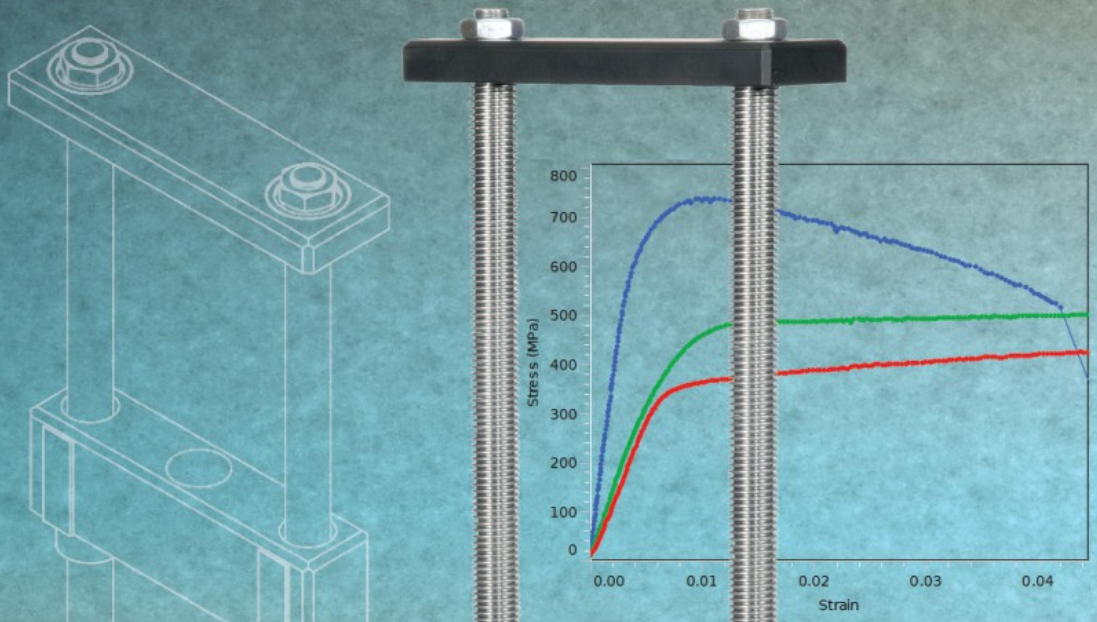
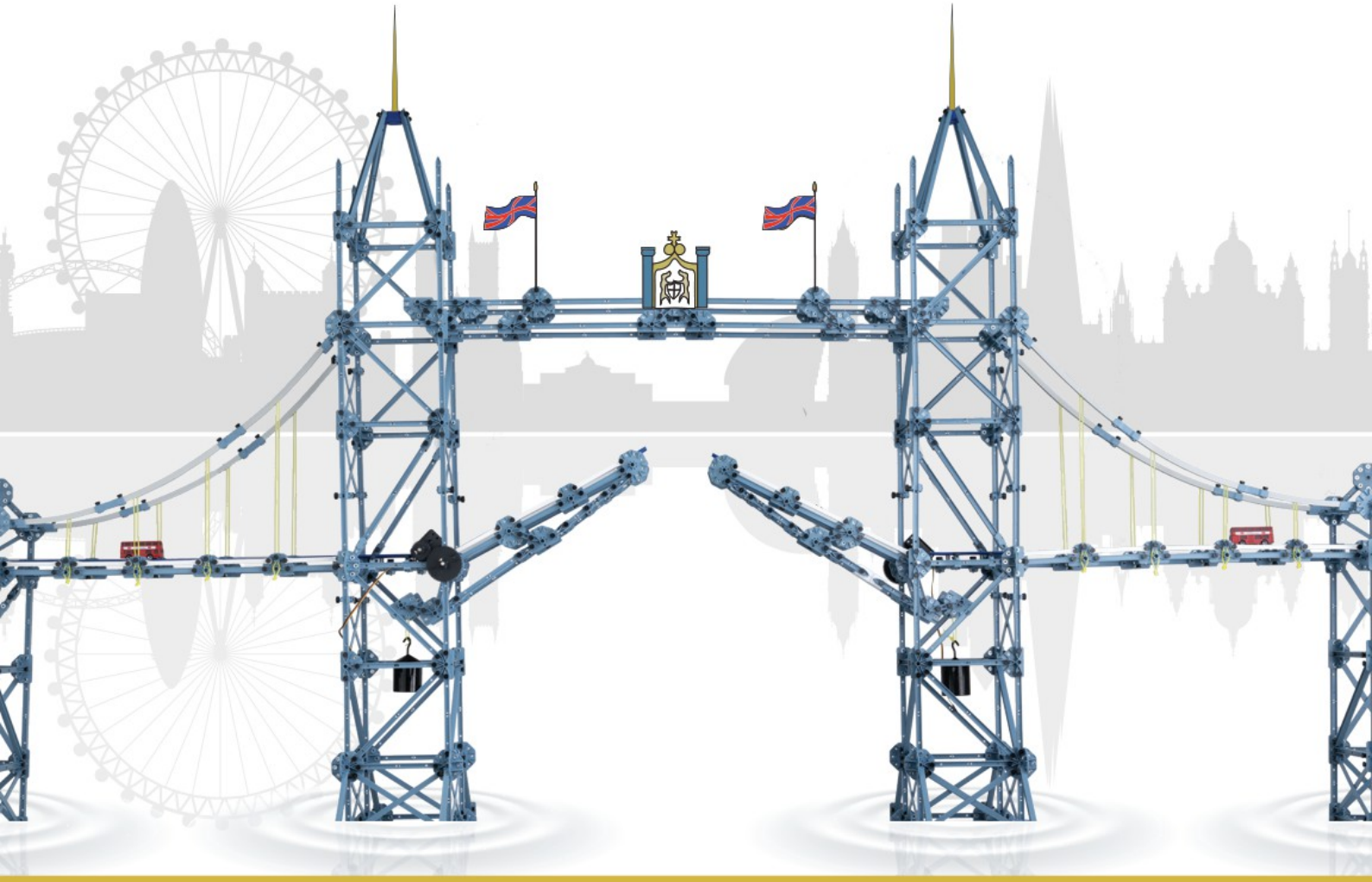
PASCO®
ENGINEERING
Unique Solutions for Engineering Education



See the Comprehensive Materials Testing System on pages 14-17.

STRUCTURES



The PASCO Structures System is a one-of-a-kind learning tool designed especially for students of civil and structural engineering. Each kit consists of just a few simple pieces, including ultra-realistic I-beams that let student models look and behave like real-life designs. Engineer a simple truss, working crane, or towering skyscraper; then put it to the test using Load Cells. With PASCO Structures, there's no limit to what students can create – all they have to do is build it.

See pages 8-13 for examples of PASCO Structures System in use.

Scan to watch the video about the PASCO Structures System.

PASCO®

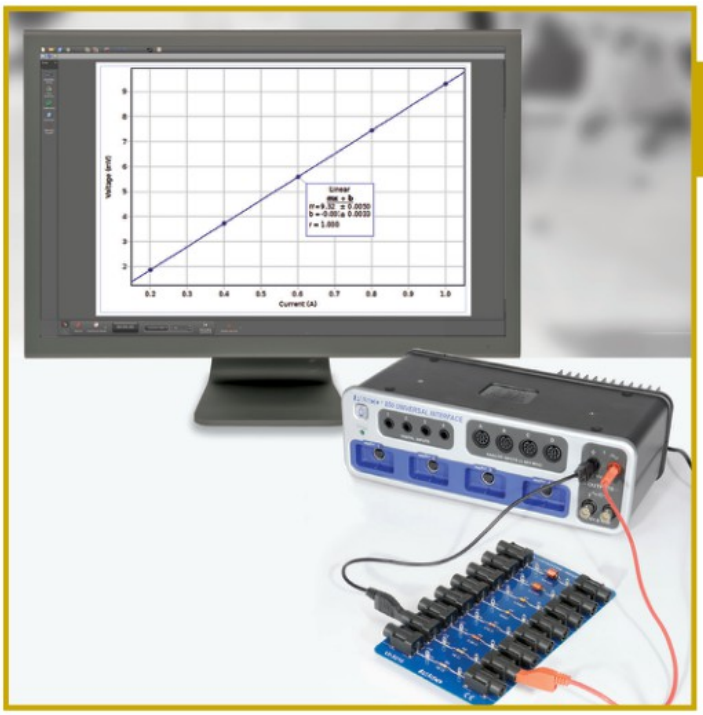
Table of Contents

OUR 5-YEAR WARRANTY

At PASCO our goal is to support you with durable, high-quality equipment that will reliably serve your lab for years to come.

All PASCO-manufactured products are ISO-9001:2015 certified and protected by a 5-Year Limited Warranty to ensure your long-term satisfaction.

Which Data Acquisition System is Right for You?



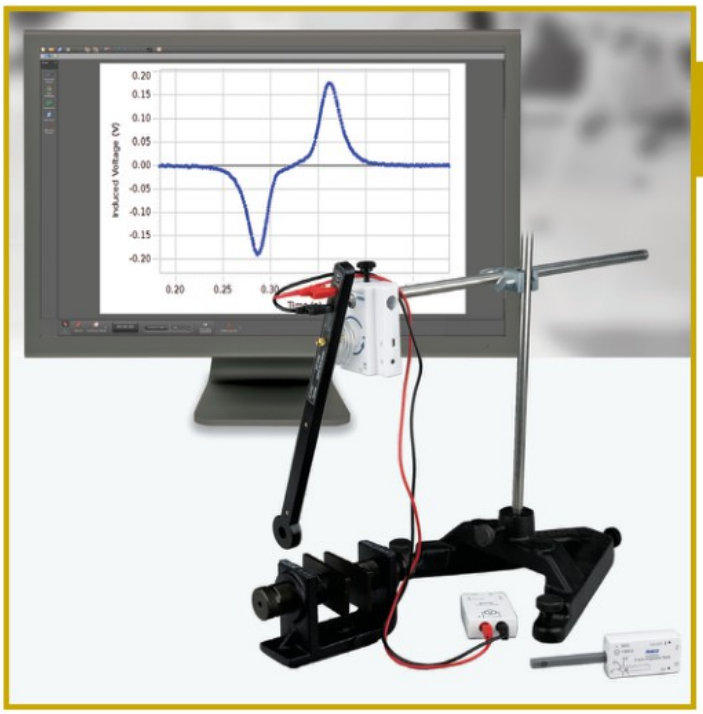
Wired System

When your applications call for high speed sampling and synchronized sensor measurements, the Wired System provides the capabilities you need.

Sensor Type	ScienceWorkshop Sensors and PASPORT Sensors
Interface	Requires one of the following: ■ 850 Universal Interface ■ 550 Universal Interface
Software	PASCO Capstone*
Connectivity	USB**
Platforms	Requires one of the following: ■ Mac® or Windows®
✓ **Benefits**	**Direct connection supports high speed sampling rates. Sensor measurements are easily synchronized.**

*PASCO Capstone is the recommended software for college engineering labs. If students do not have access to a Mac or Windows device, then SPARKvue software is recommended.

**PASPORT Sensors can connect via Bluetooth® when used with the AirLink, SPARKlink Air, or the 550 Universal Interface.



Wireless System

When your students need to quickly collect and display measurements, simplify a setup, or eliminate wires that impede data collection, the Wireless System provides an all-in-one solution.

Sensor Type	Wireless Sensors
Interface	Built-in interface. No additional interface required.
Software	PASCO Capstone* or SPARKvue
Connectivity	USB or wireless connection via Bluetooth®
Platforms	Requires one of the following: ■ Mac® or Windows® ■ Chromebook™ ■ Smartphone ■ iPad® ■ Android™ tablet
✓ **Benefits**	Built-in interface saves space on the benchtop. Bluetooth connection eliminates wires that interfere with data collection.

PASCO capstone™ 2

Advanced Data Collection Software for Engineering Education

PASCO Capstone sets the standard for data acquisition software, providing a seamless, user-friendly platform that combines precision controls, high-speed sampling, and a suite of specialized features to meet your lab's every need. With Capstone, students gain access to advanced tools for data collection, visualization, and analysis, as well as specialty features such as the signal generator, calculator, video display, and circuit simulator.

TOOLS

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

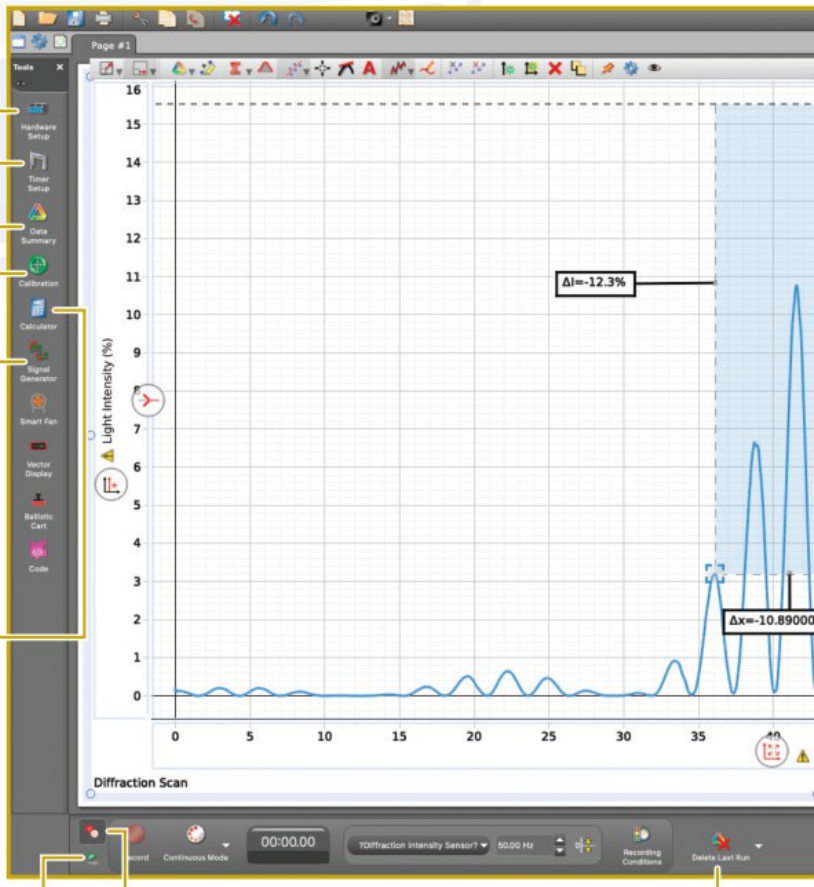
Photogate Timer Wizard
Easily configure photogates and timing measurements

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

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

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

Calculator
- Graph modeling
- Create data sets using sensor data



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

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

Download a free 60-day trial at
www.pasco.com/capstone

Requires Mac® or Windows®

PASCO Capstone Single User License
UI-5401 or UI-5401-DIG

PASCO Capstone Site License
UI-5400 or UI-5400-DIG

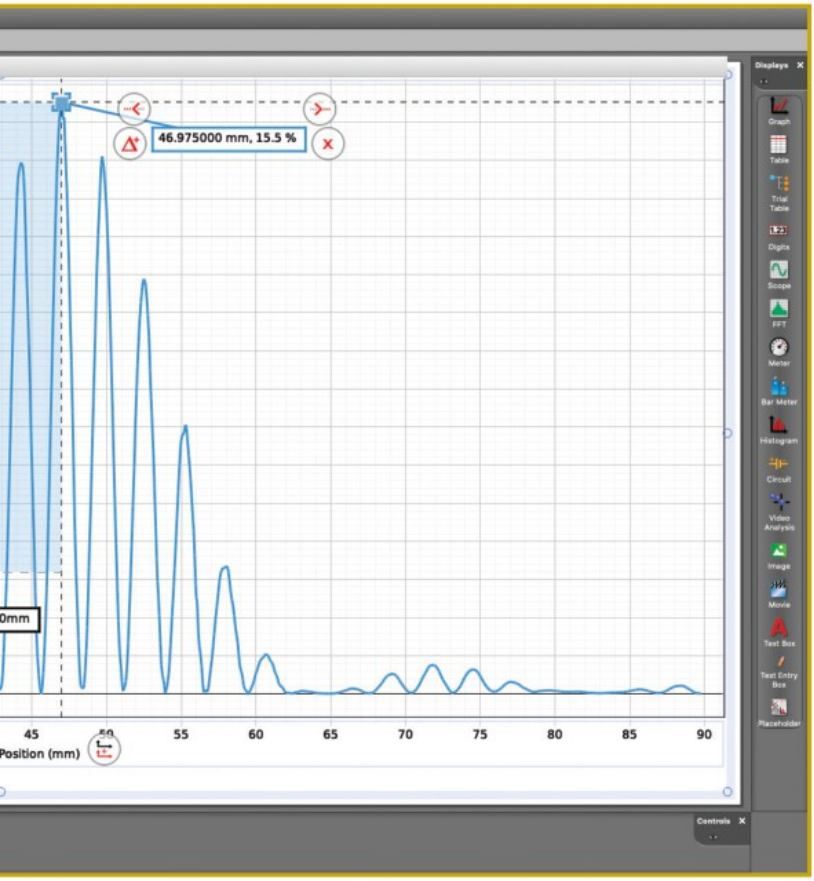
DISPLAYS

Display *Your* Data *Your* Way

■ Graph ■ Table ■ Digits ■ Scope ■ FFT ■ Meters

Graph Tools Include

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

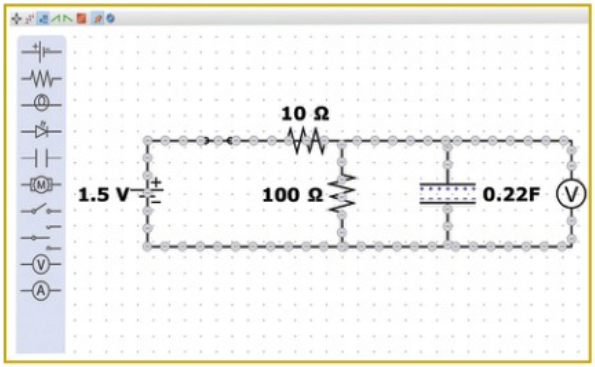


Delete Runs

- Last run only
- Select from list
- All runs

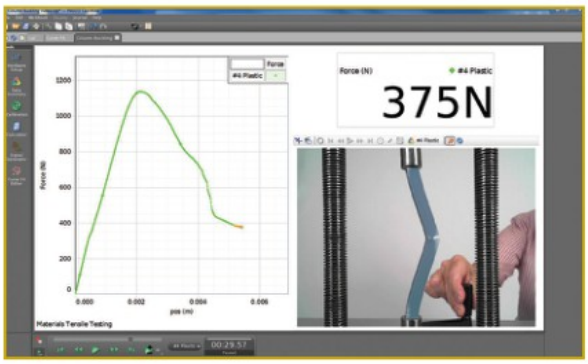
Made a mistake?
Just hit
UNDO

Circuit Display and Simulator



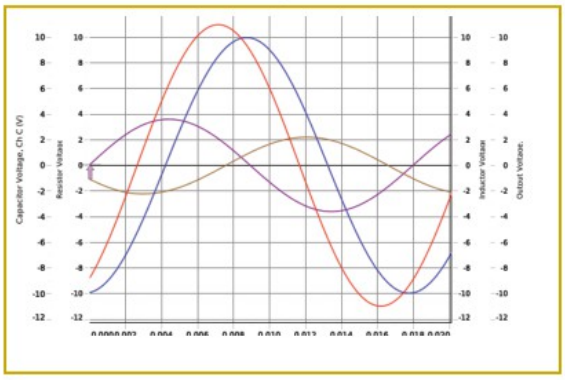
Design and simulate circuits, or display live voltage and current measurements on an integrated Circuit display.

Video Analysis



Analyze the motion of an object in a video, synchronize sensor data with a video, or replay data collection at your own speed.

Oscilloscope Display



Use the Oscilloscope display to monitor signals and waveforms. Capture one or more traces, offset a trace, or record a segment for further analysis.

PASCO's proximity in-app sensor pairing:
U.S. Patent Number 10,356,594

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

The PASCO 850 Universal Interface

The Ultimate Sensor Interface for Engineering Education

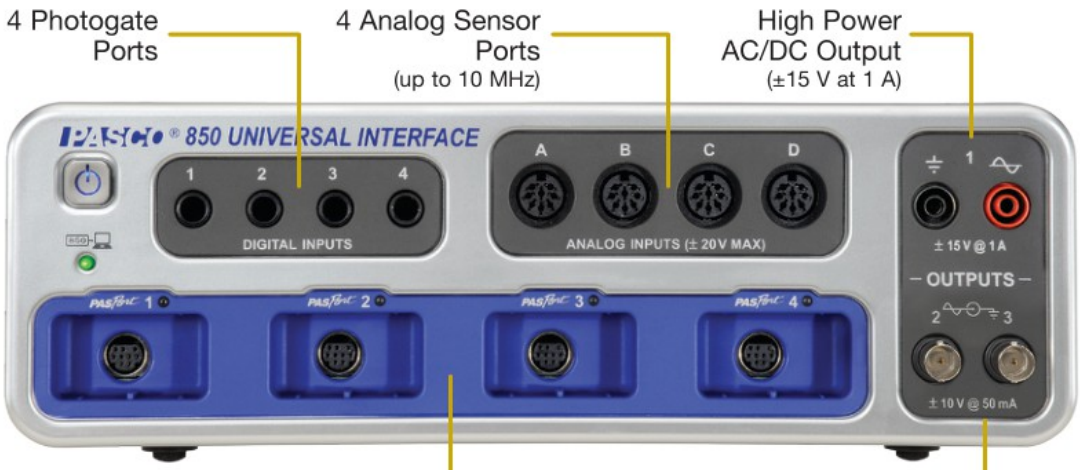
When used with PASCO Capstone, the 850 Universal Interface has the same functionality as several lab devices combined, all while taking up less than half the bench space.

An incredible value!

850 Universal Interface

PASCO Capstone Software

DC Power Supply, Oscilloscope, Digital Multimeter, and Function Generator



- **Power Amplifier:** 15 W
- **High Speed Sampling:** 10.0 MHz (1-2 channels) or 1.0 MHz (3-4 channels)
- **Function Generator:** Independently control the frequency, waveform, and amplitude of two function generators.
- **Oscilloscope:** Create and display sine, triangle, square wave, positive and negative ramps, and DC waveforms in PASCO Capstone (0.001 Hz to 100 kHz).
- **External Trigger:** Easily synchronize multiple 850 Universal Interfaces.
- **Connectivity:** Connects to a computer or laptop via USB 2.0 and PASCO Capstone.
- **Sensor Support:** Collect data from both ScienceWorkshop (analog) and PASPORT (digital) sensors.

For detailed specifications visit **www.pasco.com/850**

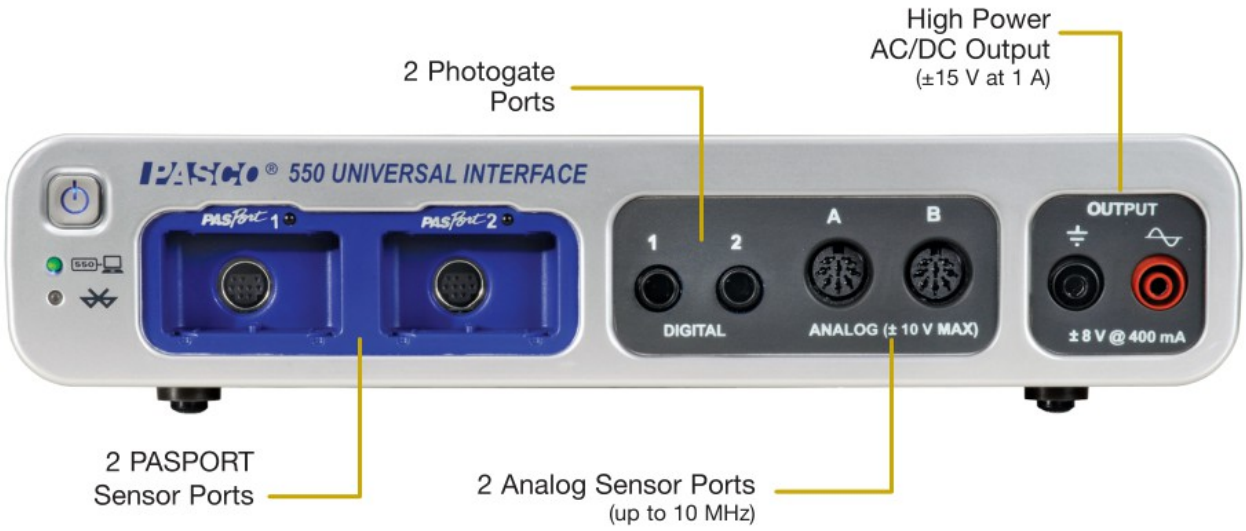
850 Universal Interface
UI-5000

- Required: PASCO Capstone Software (see pages 4-5)
- Recommended: BNC Function Generator Output Cable
- Replacement Part: 850 Universal Interface Replacement Power Supply UI-5200

The PASCO 550 Universal Interface

This powerful interface connects wirelessly or via USB.

Fast, flexible, and affordable, the 550 Universal Interface offers half the ports and many of the same features as the 850 Universal Interface.



- **Power Amplifier:** 3.2 W
- **Sampling Rate:** 2.0 MHz (max)
- **Function Generator:** Control the frequency, waveform, and amplitude of a function.
- **Oscilloscope:** Create and display sine, triangle, square wave, positive and negative ramps, and DC waveforms in PASCO Capstone (0.001 Hz to 100 kHz).
- **Connectivity:** Connects to your device via USB 2.0 or Bluetooth. Requires either PASCO Capstone or SPARKvue software.
- **Sensor Support:** Collect data using ScienceWorkshop (analog) and PASPORT (digital), or Wireless (Bluetooth) sensors.

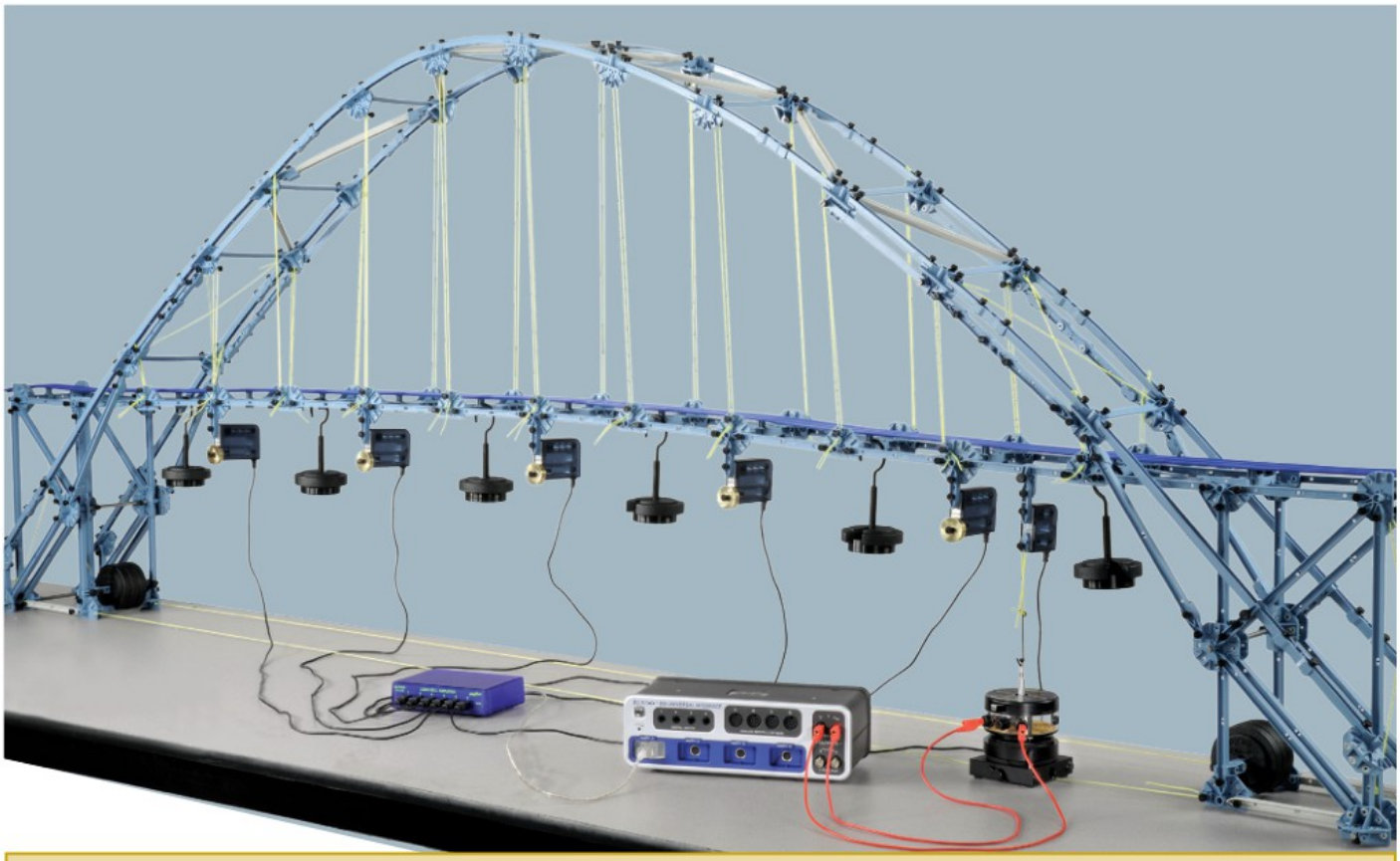
For detailed specifications visit
www.pasco.com/550

550 Universal Interface
UI-5001

▲ Required:
PASCO Capstone Software (see pages 4-5)
OR
SPARKvue Software (go to pasco.com)

PASCO® STRUCTURES SYSTEM

The PASCO Structures System is a one-of-a-kind learning tool designed especially for students of civil and structural engineering. Each kit consists of a variety of building pieces, including realistic I-beams that let student models look and behave like real-life structures. Engineer a simple truss, working crane, or a towering skyscraper; then put it to the test using Load Cells. With PASCO Structures, there's no limit to what students can create – all they have to do is build it.



