic collision

We performed a simple inelastic collision experiment to ascertain the feasibility of using the wireless smart cart in an undergraduate laboratory setting. Two similar smart carts (red and blue) were placed on a 1-m PASCO aluminum track. The free PASCO app SPARKvue was installed on an iPhone. The app paired up with the blue cart via Bluetooth and recognized the unique identification sticker on the cart. We gave the blue cart a gentle push in the direction of the stationary red cart. The two carts collided and stuck together on the Velcro pads. The two carts moved together with a slower speed. Note that we only needed one iPhone to pair up with only one cart (blue) in order to draw meaningful conclusions. The velocity and time data (in addition to position, accelerations, and a raft of other data) were wirelessly transmitted by the smart cart to the iPhone as a CSV file (comma separated values). The data were tabulated in an Excel file, and a graph of velocity vs. time is depicted in Fig. 2.

Fig. 1. The PASCO Wireless Smart Cart.

Go to **pasco.com/smartcart**

Smart Cart

ME-1240 (red)

ME-1241 (blue)

Includes: Hook, Rubber bumper, Magnetic bumper, and USB cable for charging

Also available:

Smart Cart Charging Garage ME-1243

Charge up to five Smart Carts at once. Provides storage for the carts and accessory bumpers. Includes power adapter.

Smart Cart Vector Display

NEW

Helps your students visualize acceleration, force, and velocity... in real time.

Here is the new secret weapon to teach acceleration! The rechargeable Smart Cart Vector Display plugs into the auxiliary port of the Smart Cart and shows force, acceleration, or velocity vectors. The display lights up one to five arrows, proportional to the sensor reading. The vectors are red in one direction and green in the other. The letters **F, a,** and **v** are lit with a white light that indicates which measurement is being displayed.

- Select between Force, Acceleration, or Velocity vectors and watch them in real time.
- Students can visualize constant acceleration as a cart rolls up and then down an incline.
- Great for the student lab station or for a physics lecture demonstration!
- Selectable ranges

Vector display can mount vertically for classroom demonstrations.

Vector display can sit flat in a Smart Cart.

Smart Cart Vector Display

ME-1246

Requires one of the following:

Wireless Smart Carts
Red Smart Cart, ME-1240
Blue Smart Cart, ME-1241

Smart Ballistic Cart Accessory

The original PASCO Ballistic Accessory debuted in 1994 and it is known for its reliable operation. After 25 years, we felt it was time for an update!

Here is the OTHER newest accessory for the Smart Cart! When the cart is set in motion, the piston is released, projecting the ball upward out of the tube. Both the ball and the cart share the same horizontal velocity, which is unaffected by gravity. So when the ball falls back down, it lands back in the tube and does not get "left behind" by the cart.

- Launches projectiles over 50 cm.
- Has a software control panel similar to the Smart Fan.
- Reliably and repeatedly catches the projectile.
- USB rechargeable
- Leveling/aiming adjustment screws
- Works with Blockly Coding.
- Works in manual mode with all carts.

Blockly

NEW

Smart Ballistic Cart Accessory

ME-1245

Includes two nylon balls, conical rubber catcher, spring-loaded piston, rechargeable battery, and USB cable.

Smart Fan Accessory

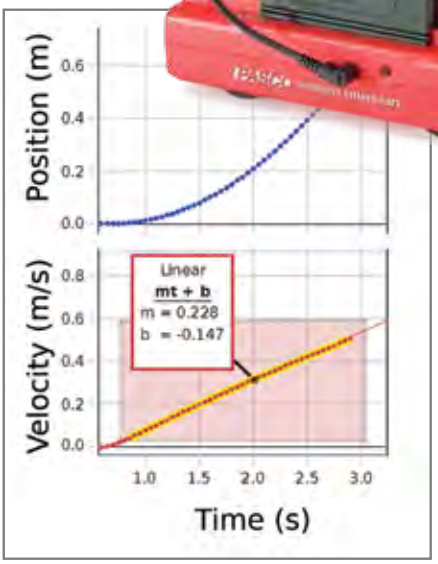
Plug it into a Smart Cart, or use it in 3-speed push-button mode with any PASCO cart!

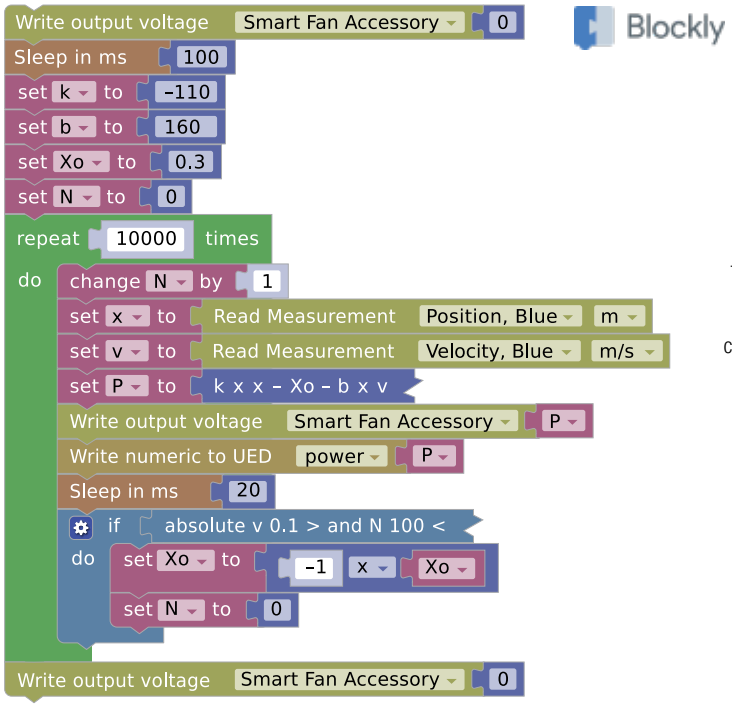
If you use this fan on a regular cart, you can turn it on and select one of three speeds by pushing the button on the side. But plugging it into a Smart Cart gives this Smart Fan Accessory added capabilities:

- **Hands-off Operation:** You can turn the Smart Fan on and off wirelessly from your computing device.
- **Adjust the Thrust:** Move the slider in the software and watch the fan respond.
- **Reverse the Spin of the Fan:** Input a negative thrust to make the fan blow in the opposite direction.
- **Set Start and Stop Conditions:** Choose to start the fan when a measurement (such as Position) reaches a certain value. Make the fan stop after a certain time so the cart coasts during part of the experiment (only available when using a Smart Cart).
- **Sense and Control with Blockly Coding** (only available when using a Smart Cart):

U.S. Patent Number 10482789

The Smart Fan Accessory becomes smart when plugged into a Smart Cart.





Blockly

This is the control panel for the Smart Fan in PASCO Capstone software. (This control screen only available when using a Smart Cart.)

Smart Fan Accessory

ME-1242

Includes Smart Fan Accessory, Smart Cart Cable (19 cm), and 4 AA alkaline batteries

Recommended:

Smart Cart or Dynamics Cart
PASCO Capstone or SPARKvue Software

Suggested:

Battery Charger with 8 AA Rechargeable Batteries
SE-3570

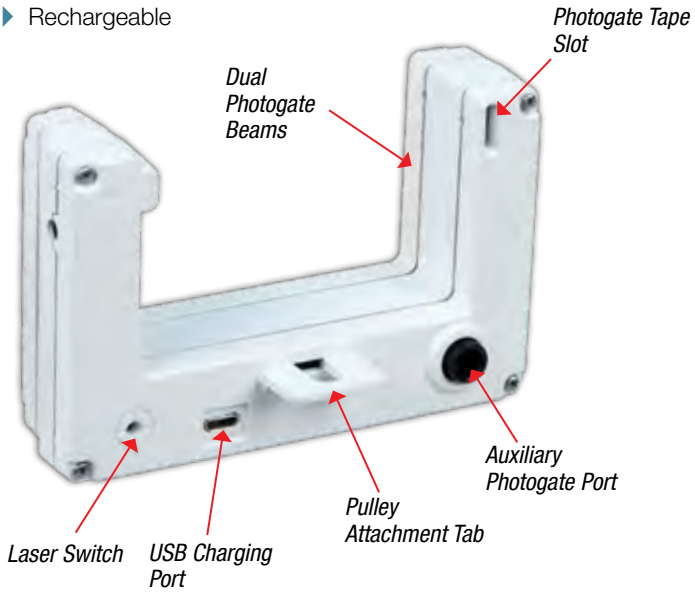
Make your fan rotatable:

3D print your own rotating base for the Smart Fan Accessory at pasco.com/diy

Wireless Smart Gate

Features:

- Dual photogate beams
- Laser switch
- Photogate tape slot
- Auxiliary photogate/Time-of-Flight port
- USB and Bluetooth®
- Rechargeable



The Wireless Smart Gate has all the features of the wired Smart Gate. It has dual photogate beams spaced at 1.5 cm to accurately measure speed. The built-in laser switch (when used with any laser) allows you to time larger objects. Use Photogate Tape passing through the photogate tape slot to measure movement of irregular objects. The auxiliary port is for adding an additional photogate head or Time-of-Flight Accessory.

NOTE: When using two Wireless Smart Gates, be aware that the syncing resolution between two gates can be as much as 2 ms.

Wireless Smart Gate

PS-3225

Specifications

- Logging: Yes
- Battery: Rechargeable Lithium-Polymer
- Connectivity: Direct USB or via Bluetooth 4.0

Projectile Launcher

ME-6800

Includes launcher base, projectile balls, loading rod, safety glasses, 2-D collision accessory and manual.

Specifications

- Ranges: 1.2, 3, 5 m
- Launch Angles: 0 to +90°
- Launcher Length: 21 cm

Mini Launcher

ME-6825B

Includes launcher base, projectile balls, loading rod, safety glasses, 2-D collision accessory, and manual.

Specifications

- Range: 0.5, 1, 2 m
- Launch Angle: 0 to +90° and 0 to -45°
- Launcher Length: 18 cm

Projectile Launcher Wireless Smart Gate System

ME-6796

Includes wireless smart gate with mounting bracket, launcher with mounting stand, steel balls (2) with loading rod, 2-D collision accessory, aluminum table clamp, and 45 cm stainless steel rod.

Choose this wireless option to eliminate cables between the computer and the projectile launcher.

The Wireless Smart Gate has all the features of the Smart Gate (PS-2180), but it connects to your computing device via Bluetooth® or USB; it does not require an interface.

Time-of-Flight Accessory

ME-6810A

Includes Time-of-Flight Accessory, instruction manual, and experiment guide.

- For use with all PASCO launchers

Wireless Rotary Motion Sensor

Show that angular momentum is conserved: The Wireless Rotary Motion Sensor records the angular velocity as a ring is dropped on a spinning disk.

The Wireless Rotary Motion Sensor measures angle, angular velocity, and angular acceleration, as well as their linear equivalents. The included three-step pulley allows different torques to be applied, rotating a rigid system at different rates of acceleration. The included rod-mounting holes let you orient the sensor for different experiments. The Wireless Rotary Motion Sensor connects directly to your devices via Bluetooth® or USB.

Specifications

- Angle resolution: 0.18° (0.00314 radian)
- Linear resolution: 0.0157 mm (with 5 mm pulley radius)
- Three-step pulley: 10, 29, and 48 mm diameter
- Shaft diameter: 6.35 mm
- Maximum rotation rate: 30 revolutions per second
- Optical encoder: 2000 divisions/rev, bidirectional
- Rechargeable battery: Lithium-polymer
- Logging: Yes
- Connectivity: via Bluetooth® Low Energy technology or USB

Wireless Rotary Motion Sensor

PS-3220

Rotational Inertia Accessory

ME-3420

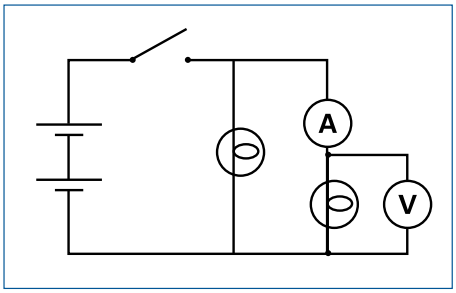
Includes disks (2): 8.9 cm diameter, 100 g; thin ring: 8.9 cm o.d., 7.9 cm i.d., 100 g; 38 cm pendulum rod (27 g); 75 g mass (2); clamp-on super pulley; alignment guides (3): 3.9 cm radius, 1.7 g

Modular Circuits

2017 AWARDS of EXCELLENCE TECH & LEARNING

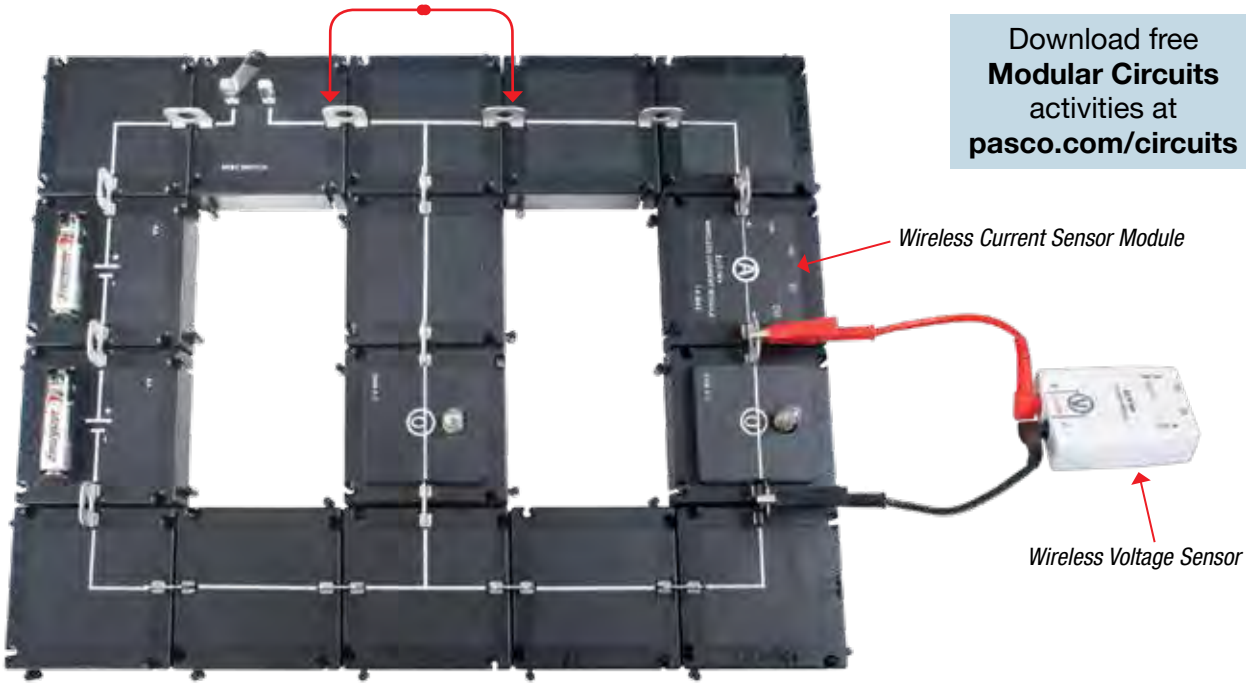
- Puts learning first
- Eliminates confusing wires
- Easy-to-connect modules

These circuit modules are designed specifically for introductory circuits labs. For students who have never wired a circuit, this modular system makes it easy for them to see the layout because it ends up looking like a circuit diagram.



Circuit Diagram

Students insert metal tabs to make the electrical connection.



Download free **Modular Circuits** activities at **pasco.com/circuits**

The Wireless Current Sensor Module makes it obvious that current goes through the component.

Since the Wireless Current Sensor is a module, it naturally fits in series with the circuit components. And since it doesn't have extra wires going to an interface, students can clearly see where the current goes.

To make them visible, many of the components are mounted on top of the module or in a well for protection.

Each module connects mechanically to another by sliding the tabs into each other.

NEW

Wireless AC/DC Module for Modular Circuits

The new Wireless AC/DC Module is a ±3 V DC power supply and AC signal generator, rolled into one compact package that fits directly into the PASCO Modular Circuits system. It is rechargeable via USB, making it the perfect battery eliminator for Modular Circuits. When used wirelessly (via Bluetooth® Low Energy), this new module provides a software-controllable signal generator for your basic circuits. Control this module with either PASCO Capstone™ or SPARKvue® software. Ultimate flexibility is achieved by using Blockly programming in either software.

The Wireless AC/DC Module is the perfect power supply for these experiments:

- Series and Parallel Circuits
- Capacitor Charge and Discharge
- RC and LRC Circuits
- Ohm's Law

Features:

- ±3 V
- DC
- Sine
- Triangle
- Square
- Bluetooth®
- USB rechargeable
- Control with software

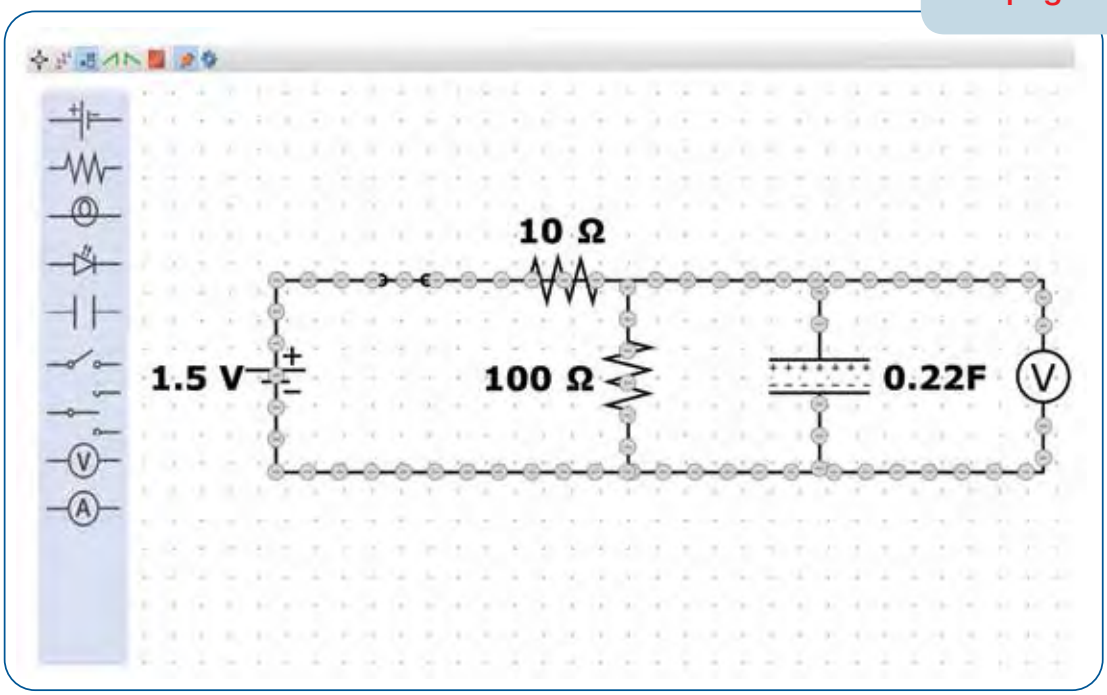
Perform Circuits Emulations with Modular Circuits and PASCO Capstone 2

Reinforce circuit concepts and tackle student misconceptions using circuit visualization.

When you use Modular Circuits and PASCO Capstone 2 and its Circuits Emulation tool, you can:

- Construct and modify circuits
- Show conventional current or electron flow animation
- Animate circuits with live sensor data

Learn more about Capstone 2 on pages 98-99.



See Modular Circuits ordering information on the following page.

Basic Modular Circuits Kit

EM-3535

See kit contents below.

Also available separately:

Battery Charger SE-3568
AA Rechargeable Batteries (4) SE-3569

Essential Physics Modular Circuit Kit

EM-3536

Includes Wireless Voltage Sensor and Wireless Current Sensor Module. See complete kit contents below.

Required:

PASCO Capstone Software See page 98
or SPARKvue Software See page 96

Also available separately:

Battery Charger SE-3568
AA Rechargeable Batteries (4) SE-3569

Modular Circuits Expansion Kit

EM-3540

See kit contents below.

Wireless AC/DC Module for Modular Circuits

EM-3533

Includes USB Cable

Required:

PASCO Capstone Software See page 98
or SPARKvue Software See page 96

Choose from 3 Modular Circuit Kits

Kits include these modules and apparatus:

	Basic EM-3535	Essential EM-3536	Expansion EM-3540
Corner Wire	4	4	2
Straight Wlre	4	5	2
Tee	2	2	2
Spring	1	1	1
Switch, SPDT	1	1	
Switch, SPST	1	1	
Resistor	2	3	
Capacitor	1	1	
Light Bulb	2	3	1
Potentiometer	0	1	
Motor	0	1	
LED	0	1	
1000 Turn Coil	0	1	
Battery Holder	2	2	1

	Basic EM-3535	Essential EM-3536	Expansion EM-3540
Battery, AA	2	2	
Jumper Clips	30	45	15
Diode	1	1	
330 ohm Resistor	1	2	
1000 ohm Resistor	1	2	
100 microfarad Capacitor	1	1	
330 microfarad Capacitor	1	1	
Magnets (0.45" x 0.25")	0	8	
Plotting Compass	0	1	
Alligator Clip Jumper Wire	0	1	
EM-3534 Current Sensor	0	1	
PS-3211 Wireless Voltage Sensor	0	1	
Gratnells® Storage Tray	1	1	1
Banana Jack Terminal			1

Wireless Sound Sensor

NEW

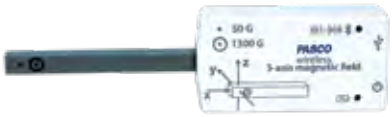
PS-3227

This new Wireless Sound Sensor is really two sensors in one device: a Sound Level Sensor and a Sound Wave Sensor.

- **The Sound Level function** gives you true sound level (intensity) measurements with both dBA and dBC scales. The dBC weighting scale measures the intensity of sounds in a wide range of frequencies. The dBA weighting scale filters some of the sound frequencies from a sound source to more closely match the frequency response of the human ear.
  Max. Sampling Rate: 100 kHz burst
- **The Sound Wave function** measures relative changes in sound pressure level as sound waves are incident on the sensor. With graphs of Sound Wave vs. Time, students can analyze wave properties such as wave shape, wave speed, amplitude, frequency, wavelength, and much more.
  Max. Sampling Rate: 20 Hz

Wireless 3-Axis Magnetic Field Sensor

PS-3221



Required to measure Earth's field:
Zero Gauss Chamber EM-8652

PASCO's new Wireless 3-Axis Magnetic Field Sensor is sensitive enough to measure Earth's magnetic field! It can also measure magnets and fields in a coil.

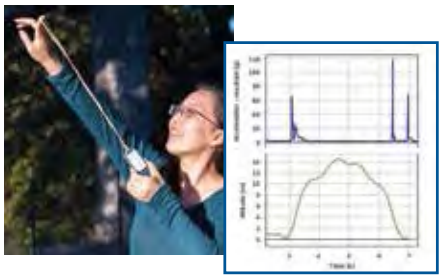
Typical Applications

- Measure magnetic field of permanent magnets.
- Measure Earth's magnetic field.
- Measure field strength of Helmholtz coils.

Wireless 3-Axis Acceleration/Altimeter

PS-3223

The Wireless 3-Axis Acceleration/ Altimeter can remotely log acceleration in three dimensions and altitude, making it ideal for recording roller coaster rides.



Typical Applications

- 3-axis accelerometer
- Four ranges: ±16 g, ±100 g, ±200 g, ±400 g
- 3-axis gyroscope on ±16 g range
- Altimeter

Award-Winning Wireless Spectrometry

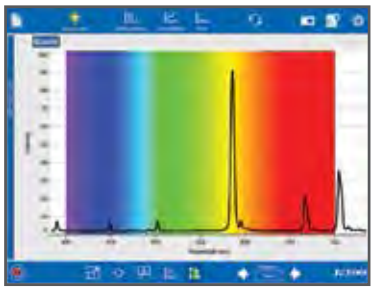
for iOS®, Android™, Chrome*, PC, and Mac®

Wirelessly measure intensity, absorbance, transmittance, and fluorescence. The Bluetooth® and USB connectivity enable use with your tablets and computers, which makes this a powerful and intuitive tool for your spectrometry needs.

winner! 2016 AWARDS EXCELLENCE TECH&LEARNING

//CODiE// 2017 SIIA CODiE WINNER

bett AWARDS 2017 FINALIST



Measure emission spectra with the Fiber Optic Cable.

