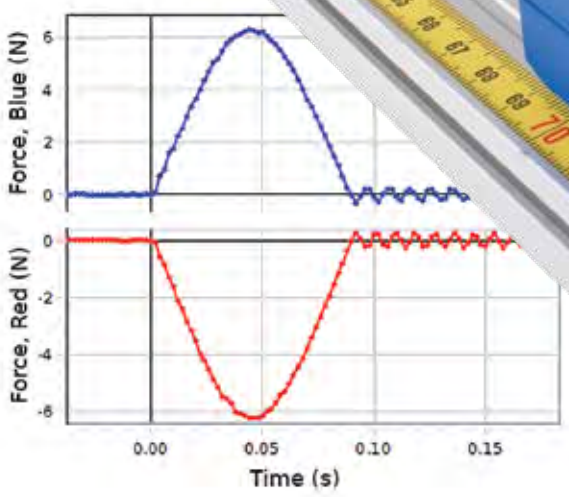
PASCO Physics 2018

PASCO's Wireless

Smart Cart

The best way to teach dynamics!

See page 2



See What's New!

Essential Physics
3rd Edition
(pages 14-15)

Hall Effect
(page 13)

Smart Fan
(page 3)

PASCO scientific

PASCO Wireless Smart Carts

Four built-in sensors, one low price, zero additional equipment

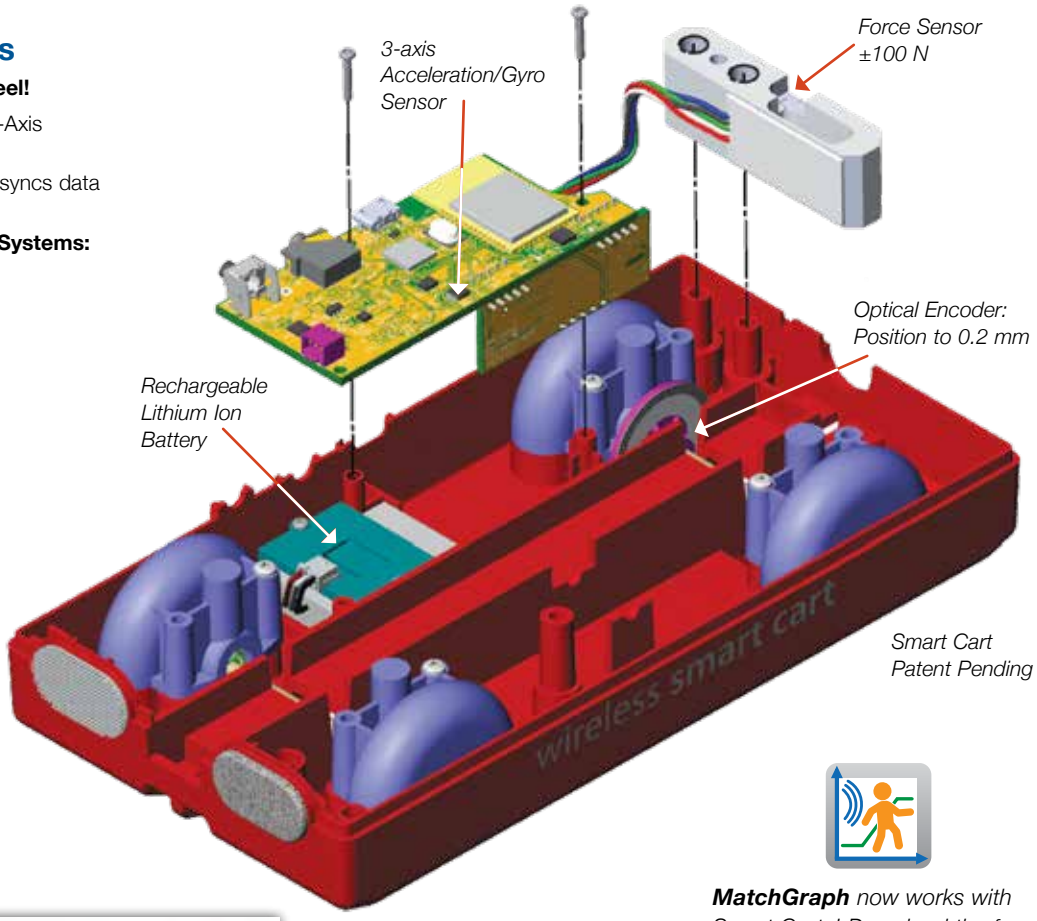
- Wirelessly measure position, velocity, acceleration (3-axis and resultant), rotation and force, either individually or simultaneously.
- Use on a tabletop or standard physics dynamics tracks.
- Wirelessly connect the Smart Cart to your laptop or tablet, and the built-in sensors will measure and transmit data.
- The Smart Cart is compatible with PASCO Capstone™ software for Mac® and Windows® computers; it also works with FREE SPARKvue® software for mobile devices.

It's what's inside that counts

- **Enclosed High-resolution Encoder Wheel!**
- **4 Embedded Sensors:** Force, Position, 3-Axis Acceleration, 3-Axis Gyroscope
- **Special Sync Technology:** Automatically syncs data from two Smart Carts to within 2 ms
- **Compatible with All PASCO Dynamics Systems:** Tracks, carts, and accessories
- **Ultra-low Friction:** Ball bearing wheels
- **Rugged Design:** Survives the drop test

