CODING TO LEARN
Explore STEM through sense and control, while developing computational thinking skills with Blockly.
20 GRANTS IN 2020

Apply for a $1,000 wireless sensor grant.

Are you a science teacher who loves hands-on experimentation? Do you use innovative methods to measure phenomena in the classroom? We want to hear how your class would benefit from sensor technology.

Throughout 2020, we’re celebrating STEM education by awarding twenty $1,000 grants to educators across the United States. Each awardee will receive a $1,000 grant to bring PASCO wireless sensors into their classroom.

How would you use your $1,000 wireless sensor grant? Applications will open on January 1, 2020, and will remain open throughout the year. We will announce the first awards in April 2020 and continue our celebration of STEM educators throughout the year.

To get more details and submit your application, visit us at pasco.com/grants/2020

Be sure to check our website throughout 2020 for updates.

New! Our growing line of wireless sensors now includes a Wireless Optical Dissolved Oxygen Sensor, a Wireless Sound Sensor, and a Wireless Motion Sensor. All of our wireless sensors work with your existing classroom technology, and our app is free for iOS, Android™ tablets and Chromebook™. Need a dedicated science device? Check out our SPARK LXi, designed to support science learning.
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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

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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
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.

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

Collect data in real time using PASPORT or wireless sensors.

SPARKvue comes installed on every SPARK LXi.
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](http://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.

We also offer free 60-day trials for Windows™ and Mac®.

Visit [www.pasco.com/downloads](http://www.pasco.com/downloads)

Cross-Platform Compatibility

![Cross-Platform Compatibility](image)

**SPARKvue (single user license)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2401</td>
<td>$99</td>
<td>Windows® and Mac®</td>
</tr>
<tr>
<td>PS-2401-DIG</td>
<td>$99</td>
<td>Windows® and Mac®</td>
</tr>
</tbody>
</table>

**SPARKvue (site license)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2400</td>
<td>$249</td>
<td>Windows® and Mac®</td>
</tr>
<tr>
<td>PS-2400-DIG</td>
<td>$249</td>
<td>Windows® and Mac®</td>
</tr>
</tbody>
</table>

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**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

**Teacher Resources**
EC-6351-DIG (digital only)

### Essential Chemistry Standard Equipment Kit
EC-6361 $559

- 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)

Includes 1 of each of the following:

- 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

**Teacher Resources**
EP-6324-DIG (digital only)

### Comprehensive Physics Equipment Kit
EP-6490A $1969

- 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 $927

- **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

Includes:

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

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**

<table>
<thead>
<tr>
<th>PS-3600A</th>
<th>$399</th>
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</table>

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  | $165 |

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.


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 Labs and Sensors Used

<table>
<thead>
<tr>
<th>Lab Title</th>
<th>Temperature</th>
<th>Light</th>
<th>Weather with GPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical and Chemical Changes</td>
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<tr>
<td>2. Conservation of Mass</td>
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<tr>
<td>3. Thermal Insulators and Conductors</td>
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<tr>
<td>5. Can Plants Survive Without Light and Water?</td>
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<tr>
<td>6. How a Greenhouse Works: Light</td>
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<tr>
<td>7. Weather: Investigating Humidity</td>
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<td></td>
</tr>
<tr>
<td>8. Weather: Investigating Barometric Pressure</td>
<td></td>
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</tr>
<tr>
<td>9. Weather Station Creation</td>
<td></td>
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<tr>
<td>10. What Is a Meteorologist?</td>
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</tbody>
</table>

Elementary School Sensor Bundle

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Price</th>
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<tbody>
<tr>
<td>PS-3308C</td>
<td>$289</td>
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</tbody>
</table>

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

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STEM................................. 14
Wireless Temperature Sensor

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 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 Temperature Sensor

PS-3201 $49
Includes 1 coin cell battery.

Wireless Light Sensor

PS-3213 $72
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 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!

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

<table>
<thead>
<tr>
<th>Lab Title</th>
<th>Temperature</th>
<th>pH</th>
<th>CO₂</th>
<th>Weather with GPS</th>
<th>Smart Cart</th>
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</thead>
<tbody>
<tr>
<td>1. Describing Ecosystems</td>
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<td>2. Photosynthesis</td>
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<td>3. Exercise and the Body</td>
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<td>4. Carbon Cycle</td>
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<td>5. Waste and Composting</td>
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<td>6. The Living Atmosphere*</td>
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<td>7. Night and Day</td>
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<td>8. The Changing Seasons</td>
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<tr>
<td>9. Water Quality</td>
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<td>10. The Greenhouse Effect</td>
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<td>11. Keeping Cool</td>
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<tr>
<td>12. Inertia</td>
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<td>13. Energy’s Changing Forms</td>
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<tr>
<td>14. Pressure and Volume</td>
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<tr>
<td>15. Acid Rain</td>
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</table>

*Also requires Wireless O₂ Sensor, below.

More Wireless Sensors for Middle School Science

Wireless Force Acceleration Sensor

| PS-3202 $99 | 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 $189 | 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.
MORE WIRELESS SENSORS FOR MIDDLE SCHOOL SCIENCE

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

<table>
<thead>
<tr>
<th>PS-3206</th>
<th>$89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes hand-grips and Bluetooth® Heart Rate Module with one coin-cell battery.</td>
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</tbody>
</table>

Wireless Light Sensor

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

<table>
<thead>
<tr>
<th>PS-3213</th>
<th>$72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes all these measurements:</td>
<td></td>
</tr>
<tr>
<td>- Illuminance (lux)</td>
<td></td>
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<td>- UVA, UVB, and UV Index</td>
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<tr>
<td>- RGB color detection</td>
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<tr>
<td>Includes 1 coin cell battery.</td>
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</table>

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

<table>
<thead>
<tr>
<th>PS-3215</th>
<th>$119</th>
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</thead>
<tbody>
<tr>
<td>Includes 10 cuvettes, 1 turbidity calibration standard (100 NTU), 2 cuvette racks, and USB charging cable.</td>
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<tr>
<td>Also available:</td>
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<tr>
<td>Spectrometer/Colorimeter Cuvettes SE-8739 $23</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>PS-3203</th>
<th>$89</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

We Can Help    sales@pasco.com    support@pasco.com
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 $189
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 $99
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 CO₂ 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.

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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
or 800-772-8700
The latest sensors for Biology!

**Wireless CO₂ Sensor**

PS-3208  $199  (page 21)

*Includes 250-mL sampling bottle and USB charging cable.*

Use this wireless sensor to measure the concentration of CO₂ gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO₂ data can be logged directly on the device for long-term life science and environmental science studies.

**Wireless Weather Sensor with GPS**

PS-3209  $185  (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  $296  (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 $189  (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  $79  (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  $89  (page 24)

*Includes 2 feet of polyurethane plastic tubing, 1 tube connector, 2 male barbed luer locks, 1 female barbed luer lock, a 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

<table>
<thead>
<tr>
<th>Lab Title</th>
<th>Starter Bundle</th>
<th>Extension Bundle</th>
<th>AP® Big Ideas*</th>
<th>IB® Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Enzyme Activity</td>
<td></td>
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<td>1, 2, 4</td>
<td>2.5</td>
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<tr>
<td>1B. Enzyme Activity***</td>
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<td>1, 2, 4</td>
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<tr>
<td>1C. Enzyme Activity***</td>
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<td>2. Diffusion</td>
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<td>3. Osmosis</td>
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<td>4. Plasmolysis</td>
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<td>5. Cell Size</td>
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<td>1.1</td>
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<td>6. Homeostasis</td>
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<td>3, 4</td>
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<td>7. Cellular Respiration</td>
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<td>8. Photosynthesis</td>
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<td>9. Plant Pigments***</td>
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<td>10. Transpiration</td>
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<td>11. Mitosis</td>
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<td>12. Meiosis</td>
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<td>3.3, 10.1</td>
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<td>13. Energy Dynamics</td>
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<td>14. Artificial Selection</td>
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<td>1</td>
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<tr>
<td>15. BLAST Bioinformatics</td>
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<td>3.1, B.5</td>
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<td>16. Population Genetics</td>
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<tr>
<td>17. Mathematical Modeling of Evolution</td>
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<td>10.3</td>
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<tr>
<td>18. Animal Behavior</td>
<td></td>
<td></td>
<td>2, 4</td>
<td>A.4</td>
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</tbody>
</table>

*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 O₂ Sensor; see page 28.

***Requires the Wireless Spectrometer; see page 26.
# Biology Solutions

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

## Biology Starter Bundle

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-7614A</td>
<td>Wireless CO₂ (PS-3208)</td>
<td>$429</td>
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<tr>
<td></td>
<td>Wireless Temp Link (PS-3222)</td>
<td></td>
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<tr>
<td></td>
<td>Wireless pH (PS-3204)</td>
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<tr>
<td></td>
<td>Wireless Pressure (PS-3203)</td>
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</tbody>
</table>

## Biology Extension Bundle

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-7615B</td>
<td>Wireless Weather with GPS (PS-3209)</td>
<td>$729</td>
</tr>
<tr>
<td></td>
<td>Wireless Optical Dissolved Oxygen Sensor (PS-3224)</td>
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<tr>
<td></td>
<td>Wireless Conductivity (PS-3210)</td>
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<tr>
<td></td>
<td>Wireless Colorimeter and Turbidity (PS-3215*)</td>
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<tr>
<td></td>
<td>EcoChamber (ME-6667)</td>
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</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>PS-2935C</td>
<td>AirLink (PS-3200)</td>
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<tr>
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<td>Wireless Hand-Grip Heart Rate (PS-3206)</td>
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<td>EKG Sensor (PS-2111)</td>
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<td>Spirometer (PS-2152)</td>
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<td>Spirometer Mouth Pieces (PS-2522)</td>
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<tr>
<td></td>
<td>Wireless Blood Pressure (PS-3218)</td>
<td></td>
</tr>
</tbody>
</table>

We Can Help  sales@pasco.com  support@pasco.com
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

<table>
<thead>
<tr>
<th>Lab Title</th>
<th>Starter Bundle</th>
<th>Extension Bundle</th>
<th>Physiology Extension Bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Enzyme Action (Oxygen)*</td>
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<tr>
<td>1B. Enzyme Action (Pressure)</td>
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<tr>
<td>2. Membrane Permeability</td>
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</tr>
<tr>
<td>3. Organisms and pH</td>
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<tr>
<td>4. Osmosis</td>
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</tr>
<tr>
<td>5. Plant Respiration and Photosynthesis</td>
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<tr>
<td>6. Respiration of Germinating Seeds</td>
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<td>7. Buffers in Biological Systems</td>
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<tr>
<td>8. Acid Rain</td>
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<td>9. Cellular Respiration in Yeast</td>
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<td>10. Energy Content of Food</td>
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<tr>
<td>11. Metabolism of Yeast</td>
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<tr>
<td>12. Photosynthesis of Aquatic Plants**</td>
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<tr>
<td>13. Soil pH</td>
<td></td>
<td></td>
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<tr>
<td>14. Transpiration</td>
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<td>15. Water and pH</td>
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<td></td>
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<td>16. Water Purification</td>
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<td>17. Weather in a Terrarium</td>
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<td>18. EKG: Factors That Affect the Heart</td>
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<td>19. Exercise and Heart Rate</td>
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<td>20. Exercise and Blood Pressure</td>
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<td>21. Muscle Fatigue</td>
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<td>22. Regulation of Body Heat</td>
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<tr>
<td>23. Volume of Breath</td>
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</table>

*Requires Wireless O₂ Sensor; see page 28.

