

The Best Dynamics Systems in the World

PASCO introduced the first dynamics system in 1992... and we have been refining it ever since.

It all started with sturdy aluminum carts:

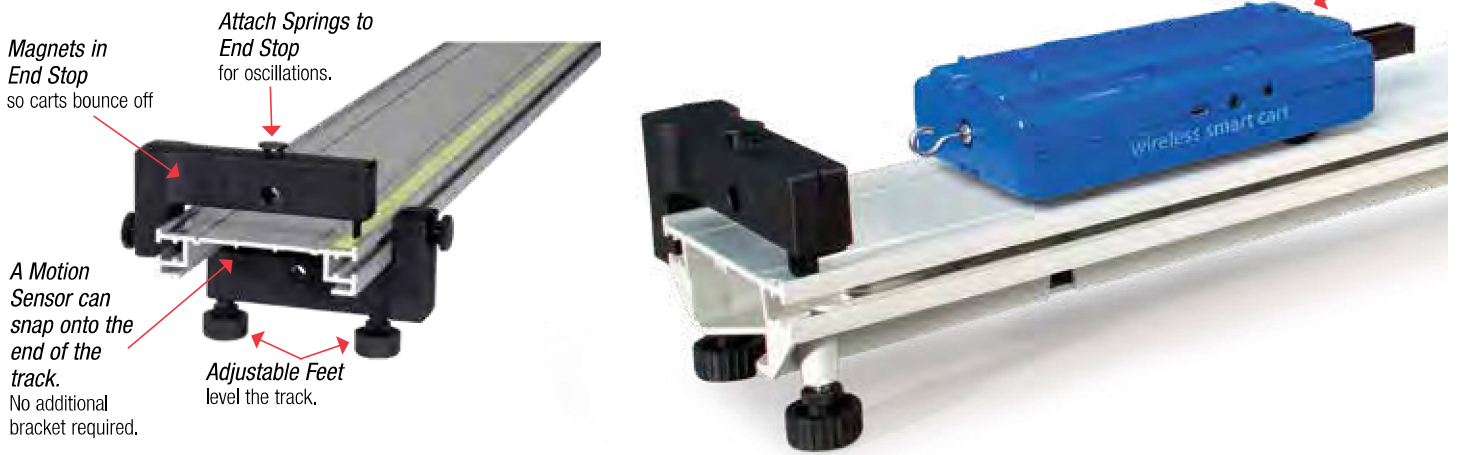


So little friction they will roll off the table if you set them down on their wheels, and so sturdy they will survive the fall!



Spring-loaded retractable wheels prevent damage and keep your students from skating on them.

Soon, we added an aluminum dynamics track to align collisions:



New technologies led to new innovations...

Plastic brought new possibilities:

- ▶ Durable lightweight PAScars
- ▶ Curved track for Conservation of Energy

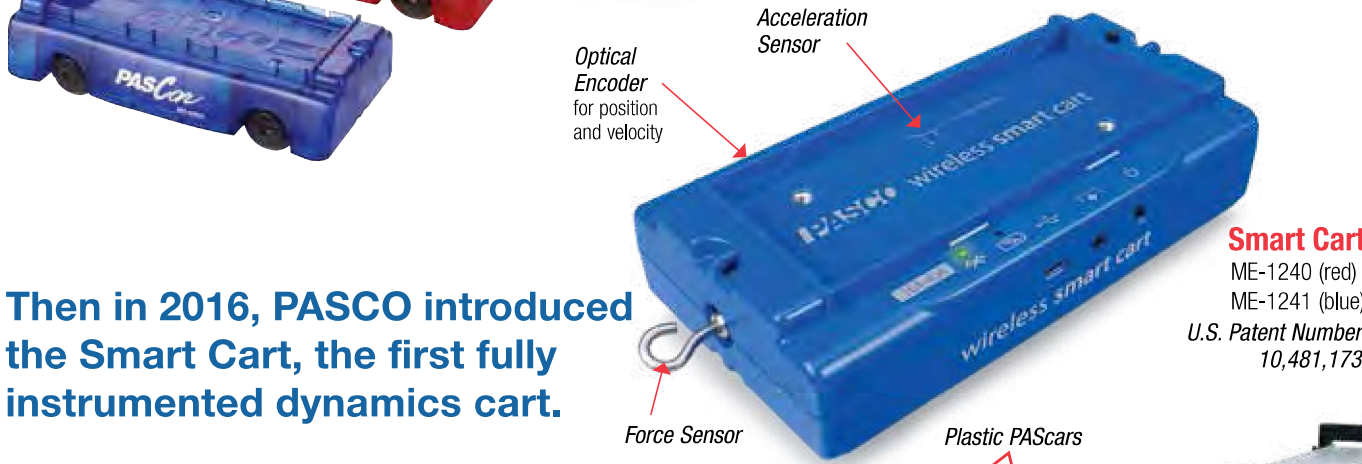


All accessories fit the plastic PATrack.

Plastic PAScars

Plastic PATrack with Curved Sections

Then in 2016, PASCO introduced the Smart Cart, the first fully instrumented dynamics cart.



Smart Cart
ME-1240 (red)
ME-1241 (blue)
U.S. Patent Number
10,481,173



Snap together individual sections to make a track as long as you want with PATrack.

Now, these three types of carts are compatible with both types of tracks, and there are many accessories to complete your lab.

See the next two pages to configure your dynamics system. 

How to choose the Dynamics System that's best for you:

1 Select the type of track you want.

Do you want metal or plastic tracks?



Metal Track Advantages

- ▶ Available in 1.2 m or 2.2 m lengths
- ▶ Straight and rigid
- ▶ Can do induced magnetic drag because it's conductive
- ▶ Feet can be placed at any position
- ▶ High-contrast scale



Plastic Track Advantages

- ▶ Can add tracks to make as long as you want
- ▶ Lightweight
- ▶ Can add curved track to do hills
- ▶ Built-in feet
- ▶ Storage: 1-meter track disassembles into two 50-cm parts
- ▶ Less expensive

2 Select the type of carts you want.

Do you want metal or plastic or Smart Carts?



Metal Cart Advantages

- ▶ Red and blue for distinguishing in collisions
- ▶ More inertia
- ▶ Sturdy body
- ▶ User-replaceable wheels



Plastic Cart Advantages

- ▶ Red and blue for distinguishing in collisions
- ▶ Least expensive
- ▶ Two string tie positions
- ▶ Plunger has a long throw.



Smart Cart Advantages

- ▶ Red and blue for distinguishing in collisions
- ▶ Completely instrumented with all the sensors you need for dynamics
- ▶ Two string tie positions
- ▶ Bluetooth 4.0 wireless: No interface required

3 Which system is best for you?

Basic System *Just Carts and Track*

Example shown:
ME-5705



OR

Standard System *Basic System + Accessory Pack*

Example shown:
ME-5715



Basic System includes

- ▶ Track
- ▶ 2 Carts
- ▶ 2 Feet
- ▶ 2 Endstops
- ▶ Rod Clamp
- ▶ 2 Mass Bars (4 with metal carts)
- ▶ Smart Cart Rod Stand Adapter*

	Plastic Track 1 m	Metal Track 1.2 m	Metal Track 2.2 m
Plastic Carts	ME-5701	ME-5702	ME-5703
Metal Carts	ME-5704	ME-5705	ME-5706
Smart Carts	ME-5707A	ME-5708A	ME-5709A

Standard System includes

- ▶ Track
- ▶ 2 Carts
- ▶ 2 Feet
- ▶ 2 Endstops
- ▶ Rod Clamp
- ▶ 2 Mass Bars (4 with metal carts)
- ▶ Spring Set
- ▶ Clamp-on Super Pulley
- ▶ Friction Block
- ▶ Angle Indicator
- ▶ Smart Cart Rod Stand Adapter*

	Plastic Track 1 m	Metal Track 1.2 m	Metal Track 2.2 m
Plastic Carts	ME-5711	ME-5712	ME-5713
Metal Carts	ME-5714	ME-5715	ME-5716
Smart Carts	ME-5717A	ME-5718A	ME-5719A

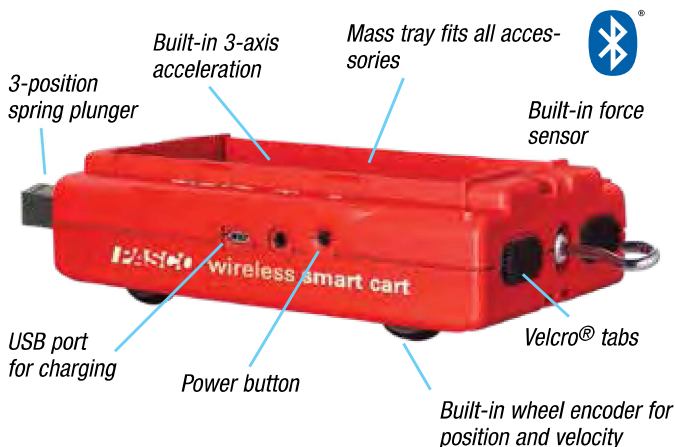
*Smart Cart Rod Stand Adapter is only included in ME-5707A, ME-5708A, ME-5709A, ME-5717A, ME-5718A, and ME-5719A.