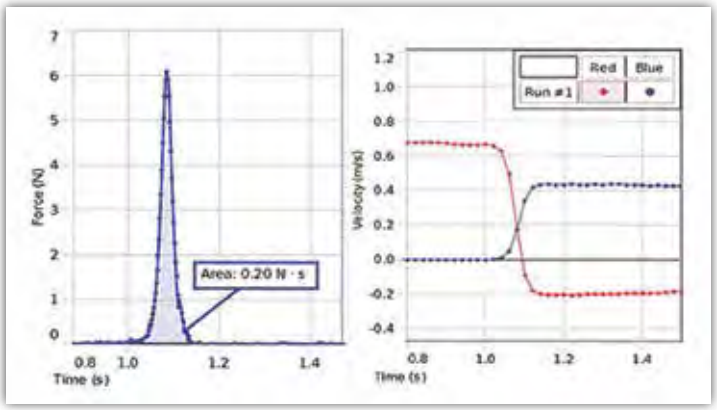
Specifications

- Position Resolution: 0.2 mm
- Maximum Velocity: ±3 m/s
- Force Range: ±100 N
- Force Resolution: 0.1 N
- Acceleration Range: ±16 g
- Maximum Sample Rate: 1000 Hz (one sensor)
- Spring Plunger: 3 settings
- Velcro Bumper & Magnetic Bumper
- Spring-loaded Retractable Wheels
- Rechargeable Li Battery
- Polycarbonate Body
- Cart Mass: 250 g



Smart Cart Patent Pending

***MatchGraph** now works with Smart Carts! Download the free app at* **pasco.com/downloads**



Smart Carts can be used to investigate impulse and collisions, as well as velocity and acceleration, motion graphs, Newton's Laws, conservation of momentum, conservation of energy, centripetal force and much more!

pasco.com/smartcart

Each Smart Cart includes:

Smart Cart, Magnetic Bumper, Rubber Bumper, Force Sensor Hook, and USB Charging Cable

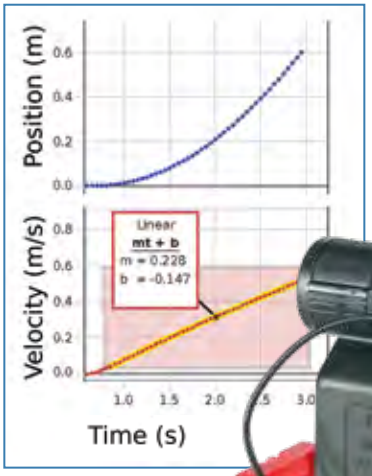
Order Information

Smart Cart – Red	ME-1240
Smart Cart – Blue	ME-1241
Recommended:	
Smart Cart Charging Garage	ME-1243
Cart Masses 250 g (set of 2)	ME-6757A

See p. 4

Smart Fan Accessory

- Complete Control Over Force for all Dynamics Experiments
- Remote Control of all Functions
- Sense and Control
- Manual Mode for Non-Smart Carts

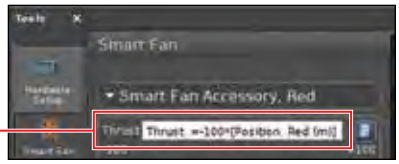


The Smart Fan Accessory becomes smart when plugged into a Smart Cart.

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



Thrust = -100*[Position]

This will cause the fan to blow harder as the cart moves down the track, causing the cart to reverse, and eventually the fan will reverse when the Position becomes negative, accelerating the cart in the positive direction.

This is the control panel for the Smart Fan in PASCO Capstone software.

Specifications

- Pushbutton for on/off: 3 speed settings
- Fits all PASCO dynamics carts
- Smart Cart required for extended Smart features
- Maximum Thrust: 0.2 N
- Uses 4 AA batteries (alkaline or rechargeable)
- Lithium Battery Performance: On medium speed, fan slows after 5.2 hrs and stops after 5.6 hrs.
- Alkaline Battery Performance: On medium speed, fan slows after 1 hr and stops after 8.9 hrs.
- PASCO Capstone software required for full feature set.
- SPARKvue software provides ON/OFF button and thrust slider.

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

Includes

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

Order Information

Smart Fan Accessory ME-1242

Requires:
Smart Cart or Dynamics Cart.....p. 2
PASCO Capstone Software .....p. 11

Suggested:
Battery Charger with
8 AA Rechargeable Batteries SE-3570

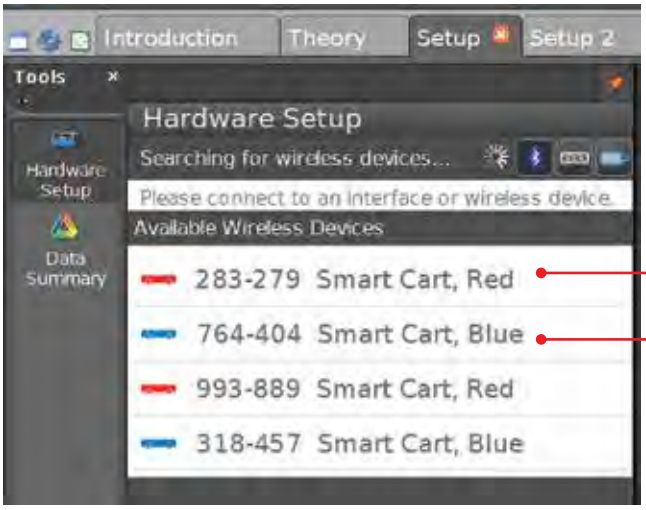
Smart Carts simplify lab management

Less equipment per lab station
makes lab setup simple: Smart Carts have all the equipment inside them!

The Smart Cart Charging Garage (ME-1243) is the perfect storage solution for your Smart Carts.

Store and charge your smart carts.
Smart Cart Charging Garage conveniently stores and charges up to five Smart Carts. It includes storage slots for the magnetic bumper, hook, and rubber bumpers. You can disconnect the garage from the wall power and carry the Smart Cart into the lab.

Easily identify and pair your carts.
Proximity detection and in-app pairing of Smart Carts let students find their carts at the top of the list. You don't have to sort through every Bluetooth® device in the room because PASCO Capstone™ and SPARKvue® software only display PASCO sensors. The closer the sensor is to your computer, the higher it is on the list.