Watch the PASCO Structures System video!

Download I-Beam Design Files for 3D Printing

pasco.com/resources/diy/209

Explore the Fundamentals of Structural Engineering

Start Simple...then Build BIG!

Start by building a simple truss; then expand your studies by constructing large-scale structures to measure and analyze. From skyscrapers and tower cranes to drawbridges and roller coasters, the possibilities are limitless when you build with PASCO Structures.

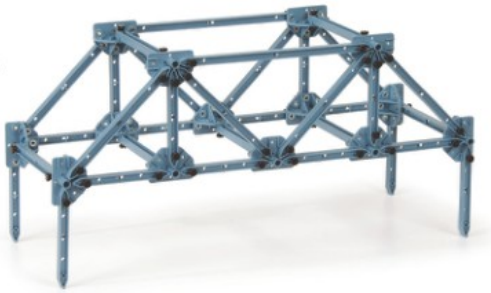
Introductory Structures Sets

Great for learning the fundamentals of structural engineering.

Truss Set

ME-6990

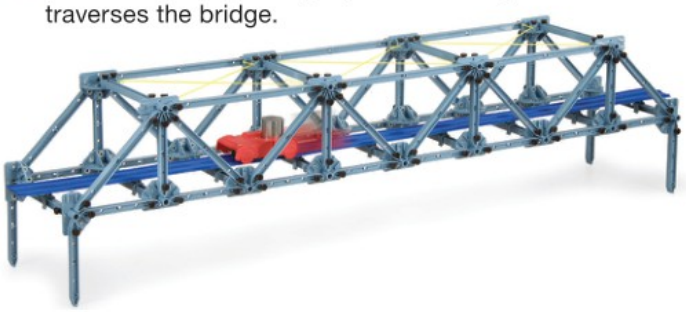
- Teach the basics of truss construction.
- Demonstrate the properties of I-Beams.



Bridge Set

ME-6991

- Construct larger bridges and trusses.
- Study the principles of bridge construction.
- Experiment with flexible road bed and mini cars.
- Add Load Cells to study dynamic loading as a car traverses the bridge.



Building Better Bridges Kit

ME-3581

- Explore the basics of bridge building.
- Make live measurements using Load Cells.
- Study internal forces, forces in equilibrium, and more!

Truss Set ME-6990
Bridge Set ME-6991

Recommended:
Load Cell and Amplifier Set PS-2199

Building Better Bridges Kit ME-3581

Want an additional Load Cell?
Wireless Load Cell and Accelerometer PS-3216

Intermediate and Advanced Structures Sets

Best for advanced studies of large-scale, real-world structures.

Advanced Structures Set

ME-6992B

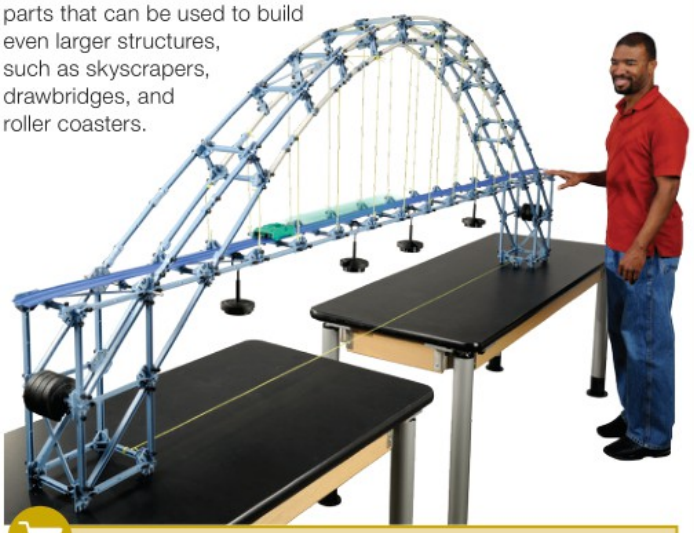
- Expand your Bridge Set.
- Construct large structures, cranes, and a catapult.

The Advanced Structures Set includes additional components for building a wider variety of structures. Build larger trusses, bridges, and even a working catapult!

Large Structures Set

ME-7003

This set includes all the components in the Advanced Structures Set, plus additional parts that can be used to build even larger structures, such as skyscrapers, drawbridges, and roller coasters.



Advanced Structures Set ME-6992B
Large Structures Set ME-7003

Recommended:
Load Cell and Amplifier Set PS-2199

Visit **pasco.com/structures** for a complete list of all contents in these sets.

Complete Experiments

Designed for use with the 850 Universal Interface and PASCO Capstone software, these complete experiments include all the components students need to study structural behaviors at scale.

Each experiment includes Microsoft® Word instructions, graphics, and a PASCO Capstone file with sample data.

Download these experiments for free at **pasco.com/CapstoneExperiments**

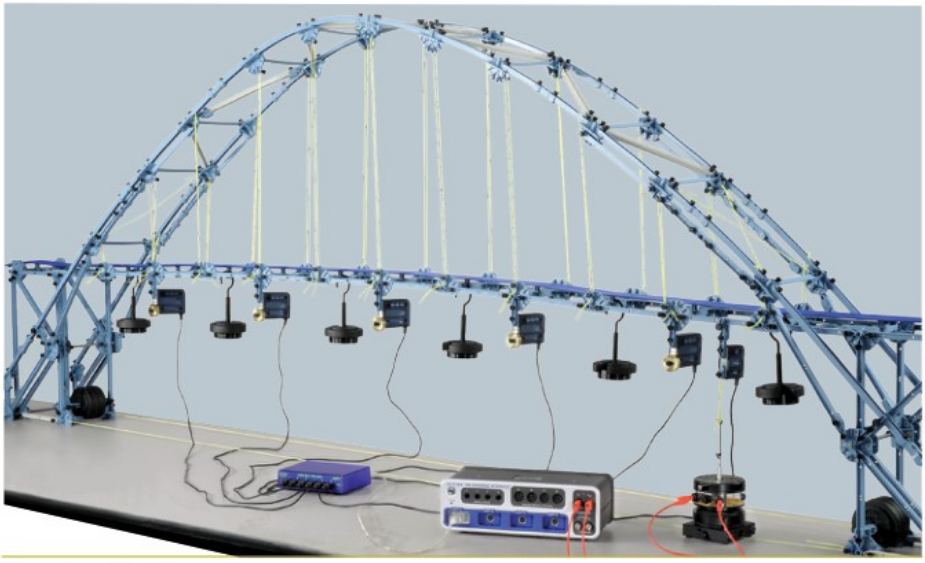
Bridge Vibrations Experiment

EX-5548

Concepts:

- Resonance in complex systems
- Driven vs. free vibrations

Students place Load Cells at different positions on the bridge to measure bridge accelerations in response to a driving force. Resonant frequencies are identified using an FFT in PASCO Capstone software.



Basic Bridges

EX-5556

Concepts:

- Construct and study a variety of bridge types.
- Measure the tension/compression in structural members with Load Cells.

Bridge Vibrations Experiment
EX-5548

▲ Required:
850 Universal Interface UI-5000
(see page 6)
PASCO Capstone Software
(see pages 4-5)

Basic Bridges
EX-5556

▲ Required:
550 or 850 Universal Interface
(see pages 6-7)
OR
AirLink PS-3200
PASCO Capstone Software
(see pages 4-5)

Shaking Tower Experiment

EX-5555

Concepts:

- Demonstrate passive damping
- Explore resonance modes
- Measure accelerations with Wireless Load Cells

Shaking Tower Experiment
EX-5555

▲ Required:
850 Universal Interface
UI-5000 (see page 6)
OR
Function Generator
PI-8127
PASCO Capstone Software
(see pages 4-5)

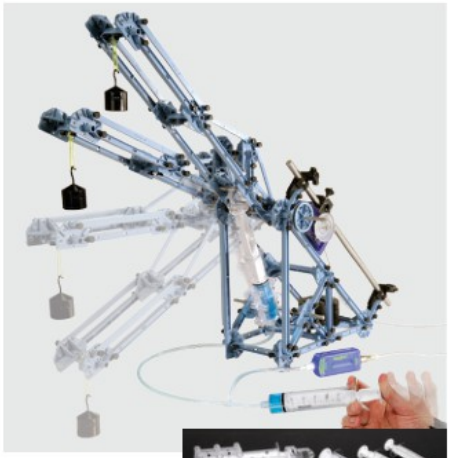
Parts and Accessories

Visit **pasco.com/structures** for a complete list of parts and accessories

Structures Hydraulic System

ME-6984

Add a hydraulic/pneumatic ram to make your structures move and do work. Not only can students see the cranes and jacks in action, they can also measure the pressure and volume to calculate how much work was done.



Includes:
Master Cylinder
Pressure Sensor "T"
Check Valves and Tubing
Syringes (10, 20, 60 ml)
Drive Belt for Rotary Motion Sensor

Flexible I-Beam Set

ME-6985

Use these flexible I-Beams to make a bridge that dramatically demonstrates structural failures. The beams return to their original shape once the load is removed.

Includes:
Flexible I-Beam #5, 24 cm long (10)
Flexible I-Beam #4, 17 cm long (18)
Flexible I-Beam #3, 11.5 cm long (18)

Structures Hydraulic System
ME-6984
Flexible I-Beam Set
ME-6985

Large Slotted Mass Set

ME-7566

Includes:
One 0.5 kg mass hanger (36 cm high)
Nine 0.5 kg slotted masses (8 cm dia.)

Short Slotted Mass Set

ME-7589 (2 kg Set)

Includes:
One 0.5 kg mass hanger (15 cm high)
Three 0.5 kg slotted masses (8 cm dia.)

Hooked Mass Set

SE-8759

Includes:
Masses:

1 x 1000 g	1 x 500 g	2 x 200 g
1 x 100 g	1 x 50 g	2 x 20 g
1 x 10 g		

Molded mass holder

6-Way Connectors (set of 6)

ME-7019

Designed for buildings, this connector secures I-beams in six directions (positive and negative x-, y-, and z-directions).

Large Slotted Mass Set (5 kg Set)
ME-7566
Large Slotted Mass Set (2 kg Set)
ME-7589
Short Mass Hanger ME-7590
Hooked Mass Set SE-8759
6-Way Connectors (set of 6)
ME-7019

Thin I-Beams

ME-7012

Set of 48 thin I-Beams.

Flat Structures Members

ME-6987

Includes 16 beams.

Structures #6 I-Beam Spares

ME-7008

Includes 24 #6 I-Beams (35 cm)

Structures #5 I-Beam Spares

ME-7017

Includes 24 #5 I-Beams (24 cm)

Photoelastic I-Beam Set

ME-7011

Clear plastic I-Beams that display stress lines. Includes 24 I-Beams.

Thin I-Beams
ME-7012
Flat Structures Members
ME-6987
Structures #6 I-Beam Spares
ME-7008
Structures #5 I-Beam Spares
ME-7017
Photoelastic I-Beam Set
ME-7011

Connector Spares

ME-7002

Set of 14 Connector Spares.

Angle Connector Spares

ME-6999A

Includes 24 of each.

Flat Round and Full Round Connector Spares

ME-6997

Includes 6 of each.

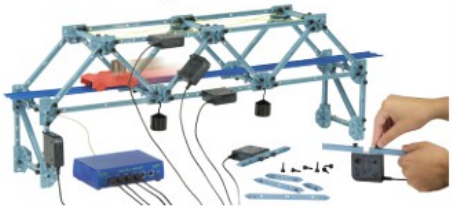
Connector Spares
ME-7002
Angle Connector Spares
ME-6999A
Flat Round and Full Round Connector Spares
ME-6997

Load Cells and Amplifiers

Load Cell and Amplifier Set

PS-2199

- Measure the compression and tension in I-beam members
- Insert Load Cells into structures by substituting beams



The Load Cell and Dual Amplifier Set can be used to test structure strength, manipulate forces, and explore dynamic force relationships. Load Cells are easily inserted by replacing one structure beam with a Load Cell connected to two, shorter beams.

Includes:
PASPORT Load Cell Amplifier PS-2198
100 N Load Cell PS-2200 (4)

Load Cell and Amplifier Set
PS-2199

PASPORT Load Cell and Dual Amplifier Set

PS-2206

The PASPORT Load Cell and Dual Amplifier Set can be used to test structure strength, manipulate force, and explore dynamic force relationships. The set includes the Dual Channel Load Cell Amplifier and one, 100 N Load Cell. You can insert a Load Cell by replacing one structure beam with a Load Cell connected to two, shorter beams. Multiple Load Cells can be purchased for more advanced structure experimentation.

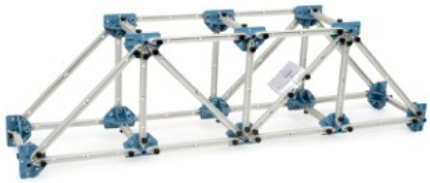
Includes:
Load Cell Amplifier (2-port)
100 N Load Cell

PASPORT Dual Load Cell Amplifier
PS-2206

Wireless Load Cell and Accelerometer

PS-3216

- Measures forces in structures
- Built-in 3-axis accelerometer measures bridge vibrations
- No wires to interfere with motion



The Wireless Load Cell and Accelerometer is designed to measure loads in the PASCO Structures Systems, without requiring additional amplification. It is particularly useful for measuring vibrations because it includes an accelerometer and has no wires to impede movement.

Specifications:

Load Cell
Range: ±50 N
Resolution: 0.03 N
Accuracy: 0.1 N
Maximum Sample Rate: 2 kHz

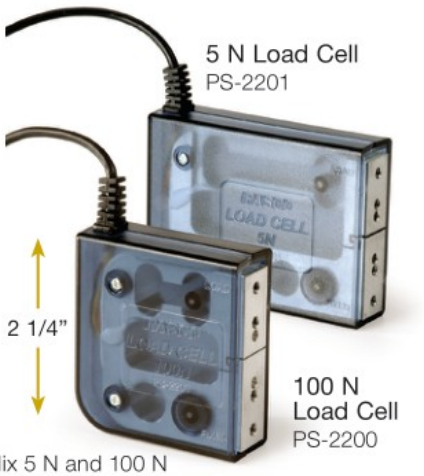
Accelerometer
Range: ±16 g (three axis)
Maximum Sample Rate: 500 Hz

Measurements: Force; Acceleration (3 axes and resultant)
Logging: Yes
Battery: Rechargeable lithium-polymer
Connectivity: Direct USB or via Bluetooth 4.0

Wireless Load Cell and Accelerometer
PS-3216
Shown in use with:
Building Better Bridges Kit
Shown on page 9 and includes PS-3216.

Load Cell 100 N PS-2200
Load Cell 5 N PS-2201

Wired Load Cells are available in two different ranges: ±100 N and ±5 N. PASCO 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.



Mix 5 N and 100 N Load Cells on the same amplifier.

PS-2200 Specifications:
Range: ±100 N
Accuracy: ±1% (±1 N)
Resolution: 0.02 N
Safe Overload: ±150 N

PS-2201 Specifications:
Range: ±5 N
Accuracy: ±1% (±0.05 N)
Resolution: 0.001 N
Safe Overload: ±7.5 N

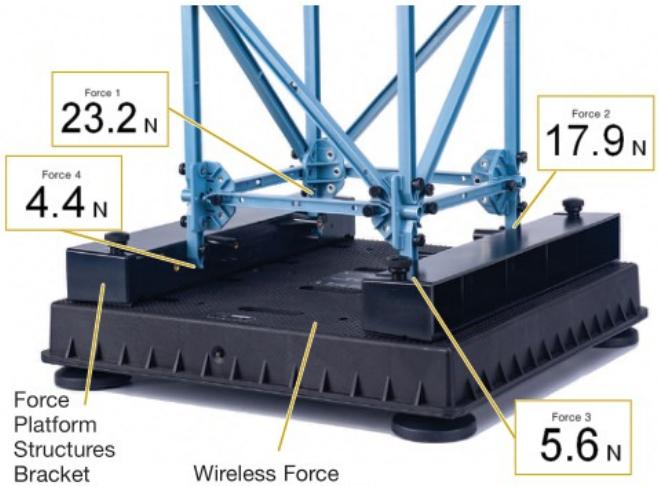
100 N Load Cell
PS-2200
5 N Load Cell
PS-2201

Measure support forces with a Force Platform

Wireless Force Platform

PS-3229

Measure the support forces of a crane by connecting it to a Wireless Force Platform using the special Force Platform Structures Bracket (ME-6988). 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.



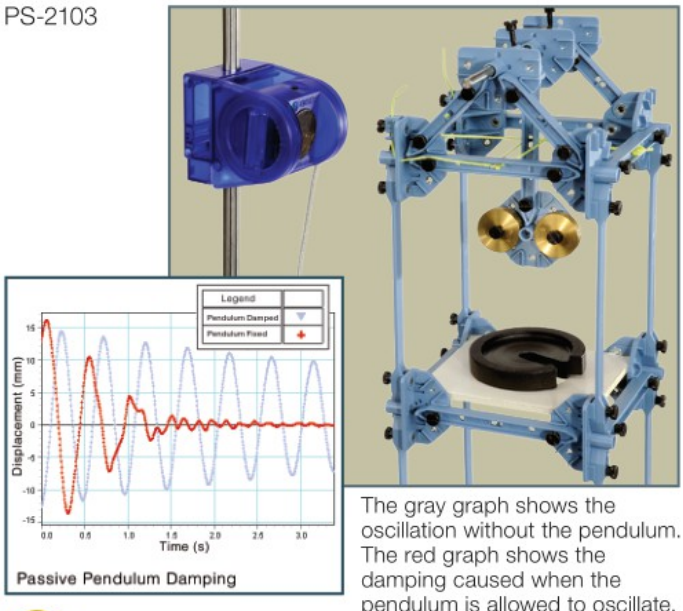
Wireless Force Platform
PS-3229

Force Platform Structure Bracket
ME-6988A

Measure passive damping with a Motion Sensor

PASPORT Motion Sensor

PS-2103



The gray graph shows the oscillation without the pendulum. The red graph shows the damping caused when the pendulum is allowed to oscillate.

Equipment shown:

Advanced Structures Set*	ME-6992B
PASPORT Motion Sensor	PS-2103A
Large Slotted Mass Set	ME-7566

*Patents pending

Measure bridge deflection with a Displacement Sensor

PASPORT Displacement Sensor

PS-2204

The Displacement Sensor measures the travel of a spring-loaded indicator as a bridge is loaded with weight.

PASPORT Displacement Sensor PS-2204

Shown in use with:

Hooked Mass Set	SE-8759
Small "A" Base	ME-8976
Stainless Steel Rod, 60 cm Threaded	ME-8977

Required:
PASPORT Interface

Comprehensive Materials Testing System

ME-8244

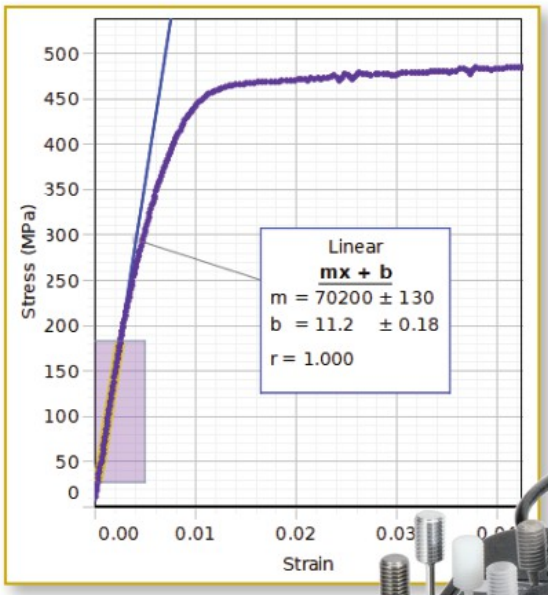
With this one system, your students can investigate:

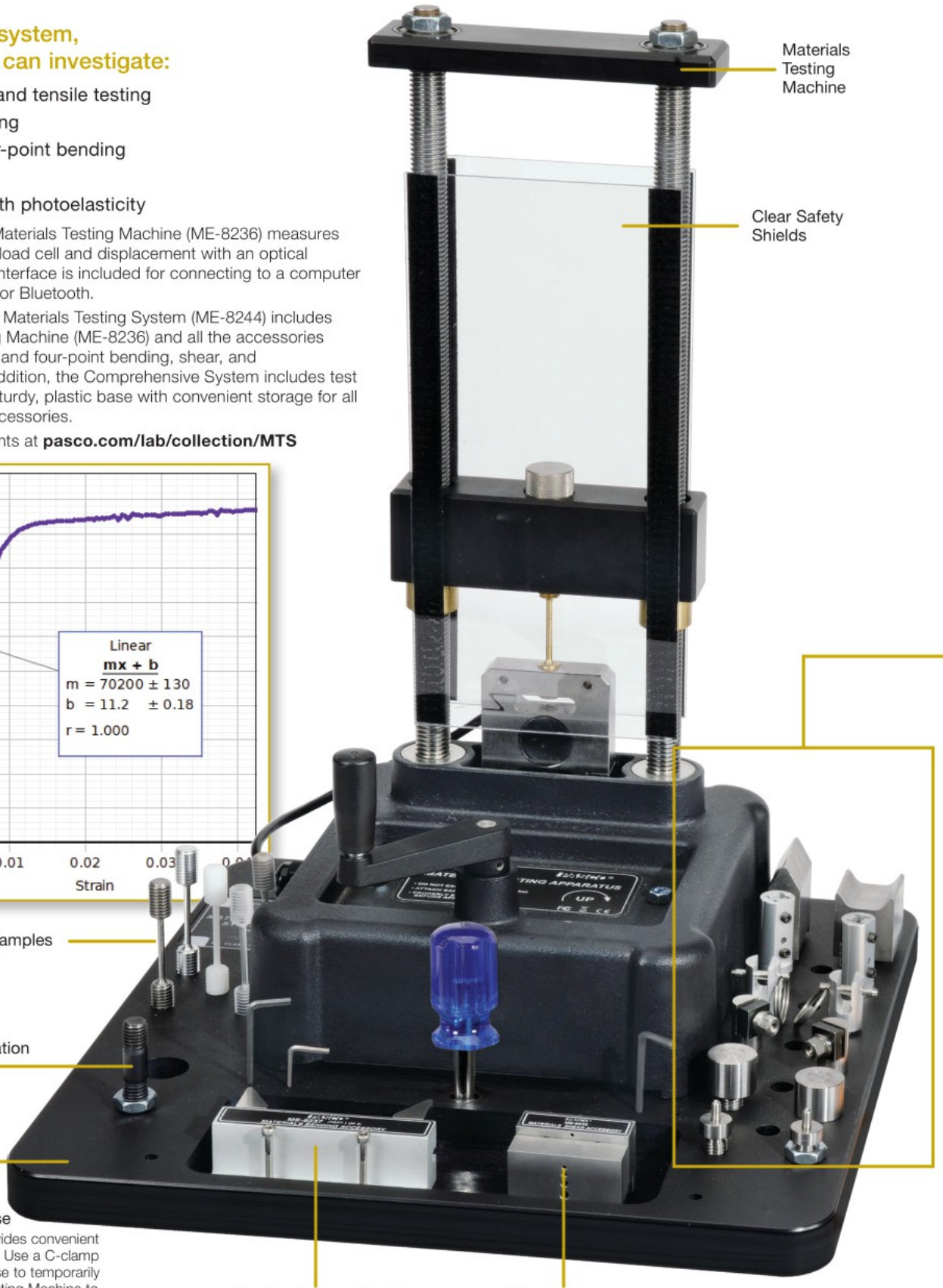
- Compression and tensile testing
- Column buckling
- Three and four-point bending
- Shear testing
- Stress lines with photoelasticity

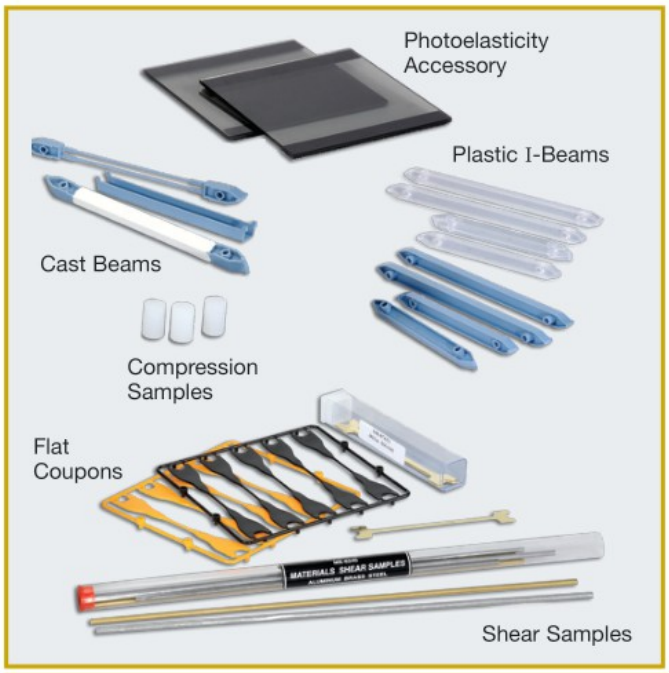
The hand-cranked Materials Testing Machine (ME-8236) measures force with a 7100 N load cell and displacement with an optical encoder. An Airlink interface is included for connecting to a computer through a USB port or Bluetooth.

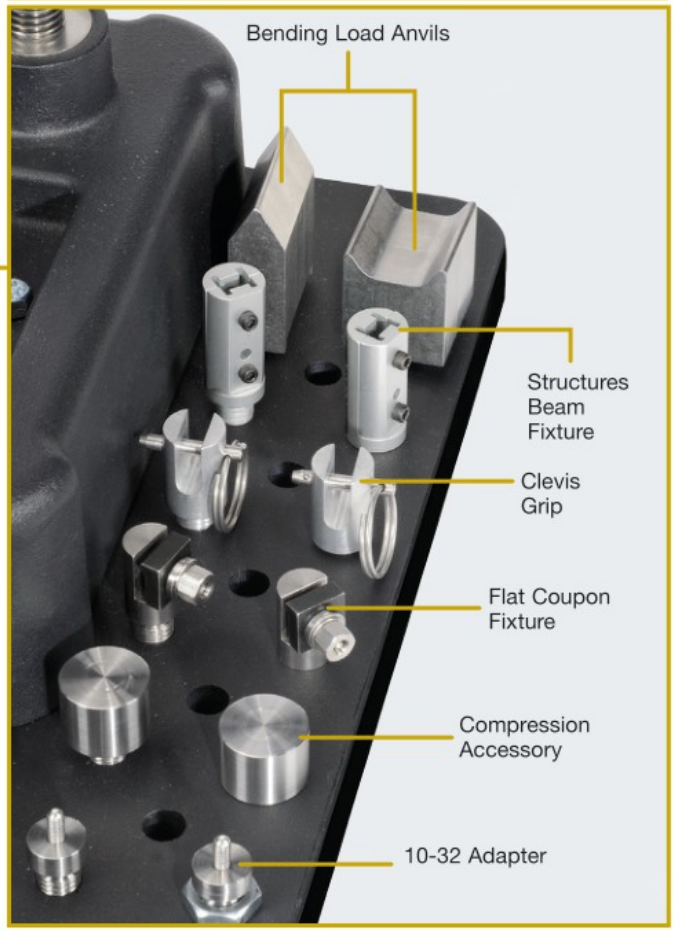
The Comprehensive Materials Testing System (ME-8244) includes the Materials Testing Machine (ME-8236) and all the accessories (compression, three and four-point bending, shear, and photoelasticity). In addition, the Comprehensive System includes test sample sets and a sturdy, plastic base with convenient storage for all components and accessories.