Wireless Spectrometer

PS-2600

Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:

Optional Fiber Optic Cable
PS-2601

Cuvettes & Caps
SE-8739

Cuvette Rack
EC-3590

*Go to **pasco.com/spectrometer** to see our ever-expanding list of supported Chromebooks™.

Wireless Temperature Sensor

PS-3201

Includes 1 coin cell battery.

Welcome to the modern thermometer. Students can access instant temperature readings but also continuously monitor, log, and plot temperature data in SPARKvue on nearly any connected device. When class-time ends but the experiment continues, students can set the sensor to log data autonomously for days or weeks and then download the data for analysis.

The versatile Wireless Temperature Sensor works well, both in the lab and outdoors.

Wireless Force Acceleration Sensor

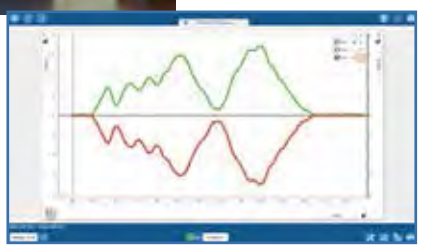
PS-3202

Includes 1 eye bolt, 1 thumb screw, 1 bumper, a lithium-ion battery, and a USB connector.

Capable of measuring force, acceleration, and rotation, this sensor is ideal for experiments involving rotating platforms, moving carts, spring oscillations, collisions, and impulse. The wireless design offers improved measurements without a cable affecting experiment outcome. Use finger-holes for handheld applications, or mount it onto a cart or rod.

When students are the force, Newton's Third Law is no longer a leap of faith.

Directly compare action and reaction of forces.



Wireless Voltage Sensor

PS-3211

Includes rechargeable battery and banana-clip cables.

Explore energy and energy transformations with this sensor. Use it to:

Wireless Current Sensor

PS-3212

Includes rechargeable battery and banana-clip cables.

This sensor's wide current range allows for introductory and advanced explorations of the fundamental concepts of electricity and basic circuits.

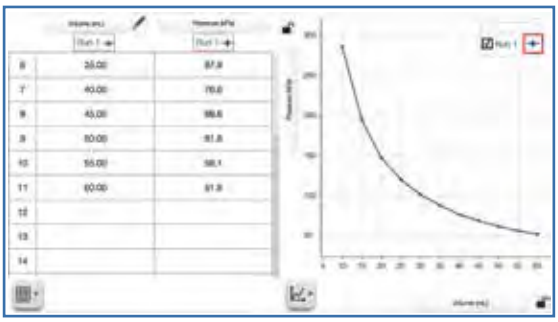
Wireless Pressure Sensor

PS-3203

Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barb connectors, 1 female barb connector, 1 60 cc syringe, a lithium-ion battery, and a USB connector.

With the Wireless Pressure Sensor you can make accurate and consistent measurements of gas pressure, regardless of ambient conditions, and explore gas laws and how chemical reactions affect gas pressure.

Make accurate and consistent measurements of gas pressure, regardless of ambient conditions. Study the Empirical Gas Laws.



Here is the ideal sensor to study gas laws!

Wireless Light Sensor

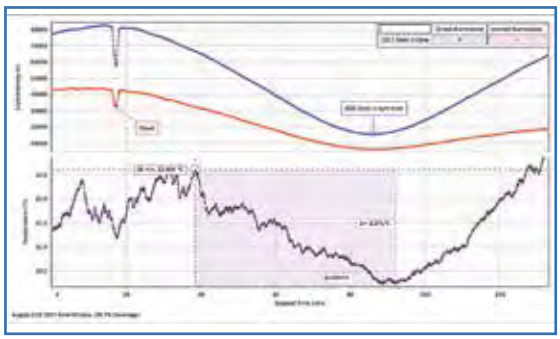
PS-3213

Includes 1 coin cell battery.

This wireless sensor is a great tool for explorations in Earth, Life, and Physical sciences. With its ambient light detector for illuminance and UV, and its directional detector for colors, your students can explore gas laws, the electromagnetic spectrum, model planetary motion, and relate photosynthesis to light color and intensity.

PASCO's Wireless Light Sensor provides students with the tools to explore the electromagnetic spectrum, model planetary motion, study gas laws, and relate photosynthesis to light color and intensity.

This eclipse data was collected at PASCO in Roseville, CA, on August 21, 2017.



Wireless Sensor Charging Station

PS-3599

Includes Charging Station (13 cm x 35 cm), power adapter, 10 USB charging cables, and 9 removable partitions.

This versatile charging station can be configured to fit any size wireless sensor by adding or removing partitions.

Typical Applications

- Charge all types of PASCO wireless sensors.
- Remove partitions to resize sensor bays.

SPARK LXi

PASCO's NEXT GEN SCIENCE DATALOGGER for indoor and outdoor use

ThIs innovative science handheld device blends PASCO probeware with SPARKvue data collection and analysis software. It is durable, splash-proof, and works seamlessly with our PASPORT and wireless sensors.

- Ruggedized case for indoor/outdoor and wet/dry lab use
- 8.0" full-color touchscreen
- Simultaneously connects up to 5 wireless sensors
- Includes 2 PASPORT ports
- Includes Voltage Probe and port
- Includes Temp Probe and port
- Can connect more PASPORT sensors with the AirLink, SPARKlink Air, and 550 Universal Interface
- Installed software: PASCO SPARKvue, MatchGraph!, Spectrometry, Microsoft Office Suite, Google Suite
- Hands-free stand

SPARK LXi

PS-3600A

Use with wired and wireless sensors, the SPARK LXi can simultaneously accommodate up to five wireless sensors. It also includes two ports for blue PASPORT sensors, plus two ports for the included Fast Response Temp Probe and the Voltage Probe.

Also available:

SPARK LXi Charging Station
PS-3602

The PASCO 550 Universal Interface…

This powerful wireless sensor interface for Physics works with SPARKvue and Capstone.

This is the interface with the measurement capability for any physics experiment your physics lab needs. It features:

- 2 MHz sampling rate
- 2 high-speed analog inputs
- 2 digital inputs for photogates and other timing sensors
- 2 PASCO PASPORT sensor inputs
- Signal generator with built-in Voltage and Current sensors.
- Use with other PASPORT interfaces
- Connect to computers via USB
- Bluetooth® connectivity

With the 550, your Physics lab is equipped with high-speed data collection, signal generation and power supply, oscilloscope and FFT displays, timers, and more.

Specifications:

2 high-speed analog inputs
Measurement Range: ±10 V differential input
Input Impedance: 1 MΩ
Input Protection: ±250 V continuous
Selectable Voltage Gain: X1, X10, X100
Resolution: 14-bit, 0.12 mV

2 Digital Inputs
Digital sensors such as Photogates and Time-of-Flight plug directly into the 550 Interface.
- Compatible with all ScienceWorkshop digital sensors
- Sensor Connect Detection
- 0-5 V TTL
- Bi-directional

2 PASPORT Inputs
Compatible with PASCO's complete line of more than 80 PASPORT sensors.
- Sample rates depend on sensors

Signal Generator
Waveforms: sine, triangle, square wave, positive and negative ramps, DC
Frequency Range: 0.001 Hz to 100 kHz; 1 mHz resolution
Amplitude Range: ±8 V;
Resolution: 1.33 mV, 12-bit DAC.
Max Output Current: 400 mA at 8 V, over-current detection
Selectable Voltage Limit
Selectable DC Offset
Frequency Sweep Function
Measure Output Current, Voltage

550 Universal Interface

UI-5001

Requires:

PASCO Capstone Software
See pages 98-99.

OR

SPARKvue Software
See pages 96-97.

Interface Comparison

Compare the features and capabilities and see which interface works best in your lab.




	SPARK LXi PS-3600A	AirLink PS-3200	SPARKlink Air PS-2011	550 Universal Interface UI-5001
PASPORT Ports	2	1	2	2
Analog Inputs	0	0	0	2 (±10 V, optional gain voltage 10x, 100x)
Digital Inputs	5	0	0	2
Connects via USB	Yes	Yes	Yes	Yes
Connects via Bluetooth	Yes	Yes	Yes	Yes
Rechargeable battery (for cordless operation only)	Yes	Yes	Yes	No (AC adapter)
Works with PASCO Capstone Software	No	Yes	Yes	Yes
Works with SPARKvue Software	Yes	Yes	Yes	Yes
Accepts PASPORT Sensors	Yes	Yes	Yes	Yes
Accepts ScienceWorkshop Sensors	No*	No*	No*	Yes
Maximum Sampling Rate	Sensor dependent <1000 Hz	Sensor dependent <1000 Hz	Sensor dependent <1000 Hz	Up to 2 MHz on one channel
Signal Generator	N/A	N/A	N/A	±8 V, at 400 mA, DC to 100 kHz
Included Items	Ruggedized case, hands-free stand, SPARKvue, MatchGraph!, Spectrometry	USB Cable	AC adapter, USB cable, fast response temperature and voltage probe	USB cable, Power supply

* The AirLink and SPARKlink Air can accept most ScienceWorkshop sensors with the proper adapter, although they won't have the same high maximum sample rates. One exception is the Sound Sensor (UI-5101), which is not recommended for use with an adapter.

AirLink

PS-3200

Includes one PASPORT sensor port, USB and Bluetooth connectivity, and USB cable.

SPARKlink Air

PS-2011

Includes 2 PASPORT sensor ports, as well as voltage and temperature ports, USB and Bluetooth connectivity, USB cable, and voltage probe and fast response temperature probe.

SPARKvue® 4 Software

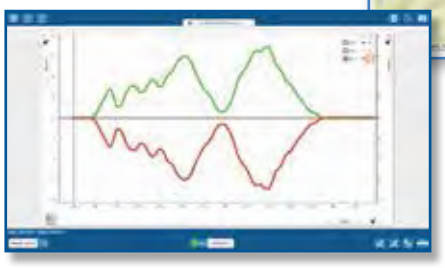
Award-winning data collection and analysis software for any platform

SPARKvue's intuitive design has made it an award-winning tool for collecting and analyzing experimental data. The user-friendly platform optimizes data collection and provides tools for in-depth analysis to provide students with a compact, yet powerful workspace. With the recent release of SPARKvue 4, we've added new features, including a new Welcome screen and Blockly coding. Now, students can use block-based code to sense and control PASCO output devices, such as the 850 Universal Interface or any of our wireless sensors.

Designed for All Sciences

Collect data in real time using PASPORT or wireless sensors.

SPARKvue comes installed on every SPARK LXi.



Interactive data displays that are specific to your activity.

Data Collection:

- **Live Data Bar:** See sensor readings before recording
- **Periodic sampling:** Automatic sampling at a fixed rate
- **Manual sampling:** Saves data only when a user specifies
- **Blockly:** Code PASCO output devices to collect data
- **Collaborate:** Start a shared session and stream results in real-time

Data Displays:

- Graph displays with multiple plot areas and axes
- Digits
- Meter
- Data tables
- FFT
- Map Display
- Weather Dashboard

Tools for Data Analysis:

- **Scale-to-fit:** Adjust axis for optimal data view
- **Data Selection:** Easily select a portion of data for analysis
- **Prediction Tool:** Visualize a prediction alongside the data
- **Smart Tool:** Find data coordinates & calculate delta values
- **Calculations Tools for Statistics:** Easily obtain statistics such as minimum, maximum, mean values and more
- **Slope Tool:** Find the slope of a point
- **Curve Fits:** Various curve fits with goodness of fit values
- **User Annotation:** Easily add text notes to runs or points
- **Axes:** Add another *y*-axis or a new plot with one button

SPARKvue Resources:

- Video Library: 330+ free videos featuring SPARKvue
- PASCO Blog: Dozens of fun applications for SPARKvue
- Experiment Library: 80+ free and downloadable SPARKvue labs
- FREE webinar training from PASCO professionals on our website
- On-site Workshops: Personalized professional development
- Visit **www.pasco.com/training-and-events** for more information

Try SPARKvue software for FREE.

Get Started Today!

The full and complete version of SPARKvue is now available as a FREE app for iPad® and Android™ tablets, Chromebook™, as well as free apps for iPhone and Android phones.

We also offer free 60-day trials for PC and Mac®* at **pasco.com**

Cross-Platform Compatibility

SPARKvue (single user license)

PS-2401

Windows® and Mac®

SPARKvue (site license)

PS-2400

Windows® and Mac®

SPARKvue App

Free downloads for iPad, iPhone, Android tablets and phones, and Chromebook.

Visit www.pasco.com/downloads

Download on the App Store

Available in the Chrome Web Store

ANDROID APP ON Google play

Make the switch to PASCO capstone™ 2

The Most Advanced Data Collection Software in Science Education

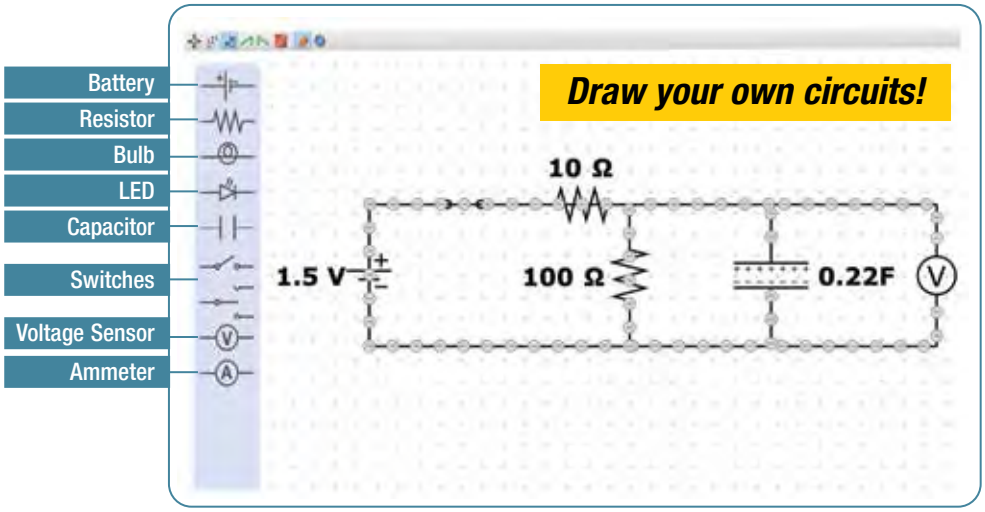
PASCO is pushing the limits of technology, so you can push your students to their potential. Working closely with educators, we continuously develop Capstone™, making improvements and enhancing the teaching features. Capstone is designed to handle large data sets, high-speed sampling, and customized preferences to fit the needs of your lab. A straightforward user interface is approachable for beginners, yet Capstone offers all the capabilities needed for even the most advanced users.

NEW Features in PASCO Capstone 2

Visit **pasco.com/capstone** for more information.

Circuits Emulation

Reinforce circuit concepts and tackle student misconceptions using circuit visualization.



Combine real-world circuits with simulations, animation, and live measurements.

With this tool you can:

- Construct and modify circuits
- Show conventional current and electron flow animation
- Animate circuits with live sensor data

Build your own circuits on Capstone. Drag and drop components and draw wires to connect.

- Demonstrate series and parallel
- Charge and discharge capacitors

Trials Table

Organize your data to analyze physical relationships.

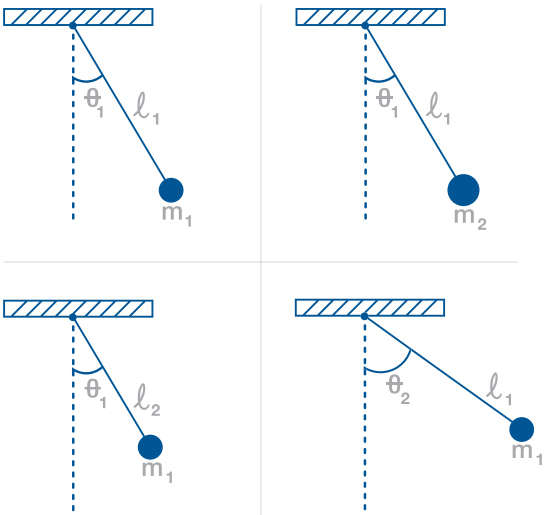
Trials Table feature coming soon in 2020!

The trials table allows you to tabulate your variables and experimental controls.

- Track variables
- Average runs
- Plot derived values
- This is how science is actually done!

Trial Table: Vary Length/Mass of Pendulum

Trial	Run	Length (cm)	Mass (g)	Period (s)	Avg Period (s)	Avg Period ± (s)
1	1	45.00	70.05	1.353	1.354	0.003
	2			1.352		
	3			1.357		
2	4	30.00	70.05	1.147	1.149	0.004
	5			1.146		
	6			1.153		
3	7	15.00	70.05	0.946	0.945	0.001
	8			0.945		
	9			0.945		
4	10	45.00	7.19	1.344	1.340	0.004
	11			1.340		
	12			1.337		

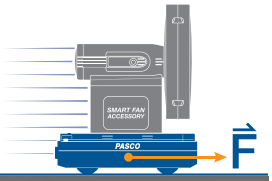


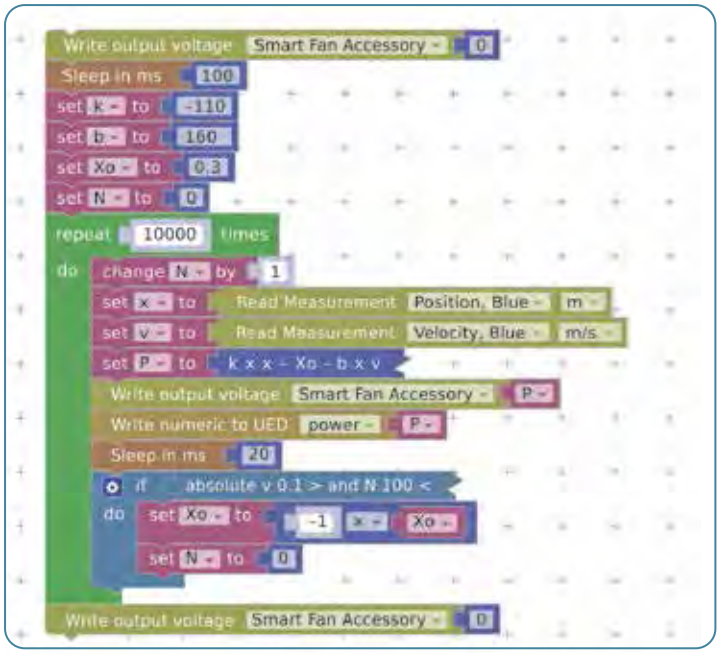
800.772.8700 (inside US) +1 916.786.3800 (outside US)

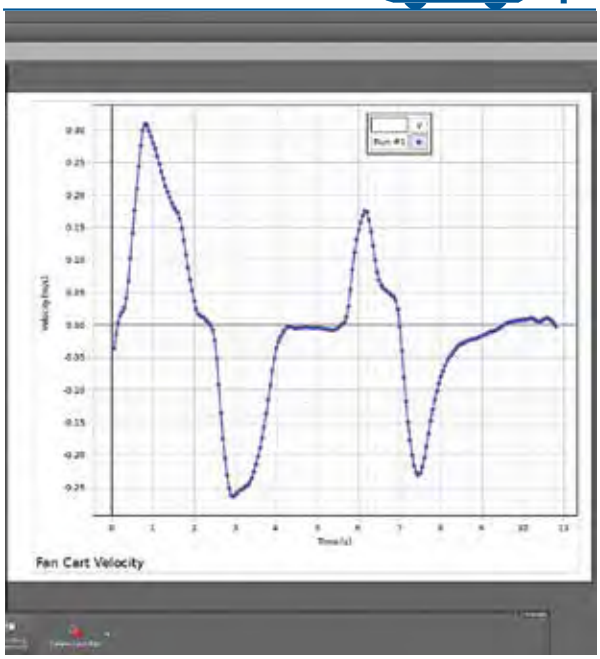
Blockly Block-based Coding

- Control all PASCO sensors and interfaces
- Create sense and control programs
- Control outputs from sensor inputs

Bring computational thinking into your science lab!



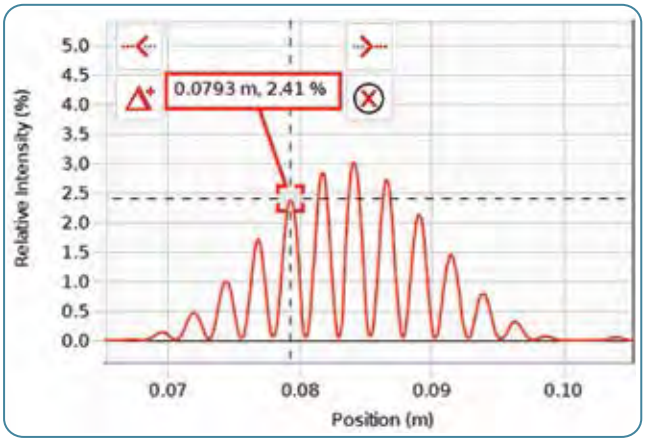




Visit **pasco.com/capstone** for more information.

Graph Pop-up Tools

Quick access to commonly used analysis tools



Capstone has all the software tools you need for data collection and analysis. And we continue to add more features, based on input from physics educators just like you!

- Exclude or delete selected data points from analysis.
- Create models using the calculator.
- Calculated columns in tables
- Error bars
- Weighted linear fit that takes into account error bars
- More complex curve fits such as damped sine, Gaussian, sine series, and user-entered fits
- Smooth data directly on a graph with slider tool.
- Global preferences settings

Download the Free Trial
www.pasco.com/Capstone
Requires Mac or Windows

PASCO Capstone 2 Software
Single User Lic. UI-5401 or UI-5401-DIG
Site Lic. UI-5400 or UI-5400-DIG

TOOLS

Configure PASCO Hardware
Works with PASPORT, ScienceWorkshop, and Wireless Sensors

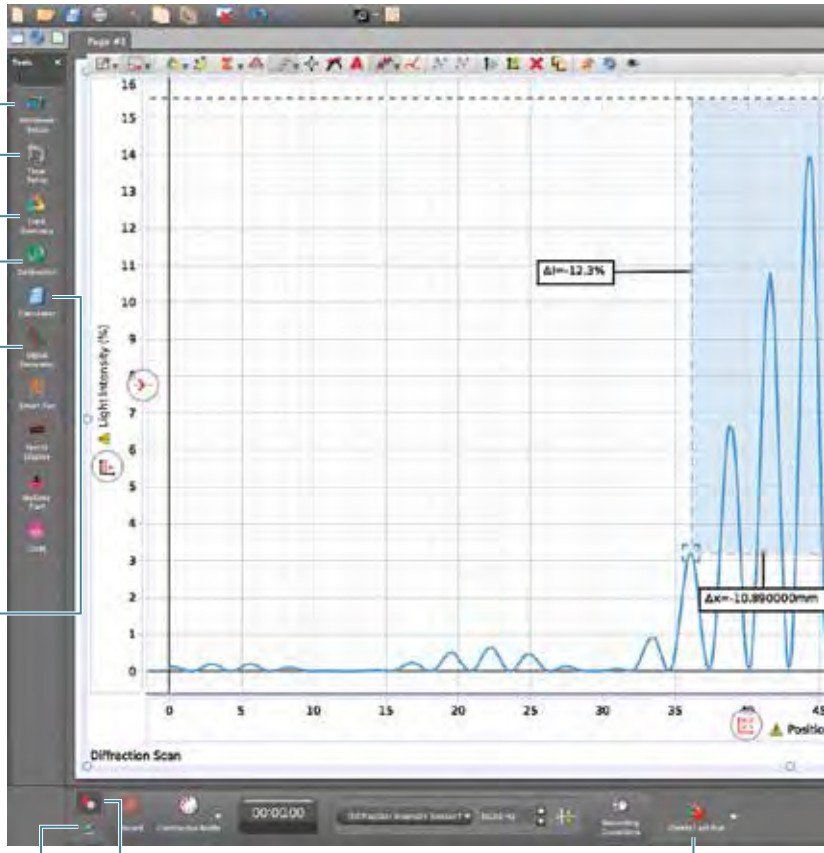
Photogate Timer Wizard
Easily configure photogates and timing measurements

Data Summary
- Equations/calculations
- Fundamental constants
- Experimental constants
- Trials and runs

Sensor Calibration Wizard
- Step by step calibration
- Many calibration types

Signal Generator
- Scan through a range of frequencies
- Control signal output with a calculation

Calculator
- Graph modeling
- Create data sets using sensor data

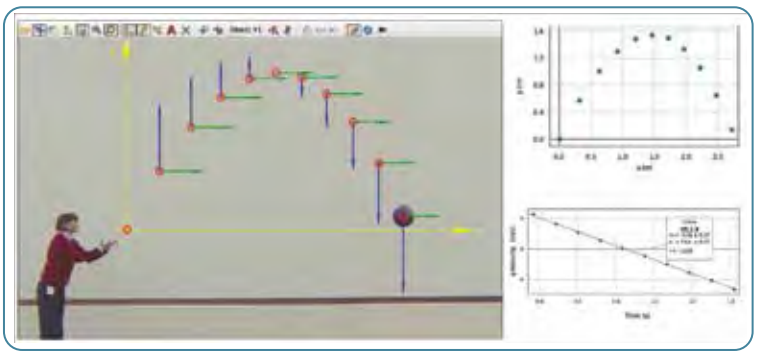


Sophisticated scientific calculator has statistics, calculus, filters, logic functions, and special operations such as amplitude and period.