These belong to my group.

Order Information

Smart Cart Charging Garage ME-1243
PASCO Capstone Software
Single User License (Mac/Windows) .....see page 11

SPARKvue® software is FREE for mobile devices and Chromebook™. Download at pasco.com/downloads

Configure your Smart Cart Dynamics System

5 Easy Steps to Configure

1 Start with a Basic Smart Cart Dynamics System.

2 Select which type of track you want in the Basic System:

Plastic Track (1 m)

1.2 m Metal Track

2.2 m Metal Track

3 Add an Accessory Pack to upgrade the Basic System to the Standard System:

The Accessory Pack Includes:
Angle Indicator, Spring Kit,
Friction Block and Clamp-On Pulley

4 Select your system from this chart:

Smart Cart Systems	Plastic Track	1.2 m Metal Track	2.2 m Metal Track
Basic Systems	ME-5707	ME-5708	ME-5709
Standard Systems	ME-5717	ME-5718	ME-5719

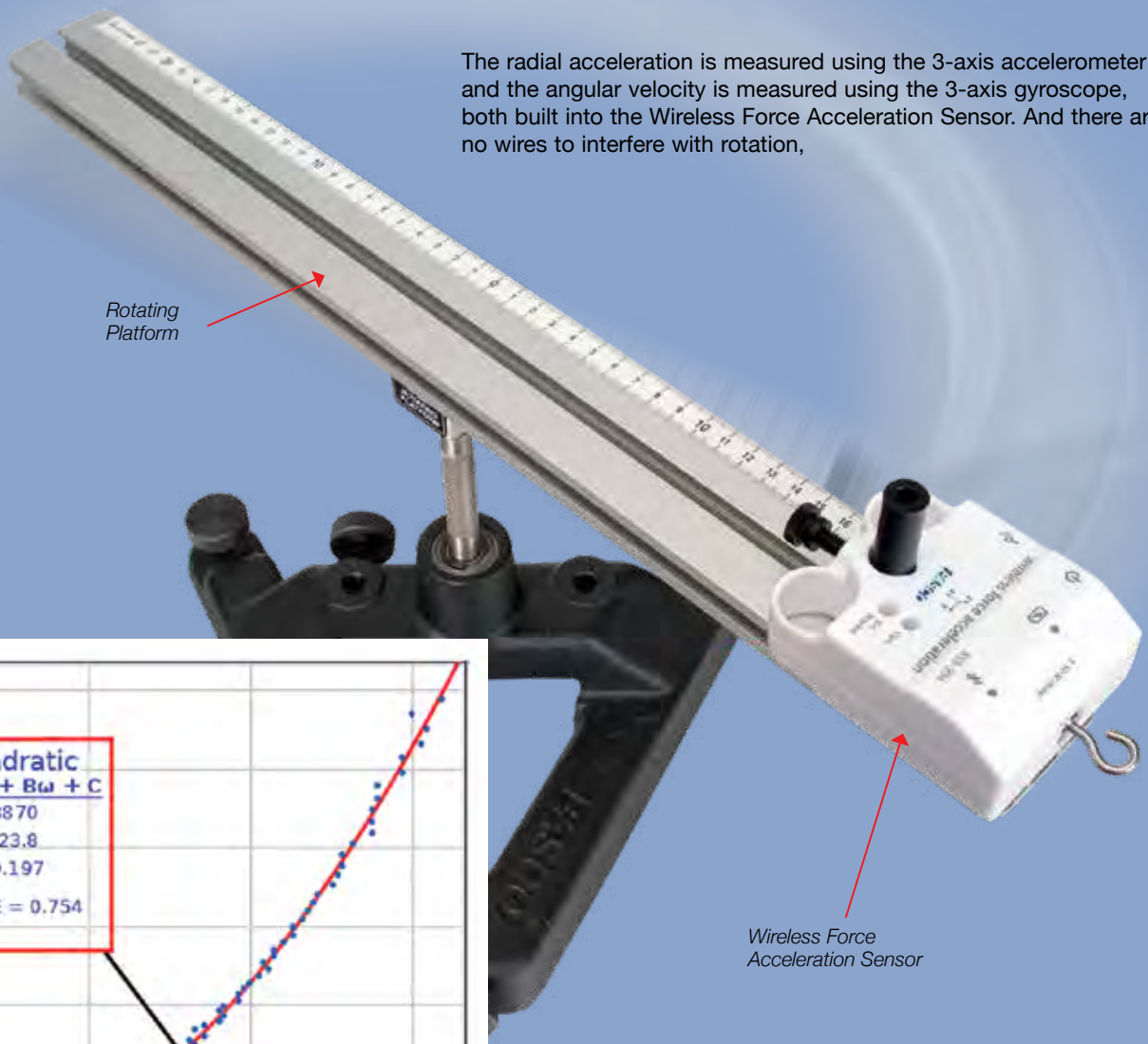
5 Download 8 free experiments at pasco.com/smartcart