How to measure motion and forces on your dynamics system:

If you have a Smart Cart Dynamics System, you don't need any other sensors or interfaces.

1. Smart Cart

The Smart Cart has built-in sensors that measure its position, velocity, acceleration, force, and angular velocity. So there is no need to add any other external sensors. It's ready to measure, right out of the box. No interface is required because it connects wirelessly to any computing device.



Smart Cart (blue) ME-1241 Smart Cart (red) ME-1240 (See page 108.)

2. PASCO Capstone Software

The site license includes student home use.



(See pages 72-75.)

Order Information

Smart Cart (red).....	ME-1240
Smart Cart (blue)	ME-1241
PASCO Capstone Software	
Single User License	UI-5401
Site License.....	UI-5400

OR

If you have any other system, you need:

1. Wireless Force Acceleration Sensor (one or two)

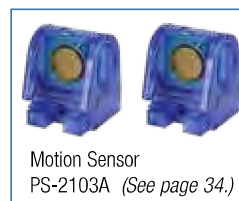
We recommend the Wireless Force Sensors because they can ride in the carts without the added friction of a cord. Although a wired force sensor can be used mounted to the end of the track to show impulse, if you want to show the forces between two carts, the wireless force sensors are required.



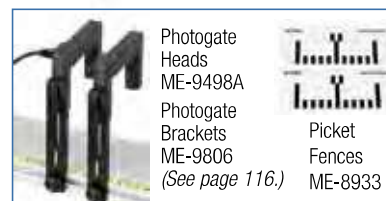
Wireless Force Acceleration Sensor PS-3202 (See page 11.)

2. Motion Sensors (2) OR Photogates (2)

Two Motion Sensors can track the velocity (speed and direction) of both carts throughout a collision for Conservation of Momentum experiments. Photogates have to be placed at just the right position to capture the before and after speeds.



Motion Sensor PS-2103A (See page 34.)



Photogate Heads ME-9498A
Photogate Brackets ME-9806 (See page 116.)
Picket Fences ME-8933

3. An interface for the Motion Sensors or Photogates (550 or 850 Interface)

The 550 is sufficient for most labs, but the 850 will meet every need, particularly college labs.



4. PASCO Capstone Software

The site license includes student home use.



(See pages 72-75.)

Order Information

Wireless Force Acceleration Sensor (order 1 or 2).....	PS-3202
Motion Sensor (order 2).....	PS-2103A
Photogate Head (order 2).....	ME-9498A
Photogate Brackets (2)	ME-9806
Smart Timer Picket Fences (2).....	ME-8933
550 Universal Interface (See p. 30)	UI-5001
OR	
850 Universal Interface (See p. 28)	UI-5000
PASCO Capstone Software	
Single User License	UI-5401
Site License.....	UI-5400

OR Without an Interface, you need:

OR With the traditional approach, you need:

1. Wireless Force Acceleration Sensor (one or two)

1. Wireless Force Acceleration Sensor (one or two)



Wireless Force Acceleration Sensor PS-3202 (See page 11.)



Wireless Force Acceleration Sensor PS-3202 (See page 11.)

2. Smart Timer with 2 Photogates

2. Tape Timer

The Smart Timer is battery-powered and very easy to just set out on the lab bench and get going. However, on days when you want to measure force, you will still need a separate computing device for the wireless force sensors.

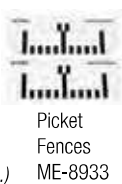
The Tape Timer gets you back to basics. Students measure the dots to get speed and plot speed vs. time to get acceleration. On days when you want to measure force, you will still need a separate computing device for the wireless force sensors.



Smart Timer ME-8930 (See page 124.)



Photogate Heads ME-9498A
Photogate Brackets ME-9806 (See page 116.)



Picket Fences ME-8933

Tape Timer Sensor ME-9283 (See page 127.)



3. PASCO Capstone Software

3. PASCO Capstone Software

The site license includes student home use. (See pages 72-75.)

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Order Information

Order Information

Smart Timer.....	ME-8930
<i>Includes two fences, 9 VAC adapter and manual.</i>	
Wireless Force Acceleration Sensor (order 1 or 2).....	PS-3202
Photogate Head (order 2).....	ME-9498A
Photogate Brackets (2)	ME-9806
PASCO Capstone Software	
Single User License	UI-5401
Site License.....	UI-5400

Tape Timer.....	ME-9283
<i>Includes one roll of paper, 10 carbon paper discs, battery and manual.</i>	
Wireless Force Acceleration Sensor (order 1 or 2).....	PS-3202
PASCO Capstone Software	
Single User License	UI-5401
Site License.....	UI-5400

Smart Gate

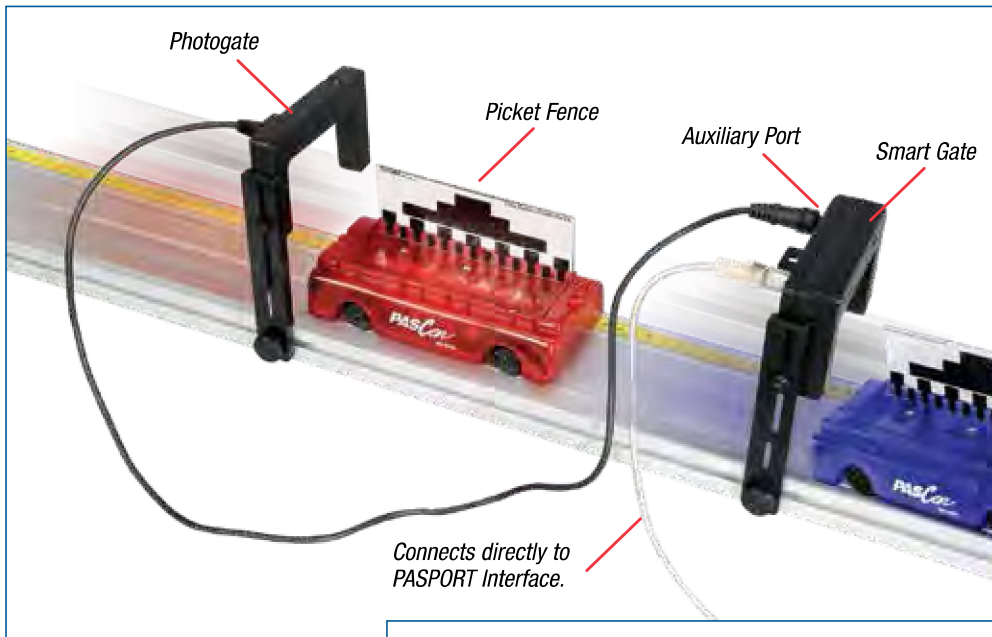
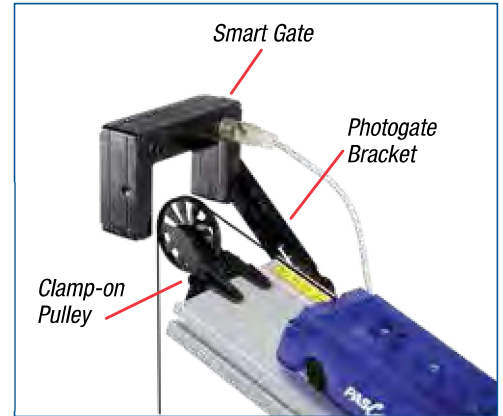
PS-2180

The Smart Gate connects directly to any PASPORT interface, and has an auxiliary port to daisy chain to an additional Photogate. Can be used with cart picket fence, clamp on super pulley, and flexible Photogate Tape.