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

### Essential Biology Teacher Lab Manual

**EB-6331-DIG** $40 (digital)

**EB-6331** (print) $50

*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 $429
- Biology Extension Bundle
  - PS-7615B $729
- Physiology Extension Bundle
  - PS-2935C $579
Wireless CO₂ Sensor

Use this wireless sensor to measure the concentration of CO₂ gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile sensor. CO₂ data can be logged directly on the device for long-term studies and monitoring.

Wireless CO₂ Sensor
PS-3208  $199
Includes 250-ml sampling bottle and USB charging cable.

Dissolved CO₂ Waterproof Sleeve

The Wireless CO₂ Sensor can be equipped for aqueous measurements using this semipermeable sleeve. The sleeve is waterproof but allows CO₂ 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 CO₂ Waterproof Sleeve
PS-3545  $21
Includes 5 sleeves and 5 O-rings

Compare the respiration rate of germinating and dry seeds.
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**

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

<table>
<thead>
<tr>
<th>Wireless Weather Sensor with GPS</th>
<th>Weather Vane Accessory</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3209  $185</td>
<td>PS-3553  $36</td>
</tr>
<tr>
<td>Includes USB charging cable.</td>
<td>Includes tripod, tripod adapter, and weather vane.</td>
</tr>
</tbody>
</table>

**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.

**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)

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

<table>
<thead>
<tr>
<th>Wireless Temperature Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3201  $49</td>
</tr>
<tr>
<td>Includes 1 coin cell battery.</td>
</tr>
</tbody>
</table>
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

Cuvette Rack

EC-3590 $10
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.

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)

Cuvettes and Caps

SE-8739 $23
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 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 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

**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 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 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 $89
Includes hand-grips and Bluetooth® Heart Rate Module with one coin-cell battery.

Wireless Exercise Heart Rate Sensor

PS-3207 $79
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™.

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

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 $399
Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:
Optional Fiber Optic Cable
PS-2601 $74
Cuvettes & Caps
SE-8739 $23
Cuvette Rack
EC-3590 $10
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 $296
Includes USB charging cable

Wireless Optical Dissolved Oxygen Metal Guard

PS-3604 $55
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 O₂ sensor.)

Wireless Optical Dissolved Oxygen Sensor Cap

PS-3605 $55
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 O₂ 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:

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Trays</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature/pH/Conductivity</td>
<td>PS-3585</td>
<td>$30</td>
</tr>
<tr>
<td>Pressure Sensors</td>
<td>PS-3586</td>
<td>$35</td>
</tr>
<tr>
<td>Colorimeter &amp; Turbidity Sensors</td>
<td>PS-3587</td>
<td>$40</td>
</tr>
<tr>
<td>Voltage &amp; Current Sensors</td>
<td>PS-3588</td>
<td>$30</td>
</tr>
</tbody>
</table>

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 CO₂ 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 CO₂ Sensor on page 15.*

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 CO₂ 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.

Make all your sensors wireless.

Use the Metabolism Chamber to study cellular respiration and monitor CO₂ and O₂ simultaneously.

<table>
<thead>
<tr>
<th>Wireless Oxygen Gas Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3217 $189</td>
</tr>
<tr>
<td>Includes USB charging cable, 250-mL sampling bottle</td>
</tr>
</tbody>
</table>

*Also available:*

- **Wireless O₂ Replacement Sensor** PS-3606 $50

<table>
<thead>
<tr>
<th>Wireless CO₂ Sensor</th>
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</thead>
<tbody>
<tr>
<td>PS-3208 $199</td>
</tr>
<tr>
<td>Includes 250-mL sampling bottle and USB charging cable.</td>
</tr>
</tbody>
</table>

*Also available:*

- **Dissolved CO₂ Waterproof Sleeve** PS-3545 $21

<table>
<thead>
<tr>
<th>Ethanol Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2194 $160</td>
</tr>
<tr>
<td>Includes PTFE tape for membrane replacement.</td>
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</table>

<table>
<thead>
<tr>
<th>AirLink</th>
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</thead>
<tbody>
<tr>
<td>PS-3200 $60</td>
</tr>
<tr>
<td>Includes one PASPORT sensor port, USB and Bluetooth connectivity, and USB cable.</td>
</tr>
</tbody>
</table>
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.

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.

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.

Metabolism Chamber
ME-6936 $12
Includes 250 mL sampling bottle with cap.
Also available: 250 mL Sample Bottles
4-pack
SE-6938 $22
Includes four 250 mL sampling bottles with caps.

EcoChamber
ME-6667 $40
Includes EcoChamber tank with lid, 7 stoppers of various sizes, 5 probe stops, syringe and plastic tubing with connector.

EcoZone™ System
ME-6668 $109
Includes 3 EcoChambers, tray, rubber stoppers, syringe, plastic tubing and wicking cord.

Photosynthesis Tank EcoChamber

ME-6935 $15
Includes Photosynthesis Tank, large #14 stopper with sensor ports, and 2 small #3 stoppers.

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

250 mL Sample Bottles
SE-6938  $22
Includes four 250 mL sampling bottles with caps.
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

**Wireless Blood Pressure Sensor**

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3218</td>
<td>$105</td>
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</tbody>
</table>

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

**Also available:**

- **Small Blood Pressure Cuff**  
  PS-3591 $45
- **Standard Blood Pressure Cuff**  
  PS-3592 $40
- **Large Blood Pressure Cuff**  
  PS-3593 $50

---

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**

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2187</td>
<td>$225</td>
</tr>
</tbody>
</table>

Includes 10 masks and 10 clips

**Also available:**

- **Replacement Masks (10 pack)**  
  PS-2567 $20
- **Replacement Clips (10 pack)**  
  PS-2568 $15
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.

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.

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

### EKG Sensor

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.

### Spirometer

**Spirometer**

<table>
<thead>
<tr>
<th>PS-2152</th>
<th>$199</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes 2 disposable mouth pieces</td>
<td></td>
</tr>
</tbody>
</table>

**Also available:**

- Replacement Mouth Pieces (10)
  - PS-2522  $36

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

### EKG Sensor

**EKG Sensor**

<table>
<thead>
<tr>
<th>PS-2111</th>
<th>$99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes 100 self-adhesive electrode patches.</td>
<td></td>
</tr>
</tbody>
</table>

**Also available:**

- EKG Sensor Electrode Patches (100-pack; one-year shelf life)
  - CI-6620  $12
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.

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.

Goniometer Sensor

<table>
<thead>
<tr>
<th>PS-2137</th>
<th>$260</th>
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<tbody>
<tr>
<td>Includes an Angle Sensor and 1 Goniometer Probe with Velcro® connection kit.</td>
<td></td>
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</tbody>
</table>

Measure two joints simultaneously. Just add an additional probe:

Goniometer Probe

<table>
<thead>
<tr>
<th>PS-2138</th>
<th>$170</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes probe and Velcro® connection kit.</td>
<td></td>
</tr>
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</table>

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

<table>
<thead>
<tr>
<th>PS-2611</th>
<th>$615</th>
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</thead>
<tbody>
<tr>
<td>Includes Human Arm Model and Angle Sensor PS-2139</td>
<td></td>
</tr>
</tbody>
</table>

Wireless Temperature Link

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.

<table>
<thead>
<tr>
<th>PS-3222</th>
<th>$69</th>
</tr>
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<tbody>
<tr>
<td>Includes Fast Response Temperature Probe</td>
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</tbody>
</table>

Diffusion/Osmosis Kit

<table>
<thead>
<tr>
<th>ME-6942</th>
<th>$290</th>
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</thead>
<tbody>
<tr>
<td>Includes Diffusion/Osmosis Apparatus (20 membranes and mounting stud), Dual Pressure Sensor PS-2181, tubing and connectors.</td>
<td></td>
</tr>
</tbody>
</table>

Also available:

Diffusion/Osmosis Apparatus (no sensor) | ME-6940 | $110 |
Replacement Membranes (20-pack) | ME-6941 | $21 |
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  $399
The Moticam X3 is a WiFi camera that can connect to any platform for maximum portability and flexibility.

Moticam 3+ USB
SE-6204  $735
The Moticam 3+ provides high-resolution options with a USB connection for Windows, Mac, and Chromebook.

LED Microscope with Detachable Tablet
SE-6203  $1015
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.

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:

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

SPARKvue (single user license)
PS-2401  $99
PS-2401-DIG  $99
For Mac® and Windows®

SPARKvue (site license)
PS-2400  $249
PS-2400-DIG  $249
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.

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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
or 800-772-8700
**Wireless pH Sensor**

**PS-3204** $79  (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 Sensor**

**PS-3215** $119  (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.

**Wireless Drop Counter**

**PS-3214** $99  (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** $49  (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

**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**
- **Summative assessment: The Infinite Test Bank**
- **Embedded solved problem with practice**

*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.
## Essential Chemistry Solutions

<table>
<thead>
<tr>
<th>Essential Chemistry Student Textbook</th>
<th>Essential Chemistry Student e-Book</th>
<th>Essential Chemistry Teacher Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC-6350 Hardbound student textbook</td>
<td>EC-6350-EB5 (5-yr license)</td>
<td>EC-6351-DIG</td>
</tr>
<tr>
<td>EC-6350-EB1 (1-yr license)</td>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Standard Equipment Kit</th>
<th>42 labs are designed to use this equipment set.</th>
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<tbody>
<tr>
<td>EC-6361 $559</td>
<td></td>
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<tr>
<td>Includes 1 of each of the following:</td>
<td></td>
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<tr>
<td>• Wireless Temperature Sensor, PS-3201</td>
<td></td>
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<tr>
<td>• Wireless pH Sensor, PS-3204</td>
<td></td>
</tr>
<tr>
<td>• Wireless Conductivity Sensor, PS-3210</td>
<td></td>
</tr>
<tr>
<td>• Wireless Pressure Sensor, PS-3203</td>
<td></td>
</tr>
<tr>
<td>• Wireless Voltage Sensor, PS-3211</td>
<td></td>
</tr>
<tr>
<td>• Wireless Colorimeter and Turbidity, PS-3215*</td>
<td></td>
</tr>
<tr>
<td>• Molecular Model Kit, PS-3400</td>
<td></td>
</tr>
<tr>
<td>• Electrode Support, PS-3505</td>
<td></td>
</tr>
<tr>
<td>• Gratnells® Storage Tray</td>
<td></td>
</tr>
<tr>
<td>• Periodic Trend Cards, EC-3405</td>
<td></td>
</tr>
<tr>
<td>• Periodic Table, EC-3404</td>
<td></td>
</tr>
<tr>
<td>• Spectrum Cards, EC-3403</td>
<td></td>
</tr>
<tr>
<td>• Condenser, PS-3402</td>
<td></td>
</tr>
</tbody>
</table>