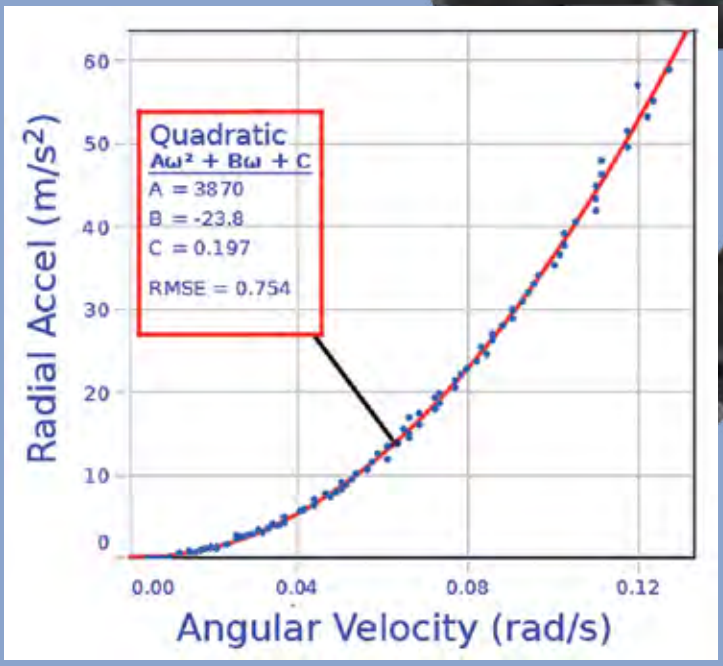
- Average Speed & Velocity
- Conservation of Energy
- Conservation of Momentum
- Graphical Analysis Motion
- Momentum & Explosions
- Momentum & Impulse
- Speed & Velocity Graphs
- Work & Kinetic Energy

Measure centripetal acceleration simply, directly, wirelessly.

Simply spin the Wireless Force Acceleration Sensor and record the radial acceleration as a function of the angular velocity as the rotator spins down.

The radial acceleration is measured using the 3-axis accelerometer and the angular velocity is measured using the 3-axis gyroscope, both built into the Wireless Force Acceleration Sensor. And there are no wires to interfere with rotation,





This PASCO Capstone graph shows that the centripetal acceleration depends on the square of the angular velocity.

Order Information

Wireless Force Acceleration Sensor	PS-3202
PASCO Capstone Software Single License	UI-5401
Shown in use with:	
Rotating Platform	ME-8951
Wireless Centripetal Force Accessory *(Contains post to attach force sensor)*	ME-8094

No interface No wires No problems

Why are PASCO Wireless Sensors the choice of so many schools?

In-app Pairing with Proximity Detection

Wirelessly connect to the sensors directly within the application (Capstone/SPARKvue) without any confusing setup in your operating system. Each lab group sees their own sensors at the top of the pairing list as the software detects which sensors are closest.

Bonus: Datalogging Capability

PASCO Wireless Sensors can collect long term data directly on the sensor without being connected to a computer. The next time the sensor is connected to a computer running PASCO software, it will prompt you to upload the data that was gathered.

Wireless Temperature

PS-3201

- Stainless steel probe
- Range: -40°C to 125°C

winner! 2016 AWARDS OF EXCELLENCE TECH & LEARNING

Wireless Pressure

PS-3203

- Maximum pressure 400 kPa
- Rechargeable battery

Wireless Voltage

PS-3211

- Bluetooth® or USB
- Maximum voltage 15 V
- Banana-clip Cables

Wireless Current

PS-3212

- Bluetooth® or USB
- Two current scales: ±0.1 A; ±1 A
- Banana-clip Cables

Wireless Light

PS-3213

- Measures red, green, blue, and white light
- Measures infrared and ultraviolet
- Measures ambient light in lux

Wireless Light (Back view)

Make any sensor wireless!

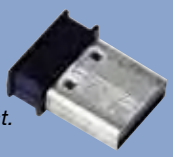
AirLink

PS-3200

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

USB Bluetooth® 4.0 Adapter

PS-3500

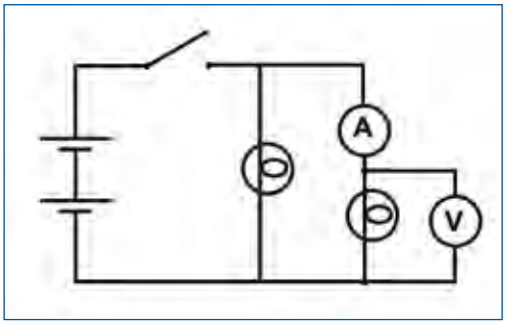


PASCO offers the PS-3500 USB Bluetooth® Adapter for computing devices that do not support direct-connect. Please go to pasco.com/compatibility to determine your direct-connect compatibility.

Modular Circuits

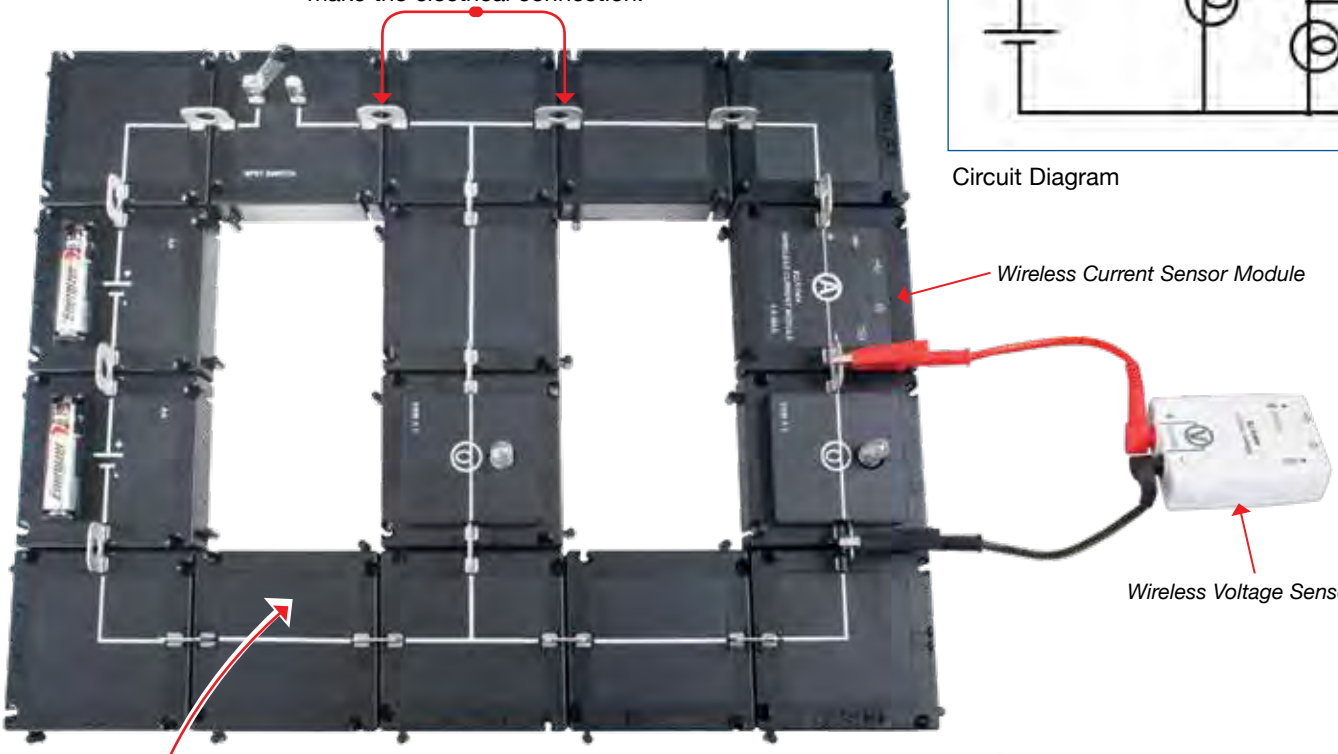
Build circuits that look like circuit diagrams.