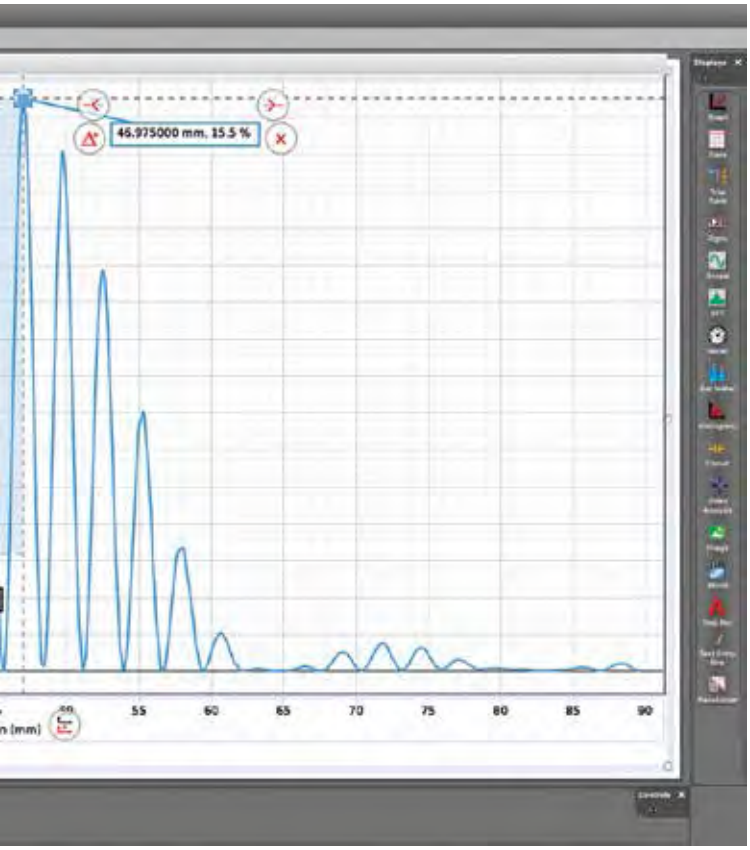
Replay Your Data
- Change replay rate
- Increment by frame
- Loop playback

Sampling Options
- Continuous manual sampling
- Fast monitor mode
- Independent sensor sampling rates
- Start/stop conditions
- Zero sensor

Capstone 2 Includes Video Analysis



Import video and analyze the motion of objects to measure position, velocity, and acceleration. With this tool you can also:
- Show velocity and acceleration vectors
- Use magnifier to identify exact center of an object
- Use calibration ruler at any time
- And so much more!



DISPLAYS

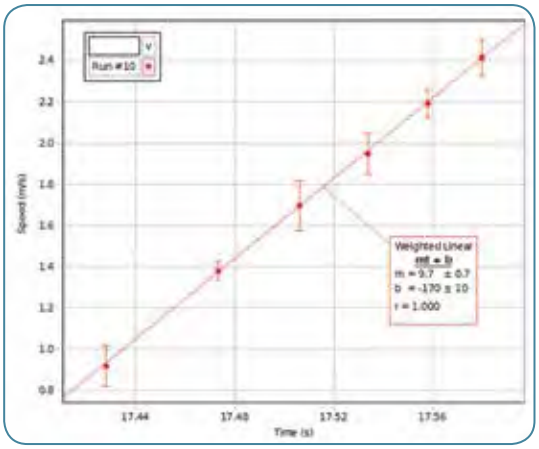
Display *Your* Data *Your* Way

- Graph
- Table
- Digits
- Scope
- FFT
- Meters

Graph Tools Include

- Draw predictions on graphs before taking data.
- Multiple *y*-axes and/or multiple plot areas
- Perform Quick-Calcs on the graph axis to linearize data.
- Curve-fits report the uncertainties in the parameters.
- Multi-coordinate tool gives *y*-values wherever it intersects data.

Error Bars and Weighted Linear Fits



Graph uncertainties using user-entered error bars, absolute error, or percent error. The weighted linear fit incorporates the error bars.

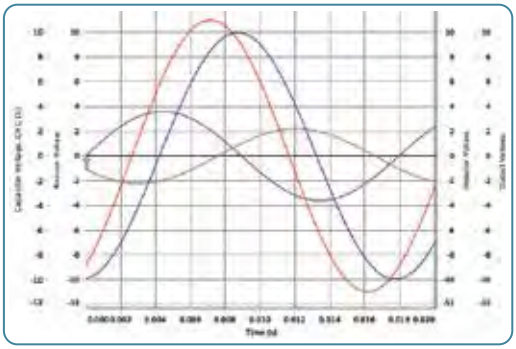
Visit **pasco.com/capstone** for more information.

Delete Runs

- Last run only
- Select from list
- All runs

Made a mistake?
Just hit
UNDO

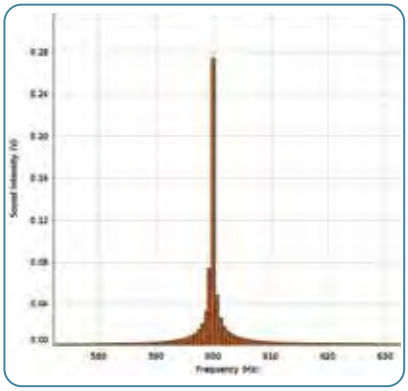
Oscilloscope Display



This display behaves like an authentic digital oscilloscope.

- Trigger
- Single trace collection
- Sample rate tied to time axis scale
- Set trace offset

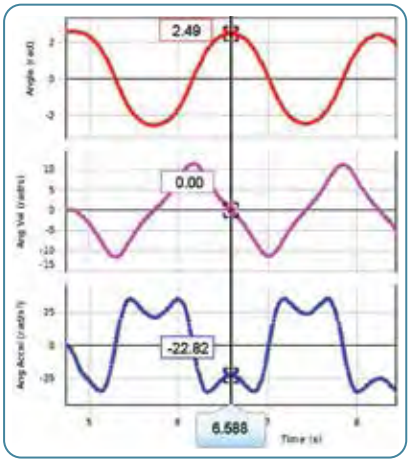
FFT



Display data in the frequency domain to find peak frequency and harmonics.

- Sample rate tied to axis scale
- Normalize data
- Adjust BIN width

Multi-Coordinate Tool



Easily show the relationship between multiple data plots by comparing data values across the time axis.

Building Better Bridges Kit

Teach engineering concepts with this complete STEM bridge-building kit.

Now is the perfect time for your students to learn about bridge-building and how bridges really work. This complete STEM kit allows students to learn and apply engineering design concepts. They can use the I-Beams to build bridges and structures that behave like the real thing! And with the included Wireless Load Cell, students can measure forces under tension or compression anywhere on their structures.

Students can perform the following lab investigations using PASCO's Building Better Bridges Kit.

- Measuring Forces
- Equilibrium of Forces
- Equilibrium of Rotation
- Forces in Trusses
- Forces in Bridges

This kit is compatible with PASCO Structures System.

Building Better Bridges Kit

ME-3581

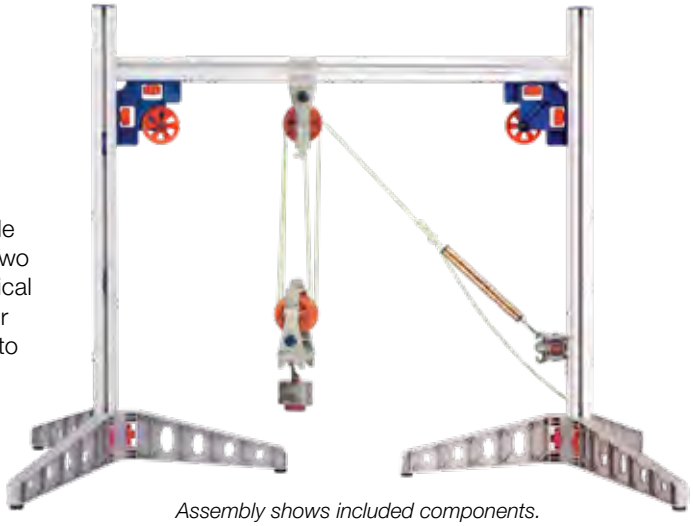
Includes Lab Activities, Wireless Load Cell (with Bluetooth® Low Energy), I-Beams (various sizes), Connectors, Truss Screws, Weight Set, a Gratnells® Case and more

Want another Load Cell?
Wireless Load Cell PS-3216

Simple Machines Engineering Kit

EP-3577

Our Simple Machines Engineering Kit engages students in a wide range of physics, physical science, and engineering concepts. Two triple-pulley blocks make it easy to build machines with mechanical advantage up to 6:1. Build all three classes of levers with our pair of 20-cm levers, or combine gears, levers, and pulleys together to show how rotating machines work.



Assembly shows included components.

Simple Machines Engineering Kit

EP-3577

Includes

- *10 N Metal Spring Scales (2)*
- *Tripod Stands (2) & Crossrail*
- *Universal Spring Hanger (2)*
- *Right-angle Connector with Pulley (2)*
- *Fixed Triple Pulley Block*
- *Hanging Triple Pulley Block*
- *Friction Block*
- *Quick-attach Gear Hubs (4)*
- *Gear Spacers (12)*
- *20 cm Levers (2)*
- *60 Tooth Spur Gears (2)*
- *40 Tooth Spur Gears (2)*
- *20 Tooth Spur Gears (3)*
- *20 cm-diam. Large Pulleys (2)*
- *Weights*
- *String*
- *Gratnells® Storage Tray*

Simple Machines Teacher Resources

EP-6483

- Complete with guided inquiry lab activities, suggested answers, and much more
- Requires Simple Machines Engineering Kit

Questions are embedded throughout the activities. Other features include sequencing and key-term challenges. Opportunities to predict outcomes prior to data collection and post-lab multiple choice questions help to make the connection between lectures and labs as seamless as possible. And the lab activities are correlated to state and national standards. For more information, visit pasco.com

Simple Machines Teacher Resources

EP-6483

Sensor Index

PASCO's 5-Year Educational Warranty

To withstand the rigors of student use, PASCO products are made of the highest quality materials. They are designed and manufactured by our team of education experts and engineers in Roseville, California. And we back up our products with a 5-year warranty, so you can be completely confident about buying PASCO solutions.

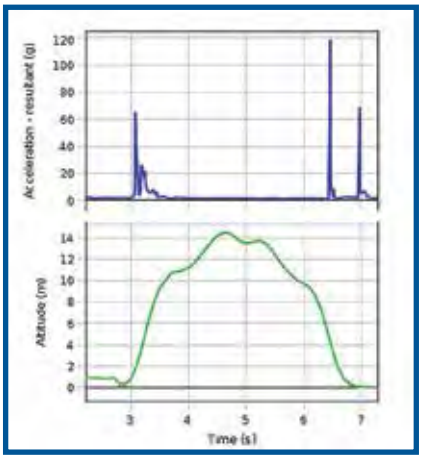
Wireless 3-Axis Acceleration/ Altimeter

PS-3223

The Wireless 3-Axis Acceleration/ Altimeter can remotely log acceleration in three dimensions and altitude, making it ideal for recording roller coaster rides.

Typical Applications

- 3-axis accelerometer
- Four ranges: ±16 g, ±100 g, ±200 g, ±400 g
- 3-axis gyroscope on ±16 g range
- Altimeter

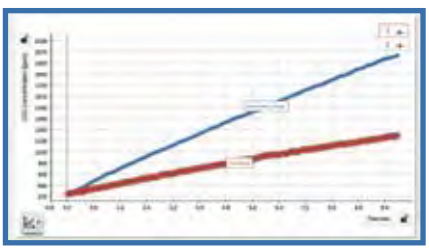


Wireless CO_2 Sensor

PS-3208

Includes 250-ml sampling bottle and USB charging cable.

Use this wireless sensor to measure the concentration of CO_2 gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO_2 data can be logged directly on the device for long-term life science and environmental science studies.



Directly compare separate controlled environments.

Wireless Colorimeter and Turbidity

PS-3215

Includes 10 cuvettes, 1 turbidity calibration standard (100 NTU), 2 cuvette racks and USB charging cable.

Also available:

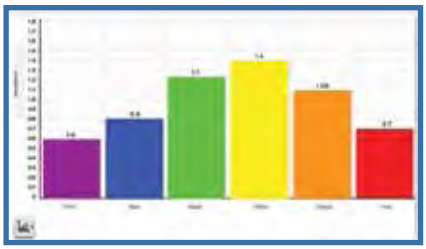
Spectrometer/Colorimeter Cuvettes SE-8739

Determine the concentration of a solution with ease. Study absorbance vs. concentration to explore Beer's Law, and measure chemical rates of reaction.

The Teaching Advantage

- Simultaneous data collection in six wavelengths (colors) of light increases accuracy of results and reduces frustration caused by missing data
- Sensor calibrates in all wavelengths automatically in one step
- Rates of reaction experiments can be conducted easily.

Set up in seconds and collect individual measurements with ease.



Determine the relationship between absorbance and concentration.

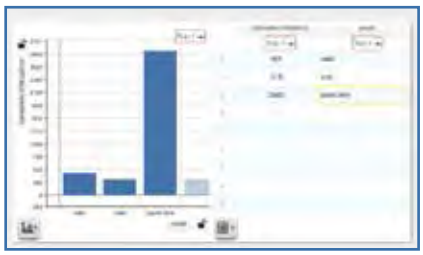
WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Wireless Conductivity Sensor

PS-3210

Includes 1 coin cell battery.

Use the Wireless Conductivity Sensor to measure the electrical conductivity of a water solution. With this wireless sensor you can investigate the properties of solutions, as well as model and measure water quality.



Measure the conductivity of water and water-based solutions.

Features

- Measure both conductivity and total dissolved solids
- Automatic temperature compensation
- Dust- and sand-proof and water-resistant (1 meter for 30 minutes)
- Battery life >1 year
- Remote logging

Wireless Current Sensor

PS-3212

Includes rechargeable battery and banana-clip cables.

This sensor's wide current range allows for introductory and advanced explorations of the fundamental concepts of electricity and basic circuits.

Features

- Range ±1A
- Bluetooth® sampling rate of 1 kHz
- High-speed sampling via USB; 100 kHz burst mode
- Includes remote logging on your device

See our complete line of sensor storage trays and rolling carts on pages 148-149.

Wireless Force Acceleration Sensor

PS-3202

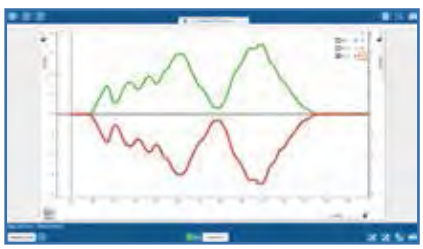
Includes 1 eye bolt, 1 thumb screw, 1 bumper, a lithium-ion battery, and a USB connector.

Capable of measuring force, acceleration, and rotation, this sensor is ideal for experiments involving rotating platforms, moving carts, spring oscillations, collisions, and impulse. The wireless design offers improved measurements without a cable affecting experiment outcome. Finger-holes support handheld applications, or mount it onto a cart or rod.

The Teaching Advantage

- Simultaneously measures force and acceleration. Measures acceleration in x, y, and z axes and resultant acceleration. Built-in gyroscope measures rotation.
- Features convenient Bluetooth® wireless connectivity and long-lasting rechargeable battery.
- Probe can be quickly zeroed through software for accurate taring.
- Logs force and acceleration data directly onto the sensor for long-term experiments.

When students are the force, Newton's Third Law is no longer a leap of faith.



Directly compare action and reaction of forces.

Wireless Light Sensor

PS-3213

Includes 1 coin cell battery.

This wireless sensor is a great tool for explorations in Earth, Life, and Physical sciences. With its ambient light detector for illuminance and UV, and its directional detector for colors, your students can explore the electromagnetic spectrum, model planetary motion, and relate photosynthesis to light color and intensity.

Features

All these measurements in one!

- Illuminance (lux), PAR, and irradiance
- UVA, UVB, and UV Index
- RGB color detection
- Battery life >1 year
- Includes remote logging on your device

Wireless 3-Axis Magnetic Field Sensor

PS-3221

Includes 3-Axis Magnetic Field Sensor, Sensor Mounting Rod, USB Charging Cable

This 3-Axis Magnetic Field Sensor can sense the Earth's magnetic field and fields from coils and bar magnets. There are two ranges: ±50 gauss and ±1300 gauss. This sensor is primarily for static fields.

The Teaching Advantage

- Simultaneous measurements on three axes
- Dual range: ±50 G and ±1300 G
- Sensitive enough to measure the Earth's magnetic field
- Measure fields from bar magnets and coils

Wirelessly measure the magnetic field strength inside a solenoid as a function of current.

Features

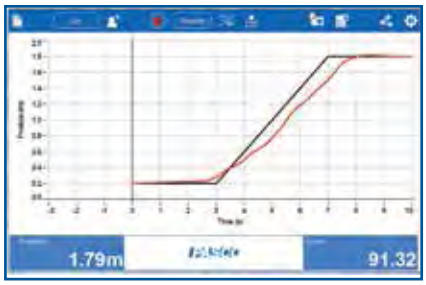
- Ranges: ±50 G and ±1300 G
- Resolution: ±0.01 G (50 G range); ±2 G (1300 G range)
- Maximum Sample Rate: 100 Hz
- Measurements: Magnetic Field Strength (3 axes and resultant)
- Logging: Yes
- Battery: Rechargeable Lithium-Polymer
- Connectivity: Direct USB or via Bluetooth 4.0

Wireless Motion Sensor

PS-3219

Recommended:
MatchGraph! Software *See page 82*

The Wireless Motion Sensor measures position, velocity, and acceleration of objects using ultrasound. Students can measure themselves and watch their motion graphed in real time. The Wireless Motion Sensor can detect objects within a range of 15 cm to 4 m away. The fact that the sensor is wireless means no cables to get in the way, which is key for handheld or ceiling-mounted applications. The Wireless Motion Sensor connects directly to your devices via Bluetooth® or USB.



The Wireless Motion Sensor works with our free MatchGraph! software (see page 76). It is an ideal way to teach the concepts of motion graphing, interpreting graphs, and rate of change or slope.

Features

- Range: 0.15 to 4 m
- Resolution: 1 mm
- Maximum sample rate: 50 Hz
- Transducer rotation range: 180°
- Rechargeable battery: Lithium-polymer
- Logging: Yes
- Connectivity: Direct USB or via Bluetooth® (Bluetooth 4.0)

Wireless Oxygen Gas Sensor

PS-3217

Includes USB charging cable, 250-mL sampling bottle

The Wireless Oxygen Gas Sensor is accurate and easy to use, which makes it the perfect sensor to study photosynthesis, respiration, and oxygen cycling in the environment. With remote logging, simultaneous measurement of humidity and temperature experiments can go beyond the lab period and easily give students hours or days of data for analysis.

Features

- Bluetooth® and USB connectivity
- 0-100% Oxygen Gas Concentration
- ±1 % Oxygen at constant temperature and pressure
- Also reports ambient temperature and humidity
- 2-3yr operating life with replaceable sensing element

(See pasco.com for full specifications.)

PASCO's 5-Year Educational Warranty

To withstand the rigors of student use, PASCO products are made of the highest quality materials. They are designed and manufactured by our team of education experts and engineers in Roseville, California. And we back up our products with a 5-year warranty, so you can be completely confident about buying PASCO solutions.

Wireless pH Sensor

PS-3204

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

This sensor measures the pH of a solution as discrete measurements or as a continuous reading. Use the probe to study water quality, test household solutions, or perform high-resolution acid-base titrations.

The Teaching Advantage

- High resolution with low noise allows even subtle pH changes to be observed.
- Factory calibration lets students get right to data collection, with optional user calibration supported.
- Uses durable, accurate gel-filled Ag-Ag Cl electrode.
- Features convenient Bluetooth® wireless connectivity and long-lasting coin cell battery.
- Logs pH data directly onto the sensor for long-term experiments.

The versatile Wireless pH Sensor works as well in the field as in the lab.

Easily measure and compare the pH of common acids and bases.

Wireless Pressure Sensor

PS-3203

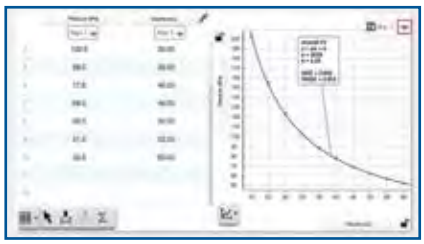
Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barbed luer locks, 1 female barbed luer lock, 1 60cc syringe, a lithium-ion battery, and a USB connector.

With the new Wireless Pressure Sensor you can make accurate and consistent measurements of gas pressure, regardless of ambient conditions, and explore gas laws and how chemical reactions affect gas pressure.

The Teaching Advantage

- Measures pressure relative to an internal sealed reference vacuum, which allows the collection of reliable data even when the pressure within the system drops below ambient pressure.
- Supports common units (kPa, atm, psi, mmHg, or N/m2) for many applications.
- Features Bluetooth® wireless connectivity and long-lasting rechargeable battery.

A test tube, piece of steel wool, and a Wireless Pressure Sensor are all you need to have your students calculate the amount of oxygen in the air.



With the included syringe, your students can easily quantify the relationship between pressure and volume.

Wireless Rotary Motion Sensor

PS-3220

The Wireless Rotary Motion Sensor measures angle, angular velocity, and angular acceleration, as well as their linear equivalents. The included three-step pulley allows different torques to be applied, rotating a rigid system at different rates of acceleration. The included rod-mounting holes let you orient the sensor for different experiments. The Wireless Rotary Motion Sensor connects directly to your devices via Bluetooth® or USB.

Show that angular momentum is conserved: The Wireless Rotary Motion Sensor records the angular velocity as a ring is dropped on a spinning disk.