Wireless Smart Gate

PS-3225

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



Smart Pulley

Use the Smart Gate and Photogate Bracket with the Clamp-on Super Pulley to create a "smart pulley."

Double Infrared Beams

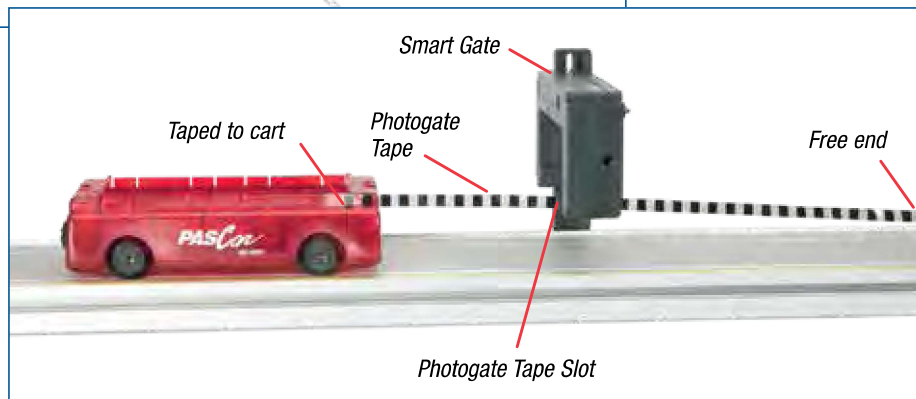
Using the double beam of the Smart Gate, the velocity of the cart can be determined accurately using the front edge of a single flag.

Auxiliary Port

A second photogate is connected to the Smart Gate Auxiliary Port so only one PASPORT port is required for two photogates.

Photogate Tape Slot

The Smart Gate has a special slot through which the Photogate Tape can be threaded. This creates an excellent way of measuring the speed of the cart the full distance of the track as the cart accelerates down the inclined track.



Includes

- Smart Gate
- PASPORT Cable



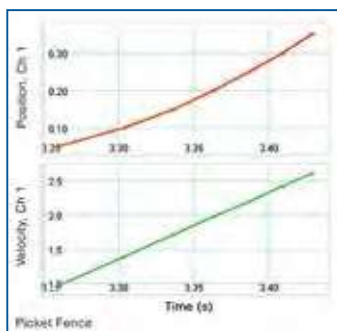
Order Information

Smart Gate	PS-2180	p. 44
Wireless Smart Gate	PS-3225	p. 10
<i>Recommended:</i>		
Photogate Head	ME-9498A	p. 45
High Resolution Photogate Tape.....	ME-6666	p. 46
Photogate Brackets (2)	ME-9806	p. 46
Cart Picket Fences (2).....	ME-9804	p. 46
Super Pulley with Clamp.....	ME-9448B	p. 194

Photogates and Fences

ME-9471A

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



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

Includes

- Photogate Heads (2)
- Photogate Brackets (2)
- Picket Fences (2)
- Super Pulley with attachment screw (attaches Super Pulley to Photogate)
- Pulley Mounting Rod



Order Information

Photogates and Fences.....	ME-9471A	
<i>Individual Components:</i>		
Photogate Head	ME-9498A	p. 45
Photogate Brackets (2)	ME-9806	
Cart Picket Fences (2).....	ME-9804	
Super Pulley	ME-9450A	p. 194
Pulley Mounting Rod.....	SA-9242	p. 194
<i>Required for use with PASPORT Interfaces:</i>		
Digital Adapter.....	PS-2159	p. 47

Cart Picket Fences (set of 2)

ME-9804



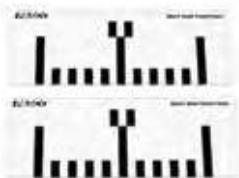
Order Information

Cart Picket Fences (set of 2).....	ME-9804
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Smart Timer Picket Fences (set of 2)

ME-8933

See Smart Timer on pages 124-125.



Order Information

Smart Timer Picket Fences (set of 2).....	ME-8933
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Photogate Brackets

ME-9806 (2)

- ▶ Attaches Photogates to PASCO Dynamics Tracks
- ▶ Easily Adjust Photogate Height

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



(Photogates not included.)

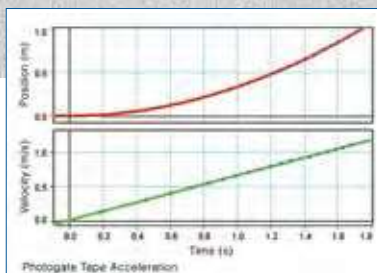
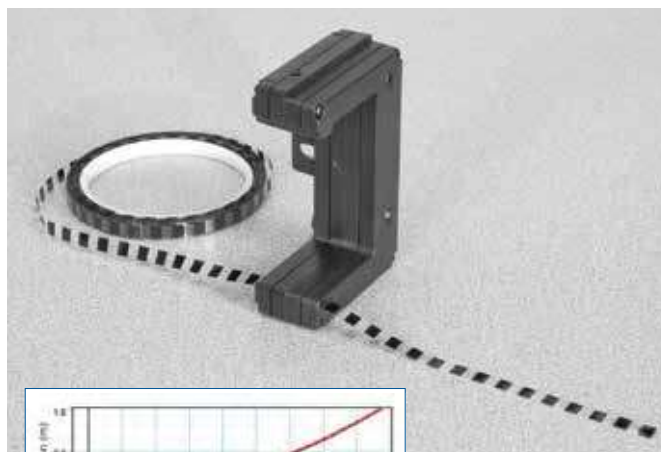
Order Information

Photogate Brackets (2)	ME-9806
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Photogate Tape

ME-6666

Flexible Mylar® picket fence tape can be cut to any length. Tape slides into a Smart Gate to more accurately measure the motion of a cart.



Photogate tape can be used as a picket fence "string" to continuously measure the motion of the cart.

Slide the photogate tape through the slot to measure position, velocity, and acceleration. The band spacing on the tape is 1 cm from edge to edge.

Order Information

High Resolution Photogate Tape.....	ME-6666	
<i>Required:</i>		
Smart Gate	PS-2180	p. 44
Wireless Smart Gate.....	PS-3225	p. 10

Wireless Smart Cart

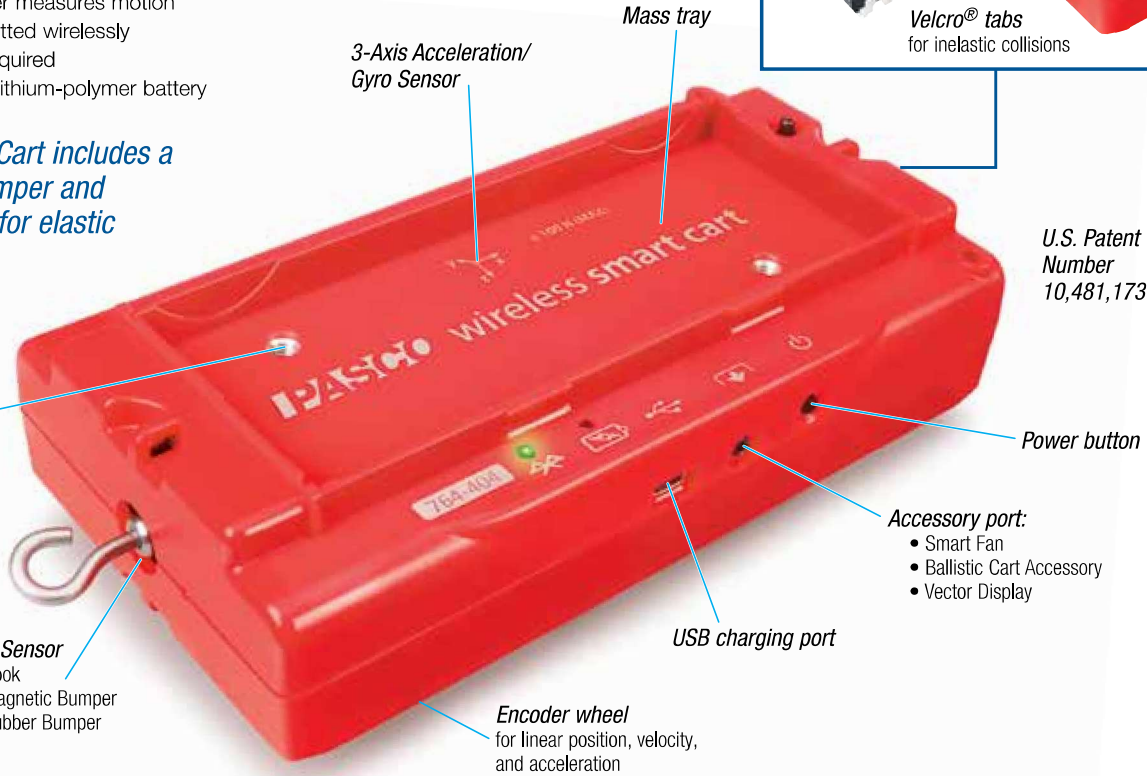
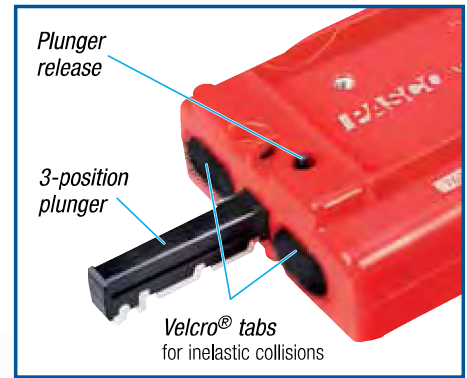


