

# PASPort<sup>®</sup> Probeware: Designed for Science Education

The PASPORT System was designed to meet the needs of the science classroom and lab. Below are a few of the reasons PASPORT is a leading probeware system used throughout the world:

## 1 Five Interfaces to Fit Your Needs

- ▶ Avoid the “one size fits all” mentality of other probeware systems.
- ▶ USB Link is the most economical interface available.
- ▶ Use multiple interfaces together in any combination.
- ▶ All interfaces compatible with both Windows and Macintosh computers.



## 2 Superior Sensors

- ▶ Sensors are automatically identified by the computer or datalogger when plugged in.
- ▶ MultiMeasure sensors combine complimentary measurements into one sensor for convenience, superior performance and cost savings.
- ▶ Use any combination of sensors together, even with different data collection rates.
- ▶ Dynamic variable over-sampling greatly reduces noise level at low sample rates.

Motion Sensor  
PS-2103A



Force Sensor  
PS-2104



Voltage/Current Sensor  
PS-2115



Absolute Pressure/  
Temperature Sensor  
PS-2146



## 3 Built to Last

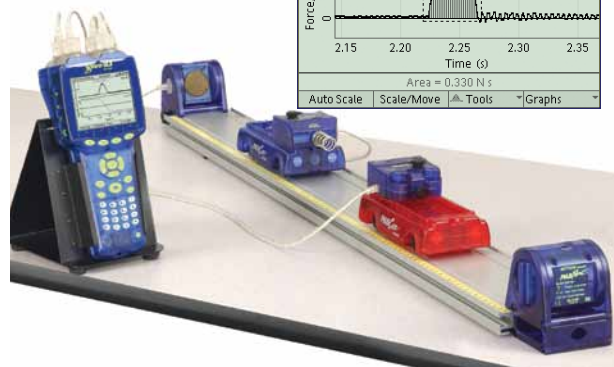
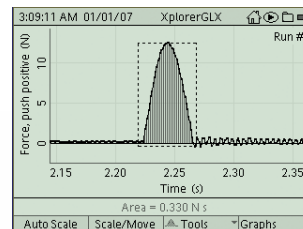
- ▶ Sensor cables are designed with appropriate strain relief in the connections to prevent wire breakage.
- ▶ PASPORT sensors can only be plugged into interfaces in the correct orientation, preventing damage to the sensor pins and the interfaces.
- ▶ Sensor and interface cases are designed to withstand student use. Most use impact-resistant poly-carbonate, while PASCO's Drop Counter uses the chemically-resistant polypropylene.



## 4 Xplorer GLX is Fully Self-contained

*Computer, graphing calculator or PDA not required*

- ▶ Xplorer GLX includes all the tools to complete most physics experiments.
- ▶ Collect data and save files.
- ▶ View graphs, tables or other displays.
- ▶ Apply analysis tools such as derivatives, integration, linear fit and statistics.
- ▶ Print data tables and graphs directly from the Xplorer GLX.








## 5 ScienceWorkshop Sensors can be used with PASPORT Interfaces

- ▶ Analog and Digital Adapters (page 85), enable students to use *ScienceWorkshop* Sensors with the USB Link, PowerLink, Xplorer, Xplorer GLX and SPARKlink.

# PASPort<sup>®</sup> Interface Comparison

Use the following table to compare the features and capabilities of PASPORT Interfaces:

	 USB Link PS-2100A <i>See p. 18</i>	 Xplorer PS-2000 <i>See p. 18</i>	 PowerLink PS-2001 <i>See p. 19</i>	 SPARKlink PS-2009 <i>See p. 22</i>	 Xplorer GLX PS-2002 <i>See p. 10</i>
Features					
Collects Data with a Computer	yes	yes	yes	yes	yes
Data Logging	-	yes	-	-	yes
Print Graphs and Tables Directly from Interface	-	-	-	-	Using a USB Printer
Operate with USB Keyboard and Mouse	-	-	-	-	yes
Works in the field with a Laptop	yes	yes	yes	yes	yes
USB "On the Go" Ports	-	-	-	-	Use mouse, keyboard, printer
Graphical Display	-	-	-	-	320 x 240 pixels
Display Size	-	1.3" x 0.3"	-	-	3" x 2.2"
Display Color Mode	-	Black and White	-	-	Grayscale
Character Display	-	2 lines x 16 characters	-	-	-
Icon-Based Operating System	-	-	-	-	yes
Maximum Sample Rate	1000 Hz	1000 Hz	1000 Hz	1000 Hz	50,000 Hz
Number of Sensor Ports	1	1	3	4*	8**
Built-in Sensors	-	-	-	Voltage, Temp	Voltage, Sound, Temperature (2)
Built-in Function Generator	-	-	-	-	Dual, Independent
Built-in Speaker for Sound Output	-	-	-	-	yes
Data Storage Memory	-	0.1 MB	-	-	12 MB
Built-in Data Analysis Tools	-	-	-	-	yes
Built-in Graphing Calculator with Expression Editor	-	-	-	-	yes
Built-in USB Hub (to add additional PASPORT Interfaces)	-	-	yes	-	-
Pre-loaded Experiment Files	-	-	-	-	yes
Built-in File Management System	-	-	-	-	yes
Annotations for Data Points and Runs	-	-	-	-	Voice and Text
Battery Power	-	2 "AA"	2 "C"	-	Built-in Rechargeable (NiMH)
Free DataStudio <sup>®</sup> Lite Software Included	yes	yes	yes	yes	yes
Compatible with DataStudio Software	yes	yes	yes	yes	yes
Powered by Computer's USB Port	yes	yes	-	yes	-
Compatible with <i>ScienceWorkshop</i> Sensors	yes***	yes***	yes***	yes***	yes***
Upgradable Operating System	yes	yes	yes	yes	yes

\* Includes two built-in sensors

\*\* Includes four built-in sensors

\*\*\* Using either Analog or Digital Adapters (see page 85)

## Xplorer GLX® Handheld Computer/ Datalogger

- ▶ Collect and analyze data away from the computer
- ▶ Print directly from the Xplorer GLX
- ▶ Also functions as a computer interface

### File Management System

Create and save experiment templates and student files right on the Xplorer GLX. Up to 100 files.

### Two Built-in Temperature Ports

Includes two Fast Response Temperature Probes.

### Built-in Voltage Port

Includes one Voltage Probe.

### Sound Output

Use with optional external speakers to study the properties of sound waves.

### Dual Function Generator

Produce multiple waveforms and frequencies.

### 50 MHz Floating Point Processor (FPU)

- ▶ Crunches numbers faster than any other handheld device
- ▶ Faster graphing, faster analysis

### Built to Last

- ▶ Rechargeable 1700mAh NiMH battery and charger included
- ▶ Tough polycarbonate case
- ▶ Firmware updates available at [www.pasco.com](http://www.pasco.com)

### Sized for the Lab

- ▶ Small enough to hold in your hand
- ▶ Requires minimal desk space
- ▶ Screen large enough to see data in fine detail and conduct analysis

### 12MB of Data Storage

12 MB of user-available memory allows a full day of experiments.

### Flash Memory

Data retained even if batteries discharge.

### Microphone/Sound Sensor

- ▶ Display sound waveforms
- ▶ Measure sound level (dB)
- ▶ Voice annotate an experiment

### Speaker

For sound output.

### Four Universal Ports

Connect up to four PASPORT sensors in any combination— including MultiMeasure™ Sensors.

## Xplorer GLX Experiment Bundles:

See pages  
96-101

Shown Actual  
Size with  
Actual Screen  
Resolution

Up to 50,000 Hz  
Max Sampling  
Rate

### Two USB Ports

- ▶ Print directly to an HP printer
- ▶ Use a mouse and/or keyboard
- ▶ Save data to a flash drive
- ▶ Connect to a computer using the included USB cable.

### Intuitive Icon-Based Navigation

Scientific symbol fonts mean pi looks like  $\pi$ . Supports 15 languages.

### High-Resolution Screen

- ▶ Crisp, clear output allows for easier data analysis
- ▶ 320 x 240 grayscale
- ▶ Transflective technology for optimal visibility in all lighting conditions—even sunlight!
- ▶ Backlit for use in darkened optics lab

### Built-in Graphing Calculator with Expression Editor

- ▶ Create/edit/graph mathematical models
- ▶ Perform real-time calculations
- ▶ Use calculator functions with Relay (CI-6462) to do sense and control experiments

### Calculator and Manual Data Entry Keys

- ▶ Enter alphanumeric data
- ▶ Annotate graphs
- ▶ Creates experiment notes pages
- ▶ Perform calculations

### Includes:

- ▶ Two fast response, low thermal mass temperature probes
- ▶ Voltage probe
- ▶ Built-in sound sensor
- ▶ Built-in speaker
- ▶ Power adapter and battery charger
- ▶ USB "A" to USB "B" cable
- ▶ DataStudio Lite for use as a PASPORT interface to computer
- ▶ Users guide and tutorial CD

See pages 12-14  
for accessories.

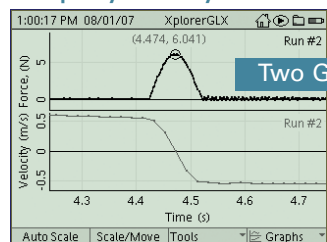
### Order Information:

Xplorer GLX.....PS-2002

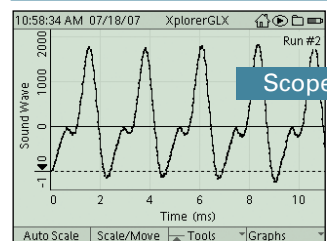
The Xplorer GLX currently supports the following languages:

- ▶ Arabic
- ▶ Chinese (Traditional)
- ▶ Chinese (Simplified)
- ▶ Danish
- ▶ English
- ▶ French
- ▶ German
- ▶ Italian
- ▶ Japanese
- ▶ Norwegian
- ▶ Portuguese
- ▶ Russian
- ▶ Spanish
- ▶ Swedish
- ▶ Turkish

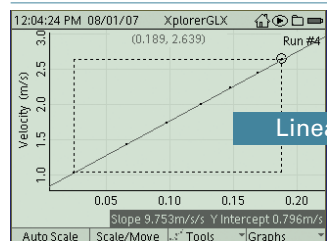
## Display/Analyze Data



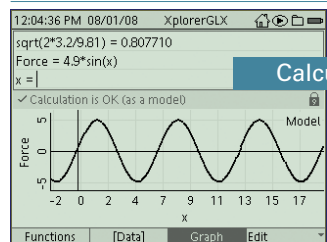
Display two different graphs to compare and analyze data.



Use your GLX as an oscilloscope. Set trigger criteria and go. Display two measurements simultaneously.



Choose the Linear Fit Tool, then select the appropriate region of data. Slope and Intercept are at bottom of screen.



Perform any single calculation or create a calculated data set based on measurements from a sensor. Any function can be graphed directly from the calculator window. Students see both equation and graph.

Use the Xplorer GLX 3 ways:

## 1 Instead of a computer, PDA or graphing calculator

The Xplorer GLX includes the most important functions from other computing devices for effective physics teaching. Collect and analyze data, even print directly from the Xplorer GLX. Plus, never worry about operating system or computer network problems.



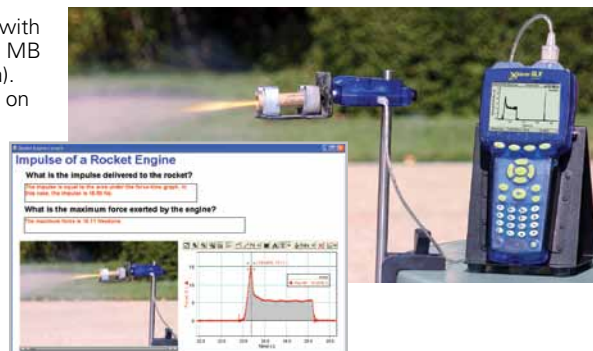
## 2 As a real-time interface

Connect the Xplorer GLX directly to a computer via the USB connection. When connected, the Xplorer GLX acts as a typical PASPORT interface controlled by the computer, presenting real-time data collected by the sensors. As with all PASPORT interfaces, DataStudio® software is launched when a PASPORT® sensor is connected. Sensors are automatically identified and displays set up.



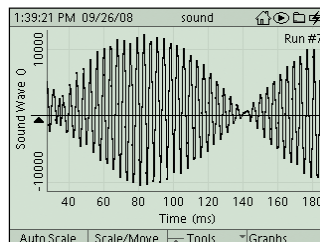
## 3 As a remote datalogger

Take data anywhere, anytime with the Xplorer GLX. (And with 12 MB of memory, that's a lot of data). Display and even analyze data on the Xplorer GLX screen. Later, simply connect the Xplorer GLX to the USB port on your computer and all stored data is downloaded, ready for writing reports or further analysis. Xplorer GLX lets you take data anywhere, any time and still have the data available for use on your computer. Data can also be stored on a USB flash drive.



## Measure resonances or the speed of sound

The Xplorer GLX, with its built-in microphone and 50 KHz sample rate, lets you look at waves produced by musical instruments. Students perform many acoustic experiments. The GLX can even create its own sound waves, using its dual channel sine wave generator and built-in speaker.



Two tuning forks of slightly different frequencies are sounded together. Now your students can hear and SEE the waveforms, and understand the concept of beats.



Order Information:

Resonance Box Set.....SE-7345 p. 302

## Xplorer GLX Portable Lab Kit

PS-2688

Easy to store, quick to set-up.  
Turn any available surface into a science lab.



### Kit Includes:

- Xplorer GLX
- Deluxe Storage Case
- Mobile USB keyboard
- USB Mouse
- Xplorer GLX peripheral cable (not shown)
- Two Stainless Steel Temperature Probes

### Order Information:

Xplorer GLX Portable Lab Kit.....PS-2688  
Deluxe Storage Case (only).....PS-2542

## USB Flash Drive

512 MB

PS-2551

Use this 512 MB storage device with your Xplorer GLX to transfer files to your computer or another GLX.



### Order Information:

USB Flash Drive.....PS-2551

## Xplorer GLX 20-Unit Charging Station

PS-2557



Conveniently store and charge your set of Xplorer GLX graphing dataloggers with this 20-unit charging station. This compact-sized and light-weight charging station simplifies storage—fits nicely on most shelves or table tops—yet stores and charges up to 20 Xplorer GLXs. Just one outlet required to charge all 20 units. With this new charging station, your Xplorer GLXs are always ready to go.

Dimensions: 12" x 24" x 5.25"

Weight: 10 lbs

Designed and manufactured for PASCO by TriBeam Technologies.

### Order Information:

Xplorer GLX 20-Unit Charging Station.....PS-2557

## Xplorer GLX Mobile Cart

PS-2558



Get the convenience of a lockable rolling cart with your Xplorer GLX charging solution. This Xplorer GLX Mobile Cart has the Xplorer GLX 20-Unit Charging Station built right into it. Provides added security and easy transport from classroom to classroom or supply room to lab. Easy View locking cover accepts any standard padlock. Desktop height and top-loading design means easy access. The wire mesh design provides security but keeps weight down for easier maneuvering. Just one outlet required to charge up to 20 units. Use bottom shelf for storing sensor boxes or printer.

Dimensions: 34" x 19" x 34"

Weight: 57 lbs

Designed and manufactured for PASCO by TriBeam Technologies.

### Order Information:

Xplorer GLX Mobile Cart.....PS-2558

## Tripod Stand (5-pack)

SE-7397A



Use this portable tripod to support the Xplorer GLX or just about any PASCO sensor. The lightweight tripod (0.18 kg) stands 17 cm high with a 25 cm footprint.

The adjustable tripod head provides support for the Xplorer GLX or sensor in many orientations.

**Order Information:**

**Tripod Stand (5-pack)**.....SE-7397A

## Lab Stand

PS-2526



Slide the Xplorer GLX into the cradle of this sturdy metal stand to position the screen at the ideal angle for desktop experiments.

**Order Information:**

**Lab Stand**.....PS-2526

## USB Mouse

PS-2539



Directly manipulate data on graphs and tables using common mouse functions such as drag and drop.

**Order Information:**

**USB Mouse**.....PS-2539

## USB Connection Cable

PS-2528



To connect an Xplorer GLX or a SPARK SLS to a computer to use as an interface, use this USB A-to-mini B cable (1.8 m long) to connect the USB mini B port on the Xplorer GLX or the SPARK SLS to the USB port on a computer.

**Order Information:**

**USB Connection Cable**.....PS-2528

## Peripheral Cable

PS-2536



Plug this USB cable into the Xplorer GLX USB B port to convert it to a USB A port. Then use this port and the Xplorer GLX's other USB A port to attach two peripheral devices simultaneously, such as a mouse and a printer.

**Order Information:**

**Peripheral Cable**.....PS-2536

## Xplorer GLX Replacement Parts

(not shown)

**Order Information:**

**Power Adapter**.....PS-2529

**Voltage Probe** .....PS-2165

**Fast Response Temperature Probes (3)**.....PS-2135

**Rechargeable Battery**.....PS-2527

## Xplorer GLX Pack

PS-2549



Carry your GLX and sensors safely when data collection takes you out of the classroom. Includes detachable strap.

**Order Information:**

**Xplorer GLX Pack**.....PS-2549

## Xplorer Vest

PS-2517



*Xplorer GLX not included*

Keeps the Xplorer or Xplorer GLX secure during outdoor activities.

Includes extra pockets for safely storing sensors.



**Order Information:**

**Xplorer Vest**.....PS-2517

## Xplorer GLX Power Amplifier

PS-2006

- ▶ Amplifies the signal output from the Xplorer GLX®
- ▶ DC, Sine, Square, Triangle, Ramp
- ▶ Built-in Current Sensor

The GLX Power Amplifier amplifies the signal generated by the Xplorer GLX. Output current is measured directly by the Power Amplifier.

### Typical Applications

- ▶ Power AC or DC Circuits and Measure Power Input
- ▶ Power Motors
- ▶ Vary Driving Frequency of a String Vibrator
- ▶ Power a Speaker for a Resonance Tube

In the experiment shown below, the Xplorer GLX and the GLX Power Amplifier are used as a variable frequency sine wave power supply for the String Vibrator (WA-9857). The Force Sensor (PS-2104) is used to measure the tension in the string. All parameters can be varied, including tension, amplitude, frequency, and the number of vibrating segments.

5:34:03 PM 11/08/08 wave

Force, pull positive (N)

**8.4**

5:19:18 PM 11/08/08 wave

frequency (Hz)

number of segments

Slope=18.7±0.0537 Hz/ Y Int.=0.208±0.302 Hz

r=1.00 MSE=0.134 √MSE=0.367

Auto Scale Scale/Move Tools Graphs

*Digits Display (top screen) shows the tension in string when not vibrating.*

*The bottom screen shows a graph of frequency vs. number of vibrating segments. The slope of this line, along with the tension and length of the string, allows calculation of the wave speed and density of the string.*



For the Ohm's Law Experiment shown below, the GLX Power Amplifier provides a 20 second long voltage ramp, and a Voltage vs Current graph is generated for a resistor and a light bulb. The CI-6512 RLC Circuit board also includes two capacitors and an induction coil for performing low frequency RC and RLC circuit experiments.

2:17:43 PM 01/25/07 Ohms Law

Voltage (V)

Current (A)

Slope=32.5±0.00844 V/A Y Int.= -0.0553±9.67E-4 V

r=1.00 MSE=9.48E-6 √MSE=0.00308

Auto Scale Scale/Move Tools Graphs

*Graph shows V vs I data for a 33 Ω resistor and a light bulb. The slope of the linear graph gives the resistance of the resistor. Note the non-linear graph for the bulb, due to its large change in temperature.*

### Includes:

- GLX Power Amplifier
- Power Adapter



### Specifications

- Output Power:** ± 1A @ ± 10 V
- DC Offset:** ± 10 V
- Waveform Maximum Frequency:** 5000 Hz
- Waveform Maximum Period:** 1 Hour

### Waveforms:

- DC
- Sine
- Square
- Triangle
- Ramp

### Order Information:

<b>GLX Power Amplifier</b> .....	<b>PS-2006</b>	
<b>Required:</b>		
Xplorer GLX.....	PS-2002	p. 10
<b>Recommended:</b>		
RLC Circuit.....	CI-6512	p. 254
String Vibrator.....	WA-9857	p. 288

# 1 MHz 2-channel Voltage Sensor

PS-2190

- ▶ Turn your Xplorer GLX into a 2-channel oscilloscope
- ▶ Measure two channels at sample rates up to 1 MHz

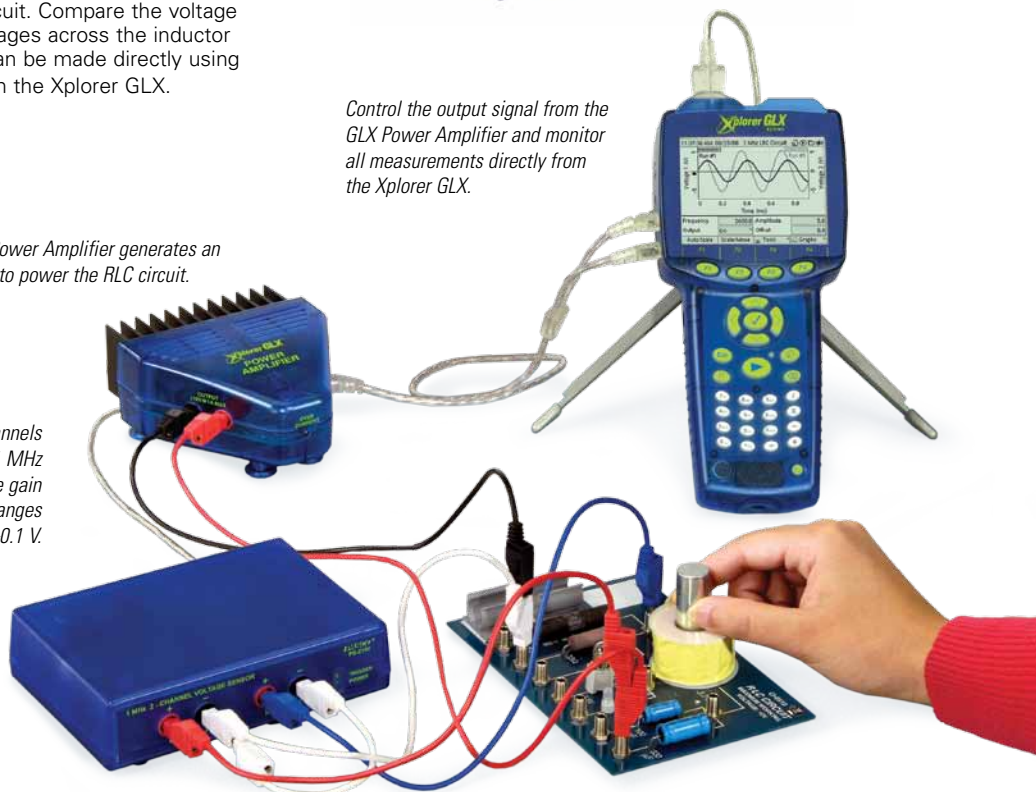
Use the Xplorer GLX and the PS-2190 1 MHz Voltage Sensor to measure the phase shift between the driving voltage and the resulting current in an RLC Circuit. Compare the voltage drop across the resistor to the voltages across the inductor and capacitor. All measurements can be made directly using the displays and tools included with the Xplorer GLX.



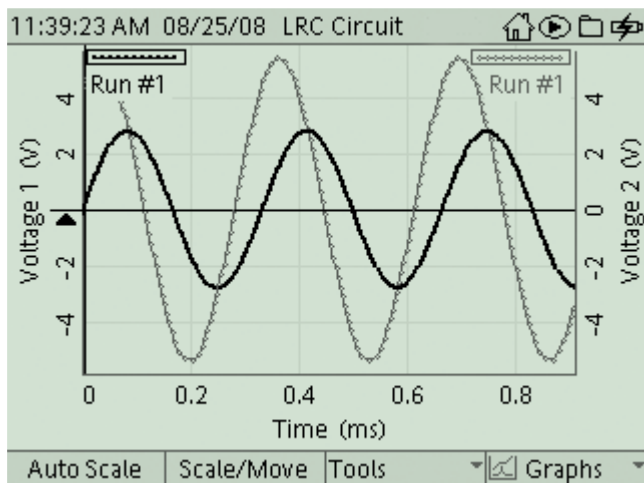
Control the output signal from the GLX Power Amplifier and monitor all measurements directly from the Xplorer GLX.

The GLX Power Amplifier generates an AC signal to power the RLC circuit.

The PS-2190 measures two channels simultaneously at up to 1 MHz sampling rate. It has three gain settings with full-scale input ranges of  $\pm 10$  V,  $\pm 1$  V, and  $\pm 0.1$  V.



The CI-6512 RLC Circuit Board is perfect for studying introductory AC circuit theory. Vary all parameters, including resistance, capacitance, and even the inductance of the coil by using the included iron core.



Graph shows driving voltage and voltage drop across the resistor.

## Specifications

- Two differential channels
- 1 MHz max sample rate
- $\pm 10$  V max input
- Three gain settings
- Overvoltage protection

### Order Information:

<b>1 MHz 2-channel Voltage Sensor</b> .....	<b>PS-2190</b>	
<i>Required for this experiment:</i>		
Xplorer GLX.....	PS-2002	p. 10
<i>Shown in use with:</i>		
GLX Power Amplifier.....	PS-2006	p. 14
RLC Circuit.....	CI-6512	p. 254
Short Patch Cords.....	SE-7123	p. 261



## Display Full-scan Spectrum with Ocean Optics Red Tide Spectrometer

### Emission Spectrometer System for Xplorer GLX

PS-2635

- ▶ Uses Ocean Optics Red Tide Spectrometer
- ▶ Full-scan spectroscopy without a computer!

The Xplorer GLX controls the Ocean Optics Red Tide Spectrometer which detects the spectrum using a 2048 pixel CCD linear array. The Xplorer GLX does a full sweep in less than one second.

#### Specifications

**Range:** VIS-NIR, 350-1000 nm

**Optical Resolution:** 2 nm



#### Includes:

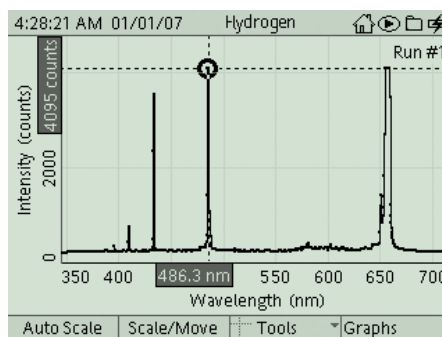
- Ocean Optics Red Tide Spectrometer
- Fiber Optics Cable
- USB Cable
- License key for Ocean Optics GLX feature set



Light from a Hydrogen tube is sampled using the fiber optics cable connected to the Ocean Optics Spectrometer. The Spectrometer is plugged into the USB port on the Xplorer GLX. (Light Source sold separately.)

#### Order Information:

<b>Emission Spectrometer System for Xplorer GLX</b> .....	<b>PS-2635</b>
<i>Required:</i>	
Xplorer GLX.....	PS-2002
<i>Shown in use with::</i>	
Spectral Tube Power Supply.....	SE-9460
Hydrogen Tube.....	SE-9461

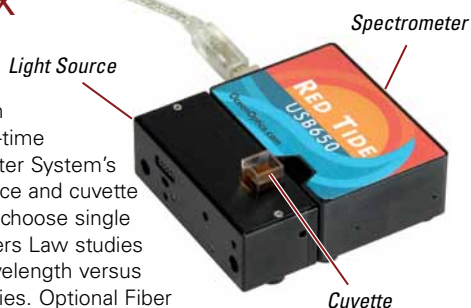


Light from a Hydrogen tube is sampled using the fiber optics cable connected to the Ocean Optics Spectrometer. The Spectrometer is plugged into the USB port on the Xplorer GLX.

## Absorption Spectrometer System for Xplorer GLX

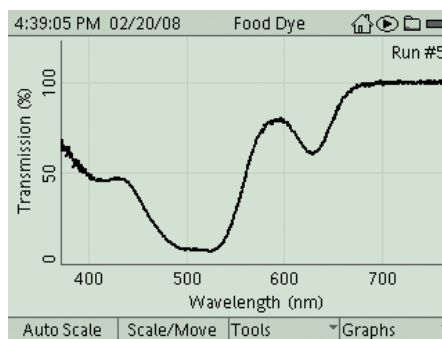
PS-2642

Investigate full scan absorption data real-time with the Spectrometer System's integrated light source and cuvette holder. You can also choose single wavelengths for Beers Law studies or scan a single wavelength versus time for kinetic studies. Optional Fiber Optics Cable (SE-7194) can be used with the PS-2642 System to perform all experiments shown with the (PS-2635) Emission Spectrometer System.



#### Includes

- Ocean Optics Red Tide Spectrometer
- Light Source and Cuvette holder, 10 Plastic Cuvettes
- USB Cable
- License key for Xplorer GLX Spectrometer



Graph shows two absorption bands due to the two colors of food dye added to the water in the cuvette.

#### Specifications

**Range:** VIS-NIR, 370-980 nm

**Optical Resolution:** 2 nm

#### Order Information:

<b>Absorption Spectrometer System for Xplorer GLX</b> .....	<b>PS-2642</b>
<i>Required:</i>	
Xplorer GLX.....	PS-2002
<i>Recommended:</i>	
Fiber Optics Cable.....	SE-7194

# Record Latitude and Longitude of Sensor Measurements

## GPS Position Sensor

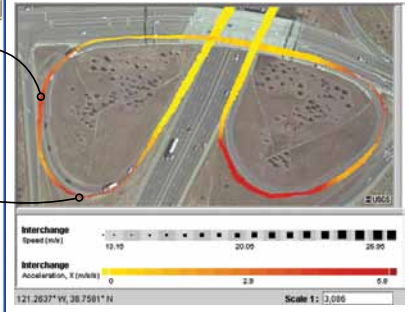
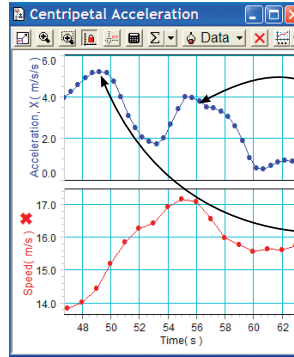
PS-2175

The GPS Position sensor utilizes satellite triangulation to determine the sensor's position and velocity in outdoor environments. Obtain sensor data simultaneously linked to your latitude, longitude, altitude, and velocity.

### Two Modes

**Absolute Position Mode:** Pinpoints your location in the world and reports the latitude and longitude with a resolution of two meters. This data can be imported into My World GIS™ software to overlay sensor data on maps or aerial photos.

**Relative Position Mode:** This mode enables a higher resolution (0.2 meters), suitable for experiments involving bicycles or people running or walking, in which the position in the world is not required.



Car acceleration was measured with an Acceleration Sensor, and position and velocity were measured with the GPS Position sensor, then plotted on an aerial photo in My World software. The size of the plotted data point indicates the speed of the car, and the data is color coded to indicate the car's centripetal acceleration.

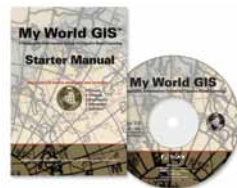
### Order Information:

GPS Position Sensor.....	PS-2175
<i>Recommended:</i>	
3-Axis Acceleration Altimeter.....	PS-2136
My World GIS 5.0 Student License.....	SE-7363
(For volume licensing, see <a href="http://www.pasco.com/myworld/">www.pasco.com/myworld/</a> )	

# Like online mapping? You'll love My World GIS!

## My World GIS™ 5.0

SE-7363



- ▶ PC and MAC compatible
- ▶ Simple to use interface
- ▶ Import and export industry standard data
- ▶ One disk installation
- ▶ Student projects are saved in one compressed data file – including project data and analysis
- ▶ Activities and projects

Link graphics, videos, or documents to features on maps. Click flag to open picture.

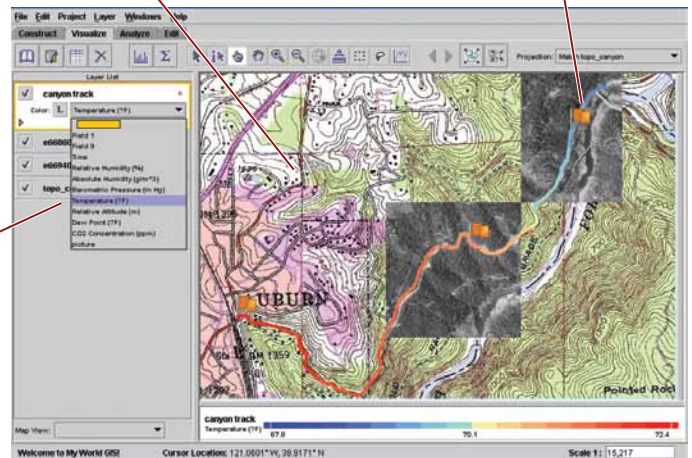


Directly access and retrieve topographic maps and aerial photographs from TerraServer and other Web Map Servers.



Developed by the GEODE Initiative at Northwestern University

Quickly switch between all the available measurements using layer data menu.



Track showing the change in temperature during descent into the American River Canyon. The temperature was recorded with the Xplorer GLX and the Weather Sensor, and position data with a GPS unit. This track was recorded late in the afternoon as cold air collected in the bottom of the canyon, creating a temperature inversion.

### Order Information:

My World GIS 5.0 Student License.....	SE-7363
(For volume licensing, see <a href="http://www.pasco.com/myworld/">www.pasco.com/myworld/</a> )	
<i>Required:</i>	
GPS Position Sensor.....	PS-2175

## Xplorer: Interface and Datalogger

PS-2000

### Affordable, Portable Data Collection

- ▶ Datalogger with 2-Line Display

**LCD Display**

Clearly displays measurement name, value and units.

**Check Button**

Allows students to save changes to measurements, units or sampling rate.

**Start/Stop Button**

Start and stop data collection  
“Sticky Start/Stop” option prevents accidental starts and stops of data runs.

**1000 Hz Maximum Sampling Rate with PASPORT Sensors**

**Desktop or Field Use**

Xplorer functions as a computer-based interface when connected to a USB port. Collect data in the field without any computer setup, then easily download the data to a computer back in the lab.

**Built to Last**

Polycarbonate case will withstand the rigors of student use. PASPORT Sensors can only be plugged in the correct orientation. Preventing damage to the sensor pins and interface.

**Compatible with ScienceWorkshop Sensors**

Requires Analog or Digital Adapter.

**Power Button**

Recessed to avoid accidentally turning off the Xplorer.

**Universal Sensor Port**

Compatible with all PASPORT Sensors. PASPORT MultiMeasure™ Sensors record multiple measurements through a single port.

**USB Connection**

Connects Xplorer to the computer for downloading data. Provides power to the Xplorer, so no external power cable is needed. Power Adapter (not included) is available separately below.

**Edit Buttons**

Change measurements, units, or sampling rate.

**Menu Button**

Cycles through the various menu options.

**Long Battery Life**

Two “AA” batteries (included) will provide several days of use in the field.



## Power Adapter

PS-2530



The Xplorer is powered through the USB cable when connected to the computer and its own batteries when out in the field. The Xplorer can also be powered from a wall outlet using the Xplorer Power Adapter, when not connected to the computer.

**Order Information:**

**Power Adapter**.....PS-2530

**Order Information:**

**Xplorer** .....PS-2000

## USB Link: Connects Sensors to a Computer

PS-2100A

- ▶ Directly Link One PASPORT Sensor to a USB Port
- ▶ Use Multiple Links for More Sensors
- ▶ 1000 Hz Maximum Sampling Rate with PASPORT Sensors

**USB Connection**

Connects USB Link to the computer for downloading data. Provides power to the USB Link, so no external power cable is needed.

**Built to Last**

Polycarbonate case withstands rigors of student use. PASPORT Sensors can only be plugged in the correct orientation. Preventing damage to the sensor pins and interface.

**Compatible with**

**ScienceWorkshop Sensors**  
Requires Analog or Digital Adapter.

**Universal Sensor Port**

Compatible with all PASPORT Sensors. PASPORT MultiMeasure Sensors record multiple measurements through a single port.

**Desktop Use**

Connects to the USB port of a computer.



**Order Information:**

**USB Link** .....PS-2100A

## PASPORT Interfaces Work Together

Use any combination of PASPORT Interfaces together. Simply plug interfaces into multiple USB ports or a USB hub.



## New to Probeware?

### Motion Lab

PS-2794



The Motion Lab is a great way to get started using probeware in your physics classroom or lab. The Motion Sensor is the most versatile and valuable sensor for physics, since it can be used for experiments throughout the entire mechanics curriculum.

All PASPORT sensors include DataStudio® Lite software, which allows for basic data collection and analysis. A full version of DataStudio can also be purchased to access the full suite of data collection and analysis tools (see pages 86-89).



#### Includes:

USB Link  
Motion Sensor  
DataStudio Lite Software



#### Order Information:

Motion Lab ..... PS-2794

## PowerLink: Connect Three Sensors to a Computer

PS-2001

- ▶ Ideal for Experiments Using Multiple Sensors
- ▶ Three Sensor Ports in one USB Connection
- ▶ 1000 Hz Maximum Sampling Rate with PASPORT Sensors

#### Compatible with ScienceWorkshop Sensors

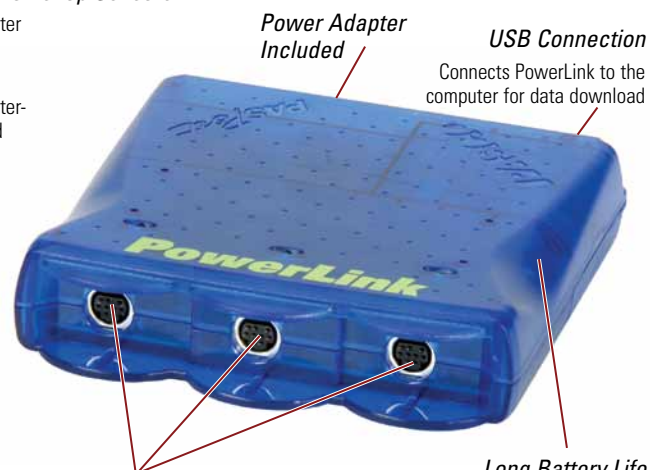
Requires Analog or Digital Adapter

#### Desktop or Field Use

PowerLink functions as a computer-based interface when connected to a USB port, and can also collect data in the field using a laptop computer

#### Includes:

Sensor Extension Cable  
Power Adapter  
Built-in  
USB Hub



#### Three Universal Sensor Ports

Ideal for experiments using multiple sensors. Compatible with all PASPORT Sensors. PASPORT MultiMeasure Sensors record multiple measurements through a single port

#### Long Battery Life

Two "C" batteries (not included) will provide several days of use in the field

#### Order Information:

PowerLink ..... PS-2001

## sparklink

PS-2009

- ▶ Two PASPORT sensor ports
- ▶ Built-in Temperature and Voltage Sensors with Probes
- ▶ Simple USB connectivity to computer
- ▶ Rugged Polycarbonate Case

The SPARKlink is a two-port computer interface with a USB-to-computer connection, providing you an easy way to use multiple sensors simultaneously. Plus, the built-in temperature and voltage sensors enable you to take measurements right out of the box with no additional sensors.