Download experiments at **pasco.com/lab/collection/MTS**









Materials System Storage Base

The plastic base is made of High Density Polyethylene (HDPE). Includes base and mounting hardware.

Includes:

Materials Testing Machine	ME-8236
Tensile Samples (10 of each): Aluminum, Brass, Annealed Steel, Steel, Acrylic, Polyethylene	
Bending Accessory	ME-8237
Four-point Load Anvil	ME-8249
Photoelasticity Accessory	ME-8241
Shear Accessory	ME-8239
Materials System Storage Base	ME-8229
Structures Beam Fixture	ME-8242
Thin I-Beams	ME-7012
Cast Beam Spares Set	ME-6983
Compression Accessory	ME-8247
Flat Coupon Fixture	ME-8238
Stress Strain Apparatus Coupons:	
Plastic	AP-8222
Metal	AP-8223
Clevis Grip	ME-8245
10-32 Adapter	ME-8246
AirLink Interface	PS-3200
PASCO Capstone Single User License	UI-5401

Materials Testing Machine

ME-8236

- 7100 N max load
- Hand-cranked so students can feel samples break

The Materials Testing Machine measures force with a 7100 N load cell and displacement with an optical encoder. It runs on PASCO Capstone software, which has a built-in compliance calibration wizard – plus tools to record and display stress vs. strain, apply linear fits to find Young's Modulus, and to record and play back video of the samples breaking in sync with the data.

Includes
Machine
Compliance calibration rod
Safety shields
(requires Capstone software)

Shown in use without the included safety shields.

Comprehensive Materials Testing System
ME-8244
Materials Testing Machine ME-8236

Materials Testing Accessories

USB Camera Microscope

PS-2343

- Use as a webcam or microscope
- Adjust the optical zoom from 1x to 60x
- Sync data to recordings of tensile tests in PASCO Capstone

The versatile USB Camera Microscope can take pictures and video just like a digital camera, but it can also magnify like a microscope when it's up close to a specimen.

Image of broken steel tensile sample taken with the microscope.

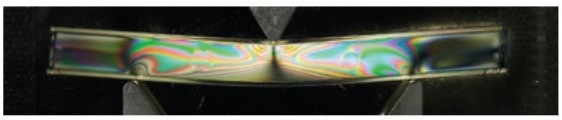
Includes:
Camera
Microscope Stand

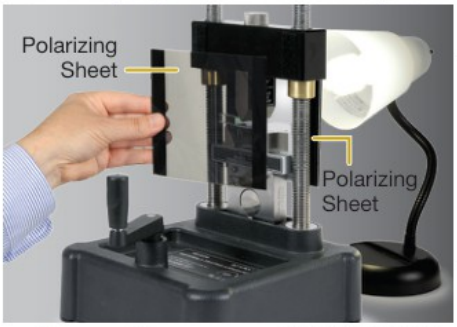
USB Camera Microscope PS-2343

Photoelasticity Accessory

ME-8241

See stress lines by bending a clear, colorless photoelastic I-Beam between two polarizing sheets. As the beam is bent, areas of greater stress show up as patterns of colored lines.





Lamp not included.

Photoelasticity Accessory consists of two crossed polarizing sheets that are placed in front of and behind the clear beam. When illuminated from behind by a bright white light, fringes due to the stress lines become visible.

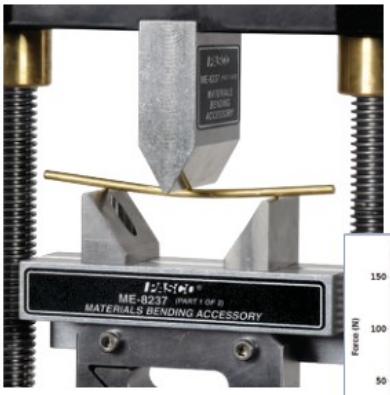
Includes:
One Photoelastic I-Beam Set: ME-7011
Two polarizing sheets, 5 3/8" x 5 3/8" x 1/8"

Photoelasticity Accessory ME-8241

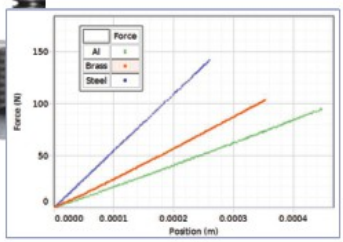
Bending Accessory

ME-8237

Perform three-point bending tests of various materials, including beams from the PASCO Structures System. Support anvils have adjustable separation up to 10 cm.



A Three-Point Bend Test is performed on a brass rod from the ME-8240 Shear Samples. The support anvils have adjustable separation up to 10 cm.



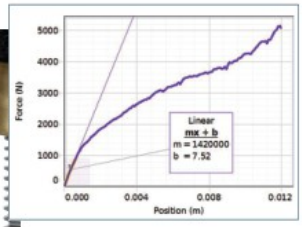
This Force vs. Position graph shows three-point bending for aluminum, brass, and steel samples, all with the same anvil spacing. From this graph, the flexural elastic modulus for each material is measured.

Bending Accessory ME-8237

Compression Accessory

ME-8247

This one-inch diameter platform provides a sturdy base to investigate compression of a variety of materials. It is shown here in a compression test on one of the included polyethylene test samples.



Includes:
Platform
20 Polyethylene cylinders (ME-8248), 1.3 cm dia. x 2 cm long

Before and after photo of compression sample

Compression Accessory ME-8247
Replacement Supplies: Compression Samples ME-8248

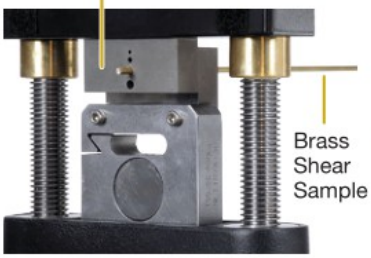
Visit **pasco.com** for a complete list of Materials Testing accessories.

Shear Accessory

ME-8239

The Shear Accessory facilitates shear tests for wires with diameters of 1/16", 3/32", 1/8", and 5/32".

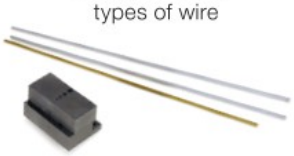
Includes Shear Samples and three of each: aluminum, brass, and mild steel (1/8" diameter, 12" long)



Includes:

Shearing Block and Shear Samples (ME-8240)

3 Each of three types of wire

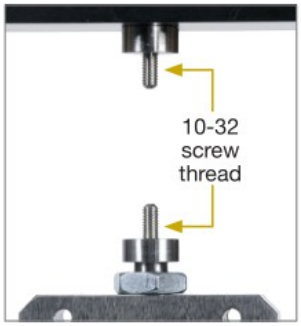


10-32 Adapter

ME-8246

Allows use of grips and attachments from other vendors that require a 10-32 male thread.

Includes:
Upper and lower adapters



Clevis Grip

ME-8245

This generic pin and clevis adapter allows the user to tensile test a wide variety of samples with hooked ends or through-holes. It is shown here testing an extension spring (not included).

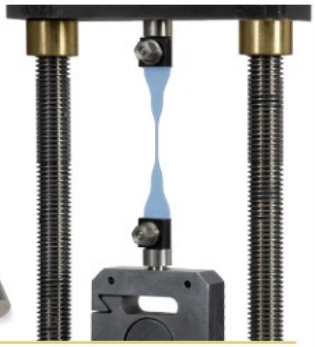
Includes:
Clevis adapter and pin. Pin diameter is 0.187 in. Max width of sample is 0.300 in.

	Shear Accessory	ME-8239
■	Replacement Supplies:	
	Shear Samples	ME-8240
	10-32 Adapter	ME-8246
	Clevis Grip	ME-8245

Flat Coupon Fixture

ME-8238

Test any flat material, such as paper, foil, or plastic. Shown using the Flat Plastic Test Coupons (AP-8222).



Includes:
Clamps (2)
Wrench

Plastic Test Coupons

AP-8222

Includes a set of plastic coupons, with four types of color-coded samples. 10 pieces per sample:

- High impact polystyrene (HIPS)
- Nylon 6 (15% glass fiber reinforced)
- Acrylonitrile butadiene styrene (ABS)
- Polypropylene (PP)

Metal Test Coupons

AP-8223

This set includes metal test coupons of varying strengths. Includes five types of samples, ten pieces per sample.

- Brass (thin) 0.003"
- Brass (thick) 0.005"
- Cold-rolled steel 0.003"
- Aluminum 0.003"
- Annealed steel 0.003"

	Flat Coupon Fixture	ME-8238
	Plastic Test Coupons	AP-8222
	Metal Test Coupons	AP-8223

Tensile Samples

Set of 10 each.

	Aluminum Tensile Sample	ME-8231
	Brass Tensile Sample	ME-8232
	Annealed Steel Tensile Sample	ME-8233
	Steel Tensile Sample	ME-8243
	Acrylic Tensile Sample	ME-8234
	Polyethylene Tensile Sample	ME-8235

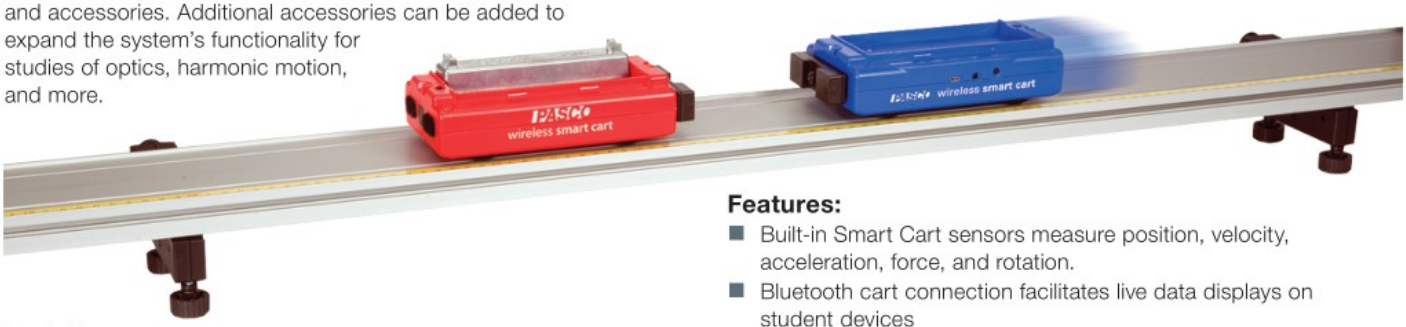
Carts and Tracks

Standard Smart Cart Metal Track 1.2 m System

ME-5718A

A staple in labs for more than 25 years, PASCO Dynamics Systems provide an all-in-one solution for facilitating student investigations of mechanics concepts – ranging from velocity and acceleration to forces and Newton's laws.

This system includes two patented Smart Carts (one red, one blue), a 1.2 m Aluminum Track, and accessories. Additional accessories can be added to expand the system's functionality for studies of optics, harmonic motion, and more.



Includes:

Aluminum Dynamics Track, 1.2 m	ME-9493
Smart Cart (Red)	ME-1240
Smart Cart (Blue)	ME-1241
Cart Mass (Set of 2)	ME-6757A
Super Pulley with Clamp	ME-9448B
IDS Spring Kit	ME-8999
Friction Block	ME-9807
Angle Indicator	ME-9495A
Dynamics Track End Stop (Pair)	ME-8971
Dynamics Track Feet (Pair)	ME-8972
Track Rod Clamp	ME-9836
Smart Cart Rod Stand Adapter	ME-1244

Features:

- Built-in Smart Cart sensors measure position, velocity, acceleration, force, and rotation.
- Bluetooth cart connection facilitates live data displays on student devices
- Carts feature two string tie positions
- Red and blue carts for distinguishing during collisions
- Conductive track facilitates the study of induced magnetic drag
- Track features a high-contrast scale for quick measurements

Smart Cart

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

Transform tough topics into tangible hands-on labs with the sensor-loaded Smart Cart!

The patented Smart Cart is the ultimate tool for investigating topics involving kinematics, dynamics, Newton's laws, and more. Built on a durable ABS body with nearly frictionless wheels, the Smart Cart features a suite of built-in sensors that allow students to make measurements as their labs unfold, plotting them in real time for instant insights.

Specifications:

Force Range: ±100 N
Force Resolution: 0.1 N
Force Accuracy: ±1.0%
Force Maximum Sampling Rate: 2.0 kHz
Position Resolution: ±0.2 mm
Max Velocity: ±3.0 m/s
Velocity Max Sample Rate: 500 Hz
Acceleration Range: ±16 g
Acceleration Max Sample Rate: 500 Hz
Max Rotational Speed Sampling Rate: 500 Hz
Max Wireless Range: 30 m (unobstructed)
Maximum Measurable Rotation Rate (Gyro): ±245 deg/second
Mass Without Accessories: 245 g
Patent No.: 10,481,173
Magnetic Bumper Mass: 23.6 g

U.S. Patent Number 10,481,173

Includes:

Hook
Rubber bumper
Magnetic bumper
USB cable for charging

Standard Smart Cart Metal Track 1.2 m System	ME-5718
Smart Cart (Red)	ME-1240
Smart Cart (Blue)	ME-1241

Visit **pasco.com/dynamics** for more information on carts and tracks.

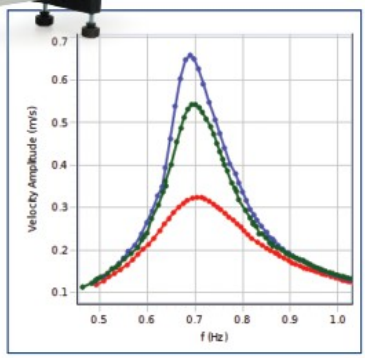
Driven Damped Cart Oscillations

EX-5551A

Concepts:

- Resonance curves
- Magnetic drag

Magnets induce currents in the aluminum track and cause a drag force that is proportional to the cart velocity.



The amplitude of the cart's velocity is plotted vs. the driving frequency.

In this experiment, students study an oscillator that consists of a Smart Cart attached to two springs. As the cart moves along the track, magnets mounted to the cart cause eddy currents in the aluminum track. Students plot the amplitude of the oscillation against the driving frequency for various amounts of magnetic damping, and analyze their results to develop a better understanding of oscillations and resonance curves.

PASCO Advantage:

The Smart Cart wirelessly measures the position and velocity of the cart as well as the magnetic drag, since the magnetic drag bumper is attached to the Smart Cart's force sensor.

Download this experiment.
The FREE experiment files include Microsoft Word® instructions, PASCO Capstone™ workbook files with sample data, and graphics. Download this experiment at **www.pasco.com/CapstoneExperiments.**

Includes:

Smart Cart and Dynamics Track	
Mechanical Oscillator/Driver	ME-8750
Dynamics Cart Magnetic Damping	ME-6828
IDS Spring Kit	ME-8999
Photogate Head	ME-9498A
PAScar Cart Mass (Set of 2)	ME-6757A

Driven Damped Cart Oscillations	EX-5551A
▲ Required:	
Ohaus Triple-Beam Balance (with Tare)	SE-8707
850 Universal Interface	UI-5000 (see page 6)
PASCO Capstone Software	(see pages 4-5)

PAStrack

ME-6960

Includes:

Two piece track
Connector clips (2)
Leveling feet (6)

Curved PAStrack

ME-6841

Snap the Curved PAStrack to a straight PAStrack segment to create hills, valleys, and inclines.

Includes:

Concave-up Curved Piece
Concave-down Curved Piece
PAStrack Connector Clips (2)

PAStrack	ME-6960
Curved PAStrack	ME-6841

Aluminum Starter Tracks

Explore magnetic drag with an aluminum track.

These aluminum tracks are available in 1.2 m and 2.2 m lengths.

1.2 m Aluminum Dynamics Track	ME-9493
2.2 m Aluminum Dynamics Track	ME-9779

Cart Accessories

Smart Fan Accessory

ME-1242

- Provides a constant force
- Hands-off operation
- Manual mode for non-Smart Carts

U.S. Patent Number 10,482,789

What makes this fan so smart?

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

- **Hands-off Operation:** Turn the Smart Fan on and off wirelessly from your computing device.
- **Adjust the Thrust:** Move the slider in the software and watch the fan respond.
- **Reverse the Spin of the Fan:** Input a negative thrust to make the fan blow in the opposite direction.
- **Set Start and Stop Conditions:** Choose to start the fan when a measurement (such as position) reaches a certain value. Make the fan stop after a certain time so the cart coasts during part of the experiment.
- **Sense and Control:** Program the Smart Fan thrust to respond to a calculation based on sensor measurements, for example:

Thrust = -100*[Position]

- The fan will blow harder as the cart moves down the track, causing the cart to reverse. Eventually the fan will reverse when the position becomes negative, accelerating the cart in the positive direction.

Includes:
Smart Fan Accessory
Smart Cart Cable (19 cm)
AA Alkaline Batteries (4)

Make your fan rotatable:
3D print your own rotating base for the Smart Fan Accessory at **pasco.com/diy**

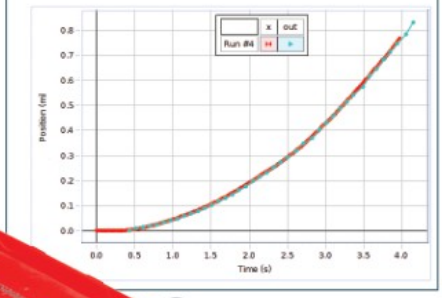
Smart Fan Accessory ME-1242
Required:
Smart Cart or Dynamics Cart
PASCO Capstone Software (see pages 4-5)
Recommended:
Battery Charger and 8 AA Batteries SE-3570

Smart Cart Motor

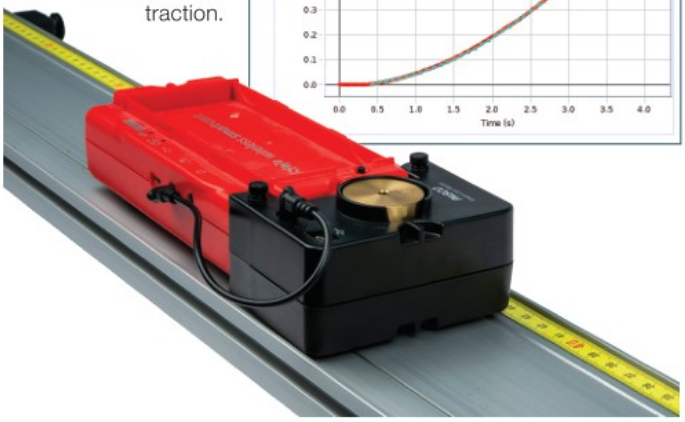
ME-1247

The Smart Cart Motor is a motor-driven wheel that attaches to the Smart Cart to make it go at a constant velocity, forwards or backwards. In PASCO Capstone or SPARKvue, you can control the motor remotely through its wired connection to the Smart Cart by setting the power on a scale of -100 to +100%.

$x = v_0t+(1/2)at^2$
$v_0=0$ m/s $a = 0.05$ m/s²



A brass mass is added to the slot on top of the Motor to increase the traction.



Includes:
Smart Cart Motor
Smart Cart Connector Cable
USB Charging Cable

Smart Cart Motor ME-1247
Required:
Smart Cart (Red) ME-1240
OR
Smart Cart (Blue) ME-1241
Recommended:
1.2 m Aluminum Dynamics Track ME-9493

Visit **pasco.com** for more information on all Smart Cart Accessories.

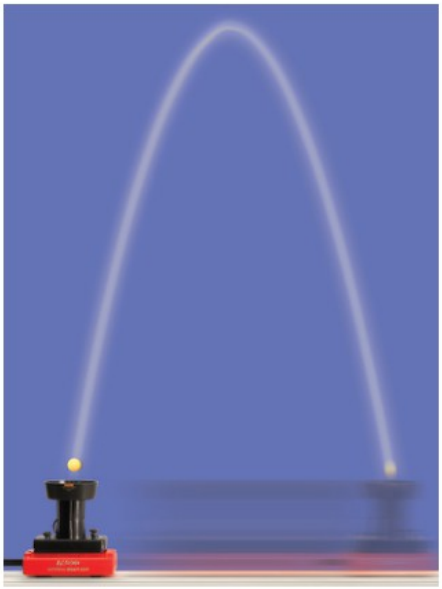
Smart Ballistic Cart Accessory

ME-1245

- Demonstrates the independence of vertical and horizontal motion
- Shoots over 50 cm high
- Works with all PASCO carts
- Updated to take advantage of Smart Cart capabilities

The Smart Ballistic Cart Accessory mounts to any PASCO dynamics cart for a classic demonstration on the independence of X and Y motion. A projectile fired from the accessory while a cart is in motion will be caught farther down the track. When mounted to a PASCO aluminum cart, or PAScar, the projectile is launched using a push button timer delay.

When connected to a PASCO Smart Cart, the accessory takes on new features, allowing it to launch the projectile based on measurements made by the Smart Cart in either SPARKvue or PASCO Capstone software.



Includes:
Smart Ballistic Cart Accessory
Plastic Balls (2)
USB Charging Cable
Smart Cart Accessory Cable

Smart Ballistic Cart Accessory ME-1245
▲ Required:
Smart Cart or any other PASCO Cart
● Recommended:
Aluminum Dynamics Track with Leveling Feet

Smart Cart Vector Display

ME-1246

Help your students visualize acceleration, force, and velocity in real time!

The vector display can sit flat in a Smart Cart.

The Smart Cart Vector Display adds visual vectors to your Smart Cart for Force, Acceleration, or Velocity. Connect it to the Smart Cart's accessory port to visualize vectors in real time! The arrows light up proportional to the sensor reading and indicate both magnitude and positive or negative direction.

Features

- Select between force, acceleration, or velocity vectors and display them in real time.
- Visualize constant acceleration as a cart rolls up and then down an incline.
- Great for the student lab station or for a lecture demonstration!
- Selectable ranges

The vector display can mount vertically for classroom demonstrations.

Smart Cart Vector Display ME-1246

Projectile Launchers

Projectile Launcher

ME-6800

- Accurate
- Durable
- High Repeatability

The Projectile Launcher demonstrates the concept that motion in different dimensions is absolutely independent. A good launcher not only illustrates this non-intuitive idea, but also describes the exact motion of the projectile. PASCO has precision-engineered the Projectile Launcher to be durable, accurate, and consistent for highly repeatable results.

Includes:
Projectile Launcher
Launcher Base
Projectile Balls (2)
Loading Rod
Safety Glasses
2-D Collision Accessory
Manual

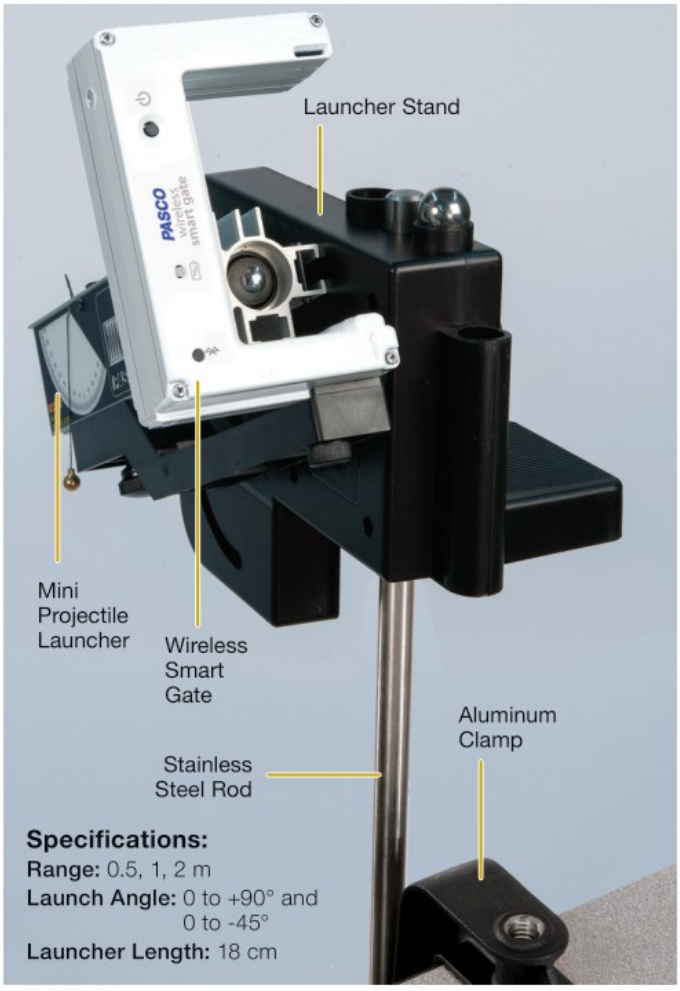
Projectile Launcher	ME-6800
Recommended:	
Large C Clamp (6 Pack)	SE-7285
Plumb Bobs (10 Pack)	SE-8728
Carbon Paper (100 Sheets)	SE-8693

Projectile Launcher Wireless Smart Gate System

ME-6796

- Vary height
- Vary launch speed
- Vary angle
- Measure accurately with Smart Gate

Study projectile motion through live data collection and analysis with this complete system. The Mini Launcher and Wireless Smart Gate make the setup simple: Just clamp the launcher to the table and slide the Wireless Smart Gate on. The Wireless Smart Gate's dual photogate beams accurately capture initial velocity data, without requiring any additional equipment. Includes complete equipment set.



Includes:
Wireless Smart Gate with Mounting Bracket
Mini Launcher with Mounting Stand
Steel Balls (2) with Loading Rod
2-D Collision Accessory
Aluminum Table Clamp
45 cm Stainless Steel Rod

Projectile Launcher Wireless Smart Gate System	ME-6796
Available Separately:	
Mini Launcher	ME-6825B

Wave Driver and Accessories

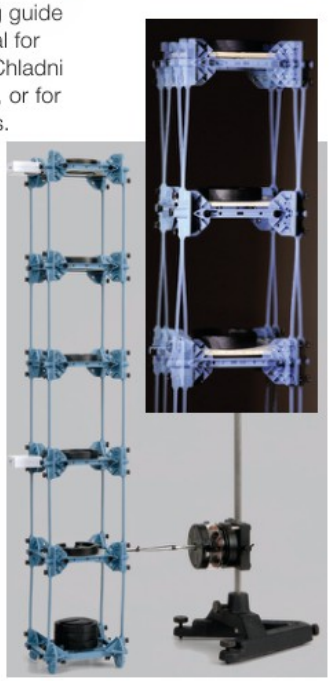
Wave Driver

WA-9855

- New, improved design
- Greater amplitude
- Stronger magnet for stronger force
- Built-in string guide

This newly redesigned Wave Driver offers improvements in driving force and amplitude as well as a built-in string guide so tiny parts don't get lost. It is ideal for vibrating waves in a string, driving Chladni plates to show the vibration modes, or for demonstrating resonance vibrations.

A generator (sold separately) is required to power the Wave Driver.



Specifications:

Frequency Response:
0.1 to 5000 Hz

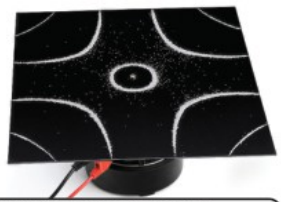
Driving Signal Required:
Requires a function generator with a minimum of 8 V at 0.5 A.

Includes:
Wave Driver with built-in rod clamp and string holder
Sample wave string

	Wave Driver	WA-9855
▲	Required:	
	Function Generator	
	Banana Plug Cord-Black	SE-9751

Chladni Plate

WA-9406



Set this plate on the Wave Driver and sprinkle sand on it to visualize various modes of vibrations.

The Chladni Plate includes a 24 cm x 24 cm square metal plate, 0.8 kg of extra-fine sand, and a sand shaker.