ME-1240 (red) ME-1241 (blue)

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

- ▶ Built-in force sensor (± 100 N)
- ▶ Built-in 3-D acceleration sensor (± 16 g)
- ▶ Optical encoder measures motion
- ▶ Data is transmitted wirelessly
- ▶ No interface required
- ▶ Rechargeable lithium-polymer battery

Every Smart Cart includes a magnetic bumper and Velcro® tabs for elastic and inelastic collisions!



U.S. Patent Number 10,481,173

Mounting threads for accessories

- Force Sensor**
- Hook
 - Magnetic Bumper
 - Rubber Bumper

Encoder wheel
for linear position, velocity, and acceleration

- Accessory port:**
- Smart Fan
 - Ballistic Cart Accessory
 - Vector Display

Imagine the possibilities...



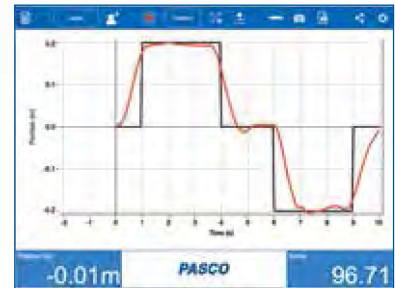
1. Measure cart velocity on a curved track where Motion Sensors cannot work because there is no straight line of sight.

2. Directly measure the tension in the string connected to the Smart Cart.

Hang a mass over a pulley, hold the cart in place, and then let go. When the cart is stationary, the tension is equal to the hanging weight. When the cart accelerates, the tension is less than the hanging weight.



3. Match Position and Velocity vs. Time graphs with FREE MatchGraph Software! pasco.com/downloads



4. Measure oscillations of a cart and spring.

Measure position, velocity, and acceleration of the cart, and force of the spring.



5. Place the cart on the floor or table.

Measure velocity as cart travels across the floor or table without a track.

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

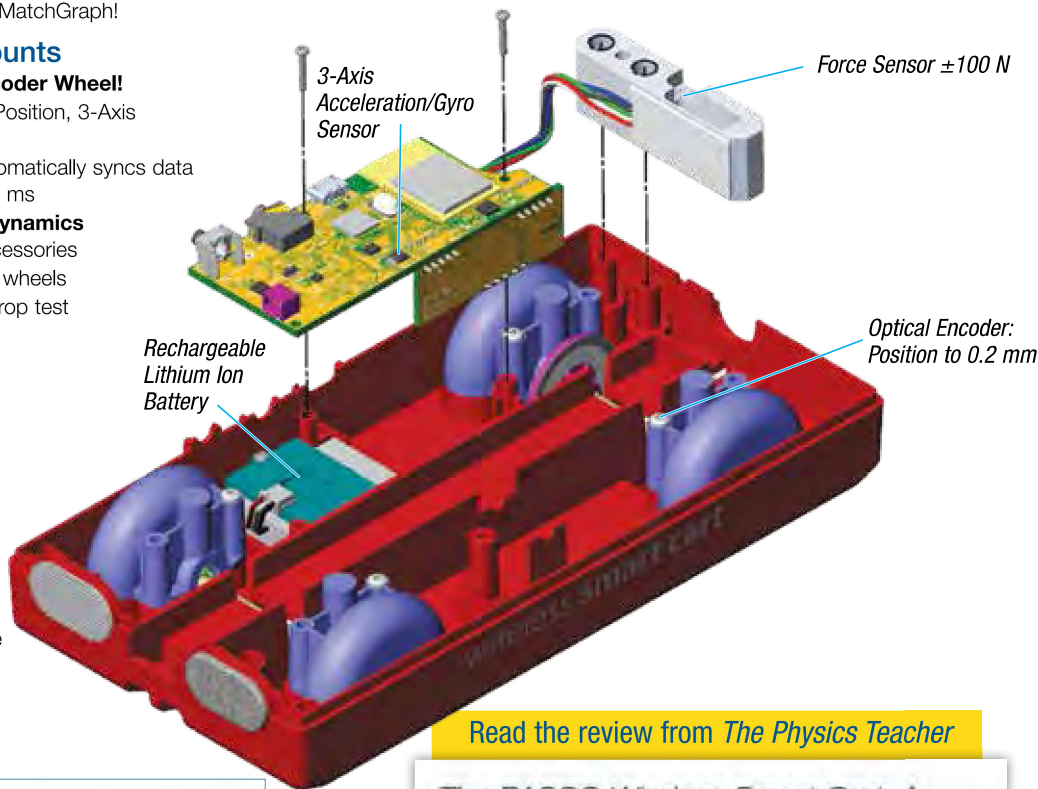
- ▶ Wirelessly measure position, velocity, acceleration (3-axis and resultant), rotation and force, either individually or simultaneously.
- ▶ Use on a tabletop or standard physics dynamics tracks.
- ▶ Wirelessly connect the Smart Cart to your laptop or tablet, and the built-in sensors will measure and 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 and MatchGraph!

It's what's inside that counts

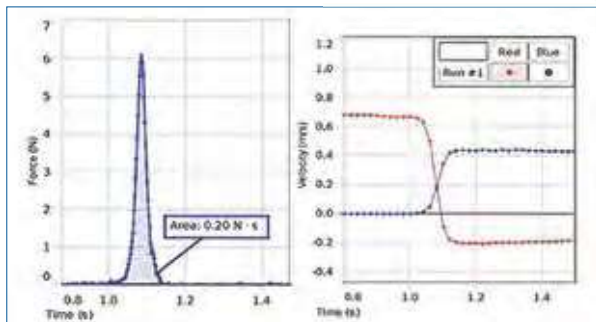
- ▶ **Enclosed High-resolution Encoder Wheel!**
- ▶ **4 Embedded Sensors:** Force, Position, 3-Axis Acceleration, 3-Axis Gyroscope
- ▶ **Special Sync Technology:** Automatically syncs data from two Smart Carts to within 2 ms
- ▶ **Compatible with All PASCO Dynamics Systems:** Tracks, carts, and accessories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

Specifications

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



Read the review from *The Physics Teacher*



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!



Go to pasco.com/smartcart

6. Use for collisions with two Smart Carts.

- Each cart measures its own velocity and force. Will students correctly predict the forces recorded by each cart for these parameters?
- ▶ Use equal masses and unequal masses.
 - ▶ Use the same spring bumpers on the Smart Cart force sensors and then change the spring on one Smart Cart to a weaker spring.



The magnetic bumper for the force sensor is included with the Smart Cart.

Each Smart Cart Includes

- Smart Cart
- Magnetic bumper
- Hook
- USB charging cable
- Rubber bumper



Order Information

Smart Cart (red).....	ME-1240	
Smart Cart (blue)	ME-1241	
<i>Recommended:</i>		
Smart Cart Charging Garage.....	ME-1243	p. 111
Cart Masses 250 g (set of 2)	ME-6757A	p. 113

Smart Cart Accessories

Smart Cart Vector Display

ME-1246

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

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

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



Vector display can mount vertically for classroom demonstrations.

The vector display can sit flat in a Smart Cart.