#### Specifications

**Power:** Powered through the USB port

#### Order Information:

SPARKlink ..... PS-2009

## Which is better for your purposes: Xplorer GLX<sup>®</sup> or SPARK<sup>™</sup> SLS?

### Xplorer GLX

The Xplorer GLX is a powerful instrument used for datalogging in the field or as a computer interface. It can be used as a stand-alone hand-held computer which can collect data from sensors, analyze data, and print directly to select HP printers. The Xplorer GLX has a dual function generator for studying circuits and outputting sound. It also has a built-in sound sensor and an oscilloscope mode for displaying waveforms.

Xplorer GLX is ideal for Physics and Engineering classes. It is an excellent tool for student projects.



### SPARK SLS

The SPARK SLS has a large color touch screen with a simple user interface. The SPARK SLS can display workbooks with step-by-step instructions: Workbook pages have live graphs, tables, and other data displays.

Students do not have to leave the instruction pages to take data.

The SPARK SLS can be used as a stand-alone device as well as an interface to the computer.



Features	Xplorer GLX	SPARK SLS
Compatible with PASPORT Sensors	Yes	Yes
Works as an interface with a computer	Yes	Yes
Desktop Software	DataStudio (Lite included); GLX emulator; GLX projector	SPARKvue, DataStudio
Desktop Platforms	Windows, MAC	Windows, Mac
Stand-alone Datalogger	Yes	Yes
Prints directly without computer	With select HP printers	With select HP printers
Graphical Display Resolution	320 x 240	640 x 480
Display Size	7.8 x 5.9 cm	11.6 x 8.8 cm
Display Color Mode	Greyscale	Color
Touch Screen	No	Yes
Keyboard	Yes	Touch
Maximum Sample Rate	50 kHz* **	1 kHz*
Oscilloscope Mode	Yes	No
Built-in Function Generators	Two	None
External Power Amplifier Available	Yes	No
Number of PASPORT sensor ports	Four	Two
Included sensors	Voltage, Sound, Temperature(2)	Voltage, Temperature
Built-in Speaker for sound output	Yes	No
Voice Notes	Yes	No
Compatible with ScienceWorkshop sensors using Analog Adapter	Yes	Yes
Use photogates with Digital Adapter	Yes	Yes
Data Analysis Tools	Yes	Yes
External USB mouse/keyboard support	Yes	No
Displays pictures	No	Yes
Can run workbooks	No	Yes
Pre-loaded workbooks	0	61
User Storage	12 MB	2 GB
USB-to-USB file transfer between devices	Yes	Yes
Supports Ocean Optics Spectrometers	Yes	Spring 2011
Rechargeable Batteries	NiMH	Lithium Polymer
Battery Life (1 sensor @ 10 Hz, continuous use)	4-8 hrs	2.5-4.5 hrs

\*Sensor dependent

\*\*1 MHz when using PS-2190 1MHz 2-channel Voltage Sensor

More than just hardware and software, it's an integrated science solution!

## SPARK Science Learning System

PS-2008A

- ▶ Full-color touch screen display with large screen. 5.7" (14.5 cm) diagonal display, 640 x 480 resolution.
- ▶ Temperature and voltage sensors included.
- ▶ Two ports for additional PASPORT sensors.
- ▶ More than 60 SPARKlabs™ pre-loaded.

### Handles

Rubberized handles built into the body make the system rugged, easy to pick up, move around, and share with other students.

See  
Physics Manuals  
on page 102



### USB Port

Print or share data and images using a flash drive.

### PASPORT Sensor Ports

Two sensor ports provide connection to the PASPORT line of over 60 sensors.

### Tactile Data Control:

Control Data Collection with dedicated buttons.

### Large Display

Full-color 5.7" (14.5 cm) display.

### Touch-screen

Just use a finger, no stylus to lose!



### Includes Temperature and Voltage Sensors

Make measurements right out of the box with no additional sensors.

### Includes:

- Voltage sensor
- Temperature sensor
- AC power supply
- Pre-installed experiment activities with teacher background material



The Spark Science Learning System combines powerful measurement with portable visualization. Make measurements wherever the science leads you. The core of the SPARK Science Learning System is the all-new touch screen user interface.

For computer desktop software, see SPARKvue on page 22.

### Specifications

- Weight:** 21 oz. (595 grams)
- Hand Straps:** 6.7" x 5.5" x 1.7" (17 cm x 14 cm x 4.5 cm)
- Resolution:** 640 x 480
- Power Supply:** AC/Rechargeable battery

### Order Information:

SPARK Science Learning System.....PS-2008A

## SPARK Charging Station

PS-2570

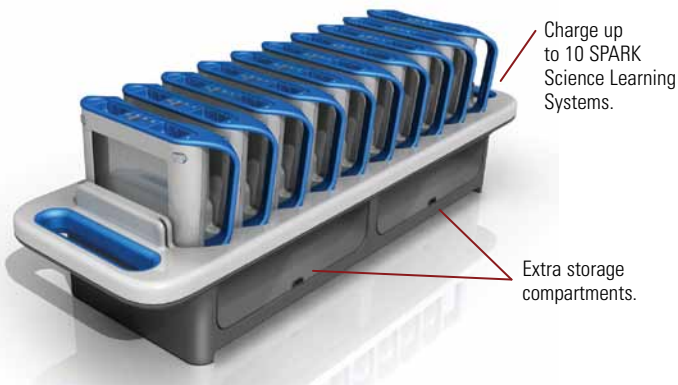
- ▶ Charges up to 10 SPARK Science Learning Systems simultaneously with a single power source.

Conveniently store and charge your SPARK Science Learning Systems with the SPARK Charging Station.

Compact design takes very little counter space and offers storage drawers below for sensors and supplies.

### Order Information:

SPARK Charging Station.....PS-2570



Charge up to 10 SPARK Science Learning Systems.

Extra storage compartments.

# sparkvue™ Integrated Science Learning Environment

PS-2400

- ▶ Desktop software reflects the SPARK SLS operating system
- ▶ Works with PASPORT sensors for real time analysis
- ▶ Compatible with SPARK SLS and all PASPORT interfaces

SPARKvue was designed to be a solution for science students of all levels – simple enough for elementary-level learners but with the features to suit the needs of secondary school physics, chemistry, biology or environmental science students. The key is that SPARKvue has a layered interface which doesn't overburden the user with tools, but reveals powerful capabilities when needed.

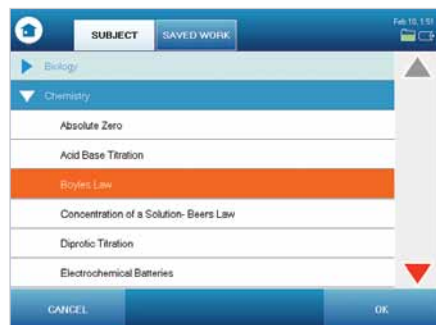
And the bold, full-color interface allows you to use media-rich content to grab students' attention and keep them engaged. You can create your own labs with any graphics or text that you wish, or use the set of over 60 included SPARKlabs we have created for every subject area.

## Minimum System Requirements for SPARKvue

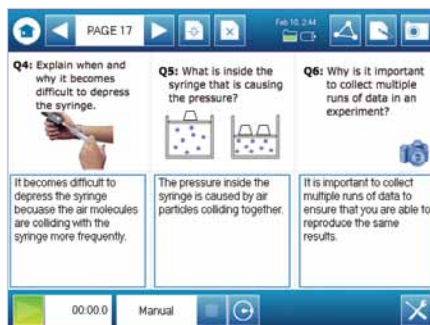
- Windows:** XP or higher
- Processor:** 300 MHz
- RAM:** 128 MB
- Resolution:** Super VGA (800 x 600)
- Disk Space:** 100 MB available
- USB:** At least one free port

## Features

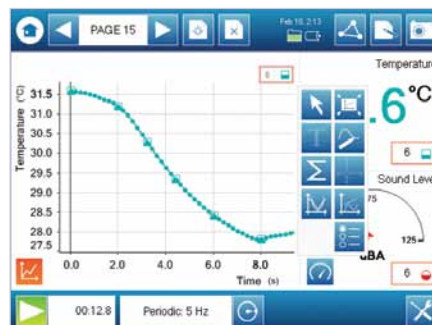
- ▶ Designed to enable simpler, smoother, and faster interactions between your students and the science you're teaching.
- ▶ Intuitive icon-based navigation keeps the focus on the learning, not the tool
- ▶ Provides real-time, quantitative measurement and analysis with the PASPORT line of sensors.
- ▶ Includes 61 complete SPARKlabs free.
- ▶ Energize student reflection and discussion with built-in predictions, annotation tools, snapshot capability, and an electronic journal.
- ▶ Display data in multiple simultaneous representations, including graphs, tables, digital displays, and analog meters.
- ▶ Easily export data in a range of formats: text, gps formats
- ▶ Create interactive SPARKlabs for use on your computer or on the SPARK Science Learning System.
- ▶ Transfer files between the SPARK Science Learning System and SPARKvue via USB flash drive.
- ▶ Enables multiple modes of discovery -- from guided inquiry to open-ended exploration.



Browse installed activities by subject



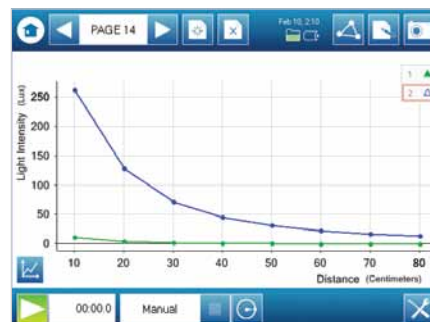
SPARKlabs integrate data, text and images, plus capture student responses.



Use analysis tools to explore data



Instantly view live measurements



Quickly view large displays of data



Create custom pages visually

### Order Information:

**SPARKvue Single User License** .....PS-2401  
*This license authorizes the installation on a single computer.*

**SPARKvue Site License** .....PS-2400  
*This license authorizes the installation on all computers on a K-12 school campus or in a college/university department.*

## SPARK Physics Sensor Starter Kit

PS-2923

Add this Starter Kit to conduct Physics experiments immediately with the pre-installed student labs on your SPARK SLS.



SPARK Science Learning System sold separately. See below for list of parts included in kit.

### Pre-installed Experiments:

1. Speed and Velocity
2. Acceleration
3. Newton's 1st Law
4. Newton's 2nd Law
5. Conservation of Energy
6. Ohm's Law
7. Magnetism
8. Archimedes' Principle
9. Voltage – Fruit Battery
10. Electromagnetic Induction

### Includes:

- Motion Sensor
- Force Sensor
- Voltage/Current Sensor
- Magnetic Field Sensor

### Order Information:

**SPARK Physics Sensor Starter Kit** ..... **PS-2923**

### Required:

**SPARK Science Learning System (includes built-in Temperature and Voltage Sensors)** ..... **PS-2008**

Student experiments are pre-installed on the SPARK and supplemental teacher instructions, tips, questions and answers are included. Other labware may be required.

## Bluetooth USB Adapter

PS-2553

### ▶ For use with AirLink

The Bluetooth USB Adapter allows any computer with USB connections to become a Bluetooth-Enabled computer, and communicate with other Bluetooth-Enabled computers and devices without cable connections. The Bluetooth USB adapter supports Bluetooth Class I, enabling a range of to 100 meters with other Class I devices, or up to 10 meters with Class 2 devices (e.g., PASPORT AirLink SI). The Bluetooth USB adapter works with Microsoft XP – SP2 and Mac OS X with no drivers required.

### Order Information:

**Bluetooth USB Adapter** ..... **PS-2553**



## PASPORT AirLink 2

PS-2010

**NEW**

- ▶ **Wireless Data Collection**
- ▶ **Make Any PASPORT Sensor Wireless**



The AirLink 2 allows any single PASPORT sensor to be connected via Bluetooth to a Bluetooth enabled device running DataStudio, SPARKvue or SPARKvue for iPhone. The AirLink 2 conforms to Bluetooth connection protocols and has a maximum range of 10m. Newly designed internal antenna decreases overall size of the unit and increases signal integrity.

This wireless solution allows data to be taken for experiments such as throwing a football or riding a rollercoaster. Data rates will vary depending on the sensor selected. With manual on/off switch, connectivity and low battery indicator and charge through USB connection this is a good wireless data acquisition solution for any classroom.

Only one AirLink can be used at one time on a computer or iPhone.

### Specifications

**Case Dimensions** 2.5cm x 4.0cm x 10.5cm

**Power:** Rechargeable Li ion battery; Charge via USB

**Data Rate:** Maximum 1,000 Hz, Sensor Dependent

**On/Off Switch**

**Connectivity Indicator**

**Maximum Transmission Distance:** 10 m

### Order Information:

**PASPORT AirLink 2** ..... **PS-2010**

## SPARKvue for iPhone

**NEW**



Available from the Apple iPhone Apps store for free. This App turns your iPhone, iPad or iPod Touch into a data-logging device. Using either the iPhone's built in accelerometers or a sensor connected via the AirLink 2 shown above, this App allows you to choose the display (digits, meter or graph) and, within limits of the sensor, the data rate. Download for free from the iPhone Apps Store.





## PASPORT Sensor Extension Cable

PS-2500



Now you can conduct in-classroom experiments further away from a computer. Our PASPORT Extension Cable extends the distance a sensor can reach from a computer. The two-meter cable works with any PASPORT sensor. Two cables CANNOT be connected together.

**Order Information:**

**PASPORT Sensor Extension Cable**..... **PS-2500**

## Sensor Handles (4 pack)

CI-9874



These convenient handles screw into virtually any *ScienceWorkshop* or PASPORT sensor and can be used with any standard lab clamp.



The Sensor Handle is hollow and fits onto the shaft of the Rotary Motion Sensor.

**Order Information:**

**Sensor Handles (4 pack)**..... **CI-9874**

## Sensor Index

Sensor Description	Prod. #	Pg. #	Sensor Description	Prod. #	Pg. #
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Barometer/Low Pressure	PS-2113A	63	Load Cell, 5N	PS-2201	33
Blood Pressure	PS-2207	53	Load Cell, 100N	PS-2200	33
Breath Rate	PS-2187	54	Magnetic Field	PS-2112	50
3-Axis Acceleration/Altimeter	PS-2136	35	Magnetic Field (2-axis)	PS-2162	50
3-Axis Acceleration	PS-2119	35	Motion	PS-2103A	25
2-Axis Acceleration	PS-2118	34	Oxygen Gas	PS-2126A	60
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Carbon Dioxide Gas	PS-2110	60	pH/ORP/ISE	PS-2147	57
Chemistry	PS-2170	57	Accessory Photogate	ME-9204B	37
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Conductivity	PS-2116A	56	Pressure - Dual	PS-2181	40
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Light	PS-2106A	46	Water Quality Colorimeter	PS-2179	66
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Light/High Sensitivity	PS-2176	46	Weather/Anemometer Sensor	PS-2174	62
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## Motion

PS-2103A



PASCO's Motion Sensor is used to measure position, velocity and acceleration. Ultrasonic pulse-ranging technology has a switch-selectable Standard Beam or Narrow Beam to reject false signals and produce cleaner data. The Motion Sensor sits firmly on a desktop or easily mounts to a rod stand or PASCO Dynamics Track.

### Typical Applications

- ▶ Study conservation of energy and momentum during collisions
- ▶ Monitor the sinusoidal motion of a mass on a spring
- ▶ Measure the motion of large objects, such as students

### Specifications

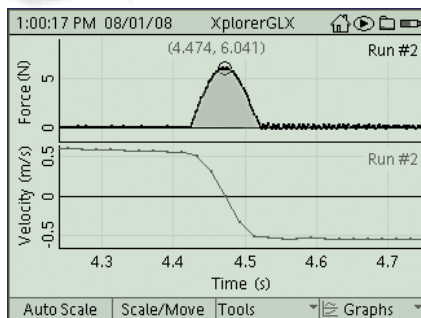
**Minimum Range:** 0.15 meters

**Maximum Range:** 8 meters

**Resolution:** 1 mm

**Transducer Rotation:** 180°

**Cable Length:** 1.8 meters



*Students can compare impulse and change in momentum for a cart involved in elastic collision.*

#### Order Information:

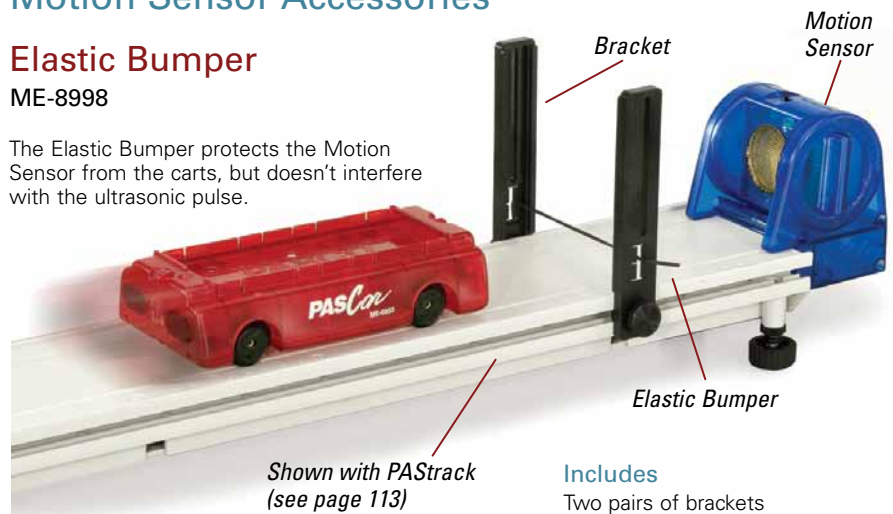
<b>Motion Sensor</b> .....	<b>PS-2103A</b>
<i>Recommended:</i>	
Motion Sensor Guard.....	SE-7256
Coffee Filters.....	SE-7252
Magnetic Motion Sensor Bracket.....	PS-2546
Cart Adapter Accessory.....	ME-6743

## Motion Sensor Accessories

### Elastic Bumper

ME-8998

The Elastic Bumper protects the Motion Sensor from the carts, but doesn't interfere with the ultrasonic pulse.



Shown with PAStrack (see page 113)

#### Includes

Two pairs of brackets  
10 meters of elastic material

#### Order Information:

**Elastic Bumper**.....**ME-8998**

### Motion Sensor Guard

SE-7256

Use this wire guard to protect the Motion Sensor when dropping objects from above.



#### Order Information:

**Motion Sensor Guard**.....**SE-7256**

### Coffee Filters (500 pack)

SE-7252

These extra-large coffee filters are ideal for freefall and terminal velocity experiments with the Motion Sensor. Each filter has a 34 cm diameter with a height of 13 cm.



#### Order Information:

**Coffee Filters (500 pack)**.....**SE-7252**

### Magnetic Motion Sensor Bracket

PS-2546

This magnetic bracket allows a Motion Sensor to be easily hung from a drop ceiling. Simply screw the bracket into the 1/4"-20 threads on the sensor and use the included adjustment nut to hold the sensor in the desired orientation.



The bracket can also be used to hold the Motion Sensor on vertical surfaces such as filing cabinets and magnetic whiteboards.

#### Order Information:

**Magnetic Motion Sensor Bracket**.....**PS-2546**

### Cart Adapter Accessory

ME-6743

A Motion Sensor can be directly mounted to Dynamics Carts, PAScars or GOcars using the Cart Adapter Accessory. Mounting a Motion Sensor on a cart is ideal for the study of relative motion. The adjustment knob on the bracket allows the Motion Sensor to face any direction.

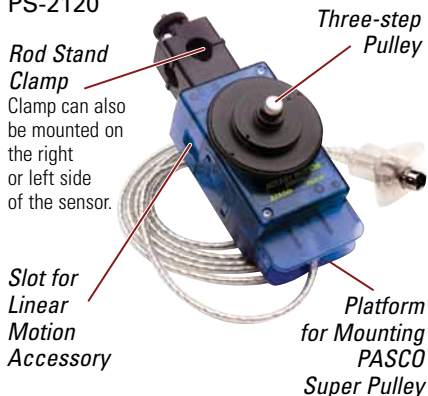


#### Order Information:

**Cart Adapter Accessory**.....**ME-6743**

## Rotary Motion

PS-2120



The Rotary Motion Sensor is the most versatile position and motion-measuring device available for the physics lab. It measures angles to a resolution of  $0.09^\circ$ . This sensor is also bi-directional, indicating the direction of motion. The maximum spin rate of the sensor is 30 revs/second.

The 6.35 mm diameter, dual ball bearing shaft extends from both sides of the unit and provides an excellent platform for rotational experiments. The rod clamp (which can be attached on three sides of the sensor) allows the unit to be mounted in almost any orientation. A three-step pulley and a mount for the PASCO Super Pulley make it easy to perform torque experiments.

### Specifications

**Three-step Pulley:** 10 mm, 29 mm and 48 mm diameter

**Resolution:**  $0.09^\circ$

**Maximum Speeds:** 30 revs/sec

**Optical Encoder:** bidirectional, indicates direction of motion; 4000 divisions/rev

**Sensor Dimensions:**

10 cm x 5 cm x 3.75 cm, 6.35 mm diameter shaft

### Conservation of Angular Momentum



#### Order Information:

Rotary Motion Sensor .....PS-2120

Recommended:

Linear Motion Accessory .....CI-6688

Three-step Pulley .....CI-6693

## Equipment used with a Rotary Motion Sensor

### Rotary Motion Spares Kit

ME-8997

A replacement kit for items commonly misplaced.



#### Includes:

Three-step Pulley (2)

Pulley "O"- Ring (2)

Pulley Thumb Screw (4)

Rod Clamp (2)

#### Order Information:

Rotary Motion Spares Kit .....ME-8997

### Mini Rotational Accessory

CI-6691



Use the Mini Rotational Accessory to study rotational inertia, pendulum oscillations, and conservation of angular momentum.

#### Order Information:

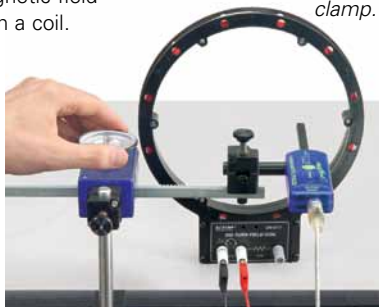
Mini Rotational Accessory .....CI-6691

### Linear Motion Accessory

CI-6688

Measuring magnetic field from a coil.

See page 50.  
Includes rack and rod clamp.



#### Order Information:

Linear Motion Accessory .....CI-6688

### Damped Pendulum

CI-6689A



Magnetically damped pendulum disk for studying exponential damping, driven harmonic motion, and chaos.

See page 197.

#### Order Information:

Chaos/Driven Harmonic Accessory .....CI-6689A

### Centripetal Force

ME-9821

The Force Sensor mounts onto the Rotary Motion Sensor to directly measure Centripetal Force.

See page 193.



#### Order Information:

Centripetal Force .....ME-9821

## Equipment used with a Rotary Motion Sensor

### Ballistic Pendulum Accessories

- Ballistic Pendulum Accessory  
ME-9892
- Mini Launcher Ballistic Pendulum Accessory  
ME-6829



See page 156.

Turn your PASCO Launcher into a Ballistic Pendulum using your Rotary Motion Sensor.

**Order Information:**

- Ballistic Pendulum Accessory.....ME-9892
- Mini Launcher Ballistic Pendulum Accessory.....ME-6829

### Track String Adapter

ME-6569



### Dynamics Track Mount

CI-6692



Use a Rotary Motion Sensor to measure position of a cart on a Dynamics Track.



See page 132.

**Order Information:**

- Track String Adapter.....ME-6569
- Dynamics Track Mount.....CI-6692

### Spectrophotometer

OS-8539



60:1 gear ratio of rotating disk and pin gives the rotary motion sensor a higher resolution for spectrophotometry.

See pages 328-329.

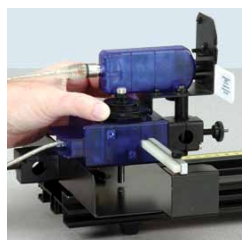
**Order Information:**

- Educational Spectrophotometer System.....OS-8539

### Linear Translator

OS-8535

See page 314.



The Rotary Motion Sensor's built-in gear system accepts the geared rack to create a high-resolution linear translator for optics.

**Order Information:**

- Linear Translator.....OS-8535

### Polarization Analyzer

OS-8533A

See page 311.



The drive belt allows the Rotary Motion Sensor to measure the rotation of the polarizer.

**Order Information:**

- Polarization Analyzer.....OS-8533A

### Gyroscope

ME-8960

Use two Rotary Motion Sensors to measure both the nutation and precession of this demonstration gyroscope.

See pages 200-201.



**Order Information:**

- Gyroscope.....ME-8960

## Materials Stress/Strain Apparatus

AP-8213



Plot Stress vs. Strain in real-time for several different materials.

See pages 202-203.

**Order Information:**

- Materials Stress/Strain Apparatus (PASPORT).....AP-8213

## Computer-Based Thermal Expansion

TD-8579A



Rotary Motion Sensor measures the expansion of the tube.

See page 227.

**Order Information:**

- Computer-based Thermal Expansion.....TD-8579A

## Heat Engine

TD-8572

Use a Rotary Motion Sensor with PASCO's Heat Engine Apparatus to graph a real Heat Engine Cycle.

See pages 240-241.



**Order Information:**

- Heat Engine.....TD-8572

## Force

PS-2104

- ▶ Binocular force beam minimizes side force measurements

The Force Sensor is ideal for the student lab. Finger holes are provided for hand-held use. It will mount directly to a PASCO Dynamics Cart or 1.2 cm rod.



### Typical Applications

- ▶ Measure force exerted by an oscillating mass
- ▶ Measure force during elastic and inelastic collisions
- ▶ Measure force of a swinging pendulum

### Specifications

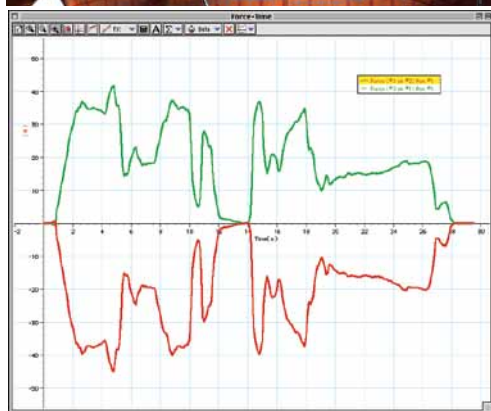
**Range:**  $\pm 50$  N

**Resolution:** 0.03 N or 3.1 grams

**Zero (Tare) Function:** push-button

**Max Sample Rate:** 1000 Hz

Force Overload Protection



This graph displays Newton's 3rd Law during a "Tug of War" experiment.

### Order Information:

<b>Force Sensor</b> .....	<b>PS-2104</b>	
<b>Recommended:</b>		
Force Accessory Bracket.....	CI-6545	p. 126
Rocket Engine Test Bracket.....	ME-6617	p. 30
Force Sensor Balance Stand.....	CI-6460	p. 30

## Force Sensor Spares Kit

CI-6463

### Includes:

Hook, rubber bumper and screw to attach to a cart.



### Order Information:

<b>Force Sensor Spares Kit</b> .....	<b>CI-6463</b>
--------------------------------------	----------------

## High Resolution Force

PS-2189

- ▶ 0.002 N Resolution
- ▶ Dynamic Over-sampling



Although this Force Sensor has the same case as the PS-2104, and can perform all of the same experiments, it has much better resolution and the dynamic variable over-sampling greatly reduces the measurement noise at low sample rates.

### Specifications

**Range:**  $\pm 50$  N

**Measurement Resolution:** 0.002 N or 0.2 g

**Zero (Tare) Function:** push-button

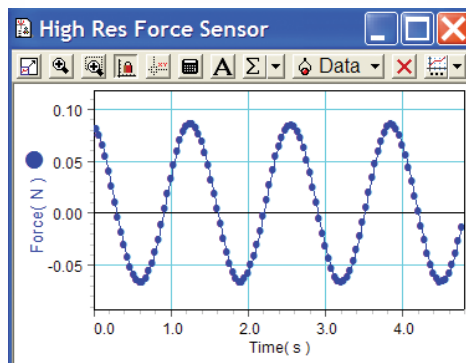
**Max Sample Rate:** 1000 Hz

Force Overload Protection

The digital design of the PS-2189 results in very little drift, ensuring that the tare will hold for hours. You can use this force sensor as a pan balance for long term experiments, like investigating the evaporation of liquids such as alcohol or liquid nitrogen, and the sublimation of dry ice!



The High Resolution Force Sensor has 10 times the resolution of the PS-2104, and can measure changes in force of less than 0.01 N.



Graph shows force data for the oscillation of a mass and spring system.

### Order Information:

<b>High Resolution Force Sensor</b> .....	<b>PS-2189</b>	
<b>Shown in use with:</b>		
Mass and Hanger Set.....	ME-8979	p. 223
Spring Set.....	ME-8999	p. 116
Force Sensor Balance Stand.....	CI-6460	p. 30

## Force Sensor Accessories

### Force Accessory Bracket

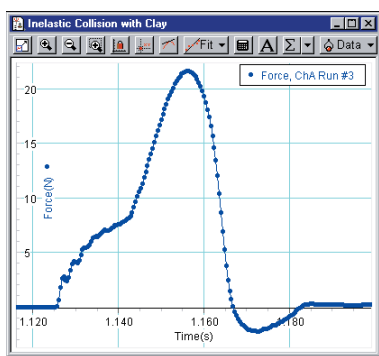
CI-6545

The Force Accessory Bracket with Bumpers mounts the CI-6746 Economy Force Sensor or CI-6537 Force Sensor directly to a dynamics track. Includes five 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.



Note the bumper springs and various mounting options.



Force time data for a clay collision.

#### 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)

#### Order Information:

Force Accessory Bracket .....CI-6545

### Bumper Accessory Set

ME-9884



This set of bumpers can be used with any PASCO Force Sensor to perform both elastic and inelastic collisions. The standard hook for each Force Sensor can be easily removed and replaced with any of these bumpers. Use a spring and a cup for elastic collisions. Combine two cups with clay to explore inelastic collisions.

#### Includes:

- Stiff Spring
- Light Spring
- Empty Cup (2)
- Modeling Clay



#### Order Information:

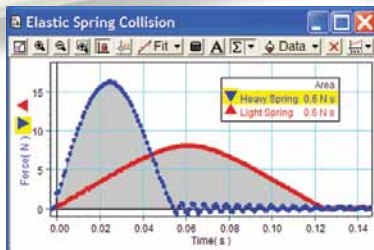
Bumper Accessory Set .....ME-9884

### Discover Collision Bracket ME-8973

The Collision Bracket fastens to the T-slot of a dynamics track, securely holding the Force Sensor for measuring collisions with a Cart. Includes two different springs.



Shown with PASTrack (see page 113)



The cart collides with the force sensor at the same initial speed for both of the springs. The area under the Force vs. time graph is the change in momentum (impulse) of the cart, and is the same for both collisions.

#### Includes:

- Two Springs
- Bracket



#### Order Information:

Force Accessory Bracket .....ME-8973

### Magnetic Bumper Set

ME-9885A



This set of magnetic bumpers can be used with any PASCO Force Sensor to perform elastic collisions without any contact. The bumpers screw directly into the beam of the sensor. They can also be used with the Force Accessory Bracket (CI-6545A).

#### Includes:

- Magnetic Bumper (2)



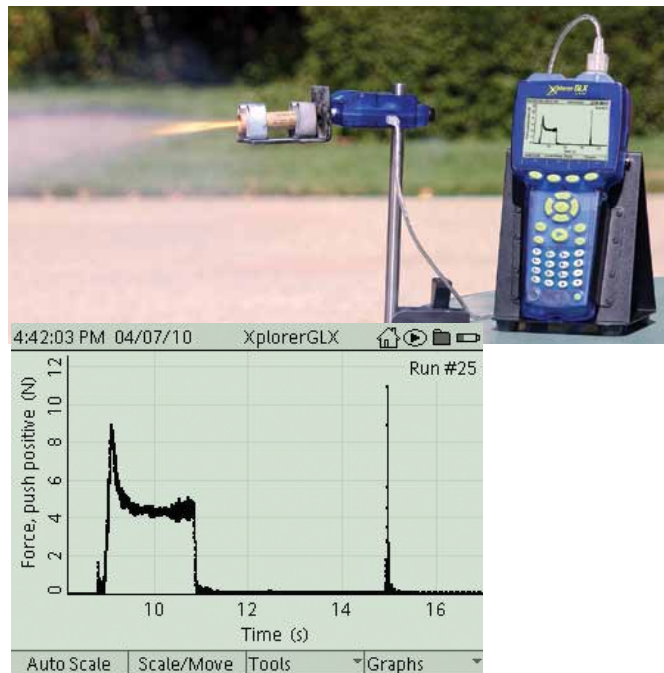
#### Order Information:

Magnetic Bumper Set .....ME-9885A

## Rocket Engine Test Bracket

ME-6617

With the Rocket Engine Test Bracket attached to a Force Sensor, students can measure and graphically display the impulse of Estes™ and other model rocket engines.



The Xplorer GLX is shown with the Rocket Engine Test Bracket attached to a Force Sensor. Students can measure and graphically display the impulse of Estes™ and other model rocket engines.



### Order Information:

Rocket Engine Test Bracket.....ME-6617

## Force Sensor Balance Stand

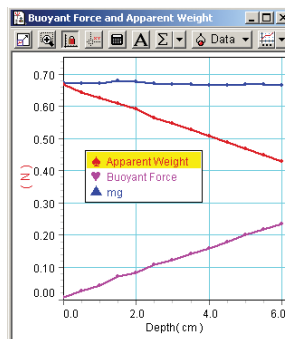
CI-6460

- ▶ Use any PASCO Force Sensor as a pan balance
- ▶ Investigate buoyancy and Archimedes' Principle

Connect any PASCO Force Sensor to this convenient stand and students have an electronic balance for a wide variety of physics experiments. Connect an Acceleration Sensor for studies of angle vs. normal force. The mounting screws and balance pan can be stored on the stand when not in use.



Force Sensor CI-6537



As the cylinder is lowered into the water, the Apparent Weight measured by the top Force Sensor decreases, while the Buoyant Force measured by the bottom Force Sensor increases. The addition of the two (actual  $mg$ ) stays constant.



### Typical Applications

- ▶ Pan Balance
- ▶ Measure Buoyant Force
- ▶ Demonstrate the change in normal force as the angle of support changes

### Includes:

- Force Sensor Stand
- Balance Pan



### Order Information:

Force Sensor Balance Stand.....CI-6460

## Force Platform Handle Set

PS-2548

Confirm Newton's Third Law by pushing on a Force Platform using two sets of handles (available separately). Handles bolt onto the Force Platform (see page 31) and can be mounted on either side or both sides.



By standing on a 2-Axis Force Platform while pushing against the wall with a 1-Axis Force Platform, a real-life statics problem can be analyzed.

### Includes:

- Set of sturdy metal handles (2)



### Order Information:

Force Platform Handle Set.....PS-2548

## Force Platform

PS-2141

- ▶ Large jumping and landing surface
- ▶ Rugged design

The sturdy glass-filled nylon platform is supported by four force beams which combine to measure the total force on the platform. The Force Platform has two loops on the side to hang it on a wall.

### Typical Applications

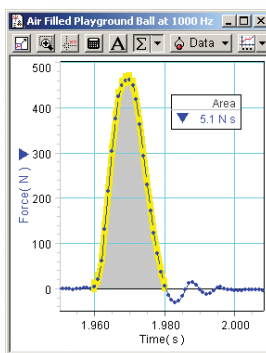
- ▶ Determine “hang time” by jumping up from the platform, then landing on it
- ▶ Measure impulse and maximum force when jumping
- ▶ Use two Force Platforms to investigate Newton’s 3rd Law as two students push against each other
- ▶ Measure the normal force on a person riding in an elevator
- ▶ Use a Motion Sensor and a bouncing ball to compare the impulse and change in momentum as the ball collides with the platform

### Specifications

**Range:** - 1100 N to + 4400 N  
**Platform Size:** 35cm x 35cm  
**Zero (tare) Function:** Push Button  
**Force Overload Protection**  
**Max Sample Rate:** 1000 Hz (2000 Hz with the Xplorer GLX)  
**Resolution:** 0.1 N  
**Mass:** 4kg (without handles)

#### Order Information:

**Force Platform**.....PS-2141  
**Recommended:**  
**Handle Set**.....PS-2548



Impulse data for a bouncing playground ball.

## 2-Axis Force Platform

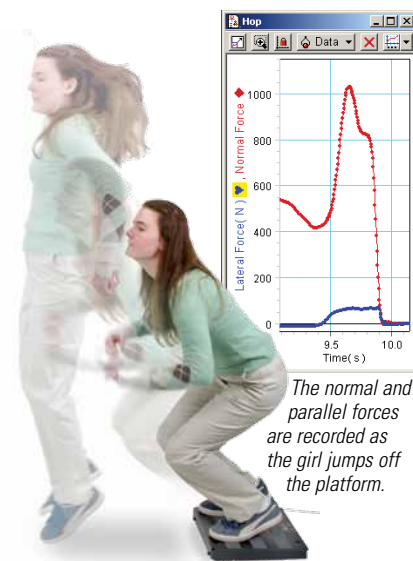
PS-2142



The 2-axis Force Platform has a second plate which rides on rollers on the base force platform to measure the force parallel to the platform. There are a total of five force beams: four corner beams to measure the normal force and a fifth beam to measure the parallel (sideways) force.