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

Chladni Violin Plate

SE-7319

This 40-cm-long metal plate is shaped like a standard violin. Place sand on the plate and excite with a wave driver. Includes a standard banana jack connector for use with the Wave Driver.

Metal Resonance Strips

WA-9404

These resonance strips demonstrate standing waves, harmonics, and the relationship between length, frequency, and resonance.

Resonance Wire Loop

WA-9405

Use this wire loop (29 cm diameter) to introduce Bohr's quantum atom with a classical model.

	Chladni Plate	WA-9406
	Chladni Violin Plate	SE-7319
	Metal Resonance Strips	WA-9404
	Resonance Wire Loop	WA-9405

Function Generator

PI-8127

- Waveforms: Sine, Triangle, Square, Positive Ramp, Negative Ramp, DC
- 0.001 Hz to 150 kHz
- 10 V at 1 A
- Programmable frequency sweep
- Use for circuits and/or driving speakers
- Use the ramp function to vary the speed of DC motors
- Frequency resolution of 0.001 Hz over entire range

Features

The Function Generator outputs sine, square, triangle, positive and negative ramps with a frequency range of 0.001 Hz to 150 kHz in addition to DC. Its powerful output, 1 amp at ±10 volts, makes it useful for driving speakers, string vibrators, and circuits.

	Function Generator	PI-8127

Biomechanics

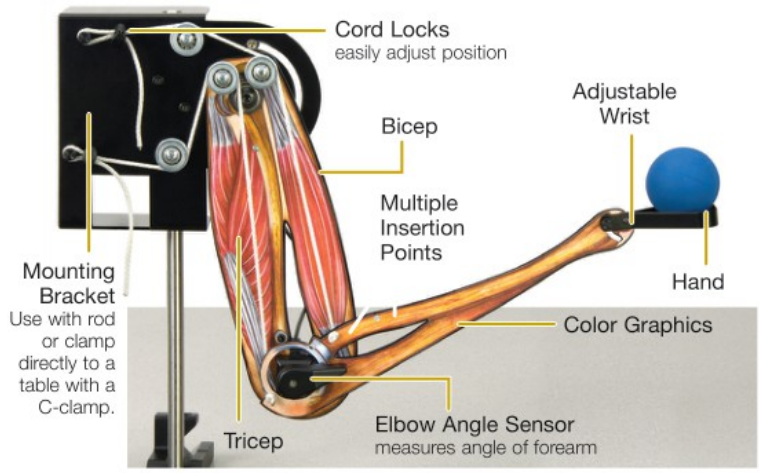
Human Arm Model

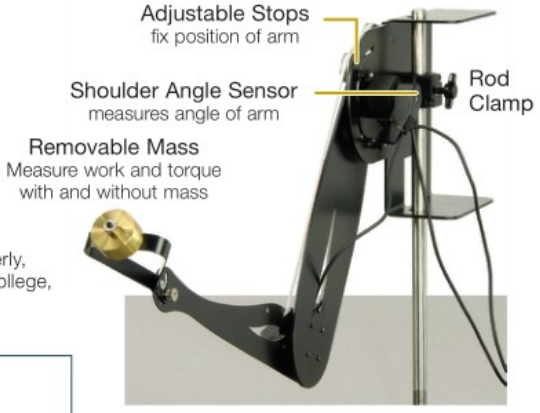
PS-2611

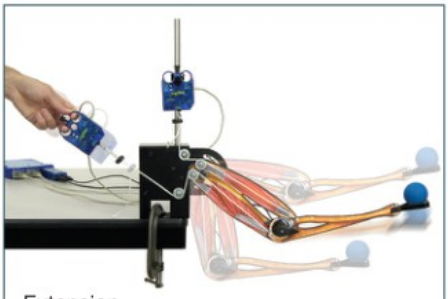
- Working model of the human arm
- Associate triceps/biceps muscle action with arm motion
- Measure torque resulting from lifting weights
- Actually throws a ball

The Human Arm Model simulates the muscles and motion of an actual human arm. It is capable of performing many types of motion, ranging from extending and lifting an object to curling or throwing a ball overhand.

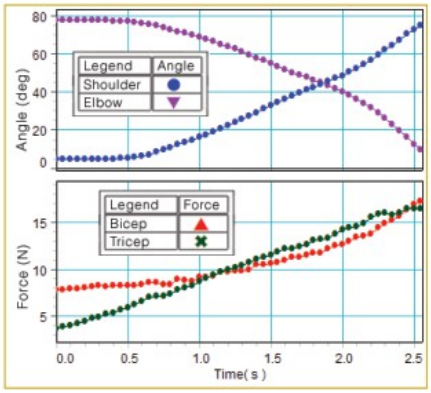
To activate the arm motion, students pull on the cord with a Force Sensor. Changes in position are measured at the shoulder and elbow using the two built-in potentiometers, which connect to the included Angle Sensor. Students can use the collected data to determine the torque applied when lifting an object, the work done by the arm when throwing a ball, and even the resulting kinetic energy delivered to the ball. Different arm muscles are activated depending on which pulleys are selected, and the static force can be measured to determine how the muscle tension changes at various arm positions.





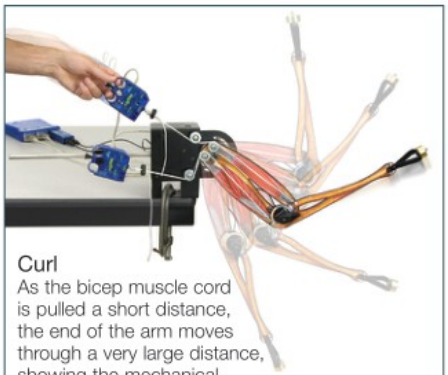


Extension
As the tricep muscle is pulled with a Force Sensor, another fixed Force Sensor records the tension in the bicep muscle cord.

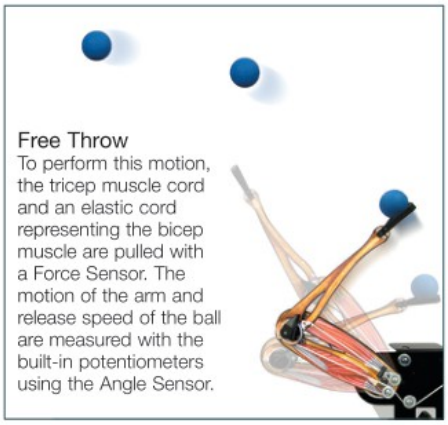


Angles and Forces During Extension
The upper graph shows the angles of the elbow (violet trace) and the shoulder (blue) as the arm is extended as shown in the picture above. Shown in the lower graph, the bicep tension (red) has little change at first and then rises sharply as the arm reaches out, while the tricep tension (green) rises steadily.

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



Curl
As the bicep muscle cord is pulled a short distance, the end of the arm moves through a very large distance, showing the mechanical advantage of the arm. The load at the end of the arm can be varied.



Free Throw
To perform this motion, the tricep muscle cord and an elastic cord representing the bicep muscle are pulled with a Force Sensor. The motion of the arm and release speed of the ball are measured with the built-in potentiometers using the Angle Sensor.

Includes:
Arm
Angle Sensor
Removable Mass
Cord & Cord Locks
Mounting Bracket with Rod
Force Sensor Mounting Rod
Rubber Ball

Human Arm Model
PS-2611
Human Arm Model Without Sensors
ME-6807A
▲ Required:
"C" Clamp or Large Table Clamp
PASPORT Force Sensor
PS-2104
850 Universal Interface
UI-5000 (see page 6)

Visit **pasco.com** for more information about the Human Structures System and Biomechanics.

Wireless Force Platforms

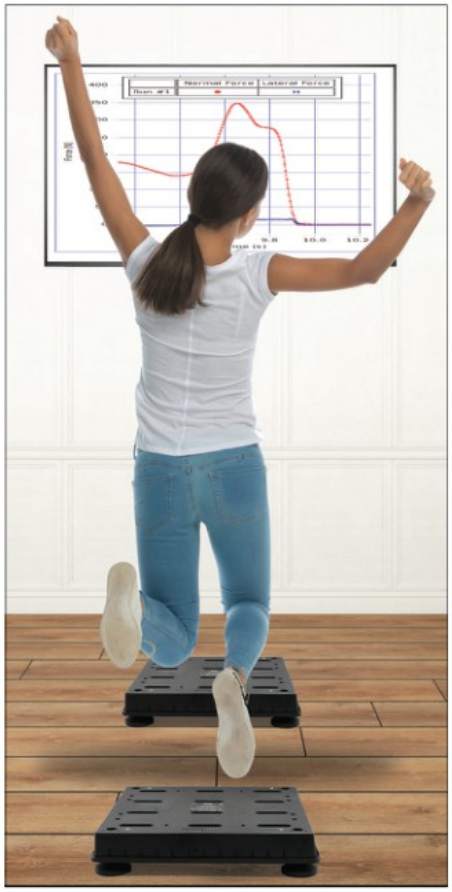
PS-3229 & PS-3230 (2-Axis)

The Wireless Force Platforms build on the success of our PASPORT Force Platforms, offering users the same reliable performance with enhanced durability and a convenient, wireless connection.

The new design features a sturdy, glass-filled nylon platform and four supporting force beams that measure the forces acting normal to the platform's surface. The 2-Axis Force Platform includes a fifth beam to measure forces acting parallel to the platform's surface. Along the bottom of the platform are four adjustable feet that make leveling quick and easy, while also ensuring stability between the force beams and the surface below. Students can measure the force applied to each beam independently or the overall resultant force acting on the surface of the platform (up to 5200 N). With the new wireless design, the Wireless Force Platforms are easier to use than ever, providing both flexibility and custom sample rates for high speed sampling over Bluetooth Low Energy (up to 10 kHz).

Measure:

- Static weight of a structure or person
- Dynamic vertical forces caused by moving or jumping
- Forces associated with the impact of falling objects
- Horizontal forces caused by pushing



Specifications:

Range (PS-3229): -1320 N to 5280 N (resultant)

Range (PS-3230): -1320 N to 5280 N (resultant); ±1300 N parallel force

Surface Dimensions: 35 cm x 35 cm

Maximum Sample Rate: 10 kHz

Resolution: 0.2 N

Force Over-Limit Protection (PS-3229): -500 N to 2000 N per beam

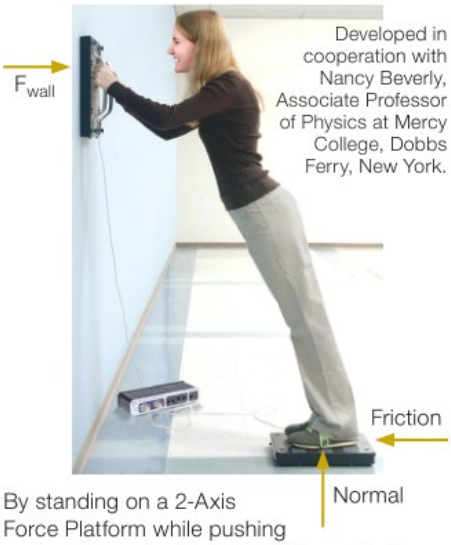
Force Over-Limit Protection (PS-3230): -500 N to 2000 N per vertical beam; ±2000 N parallel beam

Wireless Force Platform	PS-3229
Wireless 2-Axis Force Platform	PS-3230

Forces on the Human Body

- Measure forces on human body
- 1-axis and 2-axis force platforms
- Precise and fast

Explore the forces exerted on the human body in everyday situations, sports, and large-scale physics experiments. The force platforms are designed to measure large forces, such as the weight of a person.



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

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.

Confirm Newton's Third Law by pushing on a Force Platform using two sets of handles (available separately). The handles bolt onto the Force Platform (1-axis or 2-axis) and can be mounted on one or both sides.

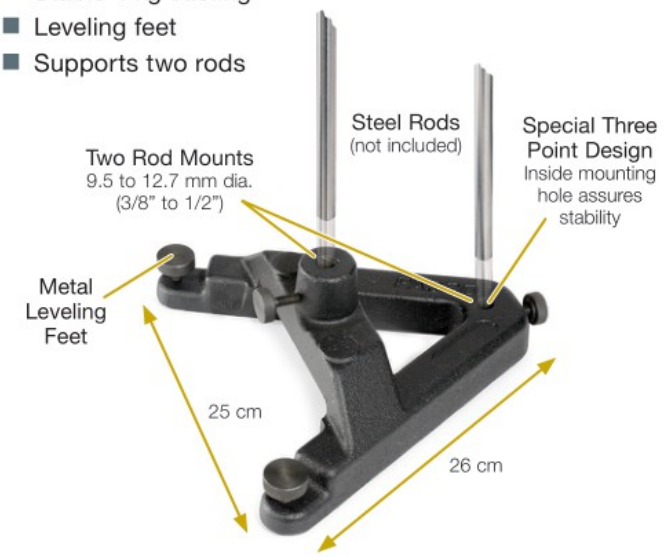
PASPORT 2-Axis Force Platform	PS-2142
PASPORT Force Platform	PS-2141
Handle Set, Force Platform	PS-2548

Rods, Stands, and Clamps

Large Rod Base

ME-8735

- Stable 4 kg casting
- Leveling feet
- Supports two rods



This sturdy 4 kg cast iron wide base supports up to two rods with a diameter of 9.5 to 12.7 mm (3/8 to 1/2 inches). Includes two adjustable feet for easy leveling.

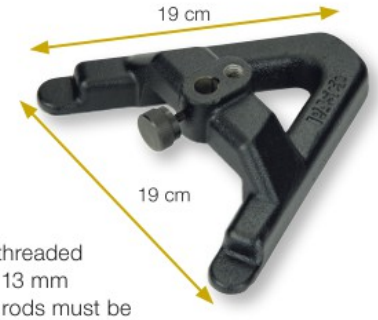
Metal Knobs and Feet (4 pack)

ME-8954

These replacement knobs and feet for the ME-8735 Large Rod Base are made of solid steel with knurled knobs and 5/16"-24 thread.

Small "A" Base

ME-8976



This 1.7 kg cast iron base is smaller than the Large Rod Base (above) and does not have leveling feet. This base can be used with both threaded and non-threaded rods. Accepts non-threaded rods with diameters of 9.5 to 13 mm (3/8 to 1/2 inches). Threaded rods must be 12.7 mm (1/2 inch) in diameter with 1/2"-13 thread, such as the 60 cm rod shown at right.

Large Rod Base	ME-8735
Metal Knobs and Feet	ME-8954
Small "A" Base	ME-8976

Stainless Steel Rods

These 12.7 mm (1/2 in.) diameter stainless steel rods do not mar like aluminum rods. They are non-magnetic, very rigid, and durable.

Non-threaded rod lengths include: 45 cm, 90 cm, and 120 cm.

The 60 cm long rod and 25 cm long rod are threaded (1/2"-13) and fit the Small "A" Base, the Small Round Base, and the Universal Table Clamp ME-9376B.

(Bases shown are not included.)

Stainless Steel Rods 12.7 mm (1/2 in.) in diameter:	
45 cm Stainless Steel Rod	ME-8736
90 cm Stainless Steel Rod	ME-8738
120 cm Stainless Steel Rod	ME-8741
Round Base with Rod	ME-8270
Stainless Steel Rod, 60 cm Threaded	ME-8977

Visit **pasco.com** for more information on rods, stands, and clamps.

How to choose the best mounting rod

Both of these rods are useful for mounting sensors, particularly photogates. They also work well with Super Pulleys.

The SA-9242 stainless steel rod is the same length as the ME-9483 plastic rod. However, the steel rod has a smaller diameter that may not work with all clamps that require a standard 12.7 mm (1/2 in) diameter. The ME-9483 is made of a hard plastic that clamp screws do not dent and it has a threaded brass stud. The lighter weight of the plastic rod will not damage pulleys when thrown into a bin.

Mounting Rods (10 pack)

ME-9483

These rigid plastic pulley handles (14 cm long, 1.27 mm diameter) have a 1/4" metal stud that screws into a Super Pulley.

Pulley Mounting Rod

SA-9242

This 14 cm long stainless steel mounting rod is 9.5 mm (3/8 in.) in diameter and fits most standard laboratory clamps, including the PASCO Universal Clamp. It has a standard 1/4"-20 thread.

Mounting Rods (10 pack)	ME-9483
Pulley Mounting Rod	SA-9242

Base and Support Rod

Large
Large Base and Support Rod with built-in leveling screws and a threaded aluminum rod that is 12.7 mm (1/2 in) in diameter and 45 cm long.

Round
Round base with rod. The threaded steel rod is 12.7 mm (1/2 in) in diameter and 25 cm long.

Base and Support Rod	ME-9355
Round Base with Rod	ME-8270

Multi-Clamp

ME-9507

Holds two rods either parallel or at right angles. Fits rods up to 12.7 mm (1/2 inch) in diameter.

Includes:
Clamp with two thumb screws

Double Rod Clamp (3 pack)

ME-9873

Holds any two rods up to 12.7 mm (1/2 inch) in diameter, either parallel or perpendicular to one another.

Multi-Clamp	ME-9507
Double Rod Clamp (3 pack)	ME-9873

Table Clamps

These clamps hold rods up to 12.7 mm (1/2 inch) in diameter, allowing them to be mounted either horizontally or vertically.

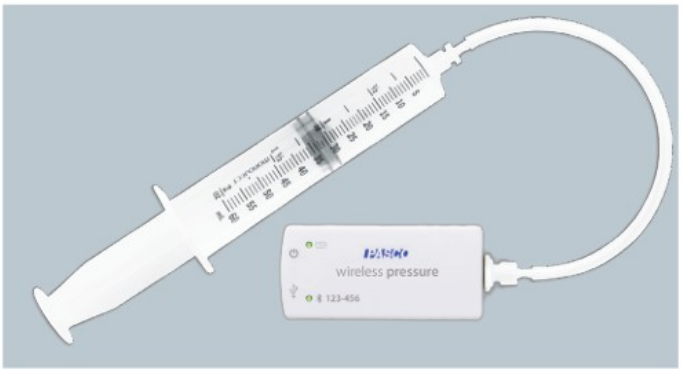
Large Table Clamp (10 cm grip range)	ME-9472
Aluminum Table Clamp (6 1/2 cm grip range)	ME-8995

Fluids

Wireless Pressure Sensor

PS-3203

The Wireless Pressure Sensor allows students to easily collect accurate gas pressure data for a wide range of applications. Included is a 60cc syringe, tubing, and connectors that facilitate studies of hydrostatic pressure, Boyle's law, and Charles' law. Within PASCO's software, students can easily select their desired units from a list containing kPa, mmHg, inHg, mbar, psi, atm, and torr.



Make accurate and consistent measurements of gas pressure, regardless of ambient conditions.

Specifications:
Range: 0-400 kPa
Resolution: 0.1 kPa
Accuracy: ±2 kPa
Logging: Yes
Max Sample Rate: 1000 Hz
Connectivity: Bluetooth 4.0

Includes:
Polyurethane Plastic Tubing, 2 ft
Tube Connector
Male Barbed Luer Locks (2)
Female Barbed Luer Lock
60 cc Syringe
Micro USB Cable (PS-3584)

Wireless Pressure Sensor PS-3203
Also Available:
Wireless Pressure Sensor Pack* PS-3333
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

PASPORT Dual Pressure Sensor

PS-2181

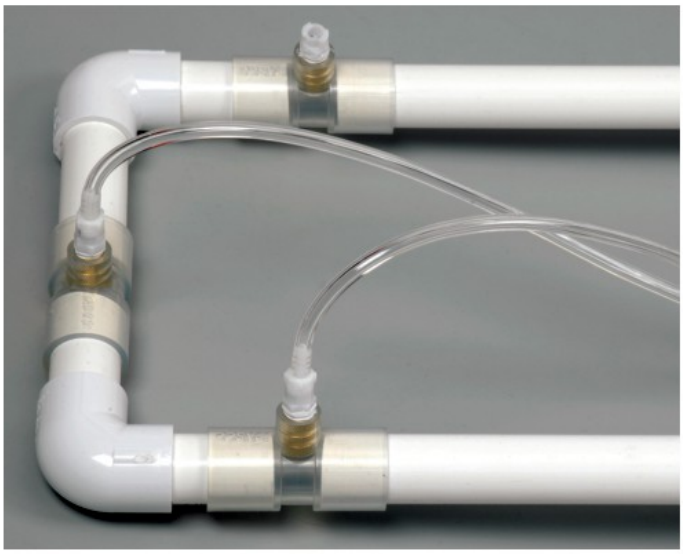
The Dual Pressure Sensor is capable of reading two absolute pressures, one gauge pressure, or one differential pressure. Dynamic variable over-sampling automatically reduces the measurement noise at low sampling rates. Sample rates up to 1000 Hz make studies of both transient and steady-state pressure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

Specifications:

Maximum Sample Rate: 1000 Hz

Absolute Pressure: 0 to 200 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (displays pressure in kPa, N/m^2, or psi)

Differential Pressure: ±100 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (displays pressure in kPa, N/m^2, or psi)



Construct a pipe network – then study it with the Dual Pressure Sensor. The sensor connects to Pressure Taps that fit into the pipe network.

PASPORT Dual Pressure Sensor PS-2181
Shown in use with:
Pressure Taps (set of 5) ME-2224A (see page 29)

Get the Pipe Network plans for **FREE** at **pasco.com/engineering/resources/pipenetwork**

General Flow Sensor

PS-2222

The General Flow Sensor determines the fluid velocity of air or water by measuring the difference in pressure between the two input tubes. The Venturi Tube or Pitot Tube must be connected to the General Flow Sensor to collect data. The type of fluid (air or water) being used is selected using PASCO software.

Applications:

- The Venturi Tube is used in a pipe network carrying water or air.
- The Pitot Tube is used in air or an open water channel.

Specifications:

Pressure Range: 0 to 50 kPa
Pressure Accuracy: ±2.5% of full scale (0 to 85°C)
Resolution: 0.2% of full scale
Venturi Range: 0 to 84 gpm (water); 0 to 773 gpm (air)
Venturi Accuracy: ±2 gpm (water); ±2.5 cfm (air)
Pitot Range: 0 to 9.98 m/s (water); 0 to 92.1 m/s (air)

General Flow Sensor PS-2222
General Flow Sensor with Venturi Tube PS-2225
General Flow Sensor with Pitot Tube PS-2226
▲ Required:
PASPORT Interface (see pages 6-7)
PASCO Capstone Software (see pages 4-5)

Venturi Tube

ME-2220

The Venturi Tube is made of clear PVC, so the water can be seen flowing through it. It has a constriction and two pressure ports with tubing attached. The Venturi Tube is connected to the General Flow Sensor by the matching couplers. The General Flow Sensor measures the difference in fluid pressure between the two different cross-sectional areas and the software does a calculation to convert this pressure difference into a velocity or volumetric flow rate. The Venturi Tube slip joints are designed to be glued into any 3/4" PVC pipe network.

Pitot Tube

ME-2221

The Pitot Tube is designed to be placed in the air flow or water flowing in a channel. The General Flow Sensor, connected to the Pitot Tube, measures the pressure difference between the fluid inlet and the static side taps of the Pitot Tube and the software calculates the fluid velocity from the pressure difference.

Pressure Taps (set of 5)

ME-2224A

The transparent Pressure Taps can be glued into a 3/4" PVC pipe network at any place, using a slip joint.

Each Pressure Tap has a quick-connect for a Dual Pressure Sensor (PS-2181). Since the quick-connect closes when disconnected, the pressure sensor can be moved around the network to determine the pressures at different positions, rather than having a separate pressure sensor for each position.

Venturi Tube	ME-2220
Pitot Tube	ME-2221
Pressure Taps (set of 5)	ME-2224A

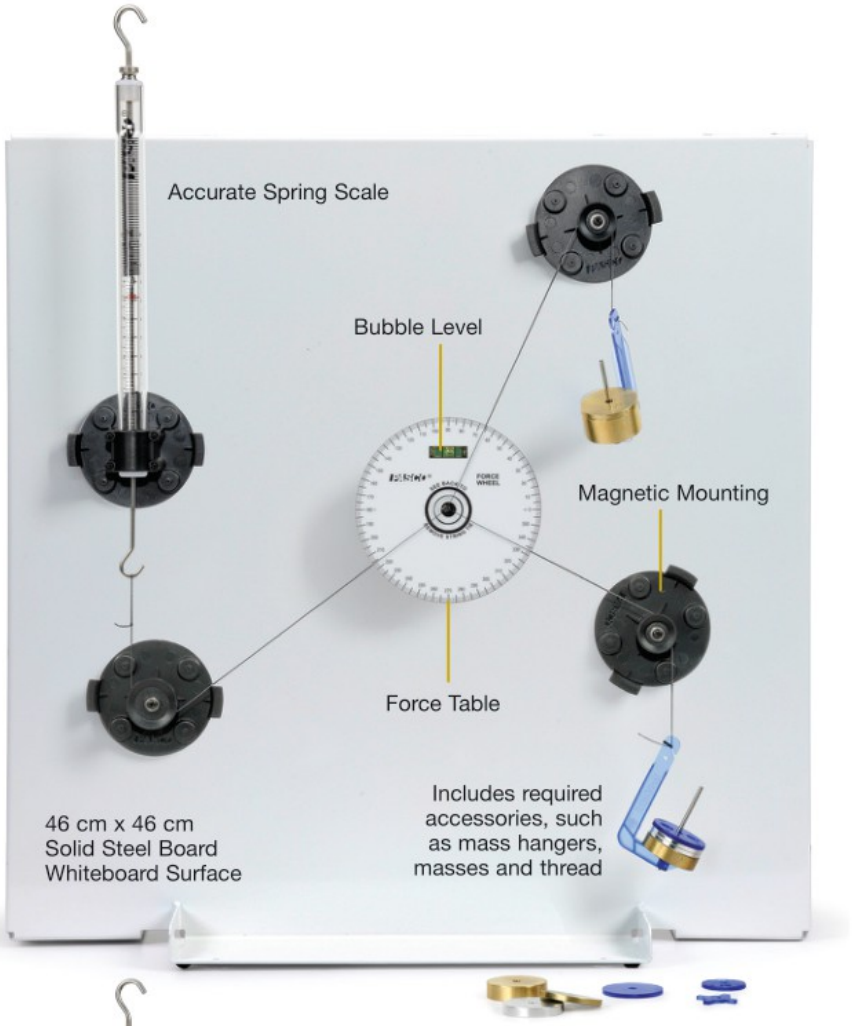
Statics

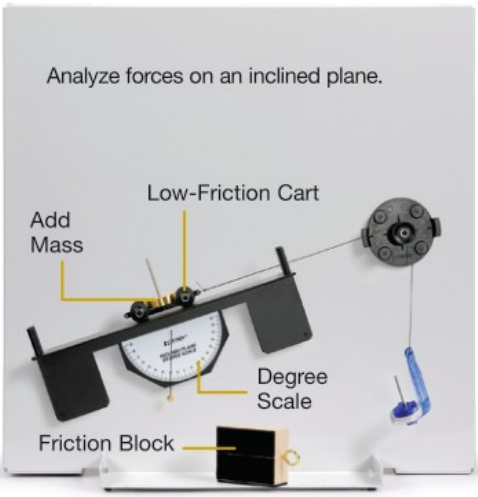
Statics System

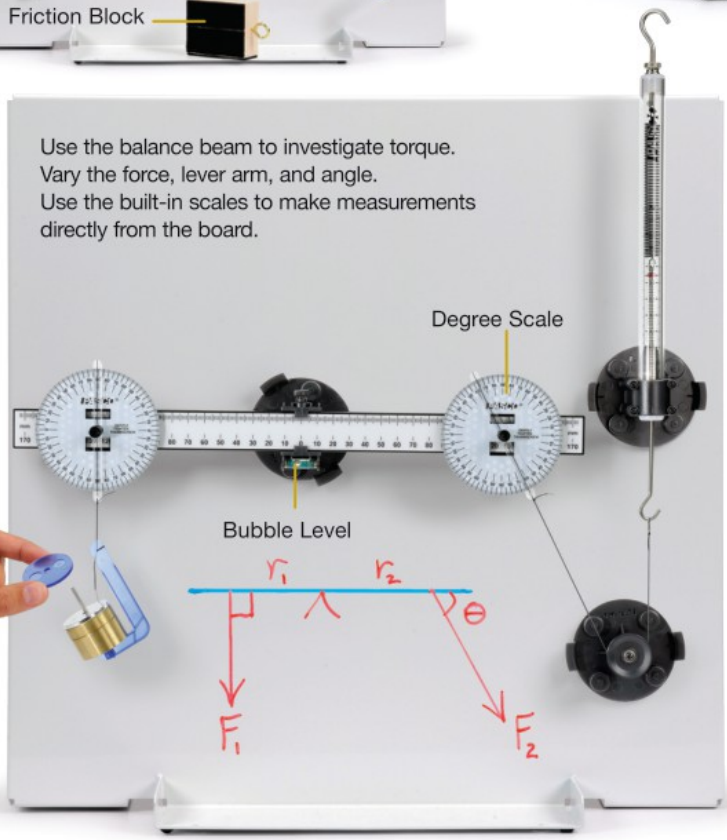
ME-9502

- Everything required for 15 experiments
- Comprehensive topics range from vector addition to simple machines
- Magnetic mounting for easy setup

The Statics System is a versatile lab system designed for demonstrating the basic concepts of vector forces, torques, center of mass, simple machines, and more. When combined with the ME-9503 Statics Board (sold separately), the Statics System doubles in width, making it ideal for lecture demonstrations.