NEW

Order Information

Smart Cart Vector Display ME-1246
 Requires one of the following:
 Wireless Smart Cart..... ME-1240 (red) pp. 108-109
 Wireless Smart Cart..... ME-1241 (blue) pp. 108-109

Smart Ballistic Cart Accessory

ME-1245

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

Here is the OTHER newest accessory for the Smart Cart! When the cart is set in motion, the piston is released, projecting the ball upward out of the tube. Both the ball and the cart share the same horizontal velocity, which is unaffected by gravity. So when the ball falls back down, it lands back in the tube and does not get "left behind" by the cart. See page 118 for details.

- ▶ Launches projectiles over 50 cm.
- ▶ Has a software control panel similar to the Smart Fan.
- ▶ Reliably and repeatedly catches the projectile.
- ▶ USB rechargeable
- ▶ Leveling/aiming adjustment screws
- ▶ Works with Blockly coding in PASCO Capstone and SPARKvue.



Includes

- 2 Nylon Balls
- Conical Rubber Catcher
- Spring-loaded Piston
- Rechargeable Battery
- USB Cable



NEW

Order Information

Smart Ballistic Cart Accessory ME-1245

Smart Fan Accessory

ME-1242

U.S. Patent
Number 10,482,789

- ▶ Provides a Constant Force
- ▶ Hands-off Operation
- ▶ Sense and Control
- ▶ Manual Mode for Non-Smart Carts

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:

- Remotely start and stop the fan.
- Adjust the thrust.
- Reverse the spin of the fan.
- Do sense and control.

Works with



in PASCO Capstone and SPARKvue.



Specifications

- Push-button 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.

Includes

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



Order Information

Smart Fan Accessory ME-1242
Requires:
 Smart Cart or Dynamics Cart pp. 102-103
 PASCO Capstone Software pp. 72-74
Suggested:
 Battery Charger with 8 AA Rechargeable Batteries SE-3570

Smart Cart Charging Garage

ME-1243

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



Order Information

Smart Cart Charging Garage ME-1243

Smart Cart Rod Stand Adapter

ME-1244

This accessory allows the Smart Cart to be suspended from a rod stand. Use the Smart Cart's force sensor to measure the force of an oscillating spring and mass.

The Smart Cart can be mounted directly to a vertical rod or to a horizontal cross-rod.



Screw storage



Order Information

Smart Cart Rod Stand Adapter ME-1244

Smart Cart Demo Kits

NEW

ME-1272 (with red cart)

ME-1273 (with blue cart)

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

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



Order Information

Smart Cart Demo Kits
 (with red cart) ME-1272
 (with blue cart) ME-1273

Carts & Tracks

PASCO Dynamics Carts

PAScar

ME-6933 (red) ME-6934 (blue)

Each 250 gram polycarbonate plastic cart includes both a spring plunger, magnets and Velcro tabs for collision studies. The PAScars come in red and blue and are compatible with all PASCO Dynamics Tracks and accessories.

Polycarbonate Body

Total mass: 250 g



Order Information

PAScar (red).....	ME-6933	
PAScar (blue).....	ME-6934	
PAScar (set of 2).....	ME-6950	
<i>Replacement Supplies:</i>		
Replacement Axles (4 pack).....	ME-6957	p. 116
Cart Mass.....	ME-6757A	p. 113

PAStack

ME-6960

Includes

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



Order Information

PAStack.....	ME-6960
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Curved PAStack

ME-6841

For use with PAStack
ME-6960.

Includes

1. Concave-up Curved Piece
2. Concave-down Curved Piece
3. PAStack Connector Clips (2)



Order Information

Curved PAStack.....	ME-6841
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Classic Aluminum Carts

Plunger Cart

ME-9430 (blue)

Collision Cart

ME-9454 (red)

These are the standard carts in thousands of physics labs around the world. With an aluminum body, high-impact ABS plastic end caps, and a 500 g mass, they make dynamics experiments quick to set up and very quantitative. The Classic Carts are compatible with all PASCO Dynamics Tracks and accessories.



Order Information

Plunger Cart (blue).....	ME-9430	
Collision Cart (red).....	ME-9454	
<i>Replacement Supplies:</i>		
Replacement Axles (4 pack).....	ME-6957	p. 116
Cart Mass.....	ME-6757A	p. 113

Aluminum Starter Tracks



Have 1.2 m length tracks and want to change to 2.2 m?

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

Order Information

1.2 m Aluminum Starter Track.....	ME-9493
2.2 m Aluminum Starter Track.....	ME-9779

Track Rod Clamp

ME-9836



Shown with PAsTrack

Track Rod Clamp fastens to the T-slot of a Dynamics Track and accepts 1/2" rod.

Order Information

Track Rod ClampME-9836

Adjustable Feet (2)

ME-8972



Order Information

Adjustable Feet (2)ME-8972

End Stops (2)

ME-8971



Order Information

End Stops (2) ME-8971

Angle Indicator

ME-9495A

The Angle Indicator fastens to the T-slot of a dynamics track. Hanging plumb-bob indicates angle to 1/2°.



Order Information

Angle Indicator ME-9495A

Recommended:

Projectile Launcher Plumb Bobs (12 pack) ME-9868A

PAScar Cart Mass (set of 2)

ME-6757A



This 250 gram mass fits in any Dynamics Cart, the Motorized Cart (ME-9781), or the Discover Friction Accessory (ME-8574).

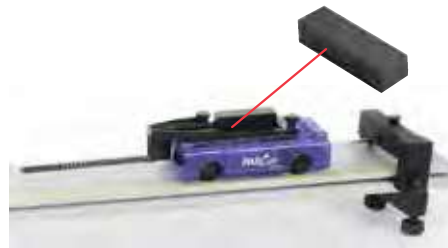
Order Information

PAScar Cart Mass (set of 2)ME-6757A

Compact Cart Mass

ME-6755

This 250 g mass allows students to change the mass of the Classic Cart or PAScar. It also fits on the Fan Cart (ME-9485).



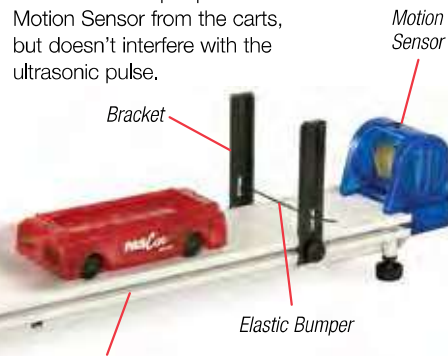
Order Information

Compact Cart Mass ME-6755

Elastic Bumper

ME-8998

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



Shown with PAsTrack

Includes

- Two pairs of brackets
- 10 meters of elastic material

Order Information

Elastic BumperME-8998

Super Pulley with Clamp

ME-9448B



Shown with PAsTrack

Pulley clamps on the end of any Dynamics Track. Its height is fully adjustable to match height of string attached to a dynamics cart.

Order Information

Super Pulley with ClampME-9448B

Dynamics Track Spring Set

ME-8999



Includes 12 springs (1.6 cm diameter) with approximate spring constants of:
 3.4 N/m (3 short and 3 long springs)
 6.8 N/m (3 short and 3 long springs)

Order Information

Dynamics Track Spring Set (12)ME-8999

Spring Set

ME-9803B



Includes eight identical springs: 8 cm long, 3.4 N/M spring constant.

Order Information

Spring Set (8) ME-9803B

Friction Block

ME-9807

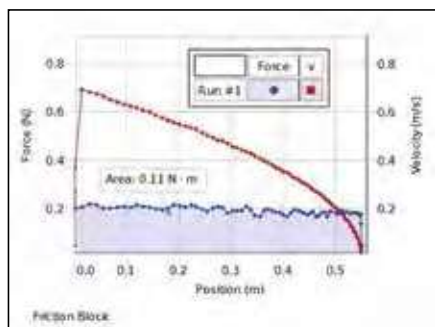


- ▶ Two types of material
- ▶ Vary surface area by using it flat or up on its side
- ▶ Hook for attaching a string to pull it
- ▶ Slot for a picket fence or flag for photogate timing

The wooden Friction Block has felt on two sides, so the frictional coefficients for felt or wood can be measured. It also fits into the dynamics cart tray so the cart can run on its wheels, or it can be turned upside down to run on the Friction Block without changing the mass.

Features

- ▶ **Dimensions:** 13 cm x 5 cm x 1.7 cm
- ▶ **Approximate Mass:** 110 g



The sliding friction block does work on the moving Smart Cart and stops it quickly. The graph above shows the cart velocity and applied friction stopping force vs. the distance travelled by the cart and block. The area under the Force vs. Distance curve gives the work done, and the loss of kinetic energy can be calculated from the velocity.