*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 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 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) $25

**Essential Chemistry Teacher Lab Manual**
EC-6330-DIG (digital) $40
EC-6330 (print) $50
*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) $125
*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 $559

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

*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:**

**Essential Chemistry Basic Equipment Kit**
EC-6360 $269
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
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 for AP® & IB®

Advanced Chemistry Through Inquiry Teacher Lab Manual

<table>
<thead>
<tr>
<th>Lab Title</th>
<th>Starter Bundle</th>
<th>Extension Bundle</th>
<th>AP® Big Ideas*</th>
<th>IB® Standards*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Analyzing Food Dyes in Sports Drinks</td>
<td></td>
<td></td>
<td>1.3, 11.2, 11.3</td>
<td>1.15, 1.16</td>
</tr>
<tr>
<td>2. Investigating the Copper Content of Brass**</td>
<td></td>
<td></td>
<td>1.2, 11.2, 11.3, 12.1</td>
<td>1.16, 3.4</td>
</tr>
<tr>
<td>3. How Hard Is Your Tap Water?</td>
<td></td>
<td></td>
<td>1.2, 1.3</td>
<td>1.19, 2.10, 3.2, 3.3</td>
</tr>
<tr>
<td>5. Separating Food Dyes Using Chromatography**</td>
<td></td>
<td></td>
<td>1.1, 4.4</td>
<td>1.20, 2.3</td>
</tr>
<tr>
<td>6. A Chemistry Mystery: Name That Unknown!</td>
<td></td>
<td></td>
<td>1.1, 4.1, 4.4</td>
<td>2.22, 2.24, 2.32</td>
</tr>
<tr>
<td>7. Stoichiometry in Solutions</td>
<td></td>
<td></td>
<td>1.2, 1.3</td>
<td>1.5, 3.3</td>
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<tr>
<td>8. Percentage of H₂O₂ in Your Drugstore Hydrogen Peroxide</td>
<td></td>
<td></td>
<td>9.1</td>
<td>3.9, 1.20, 3.3</td>
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<tr>
<td>9. Investigating the Physical and Chemical Changes of Matter</td>
<td></td>
<td></td>
<td>1.1, 4.1, 4.4</td>
<td>2.3, 2.5, 3.1, 3.10, 5.10</td>
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<tr>
<td>10. What Does Acid Rain Do to Coral Reefs?</td>
<td></td>
<td></td>
<td>6.1</td>
<td>4.1, 4.2</td>
</tr>
<tr>
<td>11. Kinetics of Crystal Violet Fading</td>
<td></td>
<td></td>
<td>16.1</td>
<td>4.2, 4.1</td>
</tr>
<tr>
<td>12. Building a Better Hand Warmer</td>
<td></td>
<td></td>
<td>5.1, 5.3</td>
<td>5.6, 5.7</td>
</tr>
<tr>
<td>13. Applications of Le Chatelier’s Principle**</td>
<td></td>
<td></td>
<td>7.1, 17.1</td>
<td>6.9, 6.10</td>
</tr>
<tr>
<td>15. Introduction to Buffers</td>
<td></td>
<td></td>
<td>18.3</td>
<td>6.20, 1.20</td>
</tr>
<tr>
<td>16. Evaluating Lemonade as a Buffer</td>
<td></td>
<td></td>
<td>18.3</td>
<td>6.18, 1.4</td>
</tr>
</tbody>
</table>

*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** $399
Includes Spectrometer and 10 cuvettes.
See page 54 for complete information.

**Advanced Chemistry Through Inquiry Teacher Lab Manual**

- PS-2828A-DIG (digital) $40
- PS-2828A (print) $50

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 $369
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

Chemistry Extension Bundle
PS-3303C $249
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.
**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.

![Image of Wireless pH Sensor](image)

**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 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.

<table>
<thead>
<tr>
<th>Wireless Sensor Storage Trays for:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature/pH/Conductivity Sensors</strong></td>
<td></td>
</tr>
<tr>
<td>PS-3585</td>
<td>$30</td>
</tr>
<tr>
<td><strong>Pressure Sensors</strong></td>
<td></td>
</tr>
<tr>
<td>PS-3586</td>
<td>$35</td>
</tr>
<tr>
<td><strong>Colorimeter &amp; Turbidity Sensors</strong></td>
<td></td>
</tr>
<tr>
<td>PS-3587</td>
<td>$40</td>
</tr>
<tr>
<td><strong>Voltage &amp; Current Sensors</strong></td>
<td></td>
</tr>
<tr>
<td>PS-3588</td>
<td>$30</td>
</tr>
</tbody>
</table>

*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.
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 $99**

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 $13**

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

### Probes and Electrodes

**Oxidation Reduction Potential Probe**

**PS-3515 $40**

- **Ammonium**
  - PS-3516 ...............$195
- **Carbon Dioxide**
  - PS-3517 ...............$250
- **Calcium**
  - PS-3518 ...............$195
- **Chloride**
  - PS-3519 ...............$195
- **Potassium**
  - PS-3520 ...............$195
- **Nitrate**
  - PS-3521 ...............$195

*Requires one of these:*

- **Wireless pH Sensor** **PS-3204 $79**
- or a **PASPORT pH Amplifier**

*Also available:*

- **Heater-Stirrer** **PS-3401 $279**
- **Electrode Support** **PS-3505 $10**
Wireless Colorimeter and Turbidity Sensor

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

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 Sensor

PS-3215 $119
Includes USB charging cable, 9 cuvettes, 2 cuvette racks, and one 100 NTU calibration cuvette.

Also available:
- Cuvettes & Caps
  SE-8739 $23
- Cuvette Rack
  EC-3590 $10

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 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:

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature/pH/Conductivity Sensors</td>
<td>PS-3585</td>
<td>$30</td>
</tr>
<tr>
<td>Pressure Sensors</td>
<td>PS-3586</td>
<td>$35</td>
</tr>
<tr>
<td>Colorimeter &amp; Turbidity Sensors</td>
<td>PS-3587</td>
<td>$40</td>
</tr>
<tr>
<td>Voltage &amp; Current Sensors</td>
<td>PS-3588</td>
<td>$30</td>
</tr>
</tbody>
</table>

### Gratnells Rolling Carts:

<table>
<thead>
<tr>
<th>Cart Type</th>
<th>Code</th>
<th>Price</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 column</td>
<td>EP-3574</td>
<td>$510</td>
<td>Stores up to 8 Gratnells F2 trays</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dimensions: 107 cm high, 70 cm wide, 43.5 cm deep</td>
</tr>
<tr>
<td>3 column</td>
<td>EP-3575</td>
<td>$627</td>
<td>Stores up to 12 Gratnells F2 trays</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dimensions: 107 cm high, 102 cm wide, 43.5 cm deep</td>
</tr>
</tbody>
</table>

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 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.

Wireless Temperature Sensor

PS-3201 $49
Includes 1 coin cell battery.

Wireless Temperature Link

PS-3222 $69
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.
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.

---

**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.

**TD-8596A $99**
Includes Ideal Gas Law syringe, built-in fast response thermistor, and quick connect pressure port.

Required:
- Wireless Pressure Sensor
  - PS-3203 $89
- Wireless Temperature Link
  - PS-3222 $69

Also available:
- Ideal Gas Law Apparatus Wireless Bundle
  - PS-3310 $249
  - 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.

**TD-8595 $229**
Includes built-in fast Response Thermistor Probe and quick-connect pressure port.

Required:
- Wireless Pressure Sensor
  - PS-3203 $89
- Wireless Temperature Link
  - PS-3222 $69

Also available:
- Absolute Zero Sphere Wireless Bundle
  - PS-3309 $370
  - Includes the Absolute Zero Sphere, the Wireless Pressure Sensor, and the Temp Link.
Wireless Pressure Sensor

Wireless Pressure Sensor

Wireless Pressure Sensor

Specifications

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

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.

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  $89

Include 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.

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 $97

Includes 1 coin cell battery.

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

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.

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

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.

SPARKvue: Try our award-winning software for FREE!
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.

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 ±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

<table>
<thead>
<tr>
<th>PS-3211</th>
<th>$65</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Includes 1 coin cell battery.</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>PS-3212</th>
<th>$74</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Includes rechargeable battery and banana-clip cables.</td>
<td></td>
</tr>
</tbody>
</table>

Wireless Sensor Storage Trays for:

Voltage & Current Sensors

<table>
<thead>
<tr>
<th>PS-3588</th>
<th>$30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Each storage tray holds up to ten sensors; sensors sold separately.</td>
<td></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>PS-3400</th>
<th>$46</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes 86 atoms and 153 bonds.</td>
<td></td>
</tr>
</tbody>
</table>

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.

**Discover Density Set**

<table>
<thead>
<tr>
<th>SE-9719A</th>
<th>$62</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes</td>
<td></td>
</tr>
<tr>
<td>Cylinders of same length and different diameters (4)</td>
<td></td>
</tr>
<tr>
<td>Cylinders of same diameter and different lengths (4)</td>
<td></td>
</tr>
<tr>
<td>Spheres with different diameters (4)</td>
<td></td>
</tr>
<tr>
<td>Rectangular shapes of various sizes and materials (10)</td>
<td></td>
</tr>
<tr>
<td>Instruction manual</td>
<td></td>
</tr>
</tbody>
</table>

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

**Density Set**

<table>
<thead>
<tr>
<th>ME-8569A</th>
<th>$77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes one irregular aluminum shape, two blocks, (aluminum and brass), three identically-sized cylinders (aluminum, brass and plastic).</td>
<td></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>SE-6849</th>
<th>$50</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
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.

You can perform these labs with the Wireless Spectrometer:
- Emission Spectra of Light
- Absorbance Spectra
- Beer’s Law
- Kinetics
- Fluorescence

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

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2600</td>
<td>$399</td>
</tr>
</tbody>
</table>

Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:
- Optional Fiber Optic Cable
  - PS-2601 $74
- Cuvettes & Caps
  - SE-8739 $23
- Cuvette Rack
  - EC-3590 $10

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

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.
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.

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

### Polarimeter

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2235</td>
<td>$499</td>
<td>Includes 1 Sample Cell</td>
</tr>
</tbody>
</table>

**Also available:**
- Polarimetry Sample Cell Replacement
  - PS-2234 $70

### Polarizer Demonstrator

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS-9477A</td>
<td>$134</td>
<td>Introduce the concept of polarization with this colorful and meaningful demonstration.</td>
</tr>
</tbody>
</table>

**Also available:**
- Polarizer Demonstrator Accessory
  - OS-8172 $113
- Linear Polarizer (2-pack)
  - OS-8549 $15

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

Optical rotation of sucrose
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!

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   Environmental Science...................................... 59
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Conductivity, Light ............................................. 63
Colorimeter and Turbidity...................................... 64
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World Class Support & Professional Development
Committed to Your Success

For more details, see page 158.

CONTACT US TODAY
www.pasco.com or
CALL: 800-772-8700
Wireless Optical Dissolved Oxygen Sensor

PS-3224  $296  (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  $185  (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 Temperature Sensor

PS-3201  $49  (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  $79  (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.