- Easy to wire
- Easy to understand



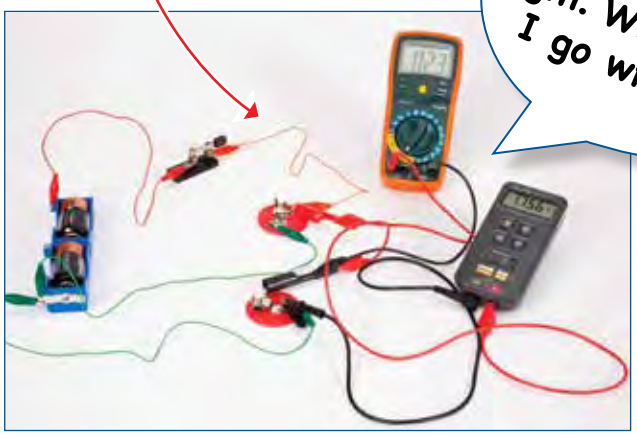
Circuit Diagram

Students insert metal tabs to make the electrical connection.



Believe it or not, these two circuits are the same.

Which would be easier for your students to understand?



PASCO Capstone software displays the voltage and current measured using wireless sensors. See page 11.

No confusing tangle of wires!

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

- The Wireless Current Sensor is a module, so it naturally fits in series with other circuit components.
- The Wireless Current Sensor Module doesn't have extra wires going to an interface, so students see clearly where the current goes.

Two Modular Circuits Kits Are Available

The Basic Modular Circuits Kit includes the modules required to investigate basic circuits. It does not include sensors and activities can be performed either with the use of a multimeter or by adding sensors. The *Essential Physics* Modular Circuits Kit includes more modules, allowing for a greater variety of activities and includes the Wireless Voltage Sensor and the Wireless Current Sensor Module.

Included in each kit

Module	Basic EM-3535	Essential EM-3536
Corner Wire Module	4	4
Straight Wire Module	4	5
Tee Module	2	2
Spring Module	1	1
Switch Module, SPDT	1	1
Switch Module, SPST	1	1
Resistor Modules:		
10 Ω	0	1
33 Ω	1	1
100 Ω	1	1
Capacitor Module	1	1
Light Bulb Module	2	3
Potentiometer Module	0	1
Motor Module	0	1
LED Module	0	1
1000 Turn Coil Module	0	1
Battery Holder Module	2	2
Battery, AA	2	2
Jumper Clips	30	45
Diode	1	1
Leaded Resistors	4	6
Leaded Capacitors	2	2
Magnets (0.45" x 0.25")	0	8
Plotting Compass	0	1
Alligator Clip Jumper Wire	0	1
EM-3534 Current Sensor Module	0	1
PS-3211 Wireless Voltage Sensor	0	1
Gratnells® Storage Tray	1	1

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

Each kit comes in a Gratnells® case with trays that organize the modules.

Order Information

Basic Modular Circuits Kit EM-3535
Essential Physics Modular Circuits Kit EM-3536
Required for EM-3536:
PASCO Capstone Software
Single License ..... see page 11
Also available separately:
Wireless Current Sensor Module EM-3534
Wireless Voltage Sensor..... PS-3211

The 550 and 850 Universal Interfaces:
Instrumentation for everything you do in physics labs

- Collect data from sensors
- Power circuits and speakers
- Replace oscilloscopes, signal generators, and power supplies with one device

550 or 850:
Which is better for your lab?

The 550 Universal Interface is the economical choice. It has six sensor ports and enough AC/DC power for circuits. It can also be connected to mobile devices through Bluetooth®.

The 850 Universal Interface has 12 sensor ports and high enough power output for speakers and mechanical drivers. It has two high frequency signal generators for LRC circuits. The voltage sensors have a higher range and higher gain. The 850 is the ultimate interface for physics.