Order Information

Friction Block..... ME-9807

Shown in use with:

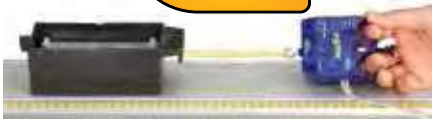
Dynamics Track System..... See pages 102-103

End Stops (2)..... ME-8971 p. 113

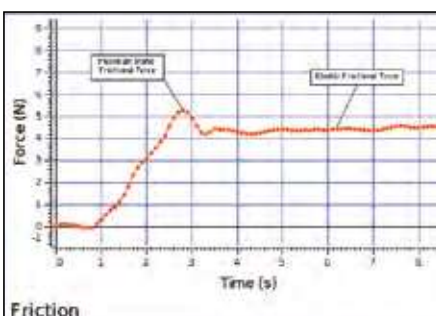
Discover Friction Accessory

ME-8574

See EX-5508 Sliding Friction Experiment on p. 336.



PASCO's Discover Friction Accessory is unlike any other friction set. The trays are designed to work effectively with PASCO carts and sensors. Using the four trays, students can discover concepts such as coefficient of friction, static friction, kinetic friction and the sliding friction equations. The two trays with identical plastic surfaces can be hooked together to explore the relationship between surface area and sliding frictional forces.



The peak of the graph represents the maximum static frictional force. Once the friction tray begins to move, the kinetic frictional force is evident on the graph.

Features

- ▶ **Easy Storage:** Friction trays are stackable
- ▶ **Versatile:** Students discover key friction concepts
- ▶ **Compatible:** Can be used with PASCO carts, masses, and Force Sensors

Includes

- Friction Tray - Felt
- Friction Tray - Cork
- Friction Tray - Plastic (2)

Order Information

Discover Friction Accessory..... ME-8574

Recommended:

Cart Mass..... ME-6757A p. 113

PAScar (red)..... ME-6933 p. 104

PAScar (blue)..... ME-6934 p. 104

Force Sensor See pages 38-39

Dynamics System See pages 102-104

Hooke's Law, Spring Potential Energy, and Work-Kinetic Energy Theorem, all in one cart launcher

Spring Cart Launcher

ME-6843*



- ▶ Affordable cart launcher
- ▶ Hooke's Law
- ▶ Spring potential energy
- ▶ See EX-5504A Hooke's Law and Energy Stored in a Spring on p. 333.

The Spring Cart Launcher provides an economical way to launch carts in a repeatable fashion. It can be used for Hooke's Law, collisions, and for Conservation of Energy. It fits into the bed of a Dynamics Cart or PAScar. To launch the cart, the plunger is pulled through the hole in the new endstop, compressing the spring, and then released. To add repeatability, a second endstop can be used with the supplied pin to hold the plunger at a specified compression position. Three different strength springs are provided with the Spring Cart Launcher. Use with or without probeware.



Includes

- Spring Cart Launcher
- Trigger Pin
- Three Different Strength Springs

Order Information

Spring Cart Launcher.....ME-6843

Required:

Dynamics Track System....See pages 102-103

*NOTE: Not compatible with the Smart Cart

Recommended:

End Stops (2).....ME-8971 p. 113

Replacement Springs.....ME-6847

(Three different strength springs, two each)

Compact Cart MassME-6755 p. 113

Force Bracket

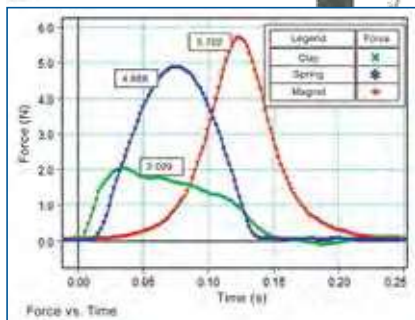
ME-6622

The Force Bracket with bumpers mounts the PASCO Force Sensor directly to a dynamics track. It includes 5 collision attachments for the Force Sensor and conveniently stores each attachment on the bracket itself.

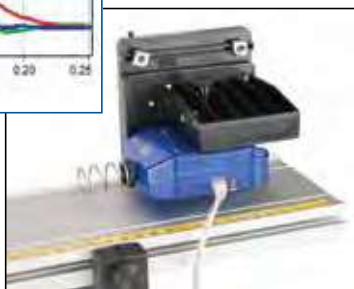
Using any of these attachments, the bracket serves as an excellent support or target for collision studies using the Force Sensor.



Wireless Force Acceleration Sensor (PS-3202) in cart collisions with fixed spring bumper on Force Bracket



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



Includes

- Spring Bumpers (2) (different spring constants)
- Magnetic Bumper (1)
- Rubber Bumper (1)
- Clay Cup for Inelastic Collisions (1; clay included)
- #0 Phillips Head Screwdriver (to attach to Force Sensor)

Order Information

Force BracketME-6622

Bumper Accessory Set

ME-9884



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

Includes

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



Order Information

Bumper Accessory Kit.....ME-9884

Magnetic Bumper Set

ME-9885A

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



Includes

- Magnetic Bumper (2)



Order Information

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

Cart Adapter Accessory

ME-6743

The Cart Adapter Accessory allows the Motion Sensor and many other sensors to be mounted to a Dynamics Cart or a PASCar.



Mounting a Motion Sensor on a cart is ideal for the study of relative motion. The adjustment knob on the bracket allows the Motion Sensor to face any direction.

Includes

- Two M5 thumb screws to attach to cart
- 1/4"-20 screw at center

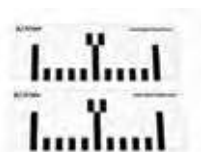


Order Information

Cart Adapter Accessory.....ME-6743

Photogate Bracket

ME-9806 (2)



ME-8933



ME-9804

Order Information

Photogate Brackets (2) ME-9806
 Smart Timer Picket Fences (2) ME-8933
 Dynamic Cart Picket Fences (2) ME-9804

Cart Replacement Axles* (4 pack)

ME-6957



**Not suitable for Smart Carts*

Although the ball bearings are designed for many years of use, the bearings may become damaged from dirt and other contaminants. The wheels and axles of the PAScar can be easily replaced by removing the lower section of the car and placing the new wheels in the chassis. A perfect tune-up for a PAScar or GOcar! The wheels of the Classic Carts can also be replaced with the same set of wheels. Contact PASCO's technical support for further assistance.

Order Information

Cart Replacement Axles (4 pack) ME-6957

Braided Physics String

SE-8050

▶ 30-lb. test

This braided Dacron® string is tough, resists stretching, and won't unravel. Withstands up to 133 Newtons of force (equivalent to 13.6 kg). Each roll provides 320 meters of string.



Order Information

Braided Physics String SE-8050

Dynamics Systems Spares Kit

ME-9823

The Spares Kit contains many of the small parts that can get lost after classroom use. All parts are organized in a convenient case for easy storage.

Includes

- Cart Bumper Magnets (2)
- Velcro® Hoop and Loop Bumpers (4)
- Dynamics Track Feet Screws (4)
- 1/4"-20 x 9/16" Tee Thumb Screws (4)
- 1/4"-20 x 9/16" Round Thumb Screws (6)
- 1/4"-20 x 3/8" Round Thumb Screws (6)
- 1/4"-20 x 7/32" Square Nuts (20)
- 1/4"-20 Nylon Thumb Nuts (6)
- 6-32 x 3/8" Nylon Thumb Screw (6)
- M5 x 0.8 x 20 mm Nylon Thumb Screw (4)
- 1/4"-20 x 3/8" Set Screws (4)
- Bumper Squares (8)
- Round Rubber Bumpers (4)



Order Information

Dynamics Systems Spares Kit ME-9823

Rubber Cord (30 meters)

ME-8986

For Elastic Bumper (ME-8998). Also fits Air Track Bumpers



Order Information

Rubber Cord (Spool of 30 m) ME-8986

Use your Rotary Motion Sensor to track cart motion.

Dynamics Track Mount

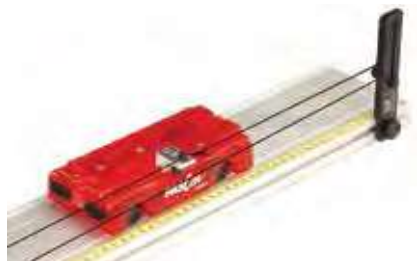
CI-6692

Track String Adapter (RMS/IDS Kit)

ME-6569



The Dynamics Track Mount (CI-6692) is used to mount the Rotary Motion Sensor to the Dynamics Track, allowing it to act as a high resolution, bi-directional Smart Pulley.