Easy Storage

Store magnetic components on the back of the board.

Includes:

Experiment Board
Components
Mass Set
Comprehensive Manual with 16 Copy-Ready Experiments

Statics System	ME-9502
Additional Equipment:	
Statics Board	ME-9503
Spring Scale	ME-9824A
Statics Spares Package	ME-9504

Visit **pasco.com** for more information about these products.

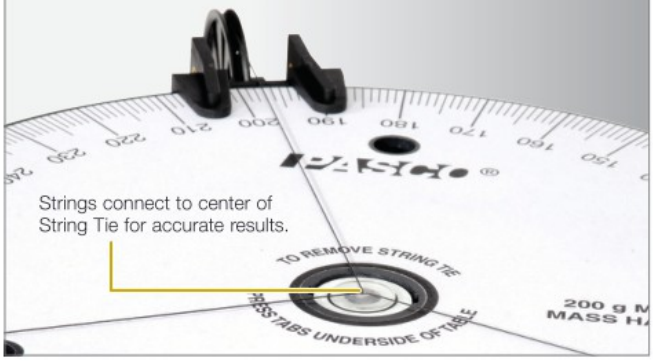
Super Pulley Force Table

ME-9447B

- Versatile, hands-on solution
- High accuracy
- Easy, compact storage

String Tie

The String Tie is captured to make hanging masses easy, but it freely floats over the bulls-eye pattern to clearly show even small changes in equilibrium.



Adjustable height

The swivel feature of the pulleys can virtually eliminate parallax for more precise angle measurements.

Built-in Scale
Measure angles quickly and accurately.

Compact, Easy Storage

Mass and Hanger
(sold separately)

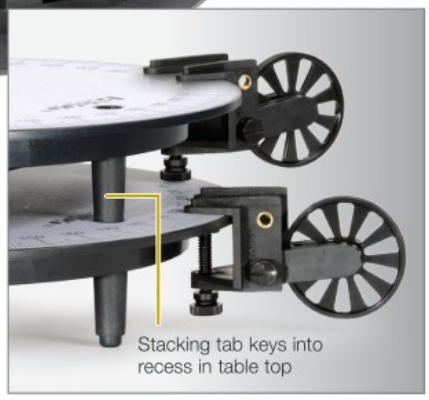
Change the mass by 1/2 gram or an angle by 1/2 degree and see an immediate change in the equilibrium.

Improved leg storage

The screw-in legs snap under the table for easy storage.

Improved stacking

Stacked tables are keyed together to eliminate slipping. Now you can store all your Force Tables in one convenient stack!



Includes:

25 cm diameter table with detachable legs
Adjustable Super Pulleys with clamps (3)
Spool of thread

Mass and Hanger Set is sold separately.

	Super Pulley Force Table	ME-9447B
▲	Required: Mass and Hanger Set	ME-8979
■	Additional Pulleys: Super Pulley with Clamp	ME-9448B

Pulley System and Tension Protractor

Pulley Demonstration System

SE-8685

- Demonstrate the mechanical advantage of single or combination pulleys
- Complete standalone pulley apparatus
- Simple setup

Set up a double pulley and a single pulley, each with a 200 g mass. Simultaneously pull the string of each from the same vertical height down to the base. The mass of the single pulley moves twice as high as the double pulley with twice the force!

Includes:

20 cm x 81 cm base with eye-hook and capstan
Threaded 81 cm rods (2)
Clamps (2)
Horizontal rod
Hook collars (8)
90° clamp
Single pulleys (2)
Triple-tandem pulleys (2)
Quadruple pulleys (2)
Four-step pulley
Slotted masses (13)
Mass hangers (6)

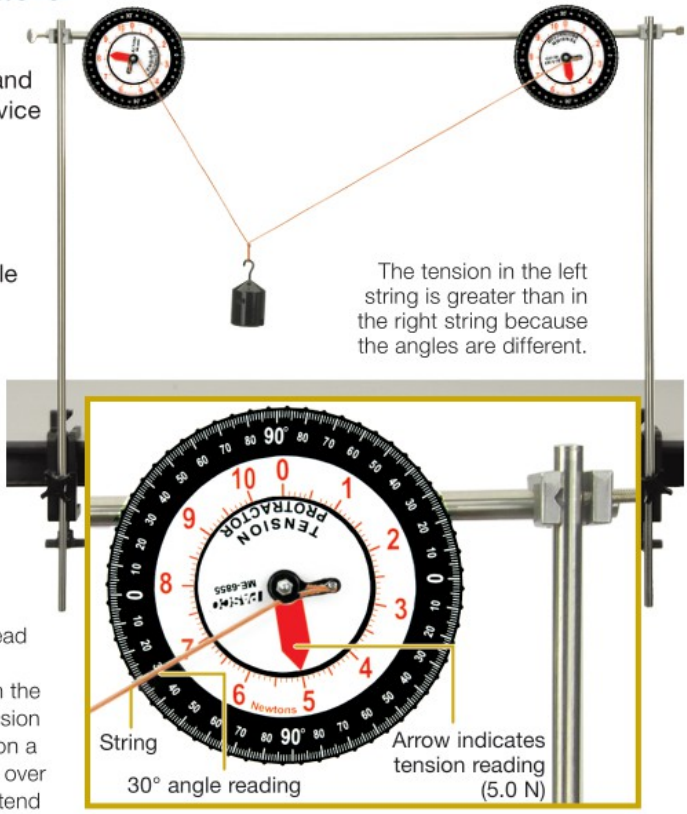
Pulley Demonstration System
SE-8685

Tension Protractor

ME-6855

- Measure tension and angle with one device
- Large scale for viewing demonstrations
- Zero-adjust for torsion spring scale
- Built-in rod clamp

The Tension Protractor is a spring scale and a protractor integrated into one device. Perfect for static equilibrium experiments, the rotary dial indicates the tension in the string and the angle is read where the string passes over the degree scale on the outer ring. Since the Tension Protractor is supported on a rod, it has an advantage over other spring scales that tend to weigh down the string, changing the angle.



Even if the mounting rod is not plumb, the Tension Protractor's degree scale can be adjusted to read 90 degrees vertically by rotating the outer ring until the string with a hanging mass aligns with 90 degrees.

A 50 gram mass hangs vertically from the Tension Protractor: The tension reads 0.5 N as expected and the outer degree scale is dialed to align the 90° mark with the string. This compensates for unlevel tables or bent rods.

Specifications:

Force Range: 0 N to 10 N
Smallest Force Division: 0.1 N
Force Accuracy: ±4% of Reading
Angle Range: -90° to +90°
Smallest Angle Division: 1°
Diameter: 15 cm

Includes:

One Tension Protractor

Tension Protractor	ME-6855
Recommended:	
Large Table Clamp	ME-9472
90 cm Stainless Steel Rod	ME-8738
Multi-Clamp	ME-9507
Hooked Mass Set	SE-8759

Meter Stick Torque Set

Visit **pasco.com** to see the Static Equilibrium Experiment (EX-5564) using the Meter Stick Torque Set.

Meter Stick Torque Set

ME-7033

- Study torque and rotation
- Mount at any height on any rod stand
- Mass hangers (10 g) have built-in angle indicators
- Built-in bubble level on Pivot meter stick clamp

The Meter Stick Torque Set improves upon the classic meter stick balance by mounting the Pivot on a rod stand and using an aluminum meter stick. This complete set is designed to simplify student measurements with specialized components that include:

Aluminum Meter Stick
- Sleek, rigid design with laser-etched markings

Dual Ball-Bearing Pivot
- Functions as a fulcrum in meter stick torque investigations
- Serves as a rotation device for rotational inertia experiments

Meter Stick Clamp
- Fits onto either the Pivot or a PASCO Rotary Motion Sensor
- Built-in bubble level indicates when the meter stick is level
- One centered mounting point for rotation and pendulum experiments
- One offset mounting point that keeps the meter stick's center of mass below the pivot point for stability

Mass Hangers
- Built-in degree scale provides the angle of the applied force
- 10-gram hangers make it easy to calculate the total hanging mass
- Use it as a mass hanger in meter stick torque studies or suspend a string from it to explore statics.

Specifications:

Aluminum Meter Stick Dimensions: 6.95 mm x 28.0 mm x 1.0 m

Aluminum Meter Stick: Approximate mass 150 g

Pivot Slotted Shaft: 1/4-inch (6.35 mm) diameter, 16 mm long out both sides

Mass of Hangers: 10 g

Includes:
Pivot (ME-7034)
Meter Stick Torque Mass Hanger Set (ME-7035)
Aluminum Meter Stick

Meter Stick Torque Set ME-7033
Required:
Rod Stand (see page 26)

Perform These Experiments:
- Meter Stick Torque
- Statics – Suspended Boom
- Physical Pendulum

The complete Meter Stick Torque Set includes the Pivot, Aluminum Meter Stick, Meter Stick Clamp, and three Mass Hangers. Shown in use with the Wireless Force Acceleration Sensor.

Meter Stick Torque Set Components

Pivot

ME-7034

The dual-bearing Pivot is a general purpose rotation device that can be mounted on a rod stand to perform rotation experiments in the horizontal or vertical planes.

Includes:
Pivot
3-Step Pulley

Meter Stick Torque Mass Hanger Set

ME-7035

Includes three Mass Hangers and one Meter Stick Clamp for doing meter stick torque experiments.

Includes:
Meter Stick Clamp
Mass Hangers (3)

Pivot ME-7034
Meter Stick Torque Mass Hanger Set ME-7035
Required:
Aluminum Meter Sticks (6-pack) ME-7032

Rotation

Complete Rotational System

ME-8950A

- Most versatile rotational system available
- Stable, 4 kg cast iron base
- Dual, low-friction ball bearings

The Complete Rotational System is an all-in-one apparatus for exploring concepts involving centripetal force, angular momentum, and rotational motion. Featuring a durable cast iron base, dual ball bearings, and a stainless steel shaft, this system enables students to physically experience moments of inertia as it's rotated, offering a unique, hands-on understanding of rotational motion. With PASCO software, students can visualize measurements, analyze data, and monitor both angular velocity and motorized drive. The system easily expands when used with additional accessories, allowing students to explore torques, friction, magnetic levitation, and Faraday's law.

Included Experiments

- Centripetal Force
- Rotational Inertia of a Point Mass
- Rotational Inertia of a Disk Off-Axis (fixed and rotating)
- Rotational Inertia of Disk and Ring – Two Axes
- Conservation of Angular Momentum, Using a Point Mass
- Conservation of Angular Momentum, Using a Disk and Ring
- Conservation of Angular Momentum (Projectile Version)

To see the experiments, type the product number into the search box at **www.pasco.com** and download the manual.

Includes:

Rotating Platform	ME-8951
Rotational Inertia Accessory	ME-8953
Centripetal Force Accessory	ME-8952
Instruction Manual	

System Components

1. Rotating aluminum platform with 4 kg cast iron base, dual ball bearings, stainless steel shaft, three-step pulley, two rectangular sliding 300 g masses, and 50 cm track where a number of accessories may be mounted.
2. The Rotational Inertia Accessory with a 22.9 cm diameter, 1.50 kg disk (which may be rotated on two axes), a 12.7 cm diameter, 1.42 kg ring and Super Pulley with support rod and adapter.
3. The Centripetal Force Accessory with spring support and radius indicator, mass support, three masses, and Super Pulley with Clamp.

Complete Rotational System	ME-8950A
▲ Required:	
Mass and Hanger Set	ME-8979

Interfacing Options

Monitor rotational motion from your computer using one of the following options:

1. **The ME-9498A Photogate Head** mounts directly to the rotating platform base and measures angular speed. This works with the 850 and 550 Universal Interfaces.
   NOTE: PASPORT interfaces require a Digital Adapter (PS-2109).

● Recommended:	
Photogate Head	ME-9498A

2. **The CI-6538 or PS-2120 Rotary Motion Sensor** mounts to the base with an "A" Adapter and measures both angular speed and direction.

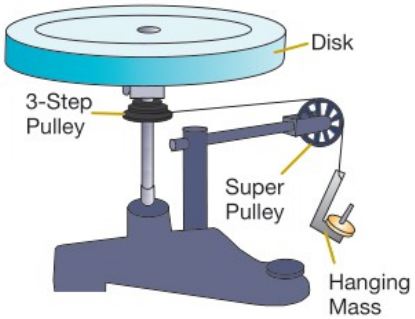
▲ Required for use with ScienceWorkshop:	
Rotary Motion Sensor	CI-6538
▲ Required for use with PASPORT:	
PASPORT Rotary Motion Sensor	PS-2120A
A-Base Rotational Adapter	CI-6690

Explore rotational inertia, centripetal force, and more!

Rotational Inertia of a Disk and Ring, 2 Axes

Center axis

With the disk mounted on the top of the vertical shaft, a torque is applied by a hanging mass. From the mass, radius, angular acceleration, and the rotational inertia of the disk can be determined.

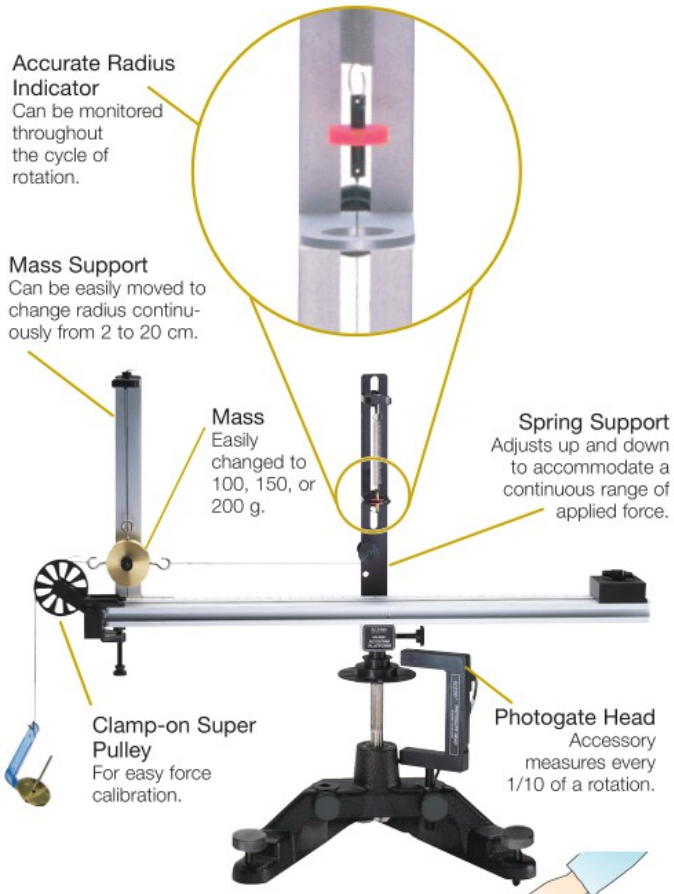


Radial axis

The disk can also be mounted on its edge to decrease the rotational inertia by half.

Centripetal Force

Centripetal force may be thoroughly investigated by varying both the mass and radius. The unique radius indicator allows students to continuously monitor the equilibrium position.

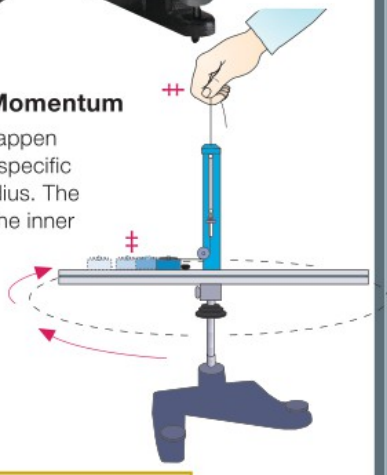


Rotational Inertia of an Off-axis Disk

The Rotational Inertia Adapter allows students to mount the disk anywhere along the platform. A bearing mounted on one side of the disk allows it to act either as a rigid mass or as a mass free to rotate around its point of attachment as the platform turns on the vertical shaft.

Conservation of Angular Momentum

Students can predict what will happen when a point mass rotating at a specific radius is pulled into a smaller radius. The rotational inertia of the mass at the inner and outer radii can be calculated and the results verified.



Visit **pasco.com** to see the full line of Rotational System Accessories.

Rotating Platform and Rotational Inertia Accessory

Centripetal Force Accessory

Rotational Motor Drive

A-base Rotational Adapter

Gyroscopic Motion

Demonstration Gyroscope (3-Axis)

ME-8960

- Excellent demonstration tool
- Fully open design
- Precision angle indicator

The low friction, open design of PASCO's Gyroscope enables rotational motion studies that were previously impossible with commercial units. The completely open design lets students stop precession by grabbing the vertical shaft, causing the Gyroscope to dip. Rotational mathematics can predict the dipping motion, but with PASCO's Gyroscope it can finally be confirmed.

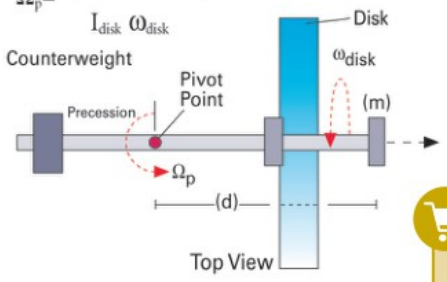
How It Works:

The disk is spun by wrapping a string around the pulley and pulling. Or the disks can be spun by hand. Add mass to either end of the gyroscope and it will respond with a predictable precession.

Features:

- **Low Friction:** The disk takes almost 6 minutes to slow to half of its original speed due to low-friction bearings in the gyroscope axle and vertical shaft.
- **Accurate Angle Indicator:** Measures from 30° to 140° and is easily read to the nearest degree. A retractable stop acts as a marker during experiments.
- **Easy Timing:** Low rotation speeds allow measurement of angular speed by counting revolutions and using a stopwatch.
- **Easy Balancing:** Two counterweights allow coarse and fine balance adjustment.
- **Large Inertia Disk:** With the large rotational inertia of the disk, PASCO's Gyroscope generates precession rates similar to smaller, enclosed gyroscopes. The slow rotation speed of PASCO's disk lets students study fast as well as slow precession and use a stopwatch to make measurements.

$$\Omega_p = \frac{mgd}{I_{disk}\,\omega_{disk}}$$



Students can determine the rotational inertia of the rotating disk. They can then check the measured precession rate when a mass (m) is added a distance (d) from the pivot point.

Demonstration Gyroscope (3-Axis)
ME-8960

Recommended:
Gyroscope Disk and Mass
ME-8961

A Unique Experiment: Rotate two disks in opposite directions at the same speed. The angular momenta cancel and the total angular momentum of the gyroscope is zero. The result is no precession.

Gyroscope Disk and Mass

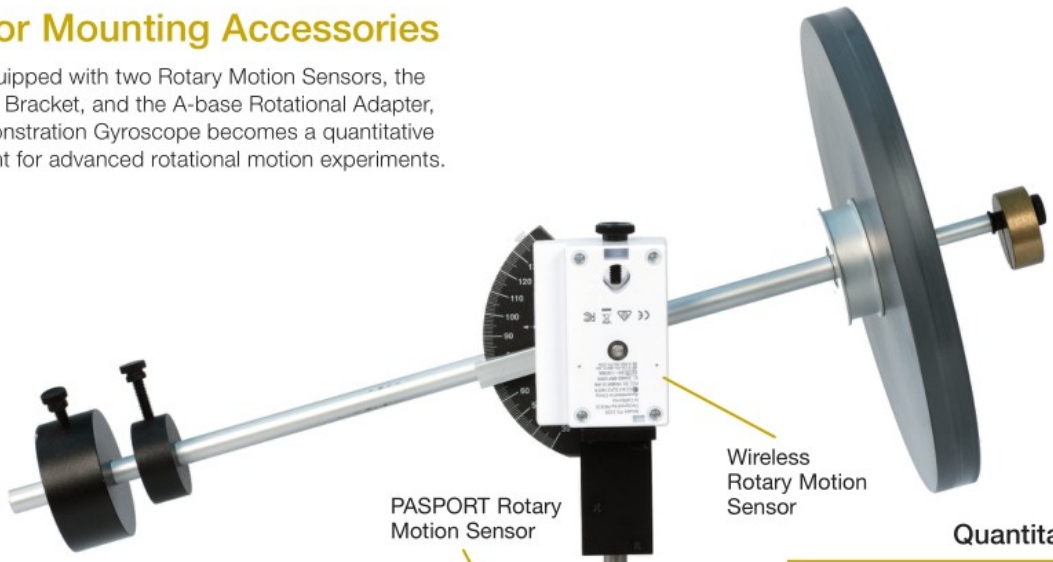
ME-8961

Includes:
Accessory Disk
Extra Counter Mass

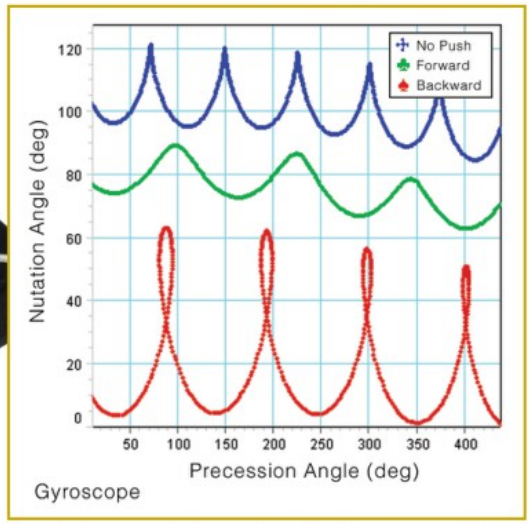
Gyroscope Disk and Mass
ME-8961

Sensor Mounting Accessories

When equipped with two Rotary Motion Sensors, the Mounting Bracket, and the A-base Rotational Adapter, the Demonstration Gyroscope becomes a quantitative instrument for advanced rotational motion experiments.



Quantitative Measurements



Graph shows nutation pattern for three cases. The blue trace results when the Gyroscope is released from rest, with no initial push forward or backward.

Gyroscope Mounting Bracket

for Rotary Motion Sensor

ME-8963

When used with the Mounting Bracket and the A-base Rotational Adapter (CI-6690), the Demonstration Gyroscope becomes a quantitative instrument for advanced rotational motion experiments. Using two Rotary Motion Sensors allows students to obtain a graphical picture of the Gyroscope's nutation and precession motions.

For Recording Nutation Data:

Gyroscope Mounting Bracket for Rotary Motion Sensor	ME-8963
▲ Required:	
PASPORT Rotary Motion Sensor	PS-2120A
Interface (see pages 6-7)	
OR	
Wireless Rotary Motion Sensor	PS-3220

A-Base Rotational Adapter

CI-6690

The A-base Adapter allows students to mount a Rotary Motion Sensor for high resolution data collection. One revolution of the vertical shaft corresponds to one revolution of the Rotary Motion Sensor, generating up to 4000 data points per revolution.

Includes:

Rotary Motion Sensor Mounting Post
O-Ring Drive Belt
Three-Step Pulley
Pulley Mounting Screw

This accessory is not compatible with PS-3220 Wireless Rotary Motion Sensor.

For Recording Precession Data:

A-Base Rotational Adapter	CI-6690
▲ Required:	
PASPORT Rotary Motion Sensor	PS-2120A
Interface (see pages 6-7)	

Thermal Expansion and Conductivity

Thermal Expansion Apparatus

TD-8856

- Measure the expansion of various rods
- Brass, copper, and aluminum tubes included

With PASCO's Thermal Expansion Apparatus, students can accurately and easily investigate the expansion of metals with increasing temperature.

Features:

- **Built-in Digital Gauge:** Measure the rod expansion with 0.01 mm resolution
- **Built-in Thermistor:** A 10 kΩ thermistor is connected directly to each tube and the temperature can be determined using a digital ohmmeter or Temperature Sensor.
- **Heat with Steam or Water:** The fluid used may be steam or water at any temperature.
- **Three Drop-in Metal Tubes:** Each tube connects securely onto the rigid base. The other two can be simultaneously mounted on the base for convenient storage.

Includes:

Base with built-in dial gauge and thermistor

Expansion tubes: brass, copper and aluminum

	Thermal Expansion Apparatus	TD-8856
▲	Required:	
	Steam Generator	TD-8556A
●	Recommended:	
	Basic Digital Multimeter	SE-9786A
	OR	
	PASPORT Quad Temperature Sensor	PS-2143

Thermal Conductivity Apparatus

TD-8561

- Measure heat flow through five different materials
- Constant temperature differential makes calculations easy
- Easy to use, no mess

One of the most important considerations for buildings in the modern world is their ability to provide good thermal insulation. This apparatus gives students a way to observe and quantify heat flow across a constant temperature differential. Students use five common materials as test samples: glass, wood, polycarbonate, Masonite® and sheetrock.

Includes:

Stand with insulating pads

Ice molds (2)

Materials: 12.7 cm squares of glass, wood, polycarbonate, Masonite, and sheetrock

Plastic tubing to connect steam generator

Instruction manual and experiment guide

	Thermal Conductivity Apparatus	TD-8561
▲	Required:	
	Steam Generator	TD-8556A
	Graduated Cylinder	

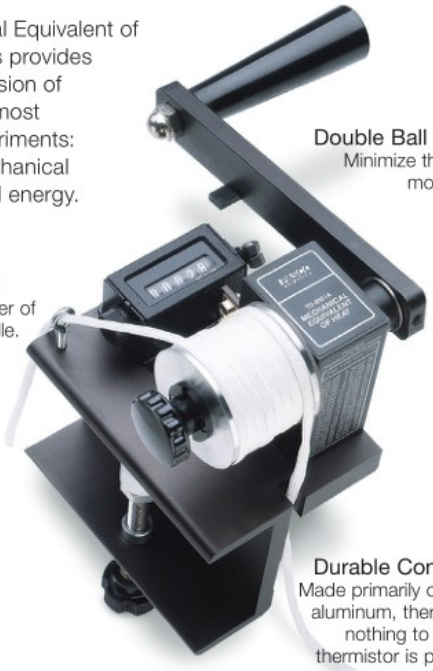
Equivalent of Heat

Mechanical Equivalent of Heat Apparatus

TD-8551A

- Accurate to 5%
- Rugged ball-bearing construction
- Thermistor—no thermometer to break

This Mechanical Equivalent of Heat Apparatus provides an updated version of one of Joule's most important experiments: converting mechanical work to thermal energy.



Double Ball Bearings
Minimize the wear on moving parts.

Crank Counter
Counts the number of turns on the handle.

Thermistor
Embedded in the cylinder, it has lower thermal mass than a thermometer and is less breakable.

Durable Construction
Made primarily of steel and aluminum, there's virtually nothing to break. The thermistor is protected in the cylinder.

How It Works:

Students turn the hand crank to perform a measurable amount of work. As the crank turns, it rotates an aluminum cylinder wrapped in flat nylon rope. The friction between the rope and the cylinder is just strong enough to support a mass hanging from the other end of the rope, ensuring the resulting torque is both constant and measurable. A counter keeps track of the number of turns, and an embedded thermistor monitors the cylinder's temperature to measure thermal energy. The equivalence of work and heat is easily established to within 5%.

Includes:

Base, cylinder, crank, and counter with a built-in table clamp
1-gallon can that can be filled with a measured mass of sand or water (if 10 kg of laboratory masses are not available)
3.7 m of flat nylon rope
Laboratory manual including theory, step-by-step instructions, and data tables

Mechanical Equivalent of Heat Apparatus
TD-8551A

▲ Required:

Basic Digital Multimeter	SE-9786A
Ohaus Triple-Beam Balance (with Tare)	SE-8707

A refrigerator (or ice) for cooling the cylinder below room temperature; calipers and a thermometer for measuring room temperature are helpful, but not necessary.