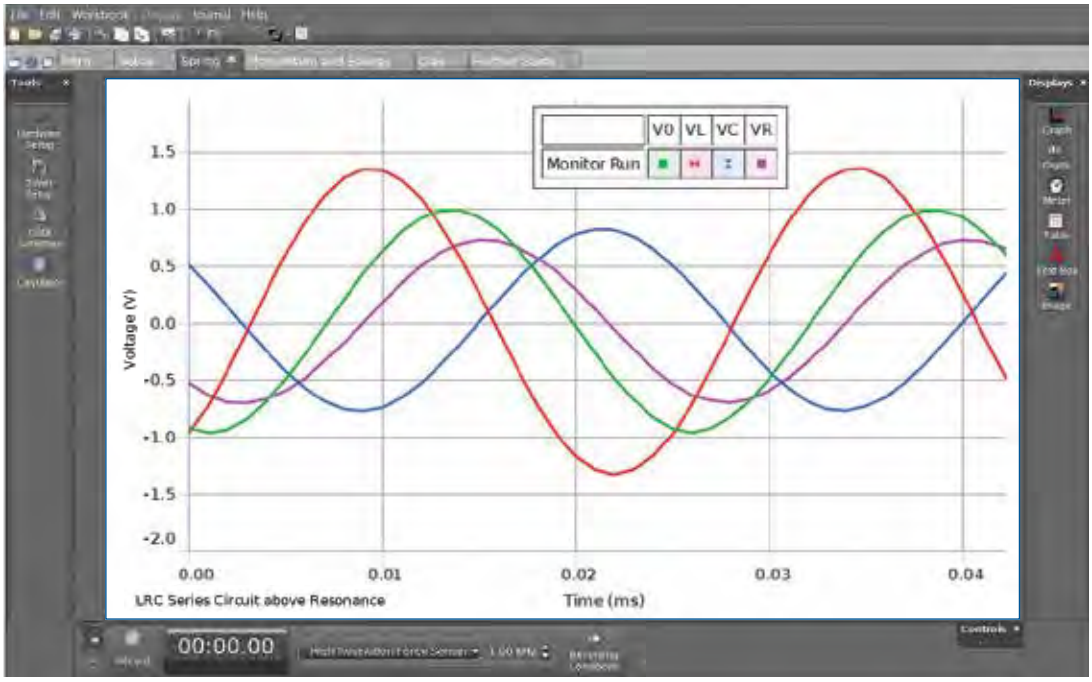
Order Information

550 Universal Interface UI-5001
850 Universal Interface UI-5000

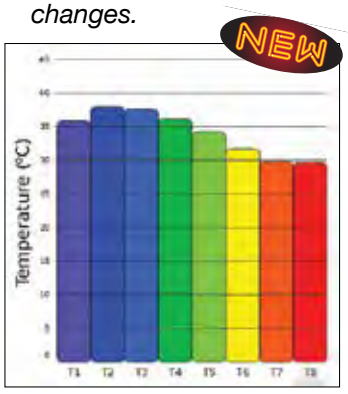
Feature	550	850
Wireless Connectivity	Bluetooth	No
Digital Photogate Ports	2	4
Analog Input Voltage Range	±10 V	±20 V
PASPORT Sensor Ports	2	4
Analog Sensor Ports	2	4
Selectable Voltage Gain	x1, x10, x100	x1, x10, x100, x1000
Resolution	14-bit, 1.22 mV	14-bit, 2.44 mV
Input Impedance	1 MΩ	1 MΩ
Signal Generators:	1	3
Signal Generator #1	±8 V @ 400 mA	±15 V @ 1 A
Resolution	3.9 mV, 12-bit DAC	7.3 mV, 12-bit DAC
Frequency Range	1 mHz to 100 kHz	1 mHz to 100 kHz
Frequency Resolution	1 mHz	1 mHz
High Freq. Signal Generators #2 & #3	-	±10 V @ 50 mA
Resolution	-	4.88 mV, 12-bit DAC
Frequency Range	-	1 mHz to 500 kHz
Resolution	-	1 mHz
Trigger Out	No	Yes
44 pin I/O Expansion Port	No	Yes
Compatible with SPARKvue	Yes	No
Compatible with Capstone	Yes	Yes

PASCO capstone™

Designed specifically to collect, display, and analyze data in physics and engineering labs



- Site license includes student home use
- For Mac® and Windows®
- ***New*** Bar Meter: *Bars go up and down as the measurement value changes.*



PASCO Capstone Basic Features

Sensors

- *Auto-ID sensors are recognized when they are plugged in (or identified through Bluetooth®)*
- *Works with PASPORT, ScienceWorkshop, and new Wireless sensors*
- *In-app pairing of wireless sensors makes it easy to pick wireless sensors by proximity*
- *Pre-configured photogate timer*

Workbook Format

- *Basic displays include graph, table, digits, meter, bar meter, oscilloscope, text box, picture.*
- *Make multiple pages with instructions and embedded live graphs.*
- *Collect data and display it in real time.*
- *Play back data in real time or slow or high speed.*
- *Enter data manually: easy setup in a table.*
- *Layout displays with smart guidelines.*
- *Create a Journal by taking snapshots of pages or displays.*
- *Copy and paste displays into documents.*
- *Made a mistake? Just hit the Undo button.*

Graphs

- *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.*

PASCO Capstone Advanced Features

Sensors & Signal Generators

- *Calibration wizard for sensors steps you through the calibration process.*
- *Create your own timers for photogates.*
- *Configure signal generators with DC offset.*
- *Scan through a range of frequencies.*
- *Control the output with a calculation.*

Data Collection Modes

- *Strip chart mode*
- *Start and stop conditions on time and sensor measurements*
- *FFT and oscilloscope*
- *Histogram*
- *Manual data collection: keep sensor data points with click of button.*
- *Analyze video and display velocity and acceleration vectors on the video.*
- *Sync movies with sensor data.*