Wireless CO₂ Sensor

PS-3208  $199  (page 60)
Use this wireless sensor to measure the concentration of CO₂ gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO₂ 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 Optical Dissolved Oxygen Sensor

PS-3224  $296  (page 65)
Includes USB charging cable.

The versatile Wireless Optical Dissolved Oxygen 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.
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

<table>
<thead>
<tr>
<th>Lab Title</th>
<th>Starter Bundle</th>
<th>Extension Bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Determining Soil Quality</td>
<td></td>
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<td>2. Insolation and the Seasons</td>
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<td>3. Investigating Specific Heat</td>
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<td>4. Monitoring Microclimates</td>
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<td>5. Sunlight Intensity and Reflectivity</td>
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<td>6. Tracking Weather</td>
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<td>7. Earth’s Magnetic Field**</td>
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<td>8. Radiation Energy Transfer</td>
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<td>9. Seafloor Spread Plate Tectonics**</td>
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<td>10. Modeling an Ecosystem</td>
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<td>11. Photosynthesis and Primary Productivity</td>
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<td>12. Photosynthesis and Cell Respiration</td>
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<td>13. Cellular Respiration and Carbon Cycle</td>
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<td>14. Energy Content of Food</td>
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<td>15. Weather in a Terrarium</td>
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<td>16. Yeast Respiration</td>
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<td>17. Properties of Water</td>
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<td>18. Air Pollution and Acid Rain</td>
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<td>19. Monitoring Water Quality</td>
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<td>20. Toxicology Using Yeast</td>
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<td>21. Water Treatment</td>
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<td>22. Greenhouse Gases</td>
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</tbody>
</table>

### AP® Big Ideas*

- Temperature
- Conductivity
- Optical Dissolved Oxygen
- CO₂
- Colorimeter
- EcoZone
- 1.2, 5.1, 5.2, 5.3

### IB® Connections*

- Weather with GPS
- pH
- Start Bundle
- Extension Bundle
- 1.2, 5.2, 6.1, 6.2

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*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

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless Weather with GPS</td>
<td>PS-3209</td>
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<tr>
<td>Weather Vane Accessory</td>
<td>PS-3553</td>
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<tr>
<td>Wireless Temperature</td>
<td>PS-3201</td>
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<tr>
<td>Wireless pH</td>
<td>PS-3204</td>
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<tr>
<td>Wireless Conductivity</td>
<td>PS-3210</td>
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Environmental Science Extension Bundle

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Code</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Wireless Optical Dissolved Oxygen Sensor</td>
<td>PS-3224</td>
<td></td>
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<tr>
<td>Wireless CO₂</td>
<td>PS-3208</td>
<td></td>
</tr>
<tr>
<td>Wireless Colorimeter &amp; Turbidity Sensor</td>
<td>PS-3215*</td>
<td></td>
</tr>
<tr>
<td>EcoZone ME-6668</td>
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*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

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Code</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Wireless 3-Axis Magnetic Field Sensor</td>
<td>PS-2829A-DIG (digital) $30</td>
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<tr>
<td></td>
<td>PS-2829A (print) $50</td>
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</table>

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

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless 3-Axis Magnetic Field Sensor</td>
<td>PS-3221 $69</td>
<td></td>
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</tbody>
</table>

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

Recommended:
Zero Gauss Chamber
EM-8652 $206

See our digital Ag Science Labs for Environmental Science on page 69.
Wireless CO₂ Sensor

Use this wireless sensor to measure the concentration of CO₂ gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO₂ data can be logged directly on the device for long-term life science and environmental science studies.

Using the logging function, CO₂ 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 CO₂ levels increase as the days progress.

Dissolved CO₂ Waterproof Sleeve

The Wireless CO₂ Sensor can be equipped for aqueous measurements using this semipermeable sleeve. The sleeve is waterproof but allows CO₂ 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.)

Wireless Sensor Storage Trays for:

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Sensor with GPS</td>
<td>$35</td>
</tr>
<tr>
<td>CO₂ Sensor</td>
<td>$35</td>
</tr>
</tbody>
</table>

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.

Specifications:

**Battery:** Rechargeable

**Water-resistant**

(Please see pasco.com for detailed specifications.)

**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!

**Wireless Weather Sensor with GPS**

**PS-3209** $185

Includes USB charging cable

**Weather Vane Accessory**

**PS-3553** $36

Includes tripod, tripod adapter, and weather vane.

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.

We Can Help sales@pasco.com support@pasco.com
Wireless Temperature 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 $49
Includes 1 coin cell battery.

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!

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, 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 $79
Includes 1 coin cell battery and a direct-connect pH probe with storage bottle.

Wireless pH Sensor
PS-3201 $49
Includes 1 coin cell battery.

Electrode Support
PS-3505 $10

Measure pH of water at different locations and annotate with text and images.
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 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: 0–20,000 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

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 $97

Wireless Light Sensor

PS-3213 $72
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

Wireless Colorimeter and Turbidity
PS-3215 $119
Includes USB charging cable, 9 cuvettes, 2 cuvette racks, and one 100 NTU calibration cuvette.

Also available:
Cuvettes & Caps
SE-8739 $23
Cuvette Rack
EC-3590 $10

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
Pressure Sensors
PS-3585 $30
PS-3586 $35
Colorimeter & Turbidity Sensors
Voltage & Current Sensors
PS-3587 $40
PS-3588 $30

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:** 0–60°C
- **Range:** 0–20 mg/L or 0–300% saturation
- **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** $296
Includes USB charging cable

**Wireless Optical Dissolved Oxygen Sensor Cap**

**PS-3605** $55
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.

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

**Make all your sensors wireless!**

**AirLink**

**PS-3200** $60
Includes one PASPORT sensor port, USB and Bluetooth connectivity, and USB cable.

**Flow Rate/Temperature Sensor**

**PS-2130** $135

Salinity level of sample taken from a bay

**Salinity Sensor**

**PS-2195** $160

(See page 27 for full details.)
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.

**Water Quality Colorimeter**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>PS-2179</td>
<td>$160</td>
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Includes Sensor Extension Cable.

**ezSample™ Snap Vial Kits**

- Ammonia EZ-2334A $40
- Chlorine EZ-2339A $40
- Iron EZ-2331 $40
- Nitrate EZ-2333B* $50
- Phosphate EZ-2337 $35

**Requires:**

- Water Quality Colorimeter PS-2179 $160

*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 $45
- Carbon Dioxide EZ-2341* $45
- Total Hardness EZ-2338 $45

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.

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.

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

*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 $109
Includes 3 EcoChambers, tray, rubber stoppers, syringe, plastic tubing and wicking cord.

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 $40
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 halocline
- Inversions

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).

Density Circulation Model
ME-6816 $75

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.

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.
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.

<table>
<thead>
<tr>
<th>Experiments and Sensors Used</th>
<th>Wireless Sensors</th>
</tr>
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<tbody>
<tr>
<td>Experiments</td>
<td>CO₂ Gas</td>
</tr>
<tr>
<td>1. Determining Soil Quality</td>
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<tr>
<td>2. Water Treatment</td>
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<tr>
<td>3. Freshwater Quality Monitoring</td>
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<tr>
<td>4. Water and pH</td>
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<tr>
<td>5. Respiration of Germinating Seeds</td>
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<tr>
<td>6. Plant Pigments and Photosynthesis</td>
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<tr>
<td>7. Plant Respiration and Photosynthesis</td>
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<tr>
<td>8. Modeling an Ecosystem</td>
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<tr>
<td>9. Greenhouse Gases</td>
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<td>10. Energy Content of Food</td>
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<td>11. Diffusion</td>
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<tr>
<td>12. Soil and pH</td>
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</tbody>
</table>

Ag Science Starter Bundle

PS-7621A $539

1. Wireless pH PS-3204
2. Wireless Conductivity PS-3210
3. Wireless CO₂ PS-3208
4. Wireless Colorimeter PS-3215*
5. Wireless Temperature Sensor PS-3201

Ag Science Extension Bundle

PS-7622A $619

1. EcoZone ME-6668
2. Wireless Optical Dissolved O₂ Sensor PS-3224
3. Wireless Weather with GPS PS-3209
4. Weather Vane Accessory PS-3553

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.

®
®
®
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.

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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) $169
- ME-1241 (blue) $169

*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®.

**Wireless Sound Sensor**

- PS-3227 $89 *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**

- ME-1272 (with red Smart Cart) $549
- ME-1273 (with blue Smart Cart) $549 *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**

- EM-3533 $149 *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 $14

**10-port USB Charging Station**

- PS-3501 $62
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

**Objective 2:**

Do the lengths of the velocity, acceleration or force vectors change as the object moves around the circle?

**Questions:**

1. On the circle below, sketch the velocity, force and acceleration vectors for at least five lengths = 5.0 m/s.

2. What is the magnitude of the centripetal acceleration felt by the driver?

   Answer: 10.3 m/s² (1.0 g)

3. What is the centripetal force acting on the car?

   Answer: 8240 N

**Objective 3:**

A racecar is moving with a speed of 200 km/h on a circular section of the racetrack that has a radius of 300 m. The racecar and the driver have a mass of 1290 kg.

- Apply Newton's second law to circular motion problems; and
- Demonstrate the relationships between velocity, centripetal acceleration, and centripetal force for objects in circular motion through a guided inquiry activity, using an interactive simulation. The quantitative relationships between these variables are presented and connected to Newton's second law. The four-step problem solving method is demonstrated in the case of a car rounding a turn as shown, what physical force is road provides the centripetal force.

**Method:**

1) Slide presentation: “CentripetalForce.ppt”
2) Demonstration: Swing the yo-yo in a circle at constant speed and ask the students to discuss what is happening to the yo-yo.
3) Students model a mass around the circle.
4) Students compare the proportional relationship of velocity, acceleration and force vectors. In part 2 they model a mass road provides the centripetal force.
5) Students graph the proportional relationship depicted in the two graphs in part three.

**Key to differentiated instruction:**

- Standards
- Vocabulary
- Knowledge
- Evidence
- Assessment

**Diagrams:**

- Demonstration: Swing the yo-yo in a circle at constant speed and ask the students to discuss what is happening to the yo-yo.
- Laboratory equipment: PASCO equipment, including sensors and software for data collection and analysis.
- Textbooks and e-books: PASCO Essential Physics textbooks and e-books, which include interactive simulations and assessments.

**Equipment:**

- PASCO equipment, including sensors and software for data collection and analysis.
- Textbooks and e-books: PASCO Essential Physics textbooks and e-books, which include interactive simulations and assessments.

**Conclusion:**

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**
- **Full audio read**
- **31 embedded animations**
- **71 interactive simulations**
- **Summative assessment: The Infinite Test Bank**
- **Formative assessment**

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

---

The biceps and triceps muscles in your arm work the same way: When you flex your arm the biceps muscle contracts as it releases its stored elastic potential energy; at the same time, the triceps muscle is stretched, storing up elastic potential energy. The arm extends by contracting the triceps muscle and releasing its stored energy; at the same time, the biceps muscle is stretched, storing energy. The biceps and triceps muscles work in tandem: One contracts, releasing energy to move the joint, while the other is stretched, storing energy. Every joint in your body moves in a similar way, using opposing pairs of muscles that exert force by contracting.