■ Replacement Supplies:

Replacement Brush	TD-8583

Download this experiment.
The FREE experiment files include Microsoft Word® instructions, graphics, and PASCO Capstone™ workbook files with sample data. Download this experiment at **pasco.com/CapstoneExperiments.**

Have the 550 or 850 Universal Interface? View the corresponding experiment (EX-5525) online at **pasco.com/CapstoneExperiments.**

Electrical Equivalent of Heat Experiment

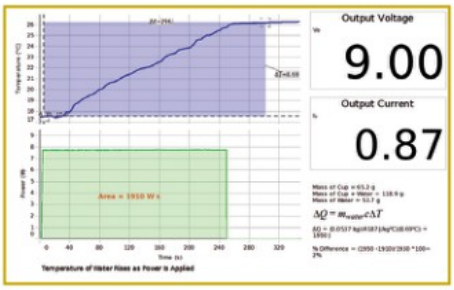
EX-5625

Concepts:

- Compare electrical energy input to changes in internal energy

In this complete experiment, students experimentally determine the electrical equivalent of heat using Wireless Current, Voltage, and Temperature sensors. To perform the experiment, students heat a calorimeter filled with water and measure both the change in temperature and the electrical power required.

Next, students find the area under the resulting power versus time curve to determine the amount of electrical energy used; then calculate the amount of heat delivered to the water using the increase in temperature and the mass of the water. They compare the heat and electrical energy and determine the number of Joules in a calorie.



The bottom graph displays the power output from the generator and the top graph shows the increase in temperature. The amount of electrical energy used to heat the water is determined by finding the area under the Power vs. Time curve.

Includes:

Energy Transfer – Calorimeter	ET-8499
Wireless Temperature Sensor	PS-3201
Wireless Voltage Sensor	PS-3211
Wireless Current Sensor	PS-3212
Ohaus Triple-Beam Balance (with Tare)	SE-8707
Student Power Supply	SE-8828

Electrical Equivalent of Heat Experiment
EX-5625

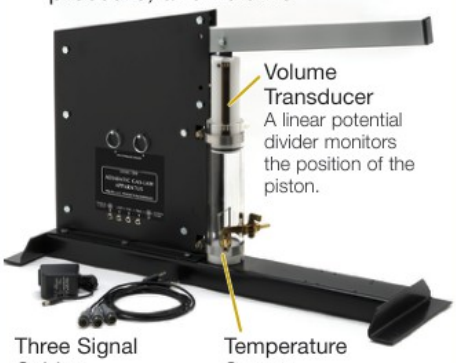
▲ Required:
PASCO Capstone Software (see pages 4-5)

Gas Laws

Adiabatic Gas Law Apparatus

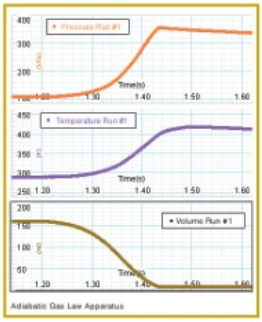
TD-8565

- Investigate the compression of gases
- Computer monitors temperature, pressure, and volume



Three Signal Cables
Carry the volume, pressure, and temperature signals to the computer.

Temperature Sensor
Measures rapid changes in temperature as the resistance of a fine nickel wire changes.



Students monitor pressure, temperature, and volume as a gas is compressed rapidly.

Applications:

- Compare final pressure and temperature values with those predicted by the Adiabatic Gas Law.
- Measure the work done on the gas. Compare the change in internal energy and the theoretical work performed.
- Determine gamma, the ratio of specific heats for the gas (Cp/Cv).
- Investigate isothermal compression and expansion.

Includes:

Adiabatic Gas Law Apparatus
Instruction Manual, Experiment Guide
Signal Cables 3.5 mm plug to 5-pin DIN
Power Adapter 9 V DC @ 1 A

Adiabatic Gas Law Apparatus
TD-8565

▲ Required:
PASCO Capstone Software
(see pages 6-7)
A computer with an interface that will accept three analog signals simultaneously via 5 or 8-pin DIN connectors such as PASCO's 550 and 850 Interfaces.

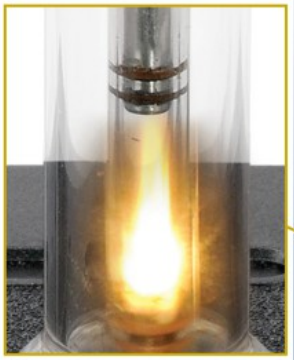
Compression Igniter

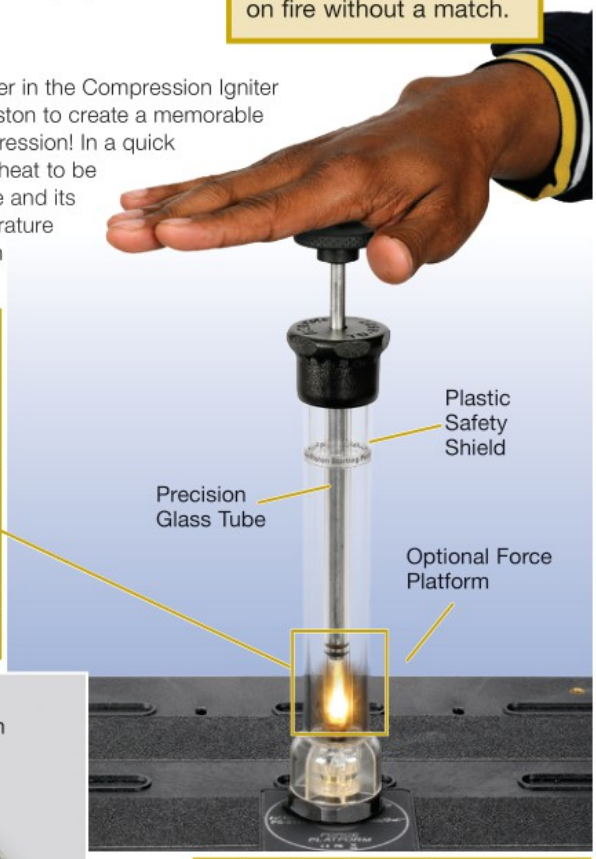
TD-8577

- Adiabatic compression ignites paper!
- Works every time
- Durable and cleanable

Students will be amazed to see the paper catch on fire without a match.

Place a small piece of tissue paper in the Compression Igniter and quickly push down on the piston to create a memorable demonstration of adiabatic compression! In a quick compression there is no time for heat to be exchanged between the air inside and its surroundings, causing the temperature to rise well above the combustion temperature of paper.



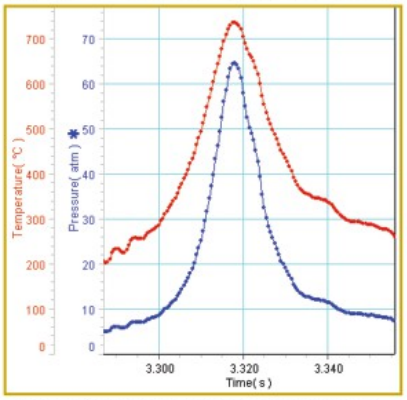


This Compression Igniter has been specially designed to be cleanable. The bottom screws off to clean out the soot and to load the paper. The large piston handle decreases the pressure on your hand and makes it easier to hit the piston quickly.

The glass tube is surrounded by plastic for safety. In the event that the glass tube breaks, the glass tube can be replaced.

Includes:

Compression Igniter
Spare Glass Tube with O-rings
Cleaning Wire
Complete Instructions with Theory



Pressure data is calculated using the force measured by the Force Platform. Assuming adiabatic, the data shown gives a compression ratio of nearly 20:1 and a peak temperature of over 700°C.

Compression Igniter
TD-8577
Replacement Glass Tubes
TD-8498A

■ Shown in use with:
PASPORT Force Platform
PS-2141

Heat Engine

Heat Engine Cycles Experiment

EX-5630

Concepts:

- Heat engine efficiency
- Isothermal processes
- Isobaric processes
- Ideal Gas Law

In this experiment, students generate a P-V diagram as a heat engine is taken through a cycle. They use the resulting diagram to measure both the heat added to the gas and the work done by the engine to determine the engine's efficiency. The actual efficiency is compared to the theoretical maximum efficiency.

Pressure changes are measured in real time using a Wireless Pressure Sensor, while changes in piston height are measured using a Wireless Rotary Motion Sensor. The change in volume is calculated by multiplying the change in piston height by the piston cross-sectional area.

The heat engine consists of an air-filled cylinder attached to a can. When the can is immersed in hot water, the air inside the cylinder expands, pushing on the piston and doing work by lifting a weight. The heat engine cycle is completed by immersing the can in cold water, which returns the air pressure and volume to the starting values.

The cycle is performed as follows:

- With the can in the cold bath, the 200 g mass is placed on the platform.
- The can is moved from the cold bath to the hot bath.
- The 200 g mass is removed from the platform.
- The can is moved from the hot bath to the cold bath.

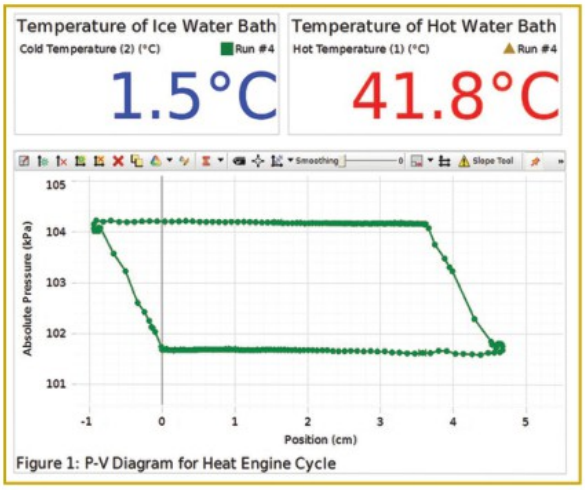


Figure 1: P-V Diagram for Heat Engine Cycle

The PASCO Capstone™ graph shows an isobaric/ isothermal heat engine cycle operating between a cold water bath at 1.5°C and a hot water bath at 41.8°C.

PASCO Advantage:

This operating heat engine shows how a difference in temperature can be used to do work. Each part of the cycle is easily identifiable, and the actual efficiency as well as the maximum possible efficiency can be easily determined.

Download this experiment.
The FREE experiment files include Microsoft Word® instructions, graphics, and PASCO Capstone™ workbook files with sample data. Download this experiment at **pasco.com/CapstoneExperiments.**

Have the 550 or 850 Universal Interface? View the corresponding experiment (EX-5530B) online at **pasco.com/CapstoneExperiments.**

The actual efficiency is determined for a heat engine that lifts a weight as heat is added to the gas.

Includes:

Heat Engine and Gas Law Apparatus	TD-8572A
Large Rod Base	ME-8735
Mass and Hanger Set	ME-8979
3-Liter Plastic Tub (2-Pack)	ME-7559
Thread	
Stainless Steel Temp Probe (2)	PS-2153
90 cm Stainless Steel Rod	ME-8738
Wireless Rotary Motion Sensor	PS-3220
Wireless Temperature Link (2)	PS-3222
Wireless Pressure Sensor	PS-3203

Heat Engine Cycles Experiment
EX-5630
▲ Required:
PASCO Capstone Software (see pages 4-5)

Radiation

Complete Thermal Radiation System

TD-8855

The Complete Thermal Radiation System facilitates four key experiments in thermal radiation. It includes a Radiation Sensor, a versatile Radiation Cube, and a Stefan-Boltzmann Lamp.

Students begin by studying the thermal radiation emitted from each of the Radiation Cube's four surface types, including matte black, matte white, polished aluminum, and dull aluminum. The thick aluminum walls ensure that all four surfaces maintain the same temperature to within a fraction of a degree. The Radiation Sensor provides accurate measurements of thermal radiation throughout the infrared region, outputting values as a voltage that is proportional to the intensity of radiation.

In the next experiment, students use the system to investigate the Inverse Square Law, where the Stefan-Boltzmann Lamp provides a near-perfect point source for accurate results.

Finally, students verify the Stefan-Boltzmann Law for both low and high temperatures by using the Radiation Cube for the low temperatures and the Stefan-Boltzmann Lamp for the high temperatures.

Includes:
Thermal Radiation Cube
Stefan-Boltzmann Lamp
Radiation Sensor

Visit **pasco.com** for component details.

Included Experiments

With Teacher's Guide and Sample Data

- Introduction to Thermal Radiation
- Stefan-Boltzmann Law at Low Temperatures (Rrad = σT4)
- Inverse Square Law
- Stefan-Boltzmann Law at High Temperatures

To see the experiments, type the product number into the search box at **www.pasco.com** and download the manual.

Complete Thermal Radiation System
TD-8855

▲ Required:

Basic Digital Multimeter	SE-9786A
Low Voltage AC/DC Power Supply	SF-9584B

■ Shown in use with:

2 Meter Patch Cord Set	SE-9415A

Heat Engine

Glass Stirling Engine

SE-8636A

This functional Stirling Engine provides a close-up look at the Stirling Cycle Principle with its active pistons and glass cylinders. This highly engaging apparatus connects to a generator which lights LEDs and includes a burner for denatured alcohol, as well as a platform for solid fuel.

Features:

- Completely assembled and ready to run
- Clear cylinders for viewing pistons
- Solid hardwood platform
- Replaceable Pyrex® power cylinder
- Replaceable, adjustable Pyrex® heat cap
- Generator with LEDs

Glass Stirling Engine SE-8636A

Thermoelectric Converter

TD-8550A

- Demonstrate the First Law of Thermodynamics
- Reversible

Features:

- Demonstrates that a temperature differential is essential for extracting usable energy
- Produces electrical energy from a temperature differential
- Produces a temperature differential with electrical energy
- 15 cm tall with 6 cm diameter fan

How It Works:

The Thermoelectric Converter uses a series of semiconductor thermoelectric cells to convert thermal energy into electrical energy. The output from the cells drives a small electric motor.

Heat to Electrical Energy

Place one leg of the Thermoelectric Converter into cold water, the other into hot. The fan turns as the converter draws energy from the hot source (typically a 50°C temperature differential is required).

Electrical Energy to Heat

Pass a current (3 ADC at 5 V) through the Thermoelectric Converter. It acts as a heat pump. One leg becomes warmer while the other becomes cooler.

When a temperature differential is established between the two legs, the fan turns.

Thermoelectric Converter TD-8550A

▲ Required:
Containers for holding hot water, cold water, etc.
Triple Output Power Supply SE-8587
Partial Immersion Thermometer SE-9084B

Sense and Control using PASCO Devices

Controller

//control.Node

PS-3232

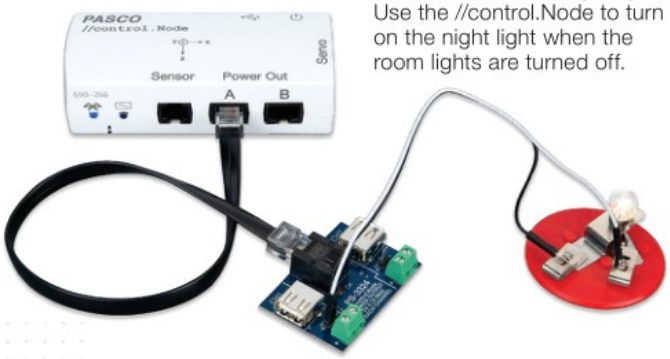
- Control motors, fans, pumps and more.
- Program with Blockly code in PASCO software.
- Use the Sensor Port to incorporate sensor data into a program.
- View and record sensor measurements as the program runs.
- Rechargeable battery provides power to the //control.Node and connected devices.
- Upload code to the //control.Node, then disconnect it to run a program autonomously.

The //control.Node is a compact control device that enables students to program a wide variety of accessories, ranging from stepper and servo motors to fans, pumps, and more. Complete with built-in memory and a rechargeable battery, the //control.Node lets students create, store, and execute unique programs that can be run autonomously. It features both Bluetooth and USB connectivity, which enable students to run programs—written in Blockly code in PASCO Capstone software—with or without a wired connection to a computer.

Built-in Features:

- Accelerometer (3-axis)
- Speaker
- Sensor Port
- Two Power Output Channels
- Two Servo Ports
- Rechargeable lithium ion battery
- Bluetooth BLE communication
- USB Port for charging and connectivity
- Two 6-32 threaded holes for mounting

Build an automatic night light! Use the //control.Node to turn on the night light when the room lights are turned off.



The //control.Node can power and control up to two stepper motors, two servo motors, and a sensor (such as the Line Follower Module shown).

Designed for use with:

PASCObot Sense and Control Kit (ST-7840)
Greenhouse Sense and Control Kit (ST-2997)
//control.Node Sense and Control Kit (PS-5050)
Stepper Motors (PS-2976)
Servo Motors (Standard and Continuous Rotation)
Power Output Module (PS-3324)
Greenhouse Sensor (PS-3322)
PASCObot (PS-2994)

Includes:

//control.Node
USB Charging Cable

//control.Node	PS-3232

//control.Node Accessories

Stepper Motors

High Speed Stepper Motor PS-2976
Low Speed Stepper Motor PS-2978

These Stepper Motors plug into one of the Power Output ports on the //control.Node using the included cable. They can be set to rotate through a given angle or at a given speed with a resolution of 480 steps/ revolution (0.75°).

When used with PASCO software and the //control.Node, the Stepper Motors monitor how far and how fast the motor moves. The feedback loop that controls the motors' constant speed is contained within the //control.Node, so there is no delay while waiting for the computer to respond to coded commands.

Both Stepper Motors include a hub with threaded holes that can be fitted onto the spline to securely mount accessories such as the PASCObot wheels, pulleys, and gear.

Specifications:

Number of Teeth: 24
Voltage: 5 V
Max Speed: 2 rev/s (high)
0.33 rev/s (low)

Each Motor Includes:

Stepper Motor
Cable for connecting motor to //control.Node
Hub with threaded holes for mounting accessories

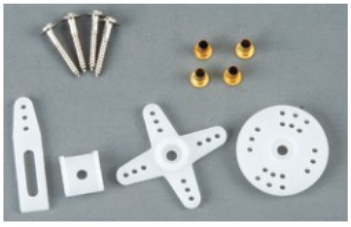
Continuous Rotation Servo

SE-2977

This Continuous Rotation (non-proportional) Servo can rotate continuously in the same direction and is ideal for robotic applications.

Specifications:

Operating Voltage: 4.8 V to 6.0 V
No-Load Speed (6.0 V): 52 rpm
Dimensions: 40.6 x 19.6 x 36.6 mm
Mass: 41.7 g
Number of Teeth: 24



Includes:
Hitec HSR-1425CR Servo
Servo Horns (4)

High Speed Stepper Motor	PS-2976
Low Speed Stepper Motor	PS-2978
Continuous Rotation Servo	SE-2977

Power Output Module

PS-3324

- Use Blockly to independently control accessories connected to channels 1 and 2.

The Power Output Module supports additional connections to the //control.Node, enabling students to extend their engineering projects beyond the contents in their kit. Simply plug the Power Output Module into the //control.Node, attach your accessory to the Output Module, and start coding your project! The Power Output Module splits access to the //control.Node's battery power, enabling students to power motors, solenoids, switches, lights, and many other accessories using the Blockly programming integration available in SPARKvue and PASCO Capstone.

Specifications:

Connector: 16" 8-pin modular plug to the control node
Channels: 2 independently controlled sides of the board
Device Connector Options: 0.025" square post header, terminal block screw, USB
Current Per Output Channel: 0.7 A
Voltage: 5 V
Dimensions: 3.7 x 5.7 cm

Includes:
8-pin modular plug to connect to the //control.Node

Servo Motor

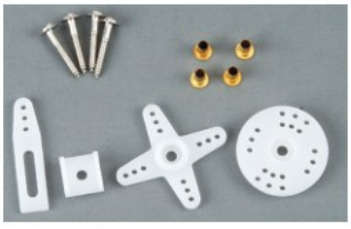
SE-2975

This standard Servo Motor plugs into one of the two Servo ports on the //control.Node (PS-3232). The motor rotates through 180 degrees, moving a push rod that rotates a part, such as the aileron on an airplane.

Within the //control.Node is an internal current sensor that monitors the Servo Motor Ports, making it easy for students to know when a load is placed on the servos. When the servos on the PASCObot Gripper start to draw more current, the code can detect that an object has been gripped and determine how hard the object is being squeezed.

Specifications:

Operating Voltage: 4.8 V to 6.0 V
Maximum Torque Range: 3.3 to 4.1 kg/cm
Dimensions:
40.6 x 19.8 x 36.6 mm
Mass: 45.5 g
Number of Teeth: 24



Includes:
Hitec HS422 Deluxe Servo
Servo Horns (4)

Power Output Module	PS-3324
Servo Motor	SE-2975

PASCO Robotics

PASCObot

PS-2994

- Explore sense and control applications
- Experiment with self-driving technology
- Create data-driven feedback loops using PASCO sensors

The PASCObot is an expandable STEM robot that enables students to explore a series of real-world robotics applications. At its core is the //control.Node, which allows students to upload and execute code, track the PASCObot's motion, and monitor data as the bot moves for real-time feedback.

The PASCObot includes the //control.Node, two Stepper Motors with Wheels, and the PASCObot Body. It is also compatible with PASCO Wireless Sensors, including the //code.Node, which fits into the top slot of the PASCObot. When used with the //code.Node, students can explore more complex programs where the //code.Node acts as a turn signal, remote control, or a car alarm.

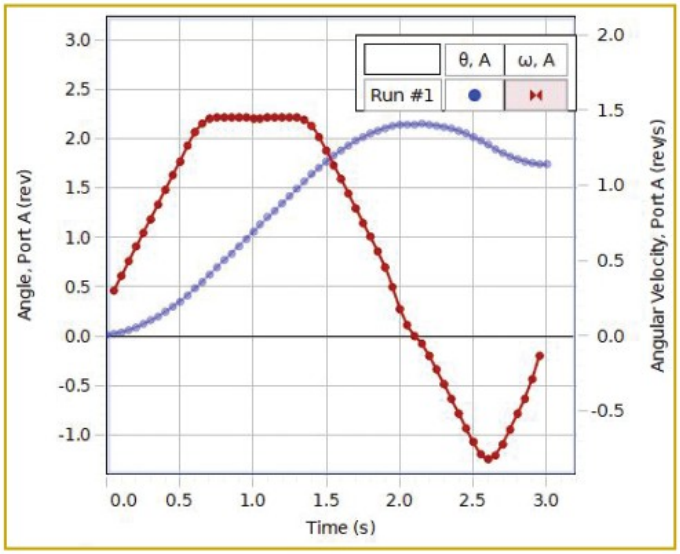
The //code.Node can ride in the PASCObot and be programmed to make turn signals on the LED array.

Features:

- Enables students to design, code, and test unique applications
- Built-in accelerometer for real-time motion tracking
- Live data plots provide instant feedback
- Code using Lua or Blockly code, available in PASCO software.
- Easily expands with PASCO sensors, such as the //code.Node

Students can assemble the PASCObot in minutes, putting together only seven parts, compared to the hundreds of parts in other robot kits.

Execute code and produce motion data with PASCObot.



The PASCObot is more than just a robot. As students run their code, a real-time display of the bot's speed and distance can be viewed alongside the robot's motion. This feedback helps inform students when debugging their code and makes it easier for students to assess the effects of their code as it's executed.

Includes:

PASCObot Body	PS-3318
High Speed Stepper Motor (2)	PS-2976
PASCObot Wheel with Tire (2)	PS-3319
//control.Node	PS-3232
Small #1 Phillips Screwdriver	
PASCObot Assembly Hardware	

PASCObot PS-2994

PASCObot (without //control.Node) PS-2995

Required:

PASCO Capstone Software (see pages 4-5)

OR

SPARKvue Software (visit pasco.com)

Sense & Control Using the PASCObot

PASCObot Sense & Control Kit

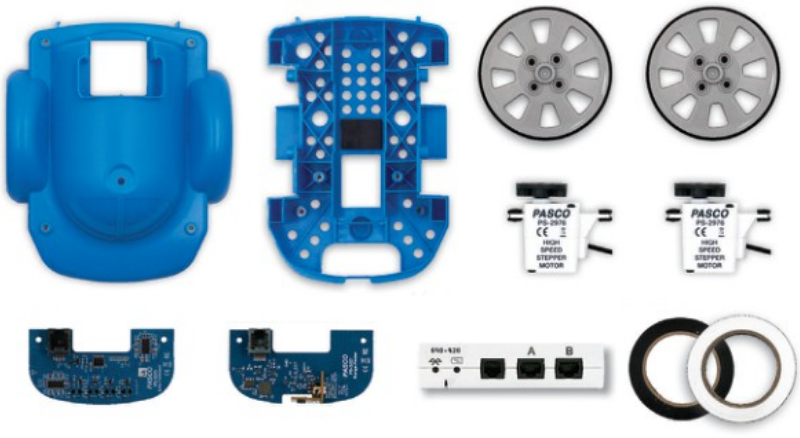
ST-7840

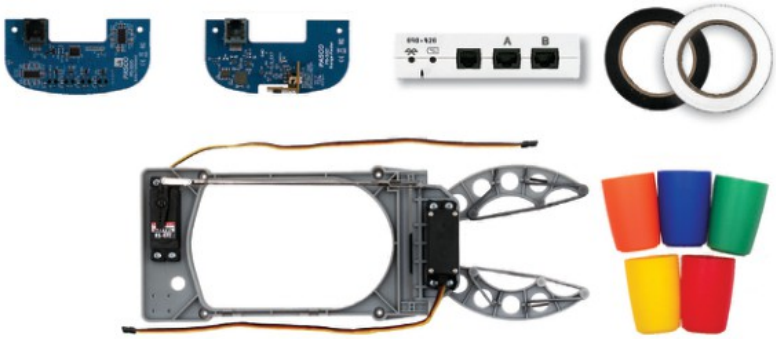
The PASCObot Sense & Control Kit is a comprehensive robotics kit that allows students to investigate a wide variety of real-world applications. This complete kit includes a PASCObot, //control.Node, and a suite of programmable accessories.

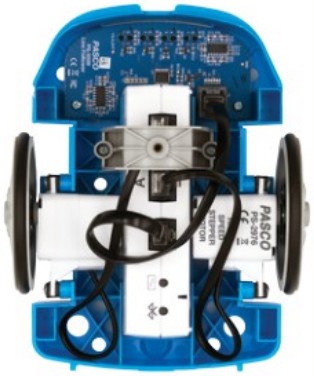
Simple to build and easy to program, the PASCObot Sense & Control Kit takes students beyond basic robotics applications, combining PASCO's real-time data collection, graphing, and analysis system with an intuitive coding interface that scales to their skill level.

Programmable Components Include:

- **//control.Node:** Stores code aboard the PASCObot and tracks its motion using a built-in accelerometer.
- **Stepper Motors:** Connect to the PASCObot's Wheels. Can be independently controlled to move the bot forwards, backwards, or around corners and curves.
- **Line Follower Module:** Allows the PASCObot to detect and respond to custom line paths, created using the included tape.
- **Range Finder Module:** Gives the PASCObot sight, allowing it to locate, avoid, and respond to objects based on code.
- **PASCObot Gripper:** Enables the PASCObot to be programmed to move, pick up, stack, or sort objects.







Mount accessories like the Line Follower Module (included) in the PASCObot to expand your sense & control capabilities.