Data Analysis

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

Download the Free Trial

pasco.com/Capstone

Order Information

PASCO Capstone Software

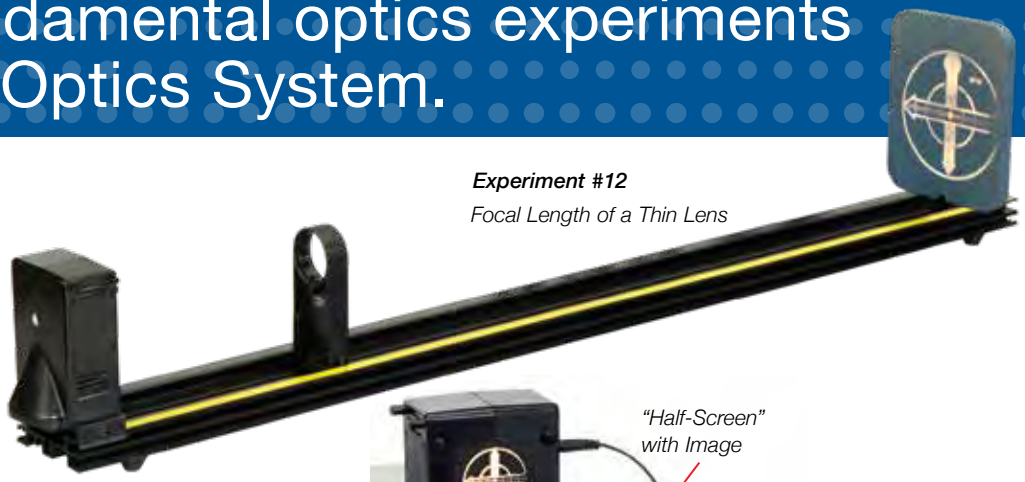
Single User License..... UI-5401

College/University Department License..... UI-5406
(includes student home use)

K-12 Campus License
(includes student home use)..... UI-5405

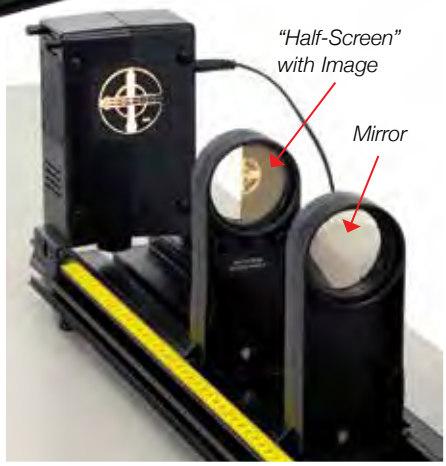
Perform 17 fundamental optics experiments with the Basic Optics System.

1. Color Addition
2. Prism
3. Reflection
4. Snell's Law
5. Total Internal Reflection
6. Convex and Concave Lenses
7. Hollow Lens
8. Lensmaker's Equation
9. Apparent Depth
10. Reversibility
11. Dispersion
12. Focal Length and Magnification of a Thin Lens
13. Focal Length and Magnification of a Concave Mirror
14. Virtual Images
15. Telescope
16. Microscope
17. Shadows



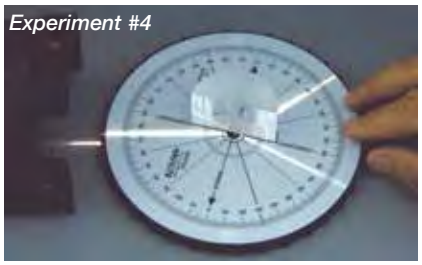
Experiment #12

Focal Length of a Thin Lens

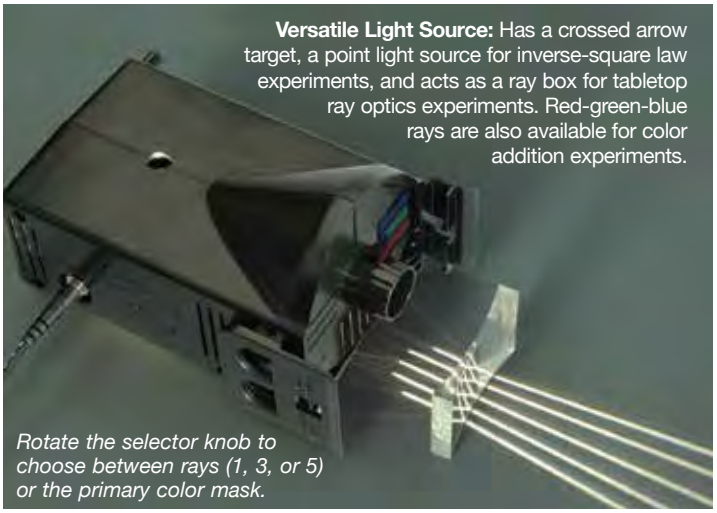


Experiment #13

Light Source: Has a lighted crossed arrow target with metric scale for focusing images through lenses or for use with the concave mirror.

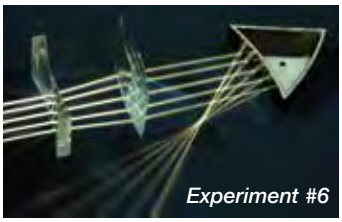


Ray Table in use showing both the reflected and refracted rays

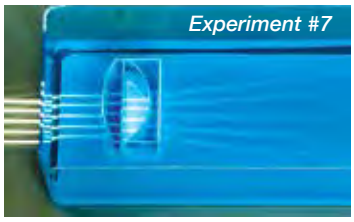


Versatile Light Source: Has a crossed arrow target, a point light source for inverse-square law experiments, and acts as a ray box for tabletop ray optics experiments. Red-green-blue rays are also available for color addition experiments.

Rotate the selector knob to choose between rays (1, 3, or 5) or the primary color mask.



Components from the Ray Optics Kit showing refraction and reflection



The storage tray is used to create a "hollow" air-filled convex lens. Note that the rays diverge.