<table>
<thead>
<tr>
<th>Elastic potential energy calculator</th>
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<tr>
<td>0.05000 10 0.1000</td>
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<tr>
<td>A. B. C.</td>
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<tr>
<td>×</td>
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<tr>
<td>1 2 2 × k x</td>
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<tr>
<td>(newton per meter, N/m) (meter, m) (joule, J)</td>
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</table>

<table>
<thead>
<tr>
<th>Spring constant Displacement Elastic potential energy</th>
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<tr>
<td>pE</td>
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<tr>
<td>1 2 3 4 5 6 E 0 . ENTER CLEAR</td>
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</table>
The Digital Teacher Resources include lesson plans, slide presentations, student work, and answer keys, all at point-of-use.
Get a textbook, an e-book, and equipment for the price of most textbooks!

### Comprehensive Equipment Kit

43 labs are designed to use this equipment set.

<table>
<thead>
<tr>
<th>Kit Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>EP-6490A</td>
<td>$1969&lt;br&gt;• Forces &amp; Motion Kit&lt;br&gt;• Simple Machines Engineering Kit&lt;br&gt;• Oscillations, Waves &amp; Sound Kit&lt;br&gt;• Light, Color &amp; Optics Kit&lt;br&gt;• Essential Physics Modular Circuits Kit&lt;br&gt;• Additional Red Smart Cart&lt;br&gt;• Mini Launcher, Clamp &amp; Rod&lt;br&gt;• One 1.2m Metal Dynamics Track&lt;br&gt;• Two Tripod Stands&lt;br&gt;Each kit includes a Gratnells® Storage Tray.</td>
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### Standard Equipment Kit

23 labs are designed to use this equipment set.

<table>
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<tr>
<td>EP-3567A</td>
<td>$927&lt;br&gt;Includes 1 of each of the following:&lt;br&gt;• Smart Cart (Blue), ME-1241&lt;br&gt;• Friction Block, ME-9807&lt;br&gt;• PAScar Cart Mass (set of 2), ME-6757A&lt;br&gt;• Angle Indicator, ME-9495A&lt;br&gt;• Track End Stop (set of 2), ME-8971&lt;br&gt;• Super Pulley with Clamp, ME-9448B&lt;br&gt;• 1.2m Dynamics Track, ME-9493&lt;br&gt;• Track Feet (set of 2), ME-8972&lt;br&gt;• Weights&lt;br&gt;• Modular Circuits&lt;br&gt;• Wireless Current Module&lt;br&gt;• Wireless Voltage Sensor&lt;br&gt;• Gratnells® Storage Tray</td>
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</table>
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

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.

**Essential Physics Student Lab Manual**

EP-6326
(stUDENT- consumable)
$25

**Essential Physics Teacher Lab Manual**

EP-6329-DIG (digital) $40
EP-6329 (print) $50

**Essential Physics Teacher Lab Manual Resources**

EP-6328-DIG (digital) $125
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 $1969

- 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.*

---

800.772.8700 (inside US)  +1 916.786.3800 (outside US)
Choose the Kits You Need...

**Forces & Motion Kit**
EP-3576 $593  
*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

**Simple Machines Engineering Kit**
EP-3577 $505  
*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

**Essential Physics Modular Circuits Kit**
EM-3536 $369  
*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

**Light, Color & Optics Kit**
EP-3558 $329  
*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 $309  
*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

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

- Every lab is based on the College Board Learning Objectives.
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- 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**

<table>
<thead>
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<th>LAB</th>
<th>EQUIPMENT</th>
<th>ALIGNMENT</th>
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<td>Add the PS-3814 Expansion Kit to perform all these labs</td>
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<tr>
<td>1. Graphical Analysis: Motion</td>
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<td>2. Newton's Second Law</td>
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<tr>
<td>3. Atwood's Machine</td>
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<tr>
<td>4. Coefficients of Friction</td>
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<tr>
<td>5. Two Dimensional Motion: Projectiles</td>
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<tr>
<td>6. Conservation of Mechanical Energy</td>
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<td>7. Work and Kinetic Energy</td>
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<td>9. Momentum and Impulse</td>
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<tr>
<td>10. Rotational Dynamics</td>
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<tr>
<td>11. Rotational Statics</td>
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<tr>
<td>12. Periodic Motion: Mass and Spring</td>
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<tr>
<td>13. Simple Pendulum</td>
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<tr>
<td>15. DC Circuits</td>
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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.

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## Advanced Physics 1 Equipment Kit

**PS-3813 $929**

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<td>Dynamics Track End Stop (2 pack)</td>
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<td>Four Scale Meter Stick</td>
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<td>250-g Compact Cart Mass</td>
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<td>Super Pulley Kit</td>
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<td>Thread</td>
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<td>60-cm Stainless Steel Rod</td>
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<td>Aluminum Table Clamp</td>
<td>ME-8995</td>
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<td>Wireless Smart Gate</td>
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<tr>
<td>Right Angle Clamp</td>
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## Advanced Physics 1 Expansion Kit

**PS-3814 $1550**

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<td>Pendulum Accessory</td>
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<td>Aluminum Table Clamp</td>
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<td>Wireless Rotary Motion Sensor</td>
<td>PS-3220</td>
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<tr>
<td>Stainless Steel Calipers</td>
<td>SF-8711</td>
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<td>Tension Protractor</td>
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## Advanced Physics Sensor Bundle

**PS-3818 $865**

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<td>3. Smart Cart (blue)</td>
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<td>5. Wireless Voltage Sensor</td>
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<td>6. Wireless Current Sensor</td>
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<td>7. Wireless Pressure Sensor</td>
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<td>8. Wireless Magnetic Field Sensor</td>
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We Can Help    sales@pasco.com    support@pasco.com
Advanced Physics 2 Lab Manual

PS-3815-DIG (digital) $40  PS-3815 (print) $50

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<tbody>
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<tr>
<td></td>
<td>IB® Standards*</td>
<td>AP® 2 Standards**</td>
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<td>1. Hydrostatic Pressure</td>
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<td>5. Spherical Mirror Reflection</td>
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<td>7. Focal Length of a Converging Lens</td>
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<td>8. Interference and Diffraction</td>
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<td>9. Electric Field Mapping</td>
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<td>11. Magnetic Field Strength</td>
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<td>15. RC Circuits</td>
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<td>16. Planck’s Constant</td>
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### Advanced Physics 2 Equipment Kit

**PS-3816 $989**

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<td>Adjustable Lens Holder</td>
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<td>Rod, 45-cm</td>
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<td>Laser Pointer (with known wavelength)</td>
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<td>Wireless Voltage Sensor</td>
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<td>Not Pictured: .539 ID Plastic Tube, 12”</td>
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<td>Magnet or Enameled Wire, 22-gauge</td>
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### Advanced Physics 2 Expansion Kit

**PS-3817 $1149**

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<td>Right Angle Clamp</td>
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<tr>
<td>Field Mapper Kit</td>
<td>PK-9023</td>
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<tr>
<td>Student Power Supply, 18 VDC, 3 A</td>
<td>SE-8828</td>
<td>1</td>
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<tr>
<td>Digital Multimeter</td>
<td>SE-9786A</td>
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<tr>
<td>Neodymium Magnets, solid (16 pack)</td>
<td>EM-8648B</td>
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<tr>
<td>AC/DC Electronics Lab Kit</td>
<td>EM-8656</td>
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<td>Magnaprobe™ Wand</td>
<td>SE-7390</td>
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<tr>
<td>4-mm Banana Plug Patch Cord (5 pack)</td>
<td>SE-9750</td>
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<tr>
<td>Wireless 3-Axis Magnetic Field Sensor</td>
<td>PS-3221</td>
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<tr>
<td>Wireless Current Sensor</td>
<td>PS-3212</td>
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</tr>
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</table>

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

**PS-3818 $865**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Part #</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Smart Cart (red)</td>
<td>ME-1240</td>
<td>1</td>
</tr>
<tr>
<td>2. Wireless Smart Gate</td>
<td>PS-3225</td>
<td>1</td>
</tr>
<tr>
<td>3. Smart Cart (blue)</td>
<td>ME-1241</td>
<td>1</td>
</tr>
<tr>
<td>4. Wireless Rotary Motion Sensor</td>
<td>PS-3220</td>
<td>1</td>
</tr>
<tr>
<td>5. Wireless Voltage Sensor</td>
<td>PS-3211</td>
<td>1</td>
</tr>
<tr>
<td>6. Wireless Current Sensor</td>
<td>PS-3212</td>
<td>1</td>
</tr>
<tr>
<td>7. Wireless Pressure Sensor</td>
<td>PS-3203</td>
<td>1</td>
</tr>
<tr>
<td>8. Wireless Magnetic Field Sensor</td>
<td>PS-3221</td>
<td>1</td>
</tr>
</tbody>
</table>
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 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 $99
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.
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®.

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

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)  $549
ME-1273 (with blue cart)  $549

Read the review from The Physics Teacher

Go to pasco.com/smartcart

Smart Cart

ME-1240 (red)  $169
ME-1241 (blue)  $169
Includes: Hook, Rubber bumper, Magnetic bumper, and USB cable for charging

Also available:
Smart Cart Charging Garage
ME-1243  $110
Charge up to five Smart Carts at once. Provides storage for the carts and accessory bumpers. Includes power adapter.
Smart Cart Vector Display

*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

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.
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):

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sleep in ms: 100</td>
</tr>
<tr>
<td>2</td>
<td>set ( k ) to -110</td>
</tr>
<tr>
<td>3</td>
<td>set ( b ) to 160</td>
</tr>
<tr>
<td>4</td>
<td>set ( X_0 ) to 0.3</td>
</tr>
<tr>
<td>5</td>
<td>set ( N ) to 0</td>
</tr>
<tr>
<td>6</td>
<td>repeat 10000 times</td>
</tr>
<tr>
<td>7</td>
<td>do</td>
</tr>
<tr>
<td>8</td>
<td>change ( N ) by 1</td>
</tr>
<tr>
<td>9</td>
<td>set ( x ) to ( \text{Read Measurement} )</td>
</tr>
<tr>
<td>10</td>
<td>set ( V ) to ( \text{Read Measurement} )</td>
</tr>
<tr>
<td>11</td>
<td>set ( P ) to ( k \times x - b \times x )</td>
</tr>
<tr>
<td>12</td>
<td>Write output voltage: Smart Fan Accessory - P -</td>
</tr>
<tr>
<td>13</td>
<td>Write numeric to UED: power - P -</td>
</tr>
<tr>
<td>14</td>
<td>Sleep in ms: 20</td>
</tr>
<tr>
<td>15</td>
<td>if absolute ( v ) &gt; 0.1 and ( N ) &lt; 100 do</td>
</tr>
<tr>
<td>16</td>
<td>set ( X_0 ) to -1</td>
</tr>
<tr>
<td>17</td>
<td>set ( b ) to -0.147</td>
</tr>
<tr>
<td>18</td>
<td>set ( N ) to 0</td>
</tr>
<tr>
<td>19</td>
<td>Write output voltage: Smart Fan Accessory - 0 -</td>
</tr>
</tbody>
</table>

**Smart Fan Accessory**

ME-1242 $75

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 $25

---

U.S. Patent Number 10482789

Make your fan rotatable:

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

---

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

This is the control panel for the Smart Fan in PASCO Capstone software. (This control screen only available when using a Smart Cart.)
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 | $85 |

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

Projectile Launcher

| ME-6800 | $376 |

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

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

Mini Launcher

| ME-6825B | $155 |

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 | $310 |

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 | $75 |


- For use with all PASCO launchers
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 $179

**Rotational Inertia Accessory**
- ME-3420 $110
  - 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

- 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.