Features:

- Angle resolution: 0.18° (0.00314 radian)
- Linear resolution: 0.0157 mm (with 5 mm pulley radius)
- Three-step pulley: 10, 29, and 48 mm diameter
- Shaft diameter: 6.35 mm
- Maximum rotation rate: 30 revolutions per second
- Optical encoder: 2000 divisions/rev, bidirectional
- Rechargeable battery: Lithium-polymer
- Logging: Yes
- Connectivity: Direct USB or via Bluetooth® 4.0

Smart Cart

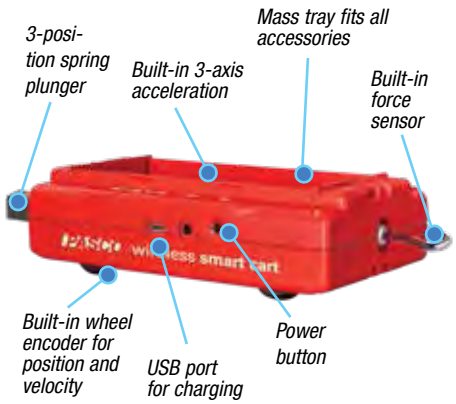
ME-1240 (red)
ME-1241 (blue)

U.S. Patent Number 10481173

It is the ultimate tool for your physics lab with built-in sensors that measure force, position, velocity, and acceleration. The Smart Cart can make these measurements on or off a dynamics track and transmit the data wirelessly over Bluetooth®.

Features:

- Built-in ±100N force sensor
- 3-axis accelerometer
- Built-in wheel encoder
- Bluetooth connectivity
- Magnetic bumper for force sensor
- 3-position plunger
- Mass tray
- Velcro® tabs
- Rechargeable battery
- Force sensor hook and rubber bumper
- Available in red and blue



Wireless Smart Gate

PS-3225

The Wireless Smart Gate has all the features of the wired Smart Gate. It has dual photogate beams spaced at 1.5 cm to accurately measure speed. The built-in laser switch (when used with any laser) allows you to time objects too large to fit through the standard photogate. Use Photogate Tape passing through the photogate slot to measure movement of objects. The auxiliary port is for adding an additional photogate head or Time-of-Flight Accessory. NOTE: When using two Wireless Smart Gates, be aware that the synching resolution between two gates can be as much as 2 ms.

Features:

- Dual photogate beams
- Laser switch
- Photogate tape slot
- Auxiliary photogate/Time-of-Flight port

Specifications:

- Logging: Yes
- Battery: Rechargeable Lithium-Polymer
- Connectivity: Direct USB or via Bluetooth

Wireless Sound Sensor

PS-3227

This new Wireless Sound Sensor is really two sensors in one wireless device: a Sound Level Sensor with both dBA- and dBC-weighted scales, and a Sound Wave Sensor that can measure changes in relative sound pressure level as a function of time.

Wireless Temperature Sensor

PS-3201

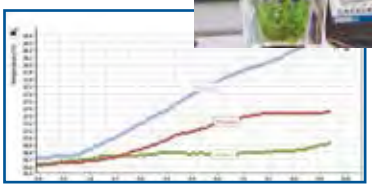
Includes 1 coin cell battery.

Welcome to the modern thermometer. Students can access instant temperature readings but also continuously monitor, log, and plot temperature data in SPARKvue on nearly any connected device. When class-time ends but the experiment continues, students can set the sensor to log data autonomously for days or weeks and then download the data for analysis.

Specifications

Range: -40°C to 125°C
Resolution: 0.05°C
Accuracy: 0.5°C
Battery: Coin cell (>500,000 samples)
Logging: Yes
Bluetooth: BT 4.0

The versatile Wireless Temperature Sensor works well, both in the lab and out of doors.



Easily compare the temperature in different environments.

Wireless Voltage Sensor

PS-3211

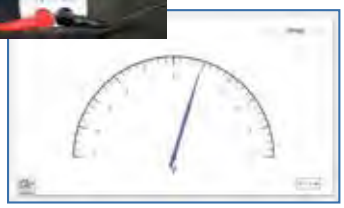
Includes 1 red and 1 black shrouded, banana-to-alligator-clip test leads.

Explore energy and energy transformations with this sensor. Use it to:

- Measure the voltage of student-constructed batteries and see how chemical energy can turn into electrical energy.
- Look at renewable energy by connecting to a wind turbine.
- Track the flow of energy by creating simple circuits.

Features

- Range ±15 V
- Bluetooth® sampling rate of 1 kHz
- High-speed sampling via USB; 100 kHz burst mode
- Includes remote logging on your device.



Wireless Weather Sensor with GPS

PS-3209

Includes USB charging cable

(Please see pasco.com for detailed specifications.)

The Wireless Weather Sensor is an all-in-one instrument for monitoring environmental conditions. By incorporating several sensing elements into a single unit, the sensor provides up to **19 different measurements!** Use the sensor in logging mode with the Weather Vane Accessory for long-term monitoring, or use it as a hand-held instrument to study microclimates and record ambient conditions relevant to many biological and environmental phenomena.

Weather Vane Accessory

PS-3553

Includes tripod, tripod adapter, and weather vane.

Equip your Wireless Weather Sensor for extended environmental monitoring with the Weather Vane Accessory. Once deployed the sensor will freely rotate to capture wind speed and direction, whether you are monitoring data in real time or using the sensor in logging mode to capture hours (or days!) of data for later analysis.

Wireless Temperature Link

PS-3222

Includes Fast Response Temperature Probe

The Wireless Temperature Link enables wireless connection for any PASCO temperature probe with a 3.5 mm connection. The link comes with a Fast Response Temperature Probe, but it can also connect to the Stainless Steel Temperature Probe, Skin/Surface Temperature Probe, the Absolute Zero Sphere, and the Ideal Gas Law Apparatus.

Specifications

Compatible Temperature Probes: Skin/Surface (PS-2131); Fast Response (PS-2135); Stainless Steel (PS-2153)
Range with included probe: -30°C to 105°C
Jack: 3.5 mm stereo
Logging: Yes
Battery: Coin cell
Connectivity: Bluetooth 4.0

Wireless Spectrometer

PS-2600

Includes Spectrometer and 10 cuvettes.

Also available:

Optional Fiber Optic Cable PS-2601
Cuvettes & Caps SE-8739
Cuvette Rack EC-3590

Award-Winning Wireless Spectrometry for iOS®, Android™, Computers, and Chrome*

Measure intensity, absorbance, transmittance, and fluorescence.

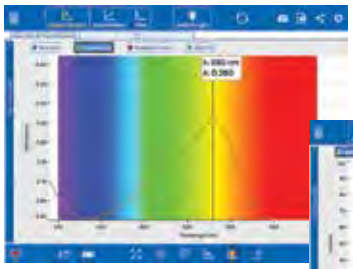
Now PASCO offers Bluetooth® spectrometry for your iPad and Android tablets! This new spectrometer from PASCO is specifically designed for introductory spectrometry experiments. The Bluetooth and USB connectivity enable use with your computers and tablets, making this a powerful and intuitive tool for your spectrometry needs. With this one apparatus you can measure intensity, absorbance, transmittance, and fluorescence.

You can perform these labs with the Wireless Spectrometer:

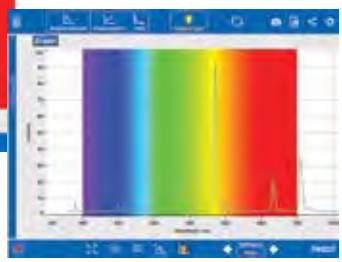
- Emission Spectra of Light
- Absorbance Spectra
- Beer's Law
- Kinetics
- Fluorescence

Specifications

- Bluetooth and USB connectivity
- 2–3 nm FWHM resolution
- 380–950 nm range
- 2 fluorescence excitation wavelengths at 405 nm and 500 nm
- LED-boosted tungsten light source



Full visible spectrum analysis of solutions



Create Beer's Law plots to relate absorbance and concentration.

2015 AWARDS EXCELLENCE TECH&LEARNING

bett AWARDS 2015 FINALIST

//CODiE// 2015 SIIA CODiE FINALIST

The Wireless Spectrometer comes with **PASCO's award-winning spectrometry software.**

- Free software for iOS, Android™, and Mac®.
- Will run on Chromebooks™ with Google Play store.
- Designed specifically for introductory spectrometry experiments.

**Go to pasco.com/spectrometer and see our ever-expanding list of compatible Chromebooks.*

Polarimeter

PS-2235

Includes 1 Sample Cell

Also available:

Polarimetry Sample Cell Replacement PS-2234

PASCO Polarimeter for your Chromebook™, iPad®, Tablets, and Computers

Measure the optical rotation of chiral compounds.

PASCO's new Polarimeter has both Bluetooth® and USB connectivity, so it works on your iPad®, Chromebook™, tablets, and computers. It is ideal for introductory Organic and Biochemistry experiments with chiral compounds.

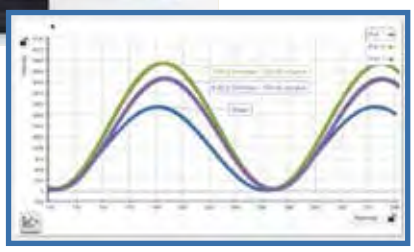
In this new device, plane polarized light is passed through a sample, which contains a chiral compound, to an analyzer and a detector. The degree of optical rotation of the plane polarized light is based on the type and amount of sample present.

Determine the concentration of a sugar solution based on the optical rotation of plane polarized light.

Specifications

- Bluetooth® and USB connectivity
- 589 nm LED light source
- Accuracy = ± 0.09° optical rotation
- SPARKvue- and Capstone-compatible
- Industry-standard, horizontal polarimeter sample cell (100 mm)

Determine the concentration of a sugar solution based on the optical rotation of plane polarized light.



Optical rotation of sucrose

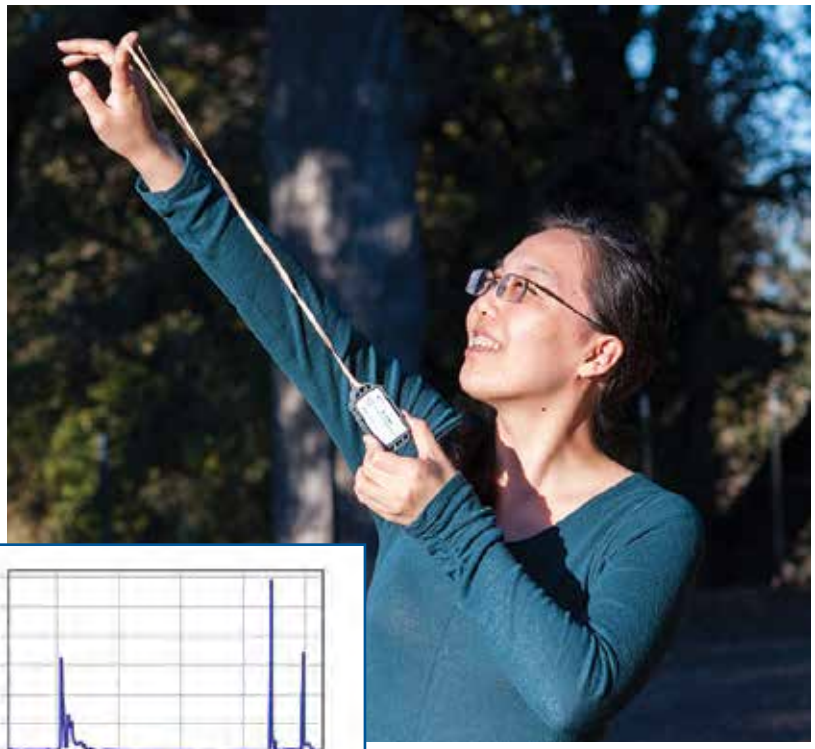
Wireless 3-Axis Acceleration/Altimeter

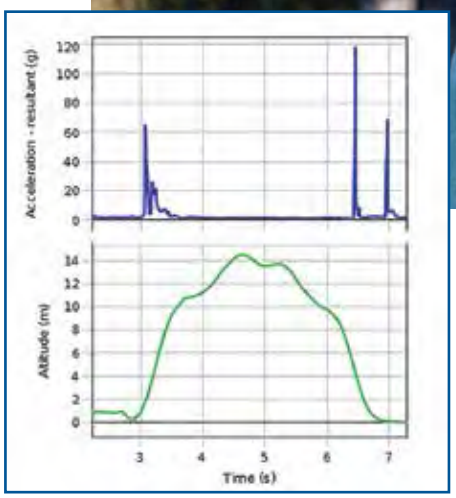
PS-3223

The Wireless 3-Axis Acceleration/Altimeter can remotely log acceleration in three dimensions and altitude, making it ideal for recording roller coaster rides.

Typical Applications

- 3-axis accelerometer
- Four ranges: ±16 g, ±100 g, ±200 g, ±400 g
- 3-axis gyroscope on ±16 g range
- Altimeter





See our complete line of sensor storage trays and rolling carts on pages 148-149.

PASCO's 5-Year Warranty

To withstand the rigors of student use, PASCO products are made of the highest quality materials. They are designed and manufactured by our team of education experts and engineers in Roseville, California. And we back up our products with a 5-year warranty, so you can be completely confident about buying PASCO solutions.

Smart Cart Vector Display

NEW

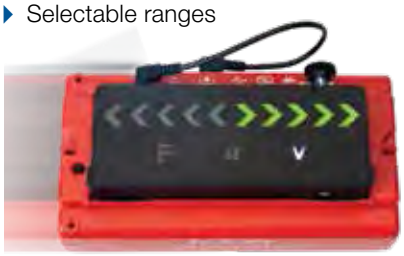
ME-1246

Requires one of the following:

Wireless Smart Carts
Red Smart Cart
ME-1240
Blue Smart Cart
ME-1241

Here is the new secret weapon to teach acceleration! The rechargeable Smart Cart Vector Display plugs into the auxiliary port of the Smart Cart and shows force, acceleration, or velocity vectors. The display lights up one to five arrows, proportional to the sensor reading. The vectors are red in one direction and green in the other. The letters **F, a,** and **v** are lit with a white light that indicates which measurement is being displayed.

- Select between Force, Acceleration, or Velocity vectors and watch them in real time.
- Students can visualize constant acceleration as a cart rolls up and then down an incline.
- Great for the student lab station or for a physics lecture demonstration!
- Selectable ranges



Vector display can sit flat in a Smart Cart.

Vector display can mount vertically for classroom demonstrations.

Smart Cart

ME-1240 (red)
ME-1241 (blue)

Includes: Hook, Rubber bumper, Magnetic bumper, and USB cable for charging

U.S. Patent Number 10481173

The patent-pending Wireless Smart Cart greatly simplifies many physics lab activities and opens up new possibilities with its integrated suite of wireless sensors! The Smart Cart can make measurements of force, position, velocity and acceleration, on or off a dynamics track, while transmitting data wirelessly over Bluetooth®.

Smart Cart Features:

- Magnetic bumper
- Sealed wheel encoder sensor
- Force sensor hook and rubber bumper
- ±100 N force sensor
- 3-axis acceleration/gyro sensor
- 3-position plunger
- Mass tray
- Velcro® tabs
- Rechargeable battery
- Bluetooth connectivity
- Available in red and blue

Wireless Solutions

for iOS, Android™, Chrome™, Mac® and Windows® devices

Have devices for your science program and just need to connect sensors?

No problem. We have the simple answer. It's the same solution, whatever device you use. Select our AirLink or SPARKlink Air and connect any PASPORT sensor to your existing tablets. Then download SPARKvue for iOS, Chrome, and Android devices.

AirLink PS-3200

The new AirLink connects any PASPORT sensor directly to your devices via Bluetooth®. Now, when you use this AirLink, you can perform experiments that were difficult or impossible before and transmit the data directly to your mobile devices. And using the AirLink will simplify your lab setup by removing the clutter of cables.

SPARKlink® Air PS-2011

Two sensor ports for connecting sensors to your computer and mobile devices via USB or Bluetooth® make the SPARKlink Air ideal for schools with computers, tablets, or a mixture of both.

SPARKvue®

Download on the App Store
ANDROID APP ON Google play
Available in the Chrome Web Store

Download SPARKvue for free! It brings real-time sensor data collection, visualization and analysis for inquiry-based science to your iPad®, Chromebook™, or Android™ tablet.

See pages 4-5 for more information.

Wireless Blood Pressure Sensor

PS-3218

Includes Blood Pressure Sensor, standard-size arm cuff, bladder and pressure release valve.

PASCO's new Wireless Blood Pressure Sensor has all the features of our PASPORT Blood Pressure Sensor, with the added convenience of collecting data wirelessly. Students can easily measure both systolic and diastolic arterial blood pressure (mmHg) as well as heart rate (pulse in bpm).

Typical Applications

- Determine the effects of exercise on blood pressure and heart rate
- Compare the blood pressure and heart rate of different students in the class
- Explore the effects of body position on blood pressure and heart rate

Students determine blood pressure using familiar methods.

A clear and easy way to observe heart rate plus systolic and diastolic blood pressure.

Breath Rate Sensor

PS-2187

Includes Masks (10) and Clips (10).

Also available:

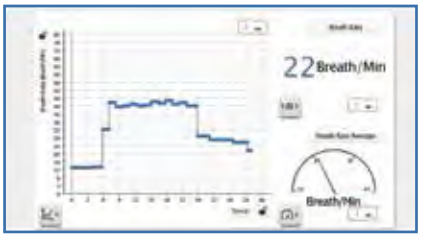
Replacement Masks (10 Pack) PS-2567
Replacement Clips (10 Pack) PS-2568

Measuring breath rate is as easy as breathing. Study physical fitness by measuring breath rate before, during, and after exercise. Add our Hand-Grip Heart Rate Sensor and Blood Pressure Sensor for a more complete study of exercise physiology.

The Teaching Advantage

- Clip the end of the sensing tube to a common dust mask worn by test subject for easy use
- Sensor provides stable output even during exercise for ease of analysis

Determine breath rate while exercising.



A graph showing a student's breath rate before, during, and after exercise.

Charge Sensor

PS-2132

Includes 0.9 m shield cable with alligator clips.

Measure the amount and the polarity of electric charge present. Demonstrate and measure charging by induction, use as a replacement for an electroscope, or explore the distribution of charge across a surface.

The Teaching Advantage

- No guessing – the polarity of the charge is shown automatically
- Built-in push-button tare
- High input impedance means repeatable results

Immediately see the polarity and the quantity of charge present on an object.

Wireless CO_2 Sensor

PS-3208

Includes 250-ml sampling bottle and USB charging cable.

Also available:

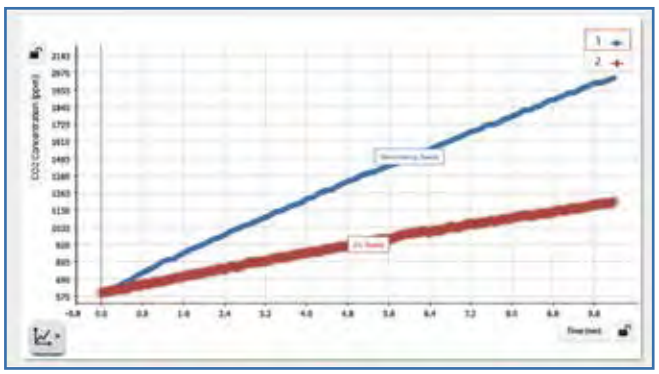
Dissolved CO_2 Waterproof Sleeve
PS-3545

2017 AWARDS OF EXCELLENCE TECH & LEARNING

Use this wireless sensor to measure the concentration of CO_2 gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO_2 data can be logged directly on the device for long-term life science and environmental science studies.

Features

- Includes remote logging on your device.



Directly compare separate controlled environments.

Wireless Colorimeter and Turbidity

PS-3215

Includes 10 cuvettes, 1 turbidity calibration standard (100 NTU), 2 cuvette racks and USB charging cable.

WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Also available:

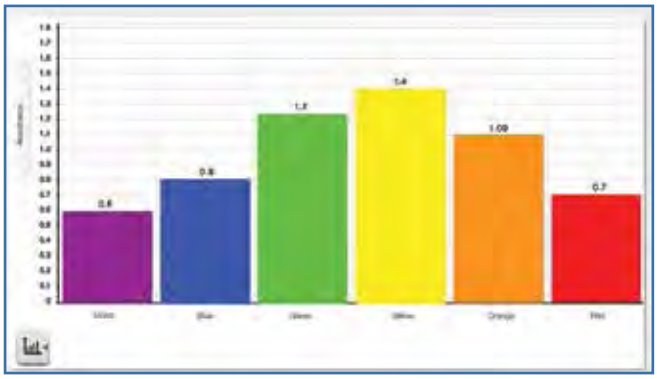
Spectrometer/Colorimeter Cuvettes SE-8739

Determine the concentration of a solution with ease. Study absorbance vs. concentration to explore Beer's Law, and measure chemical rates of reaction.

The Teaching Advantage

- Simultaneous data collection in six wavelengths (colors) of light increases accuracy of results and reduces frustration caused by missing data
- Sensor calibrates in all wavelengths automatically in one step
- Rates of reaction experiments can be conducted easily.

Set up in seconds and collect individual measurements with ease.



Determine the relationship between absorbance and concentration.

Wireless Conductivity Sensor

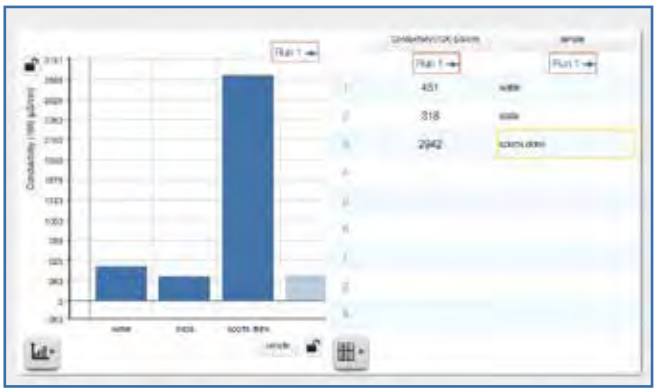
PS-3210

Includes 1 coin cell battery.

Use the Wireless Conductivity Sensor to measure the electrical conductivity of a water solution. With this wireless sensor you can investigate the properties of solutions, as well as model and measure water quality.

Features

- Measure both conductivity and total dissolved solids
- Automatic temperature compensation
- Dust- and sand-proof and water-resistant (1 meter for 30 minutes)
- Battery life >1 year
- Remote logging

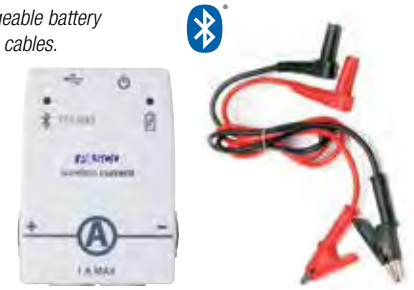


Measure the conductivity of water and water-based solutions.

Wireless Current Sensor

PS-3212

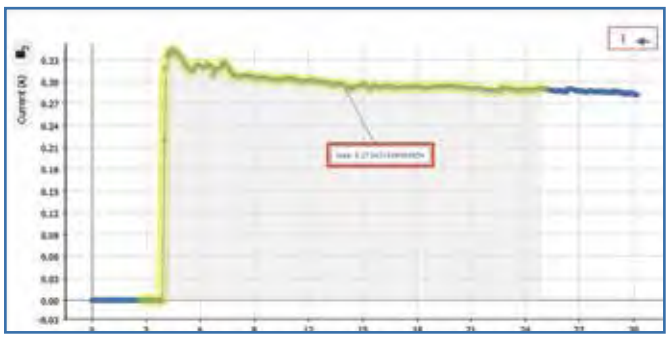
Includes rechargeable battery and banana-clip cables.



This sensor's wide current range allows for introductory and advanced explorations of the fundamental concepts of electricity and basic circuits.

Features

- Range ±1A
- Bluetooth® sampling rate of 1 kHz
- High-speed sampling via USB; 100 kHz burst mode
- Includes remote logging on your device



Wireless Optical Dissolved Oxygen Sensor

PS-3224

Includes USB charging cable

Also available:

ODO Metal Guard PS-3604

ODO Sensor Cap PS-3605

The Wireless Optical Dissolved Oxygen (DO) Sensor is the perfect solution to monitor DO in the lab or the field. Optical technology is accurate, fast, and does not require flow or calibration. With built-in memory, you can log data for hours or days to capture day/night nutrient cycles and changes in metabolic processes. With the included cover, the sensor has a fully waterproof design and is submersible to 10 m.