### Typical Applications

- ▶ Measure the sideways force during a broad jump
- ▶ Measure the normal and parallel forces on a wall as a ladder leans against the wall
- ▶ Measure the normal and parallel forces as a person walks or runs across the platform
- ▶ Pull an object across the platform and measure the normal and frictional forces



The normal and parallel forces are recorded as the girl jumps off the platform.

### Specifications

**Range:** -1100 N to +4400 N (in normal direction) -1100 N to +1100 N (in parallel direction)  
**Platform Size:** 35cm x 35cm  
**Platform Mass:** 6.4kg (without handles)  
**Zero (tare) Function:** Push Button  
**Force Overload Protection**  
**Max Sample Rate:** 1000 Hz (2000 Hz with the Xplorer GLX)  
**Resolution:** 0.1 N

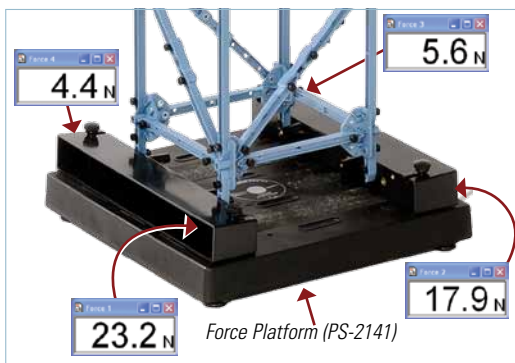
*Developed in cooperation with Nancy Beverly, Assistant Professor of Physics at Mercy College, Dobbs Ferry, New York.*

#### Order Information:

**2-Axis Force Platform**.....PS-2142  
**Recommended:**  
**Handle Set**.....PS-2548

## Measure support forces with a Force Platform

Measure the support forces of a crane by connecting it to a Force Platform (PS-2141) using the special Force Platform Structures Bracket (ME-6988A). The Force Platform is supported by four individual load cells which combine to measure the total vertical force on the platform. These four readings can also be viewed separately, to measure the unequal forces on the crane supports.



Crane built using the Large Structures Set shown on page 176.

### ME-6988A Includes:

Brackets (2)  
 Screws (4)



#### Order Information:

**Force Platform Structures Bracket**.....ME-6988A  
**Force Platform**.....PS-2141



## Load Cell & Amplifier Set

PS-2199

- ▶ For use with PASCO's Structures Systems (See pages 166-176)
- ▶ Insert Load Cells Into Structures by substituting beams
- ▶ Amplifier accepts up to six Load Cells
- ▶ Use more than six Load Cells by connecting multiple amplifiers to one computer

A load cell can be inserted into the design by replacing one beam with a load cell connected to two shorter beams. There is no need to completely disassemble the structure to add instrumentation.

The Load Cell Amplifier connects to a USB port through a PASCO PASPORT interface: The USB Link accepts one Amplifier per USB port; the PowerLink accepts up to three Amplifiers per USB port; and the Xplorer GLX™ (which is also a datalogger) accepts up to four Amplifiers per USB port.

PS-2199 includes four 100 N Load Cells and additional load cells can be purchased separately.

The PS-2200 Load Cell measures forces ranging from -100 N to 100 N and is wired with a male 6-pin mini-DIN connector for plugging into the PS-2198 Load Cell Amplifier.



I-beams key into the load cell and are fastened with thumb screws

The Load Cell Amplifier accepts up to six load cells and connects to a computer through a PASPORT interface.

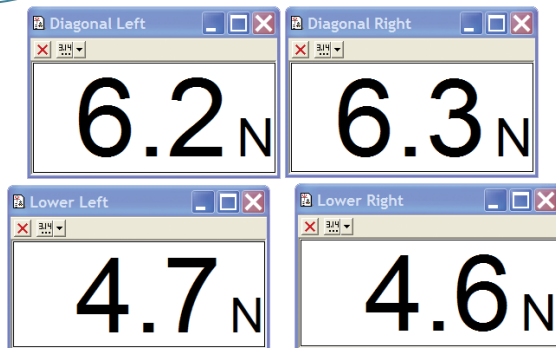
Shown in use with Structures Systems Truss Set (ME-6990). See page 168.

The load cells have a semi-transparent case so students can see the load cell design.



2 1/4"

DataStudio® software is used to display the forces measured using the four load cells shown above. The top two numbers are the left and right diagonals and the bottom two numbers are the left and right horizontal forces.



For more information on PASCO's Structures Systems, see pages 166-176.

### Includes:

- Load Cell Amplifier
- 100 N Load Cell (4)



### Order Information:

<b>Load Cell &amp; Amplifier Set*</b> (includes four 100N load cells) .....	<b>PS-2199</b>
<b>Load Cell Amplifier* (alone)</b> .....	<b>PS-2198</b>

### Required:

PASPORT Interface to USB Computer, such as	
USB Link.....	PS-2100A
PowerLink.....	PS-2001
Xplorer GLX.....	PS-2002

### Recommended:

Additional 100 N Load Cell* .....	PS-2200
5 N Load Cell*.....	PS-2201

\*Patents pending

## Two ranges of Load Cells:

Load cells are available in two different ranges:  $\pm 100$  N and  $\pm 5$  N. These load cells are designed to be inserted into structures without changing the length of the member. A load cell attached to two shorter beams is equal in length to a longer beam. Both types of load cells can be used with the same amplifier in any combination. The semi-transparent case lets students see the strain gauge and beam inside.

### Load Cell 100N

PS-2200



#### Specifications

**Range:** -100 N to +100 N

**Accuracy:**  $\pm 1\%$  ( $\pm 1$  N)

**Resolution:** 0.02 N

**Safe Overload:** -150 N to +150 N

#### Order Information:

100 N Load Cell\* ..... PS-2200

### Load Cell 5N

PS-2201



#### Specifications

**Range:** -5 N to +5 N

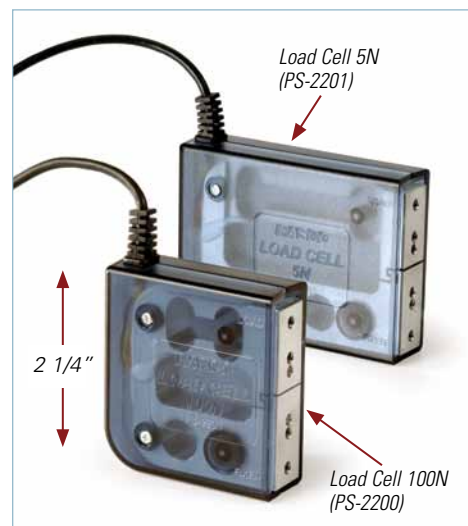
**Accuracy:**  $\pm 1\%$  ( $\pm 0.05$  N)

**Resolution:** 0.001 N

**Safe Overload:** -7.5 N to +7.5 N

#### Order Information:

5 N Load Cell\* ..... PS-2201



Mix 5N and 100N load cells on the same amplifier.

## Dual Load Cell Amplifier

PS-2205



This new Load Cell Amplifier is for applications where only one or two load cells are needed, such as measuring the force on the track at the top and bottom of a roller coaster loop. If you only want to examine the forces in a bridge one at a time, you can move a single load cell around in the bridge.

The Amplifier accepts either the 100N load cell or the 5N load cell or a combination of both. The maximum data sample rate is 1000 Hz for each port.

It is also an inexpensive way to add sensors to your structures. Later, if you want to expand the number of load cells you are using, you can add another Dual Load Cell Amplifier or a 6-port Load Cell Amplifier (PS-2198). All PASCO load cell amplifiers can work simultaneously on one computer. A PASCO PASPORT USB interface is required: Use a USBLink (PS-2100A) for just one Load Cell Amplifier or use an Xplorer GLX (PS-2002) or PowerLink (PS-2001) for multiple Load Cell Amplifiers.

#### Order Information:

Dual Load Cell Amplifier\* ..... PS-2205

Required for Use:

PASPORT Interface ..... p. 8-9

Load Cell 100N ..... PS-2200

Load Cell 5N ..... PS-2201

Also available at a discount:

Load Cell and Dual Amplifier Set\* ..... PS-2206

#### Set Includes:

Dual Load Cell Amplifier (PS-2205)

Load Cell 100N (PS-2200)

Required for use: PASPORT Interface (p. 8-9)



## Measure bridge deflection with a Displacement Sensor

### Displacement Sensor

PS-2204

The PS-2204 Displacement Sensor measures the travel of a spring-loaded indicator pressed against a bridge as the bridge is loaded. It consists of a PASPORT sensor which plugs into the included Digital Indicator, a digital travel indicator which has its own digital LED readout and can be used as a stand-alone device. When the PASPORT sensor is plugged into a PASPORT interface, the reading can be recorded.

See pages 171-172 for more uses.

#### Specifications

**Maximum Travel:** 10 mm N to +100 N

**Maximum Sample Rate:** 5 Hz

**Resolution:** 0.013 mm (0.0005 in)



#### PS-2204 Includes:

Sensor

Bracket

Dial Gauge



#### Order Information:

Displacement Sensor ..... PS-2204

Shown in use with:

Hooked Mass Set ..... SE-8759 p. 223

Small "A" Base ..... ME-8976 p. 212

60 cm long Steel Rod (threaded) ..... ME-8977 p. 212

Required for use: PASPORT Interface (p. 8-9)

## Visual Accelerometer

PS-2128

- ▶ LEDs indicate direction and magnitude of acceleration
- ▶ 1-Axis Acceleration Sensor



The Visual Accelerometer provides acceleration data and visual clues that allow students to better understand the concept of acceleration. The sensor features 10 high output, wide-angle LEDs that indicate the magnitude and direction of acceleration. The case of the sensor fits directly into a dynamics cart, and features ties for pendulum motion and a pass-through so the sensor can be thrown vertically along a rope.

The Visual Accelerometer features three fixed ranges, an auto-scale and a peak-hold option. The peak-hold mode stores the maximum acceleration experienced by the sensor after a countdown appears on the LEDs. The zero button on the sensor negates the effect of changing the orientation of the sensor.

The Visual Accelerometer can also be used in stand-alone mode. While away from the computer, the LEDs give students a meaningful, visual measurement of acceleration.

### Typical Applications

- ▶ Real-time measurement of acceleration during simple harmonic motion
- ▶ Measure acceleration due to gravity
- ▶ Measure acceleration of a cart on an inclined plane
- ▶ Discover the acceleration of an elevator

See page 128 for more applications.

### Specifications

**Ranges:**  $\pm 1.0 \text{ m/s}^2$ ,  $\pm 5.0 \text{ m/s}^2$ ,  $\pm 20 \text{ m/s}^2$

**Accuracy:**  $0.2 \text{ m/s}^2$

**Resolution:**  $0.01 \text{ m/s}^2$

**Max Sample Rate:** 100 Hz

Includes sensor extension cable

Requires three AA batteries (included)

**Order Information:**  
**Visual Accelerometer**.....PS-2128

For freefall studies, the bottom of the Visual Accelerometer has a channel that accepts a cord or small rope.



## Visual Accelerometer Accessory Kit

PS-2516

- ▶ Pendulum Mount
- ▶ Rod Stand Mount

The four string pendulum plate from the Visual Accelerometer Accessory Kit keeps the unit level as it oscillates, showing its horizontal acceleration.

The Accessory Kit allows the Visual Accelerometer to be mounted in various ways, including as a pendulum. It can also be attached to PASCO's Rotating Platform (ME-8951) for studies in rotation.



The Visual Accelerometer can be mounted to a rod stand using the Accessory Kit, for measurements inside a moving reference such as a car or an elevator. Shown here with the Xplorer GLX (PS-2002).



### Includes

- Four String Pendulum Plate
- Plastic Rod Clamps (2)
- M-5, 4 cm long mounting thumbscrews (2)
- 1/4-20, 5 cm long thumbscrews with nuts (4)
- Roll of thread

**Order Information:**  
**Visual Accelerometer Accessory Kit**.....PS-2516

## 2-Axis Acceleration

PS-2118

- ▶ Simultaneously measure x and y acceleration through one port



High sensitivity for small accelerations and fast response for collisions — only PASCO offers students both capabilities with just one push of a button. PASCO Accelerometers offer a wider range, making them perfect for use with a greater variety of acceleration experiments in or out of the classroom. Students no longer have to use multiple acceleration sensors or worry about separate sensor orientation. PASCO sensors are permanently mounted in the correct orientation.

### Typical Applications

- ▶ Attach to a dynamics cart for the study of Newton's Laws
- ▶ Investigate centripetal acceleration on a rotating platform (see page 188)
- ▶ Acceleration of the hand while tossing a ball

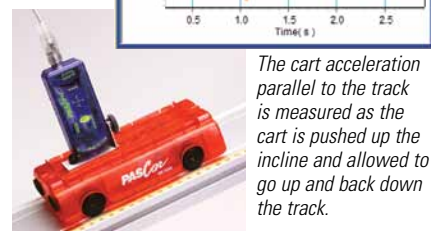
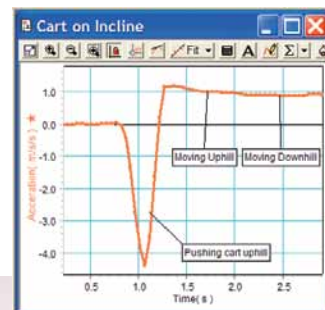
### Specifications and Special Features

**Acceleration for each axis:**  $\pm 10g$  with  $0.01 g$  resolution

Response rate button allows smoother data at lower data rate

**Max Sample Rate:** 100 Hz

The sensor includes Dynamics Cart mounting bracket and sensor extension cable



The cart acceleration parallel to the track is measured as the cart is pushed up the incline and allowed to go up and back down the track.

**Order Information:**  
**Acceleration Sensor (2-Axis)**.....PS-2118

## 3-Axis Acceleration

PS-2119

- ▶ 100 Hz Sample Rate
- ▶ Simultaneously measure x, y and z acceleration through one port



High sensitivity for small accelerations and fast response for collisions — only PASCO offers students both capabilities with just one push of a button. PASCO Accelerometers offer a wider range, making them perfect for use with a greater variety of acceleration experiments in or out of the classroom. Students no longer have to use multiple acceleration sensors or worry about separate sensor orientation. PASCO sensors are permanently mounted in the correct orientation.

### Typical Applications

- ▶ Attach to a dynamics cart for the study of Newton's Laws
- ▶ Investigate centripetal acceleration on a rotating platform
- ▶ Acceleration of the hand while tossing a ball

### Specifications and Special Features

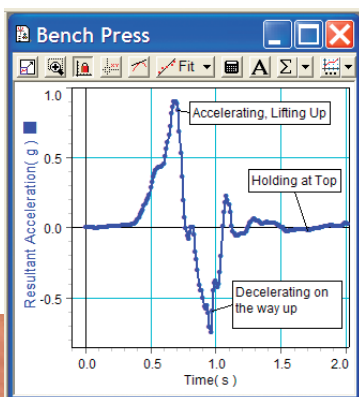
**Acceleration for each axis:**  $\pm 10g$  with 0.01 g resolution

Response rate button allows smoother data at lower data rate

**Max Sample Rate:** 100 Hz

The sensor includes Dynamics Cart mounting bracket and sensor extension cable

During a bench press, the weight lifter accelerates and then decelerates the weights. The acceleration is zero at the top of the lift where the weights are held at rest. This graph shows the resultant acceleration calculated from all three axes, so the orientation of the sensor does not affect the measurement. The acceleration due to gravity has been subtracted out.



Order Information:

3-Axis Acceleration .....PS-2119

## 3-Axis Acceleration Altimeter

PS-2136

- ▶ 0.01 g Resolution
- ▶ 30 cm Altitude Resolution



PASCO's 3-Axis Acceleration Altimeter allows students to measure acceleration in all three dimensions along with changes in altitude. Students can easily read changes in altitude with 0.30 m resolution. In addition, all three dimensions of acceleration are automatically combined by the sensor, making resultant acceleration an available measurement. Acceleration and altitude can be displayed on the same DataStudio graph, leading students to a better understanding of the physics of rides and other outdoor activities.

The Outdoor Physics Xplorer Bundle is also available and includes the 3-Axis Acceleration Altimeter, Xplorer Vest and Xplorer datalogger.

### Typical Applications

- ▶ Roller Coaster Amusement Park Physics
- ▶ Hiking, mountain biking, skiing
- ▶ Starting, stopping, turning of an automobile

### Specifications and Special Features

**Acceleration for each axis and resultant:**  $\pm 10g$  with 0.01 g resolution

**Altitude:** Any place on Earth to 7 km above sea level with 30 cm resolution

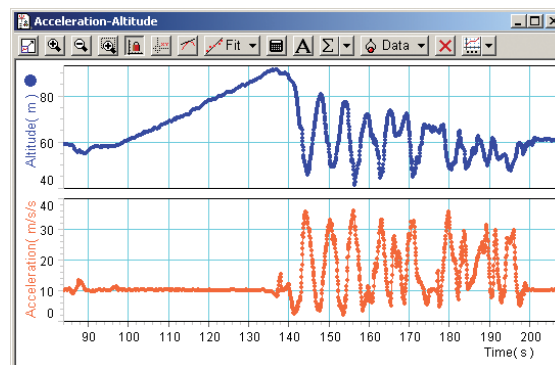
Accelerations can be measured in g or m/s<sup>2</sup>.

Maximum sampling rate of 20 Hz will allow approximately nine minutes of ride data to be stored in the Xplorer

Xplorer Vest secures the Xplorer or Xplorer GLX and sensor during aggressive activities

#### Five simultaneous measurements:

acceleration in x, y and z axes, resultant acceleration and altitude (in meters).



Acceleration and altitude data from a roller coaster.

#### Order Information:

3-Axis Acceleration/Altimeter .....PS-2136

Recommended:

Xplorer Datalogger .....PS-2000

Xplorer Vest .....PS-2517

## Digital Adapter

PS-2159



- ▶ Required for counting and timing sensors
- ▶ Allows Digital ScienceWorkshop Sensors to be used with PASPORT Interfaces

The Digital Adapter is required when photogates, timing and counting sensors are used with any PASPORT interface\*. Each Digital Adapter accommodates two sensors at once. Each port on the Digital Adapter automatically “senses” a connection and initiates a selection of pre-configured or user-defined options. Several Digital Adapters can be used simultaneously when required. See next page for a list of counting/timing sensors which require a Digital Adapter.

*DataStudio 1.9.5 or later is required to use the Digital Adapter.*

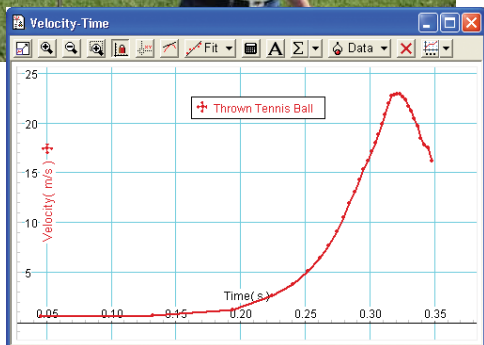
*\*Xplorer must be connected to a computer to measure calibrated values.*

### Specifications and Special Features

- 2 μs resolution for counting and timing
- 1 μs resolution for motion sensing
- Two 1/4” stereo phone jacks



*The Digital Adapter and an Xplorer are used here with the Photogate and Tape Set to investigate the throwing of a tennis ball.*



#### Order Information:

Digital Adapter.....PS-2159

Also shown:

Xplorer.....PS-2000 p. 18  
 Photogate Head.....ME-9498A p. 37  
 Photogate Tape Set.....ME-6664 p. 38

## Relay

CI-6462



- ▶ Single-Pole Double-Throw Switch
- ▶ Activated by DataStudio or Xplorer GLX
- ▶ For Sense and Control Projects

This relay is a single-pole double-throw switch that is controlled by DataStudio or an Xplorer GLX. It acts as a switch to turn equipment on or off in sense and control experiments. Some applications include: Turning off a fan cart when it reaches a certain speed, turning on a lamp when the chicken’s cage gets too cold, or turning on a motor when a condition is met.

The relay plugs into a PASPORT interface with a Digital Adapter using a 1/4” stereo phone plug. The device to be controlled is connected to two of three banana jacks on the front of the relay: One jack is the common, one jack is for a normally open connection, and the third jack is for a normally closed connection.

There is a push-button for manually activating the relay to test your connection. An LED indicates when the relay is activated.



*The Xplorer GLX controls the Relay to turn a light on when the temperature sensor above the bulb reads less than 25 °C. Shown in use with EM-8678 Charge/Discharge Circuit.*

```

2:16:04 PM 11/07/07 XplorerGLX
outputsstate(1,1,[Temperature (°C)]<25)

The above calculation means the relay which is
plugged into the first jack on the Digital Adapter
that is plugged into Port #1 on the GLX will be
activated when the condition of temperature
less than 25 °C has been met.

✓ Calculation is OK
RAD
    
```

*The calculator on the GLX is used to define the conditions which activate the Relay.*

### Specifications

- 30V, 5A maximum
- 1.7 m long cord
- 10 cm x 7 cm x 3 cm

#### Order Information:

Relay.....CI-6462  
 Required:  
 Digital Adapter.....PS-2159

## Photogate Head

ME-9498A



### Specifications

- Photogate Width:** 7.5 cm
- Fall Time:** < 50 ns
- Spatial Resolution:** < 1 mm
- Timing Resolution:** 0.1 millisecond
- Connector:** Stereo phone plug

#### Order Information:

Photogate Head.....	ME-9498A
<i>Recommended:</i>	
Photogate Stand.....	ME-9805

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Accessory Photogate

ME-9204B

Includes both a Photogate Head and a Photogate Stand for flexible experiment design. The Photogate Stand is also sold separately.



#### Order Information:

Accessory Photogate.....	ME-9204B
Photogate Stand.....	ME-9805
<i>Required:</i>	
Digital Adapter.....	PS-2159 p. 85

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Photogate Brackets

ME-9806

- ▶ Attaches photogates to PASCO dynamics tracks
- ▶ Easily adjust photogate height



*(Photogate not included.)*

The Photogate Bracket allows the Photogate Head to be attached directly to PASCO dynamics tracks. This eliminates the need for separate photogate stands and allows the photogate height to be easily adjusted relative to the track. Includes two Photogate Brackets.

#### Order Information:

Photogate Brackets (2).....	ME-9806
-----------------------------	---------

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Photogate/Pulley System

ME-6838A

### Includes:

- Photogate Head
- Super Pulley with Rod



### Specifications

- Pulley:** Rotational inertia:  $1.8 \times 10^{-6} \text{ kg m}^2$  Coefficient of friction:  $< 7 \times 10^{-3}$  Diameter: 5 cm, Mass: 5.5 g
- Photogate: Width:** 7.5 cm, Fall time: < 50 ns Spatial resolution: < 1 mm
- Timing Resolution:** 0.1 millisecond
- Connector:** Stereo phone plug

#### Order Information:

Photogate/Pulley System.....	ME-6838A
------------------------------	----------

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Photogate Pendulum Set

ME-8752

The Photogate Pendulum Set is a unique set of pendula that have exactly the same shape and size, but different masses. These pendula are ideal for use with photogates due to their cylindrical shape. One pendulum each of brass, plastic, wood and aluminum is included. See page 185 for more information.



#### Order Information:

Photogate Pendulum Set.....	ME-8752
-----------------------------	---------

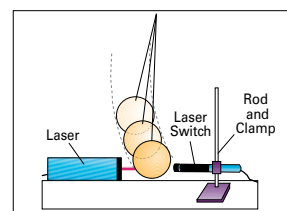
*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Laser Switch

ME-9259A



This Laser Switch acts as a large photogate so you can time objects too large to pass through a standard Photogate. Use the Red Laser Pointer below or other laser as your light source.



#### Order Information:

Laser Switch.....	ME-9259A
-------------------	----------

#### Required:

Laser such as X-Y Adjustable	
Diode Laser.....	OS-8526A

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Timer Switch

ME-9819



This push-button switch has a 1.7 m cable ending in a "Y" with two stereo phone plugs. When the button is pressed, the Timer Switch sends a start signal to both devices to which it is connected.

#### Order Information:

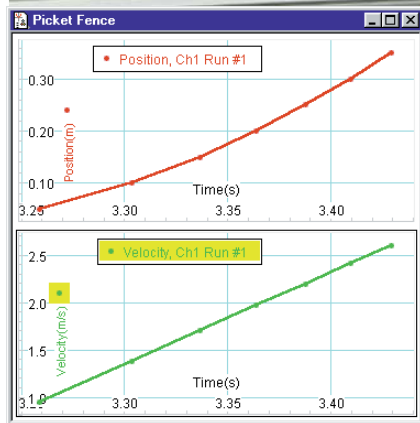
Timer Switch.....	ME-9819
-------------------	---------

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

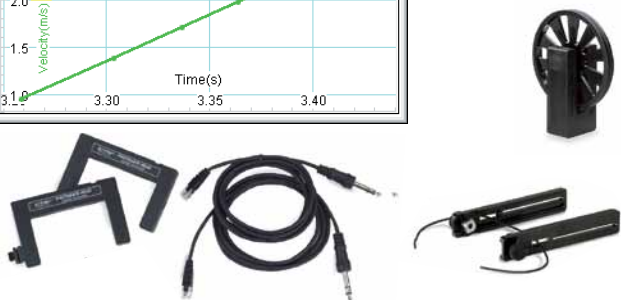
## Photogates and Fences

ME-9471A

When used with the computer for data recording, display and analysis, the photogate/pulley timing system can provide a wide range of time, speed and velocity measurements. The photogates mount to the dynamics track using the provided brackets. The “picket fences” provided mount directly to the dynamics carts.



Position and velocity graphs are obtained using a Picket Fence and Photogate.



**Order Information:**

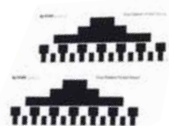
<b>Photogates and Fences</b> .....	<b>ME-9471A</b>
<b>Includes:</b>	
Photogate Head.....	ME-9498A p. 37
Photogate Brackets (2).....	ME-9806 p. 37
Cart Picket Fences (2).....	ME-9804
Super Pulley with Screw.....	ME-9450A p. 164

Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.

## Cart Picket Fences

(set of 2)

ME-9804



**Order Information:**

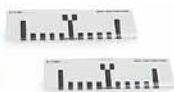
<b>Cart Picket Fences (set of 2)</b> .....	<b>ME-9804</b>
--	----------------

## Smart Timer Picket Fences

(set of 2)

ME-8933

See Smart Timer on pages 146-147.



**Order Information:**

<b>Smart Timer Picket Fences (set of 2)</b> .....	<b>ME-8933</b>
---	----------------

## Large Picket Fence

ME-9377A

Conduct free fall experiments by dropping this Picket Fence through the PASCO Photogate. The distance from the leading edge of each black bar to the leading edge of the next black bar is 5.0 cm. The Picket Fence has eight black bars and is 40 cm long.



**Order Information:**

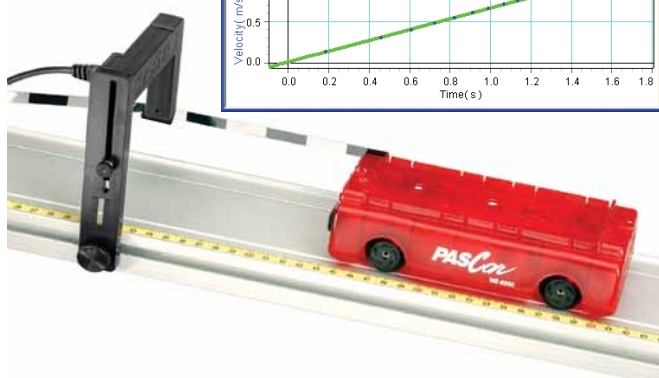
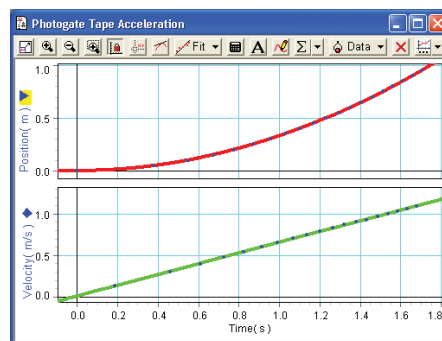
<b>Large Picket Fence</b> .....	<b>ME-9377A</b>
---------------------------------	-----------------

## Photogate Tape Set

ME-6664

Flexible Mylar picket fence tape can be cut to needed length. Tape guide slides onto the arm of PASCO photogates to more accurately measure the motion of a cart.

Photogate tape can be used as a picket fence “string” to continuously measure the acceleration of the cart.

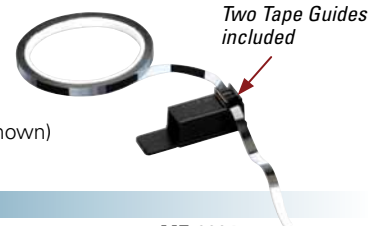


Slide the included bracket onto the arm of a PASCO photogate (ME-9498A or ME-9204B) and slide the photogate tape through the slot to measure position, velocity, and acceleration. The band spacing on the tape is 5 cm from edge to edge, which is identical to the Large Picket Fence (ME-9377A).

The High Resolution Photogate Tape, available separately, has a distance of 1 cm between edges for more data points during high velocity or acceleration phenomena.

**Includes:**

- Photogate Tape (30 m)
- Photogate Tape Guide (2)
- Double-Adhesive Tape (not shown)
- Velcro Strips (not shown)



**Order Information:**

<b>Photogate Tape Set</b> .....	<b>ME-6664</b>
<b>High Resolution Photogate Tape</b> .....	<b>ME-6666</b>

**Required:**

Photogate Head.....	ME-9498A p. 37
or Accessory Photogate.....	ME-9204B p. 37

## Photogate Mounting Bracket

ME-6821A



Mount one or two photogates on any Projectile Launcher. Compatible with ME-9498A and ME-9204B Photogate Heads.



### Order Information:

<b>Photogate Mounting Bracket</b> .....	<b>ME-6821A</b>	
<i>Shown in use with:</i>		
Photogate Head.....	ME-9498A	p. 37
Accessory Photogate.....	ME-9204B	p. 37

## Phone Jack Extender Cable

PI-8117

This 6 meter phone jack-to-phone jack extension cord can be used with any Photogate/Timing accessory.



### Order Information:

<b>Phone Jack Extender Cord (20' cable)</b> .....	<b>PI-8117</b>
---	----------------

## G-M Tube/Power Supply

SN-7927A

- ▶ Ideal general purpose nuclear sensor



The G-M Tube/Power Supply senses alpha, beta and gamma radiation. Power for the tube is supplied through the connection to an interface that supplies an operating voltage of +5 V.

### Specifications

**Sensitivity:** Beta, Gamma, Alpha  
**Count Detection:** Audio signal  
**Window Thickness:** 1.5 to 2 mg/cm<sup>2</sup>, mica  
**Gas Filling:** Neon, Argon and Halogen  
**Starting/Operating Voltage for tube:** 450 VDC/500 VDC  
**Dead Time:** 90 μs

### Order Information:

<b>G-M Tube/Power Supply</b> .....	<b>SN-7927A</b>
------------------------------------	-----------------

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Time-of-Flight Accessory

ME-6810

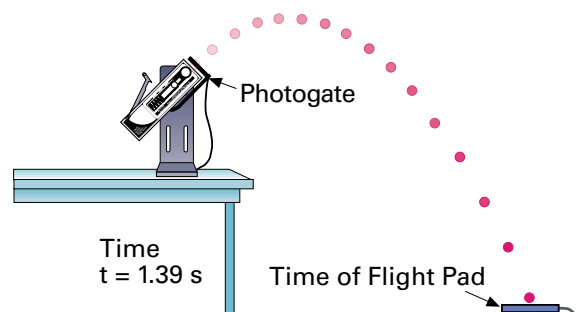
The Time-of-Flight Accessory is designed primarily for freefall or projectile experiments.

When an object hits the plate, a signal is sent to the interface. Note: When used with the projectile launcher, a photogate is used to start the timer and the 20' extension cable is recommended.



### Typical Applications

- ▶ Find Time-of-Flight for a ball shot from a Projectile Launcher
- ▶ Conduct freefall experiments



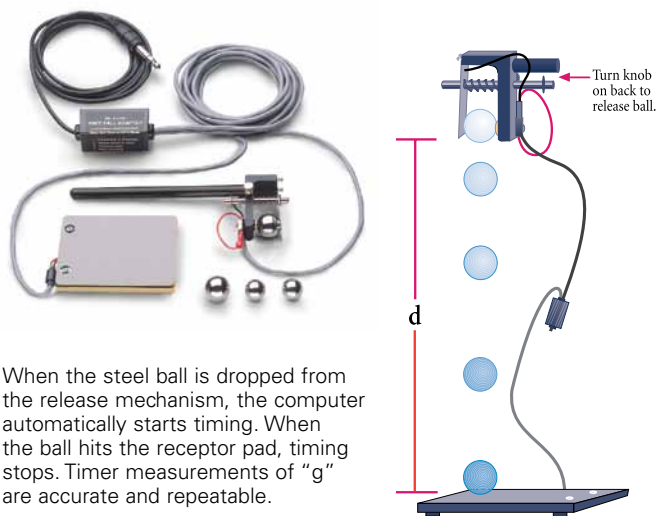
### Order Information:

<b>Time-of-Flight Accessory</b> .....	<b>ME-6810</b>
---------------------------------------	----------------

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*

## Freefall Adapter

ME-9207B



When the steel ball is dropped from the release mechanism, the computer automatically starts timing. When the ball hits the receptor pad, timing stops. Timer measurements of "g" are accurate and repeatable.

### Order Information:

<b>Freefall Adapter</b> .....	<b>ME-9207B</b>
-------------------------------	-----------------

*Requires Digital Adapter PS-2159 to use with PASPORT Interfaces.*



## Pressure (Dual)

PS-2181



The Dual Pressure sensor is capable of reading two absolute pressures, one gauge pressure, or one differential pressure. Dynamic variable over-sampling automatically reduces the measurement noise at low sampling rates. Sample rates up to 1000 Hz make studies of both transient and steady-state pressure possible. Includes quick-connect tubing.

### Typical Application

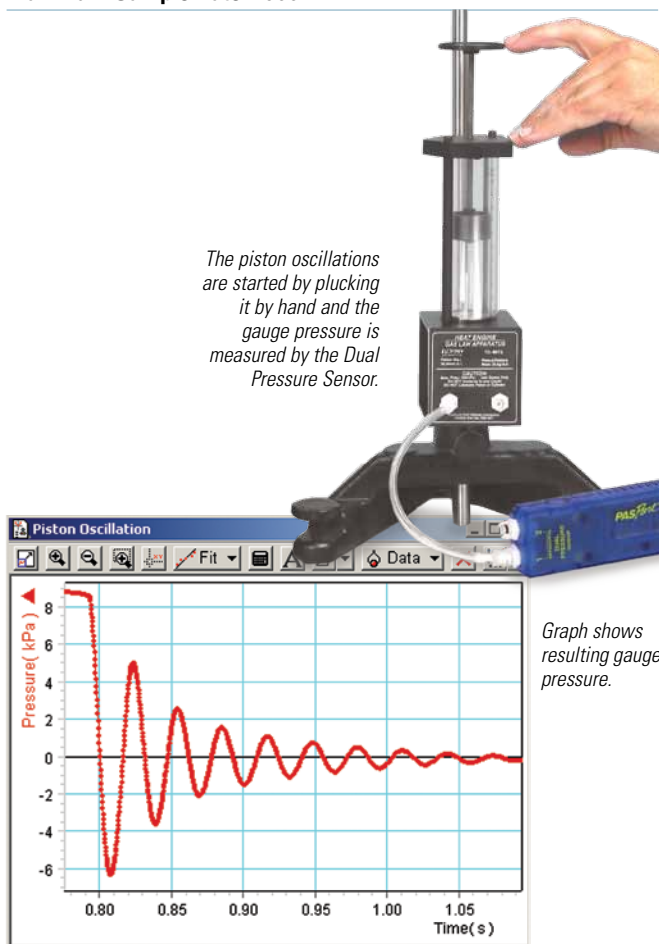
- ▶ Measure pressure in Heat Engine (TD-8572) See pages 379-380 for complete experiments.

### Specifications

**Absolute Pressure:** 0 to 200 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (Displays pressure in kPa, N/m<sup>2</sup>, and psi)

**Differential Pressure:** ±100 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (Displays pressure in kPa, N/m<sup>2</sup>, and psi)

**Maximum Sample Rate:** 1000 Hz



### Order Information:

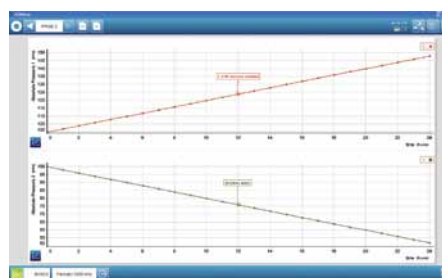
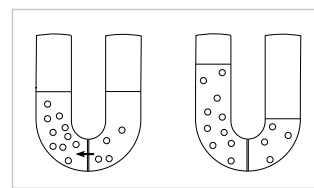
Dual Pressure Sensor..... PS-2181

## Diffusion/Osmosis Apparatus

ME-6940 Patent Pending



Open any biology textbook to the osmosis section and you will find the image of a U-shaped tube composed of two clear columns separated by a semi-permeable membrane. This classic figure is the most commonly used model to visualize the osmotic movement of water due to a concentration gradient. PASCO's Diffusion/Osmosis Apparatus is a U-shaped apparatus consisting of two cylinders separated by a semi-permeable membrane. The transparent, graduated cylinders allow students to observe and measure volume changes due to osmosis. In conjunction with PASCO's Dual Pressure Sensor, the apparatus allows students to measure the changes in pressure and volume caused by the osmotic movement of water across a semi-permeable membrane.



In this experiment, cylinder #1 was filled with 40 of 1.0 M sucrose solution. Cylinder #2 was filled with 40 mL of distilled water. The two cylinders were separated by a semi-permeable membrane and the pressure within the cylinders was monitored using the Dual Pressure Sensor.