Students insert metal tabs to make the electrical connection.

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.

Download free Modular Circuits activities at pasco.com/circuits

Wireless Current Sensor Module

Wireless Voltage Sensor

Circuit Diagram

Download free Modular Circuits activities at pasco.com/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  $180
See kit contents below.

Also available separately:
Battery Charger SE-3568  $21
AA Rechargeable Batteries (4) SE-3569  $10

Essential Physics Modular Circuit Kit

EM-3536  $369
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  $21
AA Rechargeable Batteries (4) SE-3569  $10

Modular Circuits Expansion Kit

EM-3540  $99
See kit contents below.

Wireless AC/DC Module for Modular Circuits

EM-3533  $149
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:

<table>
<thead>
<tr>
<th>Kits include these modules and apparatus:</th>
<th>Basic EM-3535</th>
<th>Essential EM-3536</th>
<th>Expansion EM-3540</th>
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<tbody>
<tr>
<td>Corner Wire</td>
<td>4</td>
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<td>Straight Wire</td>
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<tr>
<td>Tee</td>
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<td>Switch, SPDT</td>
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<td>Switch, SPST</td>
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<td>Resistor</td>
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<td>3</td>
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<td>Capacitor</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>Light Bulb</td>
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<td>3</td>
<td>1</td>
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<tr>
<td>Potentiometer</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>LED</td>
<td>0</td>
<td>1</td>
<td></td>
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<tr>
<td>1000 Turn Coil</td>
<td>0</td>
<td>1</td>
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</tr>
<tr>
<td>Battery Holder</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

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                 |                   |
Grathells® Storage Tray                             | 1             | 1                 | 1                 |
Banana Jack Terminal                               |               |                   | 1                 |
Wireless 3-Axis Magnetic Field Sensor

PS-3221 $69

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.

*Required to measure Earth’s field:
Zero Gauss Chamber EM-8652 $206

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 Sound Sensor

PS-3227 $89

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 Acceleration/Altimeter

PS-3223 $95

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.

Wireless Spectrometer

PS-2600 $399

Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:

- Optional Fiber Optic Cable
  PS-2601 $74
- Cuvettes & Caps
  SE-8739 $23
- Cuvette Rack
  EC-3590 $10

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

**Wireless Temperature Sensor**

**PS-3201** $49

Includes 1 coin cell battery.

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

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

**Wireless Voltage Sensor**

**PS-3211** $65

Includes rechargeable battery and banana-clip cables.

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 Force Acceleration Sensor**

**PS-3202** $99

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 Pressure Sensor

**PS-3203** $89
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.

Wireless Light Sensor

**PS-3213** $72
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.

Wireless Sensor Charging Station

**PS-3599** $99
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.
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**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3600A</td>
<td>$399</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3602</td>
<td>$165</td>
</tr>
</tbody>
</table>

**The PASCO 550 Universal Interface...**

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

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**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tr>
<td>UI-5001</td>
<td>$499</td>
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**Requires:**

- PASCO Capstone Software
  - See pages 98-99.
- SPARKvue Software
  - See pages 96-97.
## Interface Comparison

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

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

* 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 $60**

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

---

### SPARKlink Air

**PS-2011 $227**

- **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

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

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</tr>
<tr>
<td>PASCO Blog: Dozens of fun applications for SPARKvue</td>
<td></td>
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<tr>
<td>Experiment Library: 80+ free and downloadable SPARKvue labs</td>
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<tr>
<td>FREE webinar training from PASCO professionals on our website</td>
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<td>On-site Workshops: Personalized professional development</td>
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<tr>
<td>Visit <a href="http://www.pasco.com/training-and-events">www.pasco.com/training-and-events</a> for more information</td>
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SPARKvue (single user license)

<table>
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<tr>
<td>PS-2401</td>
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SPARKvue (site license)

<table>
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SPARKvue App

Free downloads for iPad, iPhone, Android tablets and phones, and Chromebook. Visit www.pasco.com/downloads

*iPad, iPhone, and Mac are trademarks of Apple Inc., registered in the U.S. and other countries. App Store is a service mark of Apple Inc. Android, Chromebook, Chrome Web Store, and Google Play are trademarks of Google Inc. Windows is a registered trademark of Microsoft Corporation in the United States and/or other countries. © 2019 PASCO Scientific. All rights reserved.
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.

Features in PASCO Capstone 2

Visit [pasco.com/capstone](http://pasco.com/capstone) for more information.

**Circuits Emulation**

*Reinforce circuit concepts and tackle student misconceptions using circuit visualization.*

![Circuits Emulation Diagram](image)

**Trials Table**

*Organize your data to analyze physical relationships.*

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!

**Trials Table feature coming soon in 2020!**

![Trials Table](image)
**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!*

**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**

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<tr>
<td>Site Lic.</td>
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<td>K-12 Campus Lic.</td>
<td>UI-5405</td>
<td>$299</td>
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<tr>
<td></td>
<td>UI-5405-DIG</td>
<td>$256</td>
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We Can Help sales@pasco.com support@pasco.com

Visit pasco.com/capstone for more information.
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

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!

Sophisticated scientific calculator has statistics, calculus, filters, logic functions, and special operations such as amplitude and period.
This display behaves like an authentic digital oscilloscope.
- Trigger
- Single trace collection
- Sample rate tied to time axis scale
- Set trace offset

Display data in the frequency domain to find peak frequency and harmonics.
- Sample rate tied to axis scale
- Normalize data
- Adjust Bin width

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 $189

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 $99
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.

Simple Machines Engineering Kit

EP-3577  $505

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  $102

- 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
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### 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.
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

![Image of Wireless 3-Axis Acceleration/Altimeter](image1)

**Wireless 3-Axis Acceleration/Altimeter**
PS-3223 $95

Use this wireless sensor to measure the concentration of CO₂ gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO₂ data can be logged directly on the device for long-term life science and environmental science studies.

**Wireless CO₂ Sensor**
PS-3208 $199

Includes 250-ml sampling bottle and USB charging cable.

**Wireless Colorimeter and Turbidity**
PS-3215 $119

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

**Also available:**
Spectrometer/Colorimeter Cuvettes SE-8739 $23

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.

![Image of Wireless Colorimeter and Turbidity](image2)

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](http://www.P65Warnings.ca.gov).
Wireless Conductivity Sensor
PS-3210 $97
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

Wireless Current Sensor
PS-3212 $74
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 Force Acceleration Sensor
PS-3202 $99
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.

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

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 $72**

*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 $69**

*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

---

**Wireless Motion Sensor**

**PS-3219 $99**

*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.

**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 $189**
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.)

### Wireless pH Sensor
**PS-3204 $79**
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.

### Wireless Pressure Sensor
**PS-3203 $89**
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.

---

**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.

---

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

**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

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

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®

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 Voltage Sensor

**PS-3211** $65

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.

### Specifications

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

### Features

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

---

### Wireless Temperature Sensor

**PS-3201** $49

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 Temperature Link

**PS-3222** $69

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 Weather Sensor with GPS

**PS-3209** $185

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 handheld instrument to study microclimates and record ambient conditions relevant to many biological and environmental phenomena.

**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.

---

### Weather Vane Accessory

**PS-3553** $36

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 Spectrometer

**PS-2600 $399**

Includes Spectrometer and 10 cuvettes.

*Also available:*
- Optional Fiber Optic Cable PS-2601 $74
- Cuvettes & Caps SE-8739 $23
- Cuvette Rack EC-3590 $10

**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.

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 $499**

Includes 1 Sample Cell

*Also available:*
- Polarimetry Sample Cell Replacement PS-2234 $70

**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 = ± 0.09º 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 | $95 |

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.

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**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.
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.

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

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.

**SPARKvue®**

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.*

---

**Smart Cart Vector Display**

<table>
<thead>
<tr>
<th>ME-1246</th>
<th>$75</th>
</tr>
</thead>
</table>

Requires one of the following:

**Wireless Smart Carts**
- Red Smart Cart
  - ME-1240 $169
- Blue Smart Cart
  - ME-1241 $169

**Smart Cart**

<table>
<thead>
<tr>
<th>ME-1240 (red)</th>
<th>$169</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME-1241 (blue)</td>
<td>$169</td>
</tr>
</tbody>
</table>

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

U.S. Patent Number 10481173

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**Wireless Solutions for iOS, Android™, Chrome™, Mac® and Windows® devices**

**AirLink**

| PS-3200 | $60  |

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 | $227 |

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 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.*
Students determine blood pressure using familiar methods.

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

**Wireless Blood Pressure Sensor**
**PS-3218 $105**
Includes Blood Pressure Sensor, standard-size arm cuff, bladder and pressure release valve.

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.

**Breath Rate Sensor**
**PS-2187 $225**
Includes Masks (10) and Clips (10).

*Also available:*
- Replacement Masks (10 Pack) **PS-2567 $20**
- Replacement Clips (10 Pack) **PS-2568 $15**

**Charge Sensor**
**PS-2132 $124**
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.

**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

**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 CO₂ Sensor**

**PS-3208 $199**

Includes 250-ml sampling bottle and USB charging cable.

*Also available:*

- Dissolved CO₂ Waterproof Sleeve
  - PS-3545 $21

Use this wireless sensor to measure the concentration of CO₂ gas in a closed system or open environment. Study core topics (including photosynthesis, respiration, and carbon cycling) with this versatile probe. CO₂ data can be logged directly on the device for long-term life science and environmental science studies.

**Features**

- Includes remote logging on your device.

**Wireless Colorimeter and Turbidity**

**PS-3215 $119**

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

*Also available:*

- Spectrometer/Colorimeter
  - Cuvettes SE-8739 $23

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.

Directly compare separate controlled environments.

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](http://www.P65Warnings.ca.gov).
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

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

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

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

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

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

Wireless Optical Dissolved Oxygen Sensor
PS-3224 $296
Includes USB charging cable

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

Wireless Drop Counter
PS-3214 $99
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)

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

Heater-Stirrer
PS-3401 $279
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 $15

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

Also available:
ODO Metal Guard PS-3604 $55
ODO Sensor Cap PS-3605 $55

Perform simultaneous pH, conductivity, and temperature titrations using the Wireless pH Sensor and the Drop Counter.
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.

**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.

Directly measure the products of fermentation.

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

Compare ethanol production to oxygen uptake over time.