Perform these labs with the sensor:

- Photosynthesis, respiration, and fermentation
- Monitor water quality
- Measure net primary productivity
- Model ecosystems

Specifications:

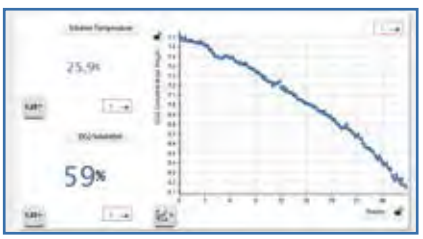
Bluetooth® and USB connectivity

Response Time: 90% in 25 sec

Operating Temperature: 0–50°C

Range: 0–20 mg/L or 0–300% saturation
Reports solution temperature and ambient pressure

Accuracy: ±0.2 mg/L or 1% (whichever is greater) with user calibration; ±0.5 mg/L or 3% (whichever is greater without user calibration; >200% saturation ±10%



Wireless Drop Counter

PS-3214

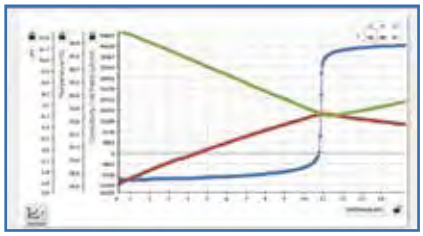
Includes Wireless Drop Counter, Stopcock Valves (2), 60 cc Drop Dispenser Syringe with Tip, and Syringe Holder. Included but not shown: Micro Stir Bar and Micro USB Cable (1 m)

Add the new Wireless Drop Counter for more efficient and accurate titration data. Conducting a titration has never been easier!

The Teaching Advantage

- IR filter assures accurate counts because room lighting cannot affect results
- Sensor unit can suspend up to three other probes in solution, simplifying many experiments
- Wider drop window (18 x 13 mm) means better drop detection and easier alignment with burettes

Integrated probe-management makes titration setup a snap.



Perform simultaneous pH, conductivity, and temperature titrations using the Wireless pH Sensor and the Drop Counter.

Heater-Stirrer

PS-3401

Includes support rod.

This compact heater-stirrer is an essential for any lab! The white ceramic top is ideal for heating and for seeing color changes when mixing solutions. It has been designed to withstand spills. Its safety features include warning labels and indicator LEDs. The included rod makes it easy to support sensors.

Micro Stir Bar (5-Pack)

PS-2565

The Micro Stir Bar maintains a constant flow of solution over the end of an electrode, such as the pH and Conductivity probes. For use with a standard magnetic stir plate and cylindrical probes of about 13 mm diameter.

The Teaching Advantage

- Magnet is completely sealed to prevent damage from chemicals
- Allows study of solutions in micro-quantities

EKG Sensor

PS-2111

Includes 100 self-adhesive electrode patches.

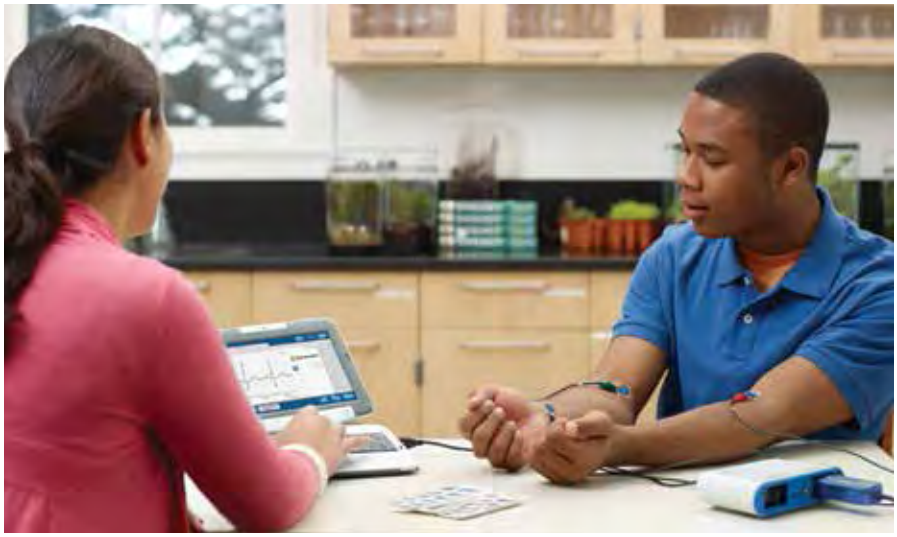
Also available:

EKG Sensor Electrode Patches (100-pack; one-year shelf life) CI-6620

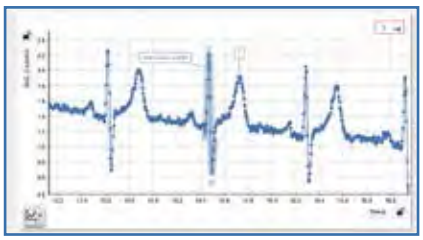
Take the mystery out of that old medical show staple by letting students measure and record the electrical signals produced by the heart. Students can use it to measure their own heart rate, and then explore the effects mild exercise has on heart rate.

The Teaching Advantage

- Three-electrode design is easy to use.
- Electrodes are contained in disposable stick-on pads, eliminating the need for messy gels.



Easy setup and quick data collection make it possible for every student to see their heartbeat in a class period.



Clear data helps students better understand the electrical signals of the heart.

Ethanol Sensor

PS-2194

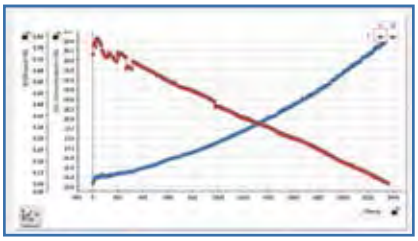
Includes probe and PTFE tape.

This sensor measures the concentration of ethanol in a gas, up to 3%. Explore the effects of temperature on ethanol production during yeast fermentation using a PASCO EcoChamber, or study combustion and its byproducts.

The Teaching Advantage

- Easy to calibrate

Directly measure the products of fermentation.



Compare ethanol production to oxygen uptake over time.

EXPLORE BLOOD PRESSURE

Round out your exploration of the circulatory system with our Wireless Blood Pressure Sensor.

For more information, see pages 30 and 114.

Flow Rate/Temperature Sensor

PS-2130

Measure the temperature and flow rate of streams, rivers, and other flowing bodies of water. Explore how geographic features can affect water flow, determine sediment transport rate, or map out flow rates and temperatures at different locations and depths in a stream.

The Teaching Advantage

- Telescoping handle allows taking data at greater depths.
- Rugged construction reduces chance of losing pieces during field use.

Collect data safely from the shore with the telescoping handle.

The built-in temperature sensor is located next to the impeller to better correlate temperature and flow rate data.

Force Platform

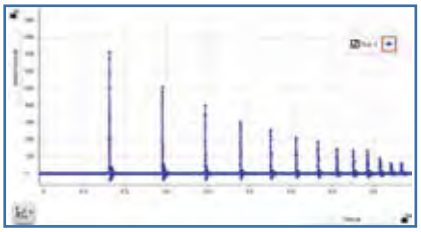
PS-2141

Measure large forces applied over a wide area. Explore the physics of jumping and hang time or study the impulse imparted by a bouncing ball. Examine the forces acting on a person riding an elevator, or use two to verify Newton's Third Law.

The Teaching Advantage

- Large surface for jumping and landing.
- High data rate provides a smooth data set to ease analysis.

Fast response, wide range, and durability make a variety of experiments possible.



Normal force decreases with each successive bounce.

2-Axis Force Platform

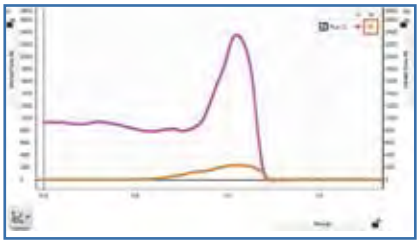
PS-2142

Go beyond models and simulation and get force data from the real world. Study friction by dragging objects across the surface and measure normal and friction forces. Explore the physics of a broad jump, and introduce vectors and force components. Use one platform on the floor and another on the wall and study the static equilibrium of a ladder leaning on a wall.

The Teaching Advantage

- 2-axis measures both normal and parallel forces
- Perfect for measuring forces on the human body

Add a new dimension to study more complex motion.



Get the complete picture by viewing the normal force and parallel force together.

Wireless Force Acceleration Sensor

PS-3202

Includes 1 eye bolt, 1 thumb screw, 1 bumper, a lithium-ion battery, and a USB connector.

Capable of measuring force, acceleration, and rotation, this sensor is ideal for experiments involving rotating platforms, moving carts, spring oscillations, collisions, and impulse. The wireless design offers improved measurements without a cable affecting experiment outcome. Finger-holes support handheld applications, or mount it onto a cart or rod.

The Teaching Advantage

- Simultaneously measures force and acceleration. Measures acceleration in x, y, and z axes and resultant acceleration. Built-in gyroscope measures rotation.
- Features convenient Bluetooth® wireless connectivity and long-lasting rechargeable battery.
- Probe can be quickly zeroed through software for accurate taring.
- Logs force and acceleration data directly onto the sensor for long-term experiments.

When students are the force, Newton's Third Law is no longer a leap of faith.

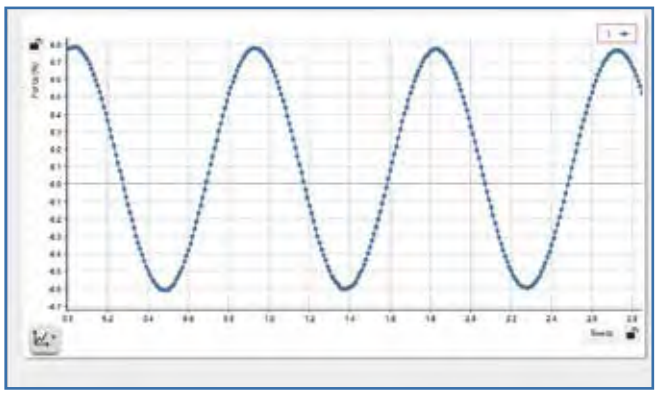
See our complete line of sensor storage trays and rolling carts on pages 148-149.

High Resolution Force Sensor

PS-2189

This force sensor allows the student to measure smaller changes in force, such as forces exerted by an oscillating mass, the force of a swinging pendulum, or use it as a pan balance for long-term experiments with evaporating liquids.

Study simple harmonic motion.



High resolution means even the smallest oscillations in force are captured with high fidelity.

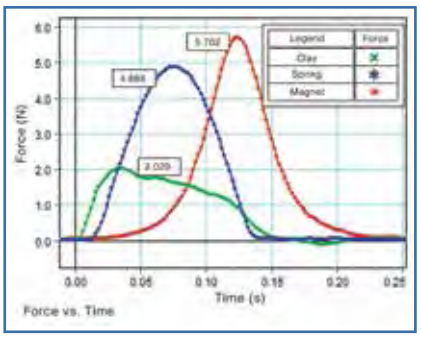
Force Bracket

ME-6622

Includes spring bumpers (2) (different spring constants), magnetic bumper (1), rubber bumper (1), clay cup for inelastic collisions (1) (clay included), #0 Phillips head screwdriver (to attach to force sensor)

The Force Bracket with bumpers mounts the PASCO Force Sensor directly to a dynamics track. It includes 5 collision attachments for the Force Sensor and conveniently stores each attachment on the bracket itself.

Using any of these attachments, the bracket serves as an excellent support or target for collision studies using the Force Sensor.



Force vs. time data for a clay, spring and magnet.

Force Sensor Balance Stand

CI-6460

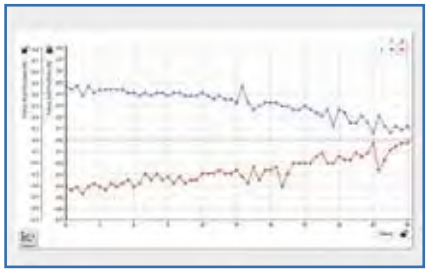
Includes Force Sensor stand and balance pan. Force Sensor sold separately.

Connect a Force Sensor to this stand and students have a convenient electronic balance for a wide variety of physics experiments. Connect an Acceleration Sensor for studies of angle vs. normal force. Use it as a pan balance or to measure buoyant force.

The Teaching Advantage

- Mounting screws and balance pan can be stored on the pan when not in use.

The Force Sensor Balance Stand lets you observe buoyant force from the perspective of the fluid.



The buoyant force exerted on the object is equal to the additional force experienced by the beaker.

Rocket Engine Test Bracket

ME-6617

Rocket Engine not included.

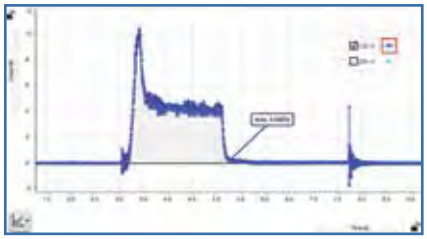
For outdoor use only!

With the Rocket Engine Test Bracket securely attached to a Force Sensor, students can measure, and graphically display, the impulse of Estes™ and other model rocket engines. A perfect supplement for rocketry studies.

The Teaching Advantage

- Accommodates rocket engine sizes A, B, C, and D.
- Finds both the impulse and the maximum force exerted by rocket engines.

Yes, this really is rocket science!



Measure the force vs. time profile of a rocket engine.

Galvanometer

PS-2160

Includes BNC to banana plug cable and jack adapter, and 2 resistors (0.1 ohm and 10 ohm).

Measure extremely small voltages with high resolution. Study sensitive circuits involving low voltages and currents, and even measure the voltage drop along a simple length of wire. This sensor is perfect for resistivity experiments.

The Teaching Advantage

- Measures with 0.1 V resolution for precise results.
- Designed to reduce measurement noise and deliver clean data.

Find out if that really is a 1% resistor with the precision of the Galvanometer.

Rock-solid performance lets you measure the smallest changes in voltage and current with confidence.

Goniometer Sensor

PS-2137

Includes an Angle Sensor and 1 Goniometer Probe with Velcro® connection kit.

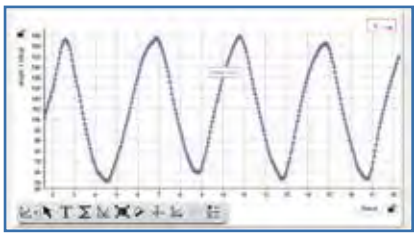
Measure two joints simultaneously. Just add an additional probe:
Goniometer Probe PS-2138
Includes probe and Velcro® connection kit.

Measure how far and how fast human limbs bend. Study how arms and legs move, and compare normal motion to that of moderate exercise and athletic activity. Use with a Force Sensor to analyze energy expenditure when lifting weights or climbing stairs.

Sensor simply straps on with Velcro®, making it easy to put on and take off. It allows the motion of several people to be compared in a short time. Can be used without calibration with good accuracy. However, calibration can reduce uncertainty to less than 1% of measured values.

See every flex and extension as your students become part of the experiment.

Study the motion of the knee while walking with the Velcro® straps included with the sensor.



Measure the extent of movement and changes in velocity during normal actions.

WE CAN HELP

We offer support, training, and customer service by email or phone and through self-directed online tutorials, live webcam feeds, or in-person training in your school.

Visit PASCO.com for details

Wireless Weather Sensor with GPS

PS-3209

Includes USB charging cable

The Wireless Weather Sensor is an all-in-one instrument for monitoring environmental conditions. By incorporating several sensing elements into a single unit, the sensor provides up to **19 different measurements!** Use the sensor in logging mode with the Weather Vane Accessory for long-term monitoring, or use it as a hand-held instrument to study microclimates and record ambient conditions relevant to many biological and environmental phenomena.

Specifications:

Battery: Rechargeable lithium polymer

Please see pasco.com for detailed specifications.

Equip your Wireless Weather Sensor for extended environmental monitoring with the Weather Vane Accessory. Once deployed the sensor will freely rotate to capture wind speed and direction, whether you are monitoring data in real time or using the sensor in logging mode to capture hours (or days!) of data for later analysis.

Weather Vane Accessory

PS-3553

Includes tripod, tripod adapter, and weather vane.

General Science Sensor

PS-2168

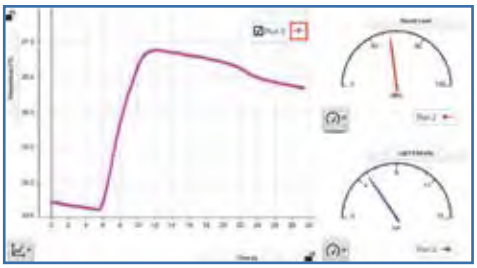
Includes built-in Light and Sound Sensors, Stainless Steel Temperature Probe and Voltage Probe.

Simultaneously measure temperature, light, sound level, and voltage — all with this one sensor. Measure the change in temperature of a cooling liquid, monitor noise levels in the classroom or in the field, or study the electrical discharge of capacitors.

The Teaching Advantage

- Easy-to-use design requires no calibration
- Versatile combination of sensors makes this a good overall solution for a General Science lab

Sensor has three selectable ranges for low, indoor, and outdoor measurements.



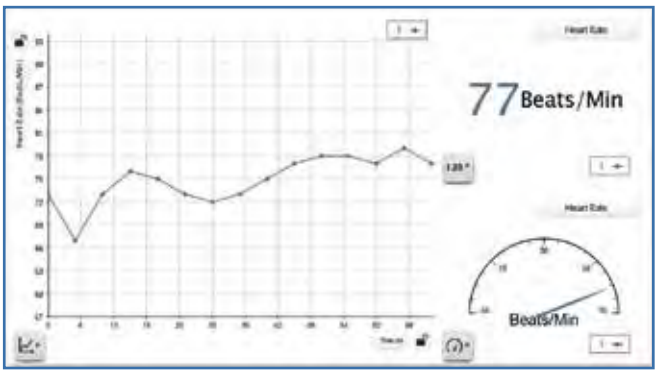
Collect and view different measurements at the same time.

Wireless Hand-Grip Heart Rate Sensor

PS-3206

Includes hand-grips and Bluetooth® Heart Rate Module with one coin-cell battery.

Using the new wireless Hand-Grip Heart Rate Sensor, it's easier than ever before to conduct physiology labs on the cardiovascular system or homeostasis. Use this sensor for a quick and easy way to acquire wireless measurement for either continuous monitoring or initial vs. final data points.



Compare your heartbeat during a variety of activities.

Wireless Exercise Heart Rate Sensor

PS-3207

Includes Bluetooth® Heart Rate Module with one coin-cell battery and chest strap (M-XXL).

The Wireless Exercise Heart Rate Sensor has a chest strap and will transmit data wirelessly up to 10 m away!

A single data set shows heart rate before, during, and after exertion.

See our complete line of sensor storage trays and rolling carts on pages 148-149.

Wireless pH Sensor

PS-3204

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

This sensor measures the pH of a solution as discrete measurements or as a continuous reading. Use the probe to study water quality, test household solutions, or perform high-resolution acid-base titrations.

The Teaching Advantage

- High resolution with low noise allows even subtle pH changes to be observed.
- Factory calibration lets students get right to data collection, with optional user calibration supported.
- Uses durable, accurate gel-filled Ag-Ag Cl electrode.
- Features convenient Bluetooth® wireless connectivity and long-lasting coin cell battery.
- Logs pH data directly onto the sensor for long-term experiments.

The versatile Wireless pH Sensor works as well in the field as in the lab.

Easily measure and compare the pH of common acids and bases.

Ion Selective Electrodes

Ammonium
PS-3516

Carbon Dioxide
PS-3517

Calcium
PS-3518

Chloride
PS-3519

Potassium
PS-3520

Nitrate
PS-3521

Each Ion Selective Electrode (ISE) includes a 2m cable.

Requires one of these:
Wireless pH Sensor PS-3204
OR
PASPORT pH Sensor PS-2102

Also available:
Electrode Support PS-3505

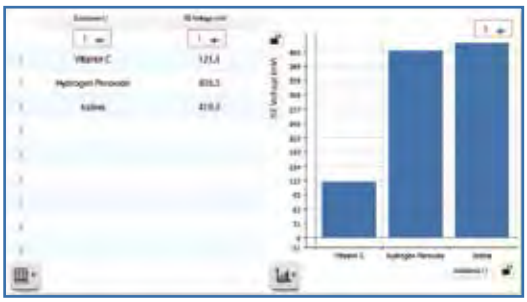
Oxidation Reduction Potential Probe

PS-3515

Requires one of these:
Wireless pH Sensor PS-3204
OR
PASPORT pH Sensor PS-2102

Also available:
Electrode Support PS-3505

Use this probe to monitor solutions during oxidation-reduction titrations, perform water quality studies, and study the effects of water chlorination. This probe is not a standalone sensor. It connects to and requires an amplifier.



Quickly determine the overall tendency of a solution to gain or lose electrons.

Wireless Light Sensor

PS-3213

Includes 1 coin cell battery.

This wireless sensor is a great tool for explorations in Earth, Life, and Physical sciences. With its ambient light detector for illuminance and UV, and its directional detector for colors, your students can explore the electromagnetic spectrum, model planetary motion, and relate photosynthesis to light color and intensity.

Features

All these measurements in one!

- Illuminance (lux)
- UVA, UVB, and UV Index
- RGB color detection
- Battery life >1 year

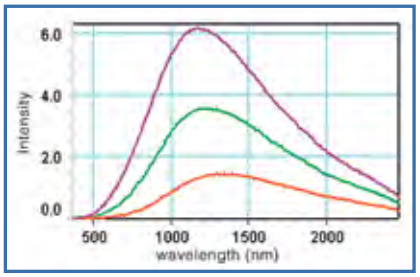
Broad Spectrum Light Sensor

PS-2150

Measure light intensity from the far infrared to the far ultraviolet. This sensor is design specifically for use with our OS-8539 Educational Spectrophotometer System and OS-8543 Prism Spectrophotometer Accessory for Black Body experiments. The Broad Spectrum Light Sensor uses a thermopile and window combination that respond to both the near infrared and visible light necessary for the Black Body Experiment.

The Teaching Advantage

- Ideal for the Black Body Spectrum
- For use with Spectrophotometer



Classic textbook diagram of the intensity versus wavelength blackbody curves.

High Sensitivity Light Sensor

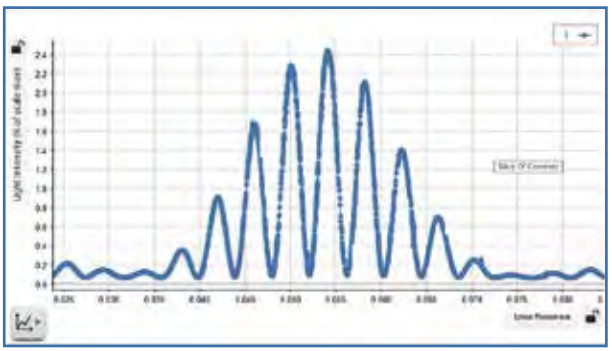
PS-2176

Measure small changes in light intensity in low intensity conditions. Conduct spectrophotometric studies on glowing gases, analyze interference and diffraction patterns. Use with our Rotary Motion Sensor to collect precise position data for more accurate results.

The Teaching Advantage

- Sensor works in three ranges from very low intensity candle light to overcast daylight
- Change ranges at the push of a button
- Detect changes in brightness as low as 0.0005 lux for finely detailed analysis

The light sensor combines with the rotary motion sensor for the diffraction of light experiment.



High sensitivity makes it possible to see the second order of the diffraction pattern.