### Order Information:

**Diffusion/Osmosis Apparatus**  
(includes 20 membranes).....ME-6940

**Diffusion/Osmosis Kit**  
(includes Diffusion/Osmosis Apparatus and Dual Pressure Sensor) .....ME-6942

**Replacement Membranes (20 membranes)**.....ME-6941

**Dual Pressure Sensor** ..... PS-2181

## Pressure (Absolute)

PS-2107



The Absolute Pressure Sensor measures the gas pressure in a container or the surroundings. Includes a 20cc syringe and quick connect tubing for investigating the Gas Laws. The sensor's wide range make it an excellent general purpose pressure device.

### Typical Applications

- ▶ Measure chemical reaction rates
- ▶ Verify Gas Laws (Ideal, Charles', Boyle's)
- ▶ Study Vapor Pressure vs. Temperature

### Specifications

**Range:** 0 – 700 kPa

**Accuracy:**  $\pm 2$  kPa

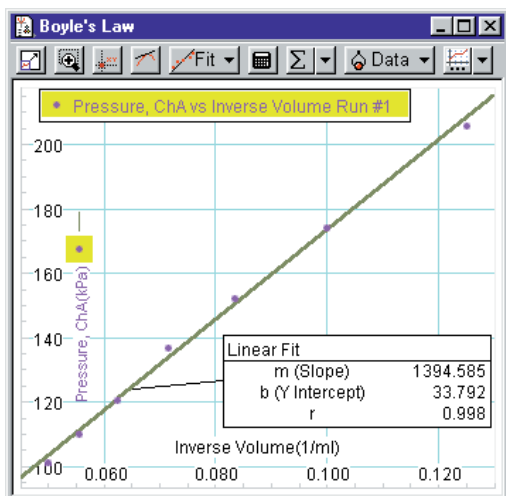
**Resolution:** 0.01 kPa

**Maximum Sample Rate:** 200 Hz

**Repeatability:** 1 kPa



The Absolute Pressure Sensor is used in a Boyle's Law experiment in which a syringe is compressed.

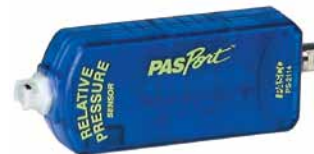


#### Order Information:

Absolute Pressure Sensor ..... PS-2107

## Pressure (Relative)

PS-2114



The Relative Pressure Sensor measures gas pressure compared to atmospheric pressure, which is commonly known as gauge pressure. Includes quick connect tubing for a variety of pressure activities. The limited pressure range of the sensor provides excellent accuracy and resolution for measuring small pressure changes.

### Typical Applications

- ▶ Heat Engine Cycles
- ▶ Measure pressure changes in a Venturi Tube
- ▶ Conduct air foil studies

### Specifications

**Range:** 0 – 10 kPa

**Accuracy:**  $\pm 0.1$  kPa

**Maximum Sample Rate:** 20 Hz

**Resolution:** 0.001 kPa

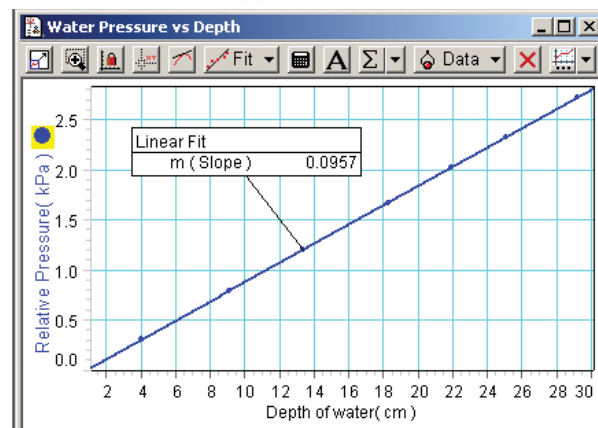
**Repeatability:** 0.01 kPa



Water Reservoir (ME-8594) is sold separately on page 221.

Pressure is measured for various water column heights.

Water pressure (relative) versus depth



#### Order Information:

Relative Pressure Sensor ..... PS-2114

## Quad Pressure

PS-2164



The 4-port Quad Pressure sensor is capable of reading up to four absolute pressures, or two gauge pressures, or two differential pressures. Dynamic variable over-sampling automatically reduces the measurement noise at low sampling rates. Sample rates up to 1000 Hz make studies of both transient and steady-state pressure possible. Includes quick-connect tubing.

### Typical Application

- ▶ Study pressure through a fluid circuit

### Specifications

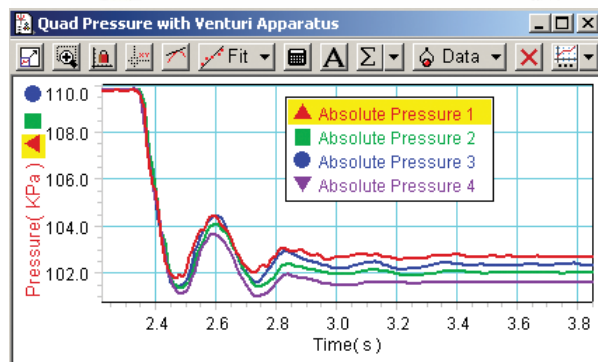
**Absolute Pressure:** 0 to 200 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (Displays pressure in kPa, N/m<sup>2</sup>, and psi)

**Differential Pressure:** ±100 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (Displays pressure in kPa, N/m<sup>2</sup>, and psi)

**Maximum Sample Rate:** 1000 Hz



Blue dye added to the water for clarity.



Shown with the ME-8598 Venturi Apparatus. The pressure at various points in the Venturi tube decreases as the water flow is turned on. Pressure variability due to cross-sectional area and fluid friction are readily seen in the data.

#### Order Information:

<b>Quad Pressure Sensor</b> .....	<b>PS-2164</b>
<i>Recommended:</i>	
Venturi Apparatus .....	ME-8598 p. 205

## Absolute Pressure/Temperature

PS-2146



This combination sensor is specifically designed for use in studying gas laws. The included thermistor temperature probe has both a fast response and very low thermal mass.

### Typical Applications

- ▶ Extrapolate absolute zero
- ▶ Explore Gas Laws (Ideal, Charles', Boyle's)

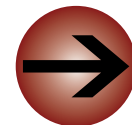
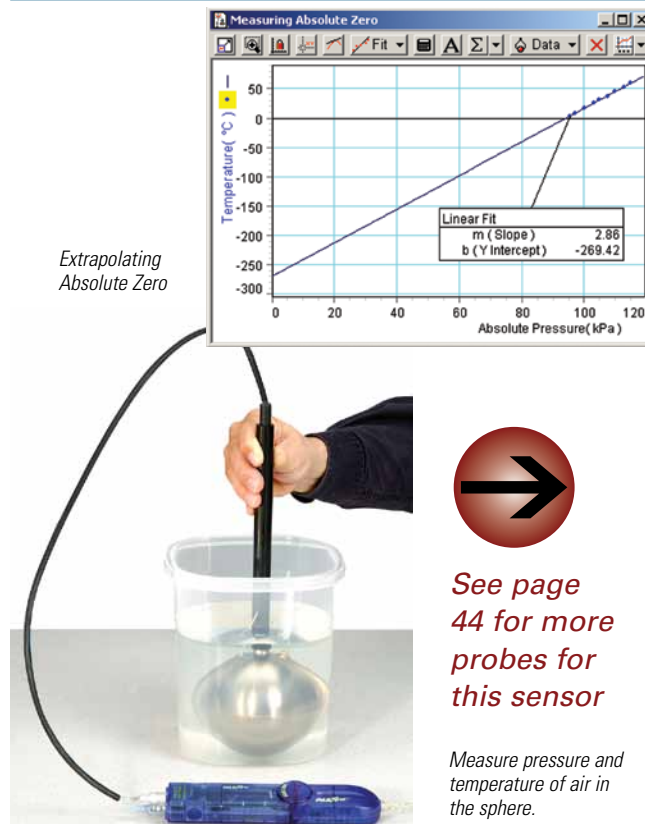
### Specifications

**Pressure:** 0 to 700 kPa with ±2 kPa accuracy, 0.1 kPa resolution and 1 kPa repeatability (Displays pressure in kPa, N/m<sup>2</sup>, and psi)

**Maximum Sample Rate:** 100 Hz

**Temperature with included Fast Response Probe:** -10 to 70 °C with ±0.5 °C accuracy (Displays Temperature in °C, K and °F)

**Sensor Extension Cable:** Included



See page 44 for more probes for this sensor

Measure pressure and temperature of air in the sphere.

#### Order Information:

<b>Absolute Pressure/Temp Sensor</b> .....	<b>PS-2146</b>
<i>Recommended:</i>	
Absolute Zero Sphere .....	TD-8595 p. 236
Ideal Gas Law Syringe .....	TD-8596A p. 237

## Temperature

PS-2125



PASCO's Stainless Steel Temperature Sensor offers fast response and superior range, resolution and accuracy. It reports temperature (in °C, °F, or K) whether it is immersed in liquids, held in the air or touching a solid surface. Teflon® covers, for use in harsh liquids or strong chemical solutions, are available as an accessory.

### Typical Applications

- ▶ Conduct general temperature experiments
- ▶ Measure rapid temperature changes found in endothermic-exothermic reactions
- ▶ Conduct environmental studies

### Specifications

**Range:** -35 °C to +135 °C

**Accuracy:** ±0.5 °C

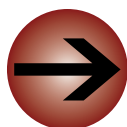
**Resolution:** 0.0025 °C

**Maximum Sample Rate:** 10 Hz

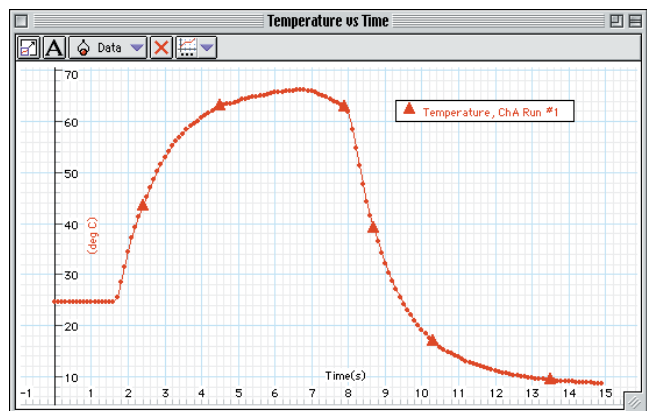
**Displays:** °C, K and °F

**Repeatability:** 0.1 °C

Teflon® covers available as an accessory



See page 44 for more probes for this sensor



Graph showing the immediate temperature change when the PS-2125 Temperature Sensor is placed in a hot water bath and then plunged into a cold bath.

#### Order Information:

Temperature Sensor.....PS-2125

#### Recommended:

Teflon Sensor Covers (10-pack).....CI-6549

## Temperature, Quad

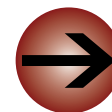
PS-2143



Connect up to four Temperature Probes for an experiment. Use with any combination of Stainless Steel, Fast Response or Skin/Surface Temperature probes for a wider variety of temperature measurements in the classroom or in the field. Sensor includes two Stainless Steel Temperature Probes (PS-2153) and one Fast Response Probe.

### Typical Applications

- ▶ Thermal heat flow (one or two dimension)
- ▶ Comparative body temperatures
- ▶ Side-by-side chemical reactions
- ▶ Solar radiation
- ▶ Properties of insulation



See page 44 for more probes for this sensor

### Specifications

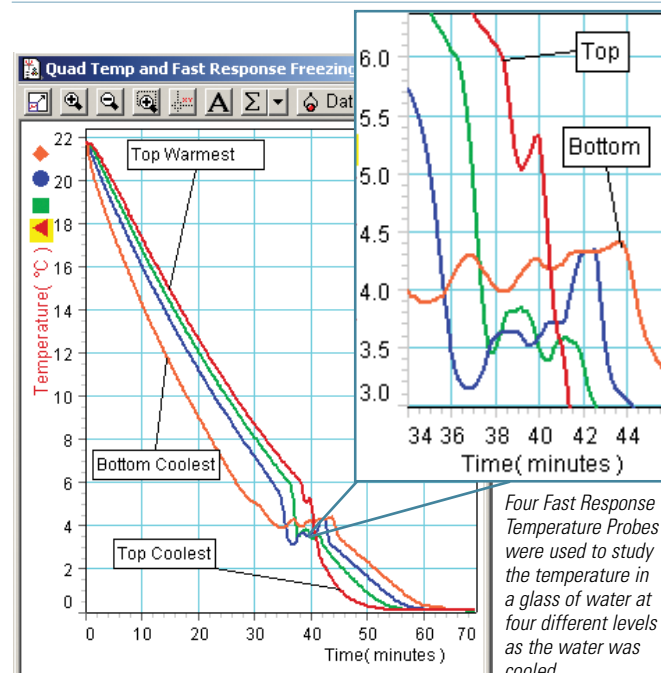
**Accuracy:** -35 to +135 °C at ±0.5 °C

**Displays:** °C, K and °F

**Resolution:** .0025 °C

**Maximum Sample Rate:** 100 Hz

Teflon® covers available as an accessory



Four Fast Response Temperature Probes were used to study the temperature in a glass of water at four different levels as the water was cooled.

#### Order Information:

Quad Temperature Sensor.....PS-2143

#### Recommended:

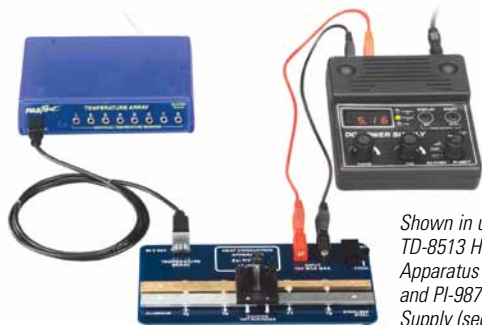
Teflon Sensor Covers (10-pack).....CI-6549

## Temperature Array

PS-2157



This array has eight 3.5 mm stereo jacks to plug in temperature probes. Only one PASPORT Channel is required to measure eight temperatures at once! Applications include measuring temperatures along the length of a metal rod as one end is heated or measuring surface temperature at eight different points on a body. The Temperature Array also has a “multiport” for plugging in a special cable (included) with eight color-coded thermistor sensors connected to a single 8-pin mini-DIN plug. The Temperature Array accepts PASPORT temperature probes: Stainless Steel, Fast Response and Skin/Surface.



Shown in use with:  
TD-8513 Heat Conduction Apparatus (see page 231)  
and PI-9877 DC Power Supply (see page 278).

### Specifications

**Range:** -35 °C to 135 °C\*

**Accuracy:** ±0.5 °C

**Resolution:** 0.0025 °C

**Repeatability:** 0.01 °C

**Maximum Sample Rate:** 100 Hz per Temperature Sensor

**Displays:** °C, K and °F

\* Sensor Dependent

### Includes

- Temperature Array Cable Assembly
- Fast Response Temperature Probe (3)
- Adhesive Patches (10)

### Order Information:

<b>Temperature Array</b> .....	<b>PS-2157</b>
<i>Recommended:</i>	
Stainless Steel Temperature Probe .....	PS-2153
Fast Response Temperature Probe.....	PS-2135
Skin/Surface Temperature Probe.....	PS-2131
Replacement Temperature Array Cable.....	PS-2552
Replacement Adhesive Patches (100 Pack).....	PS-2525

## Temperature Probes\*

### Skin/Surface Temperature\*

PS-2131



- ▶ Flat sensing element ideal for surfaces
- ▶ Quickly reaches equilibrium temperature with surface

**Range:** -10 to +70 °C



Make a temperature profile of the human hand.

### Order Information:

<b>Skin/Surface Temperature Probe</b> .....	<b>PS-2131</b>
---	----------------

### Fast Response Temperature Probe\* (3 pack)

PS-2135



- ▶ Accurately measures temperature changes in real time
- ▶ Ideal for small or hard-to-reach spaces
- ▶ Includes 10 Adhesive Patches

**Range:** -30 to +105 °C

Adhesive patches hold the Temperature Probe in place.



### Order Information:

<b>Fast Response Temperature Probe (3 pack)</b> .....	<b>PS-2135</b>
<i>Recommended:</i>	
Replacement Adhesive Patches (100 pack).....	PS-2525

### Stainless Steel Temperature Probe\*

PS-2153



**Range:** -35 to +135 °C

### Order Information:

<b>Stainless Steel Temperature Probe</b> .....	<b>PS-2153</b>
<i>Recommended:</i>	
Teflon® Sensor Covers (10 Pack).....	CI-6549

\*All of the Probes above require one of the following temperature sensors:  
 Temperature Sensor..... PS-2125 p. 43  
 Quad Temperature Sensor..... PS-2143 p. 43  
 Temperature Array..... PS-2157

## Temperature (Type K 4-Port)

PS-2127

The PS-2127 measures up to four temperatures using Type K thermocouple probes (two included). It utilizes dynamic variable oversampling to greatly reduce noise at lower sampling rates. Type K thermocouples are useful for measuring both low and high temperatures under rugged conditions. The two dissimilar metals that form the thermocouple (for Type K, the alloys chromel and alumel) generate a predictable voltage at a given temperature, thereby ensuring measurement accuracy. The low thermal mass of this sensor results in a fast response time. The long probe length permits measurements in hard-to-reach places.



### Typical Applications

- ▶ Accurately measure surface temperatures: for example, across the surface of an iron
- ▶ Map the temperature of a candle flame
- ▶ Measure temperatures down to -200 °C (liquid nitrogen)

### Specifications

**Temperature Range:** -200 °C to +1000 °C

**Maximum Sample Rate:** 250 Hz

**Accuracy:** ±3 °C or 3%, whichever is greater

**Resolution:** 0.01 °C

**Displays:** °C, K and °F

*The Type K Temperature Sensor can be used to measure the temperature of a flame. Works with any industry standard Type K thermocouple.*



### Includes:

4-Port Sensor

Type K Thermocouples (2)

#### Order Information:

<b>Temperature (Type K 4-Port) Sensor</b> .....	<b>PS-2127</b>
<i>Replacement Supply:</i>	
<b>Type K Thermocouple</b> .....	<b>PS-2155</b>

## Temperature (Type K)

PS-2134

The PS-2134 is a single channel sensor that uses the same Type K thermocouple probe as the PS-2127 shown above.

Includes one Type K Thermocouple.



### Specifications

**Temperature Range:** -200 °C to +1000 °C

**Maximum Sample Rate:** 10 Hz

**Accuracy:** ±3 °C or 3%, whichever is greater

#### Order Information:

<b>Temperature Type K Sensor</b> .....	<b>PS-2134</b>
<i>Replacement Supply:</i>	
<b>Type K Thermocouple</b> .....	<b>PS-2155</b>

## Non-contact Temperature

PS-2197

- ▶ Non-contact
- ▶ -70 °C to 380 °C



The Non-contact Temperature Sensor measures surface temperature by detecting the emitted infrared light. Record the temperature of objects without touching them!

### Typical Applications

- ▶ Compare temperature of hands, skin, face and clothes
- ▶ Measure the temperature of different outdoor ground surfaces
- ▶ Map the temperature profile of an exterior wall

### Specifications

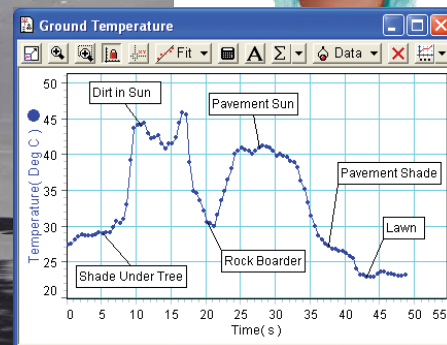
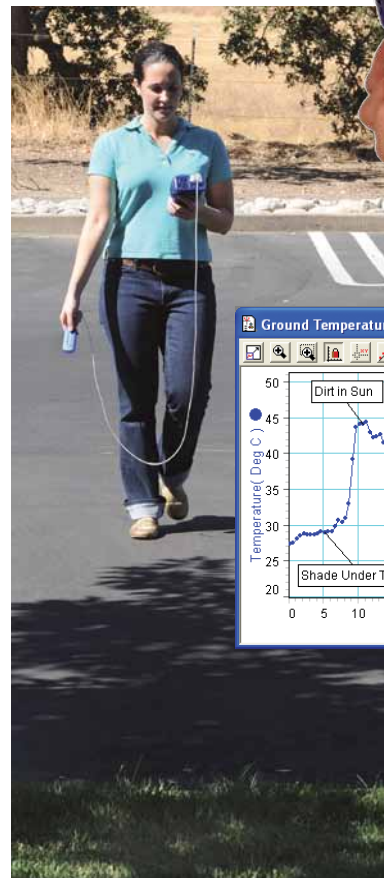
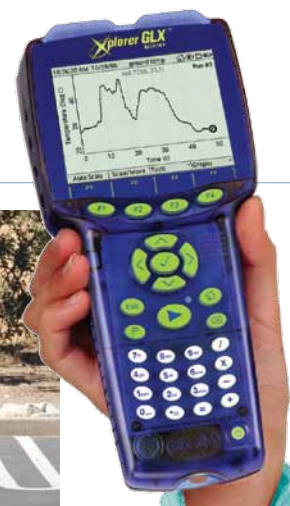
**Range:** -70 °C to 380 °C

**Accuracy:** ±0.5 °C

**Response Time:** Less than 0.1s

**Maximum Sample Rate:** 200 Hz

**Field of view:** ±35°



*The student measures the ground temperature (late morning) over four distinct surfaces: Starting in the shade under the distant tree, she then crosses bare dirt (in sun), a rock border, pavement and lawn.*

*Graph created in PASCO's DataStudio® Software.*

#### Order Information:

**Non-contact Temperature Sensor** .....

**PS-2197**

*Shown in use with:*

Xplorer GLX .....

PS-2002 p. 10

DataStudio Software .....

p. 86-89

## Light Level

PS-2177



The Light Level Sensor measures illuminance in lux. The readings of this sensor mimic the wavelength sensitivity of the human eye, which is most sensitive in the green part of the spectrum. This is achieved with a green filter in the light sensor.

Some typical readings are shown in the table:

Condition	Illuminance (lux)
Sunlight	100,000
Full Daylight	10,000
Overcast Day	1,000
Very Dark Day	100
Twilight	10
Deep Twilight	1
Full Moon	0.1
Quarter Moon	0.01
Starlight	0.001
Warehouses	150
Offices, Laboratories	500
Supermarkets	750
Normal Drawing Work, Operation Rooms	1,000
Detailed Drawing Work	1500-2000

### Specifications

**Maximum Sample Rate:** 100Hz

**Accuracy:** ±10%

**Three Ranges:**

**Candle:**  
0 to 1,500 lux      Resolution 0.5 lux

**Light Bulb:**  
0 to 15,000 lux      Resolution 5 lux

**Sun:**  
0 to 150,000 lux      Resolution 50 lux

#### Order Information:

Light Level Sensor.....PS-2177

## Light

PS-2106A



The Light Sensor is ideal for indoor and outdoor relative light intensity experiments. Data is displayed in lux, a unit of illuminance, which is a measure of luminous flux per unit of area. The Light Sensor can be used in three different ranges depending on the intensity level of the light source.

### Typical Applications

- ▶ Compare light intensity vs. distance
- ▶ Study interference/diffraction/polarization
- ▶ Measure relative light intensities in daylight
- ▶ Monitor a solar eclipse

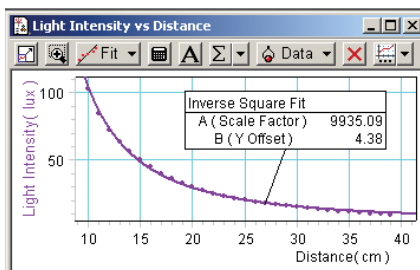
### Specifications

**Range:** 0 to 2.6 lux (candle); 0 to 260 lux (bulb); 0 to 26,000 lux (sun)

**Accuracy:** > ±1 db of max value of selected range

**Resolution:** 1/10,000 of max value of selected range

**Maximum Sample Rate:** 1000 Hz



The graph above shows that light intensity varies as the inverse square of the distance from the light source.

#### Order Information:

Light Sensor.....PS-2106A

## High Sensitivity Light

PS-2176



The High Sensitivity Light Sensor is designed to perform visible light studies from low intensity spectral studies to daylight. Built-in automatic variable oversampling reduces noise.

### Typical Applications

- ▶ Spectrophotometry
- ▶ Interference and Diffraction patterns
- ▶ Measure light intensity vs. distance

### Specifications

**Sensing Element:** Si PIN photodiode

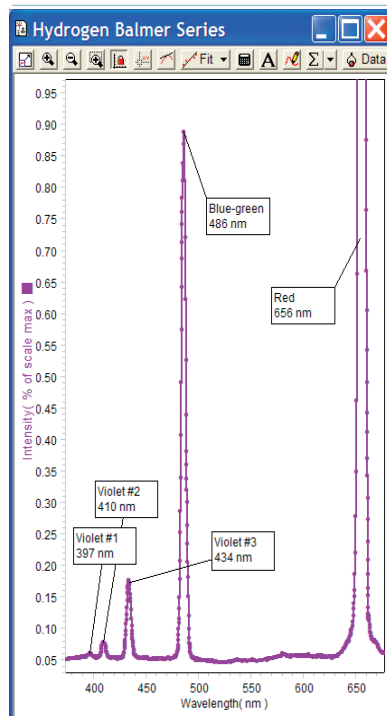
**Spectral Response:** 320 nm to 1100 nm

**Gain Levels:** 10,000x, 100x, 1x, switch selectable

**Approximate Lux Ranges:** 0 to 1, 0 to 100, 0 to 100,000

**Maximum Sample Rate:** 1000 Hz

**Resolution:** ± 0.01 Lux at 1000 Hz on 0 to 100 scale  
± 0.0005 Lux at 5 Hz on 0 to 100 scale



All five lines of the Balmer Series of Hydrogen can be detected using the PASPORT High Sensitivity Light Sensor on its most sensitive setting, a PASPORT Rotary Motion Sensor, and the Educational Spectrophotometer (see page 328). The graph is zoomed in on the dimmer blue-green and violet lines so the peak of the bright red line is not shown.

#### Order Information:

High Sensitivity Light.....PS-2176

## Infrared Light

PS-2148



The Infrared sensor uses a Nitrogen filled Thermopile with a Tallium Bromide-iodide (KRS-5) window to sense wavelengths from 580 to 40,000 nm. This allows students to measure a variety of phenomena including the infrared radiation emitted from their own hand.

### Typical Applications

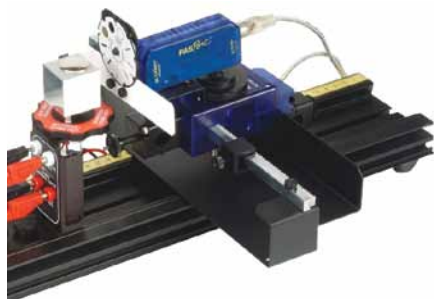
- ▶ Measure black body radiance
- ▶ Perform Leslie's Cube experiments
- ▶ Measure Solar radiance
- ▶ Evaluate heat flow into or out of the sensor
- ▶ Simulate a non-contact temperature sensor

### Specifications

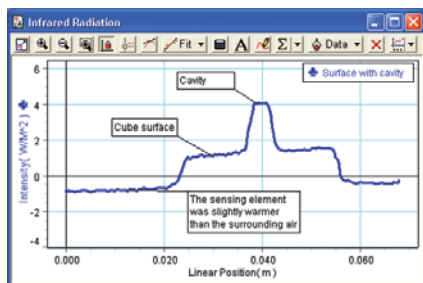
Measure intensity in Watts/Meter

**Maximum Sample Rate:** 100 Hz

Built-in thermistor to measure temperature of the "cold" side of the thermopile in °C, °F or K



Scanning the matte surface and cavity of a Leslie's Cube.



#### Order Information:

Light Sensor (Infrared).....PS-2148

## Ultraviolet Light

PS-2149



The Ultraviolet Light Sensor employs a filter to measure the UVA band (315 nm - 400 nm). With the UVA filter removed, the sensor detects the visible as well as the UVA. The sensor includes the UVA filter, a collimator, and a sensor handle.

### Typical Applications

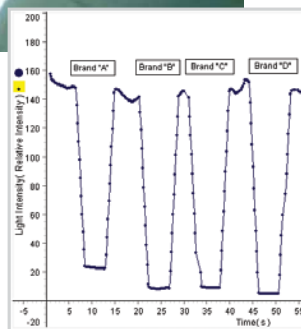
- ▶ Conduct a sky survey of UV light
- ▶ Investigate effectiveness of UV protection from sunglasses, windows or sunscreen lotions.

### Specifications

Spectral response of 315 nm to 400 nm (with filter)

Photodiode sensing element

**Maximum Sample Rate:** 1000 Hz



Student checks the effectiveness of different brands of sunglasses.

#### Order Information:

Light Sensor (UVA).....PS-2149

## Broad Spectrum Light

PS-2150



- ▶ For use with Spectrophotometer
- ▶ Ideal for Black Body Spectrum

The Broad Spectrum Light Sensor is designed 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.

### Typical Applications

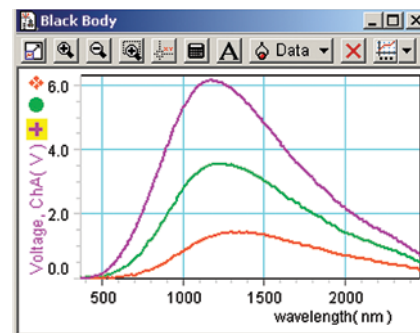
- ▶ Black Body Experiment

### Specifications

**Sensing Element:** BaF<sub>2</sub> window, xenon gas-filled thermopile

**Spectral Response:** 300 to 10,000 nm

**Maximum Sample Rate:** 100 Hz



The classic textbook diagram of the intensity versus wavelength blackbody curves can be produced with real data. In this graph, the peak wavelength in the blackbody curve shifts as the source temperature is lowered. See page 330.

#### Order Information:

Broad Spectrum Light Sensor .....PS-2150



## Voltage/Current

PS-2115



The Voltage/Current Sensor combines both sensors in one case. This multi-measure probe uses only one connection so a single USB link can be used. With overload protection, audible overload notification and automatic reset this sensor provides an ideal student measurement tool.

### Typical Applications

- ▶ Study circuit properties for both series and parallel electrical circuits
- ▶ Study the relationship of voltage and current in series-parallel circuits (Ohm's Law)
- ▶ Measure power used by an electrical device ( $P = I * V$ )
- ▶ Measure resistance of any circuit element ( $R = V / I$ )

### Specifications

**Voltage Range:** ±10 volts, resolution of 0.005 volts

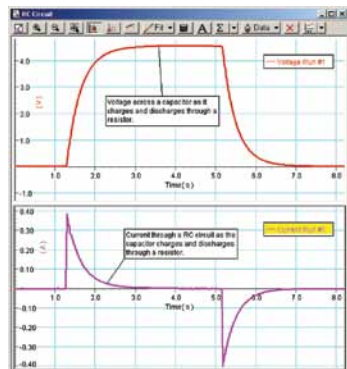
**Current Range:** ±1 amp, resolution of 500 microamps

**Current channel series resistance:** 0.6 ohms, < 0.9 ohms at room temperature

**Maximum common mode voltage:** 10 volts

**Maximum Sample Rate:** 1000 samples/sec

**Voltage Input Impedance:** 2 MΩ



Capacitor charge and discharge across an RC circuit and resulting voltage change.

#### Order Information:

**Voltage/Current Sensor**.....PS-2115

*Recommended:*

Alligator Clip Leads (set of 10).....EM-8634

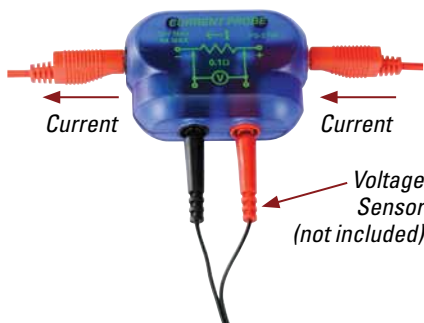
## Current Probe

PS-2184



The PS-2184 attaches to a PASCO voltage sensor to allow the measurement of current between -4 A and +4 A. The probe contains a precision 0.10 ohm resistor and allows the precise measurement of the voltage drop across the resistor.

The current is measured by creating a DataStudio calculation:  $I=V/R$ .



### Specifications

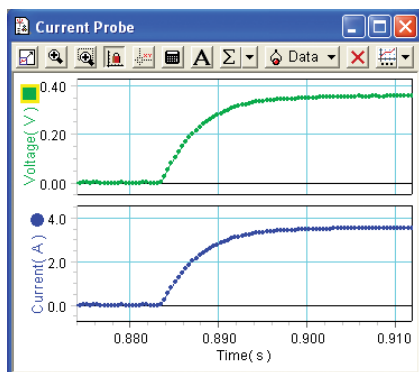
**Resistor:** 0.10 Ohm, 3.0W, 1.0%

**Maximum Current:** 4A

**Maximum Voltage:** 10V

**Maximum Voltage Without Damage:** 30V

**Terminals:** 4mm Banana Jacks



The current is calculated from the voltage across the precision 0.10 ohm resistor.

#### Order Information:

**Current Probe**.....PS-2184

## Galvanometer

PS-2160



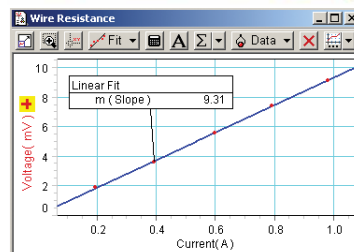
The Galvanometer Sensor is designed to measure small voltages with high resolution. Dynamic variable over-sampling greatly reduces the measurement noise at low sampling rates. Shunt resistors are included to allow measurement of current.

### Specifications

**Voltage Range:** ±2000 mV, resolution of 0.1 mV

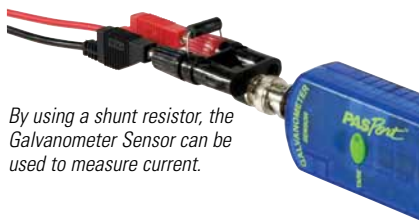
**Maximum Sample Rate:**  
5000 Hz with Xplorer GLX  
1000 Hz with other interfaces

**Input Impedance:** 1 MΩ



Galvanometer Sensor can measure the voltage drop across a short piece of wire.

A linear fit of voltage versus current yields the resistance of 0.0093 Ω for the wire.



By using a shunt resistor, the Galvanometer Sensor can be used to measure current.

### Includes:

- BNC-to-banana plug cable
- BNC-to-banana jack adapter
- 0.1 Ω and 10 Ω resistors

#### Order Information:

**Galvanometer Sensor**.....PS-2160

*Recommended:*

Alligator Clip Leads (set of 10).....EM-8634

## High Current

PS-2193

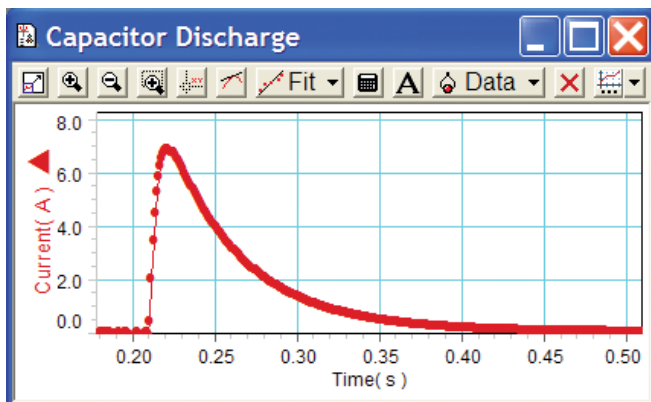
- ▶ 10 Amp
- ▶ Over-Current LED



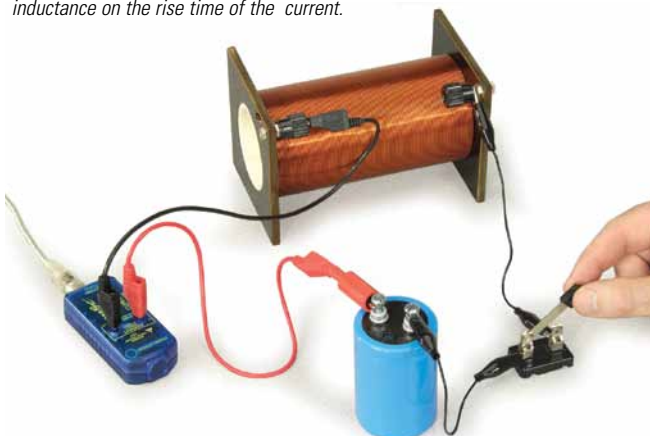
The High Current Sensor has a low ( $0.01 \Omega$ ) resistance sensing element, can measure up to 10 A, and has an LED over-current indicator. Dynamic variable over-sampling greatly reduces the measurement noise at low sample rates.

### Specifications

- Current Range:**  $\pm 10$  A, resolution of 0.5 mA
- Sensing Element Series Resistance:**  $0.01 \Omega$
- Maximum Common Mode voltage:** 10 volts
- Maximum Continuous Current Without Damage:** 12 A
- Maximum Continuous Overvoltage Without Damage:**  $\pm 40$  volts
- Maximum Sample Rate:** 1000 samples/second



The capacitor is charged with a power supply to 10 volts, and then discharged through the Air Core Solenoid. The graph of the data shows the effect of the coils inductance on the rise time of the current.



#### Order Information:

<b>High Current Sensor</b> .....	<b>PS-2193</b>	
<i>Shown in use with:</i>		
Capacitor (0.025 F) 2 pack .....	EM-8632	p. 261
Switch (SPSP) 6 pack .....	EM-8815	p. 260
Air Core Solenoid .....	SE-7585	p. 272

## Charge

PS-2132



The Charge Sensor is designed for experiments in electrostatics such as inductive charging, charge production/distribution and charge on a capacitor. The sensor features automatic scaling, thus eliminating the need for a gain switch. Designed with highly efficient input over-voltage protection, the Charge Sensor is virtually “blow-out” proof and will provide many years of use in the student lab.