Includes:

PASCObot Body	PS-3318
High Speed Stepper Motor (2)	PS-2976
PASCObot Wheel with Tire (2)	PS-3319
//control.Node	PS-3232
PASCObot Line Follower Module	PS-3320
PASCObot Range Finder Module	PS-3321
PASCObot Gripper Accessory	PS-3325
Servo Motors (2)	PS-2976
White/Black Tape (one roll each)	SE-2953
Colored Plastic Cup Set (5)	SE-2952
Small #1 Phillips Screwdriver	
PASCObot Assembly Hardware	

For more details about the contents of this kit, or to explore other kits, go to **pasco.com/STEM**

PASCObot Sense & Control Kit ST-7840
PASCObot Sense & Control Kit (without //control.Node) ST-7841

▲ Required:
PASCO Capstone Software (see pages 4-5)
OR
SPARKvue Software (visit pasco.com)

Microwave Optics System

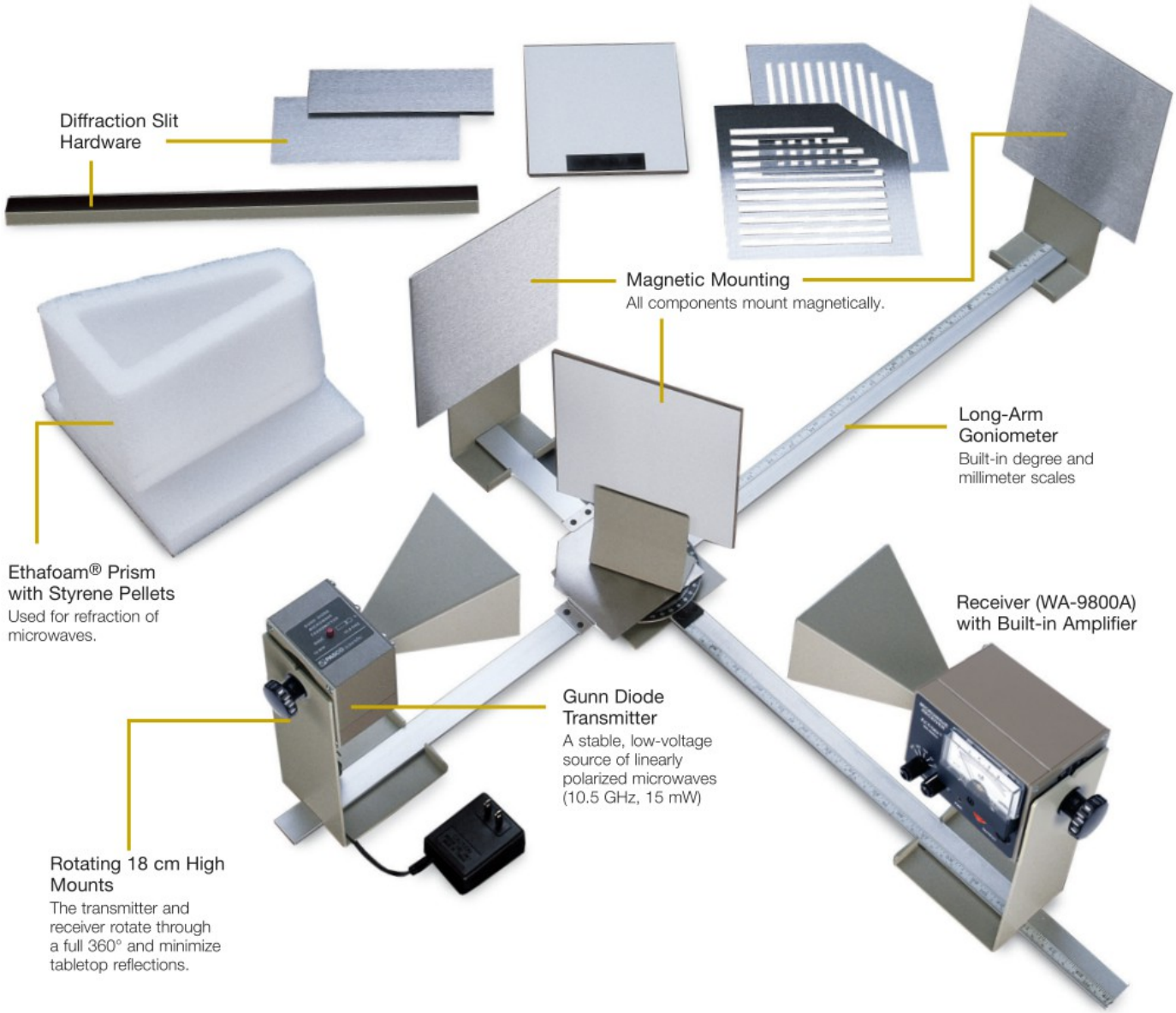
Basic System

WA-9314C

Advanced System

WA-9316A

- Perform a variety of optics experiments
- Study the laws of reflection and refraction
- Conduct Young's double-slit experiment with microwaves



The PASCO Microwave Optics System makes it possible for students to perform traditional experiments in optics—from investigating the effects of polarization to examining interference and diffraction to determining the laws of reflection and refraction. The Advanced Microwave Optics System also includes the Microwave Accessory Package, which facilitates student studies of both Brewster's angle and Bragg diffraction.

For more information about the Microwave Optics Systems, go to **pasco.com**

Features:

- **Durable Construction:** Parts are composed of stainless steel or die-cast aluminum.
- **Magnetic Mounting:** All components mount magnetically, making setup quick and easy.
- **Goniometer:** Includes a built-in degree scale and both fixed and rotatable arms
- **Gunn Diode Transmitter:** Provides a stable, low-voltage source of linearly polarized microwaves (10.5 GHz; 15mW).
- **Gunn Diode Receiver:** Features a built-in amplifier and variable sensitivity scale, ensuring accurate data for even the lowest intensity measurements.
- **Rotating Mounts:** Both the transmitter and the receiver rotate a full 360° for use in polarization experiments.

Experiments:

- Reflection
- Measuring Wavelengths in Standing Waves*
- Refraction Through a Prism
- Polarization
- Double-Slit Interference
- Lloyds Mirror
- Fabry-Perot Interferometer
- Michelson Interferometer
- Fiber Optics
- Brewster's Angle**
- Bragg Diffraction**

▲ *Requires Microwave Detector Probe (WA-9319A).

**Requires Advanced Microwave Optics System (WA-9316A) or Microwave Accessory Package (WA-9315).

Basic Microwave Optics System Includes:

Goniometer
Gunn Diode Transmitter with mounting stand
Gunn Diode Receiver with mounting stand
Component Holders: Two standard, one rotating
Reflectors: Two full (metal), two partial (wood)
Fixed-arm assembly for interferometer experiments
Rotating table
Polarizers
Diffraction slit hardware
Prism with styrene pellets
AC Adapter
Laboratory manual with 12 experiments

Advanced Microwave Optics System Includes:

Microwave Optics: Basic System (left)
Microwave Accessory Package (WA-9315):
Includes Simulated Crystal Lattice and Polyethylene Panel

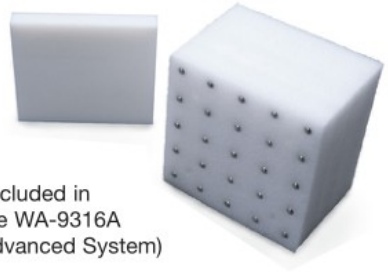
Microwave Optics: Basic System	WA-9314C
Microwave Optics: Advanced System	WA-9316A

● Recommended:
The microwave transmitter and receiver assemblies may be purchased separately:

Microwave Transmitter	WA-9801
Microwave Receiver	WA-9800A
Microwave Mounting Stand	WA-9802

Microwave Accessory Package

WA-9315



(included in the WA-9316A Advanced System)

Includes a polyethylene panel for measuring Brewster's angle and a simulated crystal for Bragg diffraction experiments. The crystal is a cubic lattice of 100 metal spheres in a 5 x 5 x 4 array, mounted in plastic foam.

Includes:

Simulated Crystal Lattice
Polyethylene Panel

Microwave Detector Probe

WA-9319A

Investigate the nodes and antinodes in standing wave patterns with this microwave probe. It plugs directly into the (WA-9800A) receiver.

Not compatible with older versions of the receiver.

Microwave Accessory Package
WA-9315
Microwave Detector Probe
WA-9319A

Meters and Decade Boxes

Student Multimeter

SE-8829

This durable and easy-to-use multimeter is a great tool for making quick measurements or continuously monitoring DC voltages and currents. It is conveniently "mini" size for student use.

Basic Digital Multimeter

SE-9786A

This basic meter includes all the functions and ranges needed for most introductory lab work.

Features:

- 10 amp range
- Backlit display with 25 mm digits
- Soft rubber boot for drop protection
- Built-in tilt stand
- Type K thermometer built in for surface or air measurements
- Auto power off saves battery life

Specifications:

DC Voltage: 0.1 mV to 600 V with ±0.5% accuracy

AC Voltage: 1 mV to 600 V with ±0.3% accuracy

DC Current: 0.1 µA to 10 A

AC Current: 0.1 mA to 10 A

Resistance: 0.1 Ω to 20 MΩ

Additional Functions: Input fuse protection, audible and visible misconnection signals, data hold freezes display reading

Display: 3-1/2 digit display with 25 mm digits, polarity indication, low battery indication

Power: 9 V battery (included)

Student Multimeter	SE-8829
Basic Digital Multimeter	SE-9786A

Precision Digital Multimeter, Component Tester and Thermometer

SB-9631B

This is an excellent general purpose multimeter that features high-accuracy overload protection on all ranges and a built-in digital thermometer. It can measure capacitance and transistor gain (hFE).

Specifications:

DC Current: 200 µA, 2 mA, 20 mA, 200 mA; ± (1% + 1 digit)

AC Current: 200 µA, 2 mA, 20 mA, 200 mA; ± (1.2% + 4 digits)

Capacitance: 20 nF, 200 nF, 2 µF, 20 µF, 200 µF; ± (3% + 10 digits)

Temperature: 4° to 1400°F; 4° to 900°F; ± (2.0% reading + 4°F); 900°F to 1,400°F; ± (3.0% reading + 4°F)

Power: 200-hour life on 9 V alkaline (battery included). Test leads, temperature probe and battery are included

DC Voltage: 200 mV, 2 V, 20 V, 200 V, 1000 V; ± (0.5% + 1 digit) 10 MΩ input impedance

AC Voltage: 200 mV, 2 V, 20 V, 200 V; ± (1% + 4 digits) 750 V; ± (1.5% + 4 digits) 10 MΩ input impedance

Resistance: 200 Ω, 2 kΩ, 200 kΩ, 20 MΩ; for 200 Ω to 200 kΩ ± (1.0% + 4 digits) for 20 MΩ ± (2.0% + 4 digits)

Additional Functions: Diode test, transistor hFE, audible continuity test, fold-out stand

Display: 3-1/2 digit LCD display, 17 mm high digits, polarity indication, low battery indication

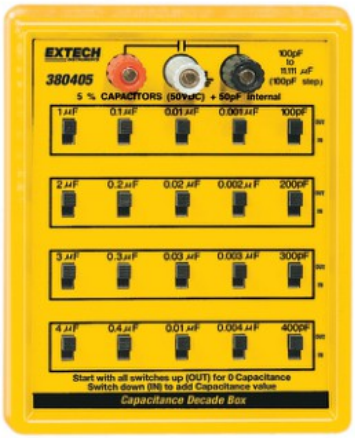
Drop Resistant

Precision Digital Multimeter, Component Tester and Thermometer	SB-9631B
Replacement Supplies:	
Thermocouple Probe	SB-9632

Visit **pasco.com** for more information on meters and decade boxes.

Decade Capacitance Box

SE-8689



This Decade Capacitance Box supplies five decades of capacitance from 100 pF to 11.111 µF in 100 pF steps. Add or subtract capacitance with slide switches. Three color-coded binding posts provide reliable connections.

Specifications:

Accuracy: ±5%

Maximum Voltage: 50 VDC

Decade Resistance Box

SE-7124

Resistance is plainly displayed with this six-decade resistance box since a rotary switch selects the resistance within each decade. With 1% accuracy and 1/2 W resistors, it will accommodate most student experiments.

Specifications:

Resistance Ranges: X1 Ω, X10 Ω, X100 Ω, X1 kΩ, X10 kΩ, X100 kΩ
Number of steps per decade: 10
Accuracy: ±1.0%
Power Dissipation: 0.5 W resistors

Decade Capacitance Box	SE-8689
Decade Resistance Box	SE-7124

Magnetic Field Meter

SE-7579B

This Hall Effect sensor measures AC and DC magnetic field strength.

Features:

- Makes AC and DC magnetic field measurements
- Measures up to 3 T
- Temperature compensated
- Sensitivity on lower scale 0.1 G
- North and South pole indication
- Zero button
- Auto power off
- LCD display
- Data hold and min/max record-recall
- Choice of gauss or mT units

Specifications:

DC Measurement Ranges:
300.00 mT (0.01 mT resolution); 3000.0 mT (0.1 mT resolution)
AC Measurement Ranges:
150.00 mT (0.01 mT resolution); 1500.00 mT (0.1 mT resolution)
Accuracy at 23°C: ±5% of reading
AC Frequency Response: 50 Hz/60 Hz
Display Sampling Time: Approx. 1 second
Operating Temperature: 0 to 50°C
Power Supply: 9 V battery (AC adapter included)
Mass: 275 g with probe
Meter Dimensions: 198 x 68 x 30 mm
Probe Dimensions: 195 x 25 x 19 mm
Probe Tip Thickness: 1.8 mm

Includes:

Magnetic Field Meter
Uniaxial Magnetic Probe Sensor with Protective Cover
9 V Battery
Universal AC Adapter (9 V, 1 A)
Hard Carrying Case

Magnetic Field Meter	SE-7579B

Meters

Heavy-duty Voltmeter

SF-9568A

The Heavy-duty Voltmeter has three ranges and is switch-selectable to measure AC or DC voltages.

Specifications:
DC Ranges: 0 to 3 V/15 V/30 V
AC Ranges: 0 to 3 V/15 V/30 V
Accuracy: ±2%
Sensitivity: 10 kΩ/V

Heavy-duty Ammeter

SF-9569A

This Ammeter has three ranges and is switch-selectable to measure AC or DC values. All ranges are overload-protected up to 15 amps.

Specifications:
DC Ranges: 0 to 50 mA/500 mA/5 A
AC Ranges: 0 to 50 mA/500 mA/5 A
Accuracy: ±2%

Heavy-duty Galvanometer

SF-9500A

This Galvanometer includes a "push-to-read" switch that protects the device during hookup by shunting the current through an equivalent resistor.

Specifications:
Current Ranges: 50 µA/500 µA/5 mA
Internal Resistance: 900 Ω/90 Ω/9 Ω
Accuracy: ±5%

Heavy-duty Voltmeter	SF-9568A
Heavy-duty Ammeter	SF-9569A
Heavy-duty Galvanometer	SF-9500A

Digital LCR Meter

SE-8792A

Measure inductance, capacitance, and resistance with this Digital LCR Meter. Test leads are included, along with a battery, a protective holster, and a manual.

Features:
- **Accuracy:** 1% or better on most ranges
- **Easy to Use:** Push-button selection for all measurements
- **Built-in Tilt Stand:** For convenient tabletop use
- Measures Inductance, Capacitance, and Resistance with secondary parameter Q (Quality), D (Dissipation), R (Resistance), P (Phase), ESR (Equivalent Series Resistance)
- Simultaneous 20,000/2,000 count backlit display of the primary parameter (L, C or R) with the secondary parameter
- Auto Select measurement function with 1 kHz default test frequency
- Five test frequencies
- Set Hi/Lo limits using absolute values or percentage limits
- Relative mode function
- Parallel or Series equivalent circuit
- Auto power off, low battery and overrange indicators
- Open and Short calibration removes unwanted stray impedances from the measurement

Specifications:

Inductance: 20 µH, 200 µH, 2000.0 µH, 20.0000 mH, 200.00 mH ±(0.5% rdg + 5 digits); 2000.0 mH, 20.000 H, 200.00 H, 2000.0 H (DF <0.1)

Capacitance: 20 pF, 200 pF, 2000 pF, 20.000 nF, 200.00 nF, 2000.0 nF ±(0.5% rdg + 5 digits); 20.000 µF, 200.00 µF, 2.0000 mF, 20.00 mF (DF <0.1)

Resistance: 20.00 Ω, 200.00 Ω, 2.0000 kΩ, 20.000 kΩ, 200.00 kΩ, 2.0000 MΩ, 20.000 MΩ, 200.0 MΩ ±(0.5% rdg + 5 digits)

Test Frequency: 100 Hz, 120 Hz, 1 kHz, 10 kHz, 100 kHz

Power: 9 V alkaline battery (included)

Accessories: Test leads (2), alligator clips (2), protective holder

Digital LCR Meter	SE-8792A

Visit **pasco.com** for a complete listing of meters.

Wireless Sensors

Wireless Motion Sensor

PS-3219

The Wireless Motion Sensor uses ultrasound to measure the position, velocity, and acceleration of objects, ranging from 15 cm to 4.0 m away. It features both Bluetooth and USB connectivity, enabling students to monitor their motion data using any device running PASCO software. The sensor can be used handheld, on a tabletop, or mounted to the ceiling.

Specifications:
Range: 0.15 to 4 m
Resolution: 1 mm
Maximum Sample Rate: 250 Hz
Transducer Rotation Range: 180°
Rechargeable Battery: Lithium-polymer
Connectivity: Direct USB or via Bluetooth 4.0

Includes:
USB charging cable

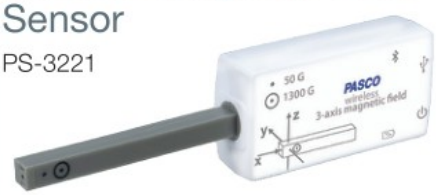
Wireless Motion Sensor
PS-3219

Recommended:
MatchGraph! Software

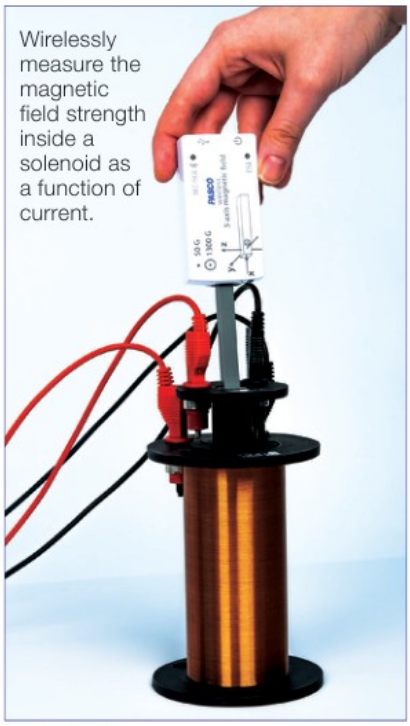
Also available:
Wireless Motion Sensor Pack*
PS-3337
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Magnetic Field Sensor

PS-3221



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



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

Specifications:
Ranges: ±50 G and ±1300 G
Resolution: ±0.01 G (50 G range); ±1 G (1300 G range)
Maximum Sample Rate: 100 Hz
Measurements: Magnetic Field Strength (3 axes and resultant)
Logging: Yes
Battery: Rechargeable lithium-polymer
Connectivity: Direct USB or via Bluetooth 4.0

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

Wireless Magnetic Field Sensor
PS-3221

Recommended:
Zero Gauss Chamber
EM-8652

Wireless Sound Sensor

PS-3227

The Wireless Sound Sensor is two sensors in one wireless package: a sound wave sensor capable of measuring changes in relative pressure level as a function of time and a sound level sensor with both dBA and dBC weighted scales.

Sound Wave Sensor: The Sound Wave Sensor measures relative changes in sound pressure level as sound waves are incident on the sensor. With graphs of sound wave measurements versus time, students can explore and analyze wave properties like wave shape, wave speed, amplitude, frequency, wavelength, and much more. Students can use this sensor to explore superposition of waves and beat frequencies, while also exploring standing wave harmonics, and the presence of overtones. Sound wave measurements are clearly displayed with the scope and FFT displays in both SPARKvue and Capstone. The Wireless Sound Sensor is capable of measuring sound wave data wirelessly at sample rates up to 100 kHz.

Sound Level Sensor: The Sound Level Sensor gives you true sound level (intensity) measurements with both dBA and dBC scales. The dBC weighting scale measures the intensity of sounds in a wide range of frequencies within, and outside the frequency range of human hearing. The dBA weighting scale filters some of the sound frequencies from a sound source to more closely match the frequency response of the human ear.

This new sensor gives you a wireless solution to measure sound level with all the capability of a sound level meter, but adds the flexibility of recording data continuously as a function of time.

Specifications:
Microphone Frequency Range: 100–15,000 Hz
Sound Wave Maximum Sampling Rate: 100 kHz
Sound Level Range: 50–110 dB
Accuracy: ±2 dB
Response: A or C weighted

Includes Sensor Handle

Wireless Sound Sensor
PS-3227

Also Available:
Wireless Sound Sensor Pack*
PS-3342
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Sensors

Wireless Light Sensor

PS-3213

The Wireless Light Sensor features two separate apertures - one for ambient light measurements and one for directional light measurements. The ambient sensor measures illuminance and UV Index, while the spot (directional) aperture measures light level and color intensity. Our software displays the relative intensities of Red, Green, and Blue light, in comparison to the total amount of White light. PAR and irradiance are also available as calculated measurements within PASCO Capstone and SPARKvue software.

Using Wireless Sensors to collect eclipse data

On August 21, 2017, a total solar eclipse occurred and was visible, in some degree, over much of the continental United States. Using PASCO Wireless Sensors, students across the United States viewed the total eclipse and measured the change in light level and temperature as the moon passed in front of the sun!

Learn how your students can study the next solar eclipse at: **pasco.com/eclipse**

Specifications:
Spectral Response: 300 nm to 1100 nm
Illuminance Range: 0 to 131,000 lux
Irradiance Range: 0 to 1362 W/m^2
PAR Range: 0 to 2400 µmol/m^2/s
UV Index Range: 0 to 12 (typical in daylight)
RGB and White Light Range: 0 to 100%
Maximum Sample Rate: 2 Hz (ambient); 20 Hz (spot)
Battery: Coin cell
Connectivity: BT 4.0

Wireless Light Sensor
PS-3213

Also Available:
Wireless Light Sensor Pack* PS-3338
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Pressure Sensor

PS-3203

The Wireless Pressure Sensor allows students to easily collect accurate gas pressure data for a wide range of applications. Included is a 60cc syringe, tubing, and connectors that facilitate experiments such as Boyle's Law or measuring pinch-grip strength. Within PASCO's software, students can easily select their desired units from a list containing kPa, mmHg, inHg, mbar, psi, atm, and torr.

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

Specifications:
Range: 0-400 kPa
Resolution: 0.1 kPa
Accuracy: ±2 kPa
Logging: Yes
Max Sample Rate: 1000 Hz
Connectivity: BT 4.0

Includes:
Polyurethane Plastic Tubing, 2 ft
Tube Connector
Male Barbed Luer Locks (2)
Female Barbed Luer Lock
60 cc Syringe
Micro USB Cable (PS-3584)

Wireless Pressure Sensor
PS-3203

Also Available:
Wireless Pressure Sensor Pack* PS-3333
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Temperature Sensor

PS-3201

Welcome to the modern thermometer. This sensor transmits live data and allows students to continuously monitor, log, and plot temperature measurements on nearly any device.

Features:

- Simply pair and go, no cables or adapters to manage
- Variable sampling rate for capturing small, fast changes or experiments that run for hours, days, or weeks
- Bluetooth wireless connectivity and long-lasting coin cell battery
- Logs temperature data directly onto the sensor for long-term experiments
- Dust, dirt, and sand-proof and water resistant (IP-X7 certified)

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

Specifications:
Range: -40°C to 125°C
Resolution: 0.01°C
Accuracy: 0.5°C
Logging: Yes
Connectivity: BT 4.0

Wireless Temperature Sensor
PS-3201

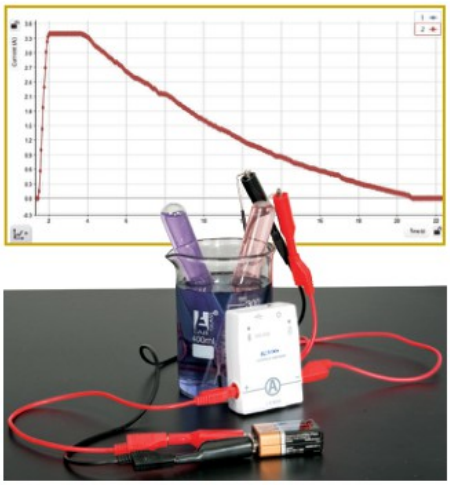
Also Available:
Wireless Temperature Sensor Pack* PS-3330
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Visit **pasco.com/wireless** to see our complete line of Wireless Sensors.

Wireless Current Sensor

PS-3212

The Wireless Current Sensor's wide current range enables introductory and advanced explorations of the fundamental concepts of electricity and basic circuits.



Features:

- **Two Ranges:** ±1.0 A and ±0.1 A
- **Resolution:** 0.2 mA at ±1 A range and 0.02 mA at ±0.1 A range
- **Bluetooth® sampling rate of 1.0 kHz**
- **High-speed sampling via USB**
- **Remote logging**
- **Variable sampling rate** for recording small, fast changes or experiments that run for hours, days, or weeks

Includes:

USB Cable
Red, Banana-to-alligator-clip
Black, Banana-to-alligator-clip
Wireless Current Sensor

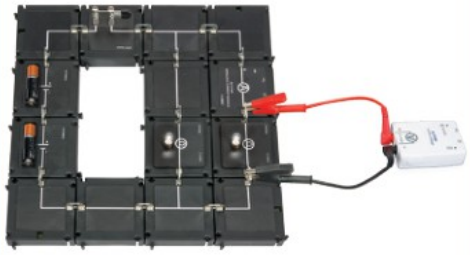
Wireless Current Sensor
PS-3212

Also Available:
Wireless Current Sensor Pack*
PS-3336
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Voltage Sensor

PS-3211

The Wireless Voltage Sensor is ideal for exploring the fundamental concepts of electricity, voltage, and basic circuits. Complete with built-in overload protection, this sensor measures voltages up to ±15 V, and features high-speed sampling rates when connected via USB. When combined with the Wireless Current Sensor, students can use it to explore Ohm's Law, circuits in series and parallel, and much more.



Features:

- **Two Ranges:** ±15 V, ±5 V
- **Resolution:** 7 mV (±15 V range); 2 mV (±5 V range)
- **Bluetooth® sampling rate of 1.0 kHz**
- **High-speed sampling via USB**
- **Remote logging**

Includes:

Wireless Voltage Sensor
USB Cable
Red, Banana-to-alligator-clip
Black, Banana-to-alligator-clip

Wireless Voltage Sensor
PS-3211

Also Available:
Wireless Voltage Sensor Pack*
PS-3335
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Geiger Counter

PS-3238

The PASCO Wireless Geiger Counter counts beta, gamma and alpha radiation particles as they enter the Geiger–Müller detector tube inside the counter. Designed for easy mounting, the Geiger Counter provides superior position control in inverse square law labs, as well as an audible beep to indicate the detection of ionizing radiation. The front plastic snout fits conveniently inside the NU-3344 Sample Holder stand (available separately), which stabilizes the front of the counter's detector tube exactly 1 cm from the first slot in the holder.

With the Wireless Geiger Counter, students can wirelessly control the high voltage supplied to the Geiger–Müller tube inside the counter, enabling them to make measurements of counts/interval for different tube voltages. They can also plot counts/interval versus tube voltages to experimentally observe the Geiger plateau characteristics of the tube.

Specifications:

Sensitivity: Alpha, Beta, Gamma
Count Detection: Switchable audio signal
Gas Filling: Ne +Halogen
Effective Tube Diameter: 9.1 mm
Window Thickness: 1.5 to 2.0 mg/cm^2
High Voltage Control Range: 150 VDC to 650 VDC
Standard Operating Voltage: 500 VDC

Includes:

Wireless Geiger Counter
Micro USB Cable (PS-3584)
Threaded handle for mounting the sensor to a ring stand

Wireless Geiger Counter
PS-3238

Also available:
G-M Probe with Sample Holder
SN-7970A
Geiger Counter Sample Holder
NU-3344

Wireless Sensors

Wireless Force Platforms

PS-3229 (1-Axis) & PS-3230 (2-Axis)

The Wireless Force Platforms build on the success of our PASPORT Force Platform and the PASPORT 2-Axis Force Platform, offering users the same reliable performance with enhanced durability and a convenient, wireless connection.

The new design features a sturdy, glass-filled nylon platform and four supporting force beams that measure the forces acting normal to the platform's surface. The 2-Axis Force Platform includes a fifth beam, attached to the movable sheet metal top, to measure forces acting parallel to the platform's surface. Students can measure the force applied to each beam independently or the overall resultant force acting on the surface of the platform (up to 5200 N).

With the new wireless design, the Wireless Force Platforms are easier to use than ever, providing both flexibility and custom sample rates for high speed sampling over Bluetooth Low Energy (up to 10 kHz). They can be used to measure the static weight of a structure or person, the dynamic vertical forces created when moving or jumping, or the forces associated with the impact of falling objects. Simply place the platform on a floor or tabletop to measure vertical force, or mount it to a wall to measure horizontal force.