Infrared Light Sensor

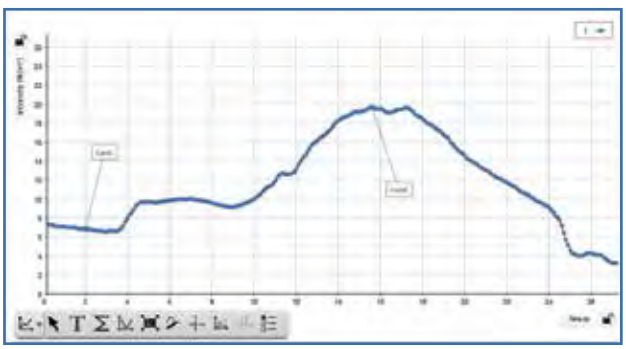
PS-2148

You can't see it, but now, you can measure it: infrared radiation. Introduce and explore blackbody radiation, estimate surface temperatures without contact, study energy received from the sun as heat, and explore radiation emitted as heat from common objects.

The Teaching Advantage

- Probe is sensitive over a vast range of wavelengths, allowing a comprehensive study of the topic at hand
- Contains a built-in thermistor to measure temperature on the "cold" side of the thermopile
- Sense wavelengths from 580 nm to 40,000 nm

Capture light beyond the visible spectrum.



Clearly see the infrared light radiating from your own hand.

Wireless Load Cell Accelerometer

PS-3216

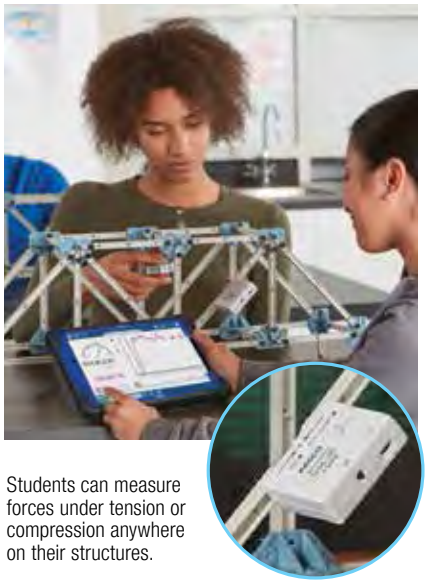
Recommended:
Building Better Bridges Kit ME-3581

The Wireless Load Cell and Accelerometer is designed for use with all PASCO Structures Systems, and is included in the Building Better Bridges Kit.

While it does not have the high resolution of the wired load cells, the Wireless Load Cell can be used for most structures related activities. It's wireless nature and the added accelerometer also make it ideal for studying the oscillations of structures.

The Teaching Advantage

- Low cost
- Built in accelerometer measures accelerations in three dimensions plus the resultant
- No wires, make it easier than ever to integrate into structures beams



Students can measure forces under tension or compression anywhere on their structures.

Load Cell & Dual Amplifier Set

PS-2206

(Includes 4 100N Load Cells and 6-Port amplifier)

Also available:
Load Cell and Amplifier Set PS-2199

These load cells are designed to be inserted directly into our Structures Systems to provide compression and tension measurement points in a student's design. The Dual Amplifier can measure the forces of one or two load cells, such as at the top and bottom of a roller-coaster loop, or on one cell moving to different parts of a bridge. Expand this set by adding another load cell.

The Teaching Advantage

- Perfect for applications requiring only one or two load cells
- Expand this set with an additional load of a 5 N or 100 N Load Cell

Measure the stress and strain experienced by a structure in-line with the load cell amplifier.

100N Load Cell

PS-2200

Displacement Sensor

PS-2204

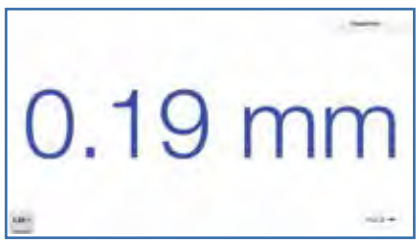
Includes digital indicator, pivot rod clamp, Phillips screw driver, and storage box.

Measure small displacement with amazing accuracy using this sensor – even the smallest deflection from a load applied to a truss, bridge, or other PASCO Structure System construction. Use the Digital Indicator as a stand-alone device to measure displacements and read them on the LCD display.

The Teaching Advantage

- Use the sensor and your PASCO interface to input and analyze collected data

- Easily mounts to a support rod with included pivot rod clamp



Detect even the smallest flex when your structure is put under load.

Wireless 3-Axis Magnetic Field Sensor

PS-3221

Required to measure Earth's magnetic field:

Zero Gauss Chamber EM-8652

PASCO's new Wireless 3-Axis Magnetic Field Sensor is sensitive enough to measure Earth's magnetic field! It can also measure magnets and fields in a coil.

Typical Applications

- Measure magnetic field of permanent magnets.
- Measure Earth's magnetic field.
- Measure field strength of Helmholtz coils.

Features:

- X, Y, Z magnetic field components
- Resultant magnetic field
- USB and Bluetooth®
- Two ranges: 50 G and 1300 G
- Rechargeable

Zero Gauss Chamber

EM-8652

This double-walled, high permeability metal chamber produces a zero-gauss field within the chamber. By placing the Magnetic Field Sensor probe into the chamber and pushing the "Tare" button, the sensor may be zeroed. Highly recommended for measurement of the Earth's magnetic field.

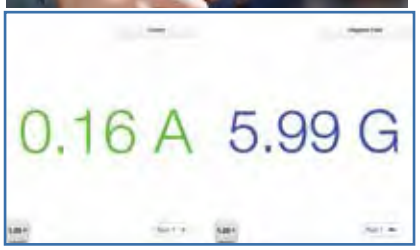
Magnetic Field Sensor

PS-2112

Make a magnetic field "visible". Use this sensor to map the magnetic field around a bar magnet, explore how the strength of a magnetic field is related to the distance from the source magnet, and explore magnetic fields formed by coils and loops.

The Teaching Advantage

- Single-range sensitivity: ±1000 gauss
- Align sensor with magnetic field along length of probe until highest field strength displays



Measure the magnetic field generated by a current passing through a coil.

2-Axis Magnetic Field Sensor

PS-2162

Includes Sensor Extension Cable.

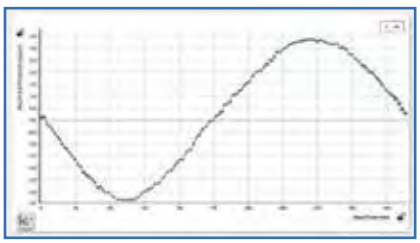
Recommended:

Zero Gauss Chamber EM-8652

Simultaneously measure radial and axial field strengths. Map magnitude and direction from a bar magnet or a coil, explore magnetic fields generated by alternating current, and measure the Earth's magnetic field. Combine with a Rotary Motion Sensor to collect precise position data at the same time for more accurate field maps.

The Teaching Advantage

- Designed to reduce noise at low sampling rates
- Simple tare button to zero (uses Zero Gauss Chamber)
- 0.01 gauss resolution @ 10 Hz

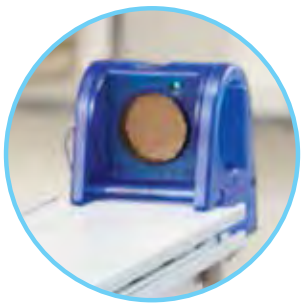


Reveal the naturally occurring magnetic field of the Earth.

Motion Sensor

PS-2103A

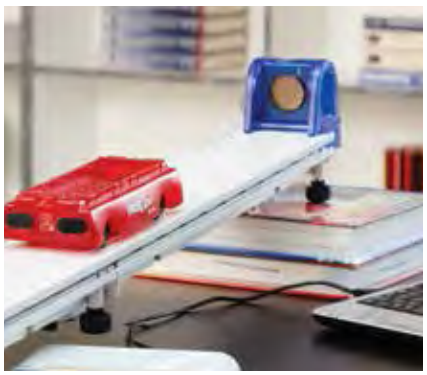
Also see the Wireless Motion Sensor on page 107.



Locked onto the end of our dynamics track

Standing flat on a table top

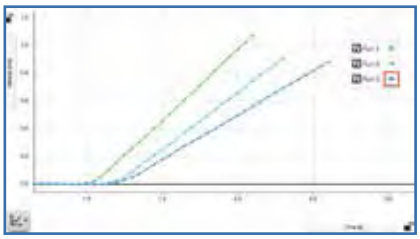
Mounted on a rod stand



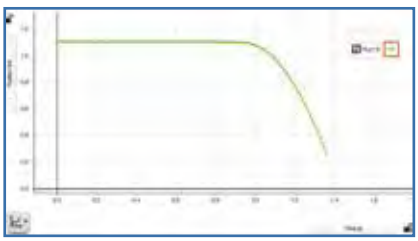
Integration of sensor and equipment makes changing the angle of incline a breeze.

Motion Sensor Guard

SE-7256



Comparing the acceleration of a cart down a track at different angles takes no time at all.



Use a Motion Sensor Guard to see the motion of an object falling toward the Motion Sensor.

Motion Sensor

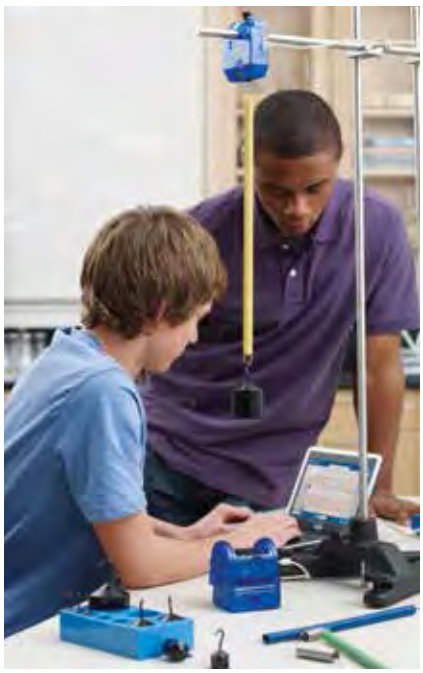
Need to know distance, velocity or acceleration? Explore linear motion in detail with this sensor. Students can study the back-and-forth motion of a cart on a track or the movement of their own bodies in the classroom. Even acceleration of a falling object due to gravity can be studied with relative ease.

The Teaching Advantage

- Tight beam allows collection of data over a greater range of distance
- Probe detects and filters out false target readings, eliminating spikes and misreadings
- Automatic determination of distance, velocity, and acceleration allows students to focus on the motion and not on tedious calculations

Magnetic Motion Sensor Bracket

PS-2546



Combine with the Force Sensor to explore simple harmonic motion or Newton's Second Law.

Rotary Motion Sensor

Put a new spin on many common experiments with this highly versatile sensor. Use it to study not only rotary motion, pendulum motion, and angular momentum, but a surprising variety of other topics as well. With the right accessories it can be used to determine the acceleration of gravity, to study linear velocity and acceleration, and it can be used in an optics lab to study interference and diffraction patterns.

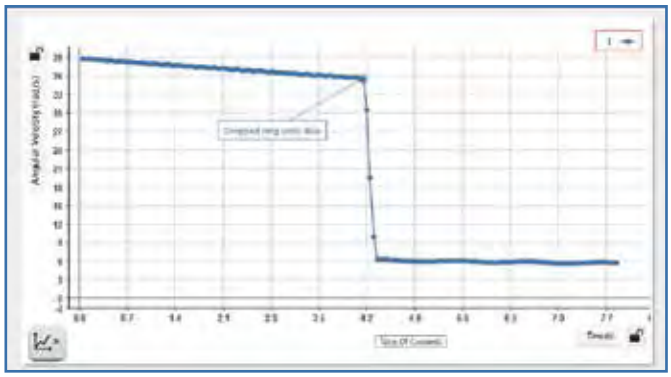
The Teaching Advantage

- Sensor's 0.09 degree resolution (about 4,000 points per revolution) allows highly precise angular measurements
- Sensor measures reliably up to 30 revolutions per second (which translates to a maximum linear speed of about 4.5 m/s)
- Attached rod clamp allows sensor to be mounted in almost any orientation

Rotary Motion Sensor

PS-2120A

Recommended:
Linear Motion Accessory CI-6688A

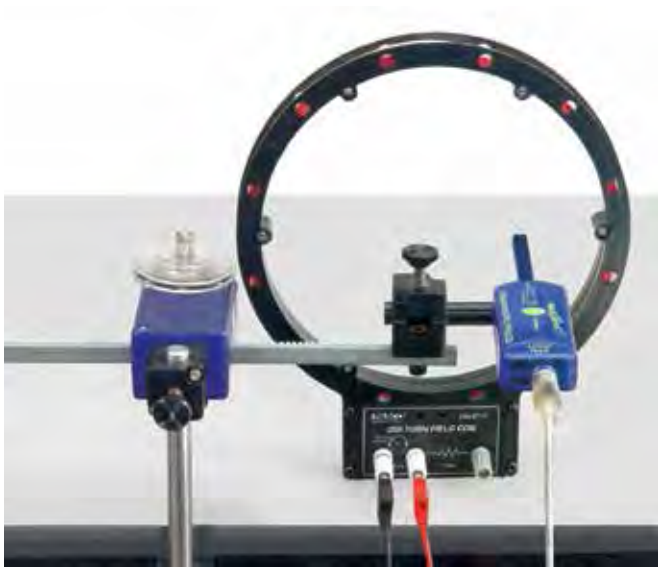


The graph captures angular velocity before and after the collision. Knowing the mass and dimensions of the ring and disk, students will find that angular momentum is conserved.

Also see the Wireless Rotary Motion Sensor on page 109.

Investigate what happens to angular momentum when a ring is dropped on a spinning disk.

Combined with the Linear Translator from the Sensor-based Diffraction Kit, the Rotary Motion Sensor controls and measures linear position during optics labs.



Add the Linear Motion Accessory to your Rotary Motion Sensor for precise distance measurements.

Flat pH Probe

PS-3514

Connects to and requires a pH Sensor. Includes soaker bottle.

This pH probe gives you the freedom to measure what you want, where you want. Study pH levels in different kinds of foods, investigate the pH of common skin and hair care products, and easily collect pH data when doing soil analysis.

Whether your flat surface is a Petri dish or a slice of cheese, find the pH with a minimum of fuss.

The Flat pH Probe (above) requires one of the following:

Wireless pH Sensor PS-3204
OR
PASPORT pH Sensor PS-2102

Wireless Optical Dissolved Oxygen Sensor

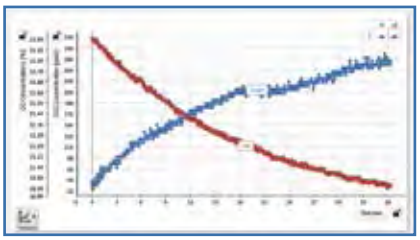
PS-3224

Includes USB charging cable.

Use this sensor for any experiment requiring the measurement of oxygen levels, such as the study of photosynthesis, animal and insect respiration, and gas production during chemical reactions. Combine with our CO_2 Sensor to also monitor conditions within a terrarium or perform simple physiological studies.

The Teaching Advantage

- Automatically compensates for temperature
- Calibrates in one step with the touch of a button



Analyze oxygen gas consumption and carbon dioxide gas production of the pea seeds.

Wireless Oxygen Gas Sensor

PS-3217

Includes USB charging cable, 250-mL sampling bottle.

The Wireless Oxygen Gas Sensor is accurate and easy to use, which makes it the perfect sensor to study photosynthesis, respiration, and oxygen cycling in the environment. With remote logging, simultaneous measurement of humidity and temperature experiments can go beyond the lab period and easily give students hours or days of data for analysis.

Wireless pH Sensor

PS-3204

Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

This sensor measures the pH of a solution as discrete measurements or as a continuous reading. Use the probe to study water quality, test household solutions, or perform high-resolution acid-base titrations.

The Teaching Advantage

- High resolution with low noise allows even subtle pH changes to be observed.
- Factory calibration lets students get right to data collection, with optional user calibration supported.
- Uses durable, accurate gel-filled Ag-Ag Cl electrode.
- Features convenient Bluetooth® wireless connectivity and long-lasting coin cell battery.
- Logs pH data directly onto the sensor for long-term experiments.

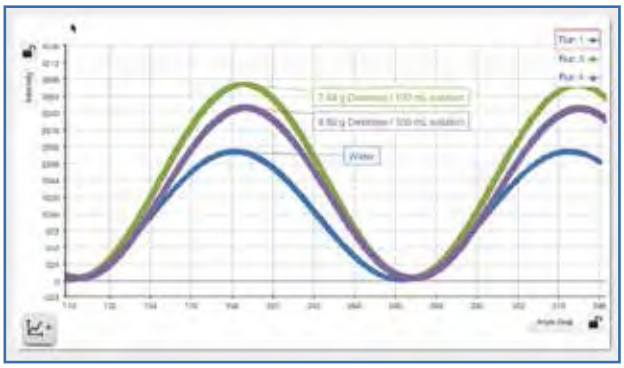
Polarimeter

PS-2235

Includes 1 Sample Cell

Also available:
Polarimetry Sample Cell Replacement
PS-2234

Determine the concentration of a sugar solution based on the optical rotation of plane polarized light.



Optical rotation of sucrose

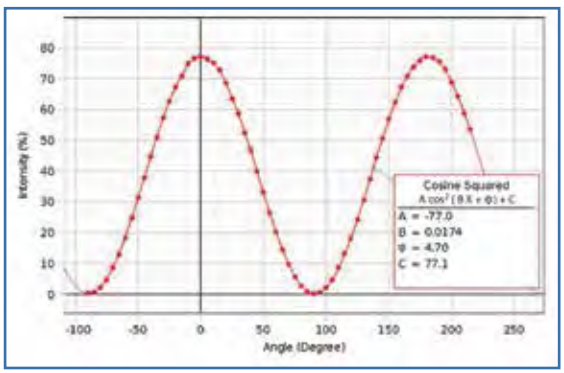
Polarizer Demonstrator

OS-9477A

Includes two round polarizer discs with stands.

Also available:
Polarizer Demonstrator Accessory OS-8172
Linear Polarizer (2-pack) OS-8549

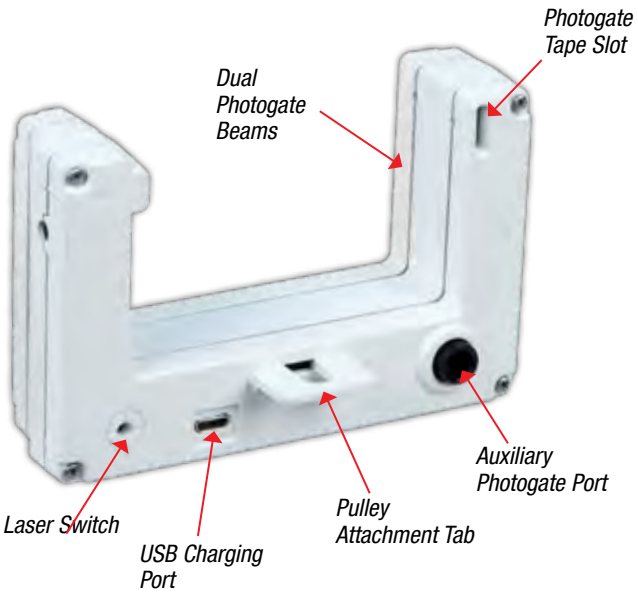
Introduce the concept of polarization with this colorful and meaningful demonstration.



As the polarizer is rotated, the intensity of the light varies as the square of the cosine of the angle between the two polarizers.

Wireless Smart Gate

- Dual photogate beams
- Laser switch
- Photogate tape slot
- Auxiliary photogate/Time-of-Flight port



The Wireless Smart Gate has all the features of the wired Smart Gate. It has dual photogate beams spaced at 1.5 cm to accurately measure speed. The built-in laser switch (when used with any laser) allows you to time objects too large to fit through the standard photogate. Use Photogate Tape passing through the photogate slot to measure movement of objects. The auxiliary port is for adding an additional photogate head or Time-of-Flight Accessory.

NOTE: When using two Wireless Smart Gates, be aware that the syncing resolution between two gates can be as much as 2 ms.

Wireless Smart Gate

PS-3225

Specifications

- Logging: Yes
- Battery: Rechargeable Lithium-Polymer
- Connectivity: Direct USB or via Bluetooth Low Energy technology

Smart Gate

PS-2180

Includes Smart Gate Cord

The Smart Gate has dual Photogate beams spaced at 1.5 cm to accurately measure speed. Built-in laser switch (when used with any laser) allows you to time objects too large to fit through the standard Photogate. Other features include a slot for Photogate Tape, and an auxiliary port for an additional Photogate or the Time of Flight Accessory.

Recommended:
High Resolution Photogate Tape ME-6666

Smart Gate System

PS-3701

Needs only one PASPORT connection. Photogate daisy-chains to Smart Gate.

Includes Smart Gate: PS-2180
Photogate Head: ME-9498A

Smart Gate Pulley System

PS-3702

The Super Pulley attaches directly to the Smart Gate, providing a simple, low-friction system to measure position, velocity and acceleration. Additionally, with the pulley removed, the photogate can be used to perform standard photogate experiments.

Includes Smart Gate (1) PS-2180, Super Pulley (1) ME-9450A
Super Pulley Rod (1) ME-8736

Projectile Launcher Wireless Smart Gate System

ME-6796

Includes wireless smart gate with mounting bracket, launcher with mounting stand, steel balls (2) with loading rod, 2-D collision accessory, aluminum table clamp, and 45 cm stainless steel rod.

The Wireless Smart Gate has all the features of the Smart Gate (PS-2180), but it connects to your computing device via Bluetooth® or USB; it does not require an interface. Choose this wireless option to eliminate cables between the computer and the projectile launcher.

Photogate Head

ME-9498A

Required:
Digital Adapter PS-2159
To Attach to Track:
Photogate Brackets (set of 2) ME-9806

Start and stop digital timers with high precision. Get reliable data when studying linear motion, conservation of momentum, or anything requiring highly accurate time data. Requires Digital Adapter PS-2159 for use with SPARK or SPARKvue or any other PASPORT systems.

The Teaching Advantage

- Can measure times as short as 0.1 ms and resolve distances just under 1 mm
- Can be mounted in any orientation for a variety of uses
- Connects to Smart Gate

Use the Photogate with the PAScars using the specially designed picket fence "flag".

When studying motion, timing is everything. Help your students understand the root concept of velocity, and acceleration.

Time-of-Flight Accessory

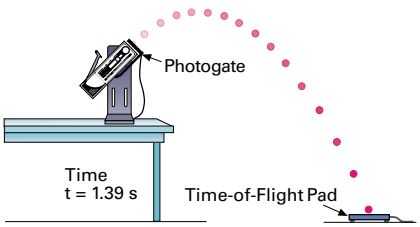
ME-6810A

Required:
Digital Adapter PS-2159
Recommended:
Phone Jack Extender Cord (6m) PI-8117

Designed primarily for freefall or projectile experiments. Measure the time a projectile or a free-falling object is in the air. Study projectile motion and the acceleration of gravity. Requires Digital Adapter (PS-2159) for use with PASPORT systems.

The Teaching Advantage

- Large surface area is easy to hit
- Automatic timing provides more reliable data leading to more accurate results
- Connects to Smart Gate



Timing begins when the photogate beam is broken and ends when the projectile hits the pad and the signal is sent to the interface.

Photogate Tape, High Resolution

ME-6666

Includes
High Resolution
Photogate Tape (30m).

Required:
Smart Gate PS-2180

Large Picket Fence

ME-9377A

An easy and highly accurate way to determine the acceleration due to gravity (g) experimentally. Conduct free-fall experiments by dropping this Picket Fence through the PASCO Photogate. As it falls, the black bars block the photogate beam. Knowing the distance between them and the time it takes them to fall through, the acceleration can be found.

Cart Picket Fences

ME-9804
(Set of 2)

Wireless Pressure Sensor

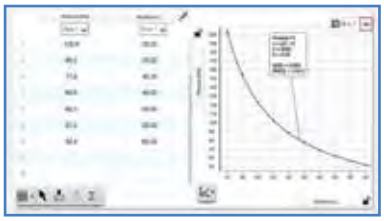
PS-3203

Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barbed luer locks, 1 female barbed luer lock, 1 60 cc syringe, a lithium-ion battery, and a USB connector.