When used with the Faraday Ice Pail, the Charge Sensor can measure the total charge on an object by the induction method.

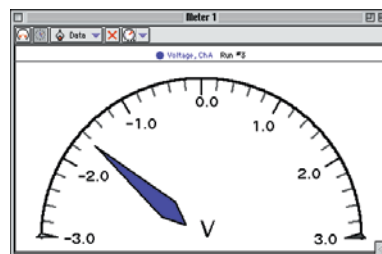
The Charge Sensor can also be used as a high impedance voltmeter ( $10^{12} \Omega$ ). It includes a 0.9m shielded cable with alligator clips to eliminate stray fields.

### Typical Applications

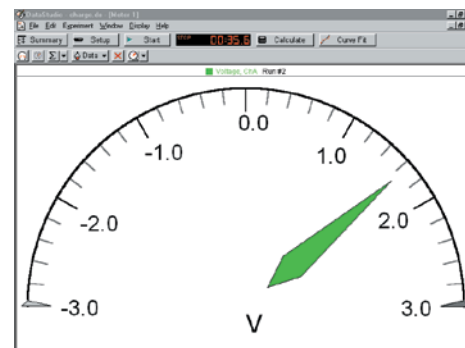
- ▶ Measure charge by induction
- ▶ Quantify the charge on a capacitor plate
- ▶ Discover the charge distribution on a conducting sphere

### Specifications

- Charge Range:**  $\pm 0.1 \mu\text{C}$
- Voltage Range:**  $\pm 10$  V
- Input Resistance:**  $10^{12} \Omega$
- Maximum Input Voltage:** 150 V
- Maximum Sample Rate:** 100 Hz
- Input Connector:** BNC
- Input Cable:** 0.9 m length; shielded with alligator termination



The Charge Sensor measures equal, yet opposite charge on two objects.



#### Order Information:

<b>Charge Sensor</b> .....	<b>PS-2132</b>
<i>Recommended:</i>	
Faraday Ice Pail .....	ES-9042A p. 251

## Magnetic Field

PS-2112



The Magnetic Field Sensor provides magnetic field measurement in a compact package. The sensor at the tip of the probe measures magnetic field strength along the axis of the probe.

### Typical Applications

- ▶ Study the field strength of bar magnets and electromagnets
- ▶ Understand the field strength of a solenoid
- ▶ Measure the field strength of a Helmholtz coil

### Specifications

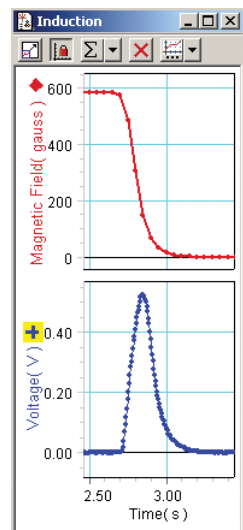
**Range:**  $\pm 1000$  Gauss

**Accuracy:**  $\pm 3$  Gauss or 5% of reading, whichever is greater @ 25 °C (after four minute warm-up)

**Resolution:** 0.1 Gauss (0.01% full-scale)

**Maximum Sample Rate:** 20 Hz

**Repeatability:** 0.05%



As the magnet is removed from the coil, a voltage is induced in the coil. The graph shows both the sudden decrease in magnetic field, as well as the voltage curve using a PS-2115 Voltage/Current Sensor.

Shown with: 3200 turn Coil (SF-8613), Magnet (EM-8620), and Voltage/Current Sensor (PS-2115).



### Order Information:

Magnetic Field Sensor .....PS-2112

## Zero Gauss Chamber

EM-8652

This double-walled, high permeability metal chamber produces a zero Gauss field within the chamber. By placing the Magnetic Field Sensor probe into the chamber and pushing the "Tare" button, the sensor may be zeroed. Highly recommended for measurement of the earth's magnetic field.

### Order Information:

Zero Gauss Chamber .....EM-8652



## 2-Axis Magnetic Field

PS-2162

- ▶ Tare button
- ▶ 1000 Hz sample rate



Measure Radial and Axial Fields simultaneously. Dynamic variable over-sampling greatly reduces noise at low sample rates.

### Typical Applications

- ▶ Measure the earth's magnetic field.
- ▶ Measure magnetic field (magnitude and direction from a coil or a bar magnet).
- ▶ Study AC fields

### Specifications

**Range:**  $\pm 1000$  Gauss

**Accuracy:** 5% of reading @ 25 °C

(after four minute warm-up and Tare using Zero Gauss Chamber)

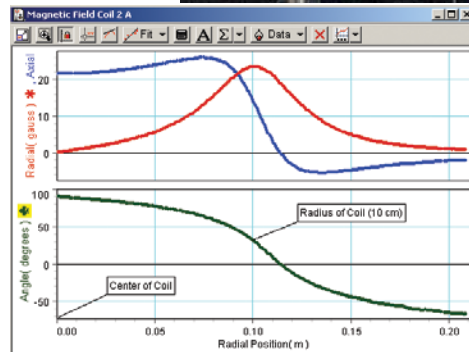
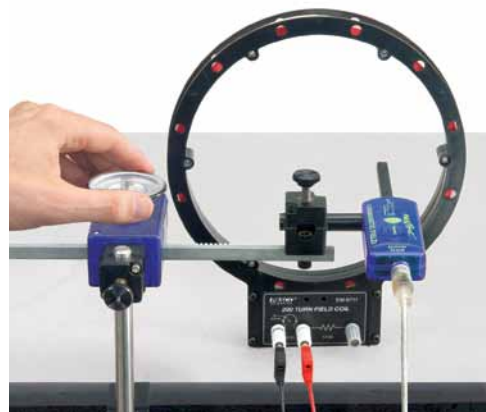
**Resolution:** 0.01 Gauss @ 10 Hz

**Maximum Sample Rate:** 1000 Hz

**Repeatability:** 0.05%

Includes sensor handle and sensor extension cable.

Shown with: Rotary Motion Sensor (PS-2120), Linear Motion Accessory (CI-6688), Field Coil (EM-6711).



Magnetic field is measured from the center out to twice the radius of the coil. The angle of the resultant field is calculated in DataStudio.

### Order Information:

2-Axis Magnetic Field Sensor .....PS-2162

Recommended:

Zero Gauss Chamber .....EM-8652

Linear Motion Accessory .....CI-6688

p. 26

## Goniometer

PS-2137

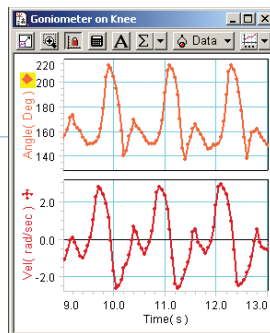
- ▶ Accurately Measures Joint Movements
- ▶ Flexible Mounting Options

PASCO's Goniometer helps students better understand physics because they use their bodies as the experimental apparatus. The Goniometer can be connected to the knee, hip or elbow joints to measure angle changes during a variety of movements. Measure the angular position, velocity and acceleration for the arm or leg. Use with the Xplorer datalogger for a compact, easy-to-use human motion lab.

The PS-2137 includes one Angle Sensor (PS-2139) and one Goniometer Probe with Velcro connection kit. To measure the motion of two joints simultaneously, simply purchase another Goniometer Probe separately.

### Specifications

- Range:** 0 to 120°
- Accuracy:** 2% of measurement
- Resolution:** 0.25°
- Maximum Sample Rate:** 500 Hz



Position and velocity of knee joint while running.

See page 180 for more information.

Developed in cooperation with Nancy Beverly, Assistant Professor of Physics at Mercy College, Dobbs Ferry, New York.

#### Order Information:

<b>Goniometer Sensor</b> .....	<b>PS-2137</b>
<i>Recommended:</i>	
Additional Goniometer Probe.....	PS-2138
PASPORT Xplorer .....	PS-2000

## Angle Sensor

PS-2139



The Angle Sensor measures angle by measuring resistance. It has two ports to accept two Goniometers (PS-2137) or the two probes in the joints of the Human Arm (ME-6807).

#### Order Information:

<b>Angle Sensor</b> .....	<b>PS-2139</b>
---------------------------	----------------

## Human Arm Model

PS-2611

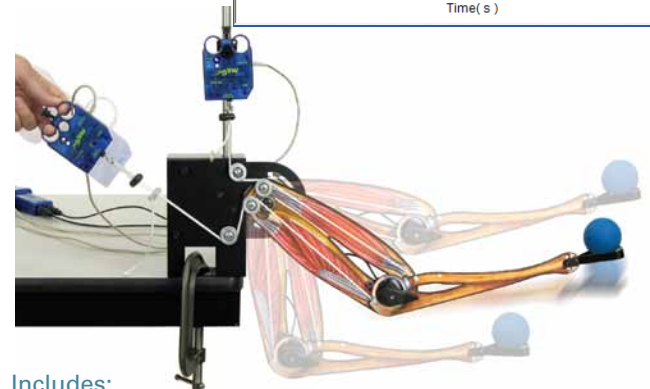
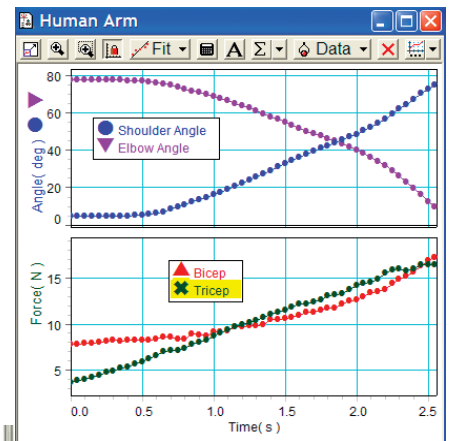


The Human Arm Model simulates the muscles and motion of an actual human arm. To activate the arm motion, students pull on the cord with a Force Sensor. Changes in position are measured at the shoulder and elbow using the two built-in potentiometers plugged into one Angle Sensor (PS-2139), included with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

The Arm can perform many types of motion such as extending and lifting an object, curling, or throwing a ball overhand. Different arm muscles are activated depending on which pulleys are selected. Static force measurements can also be made to see how the muscle tension changes at various arm positions.

### Angles and Forces

**During Extension:** The upper graph shows the angles of the elbow (violet trace) and the shoulder (blue) as the arm is extended as shown in the picture below. Shown in the lower graph, the bicep tension (red) has little change at first and then rises sharply as the arm reaches out, while the tricep tension (green) rises steadily. See page 179 for more information.



### Includes:

- Human Arm Model ME-6807
- Angle Sensor PS-2139

#### Order Information:

<b>Human Arm Model</b> .....	<b>PS-2611</b>
<i>Required for sensor measurement:</i>	
PASPORT Force Sensor (2).....	PS-2104 p. 28
PASPORT Interface .....	p. 10-23

## Exercise Heart Rate

PS-2129A



The Exercise Heart Rate Sensor measures a student's heart rate before, during and after physical activity based on electrical signals generated by the cardiac muscle. A belt worn around the ribcage houses a wireless transmitter. The voltage output from the receiver allows DataStudio software to produce the heart rate graph.

### Typical Applications

- ▶ Compare a student's heart rate before, during and after exercise
- ▶ Calculate recovery rate after physical activity
- ▶ Determine the effects of mild stimulants (i.e. caffeine)
- ▶ Investigate how heart rate changes when a student sits, reclines, stands or moves suddenly

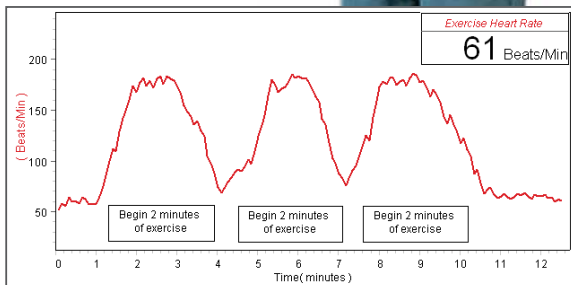
### Specifications

Digitally analyzes cardiac signal and determines heart rate

Measures in beats per minute



Graph shows the heart rate as a student alternates between exercise and resting.



### Order Information:

Exercise Heart Rate Sensor ..... PS-2129A  
 Replacement Transmitter Belt ..... PS-2518

## Hand Grip Heart Rate

PS-2186



The Hand Grip Heart Rate Sensor is the easiest way to measure resting and exercise heart rate. Our new design allows students to measure heart rate without the restriction and inconvenience of belts or clips. Extra long cords allow students to freely increase their physical activity in order to determine exercise heart rate. Simply grip the handles while the sensor measures cardiac muscle contraction in beats per minute.

### Typical Applications:

- ▶ AP Biology Lab 10: Physiology of the Circulatory System
- ▶ Measure and compare resting, exercise and recovery heart rate to determine physical fitness levels

### Specifications

**Measurement Range:** 40-240 beats per minute

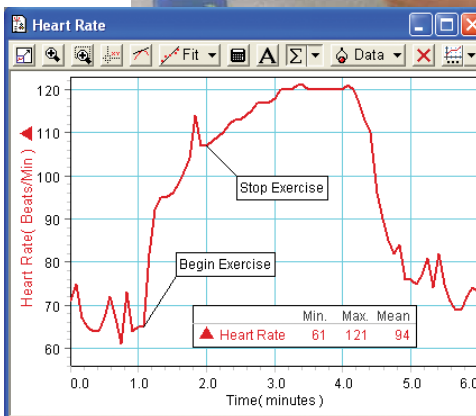
**Time to acquire heart beat:** 8-10 seconds

### Typical LED Indicators:

**Standby:** handgrips not held

**Acquire:** acquiring heart beat

**Beat:** flashes with each beat



### Order Information:

Heart Rate Sensor ..... PS-2186

## Blood Pressure

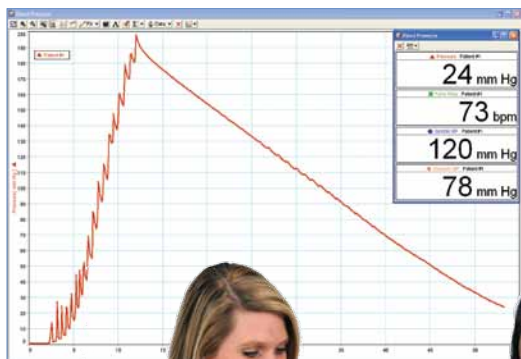
PS-2207

With PASCO's Blood Pressure Sensor students easily measure heart rate (bpm), systolic and diastolic arterial blood pressure (mmHg).

Students gain a greater understanding of the physiology of the circulatory system when they also learn about the physiology of blood pressure. The systolic and diastolic pressure provided in the digits display can be used by the student to verify their own determination of blood pressure from the graph.

### Experiment ideas:

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



A student "patient" remains still while another student uses the pump to increase the pressure in the cuff. The students observe the graph as the pressure in the cuff slowly decreases. On the digits display, students observe the patient's heart rate, systolic and diastolic blood pressure.

### Includes:

Blood Pressure Sensor, standard arm cuff\*, bladder and pressure release valve.

\*small and large cuffs are also available

### Order Information:

**Blood Pressure Sensor**.....PS-2207

### Recommended:

Small Cuff.....PS-2531

Medium Cuff.....PS-2532

Large Cuff.....PS-2533

## EKG

PS-2111



The EKG Sensor measures electrical signals produced by the heart. As cardiac muscle depolarization and repolarization occurs, the EKG trace graphically illustrates the beating of the heart. The sensor comes with 100 self-adhesive conductive patches that are easily removed from the skin after use.

### Typical Applications

- ▶ Generate a personal EKG graph
- ▶ Compare EKG graphs before and after mild exercise

### Specifications

#### EKG Waveform:

**Voltage:** 0 to 4.5 mV

**Resolution:** 4.5  $\mu$ V

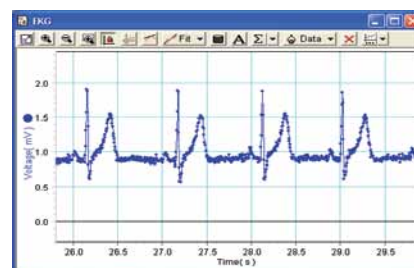
**Sample Rate:** 50 to 200 samples per second (sps)

**Default Sample Rate:** 200 samples per second (sps)

#### Heart Rate (Beats):

**Range:** 47 to 250 beats per minute (bpm)

**Resolution:** 1 beat per minute (bpm)



Additional EKG Electrode Patches (CI-6620) may be ordered separately.

NOTE: The EKG Sensor has been designed for educational purposes only and is not suitable for medical diagnoses.

### Order Information:

**EKG Sensor**.....PS-2111

**EKG Patches (100 each)**.....CI-6620

## Spirometer

PS-2152



With our Spirometer Sensor students can measure airflow, duration and lung volume. Disposable mouth pieces available for student safety.

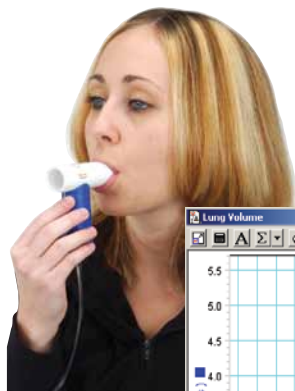
### Typical Applications:

- ▶ Compare a student's airflow before and after exercise
- ▶ Investigate the lung volume of athletes vs. non-athletes
- ▶ Compare smokers versus non-smokers
- ▶ Conduct respiratory experiments
- ▶ Determine total lung capacity

### Specifications

Displays volume in liters  
 Minimal resistance to air flow  
 Bi-directional air flow

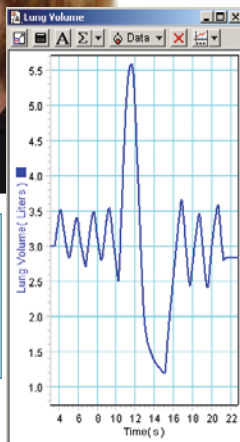
**Sample Rate Range:** 50 to 100 Hz



Measuring lung capacity.



Replaceable mouthpiece clips in.



### Order Information:

**Spirometer Sensor**.....PS-2152  
**Spirometer Mouth Pieces (10-pack)**.....PS-2522

## Breath Rate

PS-2187

- ▶ Works while exercising



The Breath Rate Sensor uses standard disposable dust masks and gives stable output even when exercising. Breath rate is measured by sensing the pressure changes inside the mask. Tubing from the sensor connects to the disposable pressure clips which fasten on the side of the mask.

### Two Modes:

- ▶ One reading every breath
- ▶ Running average over last four breaths



Data collected with Xplorer GLX while exercising.

### Includes:

Sensor with Tubing  
 Pressure Clips (10)  
 Masks (10)



### Order Information:

**Breath Rate Sensor**.....PS-2187  
**Replacement Clips (10)**.....PS-2568  
**Replacement Masks (10)**.....PS-2567

## Respiration Rate

PS-2133



The Respiration Rate Sensor uses PASCO's Relative Pressure Sensor, along with a Respiration Belt, to measure the change in pressure that occurs as the chest cavity expands and contracts during breathing. The Respiration Belt is wrapped around the lower part of the ribcage at the sternum, and the rubber bladder inside the belt is inflated using the attached squeeze bulb. A second tube connected to the rubber bladder attaches to the Pressure Sensor so that a graph of breath rate can be generated.

### Typical Applications

- ▶ Conduct comparisons before and after exercise
- ▶ Calculate possible correlations between respiration rate and heart rate
- ▶ Determine the effects of altitude variation on respiration

**Maximum Sample Rate:** 20 Hz



### Order Information:

**Respiration Rate**.....PS-2133  
**Respiration Belt**.....CI-9842

## Sound Level

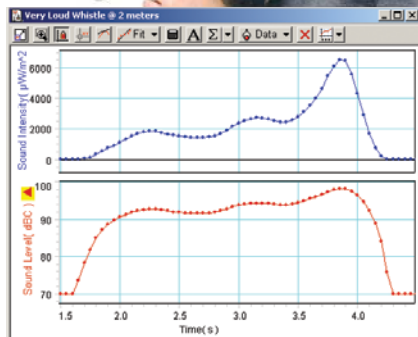
PS-2109



The Sound Level Sensor is designed to measure the intensity level of sound sources within proximity to the sensor. The sensor features three range switches to match the intensity range of the measured phenomena.

The sensor measures sound level in both the dBA and dBC scales. The dBC scale includes all frequencies incident on the Sound Level Sensor, whereas the dBA scale filters out some frequencies to more closely match the frequency response of the human ear.

The sensor also reports a measurement of sound intensity in  $\mu\text{W}/\text{m}^2$ , which is calculated from the dBC measurement of the sound level.



Graph shows sound level from a loud whistle in both intensity ( $\mu\text{Watts}/\text{m}^2$ ) and in decibels. Notice the difference in scales.

### Typical Applications

- ▶ Explore sound levels outside the classroom
- ▶ Discover the logarithmic relationship between sound level and sound intensity

### Specifications

**Range:** Sound Level Intensity  
30 dB to 70 dB;  $10^{-3} \mu\text{W}/\text{m}^2$  to  $10 \mu\text{W}/\text{m}^2$   
50 dB to 90 dB;  $1 \mu\text{W}/\text{m}^2$  to  $1000 \mu\text{W}/\text{m}^2$   
70 dB to 110 dB;  $10 \mu\text{W}/\text{m}^2$  to  $10,000 \mu\text{W}/\text{m}^2$   
**Max sample rate:** 20 Hz

**Accuracy:**  $\pm 2$  dB at 94 dB (1000 Hz)

**Resolution:** 0.1 dB

#### Order Information:

Sound Level Sensor.....PS-2109

## Temperature/Sound Level/Light

PS-2140



Launch students into an instant exploration of their environment! The Temperature/Sound Level/Light Sensor allows students to conduct all three measurements simultaneously and continuously. Students can instantly display measurements on an Xplorer or take readings over time, anywhere, and display the data on a computer. Add an optional Stainless Steel Temperature Probe (PS-2153) to conduct water studies.

### Typical Applications

- ▶ Measure the temperature difference between the floor and ceiling
- ▶ Determine the light level on a sunny versus cloudy day
- ▶ Compare sound levels of students whispering, singing loudly or applauding

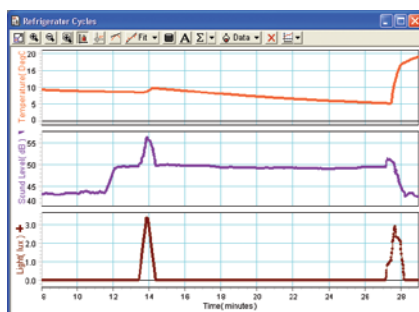
### Specifications

**Temperature (internal) Range:** -10 to  $+50 \text{ }^\circ\text{C}$

**Sound Level Range:** 40 to 90 dBA

**Light Range:** 0 to 5000 Lux

**Maximum Sample Rate:** 5 Hz



The temperature, light intensity, and sound level are simultaneously measured inside a refrigerator. Note the changes in measurements as the compressor starts and as the door is opened.

#### Order Information:

Temperature/Sound Level/Light Sensor.....PS-2140

Recommended:  
Stainless Steel Temperature Probe.....PS-2153

## General Science Sensor

PS-2168



Simultaneously measure temperature, light, sound level and voltage. Great for a variety of general science explorations.

### Specifications

**Temperature\*:**  $-35 \text{ }^\circ\text{C}$  to  $+135 \text{ }^\circ\text{C}$ ;  $\pm 0.5 \text{ }^\circ\text{C}$

\*Range is probe dependent.

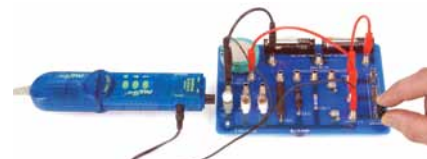
**Light:** 3 user selectable light ranges:  
0 to 100; 0 to 10,000; 0 to 150,000 Lux

**Sound Level:** 50 to 100 dB A

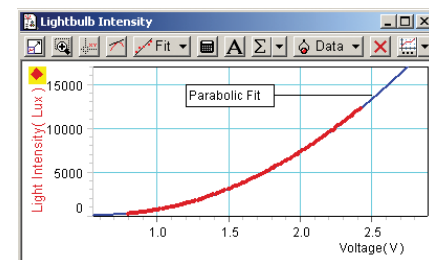
**Voltage:**  $\pm 24 \text{ V}$

**Voltage Protection:** up to 240 V

**Maximum Sample Rate:** 200 Hz



Shown using the EM-8678 Charge/Discharge Circuit. The capacitor is charged (using the AA batteries) and then discharged through the light bulb. The General Science Sensor measures the changing voltage across the bulb as well as the output light intensity.



The graph shows light intensity vs. voltage for the light bulb. The parabolic curve fit proves that light intensity is proportional to the square of the applied voltage.

### Includes

Stainless Steel Temperature Probe  
Voltage Probe

#### Order Information:

General Science Sensor.....PS-2168

Recommended:  
Charge/Discharge Circuit.....EM-8678 p. 253



**pH**  
PS-2102



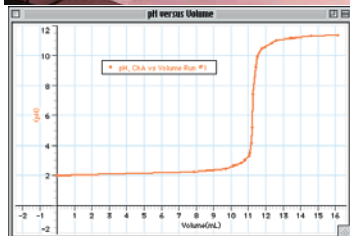
PASCO's pH Sensor measures the hydronium ion concentration in a solution and reports it as a pH value. This sensor is well-suited for a variety of activities where testing or monitoring of acidity is important.

**Typical Applications**

- ▶ Titrate an acid into a base
- ▶ Investigate the chemistry of buffers
- ▶ Monitor water quality

**Specifications**

**Range:** 0 to 14 (Probe dependent)  
**Accuracy:**  $\pm 0.1^*$   
**Resolution:** 0.01  
**Repeatability:** 0.02  
**Electrode:** gel-filled Ag-AgCl combination electrode  
**Maximum Sample Rate:** 50 Hz  
 \*After calibration



pH vs. volume graph

**Order Information:**

pH Sensor ..... PS-2102

**pH Replacement Electrode**

PS-2573  
(Previously part number 699-195)



**Order Information:**

pH Replacement Electrode ..... PS-2573

**Colorimeter**  
PS-2121



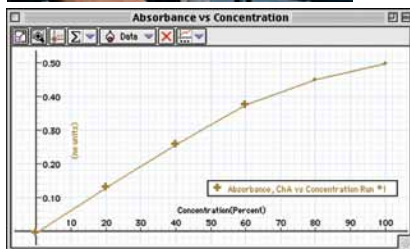
The Colorimeter Sensor allows a solution's concentration to be determined based on the ability of the solution to transmit or absorb colored light. PASCO's Colorimeter is the perfect tool for analyzing reactions indicated by color changes, or reactions where concentration changes over time. The sensor's black, opaque housing assures accuracy of data. The Colorimeter is packaged in a sturdy plastic case with five empty glass cuvettes so students can begin experimenting immediately.

**Typical Applications**

- ▶ Study absorbance vs. concentration (Beer's Law experiments)
- ▶ Determine the concentration of an unknown solution
- ▶ Measure reaction rates
- ▶ Measure four wavelengths simultaneously

**Specifications**

**Range:** 0 to 100% transmittance  
**Accuracy:**  $\pm 0.5\%$  transmittance  
**Resolution:** 0.1% transmittance  
**Operating Temperature:** 0 °C to 40 °C



Typical Beer's Law Standardization curve showing absorbance vs. concentration.

**Order Information:**

Colorimeter ..... PS-2121  
 Replacement Cuvettes/Caps (6 each) ..... PS-2509

**Conductivity**  
PS-2116A



Most Conductivity Sensors use graphite probes, but our Conductivity Sensor uses platinum for greater range and improved accuracy at high and low concentrations. The result is better measurements that lead to better labs. Three ranges, push-button selectable on the sensor, allows it to be used for a wider variety of experiments without requiring recalibration.

- ▶ Electrode houses rugged, research-grade conductors that provide superior accuracy over the entire range.
- ▶ 0-100,000  $\mu\text{S/cm}$  ranges allows salinity measurement from "fresh" water to sea water.
- ▶ Replaceable probe reduces maintenance costs.

**Typical Applications**

- ▶ Accurately compare conductivity of different water samples
- ▶ Study the effects of chemical flocculants on conductivity
- ▶ Conduct environmental studies
- ▶ Investigate drinking water purity

**Specifications**

**Range:** 0 to 1,000, 0 to 10,000, 0 to 100,000  $\mu\text{S/cm}$   
**Accuracy:**  $\pm 10\%$  of full scale without calibration  
**Accuracy:**  $\pm 0.1\%$  after calibration  
**Resolution:** Better than 0.05% of full scale  
**Repeatability:** Better than 0.01% of full scale  
**Maximum Sample Rate:** 20 Hz



Checking water quality of collected rain water.

*Location Number	*Conductivity
(no units)	( $\mu\text{S/cm}$ )
1	141
2	108
3	113
4	122
5	1327
6	83

**Order Information:**

Conductivity Sensor ..... PS-2116A

**Conductivity Replacement Probe**

PS-2571  
(Previously part number 699-06621)



**Order Information:**

Conductivity Replacement Probe ..... PS-2571

## Chemistry

PS-2170



Gas laws, acid/base, thermochemistry and redox all with one sensor! Measure temperature, pH, gas pressure and voltage. Easy to store. Easy to use. All measurements can be made simultaneously.

## Specifications

**Temperature\*:** -35 °C to +135 °C,  $\pm 0.5$  °C

**pH\*:** 0 to 14,  $\pm 0.1$  (with calibration)

**Absolute Pressure:** 0 to 700 KPa

**Voltage:**  $\pm 10$  V

**Maximum Sample Rate:** 20 Hz

\*Ranges are probe dependent.

## Includes

Stainless Steel Temperature Probe  
pH Probe  
Voltage Probe  
Gas Law Syringe with Tubing

## Order Information:

Chemistry Sensor.....PS-2170

## Micro Stir Bar

PS-2565

The Micro Stir Bar maintains a constant flow of solution over the end of the electrode, such as in the pH and conductivity probes. For use with a standard stir plate and cylindrical probes of about 13 mm diameter.

*Magnet is completely sealed to prevent damage from the chemicals.*



## Order Information:

Micro Stir Bar (set of 5).....PS-2565

## ISE – Precision pH/ORP/ISE Amplifier with Temperature

PS-2147



This high-precision sensor is ideal for Chemistry. Right out of the box students will be able to measure pH and temperature with the same sensor because the PS-2147 comes with a pH probe and a Fast Response Temperature Probe. The new ORP probe (CI-6716) can be purchased separately to measure the Oxidation Reduction Potential of a sample. With the addition of Ion Selective Probes (not included) students will be able to measure ion concentration in upper division Chemistry classes or samples brought back from the field.

Because all Ion-Selective Electrodes use the same amplifier box, each lab group requires one amplifier box plus the desired electrodes. For a complete list of available Ion-Selective Electrodes, see page 82.

## Typical Applications

- ▶ Determine the concentration of a specific ion in a solution
- ▶ Conduct water quality studies

## Order Information:

Precision pH/ORP/ISE Temperature Sensor.....PS-2147

ORP Probe CI-6716 can be used with the PS-2170 Chemistry Sensor and the PS-2147 ISE/ORP Amplifier.

ORP Probe.....CI-6716

Ion-Selective Electrodes can be used with the PS-2170 Chemistry Sensor and the PS-2147 ISE/ORP Amplifier.

Electrode	Molar Range	pH Range	Interfering Ions	Part #
Ammonium (NH <sub>4</sub> <sup>+</sup> )	1.0 to 5x10 <sup>-6</sup>	4-10	Cs <sup>+</sup> , K <sup>+</sup> , Tl <sup>+</sup> , H <sup>+</sup> , Ag <sup>+</sup> , +Tris <sup>+</sup> , Li <sup>+</sup> , Na <sup>+</sup>	CI-6717
Carbon Dioxide (CO <sub>2</sub> )	1x10 <sup>-2</sup> to 1x10 <sup>-4</sup>	4.8-5.2	Volatile weak acids	CI-6726
Calcium (Ca <sup>+2</sup> )	1.0 to 5x10 <sup>-6</sup>	3-10	Pb <sup>+2</sup> , Hg <sup>+2</sup> , Cu <sup>+2</sup> , Ni <sup>+2</sup>	CI-6727
Chloride (Cl <sup>-</sup> )	1.0 - 5x10 <sup>-5</sup>	2-12	S <sup>-2</sup> , I <sup>-</sup> , CN <sup>-</sup> , Br <sup>-</sup>	CI-6732
Lead (Pb <sup>+2</sup> )	1x10 <sup>-1</sup> to 1x10 <sup>-6</sup>	3-8	Ag <sup>+</sup> , Hg <sup>+2</sup> , Cu <sup>+2</sup> , Cd <sup>+2</sup> , Fe <sup>+2</sup>	CI-6736
Fluoride (F <sup>-</sup> )	Saturated to 1x10 <sup>-6</sup>	5-8	OH <sup>-</sup>	CI-6728
Nitrate (NO <sub>3</sub> <sup>-</sup> )	1.0 to 7x10 <sup>-6</sup>	2.5-11	ClO <sub>4</sub> <sup>-</sup> , I <sup>-</sup> , CN <sup>-</sup> , BF <sub>4</sub> <sup>-</sup>	CI-6735
Potassium (K <sup>+</sup> )	1.0 to 7x10 <sup>-6</sup>	2-12	Cs <sup>+</sup> , NH <sub>4</sub> <sup>+</sup>	CI-6733
Sodium (Na <sup>+</sup> )	Saturated to 1x10 <sup>-6</sup>	5-12	H <sup>+</sup> , K <sup>+</sup> , Li <sup>+</sup> , Ag <sup>+</sup> , Cs <sup>+</sup> , Tl <sup>+</sup>	CI-6734

\* Prices do not include the amplifier box.

**Required:** At least one CI-6738 Ion-selective Electrode Amplifier Box.

## Drop Counter (High-Accuracy)

PS-2117



At last, a professional Drop Counter can become part of the student lab. PASCO's Drop Counter has a wider (18 x 13mm) drop window for better drop detection and easier alignment with burettes. Works equally well with large or small, fast or slow drops. Easy calibration requires entering just one number into the computer. Includes a Micro Stir Bar for use with our pH and conductivity probes (see page 57).

### Typical Applications

- ▶ Determine the equivalence point
- ▶ Simple count activities

### Special Features

Measures up to 40 drops per second with drops as small as 0.5 mm.

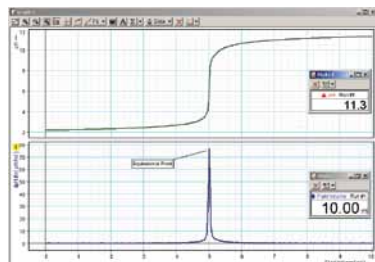
Silicone rubber-sealed polypropylene is fluid resistant and protects sensor from mild acids and bases.

Automatically recalibrates for maximum sensitivity each time the unit is turned on.

Holds up to three sensors in a 150 mL beaker

LED drop indicator

UV filter rejects all visible light - not susceptible to variations in room lighting



### Order Information:

High-Accuracy Drop Counter.....PS-2117

## Explore Fermentation with the EcoChamber and Ethanol Sensor

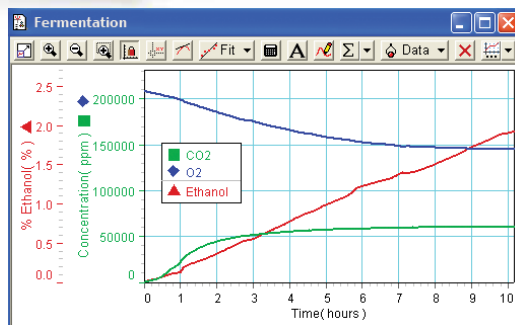
PASCO's acrylic EcoChamber is specially designed to accommodate up to three PASCO sensors. The EcoChamber can be used as a fermentation chamber in yeast fermentation experiments, a model ecosystem in photosynthesis and respiration experiments and a temperature regulation chamber when exploring the differences between endothermic and ectothermic animals. Its sturdy design and custom molding makes PASCO's EcoChamber a versatile science learning tool that is easy to use and easy to clean.



### Includes:

Acrylic chamber and rubber stoppers

*O<sub>2</sub> (ppm), CO<sub>2</sub> (ppm), and Ethanol (%) Concentration vs. Time (hours)*



### Order Information:

EcoChamber.....ME-6667  
 Shown in use with:  
 Ethanol Sensor.....PS-2194  
 Oxygen Gas Sensor.....PS-2126A  
 Carbon Dioxide Gas Sensor.....PS-2110  
 Magnetic Stirrer.....SE-7700

## Ethanol Sensor

PS-2194



The PASPORT Ethanol Sensor measures the concentration of gaseous ethanol up to 3%. In biology and environmental science labs, students can learn about anaerobic respiration by measuring the production of ethanol by bacterial or yeast fermentation. Physics and chemistry students can begin to explore combustion and thermodynamics. Connect your students to the study of respiration and alternative energy sources with the PASPORT Ethanol Sensor.

### Specifications

**Accuracy:** 20% of reading

**Range:** 0% to 3% gaseous ethanol

*In this experiment, PASCO's EcoChamber is filled with approximately 500 ml of 0.5 M sucrose solution and 1000 mL of yeast solution. The PASPORT Oxygen, Carbon Dioxide and Ethanol Gas sensors are inserted into the lid of the EcoChamber and all other holes are filled with stoppers to create an airtight environment. Students will observe the fermentation of sucrose as ethanol concentration increases in the chamber, and the simultaneous production of CO<sub>2</sub> and consumption of O<sub>2</sub>.*

## Dissolved Oxygen

PS-2108



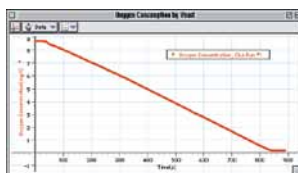
Dissolved Oxygen measurements are essential to water quality, Biology, Earth Science and Chemistry investigations. PASCO's DO Sensor accommodates more applications, allowing students to explore these subjects more thoroughly. Wider range (0 to 20 mg/L) ensures the sensor does not top out before the experiment is over.

### Typical Applications

- ▶ Measure oxygen consumption by yeast during respiration
- ▶ Investigate how the presence of organic matter affects DO levels
- ▶ Study biological oxygen demand (B.O.D.)