PS-3229 Specifications:
Range: -1320 N to 5280 N (resultant)
Surface Dimensions: 35 cm x 35 cm
Maximum Sample Rate: 10 kHz
Resolution: 0.2 N
Force Over-Limit Protection: -500 N to 2000 N per beam

PS-3230 Specifications:
Range: -1320 N to 5280 N (resultant); ±1300 N parallel force
Surface Dimensions: 35 cm x 35 cm
Maximum Sample Rate: 10 kHz
Resolution: 0.2 N
Force Over-Limit Protection: -500 N to 2000 N per vertical beam; ±2000 N parallel beam

Wireless Force Platform
PS-3229
Wireless 2-Axis Force Platform
PS-3230

Wireless Force Acceleration Sensor

PS-3202

- Eliminates wires
- Measures force, acceleration, and rotation

Capable of simultaneously measuring force, acceleration, and rotational velocity, this sensor is ideal for experiments involving rotating platforms, moving carts, spring oscillations, collisions, and impulse. The wireless design offers improved measurement accuracy by eliminating cords that affect data collection. Students can use the finger-holes for handheld applications, or mount it onto a cart or rod for more complex experiments.

Features:
- Bluetooth and USB connectivity
- Logging
- ±50 N force sensor
- 3-axis accelerometer (±16 g)
- 3-axis gyroscope
- Finger-holes
- Built-in rod clamp

Specifications:
Force Range: ±50 N
Force Resolution: 0.03 N
Accuracy: 0.1 N
Acceleration Range: ±16 g
Angular Rotation Rate Range: Up to ±2000 degrees per second
Battery: Rechargeable lithium-polymer
Logging: Yes
Connectivity: BT 4.0

Includes:
Hook attachment
Rubber bumper attachment
Cart/bracket thumbscrew
Rechargeable lithium-polymer battery
USB cable

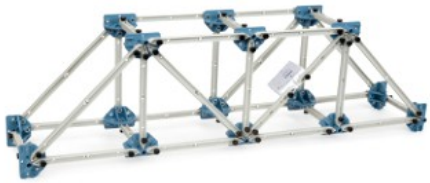
Wireless Force Acceleration Sensor PS-3202

Also Available:
Wireless Force Acceleration Sensor Pack* PS-3339
* Includes 8 sensors in a Gratnells® storage tray with custom insert.

Wireless Load Cell and Accelerometer

PS-3216

- Measures loads in PASCO structures
- Built-in 3-axis accelerometer measures bridge vibrations
- No wires to interfere with motion



The Wireless Load Cell and Accelerometer is designed to measure loads in all PASCO Structures Systems. It is particularly useful for measuring vibrations because it includes an accelerometer and has no wires to impede movement.

Specifications:
Load Cell
Range: ±50 N
Resolution: 0.03 N
Accuracy: 0.1 N
Maximum Sample Rate: 2 kHz
Acceleration
Range: ±16 g (three axis)
Maximum Sample Rate: 500 Hz
Measurements: Force; Acceleration (3 axes and resultant)
Logging: Yes
Battery: Rechargeable lithium-polymer
Connectivity: Direct USB or via BT 4.0

Wireless Load Cell and Accelerometer
PS-3216

Shown in use with:
Building Better Bridges Kit
Shown on page 9 and includes PS-3216.

Interface Guide

Use one of the following interfaces to collect data with PASPORT (digital) or ScienceWorkshop (analog) sensors.





	AirLink PS-3200	SPARKlink Air PS-2011	SPARK LXi2 PS-3600B	550 Universal Interface UI-5001	850 Universal Interface UI-5000
PASPORT Ports	1	2	2	2	4
Built-in Temp and Voltage	No	Yes	Yes	No	No
Analog Inputs	0	0	0	2 (±10 V, optional gain voltage 10x, 100x)	4 (±20 V, optional gain voltage 10x, 100x, 1000x)
Digital Inputs	0	0	0	2	4
Connects via USB	Yes	Yes	Yes	Yes	Yes
Connects via Bluetooth	Yes	Yes	Yes	Yes	No
Rechargeable Battery for Cordless Operation	Yes	Yes	Yes	No (AC adapter only)	No (AC adapter only)
Works with PASCO Capstone Software	Yes	Yes	No	Yes	Yes
Works with SPARKvue Software	Yes	Yes	Yes	Yes	No
Accepts PASPORT Sensors	Yes	Yes	Yes	Yes	Yes
Accepts ScienceWorkshop Sensors	No*	No*	No*	Yes	Yes
Maximum Sampling Rate	Sensor-dependent <1000 Hz	Sensor-dependent <1000 Hz	Sensor-dependent <100 kHz	Up to 2 MHz on one channel	10 MHz on two channels simultaneously
Signal Generator	N/A	N/A	N/A	±8 V, at 400 mA, DC to 100 kHz	#1 ±15 V at 1 A, DC to 100 kHz #2 & #3 ±10 V at 50 mA DC to 500 kHz, independent
Included Items	USB Cable	AC adapter, USB cable, fast response temperature probe, voltage probe	AC adapter, fast response temperature probe, voltage probe	USB cable, power supply	USB cable, power supply
Expansion Port	No	No	No	No	44-pin port with voltage outputs, analog inputs, and digital I/O channels

* The AirLink, SPARKlink Air, and SPARK LXi2 can accept most ScienceWorkshop sensors with the proper adapter (see pasco.com for details), although they won't have the same high maximum sample rates. One exception is the Sound Sensor (UI-5101), which is not recommended for use with an adapter.

Visit **pasco.com** for details on all of PASCO's interfaces.

Get a power amplifier, function generator, and interface in one instrument!

850 Universal Interface

UI-5000

Overview:

- Built-in power amplifier (15 W)
- 3 Built-in signal generators
- 4 Digital inputs
- 4 Analog sensor ports
- 4 PASPORT sensor ports
- Max sampling rate of 10.0 MHz (2 channels) or 1.0 MHz (4 channels)
- USB connectivity
- Compatible with PASCO Capstone

The 850 Universal Interface is the most powerful educational lab interface in the world. It provides the most ports, the fastest sampling rates, and unmatched functionality—all while maximizing your bench space.

Designed for use with PASCO Capstone software, the 850 Universal Interface provides several pieces of computer-based lab instrumentation, including an oscilloscope, power amplifier, timer, and three function generators.

Specification	15 W Signal Generator	Dual Independent High Frequency Signal Generators
Frequency Range	0.001 Hz to 100 kHz; 1 mHz resolution	0.001 Hz to 500 kHz; 1 mHz resolution
Amplitude Range	±15 V	±10 V
Resolution	7.3 mV, 12-bit DAC	2.5 mV, 12-bit ADC
Max Output Current	1 A at 15 V, over-current detection	50 mA at 10 V
Waveforms	Sine, triangle, square wave, positive and negative ramps, and DC	Sine, triangle, square wave, positive and negative ramps, and DC
Other Relevant Information	• Selectable short-circuit current limit • Selectable voltage limit • Selectable DC offset • Frequency sweep function	

850 Universal Interface
UI-5000

▲ Required:
PASCO Capstone Software (see pages 4-5)

● Recommended:
BNC Function Generator Output Cable
UI-5129 (shrouded) UI-5119 (unshrouded)

■ Replacement Part:
850 Universal Interface Replacement Power Supply
UI-5200

Visit **pasco.com** for more information about the function generator features in the 850 and 550 Universal Interfaces.

550 Universal Interface

UI-5001

Overview:

- Built-in power amplifier (3.2 W)
- Built-in signal generator with voltage and current sensors
- 2 Digital inputs
- 2 High speed analog ports
- 2 PASPORT sensor inputs
- 2.0 MHz max sampling rate
- Bluetooth and USB connectivity
- Compatible with both PASCO Capstone and SPARKvue software.

The 550 Universal Interface is fast, flexible, and cost-effective, making it an excellent addition to any engineering lab. It offers half the ports and many of the same great features as our 850 Universal Interface, with the added benefit of wireless connectivity.

When used with our advanced data-collection software, PASCO Capstone, the 550 Universal Interface can serve as a function generator, allowing students to control various DC and AC waveforms, without requiring any other technology.

Specification	3.2 W Signal Generator
Frequency Range	0.001 to 100 kHz, with 0.001 Hz resolution
Amplitude Range	±8 V
Resolution	3.9 mV, 12-bit DAC
Max Output Current	400 mA at 8 V, with over-current detection
Waveforms	Sine, triangle, square wave, positive and negative ramps, and DC
Other Relevant Information	• Selectable voltage limit • Selectable DC offset • Frequency sweep function

550 Universal Interface
UI-5001

▲ Required:
PASCO Capstone Software (see pages 4-5)
OR
SPARKvue Software (go to pasco.com)

Wired Sensors

PASPORT Absolute Pressure Sensor

PS-2107

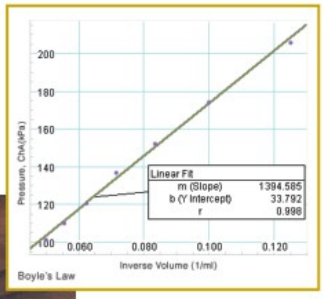
The Absolute Pressure Sensor measures the gas pressure in a container or the surrounding environment. Includes a 20 cc syringe and quick-connect tubing for investigating the gas laws. The sensor's wide range makes it an excellent general purpose pressure device.

Applications:

- Verify gas laws (Ideal, Charles', Boyle's)
- Study Vapor Pressure vs. Temperature

Specifications:

Range: 0 to 700 kPa
Accuracy: ±2 kPa
Resolution: 0.1 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.

PASPORT Dual Pressure Sensor

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.

Applications:

- Measure pressure in the Heat Engine (TD-8572).
- Measure pressure drops in pipes.

Specifications:

Maximum Sample Rate: 1000 Hz
Absolute Pressure: 0 to 200 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (displays pressure in kPa, N/m^2, and psi)
Differential Pressure: ±100 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (displays pressure in kPa, N/m^2, and psi)

PASPORT Absolute Pressure Sensor	PS-2107
PASPORT Dual Pressure Sensor	PS-2181

PASPORT Absolute Pressure/ Temperature Sensor

PS-2146

This combination sensor is specifically designed for studying the Ideal Gas Law. The included thermistor temperature probe has a fast response time and very low thermal mass.

Applications:

- Extrapolate absolute zero
- Explore gas laws (Ideal, Charles', Boyle's)

Measure the pressure and temperature of air in the sphere.

Specifications:

Pressure: 0 to 700 kPa with 2% accuracy, 0.5 kPa resolution (displays pressure in kPa, N/m^2, 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

PASPORT High Resolution Force Sensor

PS-2189

The PASPORT High Resolution Force Sensor offers a higher resolution than the PS-2104. It features a variable over-sampling rate that reduces measurement noise at lower sampling rates. The digital design minimizes drift, ensuring that the tare holds for hours. You can use this force sensor as a pan balance for long-term experiments, such as investigating the evaporation of liquids, like alcohol or liquid nitrogen, and the sublimation of dry ice.

Specifications:

Range: ±50 N
Measurement Resolution: 0.002 N
Zero (Tare) Function: Push-button
Max Sample Rate: 1000 Hz; 5000 Hz for the 550 and 850 interfaces
Force Overload Protection: Up to 75 N

PASPORT Absolute Pressure/ Temperature Sensor	PS-2146
Shown in use with:	
Absolute Zero Sphere	TD-8595
Ideal Gas Law Apparatus	TD-8596A
PASPORT High Resolution Force Sensor	PS-2189
Shown in use with:	
Mass and Hanger Set	ME-8979
IDS Spring Kit	ME-8999

Visit **pasco.com** to see our complete line of PASPORT Sensors.

PASPORT Displacement Sensor

PS-2204

The Displacement Sensor measures the travel of a spring-loaded indicator as a bridge is loaded with weight. The PASPORT Sensor plugs into the included Digital Indicator, which has its own digital LED readout and can be used as a standalone device. To record your data, simply plug the PASPORT sensor into an interface.

Specifications:

Maximum Travel: 10 mm

Maximum Sample Rate: 5 Hz

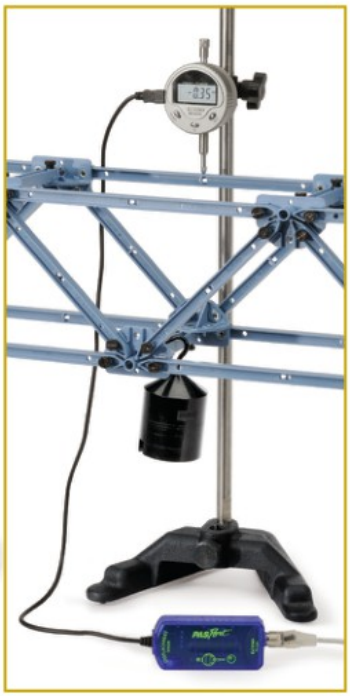
Resolution: 0.013 mm (0.0005 in)

Includes:

Sensor

Bracket

Dial Gauge



PASPORT Dual Load Cell Amplifier

PS-2205

Includes:

Dual Load Cell Amplifier

100 N Load Cell

PS-2206 Includes:

Load Cell Amplifier (2-port)

100 N Load Cell

	PASPORT Displacement Sensor	PS-2204
■	Shown in use with:	
	Hooked Mass Set	SE-8759
	Small "A" Base	ME-8976
	Stainless Steel Rod, 60 cm Threaded	ME-8977
	PASPORT Dual Load Cell Amplifier	PS-2205
	PASPORT Load Cell and Dual Amplifier Set	PS-2206

PASPORT Voltage-Current Sensor

PS-2115

The PASPORT Voltage-Current Sensor combines voltage and current sensors in one case. It can simultaneously measure voltage, current, and power, then display the collected data in the form of a digital display or graph. An audible beep can be heard when overload protection shuts down the sensor, alerting teachers and keeping students safe. The sensor will automatically reset after the high current is removed.

Specifications:

Voltage Range: ±10 V

Voltage Resolution: 0.005 V

Current Range: ±1 A

Current Resolution: 0.5 mA

Current Channel Series Resistance: 0.6 ohms, < 0.9 ohms at room temperature

Maximum Common Mode Voltage: 10 V

Maximum Sample Rate: 1000 samples/sec

Voltage Input Impedance: 2 MΩ

PASPORT High Current Sensor

PS-2193

The High Current Sensor has a low (0.01 Ω) 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: ±10 A, resolution of 0.5 mA

Sensing Element Series Resistance: 0.01 Ω

Maximum Common Mode Voltage: 10 V

Maximum Continuous Current Without Damage: 12 A

Maximum Continuous Overvoltage Without Damage: ±40 V

Maximum Sample Rate: 1000 samples/second

	PASPORT Voltage-Current Sensor	PS-2115
●	Recommended:	
	Alligator Clip Leads (Set of 10)	EM-8634
	PASPORT High Current Sensor	PS-2193
●	Recommended:	
	Capacitor (0.025 F, 2 Pack)	EM-8632
	Knife Switches	EM-8815
	Air Core Solenoid	SE-7585

Wired Sensors

For High Speed Sampling with the 550/850 Interfaces

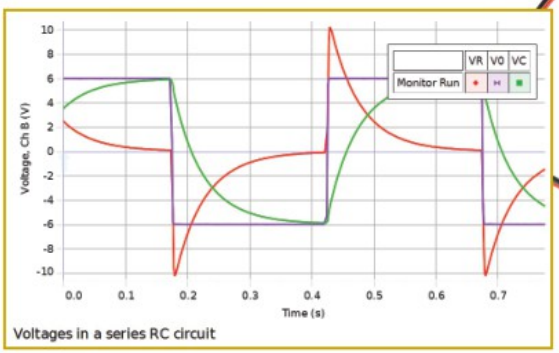
Voltage Sensor UI-5100/UI-5110

Current Probe PS-2184

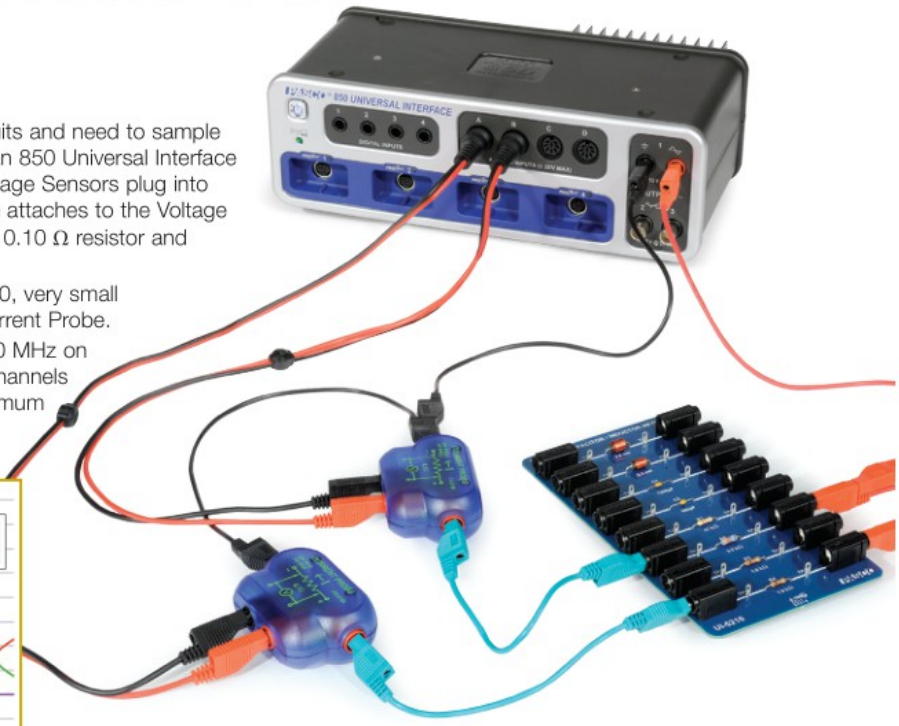
When you're measuring voltage and current in AC circuits and need to sample fast, these sensors can sample as fast as 10 MHz on an 850 Universal Interface and up to 2 MHz on a 550 Universal Interface. The Voltage Sensors plug into the analog ports of these interfaces. The Current Probe attaches to the Voltage Sensor to measure the voltage drop across a precision 0.10 Ω resistor and outputs the resultant current calculation.

Since the 850 Interface analog gain can be set to x1000, very small currents (0.024 mA resolution) can be read with the Current Probe.

The 850 Universal Interface can measure at a rate of 10 MHz on two channels simultaneously; 1 MHz on three or four channels simultaneously. The 550 Universal Interface has a maximum sample rate of 2 MHz on one channel; 1 MHz on two channels simultaneously.



Voltages in a series RC circuit



The high speed of the 850 Universal Interface, in Scope Mode, allows the examination of time varying voltages in an RC circuit to verify that Kirchhoff's loop theorem holds even when voltage is not constant.

Voltage Sensor

UI-5100 (unshrouded)
UI-5110 (shrouded)

This voltage sensor plugs into any analog channel on a Science-Workshop Interface, the 850 Universal Interface, and the 550 Universal Interface. The voltage range and frequency response depend on the interface. When the Voltage Sensor is plugged into either the 550 or 850 Universal Interface, the sensor is automatically recognized.

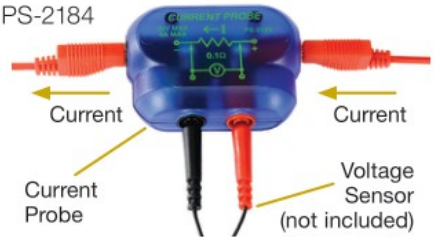
Specifications:

Voltage Range with 850 Interface: ±20 V AC/DC (850 Interface)
Voltage Range with Other Interface: ±10 V AC/DC (other than 850)
Product Pin Configuration: 8-pin DIN plug. Probe ends are standard banana plugs. Two alligator clip adapters included.

Voltage Sensor (unshrouded)	UI-5100
Voltage Sensor (shrouded)	UI-5110

Current Probe

PS-2184



The PS-2184 attaches to any 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.

Specifications:

Resistor: 0.10 Ohm, 3.0 W, 1.0%
Maximum Current: 4 A
Maximum Voltage Without Damage: 30 V
Terminals: 4 mm Banana Jacks
Maximum Sample Rate: Depends on interface

Current Probe	PS-2184

Current Sensor

CI-6556

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.

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
Pin Configuration: 5-pin DIN on box
*DC or AC RMS (root mean square)

Current Sensor	CI-6556

Visit **pasco.com** to see our complete line of ScienceWorkshop Sensors.

The PASCO Promise of Learning (90-day Satisfaction Guarantee)

We are confident that PASCO solutions will help your students achieve more in science. Within the first 90 days, if you are not satisfied that your students are more engaged and learning more effectively, return your purchase for a refund. We don't want you spending precious budget dollars on something you don't use. (We are sorry but we must exclude non-PASCO software that has been opened, radioactive products and products that contain perishables.) See instructions for Returns below.

PASCO 5-Year Limited Warranty for Education

PASCO products are built to survive. PASCO-manufactured products are covered by a limited warranty for a period of 5 years from delivery date against defects in material and workmanship. This warranty is valid for educational institution customers and only for educational use of these products. The PASCO warranty does not extend to any product, including touch screens, which have been subject to abuse, neglect, accident, improper installation or application, or products that have been repaired or altered outside of our factory. Consumables and limited-life products (such as pH probes, membranes, fast response temperature probes, batteries, chemical solutions, some light sources, printed materials, etc.) are excluded.

Other Warranty Terms

The SPARK LXi2 datalogger carries a limited warranty for a period of 3 years from delivery date against defects in material and workmanship. This limited warranty applies only to hardware components of the SPARK LXi2 that are not subject to accident, misuse, neglect, fire, or other external damage. This warranty can also be voided by unauthorized use, alterations, or repair. This warranty is valid for education institution customers and only for educational use of these products.

Products manufactured by anyone other than PASCO are subject to the conditions of the warranty supplied by the manufacturer (generally 1 year). Additional warranty information on our products is available upon request.

Free Teacher and Technical Support

We want teachers to be successful with PASCO solutions. Please contact our support team with any questions via phone or email: +1 916-786-3800 or support@pasco.com. We are here to help.

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Shipping

Items in stock will normally be shipped in less than five working days from receipt of the order. Specific requests for air shipments or special carriers will be honored at an additional cost.

Returns

Please contact the authorized PASCO representative in your country for assistance in returning equipment for repair. PASCO's International Customer Service team can be reached at +1-916-786-3800 or at intlcustserv@pasco.com. Out-of-Warranty products must be shipped prepaid, door-to-door. Returns for credit or exchange must be in new condition and packaged in original shipping cartons or packaging sufficient to prevent damage during international transport.

Trademarks

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More Product Information

Designed for education. PASCO products are designed for education; they are not intended for use in graduate research or industry, and should not be used in any apparatus involved with life support, patient diagnosis, or industrial control.

PASCO reserves the right to change the specifications of any product without prior notice. If a product is no longer available, PASCO reserves the right to substitute a product of equal, or higher, value and functionality.

FCC

Where appropriate, electrical products are marked to indicate that they conform to Federal Communications Commission (FCC) standards. Most commonly, FCC Part 15, Class A.

CE MARK

Where appropriate, products carry the CE marking, which indicates that they conform to the applicable European standards. This almost exclusively applies to products that are designed to meet the following applicable directives:

2014/30/EU	EMC Directive
2014/35/EU	Low Voltage Directive
2015/863	RoHS3
2014/53/EU	Radio Equipment Directive

Other Regulations May Apply

Local, national, and international regulations may restrict the purchase, storage, transport, use or disposal of certain products such as chemicals, radioactive sources, and specialty products and wireless transmission devices. Please consult your local regulations to ensure compliance.

Unless Otherwise Specified:

– Operating Temperature Range: 0°C to 40°C (32°F to 104°F)
– Maximum Altitude (Operational): 10,000 feet
– Recommended Storage Temperature: 10°C to 27°C (50°F to 80°F)

Quality

PASCO scientific meets the highest quality standards, and our quality management system is registered to ISO 9001.

PASCO and the Environment

PASCO is committed to being in compliance with all laws and requirements in the countries in which our products are sold. PASCO is a responsible steward of the environment and as such, continually seeks to minimize the impact that our manufacturing, distribution, and consumption practices make on the planet's natural resources.

Miscellaneous

RoHS

European Union Restriction of Hazardous Substances. EU Directive 2015/863:

- All applicable electrical products supplied by PASCO to the EU meet the requirements as specified in the RoHS directive either by substance limits or by product exemptions.

EU WEEE

Waste Electrical and Electronic Equipment. EU Directive 2012/19/EC:

- All applicable products supplied by PASCO to the EU meet the requirements as specified in the WEEE directive and are marked with the WEEE symbol.

WEEE-Product End of Life Disposal Instructions (Reference):

Electronic products are subject to disposal and recycling regulations that vary by country and region. It is a user's responsibility to recycle electronic equipment per local environmental laws and regulations to ensure that equipment is recycled in a manner that protects human health and the environment. To find equipment recycling drop-off locations, please contact your local waste recycle/disposal service or the product representative.

The European Union (EU) WEEE (Waste Electrical and Electronic Equipment) symbol on our products and packaging indicates that this product must not be disposed of in a standard waste container.

EU REACH

Registration, Evaluation and Authorization of Chemicals:

- PASCO has reviewed the REACH SVHC list and, according to our current knowledge, cables supplied with some products may contain certain phthalate plasticizers at greater than 0.1% by weight
- Regarding the other SVHC's, to the best of our knowledge, none are present in PASCO products (articles) at concentrations of greater than 0.1% by weight

Battery Replacement and Disposal Instructions (Reference):

Batteries contain chemicals that, if released, may affect the environment and human health. Batteries should be collected separately for recycling, and recycled at a local hazardous material disposal location adhering to your country and local government regulations. To find a battery recycling drop-off location, please contact local waste disposal service or the product representative.

The battery or batteries used in PASCO products are marked with the European Union symbol for waste batteries that indicate the need for separate collection and recycling. For small batteries, the symbol is printed on the packaging.

EU Battery Directive

EU Directive 2006/66/EC on Waste Batteries:

- The European Union (EU) battery directive aims to reduce the environmental impact of waste batteries and accumulators.
- According to our specifications, all products supplied by PASCO scientific into the EU that contain batteries meet the battery directive requirements, and are marked with the battery symbol.

PASCO has been supporting educators in over 100 countries around the world since 1964.

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PASCO® STRUCTURES SYSTEM

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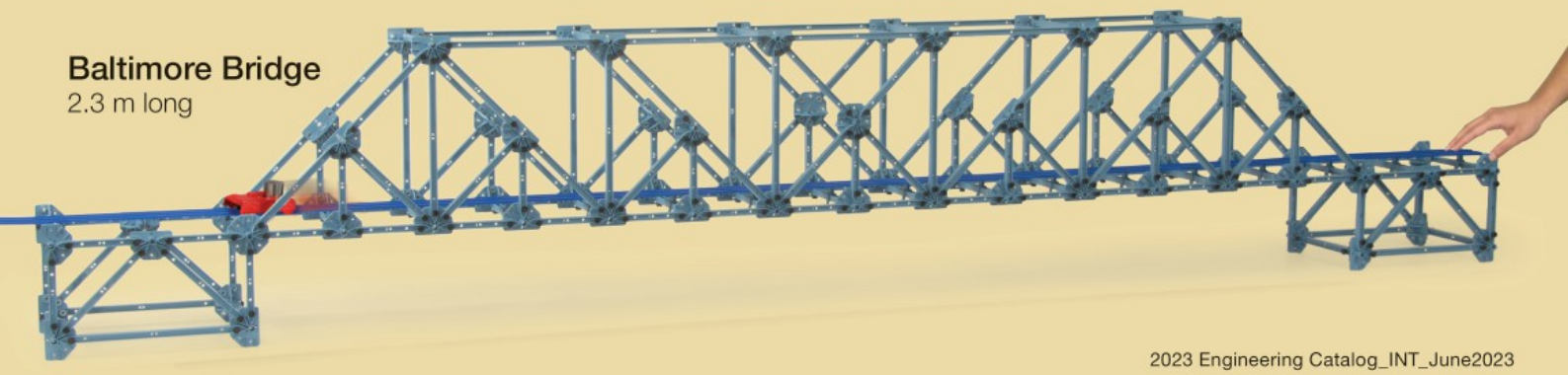
This bridge was constructed using the Bridge Set plus the Advanced Set.
See pages 8-13 for more information.



Baltimore Bridge
2.3 m long