Basic Optics System includes

- 1.2 m Optics Bench
- Basic Optics Light Source
- 50 mm diameter Glass Lenses in Holder +100 mm, -150 mm, +200 mm,+250 mm
- Adjustable Lens Holder
- Concave/Convex Mirror with Screen
- Ray Optics Kit
- Ray Table with D-shaped Lens
- Viewing Screen
- Storage Box
- Experiment Manual

Order Information

Basic Optics System.....OS-8515C

Accessory: Add Color to Your Basic Optics

The Color Mixer projects red, blue, and green circles that can be individually varied in brightness. Complete your exploration of color addition and subtraction with the color filter and color cards in the Color Mixer Accessory Kit.

OS-8496 includes

- Color Mixer
- Power Supply

OS-8495 includes

- 7 filter cards
- 11 printed color cards
- Manual with 9 lab activities

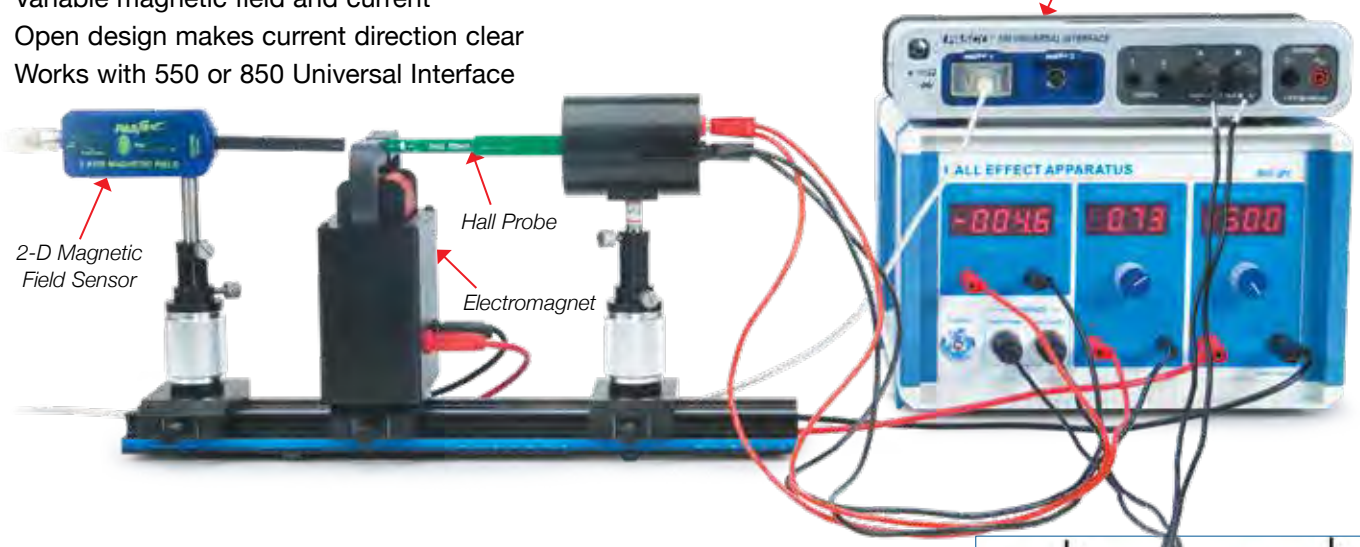
Order Information

Color Mixer.....OS-8496
Color Mixer Accessory Kit OS-8495

Hall Effect Apparatus (n-doped Germanium)

Now all physics labs can include this classic experiment!

- Variable magnetic field and current
- Open design makes current direction clear
- Works with 550 or 850 Universal Interface



The Hall Effect experiment (conducted by Edwin Hall in 1879) determines the sign of the charge carriers in current flow. A current can be thought of as a negative charge moving in one direction (Figure 1) or as a positive charge moving in the opposite direction (Figure 2). To determine which it actually is, the semiconductor is immersed in the magnetic field transverse to the direction of flow of current. The moving charge experiences a $\vec{qv}$ x $\vec{B}$ force, causing a charge build-up on one side of the semiconductor (creating an electric field), which in turn leads to a $\vec{qE}$ force. The direction of the electric field will depend on the sign of the charge carriers, and the polarity of the Hall voltage across the semiconductor reveals this sign.

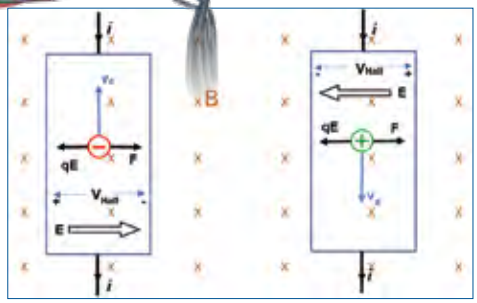
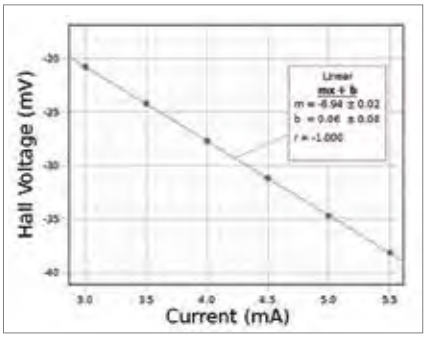


Figure 1 *Figure 2*

The directions of the current and the voltage probe are clearly marked on the probe that holds the semiconductor.

Using the 550 Universal Interface to record data, this plot of the Hall Voltage vs. the Current was made in PASCO Capstone software. In this case, the magnetic field was held constant and the current through the semiconductor was varied.



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Hall Effect Apparatus SE-7260

Note: This apparatus can be used manually by reading the digital displays. Measuring the magnetic field requires a sensor or other Tesla meter. This apparatus includes connector cables for an 850 or 550 Interface so data collection can be automated.

Required:

2-Axis Magnetic Field Sensor PS-2162

850 or 550 Universal Interface (see p. 10) ..... UI-5000 or UI-5001

PASCO Capstone Software (see p. 11)

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- Track End Stop (set of 2), ME-8971
- Super Pulley with Clamp, ME-9448B
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