### Specifications

Excellent resolution (0.01 mg/L) allows students to see small changes  
 Temperature compensated - essential for consistent measurements.  
 0 to 20 mg/L at  $\pm 10\%$  of full scale without calibration  
 $\pm 0.2$  mg/L accuracy after calibration  
 0 to 50 °C operating range  
 Easily replaced membrane cartridges maintain sensor performance  
 Maximum Sample Rate: 20 Hz  
 Includes one replacement membrane



As the yeast in the flask respire, the dissolved oxygen concentration in the sugar water solution decreases.

### Order Information:

Dissolved Oxygen Sensor.....PS-2108  
 Membrane Replacement Kit.....CI-6541  
 Photosynthesis Tank.....PS-2521A

## Dissolved Oxygen Replacement Probe

PS-2572

(Previously part number 699-063230)

### Order Information:

Dissolved Oxygen Replacement Probe.....PS-2572



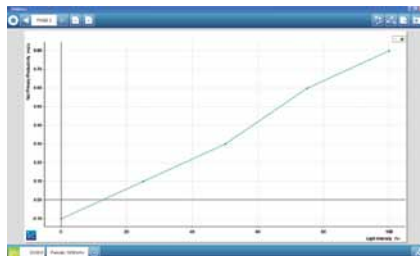
## Aquatic Productivity Bottles

ME-6937 Patent Pending

The Aquatic Productivity Bottles rest in a rack that provides consistent and reliable light control for quantitative aquatic productivity studies. The identical transparent bottles nest in each of five rack positions. The custom design of the rack shields the bottles from light by blocking a fixed percentage of light in 25% increments from zero to 100%.



The Aquatic Productivity Bottles were completely filled with algae solution, and the initial dissolved oxygen (DO) concentrations of the solutions were determined with a DO sensor. The bottles were then placed into the rack and the specially molded, light-varying lid was locked into place over the bottles. After 24 hours of incubation in fluorescent light, the bottles were removed from the rack and the DO concentration was again determined with a DO sensor. Using the initial and final (DO), students calculate Net Primary Productivity and Gross Primary Productivity.



Net Primary Productivity (mg/L) vs. Light Intensity (%): Notice that for the bottle in the dark, the Net Productivity is negative.

### Includes:

Plastic bottles w/lids (5)  
 and case with slotted lid



### Order Information:

Aquatic Productivity Bottles.....ME-6937  
 Shown in use with:  
 Dissolved Oxygen Sensor.....PS-2108

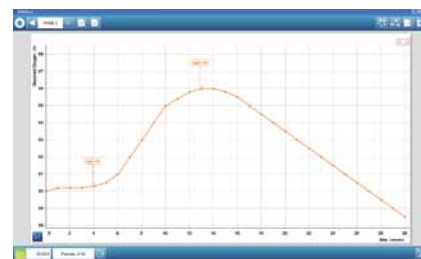
## Photosynthesis Tank

PS-2521A



- ▶ Measure O<sub>2</sub> production directly
- ▶ Control the environment of the aquatic plant
- ▶ Study changes in photosynthesis/respiration rates

Typical experiments involving photosynthesis require students to infer photosynthetic rate changes by using chloroplasts and dye. Help students understand this concept more completely by directly measuring the production of oxygen.



Water in the outer tank is used to control large fluctuations in temperature when the light is used. Students can further their understanding of photosynthetic rates by adding dyes as colored filters.

### Includes:

Acrylic chamber and rubber stoppers



### Order Information:

Photosynthesis Tank.....PS-2521A  
 Shown in use with:  
 SPARK Science Learning System.....PS-2008A  
 Dissolved Oxygen Sensor.....PS-2108  
 Magnetic Stirrer.....SE-7700

# Explore Cellular Respiration with the Metabolism Chamber

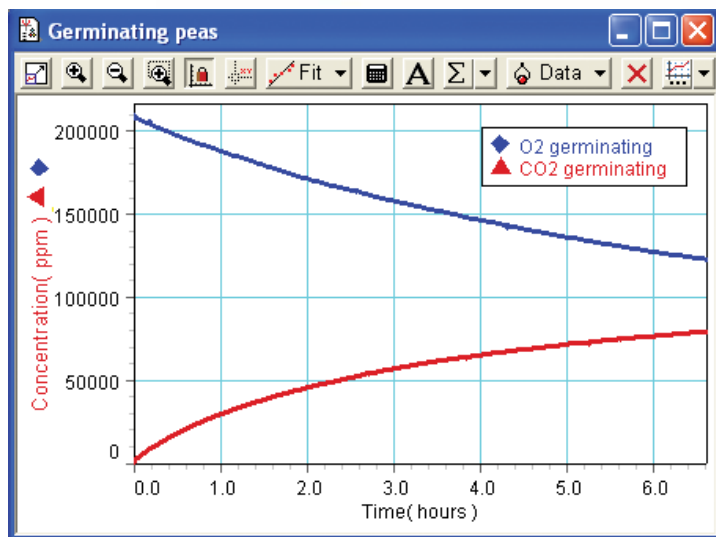
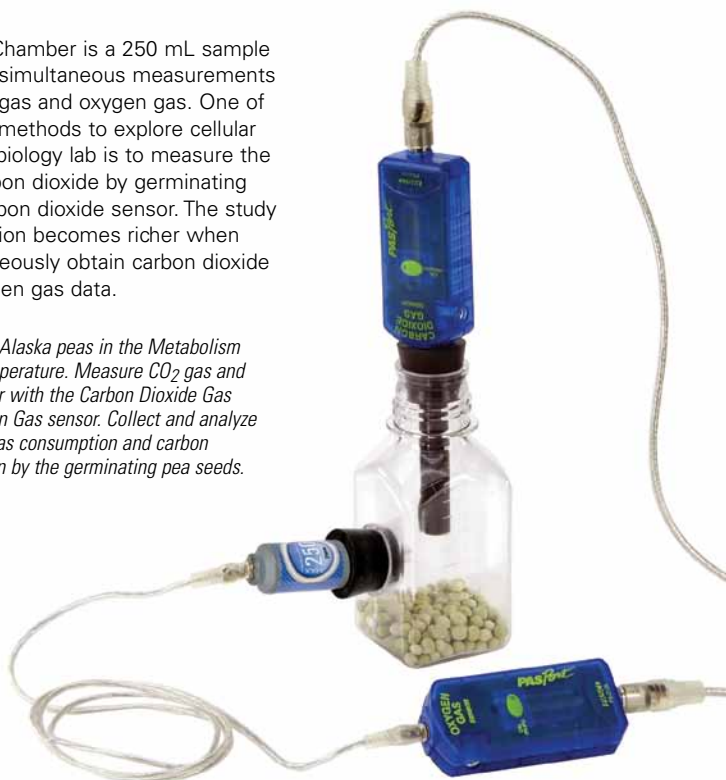
ME-6936

The Metabolism Chamber is a 250 mL sample bottle that allows simultaneous measurements of carbon dioxide gas and oxygen gas. One of the most popular methods to explore cellular respiration in the biology lab is to measure the production of carbon dioxide by germinating seeds using a carbon dioxide sensor. The study of cellular respiration becomes richer when students simultaneously obtain carbon dioxide gas data and oxygen gas data.

*Place 25 germinating Alaska peas in the Metabolism Chamber at room temperature. Measure CO<sub>2</sub> gas and O<sub>2</sub> gas in the chamber with the Carbon Dioxide Gas sensor and the Oxygen Gas sensor. Collect and analyze the data for oxygen gas consumption and carbon dioxide gas production by the germinating pea seeds.*

**Includes:**

- Plastic Bottle
- Stoppers (2)



O<sub>2</sub> and CO<sub>2</sub> Concentration (ppm) vs. Time (hours)

**Order Information:**

Metabolism Chamber.....	ME-6936
<i>Shown in use with:</i>	
Oxygen Gas Sensor.....	PS-2126A
Replacement Oxygen Electrode.....	PS-6524
Carbon Dioxide Gas Sensor.....	PS-2110
PASPORT Extension Cable.....	PS-2500

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

PS-2126A

PASCO's Oxygen Gas Sensor accurately measures oxygen concentration in the atmosphere or in enclosed spaces, such as terrariums. The sensor's wide range (0-100%) means students can use it with any experiment or investigation. Use in combination with the CO<sub>2</sub> Gas Sensor to perform an even wider variety of environmental and physiology activities in the classroom or in the field.



**Typical Applications**

- ▶ Measure the respiration of animals, insects or germinating seeds
- ▶ Study the catalase breakdown of hydrogen peroxide
- ▶ Monitor O<sub>2</sub> level changes during photosynthesis in a terrarium
- ▶ Study cellular respiration of yeast

**Specifications**

- Flow Range:** 0 to 100%
- Accuracy:** ±1% (at constant temperature)
- Resolution:** 0.025%
- Maximum Sample Rate:** 100 Hz
- Probe Shelf-life:** 3 years

**Special Features**

- Single point calibration requires just the touch of a button
- Automatic temperature compensation ensures consistent measurements
- Usable in any orientation

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

PS-2110

The CO<sub>2</sub> Gas Sensor measures carbon dioxide concentration in the atmosphere or in an enclosed volume, such as a terrarium. Using the included 250-ml sample bottle, students can even measure the exhalation of small organisms such as crickets. PASCO's proprietary design uses infrared detection to measure the energy absorbed by carbon dioxide molecules.



**Typical Applications**

- ▶ Measure CO<sub>2</sub> uptake during photosynthesis in a terrarium
- ▶ Compare indoor vs. outdoor CO<sub>2</sub> levels
- ▶ Study cellular respiration of yeast

**Specifications**

- Range:** 0 ppm to 300,000 ppm
- Accuracy:** For range of 0 to 10,000 ppm: 100 ppm or 10% of value, whichever is greater
- Calibration:** User presses one button while sampling outside air
- Default Sample Rate:** CO<sub>2</sub> concentration updates once each second
- Operating Temperature:** 20 °C to 30 °C
- Maximum Sample Rate:** 10 Hz

# EcoZone™ System

ME-6668

- ▶ Three EcoChambers, interconnected or standalone
- ▶ Designed for sensor-based measurements

PASCO's EcoZone System is designed to help students model and understand the complex interactions within, and among, different ecosystems. The three clear acrylic EcoChambers are specially designed to accommodate PASCO sensors, making qualitative and quantitative measurements as easy as observing.

With three interconnected chambers, students can model the interaction between three different ecosystems. Choose the traditional terrestrial, aquatic, and decomposition arrangement or create unique biomes to model and measure. Decouple the system for isolated investigations - how does the availability of light affect the ecosystem? Students can create two identical ecosystems and monitor one in light conditions and one in dark.

Clean up is easy, and the chambers are durable enough to use again and again. The unique design of the PASCO EcoZone System allows you to use your environmental science probes\* to actively measure a model ecosystem.

Keep the system closed during chemical testing – use the included syringe to extract water. Or “inject” pollutants into the system and see how the ecosystem responds.



Opening connects the chambers and allows the interaction between the living and non-living components of each unique ecosystem.



The included cord efficiently ‘wicks’ water between the chambers.

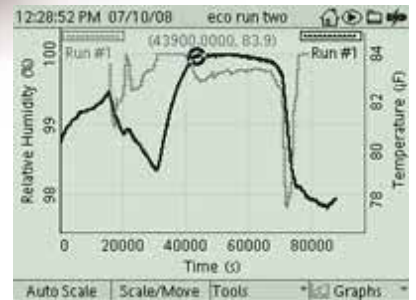
Decomposition Chamber

Terrestrial Chamber

Aquatic Chamber



Monitor the physical environment!  
This graph shows the relationship between the relative humidity and temperature within the terrestrial chamber over a 24 hour period.



**Includes:**

- Three individual EcoChambers including lids
- Custom tray for holding EcoChambers in a connected ecosystem
- Stoppers and connectors
- Cotton wick
- Syringe and plastic tubing



\*For more information on sensors and probes available for use with the EcoZone System, see [www.pasco.com/ecozone](http://www.pasco.com/ecozone) select Order Information tab.

**Order Information:**

EcoZone System .....ME-6668

## Weather/Anemometer

PS-2174



The Weather/Anemometer Sensor measures wind speed and wind chill in addition to temperature, barometric pressure, relative and absolute humidity, and dew point.

### Typical Applications

- ▶ Measure wind speed in direction of running on a track
- ▶ Study wind and pressure changes as a storm approaches
- ▶ Collect weather data for weeks inside or outside the classroom



### Specifications

**Wind Speed:** 1 to 65 miles per hour  
**Barometer:** 800 to 1090 hecto Pascals (hPa), 800 to 1090 milli Bars (mBar) and 24 to 34 inches Mercury (in Hg)  
**Humidity:** 0 to 100% RH  $\pm$  2%, 0g/m<sup>3</sup> to 50 g/m<sup>3</sup>  $\pm$  10% AH  
**Temperature:** -20 °C to 55 °C  $\pm$ 0.5 °C  
**Dew Point:** -50 °C to 55 °C  $\pm$ 2%  
**Maximum Sample Rate:** 5 Hz

#### Order Information:

Weather/Anemometer Sensor.....PS-2174

## Weather

PS-2154A



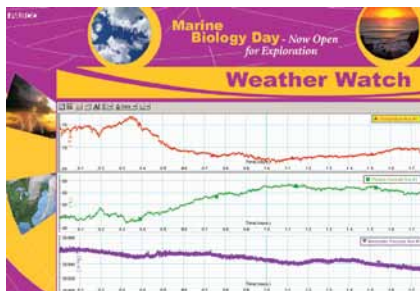
PASCO's Weather Sensor allows students to measure temperature, barometric pressure, relative and absolute humidity, and dew point. Whether you're comparing outdoor measurements to indoor, or monitoring an approaching storm, this powerful MultiMeasure Sensor™ does it all.

### Typical Applications

- ▶ Conduct weather station experiments
- ▶ Take one-time readings or collect data over days or weeks, in the classroom or anywhere
- ▶ Collect readings at various locations around school
- ▶ Study weather phenomena such as thunderstorms, cloud cover, etc...

### Specifications

**Barometer:** 800 to 1090 hecto Pascals (hPa), 800 to 1090 milli Bars (mBar) and 24 to 34 inches Mercury (in Hg)  
**Humidity:** 0 to 100% RH  $\pm$  2%, 0g/m<sup>3</sup> to 50 g/m<sup>3</sup>  $\pm$  10% AH  
**Temperature:** -20 °C to 55 °C  $\pm$ 0.5 °C  
**Dew Point:** -50 °C to 55 °C  $\pm$ 2%  
**Maximum Sample Rate:** 5 Hz



#### Order Information:

Weather Sensor.....PS-2154A

## Wind Velocity Accessory

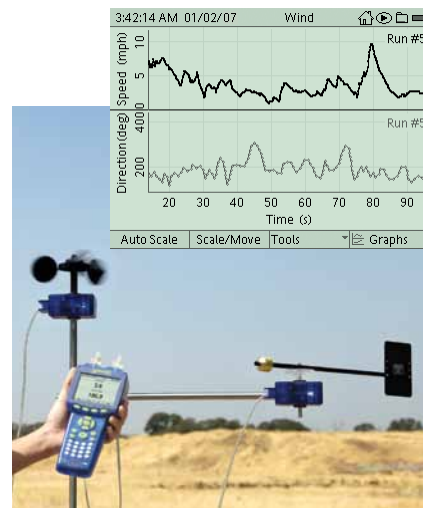
ME-6812



See page 26 for more information on the Rotary Motion Sensor.

The Wind Velocity Accessory has anemometer cups to measure wind speed and a wind vane to measure the wind direction. The anemometer cups and the wind vane each mount on a Rotary Motion Sensor (PS-2120 or CI-6538). Instructions are included for using the DataStudio or Xplorer GLX calculator to calibrate the wind speed. The wind vane must be aligned with North to specify alignment with zero degrees on the Rotary Motion Sensor and then wind direction is read as an angle between zero and 360 degrees.

When used with an Xplorer GLX, the system is portable and can be used for measuring wind or can be mounted on a bicycle or car to measure wind velocity relative to the vehicle. This is not intended as a weather-proof unit for permanent outdoor use.



#### Includes:

Anemometer cups  
 Wind vane



#### Order Information:

Wind Velocity Accessory.....ME-6812

Required:  
 Two PASPORT Rotary Motion Sensors.....PS-2120  
 or  
 Two ScienceWorkshop Rotary Motion Sensors.....CI-6538 p. 74

## Dual Humidity/Temp/Dew Point

PS-2156



The Dual Humidity/Temperature/Dew Point Sensor measures relative humidity (in units of percent (%) RH) and air temperature (in °C and °F). From these measurements, it calculates absolute humidity (in units of g/cm<sup>3</sup>) and dew point (in °C and °F). The sensor comes with two probes, to measure humidity and temperature in two locations at the same time.

### Typical Applications

- ▶ Measure humidity at two locations at the same time such as in the EcoZone™ System
- ▶ Compare humidity, dew point and temperature as they change over time
- ▶ Compare indoor and outdoor environments

### Specifications

**Range:** 3 0% to 100% (RH), 0 g/m<sup>3</sup> to 50 g/m<sup>3</sup> (AH)

**Accuracy:** from 10% to 95%, ±3% to ±5% (RH), 10% of reading (AH)

**Resolution:** 1% or better (RH), 0.1 g/m<sup>3</sup> or better (AH)

**Temperature:** -20°C to 55°C ±0.5°C

**Dew Point:** -50°C to 55°C ±2°C

**Cable Length:** 1m



PS-2156 shown in use measuring the difference in relative humidity between foliage and open area in EcoZone™ System ME-6668 (page 61).

#### Order Information:

Dual Humidity/Temp/  
Dew Point Sensor.....PS-2156

## Dual Humidity/Temp/Dew Point Replacement Sensor

PS-2161



#### Order Information:

Dual Humidity/Temp/Dew Point  
Replacement Sensor.....PS-2161

## Barometer/Low Pressure

PS-2113A



PASCO's Barometer Sensor measures changes in atmospheric pressure over long and short periods of time. The sensor reports measurements in units of in Hg, hPa, or mBar. It can also be used as a Low Pressure Sensor.

### Typical Applications

- ▶ Conduct weather station experiments
- ▶ Measure changes in elevation
- ▶ Compare classroom data to local weather reports to predict weather

### Specifications

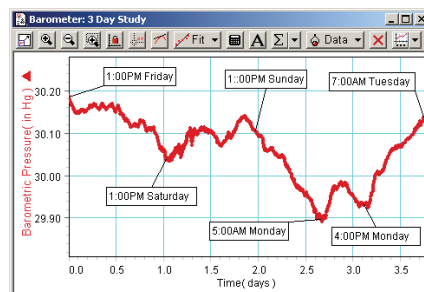
**Range:** 4.4 in Hg to 34 in Hg

**Accuracy:** ±0.03 in Hg

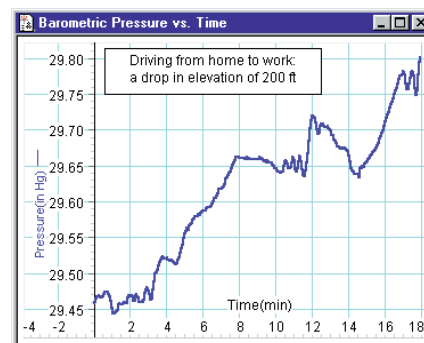
**Resolution:** 0.001 in Hg

**Maximum Sample Rate:** 20 Hz

**Operating Temperature:** 0 °C to +40 °C



Graph shows pressure changes as a storm moves through over a three day period.



Graph shows data for a 200-foot decrease in elevation during a car drive.

#### Order Information:

Barometer Sensor.....PS-2113A

## Humidity/Temp/Dew Point

PS-2124A



This PASPORT multisensor is designed for single readings or continuous monitoring of relative and absolute humidity. The sensor also reports temperature, allowing a measurement of dew point, calculated from the humidity measurements and temperature measurements.

### Typical Applications

- ▶ Conduct weather station experiments
- ▶ Check humidity in a terrarium, greenhouse or other enclosure
- ▶ Measure dew point

### Specifications

#### Humidity:

**Range:** 0 to 100% RH; 0g/m<sup>3</sup> to 50 g/m<sup>3</sup> AH

**Accuracy:** ±2% RH; 10% of reading AH

#### Temperature:

**Range:** -20 °C to +55 °C

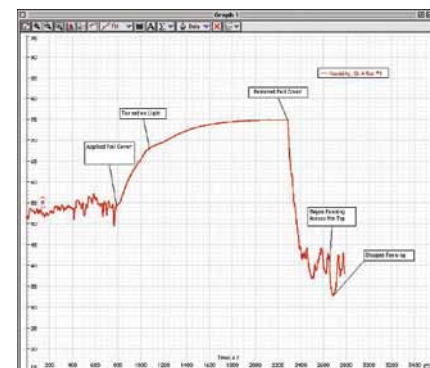
**Accuracy:** ±0.5 °C

#### Dew Point:

**Range:** -50 °C to +55 °C

**Accuracy:** ±2 °C

**Maximum Sample Rate:** 10 Hz



Graph shows the humidity in a terrarium, both covered and uncovered.

#### Order Information:

Humidity/Temp/  
Dew Point Sensor.....PS-2124A



## Soil Moisture

PS-2163



The Soil Moisture Sensor measures the water content of soil and reports it in percent. It can be used to conduct experiments in environmental science, agricultural science, horticulture and biology.

### Typical Applications:

- ▶ Measure the loss of soil moisture over time due to evaporation and plant uptake.
- ▶ Evaluate optimum soil moisture contents for various species of plants.
- ▶ Monitor soil moisture content to control irrigation in greenhouses.



### Specifications

**Sensor Range:** 0 to 45% volumetric water content in soil

**Sensor Probe Length:** 5.5 cm

**Sensor Probe Cable Length:** 5 m

**Accuracy:** ± 4%

**Resolution:** 0.1%

**Power:** 3 mA at 5 V DC

**Operating Temperature:** -40 to 60 °C

**Default Sample Rate:** 10 samples per second

#### Order Information:

Soil Moisture Sensor.....PS-2163

*Recommended:*

Soil Water Potential Probe.....PS-2513

## Soil Water Potential Probe

PS-2513

- ▶ For use with  
Soil Moisture Sensor



Water potential is often preferred over water content because it shows how water will move in soil or from the soil to the plant. The Soil Water Potential Probe measures the dielectric permittivity of its ceramic disk to determine its water potential.

#### Order Information:

Soil Water Potential Probe.....PS-2513

*Required:*

Soil Moisture Sensor.....PS-2163

## Salinity

PS-2195

The PASPORT Salinity Sensor works with the 10X Salinity Sensor Probe to measure salinity, conductivity, and temperature. The sensor determines salinity based on electrical conductivity. The sensor has a built in calculation to compensate for the change in conductivity due to temperature change based on the Practical Salinity Scale (PSS).



The Salinity Sensor measures the electric current through a solution between the two platinum electrodes in the Salinity Sensor Probe. The current through the solution is due to the movement of ions, so the higher the concentration of ions in the solution, the higher its conductivity. A voltage (AC) is applied across the two electrodes in the tip of the probe and the measured current is proportional to the conductivity of the solution.

### Typical Applications:

- ▶ Explore the salinity of local water sources.
- ▶ Explore the interrelationship of salinity, temperature, and conductivity.
- ▶ Measure the change in the salinity of saltwater as the water evaporates.

### Examples of Water Salinity

Fresh water: <0.5 ppt

Brackish water: 0.5 to 30 ppt

Saline water: 30 to 50 ppt

Ocean Water: 35 ppt

Brine: >50 ppt

### Specifications

#### Measurement Ranges:

**Conductivity:** 1,000 to 100,000  $\mu\text{S}$

**Temperature:** 0 to 50 degrees C

**Salinity:** 1 to 55 ppt  $\pm 1\%$  (with calibration)

**Sample rate (maximum):** 50 Hz

**Temperature compensation:**  $\pm 0.5$  ppt from 0 to 45 °C at 33 ppt

**Cell constant:** 10X

#### Order Information:

Salinity Sensor.....PS-2195

*Recommended:*

PASPORT Extension Cable.....PS-2500

## Thermocline

PS-2151

At last, students can measure temperature as a function of depth in local streams and lakes. PASCO's Thermocline measures depth automatically — no need to read markings on a cable and enter data manually. Weighted housing provides depth measurement stability in fast-flowing streams.



### Typical Applications

- ▶ Study thermoclines in fresh and salt water environments
- ▶ Create depth profiles for streams, small rivers, shorelines, and swimming pools
- ▶ Study ocean tides

### Specifications

#### Depth (pressure) -sensing element:

**Range:** 0m to 10.5 m

**Accuracy:** 0.15 m (in fresh water after barometric pressure compensation)

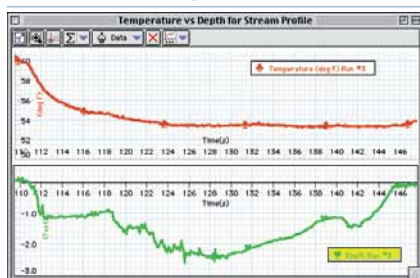
**Resolution:** 0.03 m

#### Temperature-sensing element:

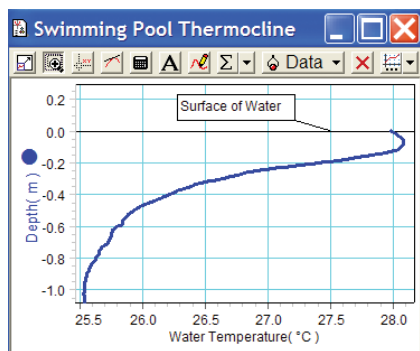
**Range:** 0 °C to 100 °C

**Accuracy:** ± 1.5 °C

**Maximum Sample Rate:** 10 Hz



Drag the Thermocline along the bottom of a pool or stream to create a temperature vs. depth profile.



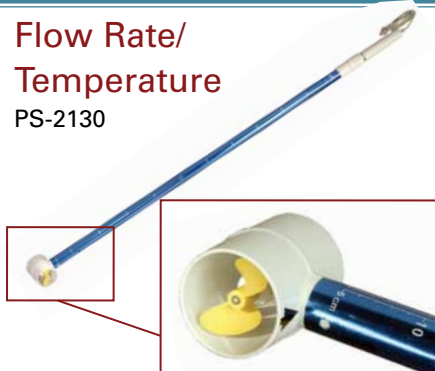
The temperature of the water in a swimming pool is measured as a function of depth.

#### Order Information:

Thermocline Sensor.....PS-2151

## Flow Rate/ Temperature

PS-2130



PASCO's Flow Rate Sensor allows students to measure the rate of movement and temperature of streams, rivers and other flowing systems. The propeller is a rugged, single-piece unit encased by protective material — no more losing pieces to the bottom of the stream.

### Typical Applications

- ▶ Determine sediment transport rate for a stream or other body of water
- ▶ Measure and compare flow rate at various locations in a stream
- ▶ Compare the characteristics of one stream to another

### Specifications

**Flow Range:** 0 m/s to 3.5 m/s

**Temperature Range:** -10 °C to 50 °C

**Maximum Length:** 1.8 m (6 feet)

Telescoping handle to reach deep levels

**Maximum Sample Rate:** 20 Hz

### Special Features:

Revolutions of a magnet on the submersible propeller are counted and converted to linear flow rate measurements in ft/sec or m/s. Students can use DataStudio software to calculate volume discharge rates

Exclusive built-in temperature sensor conveniently measures temperature at the same point as flow rate.



Graph shows the flow rates at the top (green), middle (orange), and bottom (brown) of a stream.



#### Order Information:

Flow Rate/Temperature Sensor.....PS-2130

## Turbidity

PS-2122



The Turbidity Sensor measures the cloudiness of liquid samples by quantifying the degree to which light passing through the solution is scattered by suspended particles. Calibration is done with the touch of a button in less than a minute. The sensor's black opaque housing assures accuracy of data. The Turbidity Sensor is packaged along with 5 empty glass cuvettes and a Hach StablCal 100-NTU standard in a sturdy plastic case.

### Typical Applications

- ▶ Compare the turbidity of water samples from various field locations
- ▶ Determine the rate of settling of a sample
- ▶ Conduct water quality studies
- ▶ Measure the formation of a precipitate

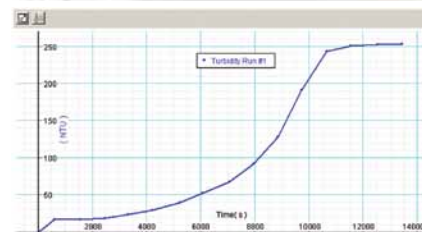
### Specifications

**Range:** 0 NTU to 400 NTU

**Accuracy:** 0 to 20 NTU: ±0.2 NTU  
20 to 100 NTU: ±0.5 NTU  
100 to 400 NTU: ±1.0 NTU

**Temperature Range:** 5 °C to 40 °C (recommended)

**Maximum Sample Rate:** 5 Hz



Over time, turbidity increases in a solution of suspended E. Coli.

#### Order Information:

Turbidity Sensor.....PS-2122  
Replacement Cuvettes/Caps (6 each).....PS-2509  
100 NTU Cal Standard.....PS-2511  
Silicone Oil (15 mL).....PS-2510

## Water Quality

PS-2169



Conduct a wide range of water studies with this single sensor: temperature, pH, dissolved oxygen and conductivity. All measurements can be made simultaneously.

### Specifications

**Temperature\*:** -35 °C to +135 °C, ±0.5 °C

**pH\*:** 0–14, ±0.1 (with calibration)

**Dissolved Oxygen:** 0 to 20 mg/l, ±0.2 (with calibration)

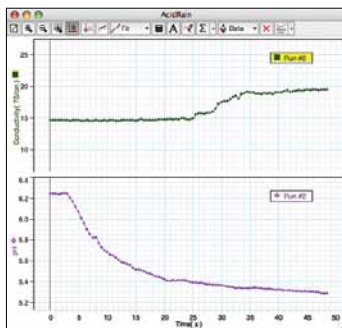
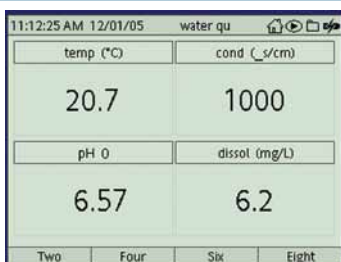
**Conductivity:** user selectable, 0 to 1,000;  
0 to 10,000;  
0 to 100,000 µS/cm;  
±0.1% (with calibration)

**Update Rate:** Every 1.3 seconds

\*Ranges are probe dependent.

### Includes

Stainless Steel  
Temperature Probe  
pH Probe  
Dissolved Oxygen Probe  
Conductivity Probe.  
Also supports ISE and  
ORP Electrodes (optional).



*pH and conductivity in a lake are measured simultaneously as simulated acid rain falls into the lake.*

### Order Information:

Water Quality Sensor ..... PS-2169

## Water Quality Colorimeter

PS-2179

This PASPORT Water Quality Colorimeter is designed specifically to support chemical analysis of water samples using PASCO's ezSample Snap Vial water quality test kits.



1. Snap tip of ampoule and sample instantly flows into tube.



2. Read concentration using Xplorer GLX.

This Water Quality Colorimeter is complete with built-in calibration curves to determine the concentration of ions in the solution for the ions listed on this page. Simple to use in the field and students avoid direct contact with chemicals!

### Specifications:

#### Measurable Ranges:

ezSample Snap Vials (Colorimetric)	
Iron	0 to 7 mg/l
Nitrate	0 to 2 mg/l
Ammonia	0 to 3 mg/l
Phosphate	0 to 8 mg/l
Chlorine	0 to 6 mg/l
ezSample Field Titrators	
Total Hardness	20 to 200 mg/l
CO <sub>2</sub>	10 to 100 mg/l
Alkalinity	10 to 100 mg/l

**Operating Temperature:** 0° to 40° C

#### Water Quality Colorimeter

PS-2179

#### Available Test Kits\*:

(30 tests per kit)

ezSample Snap Vials (Colorimetric)	
Iron	EZ-2331
Nitrate	EZ-2333A
Ammonium	EZ-2334
Phosphate	EZ-2337
Chlorine	EZ-2339
ezSample Field Titrators	
Total Hardness	EZ-2338
CO <sub>2</sub>	EZ-2341
Alkalinity	EZ-2340

*\*Special shipping restrictions may apply. Please contact PASCO for more information.*

## Water Quality Field Guide

PS-2829A

- ▶ Educator-designed, Student-tested
- ▶ Combination 'how-to' and 'why?' reference

*This handy guide was prepared for teachers and students alike, with both a good science process and effective science learning in mind.*



### Includes:

Spiral-bound Field Guide  
Electronic version of editable MS Word files on a USB flash drive

### 16 Water Quality Parameters:

- ▶ Ammonia
- ▶ Biological Oxygen Demand (BOD)
- ▶ Chlorine
- ▶ Conductivity
- ▶ Dissolved Carbon Dioxide
- ▶ Dissolved Oxygen
- ▶ Iron
- ▶ Nitrate
- ▶ pH
- ▶ Phosphate
- ▶ Salinity
- ▶ Stream Flow Rate
- ▶ Temperature
- ▶ Turbidity
- ▶ Total Alkalinity
- ▶ Total Hardness

### Order Information:

Water Quality Field Guide ..... PS-2829A

## GPS Position Sensor

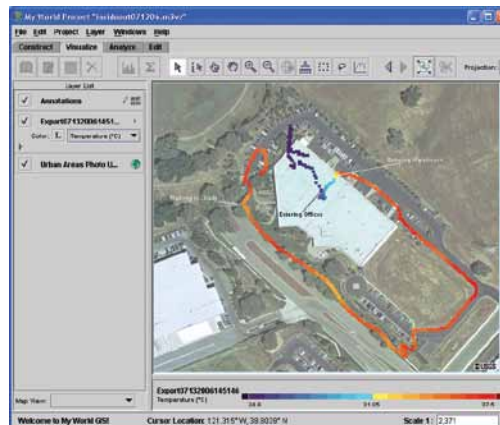
PS-2175

Use PASCO's GPS Position Sensor to collect GPS data simultaneously with other sensor measurements, automatically syncing the data to your latitude, longitude, altitude, and velocity.



Students use the Xplorer GLX, GPS Position Sensor and the Weather Anemometer to make environmental measurements around the perimeter of a park.

Aerial photograph in My World GIS™ showing humidity index and wind chill from PASCO's Weather/Anemometer Sensor. The size of the block indicates the humidity index and the color indicates the wind chill.



On a warm day, temperature and GPS position data were collected with an Xplorer GLX, as a teacher walked around and through PASCO's building. The data was then imported into My World GIS where positions were color coded by temperature.

The GPS Position sensor utilizes satellite triangulation to determine the sensor's position and velocity in outdoor environments. The highly-sensitive receiver is able to track satellites even under tree



Aerial Photo and GPS position data, color-coded by number of satellites in fix, from hike in Costa Rica. Notice, even in thick jungle canopy, there is continuous satellite reception.

canopies often found along rivers. The sensor provides latitude, longitude, horizontal speed, course over ground, altitude and the number of tracked satellites. LED indicators let the user know if the GPS Position sensor is currently computing position reports. Overlay sensor data on aerial photos and maps using My World GIS software (see page 17 for more information).

### Specifications

**Measures:** Latitude, longitude, elevation, velocity (speed and bearing), number of satellites

**Position Accuracy:** 10 meters, 2D RMS; 5 meters, 2D RMS, WAAS enabled

**Position Resolution:** 2 meters, full Latitude/Longitude mode; 0.2 meters relative position mode

**Velocity Resolution:** 0.1 m/s

**Time to First Fix (average):** 42 sec, cold start; 38 sec, warm start; 1 sec, hot start

**Channels:** 20

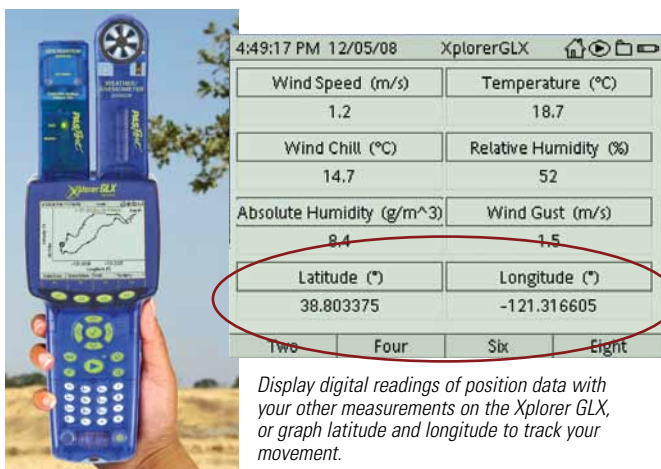
**Refresh Rate:** Once per second

### Includes

GPS Position Sensor

### Order Information:

GPS Position Sensor.....	PS-2175	
<i>Recommended:</i>		
Weather Sensor.....	PS-2154A	p. 62
My World GIS 5.0 Student License.....	SE-7363	p. 17
PASPORT Sensor Extension Cable.....	PS-2500	p. 24



Display digital readings of position data with your other measurements on the Xplorer GLX, or graph latitude and longitude to track your movement.