**Ethanol Sensor**
PS-2194 $160
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

**EKG Sensor**
PS-2111 $99

Includes 100 self-adhesive electrode patches.

*Also available:*
EKG Sensor Electrode Patches (100-pack; one-year shelf life) CI-6620 $12
<table>
<thead>
<tr>
<th><strong>Flow Rate/Temperature Sensor</strong></th>
<th><strong>Force Platform</strong></th>
<th><strong>2-Axis Force Platform</strong></th>
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<tbody>
<tr>
<td>PS-2130 $135</td>
<td>PS-2141 $289</td>
<td>PS-2142 $536</td>
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</tbody>
</table>

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.

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.

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

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.

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.

High Resolution Force Sensor
PS-2189 $129

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

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

High resolution means even the smallest oscillations in force are captured with high fidelity.

See our complete line of sensor storage trays and rolling carts on pages 148-149.
The buoyant force exerted on the object is equal to the additional force experienced by the beaker.

The Force Sensor Balance Stand lets you observe buoyant force from the perspective of the fluid.

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 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.

Connect 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 Force Bracket
ME-6622 $59
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 teaching Advantage
- Accommodates rocket engine sizes A, B, C, and D.
- Finds both the impulse and the maximum force exerted by rocket engines.

The Force Sensor Balance Stand
CI-6460 $52
Includes Force Sensor stand and balance pan. Force Sensor sold separately.

Rocket Engine Test Bracket
ME-6617 $57
Rocket Engine not included.

For outdoor use only!

Measure the force vs. time profile of a rocket engine.

The buoyant force exerted on the object is equal to the additional force experienced by the beaker.

Force vs. time data for a clay, spring and magnet.

The Force Sensor Balance Stand lets you observe buoyant force from the perspective of the fluid.

Yes, this really is rocket science!
**Galvanometer**

**PS-2160 $165**

*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.

**Goniometer Sensor**

**PS-2137 $260**

*Includes an Angle Sensor and 1 Goniometer Probe with 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.

Find out if that really is a 1% resistor with the precision of the Galvanometer.

![Image](image1.png)

Rock-solid performance lets you measure the smallest changes in voltage and current with confidence.

![Image](image2.png)

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 or call us at 800.772.8700
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** $36
  - Includes tripod, tripod adapter, and weather vane.

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

**General Science Sensor**
- **PS-2168** $50
  - Includes built-in Light and Sound Sensors, Stainless Steel Temperature Probe and Voltage Probe.
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.

A single data set shows heart rate before, during, and after exertion.

Compare your heartbeat during a variety of activities.

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

**PS-3204 $79**

*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.

### Ion Selective Electrodes

<table>
<thead>
<tr>
<th>Electrode</th>
<th>PS-3516</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td></td>
<td>$195</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>PS-3517</td>
<td>$250</td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
<td>$195</td>
</tr>
<tr>
<td>Chloride</td>
<td></td>
<td>$195</td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
<td>$195</td>
</tr>
<tr>
<td>Nitrate</td>
<td></td>
<td>$195</td>
</tr>
</tbody>
</table>

Each Ion Selective Electrode (ISE) includes a 2m cable.

**Requires one of these:**

- **Wireless pH Sensor** PS-3204 $79
- **OR** **PASPORT pH Sensor** PS-2102 $99

**Also available:**

**Electrode Support** PS-3505 $10

### Oxidation Reduction Potential Probe

**PS-3515 $40**

**Requires one of these:**

- **Wireless pH Sensor** PS-3204 $79
- **OR** **PASPORT pH Sensor** PS-2102 $99

**Also available:**

**Electrode Support** PS-3505 $10

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.

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

Quickly determine the overall tendency of a solution to gain or lose electrons.
<table>
<thead>
<tr>
<th>Wireless Light Sensor</th>
<th>Broad Spectrum Light Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-3213 $72</td>
<td>PS-2150 $288</td>
</tr>
</tbody>
</table>

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

- 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 $175**

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

![Image of High Sensitivity Light Sensor](image)

The light sensor combines with the rotary motion sensor for the diffraction of light experiment.

![Graph of light intensity](graph)

High sensitivity makes it possible to see the second order of the diffraction pattern.

### Infrared Light Sensor

**PS-2148 $283**

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

![Image of Infrared Light Sensor](image)

Capture light beyond the visible spectrum.

![Graph of infrared radiation](graph)

Clearly see the infrared light radiating from your own hand.
Detect even the smallest flex when your structure is put under load. Measure the stress and strain experienced by a structure in-line with the load cell amplifier.

**100N Load Cell**

PS-2200 $103

*Includes 4 100N Load Cells and 6-Port amplifier*

**Load Cell & Dual Amplifier Set**

PS-2206 $259

**Displacement Sensor**

PS-2204 $227

*Includes digital indicator, pivot rod clamp, Phillips screw driver, and storage box.*

**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

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

Recommended:

Building Better Bridges Kit ME-3581 $189

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.

**Students can measure forces under tension or compression anywhere on their structures.**

**Recommended:**

Building Better Bridges Kit ME-3581 $189

**Also available:**

Load Cell and Amplifier Set PS-2199 $670

**Also available:**

Load Cell and Amplifier Set PS-2199 $670

**Recommended:**

Building Better Bridges Kit ME-3581 $189

**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

Students can measure forces under tension or compression anywhere on their structures.
### Wireless 3-Axis Magnetic Field Sensor

**PS-3221** $69

*Required to measure Earth’s magnetic field:*

**Zero Gauss Chamber** **EM-8652** $206

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.

**Features:**
- X, Y, Z magnetic field components
- Resultant magnetic field
- USB and Bluetooth®
- Two ranges: 50 G and 1300 G
- Rechargeable

### Magnetic Field Sensor

**PS-2112** $75

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

### 2-Axis Magnetic Field Sensor

**PS-2162** $165

*Includes Sensor Extension Cable.*

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

### Zero Gauss Chamber

**EM-8652** $206

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.
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.

Combine with the Force Sensor to explore simple harmonic motion or Newton’s Second Law.

### 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

<table>
<thead>
<tr>
<th>PS-2546</th>
<th>$26</th>
</tr>
</thead>
</table>

### Motion Sensor Guard

<table>
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<tr>
<th>SE-7256</th>
<th>$19</th>
</tr>
</thead>
</table>

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**

PS-2103A  $90

Also see the Wireless Motion Sensor on page 107.

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.

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**Motion Sensor Guard**

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<th>$19</th>
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</thead>
</table>

Also see the Wireless Motion Sensor on page 107.
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

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.

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.

Recommended:
Linear Motion Accessory CI-6688A $61

Also see the Wireless Rotary Motion Sensor on page 109.
**Wireless Optical Dissolved Oxygen Sensor**

**PS-3224 $296**

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 CO₂ 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

**Wireless pH Sensor**

**PS-3204 $79**

Includes USB charging cable, 250-mL sampling 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.

---

**Flat pH Probe**

**PS-3514 $45**

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 $79
- **PASPORT pH Sensor** PS-2102 $99

---

**Wireless Oxygen Gas Sensor**

**PS-3217 $189**

Includes USB charging cable.

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.

---

Analyze oxygen gas consumption and carbon dioxide gas production of the pea seeds.
### Polarimeter

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2235</td>
<td>$499</td>
</tr>
</tbody>
</table>

*Includes 1 Sample Cell*

*Also available:*
- Polarimetry Sample Cell Replacement
  - PS-2234 $70

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

### Polarizer Demonstrator

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS-9477A</td>
<td>$134</td>
</tr>
</tbody>
</table>

*Includes two round polarizer discs with stands.*

*Also available:*
- Polarizer Demonstrator Accessory
  - OS-8172 $113
- Linear Polarizer (2-pack)
  - OS-8549 $15

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

Optical rotation of sucrose

As the polarizer is rotated, the intensity of the light varies as the square of the cosine of the angle between the two polarizers.
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. Other features include a slot for Photogate Tape, and an auxiliary port for an additional Photogate or the 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

**Specifications**
- Logging: Yes
- Battery: Rechargeable Lithium-Polymer
- Connectivity: Direct USB or via Bluetooth Low Energy technology

**Smart Gate**

<table>
<thead>
<tr>
<th>PS-2180</th>
<th>$55</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes Smart Gate Cord</td>
<td></td>
</tr>
</tbody>
</table>

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 $26

### Smart Gate System

<table>
<thead>
<tr>
<th>PS-3701</th>
<th>$93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs only one PASPORT connection. Photogate daisy-chains to Smart Gate.</td>
<td></td>
</tr>
</tbody>
</table>

Includes Smart Gate: PS-2180
Photogate Head: ME-9498A

### Smart Gate Pulley System

<table>
<thead>
<tr>
<th>PS-3702</th>
<th>$72</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

Includes Smart Gate (1) PS-2180, Super Pulley (1) ME-9450A
Super Pulley Rod (1) ME-8736

### Projectile Launcher Wireless Smart Gate System

<table>
<thead>
<tr>
<th>ME-6796</th>
<th>$310</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

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.
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  $15

(required)

**Photogate Head**

ME-9498A  $46

*Required:*
- Digital Adapter PS-2159  $72
- To Attach to Track:
  - Photogate Brackets (set of 2) ME-9806  $25

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”.

**Photogate Tape, High Resolution**

ME-6666  $26

*Includes High Resolution Photogate Tape (30m).*

*Required:*
- Smart Gate PS-2180  $55

When studying motion, timing is everything. Help your students understand the root concept of velocity, and acceleration.
The Dual Pressure Sensor is perfect for use with the Diffusion/Osmosis Apparatus.

Simultaneously measure the pressure on both sides of the membrane.

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.

Plot pressure versus volume to better understand their relationship.

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.

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.

Also available:
Quad Pressure Sensor PS-2164 $304

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

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.

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Plot pressure versus volume to better understand their relationship.

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.

The Dual Pressure Sensor is perfect for use with the Diffusion/Osmosis Apparatus.

Simultaneously measure the pressure on both sides of the membrane.

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.
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.
<table>
<thead>
<tr>
<th>Sensory Device</th>
<th>Part No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Moisture Sensor</td>
<td>PS-2163</td>
<td>$175</td>
</tr>
<tr>
<td>Wireless Sound Sensor</td>
<td>PS-3227</td>
<td>$89</td>
</tr>
</tbody>
</table>

### Soil Moisture Sensor
PS-2163 $175

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

![Salinity Sensor Image]  
**Compare fresh and brackish samples quickly and easily.**

### Wireless Sound Sensor
PS-3227 $89

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

**The Teaching Advantage**
- Pre-calibrated for common soil types
- Ideal for environmental science, agricultural science or biology

![Wireless Sound Sensor Image]  
**Easily observe and analyze beat frequencies.**

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

![Soil Moisture Sensor Image]  
**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.](image)

**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
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 $399
Includes Wireless Spectrometer, 10 cuvettes, and Spectrometry software.

Also available:
Optional Fiber Optic Cable
PS-2601 $74
Cuvettes & Caps
SE-8739 $23
Cuvette Rack
EC-3590 $10

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.