When used in conjunction with the Dynamics Track Mount (CI-6692), the Track String Adapter allows a Rotary Motion Sensor to continuously monitor the Dynamics Cart position. A loop of string wraps around the Rotary Motion Sensor pulley and the ball-bearing pulley, and then it attaches to the cart via a special clip (included).

CI-6692 Includes

- Bracket



PS-2120A Includes

- Bracket with Pulley
- Cart String Clip
- Thread



Order Information

Dynamics Track Mount CI-6692
 Track String Adapter (RMS/IDS Kit) ME-6569

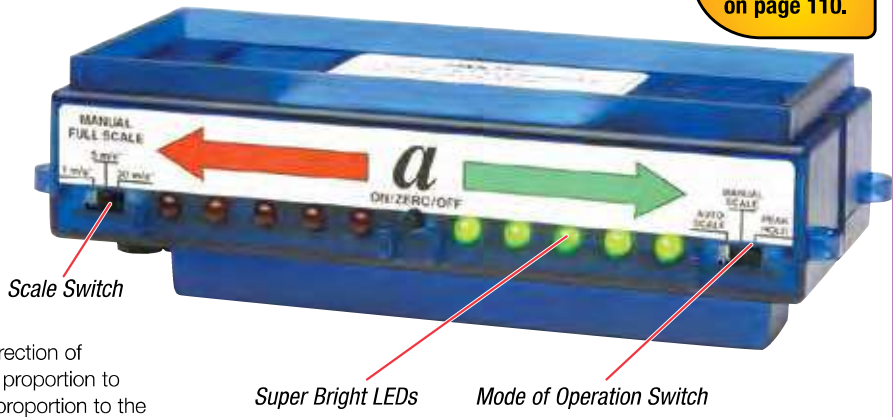
Teach the difference between velocity and acceleration.

See the new Smart Cart Vector Display on page 110.

Visual Accelerometer

PS-2128

- ▶ Clearly demonstrates the difference between velocity and acceleration
- ▶ Shows both direction and magnitude of acceleration
- ▶ Acts as a sensor when connected to a computer



How It Works

The Visual Accelerometer shows the magnitude and direction of acceleration in one dimension. Five green LEDs light in proportion to the acceleration to the right, and five red LEDs light in proportion to the acceleration to the left. Because the Visual Accelerometer is mounted on the accelerating object, students see the acceleration without having to look away at a computer.



Push a cart up the incline and let it go back down. Students will expect the direction of the acceleration to change, depending on whether the cart is going up or down the incline. They are surprised that the red lights stay lit in the same direction.



The Visual Accelerometer can be used with the Smart Fan Accessory (ME-1242).

Features

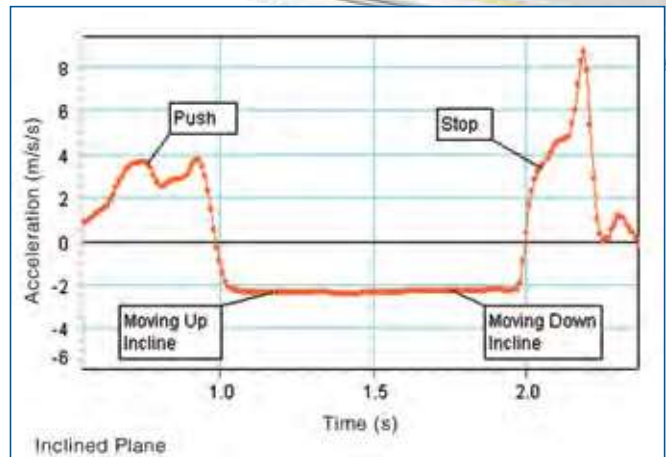
- ▶ **Super Bright LEDs:** Strong visual clues to both the magnitude and direction of the acceleration.
- ▶ **Portable:** Clearly shows magnitude and direction of acceleration with no cord attached.
- ▶ **Auto-Scale:** The auto-scale feature makes any acceleration between 0.2 and 20 m/s² a full-scale reading.
- ▶ **Peak-Hold Mode:** Freezes the lighted LEDs at the maximum acceleration so it can be viewed after the object stops.

Specifications

Three Manual Scales: 1 m/s², 5 m/s², 20 m/s² full scale
Requires three AA batteries for stand-alone operation (included)
Auto-off after three hours

Includes

- Visual Accelerometer
- Plastic M5 screws for attachment to a Dynamics Cart (2)
- Sensor Cable



When connected to a computer, the Visual Accelerometer measures the acceleration as the cart is pushed by hand. The direction and magnitude of the acceleration is constant as the cart goes up and then goes down the incline.

Order Information

PASPORT Visual Accelerometer PS-2128
 Smart Fan Accessory ME-1242

Smart Ballistic Cart Accessory

ME-1245

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

The Smart Ballistic Cart Accessory can be used with any PASCO cart to help beginning physics students grasp the independence of vertical and horizontal projectile motion. The ball is launched vertically while the cart is in motion. If the cart has a constant velocity, the ball will have the same constant velocity in the horizontal direction and will be caught by the cart.

How It Works

When used with a regular PASCO cart:

- ▶ You push the ball in the piston down until the permanent magnet is engaged.
- ▶ You push a button on the Smart Ballistic Cart Accessory, push the cart, and the ball is launched one second later.
- ▶ The ball piston is released as an electromagnet cancels the field of the permanent magnet.
- ▶ Releasing the ball does not interfere with the motion of the cart.
- ▶ The barrel of the Ballistic Cart Accessory can be adjusted to be vertical using the leveling screws.

When used with a PASCO Smart Cart, additional features are:

- ▶ You can trigger the launch of the ball by pressing a button in the software (in PASCO Capstone or SPARKvue).
- ▶ You can trigger at a specified distance as measured by the cart (PASCO Capstone only).
- ▶ You can trigger at a specified time (PASCO Capstone only).
- ▶ Use Blockly coding in PASCO Capstone or SPARKvue to program the ball to launch contingent on other sensor measurements.
- ▶ The software automatically identifies the Smart Ballistic Cart Accessory when it is plugged into the Smart Cart accessory port.



Features

- ▶ Works with any PASCO cart
- ▶ Additional features available when used with PASCO Smart Cart
- ▶ Shoots over 50 cm high
- ▶ Funnel with no-bounce foam
- ▶ Rechargeable Lithium Ion Battery
- ▶ Auto-ID in PASCO Capstone and SPARKvue software
- ▶ Use with Blockly coding in PASCO Capstone and SPARKvue software



Includes

- Smart Ballistic Cart Accessory
- 2 Nylon Balls (2.54 cm diameter)
- Rechargeable Battery
- Smart Cart Accessory Connecting Cable
- USB Cable

Order Information

Smart Ballistic Cart Accessory ME-1245

Required:

Smart Cart or any other PASCO Cart

Recommended:

Aluminum Dynamics Track with Leveling Feet

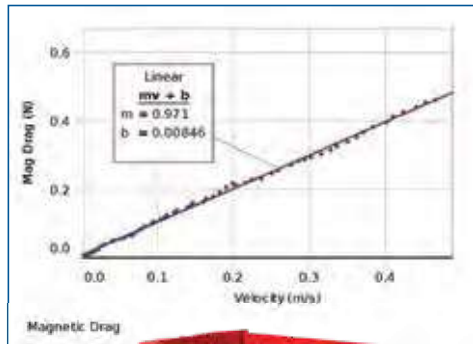
Magnetic Damping Accessory

ME-6828

- ▶ Magnets cause eddy currents in aluminum tracks
- ▶ Magnetic drag is proportional to cart speed
- ▶ Damping Accessory connects to cart magnets
- ▶ Slide magnets up/down to adjust amount of drag



Magnetic Damping using the new wireless Smart Cart
 Measure the magnetic drag force directly with on-board force sensor in the Smart Cart. The Smart Cart also has an encoder that keeps track of its velocity. This plot of Force vs. Velocity shows the induced magnetic drag is proportional to the velocity.