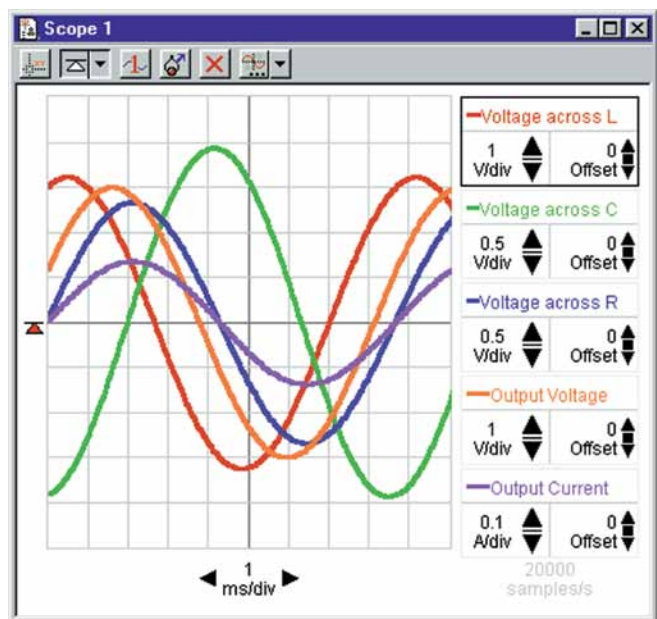
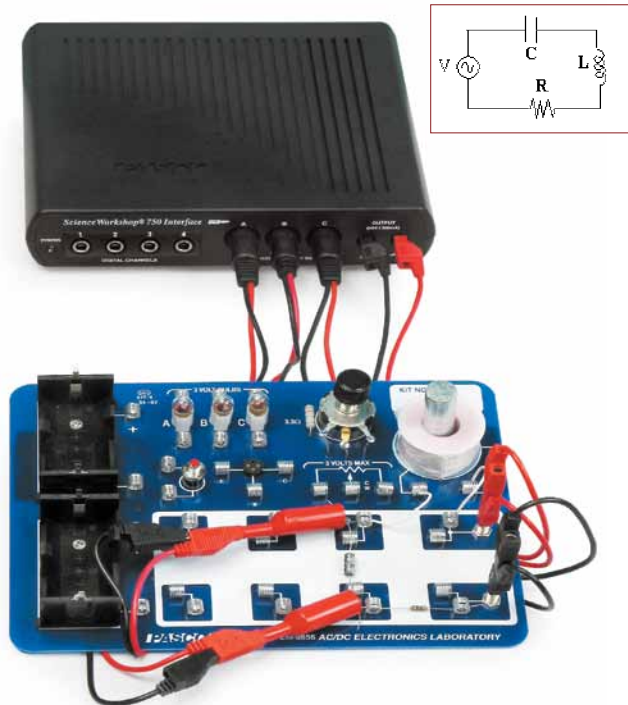
See [www.pasco.com/myworld](http://www.pasco.com/myworld) for more information on My World GIS Mapping software.

## 750 Interface

CI-7650

- ▶ Fast: 250,000 Hz
- ▶ Built-in Function Generator
- ▶ Built-in DC Power Supply (300 mA,  $\pm 5$  V)
- ▶ Accessory Power Amplifier Increases Power to 1 A,  $\pm 10$  V (See Page 56)
- ▶ Simple USB Connection to Computer

**ScienceWorkshop 750  
Experiment Bundles:**  
See pages 90-95



The 750 eliminates the need for a separate signal generator. In this LRC experiment, the 750 powers the circuit with a sinusoidal function and using 3 voltage sensors, measures the voltages across the inductor, capacitor, and resistor simultaneously. In addition, it also records the output voltage and current. DataStudio can display all 5 traces on its oscilloscope so the phase shifts can be measured.

### ▶ New Sense and Control Feature

The 750 output voltage can now be controlled using the calculator in DataStudio. For example, use the 750 output voltage to turn on a DC motor at a voltage proportional to the light intensity reading on a Light Sensor.

New calculator functions included in DataStudio are:

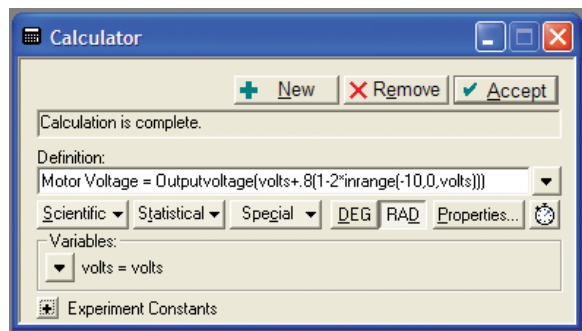
#### Outputswitch (A)

Controls the ON/OFF state of the Signal Generator window when using a ScienceWorkshop 750 interface. If the result of the sub-expression A is non-zero, then the Signal Generator is turned ON. Otherwise, the Signal Generator is turned off. The waveform, amplitude or voltage settings of the Signal Generator are unaffected by this command.

#### Outputvoltage (A)

Controls the voltage (DC) or amplitude (waveform) of the Signal Generator window when using a ScienceWorkshop 750 interface. The result of the sub-expression A is used to set the output voltage or amplitude. Note: The parameter to output voltage will be limited to the range of  $\pm 5$ V (without a power amplifier), or  $\pm 10$ V (with a power amplifier).

The 750 uses ScienceWorkshop sensors and cannot use PASPORT sensors.



## Our Most Powerful Interface

### 750 Interface Features

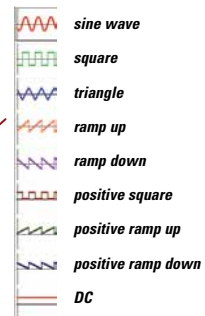
#### State-of-the-Art Circuitry

Contains:

- Flash EPROMs and Field-Programmable Gate Arrays (FPGA) for easy field upgrades
- Dual Port RAM that allows direct memory access (DMA) for fast data transfer
- Semi-RISC 32 MHz microprocessor
- 8x Oversampling
- Surface Mount, Multilayer Circuit Board

#### Built-in Function Generator

1.5 Watt function generator is ideal for basic circuit experiments and low power uses of speakers, wave drivers and sonometers.



#### Seven Input Channels

With the 750, all seven channels may be used simultaneously. There are no limitations on what combinations of sensors can be used. Analog and digital inputs may be mixed in any combination.

#### Four Digital Channels

Use up to four Photogates or two Rotary Motion Sensors, a photogate and Motion Sensor II, or any other combination.

#### Three Analog Channels

Max sample rate of 250,000 Hz when using a single channel.

#### Features

**250,000 Hz Sampling Rate:** Sample at 250,000 samples per second on a single analog channel. Students will see a true, real-time oscilloscope and incredibly responsive sound sensor data.

**Built-in 1.5 W Function Generator:** Any experiment requiring a frequency up to 50 kHz and 1.5 watt (300 mA) output can be run without additional power amplification. Output current and voltage can be monitored internally by the 750 Interface.

**20 kHz Oscilloscope:** With the 750's increased sampling rate, the oscilloscope becomes a real-time scope with refresh rates up to 40 frames per second.

**Reduced Noise, More Accurate Data:** When sampling at rates less than 100 samples per second, the 750 Interface provides 8X oversampling to reduce noise and provide smoother data curves.

#### Unique Characteristics

**Ports:** Four Digital, Three Analog, One Output

**Connection:** USB

**Data Sampling:** Simultaneous Analog and Digital Recording

**Analog Rates:** Up to 250,000 samples/sec (20 KHz Oscilloscope)

**Digital Rates:** 0.1 msec digital timing accuracy (1 mm resolution for Motion Sensor)

**Function Generator:** 0 to 50 KHz, 1.5 W (300 mA) output

**Power Amp Compatible**

#### Specifications

**Power:** 12 VDC to 20 VDC at 2 A, 2.1 mm jack (AC adapter included)

**Digital Channels:** Four identical channels, TTL compatible (8 mA max. drive current) Maximum input logic transition time: 500 ns Edge sensitive-sampled at 10 KHz. (1  $\mu$ s res. for Motion Sensor)

#### Analog Input Channels:

Three identical channels with differential inputs and 1 M $\Omega$  impedance  $\pm$ 10 V maximum usable input voltage range ( $\pm$ 12 V absolute input voltage range) Three voltage gain settings on each analog channel: 1, 10, and 100 Small signal bandwidth up to the ADC: 1 MHz for a gain of 1, 800 KHz for a gain of 10, and 120 KHz for a gain of 100; input amplifier slew rate: 1.2 V/ $\mu$ s

#### Electrostatic Discharge (ESD) protected

Both digital and analog inputs have ESD protection.

#### 12-bit Analog-to-Digital Conversion:

Five inputs: channels A–C, analog output voltage and current. Voltage resolution at ADC input: 4.88 mV (.488 mV at a gain of 10, 0.049 mV at a gain of 100) Current measurement resolution: 244  $\mu$ A, (1 V = 50mA) mA

Offset voltage accuracy <  $\pm$ 3 mV. (For measuring full-scale voltages the total error is less than  $\pm$ 15 mV, accounting for the gain error in the input amplifier.)

Sample rate range: once every 3,600 seconds (250 KHz) (Conversion time for consecutive channels in a burst is 2.9  $\mu$ s.) 8X oversampling for better accuracy at sample rates  $\leq$  100 Hz.

#### Analog Output:

DC value ranges: -4.9976 V to +5.0000 V in steps of 2.44 mV

Accuracy at the DIN connector: ( $\pm$ 3.6 mV  $\pm$ 0.1% full scale)

Peak-to-peak amplitude adjustment ranges for AC wave form: 0 V to  $\pm$ 5 V in steps of 2.44 mV AC waveform frequency ranges: 0.001 Hz to 50 KHz,  $\pm$ 0.01%

Maximum amplified output at the banana jacks: about 300 mA at  $\pm$ 5 V, current limited at 300 mA  $\pm$ 12 mA

#### Order Information:

**750 Interface - USB**..... **CI-7650**  
(USB-compatible computers)

## Power Amplifier II

CI-652A

- ▶ For the *ScienceWorkshop 750* and *700* Interfaces
- ▶ Provides up to  $\pm 10$  V at 1 A



The optional Power Amplifier connects to both the *ScienceWorkshop 700* and *750* (USB and SCSI) Interfaces. It allows students to drive and monitor experiments at the same time. By using the Power Amplifier II, the computer becomes a:

**Digital Frequency Generator:** Drive speakers, coils, resonant circuits, vibrating wires, etc.

**Variable DC Power Supply:** Drive electrical circuits, motors, lights, etc.

**Controlled Energy Source:** For a variety of simple and effective experiments in energy transformation and conservation.

**Note:** The *ScienceWorkshop 750* Interface has a built-in function generator output of  $\pm 5$  VDC at up to 300 mA. For higher output voltages and currents, the Power Amplifier II must be used.

### Specifications

#### Output:

- Variable Voltage:  $\pm 10$  V
- Current: up to 1 Amp
- Frequency: from DC to 50 kHz
- Resolution: 0.01 Hz
- Low Output Impedance:  $< 1 \Omega$
- Line and Load Regulated

**Overload Indicator:** LED

**Connector:** 8-pin DIN for *ScienceWorkshop 750* and *700* Interfaces

**Interface Capability:** for *ScienceWorkshop 750* and *700* Interfaces only

#### Order Information:

Power Amplifier II ..... CI-652A

## 8-pin DIN Extender Cable

CI-6516

This six meter DIN-to-DIN extension cord can be used with any analog sensor.



#### Order Information:

8-pin DIN Extender Cable ..... CI-6516

## Amplifier Accessories

The following accessories are designed for use with the CI-652A Power Amplifier and *750 ScienceWorkshop* Interface.

## AC/DC Electronics Laboratory

EM-8656



Use this kit with a PASCO computer interface and Power Amplifier or as a stand-alone unit. Two D-cells required (not included). Storage tray holds all components. Components include all standard electronic parts — resistors, capacitors, an inductor coil, a diode, an iron core, a potentiometer and a transistor socket.

#### Order Information:

AC/DC Electronics Lab ..... EM-8656 p. 256

## RLC Circuit

CI-6512



This board offers a unique set of components for demonstrating:

- ▶ Voltage/Current Phase Relationships
- ▶ RLC Resonance
- ▶ Non-ohmic Characteristics. Component values include resistors, capacitors and an inductor coil.

#### Order Information:

RLC Circuit ..... CI-6512 p. 254

## Motor/Generator Kit

CI-6513

Investigate the efficiency of electrical to mechanical energy conversion as the motor lifts a hanging mass.

The precision DC motor is coupled to a ball-bearing windlass by a 10:1 mechanical advantage belt drive. It will lift masses up to 1.5 kg.



#### Order Information:

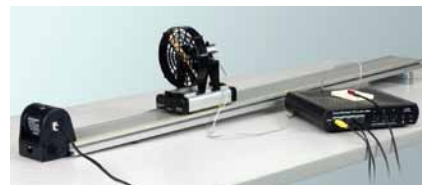
Motor/Generator Kit ..... CI-6513 p. 270

## 750 Interface and NI

## LabVIEW

CI-7650

- ▶ Use National Instruments™ LabVIEW™ software with PASCO's *750 Interface on Windows™* Computers



The *750 Interface* and LabVIEW software are used to control the Fan Accessory based on measurements from the Motion Sensor.

PASCO's *750 Interface* includes seven input channels with a 250,000 Hz maximum sampling rate.

- Four digital channels
- Three analog channels

Any combination of digital and analog sensors can be used simultaneously. Over 40 sensors are available.

Students can use the *750 interface's* built-in 1.5 Watt Function Generator to power circuits or other electrical devices.

Once data has been collected, students can use the power and flexibility of LabVIEW software to display and condition the data as needed. This system provides the perfect opportunity for students to learn about digital and analog data processing techniques.

Go to [www.pasco.com/labview](http://www.pasco.com/labview) to download files needed to use the *750 Interface* with LabVIEW.

#### Order Information:

750 Interface – USB ..... CI-7650

## Thermodynamics Kit

CI-6514A

Measure the electrical equivalent of heat and investigate thermal absorption and radiation. The kit includes a 10  $\Omega$ /10 W heating resistor and black, white and polished metal containers.



#### Order Information:

Thermodynamics Kit ..... CI-6514A p. 243

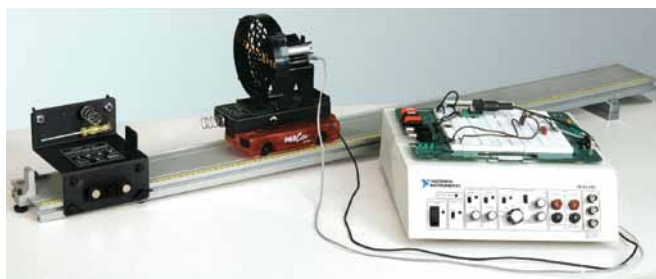
## Ni ELVIS LabVIEW Adapters

CI-6718 Analog

CI-6719 Digital

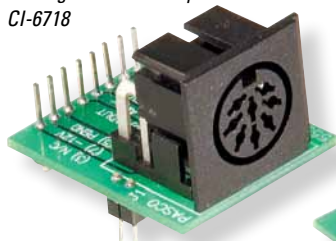
- ▶ Use *ScienceWorkshop* Sensors with NI ELVIS™ and LabVIEW™

Now you can use both digital and analog *ScienceWorkshop* sensors with National Instruments' Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) interface.



The NI ELVIS and LabVIEW software are used to control the Fan Accessory based on measurements from the Force Sensor.

Analog NI ELVIS Adapter  
CI-6718



Digital NI ELVIS Adapter  
CI-6719



NI ELVIS combines instrumentation, data acquisition and a prototyping board in one unit. For more information on NI LabVIEW™ and NI ELVIS, visit [www.ni.com](http://www.ni.com).

To collect data, plug an Analog or Digital Adapter into the prototyping board and insert a sensor. Connect the adapter to the appropriate I/O ports on ELVIS and the system is ready to use.

Once data has been collected, students can use the power and flexibility of LabVIEW software to display and condition the data as needed. This system provides the perfect opportunity for students to learn about digital and analog data processing techniques.

Virtual instruments for using PASCO sensors are available **FREE** at [www.pasco.com/labview](http://www.pasco.com/labview). Use these VIs to get started or modify them to fit the needs of your laboratory.

### Order Information:

Analog NI ELVIS Adapter .....CI-6718  
Digital NI ELVIS Adapter .....CI-6719

## USB/Serial Converter

CI-6759A

- ▶ Connects Interface's Serial Port to USB Port
- ▶ Use with *ScienceWorkshop 300, 500 and 750*
- ▶ All Drivers Included in DataStudio (1.7 or higher)



The USB/Serial Converter is used to connect the serial port of *ScienceWorkshop* Interfaces to the USB port of the computer.

### 500 Interface

CI-6400



**Obtain Higher Sustained Sampling Rates:** Increase the maximum continuous data sampling rate by a factor of eight.\*

**Use a Real-time Oscilloscope Display:** Increase the oscilloscope frame rate from two frames per second to approximately 10 frames per second, providing a real-time oscilloscope for examining electrical circuits, sound waves and more.

**Perform Fast, Reliable Data Downloads:** A buffer of logged data (up to 17,000 data points) can be downloaded in a few seconds. The same download would take several minutes using a serial port.

\*Maximum sample rate of the 500 Interface in burst mode remains at 20,000 Hz

### 750 SCSI Interface

CI-6450



**Plug and Play:** Connect and disconnect the interface without shutting down the computer.

**Maximize Your Technology Investment:** Allows 750 SCSI Interfaces to be used with the USB port for a modest investment.

**Use a Real-time Oscilloscope Display:** Oscilloscope refresh rate of approximately 10 frames per second, providing a real-time oscilloscope for examining electrical circuits, sound waves and more.

Maximum sample rate of the 750 Interface remains at 250,000 Hz in burst mode

### Order Information:

USB/Serial Converter .....CI-6759A



## ScienceWorkshop® 500 Interface

CI-6400

- ▶ Use as a computer interface
- ▶ Use as a datalogger away from the computer
- ▶ Five sensor ports
- ▶ Serial connector can be adapted to USB using optional converter



*The 500 Interface is battery powered and can record data away from the computer.*



**Simultaneous Analog and Digital Recording**  
Collect up to three analog and two digital signals at the same time.

**Datalogging Button**  
Press this button to record and store data in the interface's data storage buffer.

**Built-in Battery Compartment**  
Holds four AA batteries for field work (also runs on 9 VAC adapter included).

A versatile solution for all sciences. Combines good desktop performance with datalogging capability. Compatible with over 40 *ScienceWorkshop* sensors for use in Chemistry, Biology, Earth Science, Physics and Engineering.

### Features

**Datalogging:** The *ScienceWorkshop 500* Interface collects data directly to a computer, or students can collect data with just the interface and a sensor. Students can set up an experiment using the *500*, disconnect from the computer to collect data outside the classroom and then reconnect for data analysis.

**Portability:** With a built-in battery compartment for 4 "AA" batteries (not included) the *ScienceWorkshop 500* Interface can go just about anywhere and still collect data.

**50 KB Storage Buffer:** Stores data runs and experiment setup information.

**Cross-Platform Data:** Logged data will open on either a Macintosh or a Windows-compatible computer. The interface stores the sensor and data display information so it knows what experiment setup to open.

### Unique Characteristics

**Ports:** Two Digital, three Analog

**Connection:** Serial (also USB compatible with USB/Serial Converter)

**Datalogging:** Collect up to 17,000 Analog (force, voltage, etc.) data points or 7,000 Motion Sensor data points

**Portable:** Built-in battery compartment

**Designed for:** Starter, Biology, Chemistry, General Science, Earth Science, Physics, Math

### Specifications

**Ports:** Two Digital, three Analog  
**Connection:** Serial (also USB compatible with USB/Serial Converter)

**Communication Speed:** 19.2 kbaud.

**Crystal-controlled timebase:**  
±0.01% accuracy

**Analog Inputs:** three analog channels  
A: Differential Input— 2 MΩ impedance; gain = 1 or 10

B: Single Ended Input— 200 kΩ impedance; gain = 1 or 10

C: Single Ended Input— 200 kΩ impedance; gain = 1

±10 V range (±0.02 V + 0.1% of reading); 5 mV resolution

12-bit ADC converts samples

**Digital Inputs:** two digital I/O channels

5 μs timing resolution

**Datalogging mode without a Computer:**

Disconnect from your computer and take remote measurements.

Low power consumption mode prolongs battery life.

50 KB Storage Buffer: Collect 17,000 Analog (force, voltage, etc.) data points or 7,000 Motion Sensor data points.

50 KB data storage buffer (2N+1 bytes/sample period, N=# chs, eg: 2 chs @ 10Hz for 1,000 seconds)

Multiple data runs are appended to the buffer.

**Cross-platform Data:** Logged data will open on either a Macintosh or Windows-compatible computer. The interface stores the sensor and data display information so it knows what experiment setup to open.

**Power Supply:** 9 V@500mA DC supply or a battery pack (4 AA). All inputs and the serial interface have ESD (electrostatic discharge) protection circuitry that works with power on or off.

## Make the 500 Interface more Powerful with the USB/Serial Converter

CI-6759A



The USB/Serial Converter is the ideal solution for connecting the *500* Interface to the USB port of a computer. USB to serial adapters produced by other companies rely on constantly changing drivers that may or may not work well with a computer. PASCO's USB/Serial Converter is specifically designed for use with the *300*, *500* and *750* Interfaces. Simply install the included version of DataStudio and begin collecting data.

Not only is the USB/Serial Converter easy to use, it boosts the performance of the *500* Interface significantly.

- ▶ Increases continuous data sample rate by a factor of 8.
- ▶ Increases the oscilloscope display refresh rate by 5 times, providing a near real-time oscilloscope for examining electrical circuits, sound waves and more.
- ▶ Enables students to download a buffer of logged data (up to 17,000 data points!) in seconds (versus minutes using the serial connection). The maximum sample rate for the *500* interface remains 20,000 Hz.

### Order Information:

ScienceWorkshop  
500 Interface .....CI-6400

### Order Information:

USB/Serial Converter .....CI-6759A

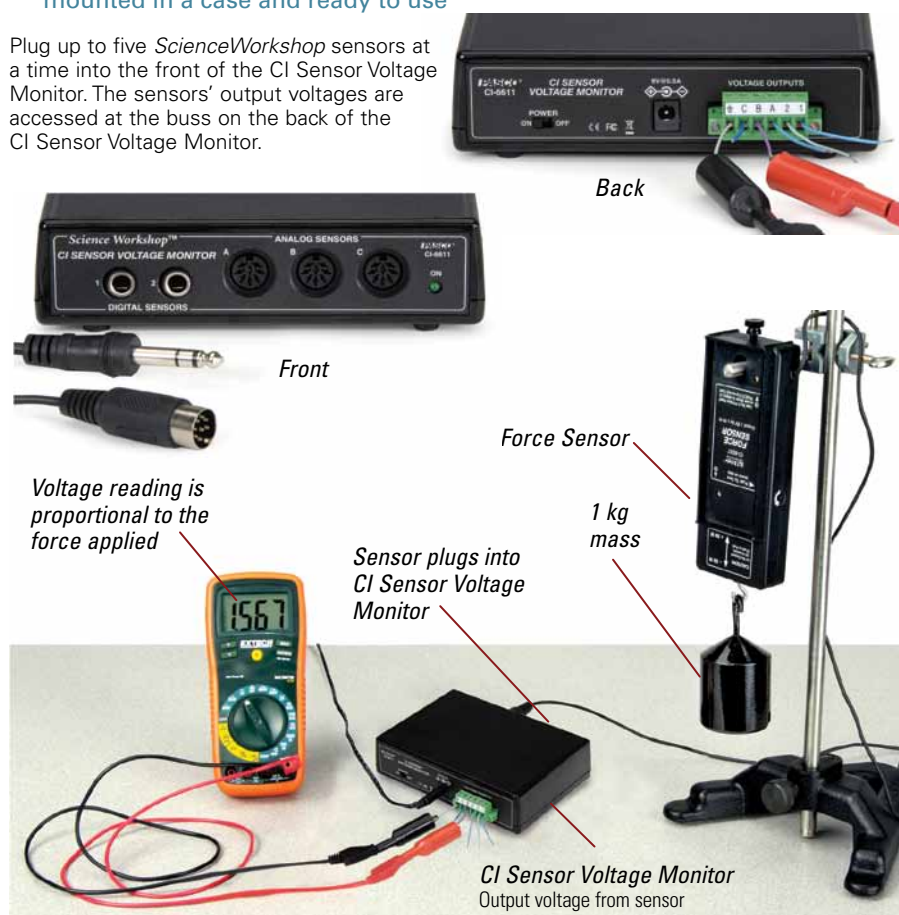
## Use PASCO sensors in your own circuits without a computer interface

### CI Sensor Voltage Monitor

CI-6611

- ▶ Take advantage of PASCO's numerous fine quality sensors already mounted in a case and ready to use

Plug up to five *ScienceWorkshop* sensors at a time into the front of the CI Sensor Voltage Monitor. The sensors' output voltages are accessed at the buss on the back of the CI Sensor Voltage Monitor.



The CI Sensor Voltage Monitor accepts any *ScienceWorkshop* CI sensor, supplies power to the sensor, and gives access to the output voltage of the sensor through the terminal strip on the back of the box. Monitor the output voltage using a voltmeter or an oscilloscope or wire the sensor output directly into your own circuit. The instruction sheet includes calibration data for relating the output voltage to the sensor reading (for example, 8 V = 50 Newtons for a Force Sensor).

#### Includes

CI Sensor Voltage Monitor  
 Power Adapter: 9 VDC @ 500 mA  
 Calibration Data in Manual

#### Specifications

**Accepts all *ScienceWorkshop* Sensors**  
**5 Voltage Outputs**  
**Power adapter:** 9 VDC, 500 mA

Not compatible with PASPORT sensors.

### ScienceWorkshop Sensor Index

The chart below lists the sensors available for use with *ScienceWorkshop* Interfaces.

Sensor Description	Part No.	Page No.
Acceleration	CI-6558	76
Barometer	CI-6531A	83
Carbon Dioxide	CI-6561	81
Charge	CI-6555	79
CI Load Cell Amplifier <b>NEW</b>	CI-6464	76
CI Load Cell and Amplifier Set <b>NEW</b>	CI-6465	167
Colorimeter	CI-6747	81
Conductivity	CI-6729	80
Current	CI-6556	79
Current, High	CI-6740	79
Dissolved Oxygen	CI-6542	82
Drop Counter	CI-6499	81
EKG	CI-6539A	84
Flow Rate	CI-6730A	83
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Force, Economy	CI-6746	74
Force Platform	CI-6461	76
Free Fall Adapter	ME-9207B	75
G-M Tube	SN-7927A	80
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Humidity, Relative	CI-6559	83
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Ion-Selective Electrode Amplifier Box	CI-6738	82
Laser Switch	ME-9259A	75
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Light, Broad Spectrum	CI-6630	78
Light, High-Sensitivity	CI-6604	78
Light, Infrared	CI-6628	78
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Oxygen Gas	CI-6562	80
pH	CI-6507A	81
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Photogate Head	ME-9498A	75
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Absolute	CI-6532A	76
Pressure Sensor—Low	CI-6534A	76
Respiration Rate	CI-6535	84
Rotary Motion	CI-6538	74
Sound	CI-6506B	84
Temperature	CI-6605A	77
Temperature, High Accuracy	CI-6525	77
Temperature with Type K Probe	CI-6526	77
Thermistor Temperature	CI-6527A	77
Thermocline	CI-6731	83
Time-of-Flight Accessory	ME-6810	75
Voltage	CI-6503	79

#### Order Information:

CI Sensor Voltage Monitor.....	CI-6611
<i>Recommended:</i>	
Any ScienceWorkshop Sensor.....	See pages 74-84
Basic Digital Multimeter.....	SE-9786A

## Force

CI-6537

▶ ±50 N range

▶ Built-in Accessory Tray



PASCO's durable, reliable Force Sensor was designed specifically for the student physics lab. Wide-range, high-frequency response and a low noise transducer help generate excellent impulse graphs, smooth harmonic motion data and more. The sensor's special strain gauge consistently generates the same output for the same force and is designed to minimize side loads. Damping materials reduce vibrations caused by collisions without affecting results. Any dynamics cart accessories can be mounted on top of the Force Sensor.

### Specifications

**Force Range:** -50 to +50 N

**Resolution:** 0.03 N or 3.1 grams

**Zero (Tare) Function:** Push button

**Force-overload Protection:** Mechanical stop prevents forces of more than 50 N from damaging the sensor

**Pin Configuration:** 8-pin DIN plug

Mounts on standard 12.7 mm support rods

#### Order Information:

Force Sensor ..... CI-6537

## Rotary Motion

CI-6538



The Rotary Motion Sensor is one of the most versatile position/motion measuring devices in the student physics lab. It is equally adept at measuring linear position with a resolution of 0.055 mm or rotary motion with a resolution of 0.25°. This sensor is also bi-directional, indicating the direction of motion.

The 6.35 mm diameter dual ball-bearing shaft extends from both sides of the unit and provides an excellent platform for rotational experiments. The rod clamp (which can be attached on three sides of the sensor) allows the unit to be mounted in almost any orientation. A three-step pulley and a mount for the PASCO Super Pulley make it easy to perform torque experiments.

### Specifications

**Three-step Pulley:** 10 mm, 29 mm and 48 mm diameter

**Resolution:** 1° and 0.25° (software selectable)

**Maximum Speeds:** 13 rev/sec at 1° resolution (360 data points/revolution) 3.25 rev/sec at 0.25° resolution (1440 data points/revolution)

**Optical Encoder:** Bidirectional, indicates direction of motion

**Sensor Dimensions:** 10 cm x 5 cm x 3.75 cm, 6.35 mm diameter shaft

**Connector:** Dual stereo phone plug for *ScienceWorkshop* Interfaces

#### Order Information:

Rotary Motion Sensor ..... CI-6538

*Recommended:*

Extra Three-step Pulley ..... CI-6693

Rotary Motion Sensor for Vernier Interfaces ..... CI-6625

## Economy Force

CI-6746

▶ ±50 N range

▶ Convenient Finger Grip



The Economy Force Sensor is an excellent, low-cost, general-purpose force sensor for the student lab. The finger holes make it ideal for hand-held use. The Economy Force Sensor can mount on a PASCO Dynamics Cart. Ideal for measuring force in one-axis experiments.

### Specifications

**Force Range:** -50 to +50 N

**Resolution:** 0.03 N or 3.1 grams

**Zero (Tare) Function:** Push button

**Force-overload Protection:** Mechanical stop prevents forces of more than 50 N from damaging the sensor

**Pin Configuration:** 8-pin DIN plug

Mounts on standard 12.7 mm support rods

#### Order Information:

Economy Force Sensor ..... CI-6746

## Force Sensor Spares Kit

CI-6463

**Includes:**

Hook, rubber bumper and screw to attach to a cart.



#### Order Information:

Force Sensor Spares Kit ..... CI-6463

## Motion Sensor II

CI-6742A

The CI-6742A Motion Sensor II uses ultrasonic pulse technology to measure object position.



### Features

**Shorter Dead Zone:** Detects targets as close as 15 cm from the sensor increasing the effective length of a dynamics track (other motion sensors have a dead zone of 42 cm, see below). **False Target Rejection Circuit:** Reduces false signals from objects near the target's path of motion, giving cleaner data.

### Specifications

**Minimum Range:** 15 cm (short dead zone)

**Maximum Range:** 8 m

**Transducer Rotation:** 360°

**Near/Far Switch Settings:**

**Narrow:** For distances up to 2 m to reject false target signals or ignore air track noise.

**Standard:** For longer distances up to 8 meters.

**Mounting Options:**

- 12.7 mm diameter rod or smaller
- Directly to the PASCO Dynamics Track
- Non-skid rubber feet for table mount

**Connector:** Dual stereo phone plug for *ScienceWorkshop* Interfaces.

#### Order Information:

Motion Sensor II ..... CI-6742A

*Recommended:*

Accessory Cable ..... CI-6748

*Allows CI-6742A to be used with CBL/EA100.*

## Photogate Head

ME-9498A

### Specifications

- Photogate Width:** 7.5 cm
- Fall Time:** < 50 ns
- Spatial Resolution:** < 1 mm
- Timing Resolution:** 0.1 millisecond
- Connector:** Stereo phone plug



### Order Information:

<b>Photogate Head</b> .....	<b>ME-9498A</b>
<i>Recommended:</i>	
Photogate Stand.....	ME-9805

## Photogate/Pulley System

ME-6838A

### Includes:

- Photogate Head
- Super Pulley with Rod



### Specifications

- Pulley:** Rotational inertia:  $1.8 \times 10^{-6} \text{ kg m}^2$  Coefficient of friction: <  $7 \times 10^{-3}$  Diameter: 5 cm, Mass: 5.5 g
- Photogate: Width:** 7.5 cm, Fall time: < 50 ns Spatial resolution: < 1 mm
- Timing Resolution:** 0.1 millisecond
- Connector:** Stereo phone plug

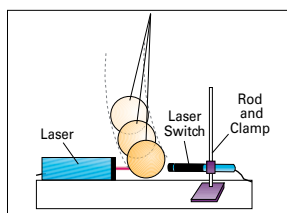
### Order Information:

<b>Photogate/Pulley System</b> .....	<b>ME-6838A</b>
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## Laser Switch

ME-9259A

This Laser Switch acts as a large photogate so you can time objects too large to pass through a standard Photogate. Use the Red Laser Pointer below or other laser as your light source.



### Order Information:

<b>Laser Switch</b> .....	<b>ME-9259A</b>
<i>Required:</i>	
Laser such as X-Y Adjustable Diode Laser.....	OS-8526A

## Time-of-Flight Accessory

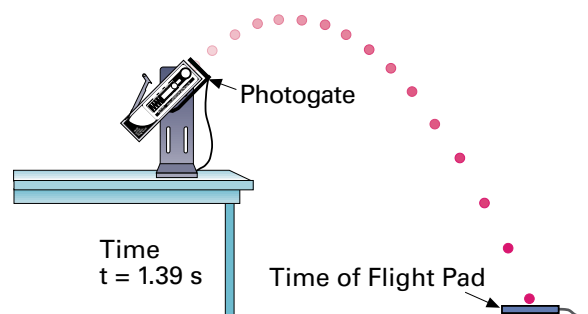
ME-6810

The Time-of-Flight Accessory is designed primarily for freefall or projectile experiments. When an object hits the plate, a signal is sent to the interface. Note: When used with the projectile launcher, a photogate is used to start the timer and the 20' extension cable is recommended.



### Typical Applications

- ▶ Find Time-of-flight for a ball shot from a Projectile Launcher
- ▶ Conduct freefall experiments

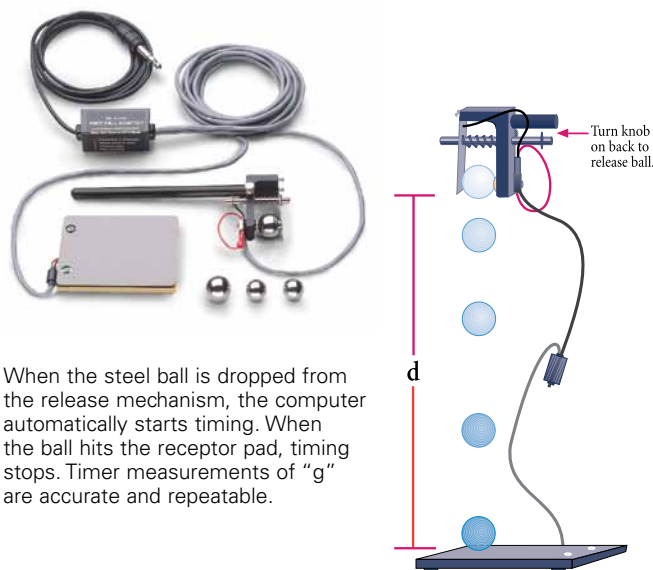


### Order Information:

<b>Time-of-Flight Accessory</b> .....	<b>ME-6810</b>
---------------------------------------	----------------

## Freefall Adapter

ME-9207B



When the steel ball is dropped from the release mechanism, the computer automatically starts timing. When the ball hits the receptor pad, timing stops. Timer measurements of "g" are accurate and repeatable.

### Order Information:

<b>Freefall Adapter</b> .....	<b>ME-9207B</b>
-------------------------------	-----------------

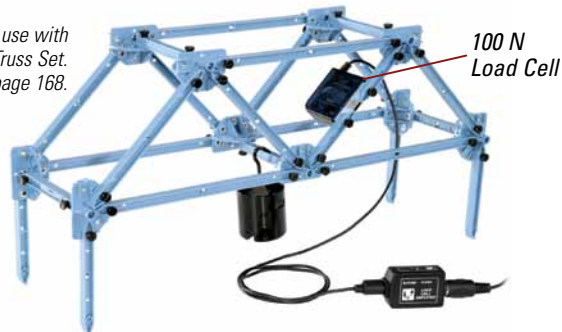
## CI Load Cell Amplifier

CI-6464

This amplifier allows users of the *ScienceWorkshop 500* and *750* interfaces to collect data using the Structures System 100N and 5N Load Cells.

This system has been successfully used at sample rates up to 10,000 Hz. The sample rate limit is determined by the interface and computer used. The amplifier accepts either a 100N Load Cell or 5N Load Cell.

*Shown in use with ME-6990 Truss Set. See page 168.*



Order Information:		
CI Load Cell Amplifier.....	CI-6464	
Required For Use:		
Load Cell 5N.....	PS-2201	p. 167
Or		
Load Cell 100N.....	PS-2200	p. 167
Also Required:		
Structures System.....		p. 166-178

## Force Platform

CI-6461

- ▶ Large jumping/landing surface
- ▶ Rugged design



The Force Platform is an excellent tool for exploring forces on the human body. The platform measures the force exerted on any object in contact with it. The sturdy glass-filled nylon platform is supported by four force beams which combine to measure the total force on the platform. The optional Handle Set (PS-2548) allows students to push and pull on the Force Platform while holding it vertically.

### Typical Applications

- ▶ Students determine their “hang time” by jumping off the platform, then landing on it
- ▶ Use two Force Platforms to investigate Newton’s 3rd Law as two students push against one another
- ▶ Measure the normal force on a person riding in an elevator

### Specifications

**Range:** -1000 N to +4000 N  
**Maximum Update Rate:** 200 Hz  
**Platform Size:** 35cm x 35cm  
**Zero (tare) Function:** Push Button  
**Force Overload Protection**  
**Pin Configuration:** 8-pin DIN plug

Order Information:	
Force Platform.....	CI-6461

## Acceleration

CI-6558

- ▶ ±5 g range
- ▶ 0.01 g resolution



The Acceleration Sensor can be used to record acceleration data for almost any application. Plug the sensor directly into the *ScienceWorkshop 500* Interface to produce a portable acceleration monitoring device.