With the new Wireless Pressure Sensor you can make accurate and consistent measurements of gas pressure, regardless of ambient conditions, and explore how chemical reactions affect gas pressure. In combination with a Temperature Probe, you can study the Ideal Empirical Gas Laws.

The Teaching Advantage

- Measures pressure relative to an internal sealed reference vacuum, which allows the collection of reliable data even when the pressure within the system drops below ambient pressure.
- Supports common units (kPa, atm, psi, mmHg, or N/m2) for many applications.
- Features Bluetooth® wireless connectivity and long-lasting rechargeable battery.



With the included syringe, your students can easily quantify the relationship between pressure and volume.

A test tube, piece of steel wool, and a Wireless Pressure Sensor are all you need to have your students calculate the amount of oxygen in the air.

Dual Pressure Sensor

PS-2181

Includes 60 cc syringe, tubing and quick-release connectors.

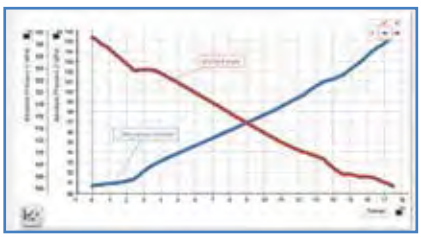
Also available:
Quad Pressure Sensor PS-2164

This sensor measures the difference in gas pressure between two inputs. Compare absolute pressures to a vacuum or ambient air pressure. Observe pressure changes in a heat engine, study air pressure on and under an airplane wing, or collect data to determine respiration rates.

The Teaching Advantage

- Relative heat-engine pressure records below zero
- Selection of units reduces the need to calculate conversions
- High-sensitivity, smooth data with little noise is easier to analyze

The Dual Pressure Sensor is perfect for use with the Diffusion/Osmosis Apparatus.



Simultaneously measure the pressure on both sides of the membrane.

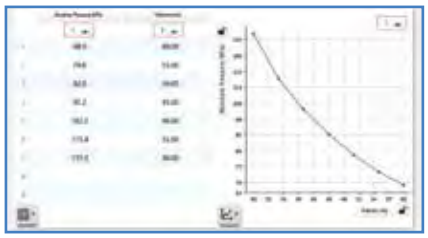
Absolute Pressure/ Temperature Sensor

PS-2146

Includes Fast Response Temperature Probe, 60 cc syringe, tubing and quick-release connectors.

Get accurate temperature and absolute gas-pressure measurements when studying the gas laws. This sensor can be used to estimate absolute zero in common ˚C and ˚F scales.

Ideal for studying gas laws such as Boyle's Law.



Plot pressure versus volume to better understand their relationship.

Alpha Beta Gamma Radiation Sensor

PS-2166

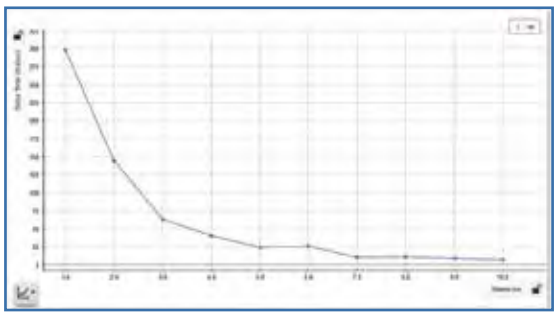
Includes Digital Adapter

Measure alpha, beta, and gamma radiation levels. Discover the relationship between radiation intensity and distance from the source. Use the Alpha Beta Gamma Radiation Sensor in conjunction with our Radiation Sources, Isotope Generator Kit and/or Absorbers.

The Teaching Advantage

- Produces clear audible beep when a count is registered
- Designed for easy mounting

Determine how activity changes with distance from a radioactive source.



Students can compare their individual data to mathematical models.

Absorbers (Set of 20)

SN-8111A

Includes 20 calibrated absorbers: 4 epoxy-coated lead, 2 plastic, 10 aluminum sheets, 2 polyethylene and 2 aluminum foil absorbers.

Radiation Sources*

SN-8110

Includes three sources: alpha (Po-210), beta (Sr-90), gamma (Co-60). The sources are USNRC License Exempt (US only).

***Note:** Purchased Sources are "Non-Cancellable" and "Non-Returnable".
See Radioactive Source Disclaimer below.

Isotope Generator Kit* (BA-137m)

SN-7995A

Includes generator, syringe, tube, 250 ml. solution and storage case.

Safely study properties of radioactive decay with the short-lived BA-137m isotope generated with this kit (half-life of just 2.6 min). Contains one USNRC License Exempt (US only) quantity of CS-137.

***Note:** Purchased Sources are "Non-Cancellable" and "Non-Returnable".
See Radioactive Source Disclaimer below.

PASCO Radioactive Source Disclaimer

Before purchasing PASCO radioactive sources:
Local, national, and international regulations may restrict the purchase, storage, transport, use or disposal of radioactive sources. Please consult your local regulations to ensure your compliance before you purchase radioactive sources.

PASCO advertised sources are direct shipped to customers from Spectrum Techniques (http://spectrumtechniques.com). Please review their "Terms and Conditions" page before purchasing. Once shipped, purchased sources are "Non-Cancellable" and "Non-Returnable". Radioactive sources cannot be returned under any circumstances including "End of Life" disposal.

Other/Misc: PASCO generally advertised sources are USNRC License Exempt (US only). International exempt sources (per the International Atomic Energy Agency) are available for international customers or by request.

Salinity Sensor

PS-2195

The Salinity Sensor measures salinity, conductivity and temperature, and determines salinity based on electrical conductivity. Great for exploring the salinity of local water sources or measuring the change in salinity of saltwater as it evaporates.

The Teaching Advantage

- Built-in calculation to compensate for the change in conductivity due to temperature change

Compare fresh and brackish samples quickly and easily.

Soil Moisture Sensor

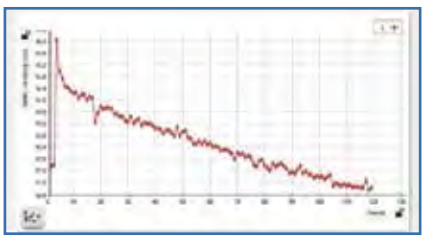
PS-2163

Just how dry is that soil sample and how does it affect your vegetation? Measure the water content of soil in percent. Measure changes in soil moisture around plants over time, study evaporation, and determine optimum moisture conditions for different species of plants.

The Teaching Advantage

- Pre-calibrated for common soil types
- Ideal for environmental science, agricultural science or biology

Quickly determine the moisture in your soil or leave for a time to see how quickly soil moisture changes.



Soil moisture data over time shows evaporation.

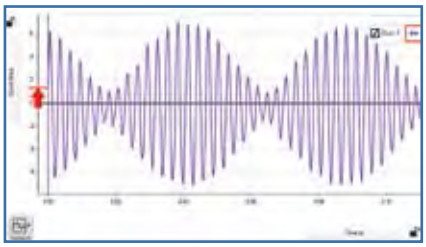
Wireless Sound Sensor

NEW

PS-3227

This new Wireless Sound Sensor is really two sensors in one device: a Sound Level Sensor and a Sound Wave Sensor.

- **The Sound Level function** gives you true sound level (intensity) measurements with both dBA and dBC scales. The dBC weighting scale measures the intensity of sounds in a wide range of frequencies. The dBA weighting scale filters some of the sound frequencies from a sound source to more closely match the frequency response of the human ear.
  Max. Sampling Rate: 20 Hz
- **The Sound Wave function** measures relative changes in sound pressure level as sound waves are incident on the sensor. With graphs of Sound Wave vs. Time, students can analyze wave properties such as wave shape, wave speed, amplitude, frequency, wavelength, and much more.
  Max. Sampling Rate: 100 kHz burst



Easily observe and analyze beat frequencies.

Award-Winning Wireless Spectrometry for iPad®, Android™ Tablets, Chromebooks* and Computers

Measure intensity, absorbance, transmittance, and fluorescence.

Now PASCO offers Bluetooth® spectrometry for your iPad, and Android and Chrome tablets! This new spectrometer from PASCO is specifically designed for introductory spectrometry experiments. The Bluetooth and USB connectivity enable use with your computers and tablets, making this a powerful and intuitive tool for your spectrometry needs. With this one apparatus you can measure intensity, absorbance, transmittance, and fluorescence.

You can perform these labs with the Wireless Spectrometer:

- Emission Spectra of Light
- Absorbance Spectra
- Beer's Law
- Kinetics
- Fluorescence

Wireless Spectrometer Specifications:

- Bluetooth and USB connectivity
- 2–3 nm FWHM resolution
- 380–950 nm range
- 2 fluorescence excitation wavelengths at 405 nm and 500 nm
- LED-boosted tungsten light source

Wireless Spectrometer

PS-2600

Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:

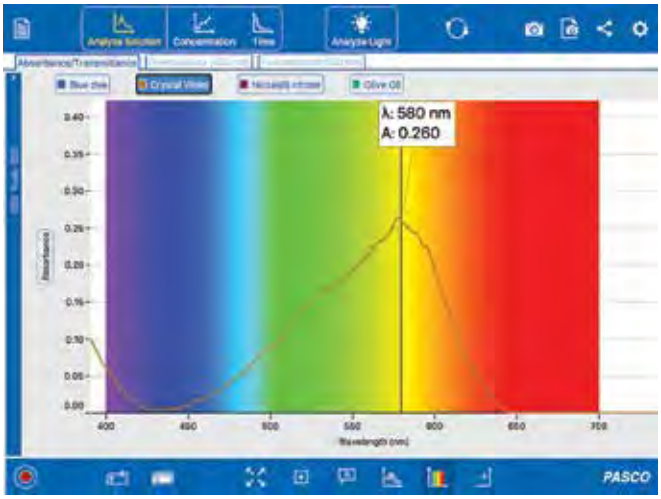
Optional Fiber Optic Cable
PS-2601

Cuvettes & Caps
SE-8739

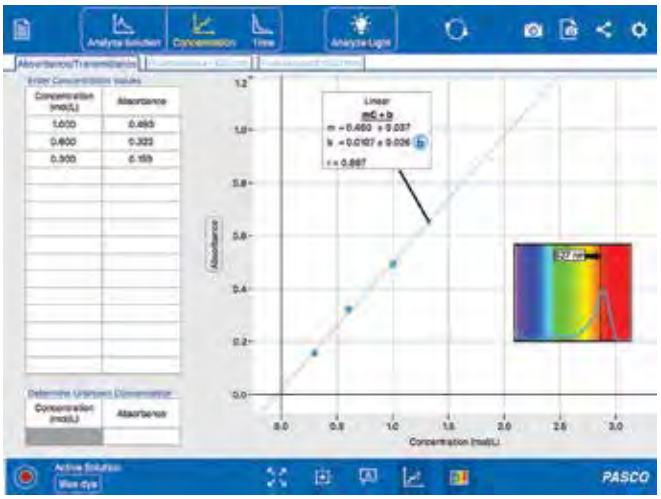
Cuvette Rack
EC-3590

The Wireless Spectrometer comes with **PASCO's award-winning spectrometry software.**

- Free software for iOS, Android™, and Mac®.
- Will run on Chromebooks™ with Google Play store.
- Designed specifically for introductory spectrometry experiments.



Full visible spectrum analysis of solutions with a large digits display helps set the wavelength and see the absorbance.



Create Beer's Law plots to relate absorbance and concentration.

winner! 2015 AWARDS of EXCELLENCE TECH & LEARNING

//CODiE// 2015 SIIA CODiE FINALIST

bett AWARDS 2016 FINALIST

**For information on Chromebook compatibility, go to pasco.com/spectrometer*

Spirometer

PS-2152

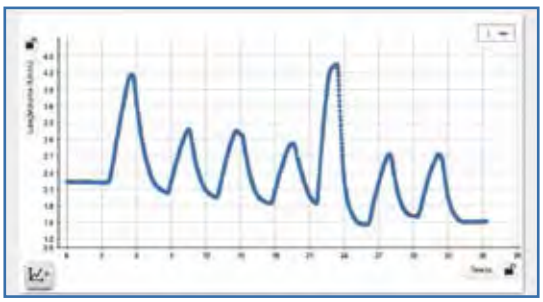
Also available:

Replacement Mouth Pieces (10)
PS-2522

Measure volume of airflow during breathing. Compare breathing patterns before and after exercise, measure lung capacity, and compare the breathing characteristics of athletes and non-athletes.

The Teaching Advantage

- Simple, easy-to-use one-piece sensor
- Disposable mouthpieces increase student safety and encourage participation.
- Designed to minimize resistance to airflow for more accurate results.



Capture breath rate and volume at the same time.

Wireless Temperature Sensor

PS-3201

Includes 1 coin cell battery.

Students can access instant temperature readings and continuously monitor, log, and plot temperature data in SPARKvue on nearly any connected device. When class-time ends students can set the sensor to log data autonomously for days or weeks and then download the data for analysis.

The Teaching Advantage

- Simplicity: just pair and go
- Variable sampling rate
- Logs temperature data directly onto the sensor for long-term experiments.

The versatile Wireless Temperature Sensor works well, both in the lab and outdoors.

Wireless Temperature Link

PS-3222

Includes Fast Response Temperature Probe

The Wireless Temperature Link enables wireless connection for any PASCO temperature probe with a 3.5 mm connection. The link comes with a Fast Response Temperature Probe, but it can also connect to the Stainless Steel Temperature Probe, Skin/Surface Temperature Probe, the Absolute Zero Sphere, and the Ideal Gas Law Apparatus.

Non-Contact Temperature Sensor

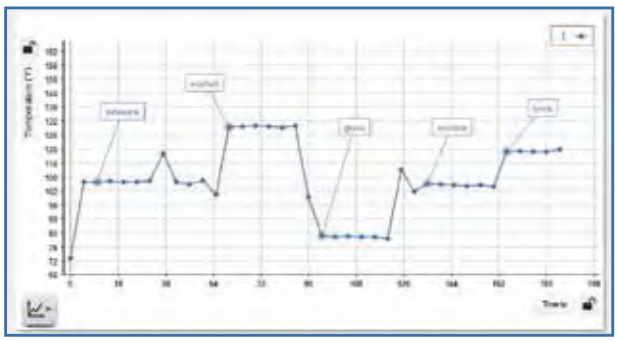
PS-2197

This sensor detects infrared light and records the temperature of objects without having to touch them. Compare different surfaces and compare the temperature results based on composition and amount of direct sunlight, even record the temperature as ice warms and melts.

The Teaching Advantage

- Quick-response time speeds data collection
- Wide temperature range and 0.5˚C resolution allows a wide variety of surfaces to be studied

Students can create a temperature profile of a surface or building with the Non-Contact Temperature Sensor.



Temperature profile provides a great foundation for discussion of insulation, energy conservation, and more.

Skin/Surface Temperature Probe

PS-2131

Requires:

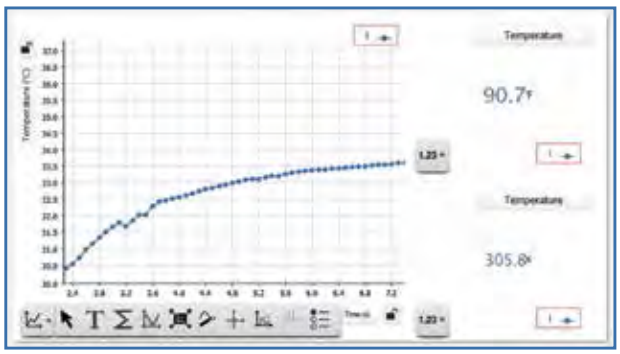
Temperature Sensor PS-2125
or
Temp Link PS-3222

Use this sensor when you need to know just how warm "warm to the touch" is. Compare skin temperature before and after exercise, map out temperature variations across the skin's surface, or perform heating and cooling experiments with solids.

The Teaching Advantage

- Wide temperature range allows a variety of surfaces and situations to be studied.
- Flat surface area assures good contact and accurate readings.

Just press the probe against a surface to get an accurate reading of the surface, not the surrounding air.



Report surface temperatures using degrees Celsius and Fahrenheit simultaneously.

Stainless Steel Temperature Probe

PS-2153

Requires:

Temperature Sensor
PS-2125
or
Temp Link PS-3222

Investigate melting and freezing points or measure rapid temperature changes found in endothermic or exothermic reactions. Connects to PASPORT temperature sensors, and the built-in temperature ports on the SPARK or SPARKlink.

The Teaching Advantage

- Teflon® covers to protect the probe from aggressive chemicals are available (CI-6549).
- A range of -35 to +135°C covers most classroom needs

Measure temperature in the water or in the ground.

Compare temperature at the soil surface to temperature below the surface

Fast Response Temperature Probes

PS-2135 (3-pack)

Includes 10 adhesive patches.

Requires:

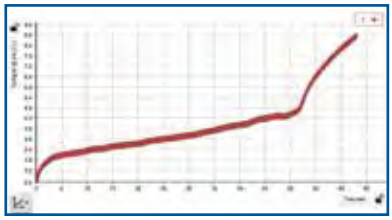
Temperature Sensor
PS-2125
or
Temp Link PS-3222

Use with a Temperature Sensor to measure temperature in sensitive and fast-changing conditions, or study air convection, evaporative cooling, or endothermic and exothermic reactions. Temperature data displays immediately.

The Teaching Advantage

- Does not require calibration – plug it in and go.
- Probe has a 1-meter-long lead, allowing use with long-necked flasks and tall graduated cylinders.

The Fast Response Temperature Probe is ideal for small, hard to reach spaces – here frozen in ice.



Investigate phase change (melting point of water).

Thermocline Sensor

PS-2151

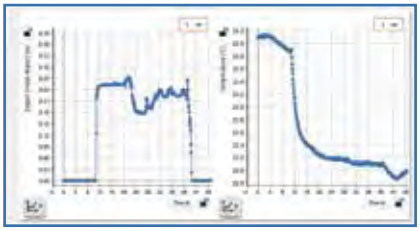
Includes Thermocline Sensor head.

Measure temperature as a function of depth in local streams and lakes while both data points are recorded automatically. Create temperature profiles for different bodies of water, compare temperature variations of freshwater vs. saltwater environments, and study ocean tides.

The Teaching Advantage

- Automatically recorded temperature and depth eliminates the need for manually marking a line, resulting in greatly increased accuracy of results
- Weighted base keeps sensor lead stable
- Works up to 10.5 m with a 0.03 m resolution

Study temperature vs. depth profiles of bodies of water – measure up to 10.5 m deep.



Show how temperature changes with depth even for small, relatively shallow bodies of water.

These sensors are still available at pasco.com

- **Temperature (PS-2125)**
- **Quad Temperature (PS-2143)**
- **Type K Temperature (PS-2134)**
- **Voltage/Current (PS-2115)**

Wireless Colorimeter and Turbidity

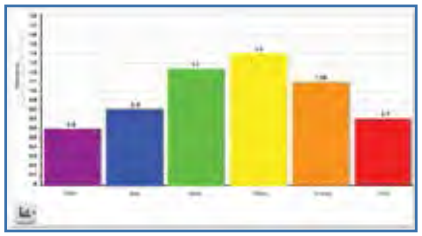
PS-3215

Includes 9 cuvettes, 1 turbidity standard calibration (100 NTU), 2 cuvette racks and USB charging cable.

The Wireless Colorimeter can measure absorbance and transmittance at six different wavelengths. Each wavelength represents a region of the ROYGBV color wheel. Measure the colors of a solution to introduce the principles of spectroscopy, relate absorbance to concentration, and study reaction rates. The colorimeter also functions as a turbidimeter for water quality analysis by measuring the scattering effect of suspended particles.

Compare turbidity of water samples from local water sources.

WARNING! This product can expose you to chemicals including Formaldehyde, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.



The simple built-in calibration – just 15 seconds – means your data is as accurate in the classroom as in the field.

Wireless Voltage Sensor

Explore energy and energy transformations with this Wireless Voltage Sensor. Use the sensor to:

- Measure the voltage of student constructed batteries and see how chemical energy can turn into electrical energy.
- Look at renewable energy by connecting to a wind turbine
- Track the flow of energy by creating simple circuits.

Use the Voltage Sensor to see how tilt angle is related to solar cell effectiveness.

Wireless Voltage Sensor

PS-3211

ezSample™ Snap Vial Kits

Ammonia EZ-2334
Chlorine EZ-2339A
Iron EZ-2331
Nitrate EZ-2333B*
Phosphate EZ-2337

* **WARNING!** This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Required:
Water Quality Colorimeter PS-2179

Chemical Water Quality Test Kits

Conduct colorimetric tests in the field and avoid the mess and tedium of mixing chemicals. These ezSample Snap Vials contain a pre-formulated reagent to test a variety of water-quality parameters. No more guessing at color variations – simply drop the vial into the Water Quality Colorimeter and read the concentration.

Snap the tip of the vial.

The sample instantly flows into tube, mixing with the reagent.

Place the vial in your Water Quality Colorimeter and read the results.

Titration in the field

PASCO also simplifies measurements that require a titration method. The ezSample Field Titrator Kits contain a vacuum-sealed quantity of titrant. The entire process requires only a minute or two, is completely portable, and avoids all the setup and cleanup associated with ordinary titrations.

Begin titrating by gently squeezing the lever to draw in your sample.

In this titration for Alkalinity, color initially changes to pink.

On final color change, turn titrator over and measure concentration using the built-in scale. That's it!

Water Quality Colorimeter

PS-2179

Designed specifically to support chemical analysis of water samples using the ezSample Snap Vial Water Quality Test Kits. Test kits include built-in calibration curves. Reports concentration value.

Iron concentration using ezSample Snap Vial and Water Quality Colorimeter

ezSample™ Field Titrator Kits

Alkalinity EZ-2340
Carbon Dioxide EZ-2341*
Total Hardness EZ-2338

* **WARNING!** This product can expose you to chemicals including phenolphthalein, which is known to the State of California to cause cancer, and methanol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Required:
Water Quality Colorimeter PS-2179

Wireless Weather Sensor with GPS

PS-3209

Includes USB charging cable

Weather Vane Accessory

PS-3553

Includes tripod, tripod adapter, and weather vane.

The Wireless Weather Sensor is an all-in-one instrument for monitoring environmental conditions. By incorporating several sensing elements into a single unit, the sensor provides up to **19 different measurements!** Use the sensor in logging mode with the Weather Vane Accessory for long-term monitoring, or use it as a hand-held instrument to study microclimates and record ambient conditions relevant to many biological and environmental phenomena.

Specifications:

Battery: Rechargeable
Water-resistant
(Please see pasco.com for detailed specifications.)

Use the Wireless Weather Sensor with GPS to find your position and your local weather conditions.

The Wireless Weather Sensor can take 19 different measurements simultaneously.

Digital Adapter

PS-2159

Connect ScienceWorkshop "digital" sensors and other PASCO counting/timing devices (such as Photogates) to SPARK Science Learning System, SPARKlink or other PASPORT interfaces. The PASPORT Digital Adapter has two ports, connecting any two PASCO sensors or timing/counting devices with ¼" stereo phone plugs to any PASPORT interface, including SPARK Science Learning System and SPARKlink.

- Connect ScienceWorkshop Sensors: Motion Sensor II (CI-6742A), Rotary Motion Sensor (CI-6538), Flow Rate (CI-6730A), Drop Counter (CI-6499)
- Connect Timing/Counting Devices: Photogates, Photogate/Pulley System, Time-of-Flight Accessory

For a complete list of sensors that connect with the Digital Adapter, see pasco.com.

Analog Adapter

PS-2158

Now connect most ScienceWorkshop sensors to our PASPORT interfaces, including the SPARK Science Learning System and SPARKlink.

The Analog Adapter works with any ScienceWorkshop Sensor with a 5-pin or 8-pin DIN connector. Please note that some ScienceWorkshop Sensors (Motion Sensor II, Rotary Motion Sensor, Flow Rate, and Drop Counter), plus our timing/counting devices such as Photogates and Time-of-Flight Accessory, require the Digital Adapter PS-2159 (shown at left).