*For information on Chromebook compatibility, go to pasco.com/spectrometer
**Spirometer**

| PS-2152 | $199 |

*Also available:*
- Replacement Mouth Pieces (10)
  
  | PS-2522 | $36 |

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.

**Wireless Temperature Sensor**

| PS-3201 | $49 |

*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.

**Wireless Temperature Link**

| PS-3222 | $69 |

*Includes Fast Response Temperature Probe*

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

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.
Temperature profile provides a great foundation for discussion of insulation, energy conservation, and more. Report surface temperatures using degrees Celsius and Fahrenheit simultaneously.

Just press the probe against a surface to get an accurate reading of the surface, not the surrounding air.

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

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

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.

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.

Non-Contact Temperature Sensor
PS-2197 $50

Skin/Surface Temperature Probe
PS-2131 $26

Requires:
- Temperature Sensor PS-2125 $40
or
- Temp Link PS-3222 $69

Requires:
- Temperature Sensor PS-2125 $40
or
- Temp Link PS-3222 $69

Temperature profile provides a great foundation for discussion of insulation, energy conservation, and more.

Report surface temperatures using degrees Celsius and Fahrenheit simultaneously.
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.

**Stainless Steel Temperature Probe**
- PS-2153  $21

**Requires:**
- Temperature Sensor PS-2125  $40
- Temp Link PS-3222  $69

**Fast Response Temperature Probes**
- PS-2135 (3-pack)  $31
  
  *Includes 10 adhesive patches.*

**Requires:**
- Temperature Sensor PS-2125  $40
- or
- Temp Link PS-3222  $69

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.

**Thermocline Sensor**
- PS-2151  $515
  
  *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.

**These sensors are still available at pasco.com**
- Temperature (PS-2125)
- Quad Temperature (PS-2143)
- Type K Temperature (PS-2134)
- Voltage/Current (PS-2115)

Compare temperature at the soil surface to temperature below the surface.

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.
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 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.

The simple built-in calibration – just 15 seconds – means your data is as accurate in the classroom as in the field.
ezSample™ Snap Vial Kits

<table>
<thead>
<tr>
<th>Test</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia EZ-2334</td>
<td>$40</td>
</tr>
<tr>
<td>Chlorine EZ-2339A</td>
<td>$40</td>
</tr>
<tr>
<td>Iron EZ-2331</td>
<td>$40</td>
</tr>
<tr>
<td>Nitrate EZ-2333B*</td>
<td>$50</td>
</tr>
<tr>
<td>Phosphate EZ-2337</td>
<td>$35</td>
</tr>
</tbody>
</table>

*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.

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.

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!

**Titration in the field**

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.

Water Quality Colorimeter

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2179</td>
<td>$160</td>
</tr>
</tbody>
</table>

Iron concentration using ezSample Snap Vial and Water Quality Colorimeter

ezSample™ Field Titrator Kits

<table>
<thead>
<tr>
<th>Test</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity EZ-2340</td>
<td>$45</td>
</tr>
<tr>
<td>Carbon Dioxide EZ-2341*</td>
<td>$45</td>
</tr>
<tr>
<td>Total Hardness EZ-2338</td>
<td>$45</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-2179</td>
<td>$160</td>
</tr>
</tbody>
</table>
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 | $72 |

Sensor Extension Cable

| PS-2500 | $25 |

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.

**Analog Adapter**

| PS-2158 | $88 |

**Replacement Items**

- **Advanced Water Quality**
  - Optical Dissolved Oxygen Sensor Cap PS-2587 $65

- **Breath Rate**
  - Replacement Masks (10 pack) PS-2567 $20
  - Replacement Clips (10 pack) PS-2568 $15

- **Colorimeter**
  - Cuvettes and Caps (set of 100) SE-8739 $23

- **EKG**
  - Electrode Patches (100 pack) CI-6620 $12

- **Exercise Heart Rate**
  - Transmitter and Belt PS-2512A $65

- **High Accuracy Drop Counter**
  - Drop Dispenser PS-6935 $13

- **Oxygen Gas**
  - Oxygen Gas Probe PS-6524 $105

- **pH**
  - pH Electrode PS-2573 $40

- **Photogate Tape**
  - High Resolution Tape (30m) ME-6666 $26

- **Polarimeter**
  - Sample Cell Replacement PS-2234 $70

- **Spirometer**
  - Mouth Pieces (10 pack) PS-2522 $36

- **Fast Response Temperature**
  - Fast Response Probes (3 pack) PS-2135 $31
  - Adhesive Patches (100 pack) PS-2525 $25

- **Turbidity**
  - Cuvettes and Caps (set of 100) SE-8739 $23

- **Voltage**
  - Voltage Probe PS-2165 $10

---

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

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.

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For a complete list of sensors that connect with the Digital Adapter, see pasco.com.
**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** $399

*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** $165
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.

Assembly is required. Trays not included.

Gratnells Rolling Carts (2 column)

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
<th>Description</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP-3574</td>
<td>$510</td>
<td>Stores up to 8 Gratnells F2 trays</td>
<td>107 cm high, 70 cm wide, 43.5 cm deep</td>
</tr>
</tbody>
</table>

Gratnells Rolling Carts (3 column)

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
<th>Description</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP-3575</td>
<td>$627</td>
<td>Stores up to 12 Gratnells F2 trays</td>
<td>107 cm high, 102 cm wide, 43.5 cm deep</td>
</tr>
</tbody>
</table>

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.
**Wireless Sensor Storage Trays with Lids**

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

<table>
<thead>
<tr>
<th>Wireless Sensor Storage Trays for:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature/pH/Conductivity Sensors</td>
<td>PS-3585 $30</td>
</tr>
<tr>
<td>Pressure Sensors</td>
<td>PS-3586 $35</td>
</tr>
<tr>
<td>Colorimeter &amp; Turbidity Sensors</td>
<td>PS-3587 $40</td>
</tr>
<tr>
<td>Voltage &amp; Current Sensors</td>
<td>PS-3588 $30</td>
</tr>
<tr>
<td>Motion Sensors</td>
<td>PS-3589 $35</td>
</tr>
<tr>
<td>AirLink &amp; Light Sensors</td>
<td>PS-3594 $30</td>
</tr>
<tr>
<td>Force Acceleration Sensors</td>
<td>PS-3595 $35</td>
</tr>
<tr>
<td>Weather Sensor with GPS</td>
<td>PS-3596 $35</td>
</tr>
<tr>
<td>CO₂ Sensor</td>
<td>PS-3598 $35</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Gratnells Storage Trays</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(F1) Shallow</td>
<td>PS-3326 $15</td>
</tr>
<tr>
<td>(F2) Deep</td>
<td>PS-3327 $20</td>
</tr>
<tr>
<td>(F25) Extra Deep</td>
<td>PS-3328 $25</td>
</tr>
<tr>
<td>(F3) Jumbo</td>
<td>PS-3329 $30</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Storage Bins (set of 5)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SE-7560 $46</td>
<td></td>
</tr>
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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 educational institution customers and only for educational use of these products.

Designed for education. PASCO products are designed for educational use only; they are not intended for use in graduate research or industry where higher degrees of accuracy and durability are required, and should not be used in any apparatus involved with life support, patient diagnosis, or industrial control. They should only be used in environments that facilitate learning in an educational setting (K-12 schools, colleges, and universities).

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Please obtain the required Return Material Authorization (RMA) prior to returning any product to PASCO (Call 1-800-772-8700). RMA's for products being returned under our 90-day Satisfaction Guarantee or In-Warranty products will include an Electronic Return Label for free shipping. Out-of-Warranty products must be shipped prepaid. Returns for credit or exchange must be in new condition and packaged in original shipping cartons or packaging sufficient to prevent damage during transit.

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More Product Information

Electrical Unless otherwise requested, all equipment is shipped in 115 V, 60 Hz configurations. Please request a different voltage if required.

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

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 Environmental Policy: 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.

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. We are here to help. See contact information below.
### Order Form

**PASCO**

10101 Foothills Blvd., Roseville, CA 95747 U.S.A.

U.S.A.: 1-800-772-8700
Fax: 1-916-786-7565
Outside the U.S.A.: Contact your local representative or phone 1-916-786-3800

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#### How to handle my order:

- **Requested Delivery Date:**

  - M / D / Y

- **Ship available items** [NOW]— Ship back-orders [AS AVAILABLE]

- **HOLD** for single shipment of all items

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#### Payment Method (in U.S. Dollars)

- **Check/Money Order**
- **Purchase Order**
- **Card Number**
- **CVC Code**

- **Expiration Date:**

  - M / D / Y

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#### 90-Day Satisfaction Guarantee:

We want you to be satisfied! Try any PASCO product for 90 days. If it doesn’t provide “a better way to teach science,” send it back for a full refund. See page 156 for information.

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#### Order Form (For orders to U.S. addresses only)

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Catalog Number</th>
<th>Description of Item</th>
<th>Unit Price</th>
<th>Total</th>
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</table>

**SUB-TOTAL**

(For Prepaid Orders to U.S. Addresses, estimate 10% of subtotal, $10 minimum)

**Shipping & Handling**

**State & Local Taxes** (Assessed as required unless Tax Exempt Certificate on file)

**Thank you for your order!**

---

**Alert!** Due to federal and state laws, PASCO does not collect information belonging to anyone under 18 years of age. If you are under 18 years of age, please have an adult (18 years or older) provide their contact information to complete the transaction.

Order or request quotes online: pasco.com

**Note:** On all credit card orders “Bill To” address must match address on credit card.

---

**Bill To:**

- **Institution**
- **Attn:**
- **Address**
- **City**
- **State/Zip**
- **Phone**

**E-mail**

---

**Payment Method:**

- **Check/Money Order**
- **Purchase Order**
- **Card Number**
- **CVC Code**

**Expiration Date:**

- M / D / Y

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A whole team behind you

Serving educators isn’t just what we do, it’s who we are.

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.
Our Education Consultants are knowledgeable about all our products and understand how they are used in the classroom. Please contact your Education Consultant for help selecting the products that will best meet your needs.

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Teacher and Technical Support

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Roseville, California 95747-7100 USA
ISO 9001:2009 Certified

Live Contact Hours:
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F: 7:00 am–2:00 pm Pacific Time
e-mail: support@pasco.com

Web:
Order and quote online
www.pasco.com

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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 Convention 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

For the latest information on PASCO STEM Workshops, go to pasco.com/training-and-events

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
Austin, TX

Thursday, May 14
Minneapolis, MN

Thursday, May 14
San Antonio, TX

Tuesday, May 19
Strongsville, OH

Tuesday, May 26
West Palm, FL

OCTOBER 2020
Thursday, Oct. 1
Portland, OR

Thursday, Oct. 1
Huntsville, AL

Tuesday, Oct. 20
Albuquerque, NM

Tuesday, Oct. 20
Milwaukee, WI

Wednesday, Oct. 21
Auburn Hills, MI

Wednesday, Oct. 21
Nashville, TN

Tuesday, Oct. 27
San Antonio, TX

OCTOBER 2020
Thursday, Nov. 2
Louisville, KY

MAY 2020
Saturday, Nov. 7
Harrisburg, PA
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
63rd 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
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