### Includes

Acceleration Sensor with two meter detachable cable  
 Bracket and hardware for attaching to a dynamics cart

### Specifications

**Range:** ±5 g range  
**Resolution:** 0.01 g range  
**Zero Function:** Push button, nulls out gravity  
**Sensor Response Settings:** Switch-selectable  
**Slow:** Reduces high frequency vibrations and noise in experiments measuring acceleration of elevators, roller coasters and automobiles, etc.  
**Fast:** Use for short duration events such as cart collisions  
**Pin Configuration:** 8-pin DIN plug on case

Order Information:	
Acceleration Sensor.....	CI-6558

## Low Pressure

CI-6534A

- ▶ Gauge Pressure
- ▶ Ideal for Small Pressure Changes



The Low Pressure Sensor measures gas pressure compared to atmospheric pressure, which is commonly known as gauge pressure. Includes quick connect tubing for a variety of pressure activities. The limited pressure range of the sensor provides excellent accuracy and resolution for measuring small pressure changes.

### Specifications

**Pressure Range:** 0 to 10 kPa above atmospheric  
**Number of Pressure Ports:** One  
**Pin Configuration:** 8-pin DIN plug on case

Order Information:	
Low Pressure Gauge Sensor.....	CI-6534A

## Absolute Pressure

CI-6532A

- ▶ Measure Absolute Pressure up to Seven Atmospheres
- ▶ Includes Syringe for Gas Laws



The Absolute Pressure Sensor measures the pressure relative to an internal reference vacuum. Includes a syringe and quick connect tubing for investigating Gas Laws.

### Specifications

**Pressure Range:** 0 to 700 kPa  
**Reference Vacuum Pressure:** 40 mTorr  
**Number of Pressure Ports:** One  
**Pin Configuration:** 8-pin DIN plug on case

Order Information:	
Absolute Pressure Sensor.....	CI-6532A

## High-Accuracy Temperature

CI-6525

- ▶ Wide Temperature Range
- ▶ Measures Temperature of Liquid Nitrogen

PASCO's resistance temperature device is a highly accurate Temperature Sensor made from platinum wire.



### Specifications

**Temperature Range:** -200 °C to + 200 °C

**Accuracy:** Less than 0.5 °C full scale

**Resolution:** 0.2 °C

**Output Voltage/Temperature ratio:** 10 mV/ °C, linear

**Temperature Sensing Junction:** Platinum wire

**Pin Configuration:** 8-pin DIN plug

### Order Information:

High-Accuracy Temperature Sensor.....CI-6525

## Temperature

CI-6605A

- ▶ Quick Response
- ▶ Rugged Sensor



This low thermal mass Temperature Sensor ensures a quick response and negligible impact on measured temperatures. Teflon® covers, for use in harsh liquids or chemical solutions, are available as an accessory.

### Specifications

**Temperature Range:** -35 °C to + 135 °C

**Accuracy:** ±0.5 °C

**Resolution:** 0.05 °C

**Pin Configuration:** 8-pin DIN plug

### Order Information:

Temperature Sensor.....CI-6605A

## Type K Temperature

CI-6526

- ▶ Extra Long Probe

The CI-6526 Type K Thermocouple is useful for both low and high temperature applications. Its long probe length (95 cm) makes it ideal for measuring temperature in hard-to-reach places.



### Specifications

**Range:** -200 °C to +400 °C

**Accuracy:** Linear from 0 °C to +400 °C (3 °C± 3% of reading)

**Pin Configuration:** 8-pin DIN plug

### Order Information:

Type K Temperature Sensor.....CI-6526

Replacement Supply:

Type K Thermocouple.....PS-2155

## Thermistor Temperature

CI-6527A

- ▶ Convert Resistance to Temperature



The Thermistor Sensor is designed to read the resistance from a thermistor (100 kΩ or 10 kΩ at 25 °C) and convert it to temperature. The computer displays the temperature in real-time in °C, eliminating the need for an ohmmeter and the use of a conversion lookup table. The sensor also reads in ohms so it can be used to read any resistance between 3 kΩ and 360 kΩ.

The Thermistor Sensor reads the type of thermistors (100 kΩ or 10 kΩ at 25 °C) featured in PASCO equipment, such as:

- Thermal Radiation Cube (TD-8554A)
- Mechanical Equivalent of Heat (TD-8551A)
- Thermal Efficiency Apparatus (TD-8564)
- Thermal Expansion (TD-8558A)
- Compact Thermal Expansion (TD-8578 and TD-8579A)
- Thermal Cavity (TD-8580)

### Specifications:

**Resistance Range:** 3.0 kΩ to 360.0 kΩ± 0.2 kΩ

**Temperature Range:** 0 °C to 120 °C

**Resolution:** 0.05 °C at 25 °C

**Pin Configuration:** 8-pin DIN plug on case

### Includes:

- BNC-to-2 Banana Cable
- One Sample 10kΩ Thermistor
- Two Alligator Clips – Banana
- One Sample 100kΩ Thermistor

### Order Information:

Thermistor Temperature Sensor.....CI-6527A

Replacement Thermistor Cable.....PS-2515

(Includes: 3.5 mm Stereo Phone-to-2 Banana Cable)

## Thermistor Probes

(The probes below must be used with CI-6527A)

### Skin/Surface PS-2131

Our Skin/Surface Temperature Sensor has a wider range to allow students to measure a wider variety of surfaces.



### Specifications

**Range:** -10 to +70 °C

### Order Information:

Skin/Surface.....PS-2131

### Fast Response PS-2135 (3 pack)

Our Fast-Response Temperature Sensor's low thermal mass and small size allows students to see changes in temperature they could never see before. Momentarily dip the sensor in water and then watch as it cools from evaporation and returns to ambient.



### Specifications

**Range:** -30 to +105 °C

### Order Information:

Fast Response (3 pack).....PS-2135

## Light

CI-6504A



- ▶ General Purpose Light Sensor

PASCO's Light Sensor is ideal for indoor and outdoor relative light intensity experiments. It can be used in a lighted room for most experiments.

### Typical Applications

- ▶ Measure relative light intensities in daylight (even monitor a solar eclipse)
- ▶ Compare light intensity vs. distance
- ▶ Study interference/diffraction/polarization

### Specifications

**Sensing Element:** Si PIN photodiode

**Spectral Response:** 320 nm to 1100 nm

**Gain Levels:** 100x, 10x, 1x, switch-selectable

**Output Voltage:** 0V to 5V

**Pin Configuration:** 5-pin DIN plug on case

**Maximum Light Intensity Levels (lux):**

<b>Gain Setting:</b>	1x	10x	100x
<b>Approximate Lux:</b>	500	50	5

#### Order Information:

Light Sensor ..... CI-6504A

## Light Broad Spectrum

CI-6630



- ▶ For use with Spectrophotometer
- ▶ Ideal for Black Body Spectrum

The Broad Spectrum Light Sensor is designed 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.

### Typical Applications

- ▶ Black Body Experiment

### Specifications

**Sensing Element:** BaF<sub>2</sub> window, xenon gas-filled thermopile

**Output Voltage:** 0V to 10V

**Spectral Response:** 300 to 10,000 nm.

**Pin Configuration:** 8-pin DIN on case

#### Order Information:

Light Broad Spectrum Sensor ..... CI-6630

## Light High-Sensitivity

CI-6604



- ▶ Ideal for low light experiments

The High-Sensitivity Light Sensor is designed for experiments involving low light level conditions.

### Specifications

**Sensing Element:** Si PIN photodiode

**Spectral Response:** 320 nm to 1100 nm

**Gain Levels:** 100x, 10x, 1x, switch-selectable

**Output Voltage:** 0V to 5V

**Pin Configuration:** 8-pin DIN plug on case

**Maximum Light Intensity Levels (lux):**

<b>Gain Setting:</b>	1x	10x	100x
<b>Approximate Lux:</b>	5	0.5	0.05

#### Order Information:

Light High-Sensitivity Sensor ..... CI-6604

## Light Infrared

CI-6628



- ▶ For heat studies

The Infrared Sensor is sensitive in the infrared portion (up to 40,000 nm) of the spectrum, but also detects the visible spectrum. It will detect the radiation from a person's hand. The response is linear over its entire frequency range.

### Specifications

**Sensing Element:** 48 junction, KRS-5 window, argon gas-filled thermopile

**Spectral Response:** Up to 40,000 nm (linear)

**Gain Levels:** 100x, 10x, 1x, switch-selectable

**Output Voltage:** 0V to 5V

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

Infrared Sensor ..... CI-6628

## Light UVA

CI-9784



- ▶ Directly measure UV radiation

The Ultraviolet Light Sensor detects the UVA band (315 nm - 400 nm) with the UVA filter installed. With the UVA filter removed, the sensor detects the visible as well as the UVA. The sensor includes the UVA filter, a collimator and a diffuser.

### Specifications

**Sensing Element:** Photodiode

**Spectral Response:** With included UVA filter– 315 nm to 400 nm

**Gain Levels:** 100x, 10x, 1x, switch-selectable

**Output Voltage:** 0V to 5V

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

UVA Light Sensor ..... CI-9784

## Voltage

CI-6503

- ▶ Standard banana plugs and alligator clips



The Voltage Sensor provides a simple connection between a *ScienceWorkshop* interface and an electronic circuit.

### Typical Applications

- ▶ Study resistance, voltage and capacitance in circuits
- ▶ Electroplating
- ▶ Conduct power amplifier experiments

### Specifications

**Voltage Range:** ±10 V AC/DC

**Pin Configuration:** 5-pin DIN plug

Probe ends are standard banana plugs. Two alligator clip adapters included.

#### Order Information:

**Voltage Sensor**.....CI-6503

## High Current

CI-6740

- ▶ Measures up to 10 Amps
- ▶ Isolated Circuit



Measure the transient or steady state current at any point in a circuit. The High Current Sensor is ideal for circuits in which the current exceeds 1 Amp. Instead of a sensing resistor, the High Current Sensor features a Hall Effect chip. Therefore, the sensor has a negligible internal resistance and will not influence the current measurements from the circuit. The sensor includes a 10 Amp fuse which can be easily replaced.

### Typical Applications:

- ▶ Measure the current through PASCO coils
- ▶ Determine the output from the Hand Crank Generator

### Specifications:

**Maximum Current Input:** +/- 10 Amps

**Maximum Voltage Input:** +/- 30 Volts

**Frequency Response:** DC – 10 KHz

**Fuse:** 10 Amps, Fast Acting (Replaceable)

**Pin Configuration:** 8-Pin DIN plug

#### Order Information:

**High Current Sensor**.....CI-6740

## BNC Adapter

CI-6685

This adapter allows BNC-terminated cables (such as oscilloscope probes) to be connected to a *ScienceWorkshop* Interface.



#### Order Information:

**BNC Adapter**.....CI-6685

## Current

CI-6556

- ▶ 1 Ω sensing resistor

The Current Sensor determines the current through it by measuring the voltage across the internal 1.00 Ω resistor. Up to 1.5 A can be measured.



### Typical Applications

- ▶ Study resistance, voltage and capacitance in circuits

### Specifications

**Maximum Current Input:** 1.5 A\*

**Maximum Differential Voltage:** 1.5 V\*

**Maximum Common Mode Voltage:** 10 V

**Resolution:** 5 mA (1X gain), 0.5 mA (10X gain)

**Pin Configuration:** 8-pin DIN on case (\*DC or AC RMS (root mean square))

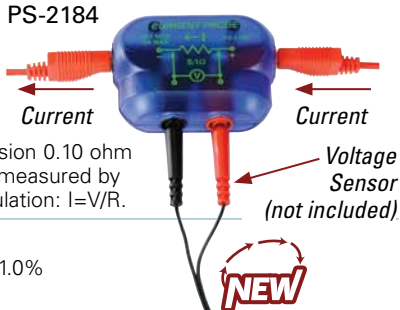
#### Order Information:

**Current Sensor**.....CI-6556

## Current Probe PS-2184

The PS-2184 and a PASCO voltage sensor allow the measurement of current between -4 A and +4 A.

The probe contains a precision 0.10 ohm resistor and the current is measured by creating a DataStudio calculation:  $I=V/R$ .



### Specifications

**Resistor:** 0.10 Ohm, 3.0W, 1.0%

**Maximum Current:** 4A

**Maximum Voltage:** 10V

**Maximum Voltage Without Damage:** 30V

**Terminals:** 4mm Banana Jacks

#### Order Information:

**Current Probe**.....PS-2184

## Charge CI-6555

- ▶ Ideal for electrostatics

PASCO's Charge Sensor is designed for experiments in electrostatics such as inductive charging, charge production and distribution, charge on a capacitor, etc.



### Typical Applications

- ▶ Connect to a Faraday Ice Pail to measure the total charge on an object by the induction method
- ▶ Use as a high-input impedance voltmeter ( $10^{12}\Omega$ )

### Specifications

**Input Capacitance:** 0.01 μF ±5%

**Input Resistance:** 10<sup>12</sup> ohms (1000 gigaohms)

**Maximum Input Voltage:** 150 V

**Input Connector:** BNC

**Input Cable:** Shielded, 0.9m, alligator clip termination

**Pin Configuration:** 8-Pin DIN plug on case

**Sensor Gain:** 1x                      5x                      20x

**Voltage Range:** ±10 V                      ±2 V                      ±0.5 V

**Charge Range:** ±0.1 μC                      ±0.02 μC                      ±0.005 μC

#### Order Information:

**Charge Sensor**.....CI-6555

*Recommended:*

Faraday Ice Pail.....ES-9042A p. 251



## Magnetic Field

CI-6520A



- ▶ Measures radial or axial fields
- ▶ Tare button

PASCO's Magnetic Field Sensor is sensitive enough to detect the earth's magnetic field.

Its application in the physics lab includes measuring and plotting fields in single or Helmholtz coils, solenoids, electromagnets and magnets.

### Features

**Measures radial or axial fields:** Two switch-selectable Hall Effect sensors measure either radial or axial fields.

**Tare button:** Zeroing or nulling out existing fields is accomplished by pushing the Tare button.

**Three switchable ranges of sensitivity:** Full scale ranges of 10, 100 and 1,000 Gauss. Measurements from earth's magnetic field to strong magnets.

**7.5 cm probe:** Sensors are mounted at the end of a fully encapsulated 7.5 cm long probe.

### Specifications

**Sensitivity:** ± 10 Gauss, 50 mG resolution  
 ± 100 Gauss, 50 mG resolution  
 ± 1000 Gauss, 500 mG resolution

**Measurement modes:** Axial and Radial

**Probe Length:** 7.5 cm

**Pin Configuration:** 8-Pin DIN plug on case

#### Order Information:

Magnetic Field Sensor.....	CI-6520A	
<i>Recommended:</i>		
Zero Gauss Chamber.....	EM-8652	p. 50

## G-M Tube/Power Supply

SN-7927A

- ▶ Ideal general purpose nuclear sensor



The G-M Tube/Power Supply senses alpha, beta and gamma radiation. Power for the tube is supplied through the connection to an interface that supplies an operating voltage of +5 V.

### Specifications

**Sensitivity:** Beta, Gamma, Alpha

**Count Detection:** Audio signal

**Window Thickness:** 1.5 to 2 mg/cm<sup>2</sup>, mica

**Gas Filling:** Neon, Argon and Halogen

**Starting/Operating Voltage for tube:** 450 VDC/500 VDC

**Dead Time:** 90 μs

#### Order Information:

G-M Tube/Power Supply.....	SN-7927A
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## Conductivity

CI-6729



The CI-6729 Conductivity Sensor, including amplifier box and 1x electrode, is designed for monitoring conductivity (μS/cm) in aqueous solutions. DataStudio can convert data to total dissolved solids (mg/L).

### Typical Applications

- ▶ Compare conductivity of different water samples
- ▶ Study the effects of chemical flocculants on conductivity

### Specifications

**Sensitivity Ranges:** 0 to 200 μS/cm, 0 to 2000 μS/cm, 0 to 20,000 μS/cm; switch-selectable on amplifier box

**Electrode:** Platinized, reduces the effects of cell polarization

**Cell Constant:** 1x

**Connector:** 8-pin DIN plug on case

#### Order Information:

1x Model Conductivity Sensor.....	CI-6729
10x Conductivity Electrode.....	CI-6739A

## Conductivity Replacement Probe

PS-2571

(Previously part number 699-06621)



#### Order Information:

Conductivity Replacement Probe.....	PS-2571
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## O<sub>2</sub> Gas

CI-6562



The Oxygen Gas Sensor accurately measures oxygen concentration in the atmosphere or enclosed spaces, such as terrariums. The sensor's wide range (0-100%) means students can use it with any experiment or investigation. Use in combination with the CO<sub>2</sub> Gas Sensor to perform an even wider variety of environmental and physiology activities in the classroom or in the field.

### Specifications

**Range:** 0 to 100%

**Accuracy:** ±1% (from 0 to 40%)

**Resolution:** 0.024%

#### Order Information:

O <sub>2</sub> Gas Sensor.....	CI-6562
<i>Replacement Supplies:</i>	
Replacement Electrode.....	PS-6524

## pH

CI-6507A

The pH Sensor is a fundamental sensor for studying a wide range of topics that involve acid-base interactions.



### Typical Applications

- ▶ Monitor acid-base titrations
- ▶ Understand the role of buffers
- ▶ Study water quality

### Specifications

**pH Range:** 0 to 14

**Electrode:** Gel-filled (nonrefillable) Ag-AgCl combination electrode with a membrane resistance of 50 MΩ at 25° C

**pH-to-voltage Ratio:** 5 pH = 0.1 V

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

**pH Sensor** ..... **CI-6507A**

## pH Replacement Electrode

PS-2573

(Previously part number 699-195)



#### Order Information:

**pH Replacement Electrode** ..... **PS-2573**

## Colorimeter

CI-6747

PASCO's Colorimeter shines a light through a solution and measures the percent transmittance. Connect to an interface or operate portably in a stand-alone mode. A two-line LCD display prompts you through the measurement process. Automatic calibration saves time and improves accuracy. Water resistant cuvette holder reduces exposure of optics and electronics to sample spills.



### Typical Applications

- ▶ Verify Beer's Law
- ▶ Monitor reaction rates for reactions that involve color changes, water clarity, etc.

### Specifications

**Transmittance Range:** 0 to 100% Transmittance with 0.1% resolution

**Wavelengths:** 470 nm (blue), 565 nm (green), 635 nm (orange) and 697 nm (red)

**LCD Display:** Updates every 0.5 seconds

**Pin Configuration:** 6-pin mini-DIN socket

Includes 15 cuvettes and a 6 foot cable (6-pin mini-DIN to 8-pin DIN) for connection to *ScienceWorkshop* Interfaces.

Batteries (four "AA" cells) not included.

#### Order Information:

**Colorimeter Sensor** ..... **CI-6747**

**Replacement Supplies:**

Cuvettes and Caps ..... **SE-8739**  
(includes 100 cuvettes and 20 caps)

## Drop Counter (High Accuracy)

CI-6499



At last, a professional Drop Counter can become part of your student lab. Our Drop Counter has a wider (18 x 13 mm) drop window for better drop detection and easier alignment with burettes. Works equally well with large or small, fast or slow drops. Easy calibration requires entering just one number into the computer. Includes a Micro Stir Bar for use with our pH and Conductivity Probes.

- ▶ Measures up to 40 drops per second with drops as small as .64 mm.
- ▶ Silicone rubber-sealed polypropylene is fluid resistant and protects sensor from mild acids and bases.
- ▶ Automatically recalibrates for maximum sensitivity each time the unit is turned on.

### Typical Applications

- ▶ Determine the equivalence point

### Specifications

Holds up to three sensors in a 150 mL beaker

LED drop indicator

UV filter rejects all visible light - not susceptible to variations in room lighting

Stereo phone plug connector

#### Order Information:

**High-Accuracy Drop Counter** ..... **CI-6499**

## CO<sub>2</sub>

CI-6561



The CO<sub>2</sub> Sensor measures carbon dioxide gas concentration, in either an open or closed system. Sensor uses NDIR (non-dispersive infrared) detection technology to sense the CO<sub>2</sub> level. On-board microprocessor supports user calibration and DSP (digital signal processing) to reduce environmental noise and improve accuracy and resolution. The CO<sub>2</sub> concentration level updates once each second. Suitable for use in classroom biological and environmental experiments.

### Typical Applications

- ▶ CO<sub>2</sub> vs. Oxygen cycles in a terrarium
- ▶ Compare indoor vs. outdoor CO<sub>2</sub> levels
- ▶ Terrarium studies of cellular respiration
- ▶ Chemical reaction studies

### Specifications

**Range:** 0 to 10,000 ppm or 0 to 100,000 ppm

**Resolution:** 0 to 10,000 (5 ppm); 0 to 10,000 (50 ppm)

**Accuracy:** 0 to 10,000: ±100 ppm or 10% of value, whichever is greater. 10,000 to 50,000: 20% of value. Over 50,000: qualitative only.

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

**CO<sub>2</sub> Sensor** ..... **CI-6561**

## Ion-Selective Electrodes

CI-6738



PASCO's family of Ion-Selective Electrodes provides either point readings or continuous monitoring of specific ion concentrations in water. PASCO recommends buying one amplifier box and desired electrodes for each student, group or class that will use the sensors. Each Ion-Selective Electrode will work with the CI-6738 Amplifier Box. Two-meter cable included. See chart below for specifications.

### Typical Applications

- ▶ Determine the concentration of a specific ion in a solution
- ▶ Water quality studies

### Specifications

**Input Impedance:** >200MΩ

**Voltage Gain:** 1x

**Electrode Connector:** BNC

**Pin Configuration:** 8-pin DIN plug on case

Functions with PASCO Ion-selective Probes, 699-085 pH Electrode and most third-party ion-selective electrodes.

### PASCO Ion-Selective Electrode Prerequisite

PASCO Ion-Selective Electrodes are industrial-quality probes that give excellent results when properly used. Operation of PASCO's electrodes assumes training in the safe handling of flammable, caustic and corrosive chemicals and a working knowledge of serial dilution and calibration procedures.

#### Order Information:

Ion-selective Electrode Amplifier Box ..... CI-6738

## Dissolved Oxygen

CI-6542



The Dissolved Oxygen (DO2) Sensor provides real-time, aqueous oxygen concentration measurements. Maintenance is simple due to an easy-to-replace electrode tip. Just pop the membrane cartridge out with a special plunger and insert a new cartridge (one replacement electrode kit is included).

### Typical Applications

- ▶ Water quality studies
- ▶ Monitor the effect of yeast respiration on O<sub>2</sub> concentration

### Specifications

**Oxygen Concentration Range:** 0 to 13.5 mg/l (the maximum in saturated water at 3 °C and 760 torr)

**Sensor Response Time:** ≈1 second

**Pin Configuration:** 5-pin DIN plug on case

#### Order Information:

Dissolved Oxygen Sensor ..... CI-6542

## Dissolved Oxygen Replacement Probe

PS-2572

(Previously part number 699-063230)



#### Order Information:

Dissolved Oxygen Replacement Probe ..... PS-2572

Electrode	Molar Range	pH Range	Interfering Ions	Part #
Ammonium (NH <sub>4</sub> <sup>+</sup> )	1.0 to 5x10 <sup>-6</sup>	4-10	Cs <sup>+</sup> , K <sup>+</sup> , Tl <sup>+</sup> , H <sup>+</sup> , Ag <sup>+</sup> , +Tris <sup>+</sup> , Li <sup>+</sup> , Na <sup>+</sup>	CI-6717
Carbon Dioxide (CO <sub>2</sub> )	1x10 <sup>-2</sup> to 1x10 <sup>-4</sup>	4.8-5.2	Volatile weak acids	CI-6726
Calcium (Ca <sup>+2</sup> )	1.0 to 5x10 <sup>-6</sup>	3-10	Pb <sup>+2</sup> , Hg <sup>+2</sup> , Cu <sup>+2</sup> , Ni <sup>+2</sup>	CI-6727
Chloride (Cl <sup>-</sup> )	1.0 to 5x10 <sup>-5</sup>	2-12	S <sup>-2</sup> , I <sup>-</sup> , CN <sup>-</sup> , Br <sup>-</sup>	CI-6732
Lead (Pb <sup>+2</sup> )	1x10 <sup>-1</sup> to 1x10 <sup>-6</sup>	3-8	Ag <sup>+</sup> , Hg <sup>+2</sup> , Cu <sup>+2</sup> , Cd <sup>+2</sup> , Fe <sup>+2</sup>	CI-6736
Fluoride (F <sup>-</sup> )	Saturated to 1x10 <sup>-6</sup>	5-8	OH <sup>-</sup>	CI-6728
Nitrate (NO <sub>3</sub> <sup>-</sup> )	1.0 to 7x10 <sup>-6</sup>	2.5-11	ClO <sub>4</sub> <sup>-</sup> , I <sup>-</sup> , CN <sup>-</sup> , BF <sub>4</sub> <sup>-</sup>	CI-6735
Potassium (K <sup>+</sup> )	1.0 to 7x10 <sup>-6</sup>	2-12	Cs <sup>+</sup> , NH <sub>4</sub> <sup>+</sup>	CI-6733
Sodium (Na <sup>+</sup> )	Saturated to 1x10 <sup>-6</sup>	5-12	H <sup>+</sup> , K <sup>+</sup> , Li <sup>+</sup> , Ag <sup>+</sup> , Cs <sup>+</sup> , Tl <sup>+</sup>	CI-6734

\* Prices do not include the amplifier box.

**Required:** At least one CI-6738 Ion-selective Electrode Amplifier Box.

## Barometer

CI-6531A



PASCO's Barometer Sensor will measure changes in atmospheric pressure over long and short periods of time.

### Typical Applications

- ▶ Weather station experiments
- ▶ Detect the regular barometric pressure changes associated with tidal flow
- ▶ Measure changes in elevation by measuring the pressure at known minimum and maximum elevations and creating a standard elevation curve

### Specifications

**Range:** 813 to 1084 mbars (24-32 inches Hg)

**Resolution:** 0.17 mbars (0.005 inches Hg)

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

Barometer.....CI-6531A

## Relative Humidity

CI-6559



The Relative Humidity Sensor is designed for single readings or continuous monitoring of relative humidity (RH).

### Typical Applications

- ▶ Weather station experiments
- ▶ Checking humidity in a terrarium, greenhouse or other enclosure

### Specifications

**Humidity Ranges:** 5-95% relative humidity (non-condensing)

**Accuracy:** ±5% RH

**Response Rate:** ≈15 seconds in slow moving air at 25 °C

**Repeatability:** ±0.5% RH

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

Relative Humidity Sensor.....CI-6559

## Thermocline

CI-6731



The Thermocline Sensor allows students to perform water studies in Ecology, Earth Science, Biology and Marine Science. It can be used to study thermoclines in ponds and small lakes, and for profiling the depth of streams, small rivers and shorelines. It can also be anchored to study ocean tides.

### Features

**Automatic Water Depth Measurement:** No need to read markings on the cable and manually enter depth.

**Weighted Housing:** Provides depth measurement stability in fast flow stream measurements.

**Sturdy 10 m Cable:** Plenty of depth to study pond and small lake thermoclines.

### Specifications

**Temperature:** 5 °C to 105 °C, ±1 °C

**Depth:** Down to 10 m with resolution of 0.03 m

**Connectors:** Uses two (one for temperature, one for depth) 8-pin DIN plugs

#### Order Information:

Thermocline Sensor.....CI-6731

## Flow Rate

CI-6730A

The Flow Rate Sensor is designed specifically to measure flow rate of streams, rivers and other flowing systems.



### Typical Application

- ▶ Study the relationship between flow rate and depth in a stream.

### Specifications

**Flow Range:** 0 m/s to 3.5 m/s

**Maximum Length:** 1.8 m

**Telescoping Handle**

**Flow Rate Measurement:** DataStudio monitors the revolutions made by a small magnet on a submersible propeller and converts the revolutions to feet per second of flow. Students can easily convert the linear flow rate to volume discharge rates in real time using DataStudio.

#### Order Information:

Flow Rate Sensor.....CI-6730A

## Sound

CI-6506B

- ▶ Measures sound waveform



The Sound Sensor houses a sensitive microphone designed to display audio waveforms of sound levels between 45 and 100 dB.

### Typical Applications

- ▶ Measure basic sound intensity
- ▶ Measure speed of sound measurement
- ▶ Measure beats
- ▶ Study the doppler effect
- ▶ Conduct voice studies
- ▶ Learn musical instrument overtones

### Specifications

**Frequency Response:** 20 to 7,200 Hz

**Decibel Range:** 45 to >100 dB

**Signal-to-Noise Ratio:** < 60 dB

**Amplification:** Two stages condition low-level signals

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

Sound Sensor ..... CI-6506B

## EKG

CI-6539A



The EKG Sensor measures the electrical signals produced by the heart. Students will learn to understand the relationship between muscle depolarization and repolarization and the contraction of the chambers of the heart.

### Typical Applications

- ▶ Generate an EKG graph
- ▶ Conduct health/exercise studies

### Specifications

**Pin Configuration:** 5-pin DIN plug on case

A package of 100 disposable silver/silver chloride electrodes is included.

#### Order Information:

EKG Sensor ..... CI-6539A

Replacement Supplies:

EKG Electrode Patches (100 pack) ..... CI-6620

## Heart Rate

CI-6543B



The Heart Rate Sensor shines light through the ear lobe and measures transmittance. As the heart forces blood through the vessels in the lobe, the light transmittance of the lobe changes. The signal can be graphed by DataStudio and the heart rate calculated.

### Typical Applications

- ▶ Measure heart rate
- ▶ Conduct health studies

### Specifications

**Pin Configuration:** 5-pin DIN plug on case

#### Order Information:

Heart Rate Sensor ..... CI-6543B

## Respiration Rate

CI-6535



With the respiration belt wrapped around their chest, students can measure their respiration rate. The Respiration Rate Sensor includes the CI-6534A Low Pressure Sensor.

### Typical Applications

- ▶ Measure respiration rate
- ▶ Conduct health/exercise studies

### Specifications

**Pin Configuration:** 8-pin DIN plug on case

#### Order Information:

Respiration Rate Sensor ..... CI-6535

Replacement Supplies:

Replacement Belt ..... CI-9842

## Use your **Black ScienceWorkshop** Sensors with **Blue PASPORT** Interfaces!

▶ No Need to Buy New Sensors

### Analog Adapter

PS-2158

Use an Analog Adapter to connect any black ScienceWorkshop sensor having an 8-pin or 5-pin DIN connector to a PASPORT interface.



**Black ScienceWorkshop sensors which connect with an Analog Adapter:**

Sensor Description	Part No.	Page No.
Acceleration	CI-6558	76
Barometer	CI-6531A	83
BNC Adapter	CI-6685	79
Charge	CI-6555	79
Colorimeter	CI-6747	81
Conductivity	CI-6729	80
Current	CI-6556	79
Current, High	CI-6740	79
Dissolved Oxygen	CI-6542	82
EKG	CI-6539A	84
Force	CI-6537	74
Force, Economy	CI-6746	74
Force Platform	CI-6461	76
Heart Rate	CI-6543B	84
Humidity, Relative	CI-6559	83
Infrared	CI-6628	78
Ion Probes		82
Ion-Selective Electrode Amplifier Box	CI-6738	82
Light	CI-6504A	78
Light, Broad Spectrum	CI-6630	78
Light, High-Sensitivity	CI-6604	78
Light, UVA	CI-9784	78
Magnetic Field	CI-6520A	80
pH	CI-6507A	81
Pressure Sensor— Absolute	CI-6532A	76
Pressure Sensor—Low	CI-6534A	76
Respiration Rate	CI-6535	84
Sound	CI-6506B	84
Temperature	CI-6605A	77
Temperature, High Accuracy	CI-6525	77
Temperature with Type K Probe	CI-6526	77
Thermistor Temperature	CI-6527A	77
Thermocline	CI-6731	83
Voltage	CI-6503	79

**Order Information:**

Analog Adapter.....PS-2158



### Digital Adapter

PS-2159

Use a Digital Adapter to connect any black sensor having one or two 1/4" stereo phone plugs to a PASPORT interface. The Digital Adapter is always needed to connect photogates to PASPORT interfaces.

Plug in one or two black digital ScienceWorkshop Sensors



**Black ScienceWorkshop sensors which connect with a Digital Adapter:**

Sensor Description	Part No.	Page No.
Drop Counter	CI-6499	81
Flow Rate	CI-6730A	83
Free Fall Adapter	ME-9207B	75
G-M Tube	SN-7927A	80
Laser Switch	ME-9259A	75
Motion Sensor II	CI-6742A	74
Photogate, Accessory	ME-9204B	37
Photogate Head	ME-9498A	75
Photogate/Pulley System	ME-6838	75
Rotary Motion	CI-6538	74
Time-of-Flight Accessory	ME-6810	75

*Note: For the Xplorer, Analog and Digital Adapters can only be used when the Xplorer is plugged into a computer. The Xplorer GLX can be used stand-alone with the adapters.*

**Order Information:**

Digital Adapter.....PS-2159

# DataStudio® Data Acquisition Software

- ▶ Controls All PASCO Interfaces
- ▶ Record and Analyze Data
- ▶ Windows and MAC Compatible
- ▶ Also Works with MAC Universal Binary

DataStudio is the software program that controls all of PASCO's interfaces. No matter which interface you own, or whether you use a PC or a MAC, DataStudio is the only program you need to record and analyze data.

## ScienceWorkshop Interfaces

500



750



Works with all ScienceWorkshop and PASPORT Interfaces

## PASPORT Interfaces

USB Link



Xplorer



PowerLink



Xplorer GLX



AirLink 2



SPARKlink



### DataStudio Lite Included with all Interfaces

PASCO provides DataStudio Lite software with each PASPORT purchase, or download for free. With the free version of DataStudio, students can:

- ▶ Use EZscreens for simple science activities (for use with PASPORT only)
- ▶ Conduct eLabs using existing Electronic Workbooks
- ▶ Display data in graph, table or digits formats
- ▶ Graph a single variable vs. time

### Works with Any Type of Computer

- ▶ Windows
- ▶ MAC
- ▶ Intel-based MAC
- ▶ Power PC-based MAC

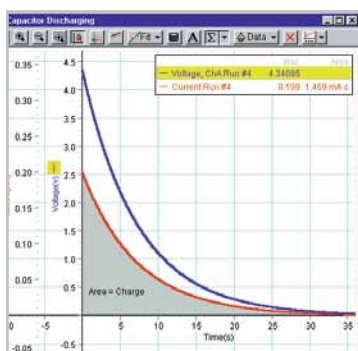
### Multi Language Support (Windows version)

Arabic, Chinese (simplified), Chinese (traditional), Danish, English, French Canadian, German, Italian, Japanese, Norwegian, Portuguese (Brazilian), Russian, Spanish, Swedish, Turkish.

## Powerful DataStudio Analysis Tools

### Graphs

DataStudio graphs are an extremely powerful way to analyze data. The multifaceted tools allow students to reveal and understand science in a way not easily accomplished otherwise.



### Editable Data:

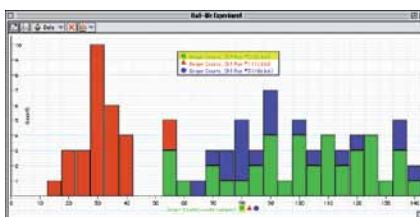
- ▶ Manually input or import data from other sources.
- ▶ Delete or hide extraneous data points so they do not affect your statistics or graph results.
- ▶ Create theoretical data sets with ease.

### Basic Meter Displays:

- ▶ Meter displays can be enlarged to fill your entire monitor – great for large classroom or lecture hall demonstrations.
- ▶ Multiple meters can be displayed in one window.
- ▶ Our analog meter can be formatted in five different styles – Small Sweep, Semicircle, Large Sweep, Full Circle and Custom Sweep.

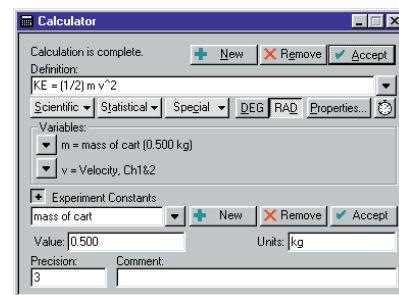
### Histogram

- ▶ Stack bins
- ▶ Compare bins (side by side)
- ▶ Overlay bins



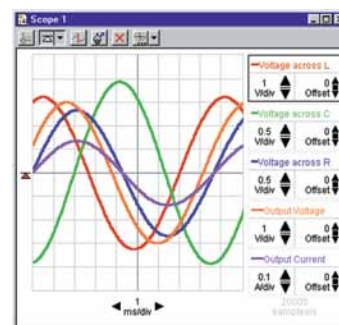
### Experiment Calculator

- ▶ Calculated quantities, such as kinetic energy or inverse volume, can be graphed in real-time or displayed in a table.
- ▶ Data modeling – To examine the shape of a function, type the equation into the calculator, provide a variable range, and Data Studio will graph it. Change parameters and see how the shape changes.



### Oscilloscope

- ▶ Displays multiple traces (up to five)



## Reasons to Upgrade to the Full Version of DataStudio

All interface and sensor purchases come with a complimentary copy of DataStudio Lite.

DataStudio Lite is sufficient to use pre-configured DataStudio files, such as those found in PASCO Physics Experiments (see page 95). However, if you want to change the preconfigured files to fit your labs, create setup files of your own, and/or do more intense data analysis, you need the full version of DataStudio.

### DataStudio Lite is limited to:

- ▶ Viewing and taking data using pre-configured files and electronic workbooks made with the full version
- ▶ Taking data and displaying it on a graph, table, or digits display (only one run on each)
- ▶ Autoscale, Smart Tool, Statistics, and Data Run Selection on the graph
- ▶ Using WAVEPORT, our sound plug-in software (purchased separately, see page 88)

### The full version of DataStudio allows:

- ▶ Creating DataStudio experiment files
- ▶ Authoring electronic workbooks
- ▶ Additional displays: meter, FFT, oscilloscope, histogram
- ▶ Multiple instances of each type of display and more than one run on each display
- ▶ Start and stop conditions
- ▶ Manual sampling
- ▶ Calculator
- ▶ Curve-fitting
- ▶ Graph annotations
- ▶ Data Editing
- ▶ Synchronizing QuickTime videos and data

### System Requirements

**Windows:** Windows 2000 or higher, Pentium or equivalent processor, 50 MB hard drive space, 16 MB RAM

**Macintosh:** MAC OS X v. 10.4 or higher (Universal Binary), 50 MB hard drive space, 16 MB RAM

### Order Information:

#### DataStudio Software

Single User.....	CI-6870G
Site License.....	CI-6871G