For a complete list of sensors that connect with the Analog Adapter, see pasco.com.

Sensor Extension Cable

PS-2500

2 meters in length, this cable is useful in the field, when an experiment involves liquids or chemicals, or any time you need a bit more length.

Replacement Items

Advanced Water Quality
Optical Dissolved Oxygen Sensor Cap PS-2587

Breath Rate
Replacement Masks (10 pack) PS-2567
Replacement Clips (10 pack) PS-2568

Colorimeter
Cuvettes and Caps (set of 100) SE-8739

EKG
Electrode Patches (100 pack) CI-6620

Exercise Heart Rate
Transmitter and Belt PS-2512A

High Accuracy Drop Counter
Drop Dispenser PS-6935

Oxygen Gas
Oxygen Gas Probe PS-6524

pH
pH Electrode PS-2573

Photogate Tape
High Resolution Tape (30m) ME-6666

Polarimeter
Sample Cell Replacement PS-2234

Spirometer
Mouth Pieces (10 pack) PS-2522

Fast Response Temperature
Fast Response Probes (3 pack) PS-2135
Adhesive Patches (100 pack) PS-2525

Turbidity
Cuvettes and Caps (set of 100) SE-8739

Voltage
Voltage Probe PS-2165

SPARK LXi

PASCO's NEXT GEN SCIENCE DATALOGGER for indoor and outdoor use

Thls innovative science handheld device blends PASCO probeware with SPARKvue data collection and analysis software. It is durable, splash-proof, and works seamlessly with our PASPORT and wireless sensors.

- Ruggedized case for indoor/outdoor and wet/dry lab use
- 8.0" full-color touchscreen
- Simultaneously connects up to 5 wireless sensors
- Includes 2 PASPORT ports
- Includes Voltage Probe and port
- Includes Temp Probe and port
- Can connect more PASPORT sensors with the AirLink, SPARKlink Air, and 550 Universal Interface
- Installed software: PASCO SPARKvue, MatchGraph!, Spectrometry, Microsoft Office Suite, Google Suite
- Hands-free stand

SPARK LXi

PS-3600A

Use with wired and wireless sensors, the SPARK LXi can simultaneously accommodate up to five wireless sensors. It also includes two ports for blue PASPORT sensors, plus two ports for the included Fast Response Temp Probe and the Voltage Probe.

Also available:
SPARK LXi Charging Station
PS-3602

Gratnells® Rolling Carts

EP-3574 (2-column) EP-3575 (3-column)

These movable storage rack carts have been designed for Gratnells trays (sold separately). With this cart system, you can transport materials to and from the classroom. They include large castors with brakes for added stability.

Here is an ideal way to store PASCO sensors and equipment. These rolling carts can be configured for whatever size trays you need.

EP-3574

These carts can be used to store the equipment kits from the *Essential Physics* or *Essential Chemistry* curriculum, the storage trays we offer for wireless sensors, or any of the four sizes of empty trays that we offer for whatever you would like to store.

EP-3575

Assembly is required.
Trays not included.

Gratnells Rolling Carts (2 column)

EP-3574

Stores up to 8 Gratnells F2 trays

Dimensions:
107 cm high,
70 cm wide,
43.5 cm deep

Gratnells Rolling Carts (3 column)

EP-3575

Stores up to 12 Gratnells F2 trays

Dimensions:
107 cm high,
102 cm wide,
43.5 cm deep

Wireless Sensor Storage Trays with Lids

Each storage tray holds up to ten sensors; sensors sold separately.

Wireless Sensor Storage Trays for:

Temperature/pH/ Conductivity Sensors
PS-3585

Pressure Sensors
PS-3586

Colorimeter & Turbidity Sensors
PS-3587

Voltage & Current Sensors
PS-3588

Motion Sensors
PS-3589

AirLink & Light Sensors
PS-3594

Force Acceleration Sensors
PS-3595

Weather Sensor with GPS
PS-3596

CO_2 Sensor
PS-3598

Gratnells® Storage Trays with Lids

These empty Gratnells storage trays with lids have a length of 427 mm and width of 312 mm. The depth of each follows:

F1: 75 mm
F2: 150 mm
F25: 225 mm
F3: 300 mm

F1 F2 F25 F3

Gratnells Storage Trays	
(F1) Shallow	PS-3326
(F2) Deep	PS-3327
(F25) Extra Deep	PS-3328
(F3) Jumbo	PS-3329

Storage Bins

SE-7560

These stackable plastic bins with lids can be useful for storing equipment and accessories in your lab.

14” L x 9.5” W x 6.9” D

Storage Bins (set of 5)
SE-7560

— A —

— B —

— C —

— D —

— E —

— F —

— G —

— H —

— I —

— J-K-L —

— M —

— N —

— O —

— P —

— Q-R —

— S —

— T —

— U —

— V —

— W —

— X-Y-Z —

The PASCO Promise of Learning (90-day Satisfaction Guarantee)

We are confident that PASCO solutions will help your students achieve more in science. Within the first 90 days, if you are not satisfied that your students are more engaged and learning more effectively, return your purchase for a refund. We don't want you spending precious budget dollars on something you don't use. (We are sorry but we must exclude non-PASCO software that has been opened, radioactive products and products that contain perishables.) See instructions for Returns below.

PASCO 5-Year Limited Warranty for Education

PASCO products are built to survive. PASCO-manufactured products are covered by a limited warranty for a period of 5 years from delivery date against defects in material and workmanship. This warranty is valid for educational institution customers and only for educational use of these products. The PASCO warranty does not extend to any product, including touch screens, which have been subject to abuse, neglect, accident, improper installation or application, or products that have been repaired or altered outside of our factory. Consumables and limited-life products (such as pH probes, membranes, fast response temperature probes, batteries, chemical solutions, printed materials, etc.) are excluded.

Other Warranty Terms

The SPARK LXi datalogger carries a limited warranty for a period of 3 years from delivery date against defects in material and workmanship. This limited warranty applies only to hardware components of the SPARK LXi that are not subject to accident, misuse, neglect, fire, or other external damage. This warranty can also be voided by unauthorized use, alterations, or repair. This warranty is valid for education institution customers and only for educational use of these products.

Products manufactured by anyone other than PASCO are subject to the conditions of the warranty supplied by the manufacturer (generally 1 year). Additional warranty information on our products is available upon request.

Free Teacher and Technical Support

We want teachers to be successful with PASCO solutions. Please contact our support team with any questions via phone or email: +1 916-462-8384 or support@pasco.com. We are here to help.

SPARKvue Licenses

SPARKvue software may be purchased as a Single License for use with one computer or as a Site License for use on all computers on a K-12 campus or in a college/university department.

SPARKvue for iPad®, Chromebook™, or Android™ tablets is licensed separately and is free through the App Store, the Chrome Web Store and Google Play. See pasco.com for more information.

PASCO Capstone Licenses

PASCO Capstone may be purchased as a Single License for use with one computer, or as a Site License for use on all computers on a primary and secondary campus or in a college/university department.

e-Book Licenses for Essential Chemistry and Essential Physics

For complete information on our one-year and five-year e-book licenses, go to **pasco.com/essentialchemistry** or **pasco.com/essentialphysics**.

Shipping

Items in stock will normally be shipped in less than seven working days from receipt of the order. Specific requests for air shipments or special carriers will be honored at an additional cost.

Returns

Please contact the authorized PASCO representative in your country for assistance in returning equipment for repair. PASCO's International Customer Service team can be reached at +1-916-462-8383 or at custserv@pasco.com. Out-of-Warranty products must be shipped prepaid, door-to-door. Returns for credit or exchange must be in new condition and packaged in original shipping cartons or packaging sufficient to prevent damage during international transport.

Trademarks

PASCO, PASCO scientific, PASCO Capstone, EcoZone, ezSample, MatchGraph!, MultiMeasure Sensors, ScienceWorkshop, SPARKscience, SPARK Element, SPARKvue, SPARKvue HD, SPARKlab, SPARKlink, PASPORT and Tension Protractor are trademarks or registered trademarks of PASCO scientific in the United States and/or in other countries. All other brands, products or service names are or may be trademarks or service marks of, and are used to identify products or services of, their respective owners. For more complete information visit pasco.com/legal.

More Product Information

Designed for education. PASCO products are designed for education; they are not intended for use in graduate research or industry, and should not be used in any apparatus involved with life support, patient diagnosis, or industrial control.

PASCO reserves the right to change the specifications of any product without prior notice. If a product is no longer available, PASCO reserves the right to substitute a product of equal, or higher, value and functionality.

FCC

Where appropriate, electrical products are marked to indicate that they conform to Federal Communications Commission (FCC) standards. Most commonly, FCC Part 15, Class A.

CE MARK

Where appropriate, products carry the CE marking, which indicates that they conform to the applicable European standards. This almost exclusively applies to products that are designed to meet the following applicable directives:

2014/30/EU	EMC Directive
2014/35/EU	Low Voltage Directive
2011/65/EU	RoHS Recast/RoHS-2
2014/53/EU	Radio Equipment Directive

Other Regulations May Apply

Local, national, and international regulations may restrict the purchase, storage, transport, use or disposal of certain products such as chemicals, radioactive sources, and specialty products and wireless transmission devices. Please consult your local regulations to ensure compliance.

Unless Otherwise Specified:

– Operating Temperature Range: 0°C – 40°C (32°F to 104°F).
– Maximum Altitude (Operational): 10,000 feet
– Recommended Storage Temperature: 10°C to 27°C (50°F to 80°F)

Quality

PASCO scientific Meets the Highest Quality Standards, and our Quality Management System is Registered to ISO 9001.

PASCO and the Environment

PASCO is committed to be in compliance with all laws and requirements in the countries in which our products are sold. PASCO is a responsible steward of the environment and as such, continually seeks to minimize the impact that our manufacturing, distribution, and consumption practices make on the planet's natural resources.

Miscellaneous

RoHS

European Union Restriction of Hazardous Substances. EU Directives 2011/65/EU:

- All applicable electrical products supplied by PASCO to the EU meet the requirements as specified in the RoHS directive either by substance limits or by product exemptions.

EU WEEE

Waste Electrical and Electronic Equipment. EU Directive 2012/19/EC, Effective July 4, 2012:

- All applicable products supplied by PASCO to the EU meet the requirements as specified in the WEEE directive and are marked with the WEEE symbol.

WEEE-Product End of Life Disposal Instructions (Reference):

Electronic products are subject to disposal and recycling regulations that vary by country and region. It is a user's responsibility to recycle electronic equipment per local environmental laws and regulations to ensure that equipment is recycled in a manner that protects human health and the environment. To find equipment recycling drop-off locations, please contact your local waste recycle/disposal service or the product representative.

The European Union (EU) WEEE (Waste Electrical and Electronic Equipment) symbol on our products and packaging indicates that this product must not be disposed of in a standard waste container.

EU REACH

Registration, Evaluation and Authorization of Chemicals, as of: Oct. 28, 2008:

- PASCO has reviewed the REACH SVHC list and, according to our current knowledge, cables supplied with some products may contain certain phthalate plasticizers at greater than 0.1% by weight
- Regarding the other SVHC's, to the best of our knowledge, none are present in PASCO products (articles) at concentrations of greater than 0.1% by weight

Battery Replacement and Disposal Instructions (Reference):

Batteries contain chemicals that, if released, may affect the environment and human health. Batteries should be collected separately for recycling, and recycled at a local hazardous material disposal location adhering to your country and local government regulations. To find a battery recycling drop-off location, please contact local waste disposal service or the product representative.

The battery or batteries used in PASCO products are marked with the European Union symbol for waste batteries that indicate the need for separate collection and recycling. For small batteries, the symbol is printed on the packaging.

EU Battery Directive

EU Directive 2006/66/EC on Waste Batteries:

- The European Union (EU) battery directive aims to reduce the environmental impact of waste batteries and accumulators.
- According to our specifications, all products supplied by PASCO Scientific into the EU that contain batteries meet the battery directive requirements, and are marked with the battery symbol.

PASCO

Since 1964

The Global Leader in 21st Century Science Education

Supporting educators in over 100 countries around the world

When you have questions or need service, we want someone who understands your local needs. We carefully select, train, and support local Science Education Partners to serve our customers in each country.

When you work with a PASCO Science Education Partner, have confidence that the entire company here in California is ready to assist our Partner – and you, our Customer.

Designed in California.
Guaranteed by PASCO.
Supported locally.
Serving science educators.

+1 916-786-3800

ISO 9001 Certified

IQNet®

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

Nemko AS has issued an IQNet recognized certificate that the organization:

PASCO Scientific
10101 Foothills Blvd.
Roseville, CA 95747, USA

has implemented and maintains a
Quality Management System

for the following scope:
Design, Manufacture, Sale, and Support of Educational Scientific Apparatus, Software, and Textbooks

which fulfils the requirements of the following standard

ISO 9001:2015

Issued on: 2018-06-07
Validity date: 2021-06-21

This attestation is directly linked to the IQNet Partner's original certificate and shall not be used as a stand-alone document
Registration Number: NO-800933

IQNet — *Alex Stoichitoiu, President of IQNet* — *Pal Eddie, Nemko AS* — N

IQNet Partners*:
AENOR *Spain* AFNOR Certification *France* APCER *Portugal* CCC *Cyprus* CISQ *Italy* CQC *China* CQM *China* CQS *Czech Republic* Cro Cert *Croatia* DQS Holding GmbH *Germany* FCAV *Brazil* FONDONORMA *Venezuela* ICONTEC *Colombia* Inspecta Sertifiointi Oy *Finland* INTECO *Costa Rica* IRAM *Argentina* JQA *Japan* KFQ *Korea* MIRTEC *Greece* MSZT *Hungary* Nemko AS *Norway* NSAI *Ireland* NYCE-SIGE *México* PCBC *Poland* Quality Austria *Austria* RR *Russia* SII *Israel* SIQ *Slovenia* SIRIM QAS International *Malaysia* SQS *Switzerland* SRAC *Romania* TEST St Petersburg *Russia* TSE *Turkey* YUQS *Serbia*
IQNet is represented in the USA by: AFNOR Certification, CISQ, DQS Holding GmbH and NSAI Inc.

* The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

A whole team behind you

Serving educators isn't just what we do, it's who we are.

PASCO is a proud recipient of the 2016 Tech & Learning Stellar Service Award!

From the production line to our shipping department, from our marketing team to our engineering groups, we are a company of science teachers, education experts, and professionals committed to making a difference in science education today and tomorrow. We succeed by helping you succeed.

If you have PASCO products in your classroom or lab, we want you to know that we are always here if you have questions or challenges or need direction.

Need help getting started? Our Education Consultants are the best first point of contact and in a position to understand your needs, whether you are a classroom teacher, a district supervisor, or head of a ministry of education.

Our Customer Support Team can also answer any questions about products or orders. And our Teacher Support Staff is always ready with answers to your questions or to walk you through any issues. They have a vast knowledge of all PASCO products and can mirror your exact setup to help find solutions.

In short, just tell us what you need and we will do everything we can to help. And remember, *we stand behind the products we make with our five-year warranty.*

Once our solutions are in your hands, we want you to have the training to use them as effectively as possible. We have an extensive library of free help videos, offer regular free online trainings, and host hands-on workshops around the country. If you like, we can even do personalized trainings at your school or with your teachers at PASCO.

The PASCO Support Team: Dedicated to Physics and Engineering Education

Make informed decisions on what equipment best meets your needs! PASCO has fully trained Science Education Partners all around the world who are ready to work with you on equipping your lab in the most cost-effective manner. If you would like an introduction to the Science Education Partner in your country, please contact the sales director below for more information.

Chris Wilhelm
Sales Director
Western Europe
wilhelm@pasco.com
+1 916.462.8259

Mark Kotlyar
Sales Director
Eastern Europe & Central Asia
mkotlyar@pasco.com
+1 916.462.8265

Tom Rush
Sales Director
Middle East & Africa
trush@pasco.com
+1 916.462.8214

John Wayne
Vice President
International Sales
wayne@pasco.com
+1 916.462.8212

Laurie Chiu-Mar
Sales Director
Asia Pacific
chiumar@pasco.com
+1 916.462.8224

Humberto Medina
Sales Director
Latin America & Canada
medina@pasco.com
+1 916.462.8223

PASCO Mission

Providing educators worldwide with innovative solutions for teaching science

Teacher and Technical Support

Melissa Pytlak

BS in Biology from State University of New York Geneseo and an MS in Plant Biology from University of California Davis

Scott Sukrapanna

BS in Physics and an MS in Plant Biology from University of California Davis

Mike Paskowitz

BS in Mechanical Engineering and Materials Science and an MS in Chemical Engineering and Materials Science from UC Davis

Angela Ziegler

BS in Biology with a minor in Chemistry from Sacramento State and Clinical Lab Scientist at UC Davis Med Center

Phone:
+1 916.462.8384

Fax:
+1 916.786.8905

E-mail:
intlsales@pasco.com
support@pasco.com

Mail:
PASCO scientific
10101 Foothills Blvd.
Roseville, CA 95747-7100 USA

Web Site:
Order and quote online **pasco.com**

Business Hours:
Monday - Thursday: 7:00 a.m. - 4:30 p.m.
Friday: 7:00 a.m. - 2:00 p.m. Pacific Time

2020 PASCO Domestic Training, Conferences, and Workshops

January 18–21
AAPT: American Association of Physics Teachers 2020
Caribe Royale Hotel | Orlando, FL

January 25
Nevada State Science Teachers Association Annual Conference 2020
Flag View Intermediate School | Elko, NV

February 9–12
Florida Association of IB World Schools FLIBS Directors' Forum
Tradewinds Island Grand Resort
St. Pete Beach, FL

February 11–13
OETC: Ohio Educational Technology Conference
Columbus Convention Center | Columbus, OH

February 13–14
Georgia Association of Science Teachers 2020
Columbus Georgia Convention and Trade Center | Columbus, GA

February 23–25
Missouri Science Teachers
Tan-Tar-A Resort | Osage Beach, Missouri

February 23–26
PETE&C: Pennsylvania Educational Technology Expo & Conference
David L. Lawrence Convention Center
Pittsburg, PA

March 6–7
MSTA: Michigan Science Teachers Association
Lansing Center/Radisson Hotel | Lansing, MI

March 16–17
NEOtech: Northeast Ohio Network for Educational Technology Consortium
John S. Knight Center | Akron, OH

March 19–21
Wisconsin Society of Science Teachers (WSST)
Kalahari Resort and Conference Center
Wisconsin Dells, WI

March 19–21
CUE: Spring CUE 2020 Conference
Palm Springs Convention Center
Palm Springs, CA

April 2–5
NSTA National Convention
Boston Convention and Exhibition Center
Boston, MA

June 28–July 1
ISTE: International Society for Technology in Education 2020
Anaheim Convention Center | Anaheim, CA

July 18–23
BCCE: Biennial Conference on Chemical Education
Oregon State University | Corvallis, OR

July 22–24
NSTA STEM Forum & Expo
Kentucky International Convention Center
Louisville, KY

July 27–August 1
NAOSMM: National Association of Scientific Materials Managers
Renaissance Downtown | Oklahoma City, OK

October 16–19
California Education Conference 2020
Palm Springs Convention Center
Palm Springs, CA

October 20–21
New Jersey Science Convention
Princeton Marriott at Forrestal | Princeton, NJ

November 2–3
Science Teachers Association of NY State (STANYS)
Rochester Riverside Convention Center
Rochester, NY

November 5–7
CAST: Conference for the Advancement of Science Teaching
George R. Brown Convention Center
Houston, TX

November 13
Colorado Science Conference 2020
Denver Mart | Denver, CO 80216

November 19–21
NSTA Area Conference
New Orleans, LA

December 4
LISTEMELA
Crest Hollow Country Club | Westbury, NY

December 10–12
NSTA Area Conference
Phoenix, AZ

PASCO SUMMER INSTITUTES

July 13–16
PASCO Capstone STEM Summer Institute
Roseville, CA

July 27–28
SPARKvue STEM Summer Institute
Bonus Day: July 29, 2020
Phenomena-Driven Learning
Roseville, CA

Join Us at a STEM Workshop!

MARCH 2020
Tuesday, Mar. 10
Phoenix, AZ

Wednesday, Mar. 11
San Jose, CA

Thursday, Mar. 12
Miami, FL

Tuesday, Mar. 17
Boston, MA

Wednesday, Mar. 18
Grand Rapids, MI

Thursday, Mar. 19
Columbia, SC

Thursday, Mar. 26
Charlottesville, VA

APRIL 2020
Tuesday, Apr. 7
Las Vegas, NV

Thursday, Apr. 9
Decatur, GA

Saturday, Apr. 11
Rochester, NY

Thursday, Apr. 16
Chicago, IL

Thursday, Apr. 16
Houston, TX

Tuesday, Apr. 21
Worthington, OH

Wednesday, Apr. 22
Dallas, TX

Thursday, Apr. 23
Nashville, TN

Thursday, Apr. 30
Raleigh, NC

MAY 2020
Tuesday, May 12
Providence, RI

Tuesday, May 12
St. Louis, MO

Saturday, May 23
Glassboro, NJ

JUNE 2020
Monday, June 1
Roseville, CA

Tuesday, June 2
Denver, CO

Thursday, June 4
Salt Lake City, UT

AUGUST 2020
Tuesday, Aug. 25
Oklahoma City, OK

SEPTEMBER 2020
Tuesday, Sept. 1
Seattle, WA

Tuesday, Sept. 15
Austin, TX

Thursday, Sept. 17
Minneapolis, MN

Thursday, Sept. 17
San Antonio, TX

Tuesday, Sept. 22
Strongsville, OH

Thursday, Sept. 24
West Palm, FL

OCTOBER 2020
Thursday, Oct. 1
Portland, OR

Thursday, Oct. 15
Huntsville, AL

Tuesday, Oct. 20
Albuquerque, NM

Tuesday, Oct. 20
Milwaukee, WI

Wednesday, Oct. 21
Auburn Hills, MI

Thursday, Oct. 22
Plymouth Meeting, PA

NOVEMBER 2020
Saturday, Nov. 7
Harrisburg, PA

For the latest information on PASCO STEM Workshops, go to **pasco.com/training-and-events**

2020 PASCO International Training, Conferences, and Workshops

January 8-11
ASE: The Association of Science Education
University of Reading, Whiteknights Campus
Reading, United Kingdom

January 22–25
BETT: British Educational Training and Technology Show
ExCeL London, Royal Victoria Dock
London, United Kingdom

February 25–27
GESS Dubai: Global Educational Supplies and Solutions
Dubai World Trade Centre | Dubai, UAE

March 17–19
IB Global Conference Bangkok
Centara Grand & Bangkok Convention Centre at CentralWorld | Bangkok, Thailand

April
Moscow International Education Fair
Moscow, Russia

June 21–24
ASEE: American Society for Engineering Education
The Palais des Congrès de Montréal
Montreal, Canada

June 22–24
20th Meeting of the Polish Physics Demonstrators Club
Poznań, Poland

July 23–26
IB Global Conference Toronto
Metro Toronto Convention Centre
Toronto, Canada

August–September
Moscow Global Forum: City of Education Forum
Moscow, Russia

September 3–4
63 Congress of the Polish Society of Chemists (Didactic Conference)
Warsaw, Poland

September 4–6
27th Congress of the Polish Association of Natural Science Teachers
Kraków, Poland

September 12–13
46th Congress Of Physicists (Didactic Conference)
Bydgoszcz, Poland

September 19–20
21st Forum of Natural Sciences Teachers
Białystok, Poland

September 25–27
II Congress Of Physics Teachers
Łódź, Poland

October 17–18
Podlasie EDU-Innovations Mońki, Poland
Warmińsko-Mazurskie

For the latest information on PASCO training, conferences, and workshops, go to **pasco.com/training-and-events**

PASCO
10101 Foothills Blvd. • Roseville, CA 95747-7100
+1 916 786 3800 www.pasco.com

Wireless Sensor Solutions

Award-winning line of sensors for STEM

Lab Organization Solutions

Convenient storage trays and carts keep your lab equipment organized.

CT-IHS