Includes

- Bracket
- Magnets
- Keeper

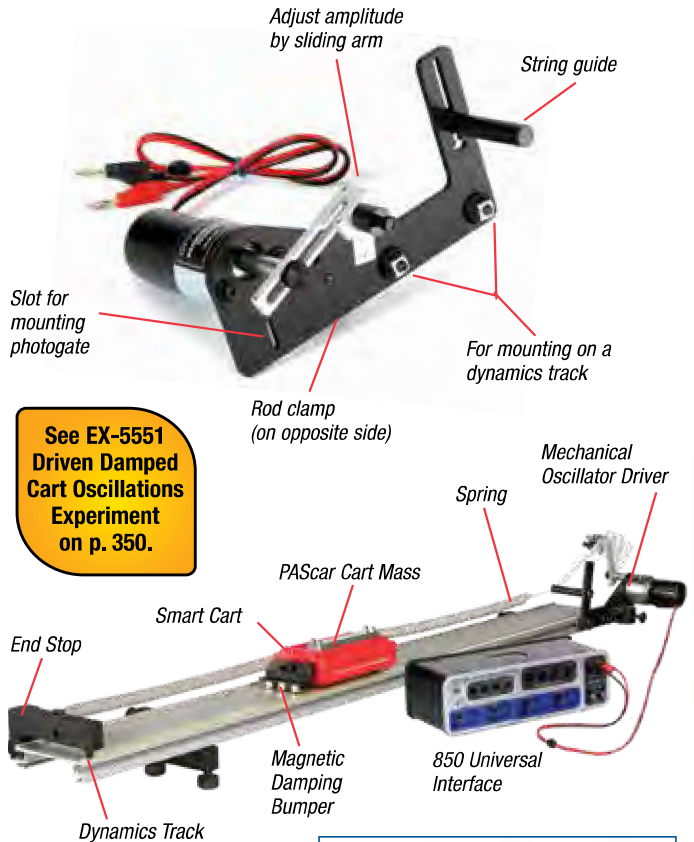
Order Information

Magnetic Damping Accessory.....	ME-6828	
<i>Equipment shown:</i>		
Basic Smart Cart Metal Track System.....	ME-5708A	p. 103
Dynamics Track Spring Set.....	ME-8999	p. 113

Mechanical Oscillator/Driver

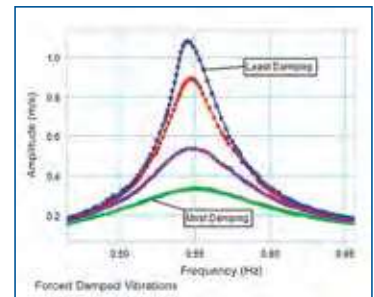
ME-8750

The Mechanical Oscillator/Driver delivers repeatable, low-frequency, high-force sinusoidal motion for harmonic motion experiments. Shown with the Smart Cart Standard Dynamics System (ME-5718), it also works with other Dynamics Systems having a metal track.



See EX-5551 Driven Damped Cart Oscillations Experiment on p. 350.

The velocity amplitude is plotted as a function of driving frequency. The four resonance curves show the effect of varying the strength of the magnetic damping.



Specifications

- ▶ **Sinusoidal Drive:** 12 VDC motor (frequency: 0.3-3 Hz, current: 0-0.3 A).
- ▶ **Adjustable Amplitude:** Up to 12 cm.
- ▶ **Mounts to Dynamics Track or Rod**
- ▶ **Photogate Mounting Holes**

Order Information

Mechanical Oscillator/Driver	ME-8750	
<i>Shown in use with:</i>		
Smart Cart Metal Track Standard System	ME-5718A	p. 103
Magnetic Damping Bumper	ME-6828	
850 Universal Interface.....	UI-5000	p. 28

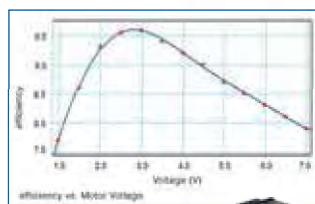
Powered Carts

Motorized Cart

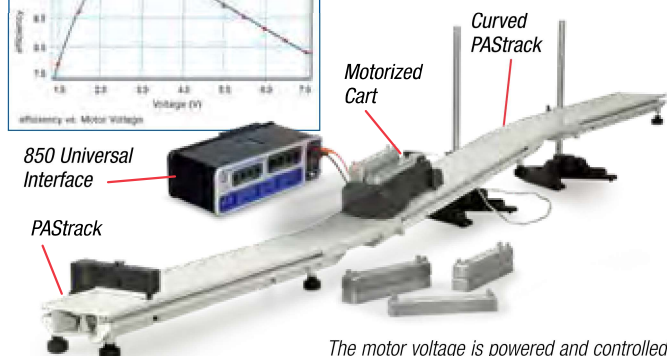
ME-9781

- ▶ Battery powered
- ▶ Adjustable speeds
- ▶ External power jack
- ▶ Climbs a 30° slope
- ▶ Durable construction

The tank-like molded casing and a rugged internal gear mechanism are built for the harshest student environment. Runs on four "C" batteries and has variable speed adjustment knob. External power input accepts phone plug cable (included) to power the car with a DC power supply or 850 Universal Interface signal generator.



This graph shows effect of increasing motor voltage on the efficiency.



The motor voltage is powered and controlled using the 850 Universal Interface.

Specifications

- Adjustable Speed:** ≈ 8-25 cm/s
- Battery Power:** Four "C" (not included)
- External Power Input Jack**
- Battery Life (Alkaline):** Six hours

Includes

- Motorized cart
- Cable for connecting to external power supply

Order Information

Motorized Cart.....	ME-9781	
PAStack.....	ME-6960	p. 122
Curved PAStack.....	ME-6841	p. 122
250 g Stackable Masses (2 pack).....	ME-6757A	p. 113
Base and Support Rods	Various	p. 190

Super Fan Cart

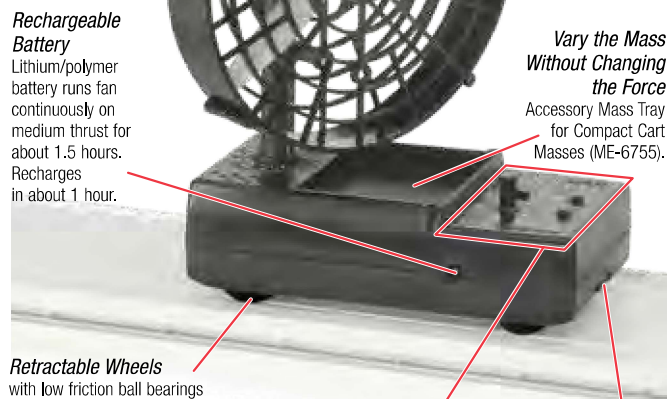
ME-6977

- ▶ Constant force
- ▶ Rechargeable
- ▶ Programmable

Teach every aspect of Newton's Second Law with PASCO's Super Fan Cart.

$$\vec{F}_{Net} = m\vec{a}$$

Adjust thrust angle to teach about vector forces
Fan turns through 180°



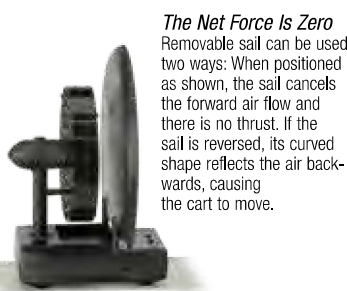
Rechargeable Battery
Lithium/polymer battery runs fan continuously on medium thrust for about 1.5 hours. Recharges in about 1 hour.

Retractible Wheels
with low friction ball bearings

Adjustable Fan Speed
Apply different forces using three standard settings or the continuously variable setting. Regulated power supply gives constant thrust even as the battery discharges.

Vary the Mass Without Changing the Force
Accessory Mass Tray for Compact Cart Masses (ME-6755).

String Attachment
Connect two fan carts together to add or subtract forces.



The Net Force Is Zero
Removable sail can be used two ways: When positioned as shown, the sail cancels the forward air flow and there is no thrust. If the sail is reversed, its curved shape reflects the air backwards, causing the cart to move.



Pulse Duration
Program fan to be pulsed on for specific time to demonstrate acceleration only occurs when a force is applied. Includes time delay and auto-repeat option.

Specifications

- Fan Cart Mass:** Approximately 0.3 kg
- Sail Mass:** Approximately 0.1 kg
- Regulated Power Supply:** Lithium/polymer battery (7.2 volts, 1.25 amp-hour)
- Run-time:** Runs approximately 1.5 hr on medium thrust
- Recharge Time:** One hour typical
- Thrust Settings:** Approximately 0.04 N on Low, 0.15 N on Medium, and 0.22 N on High
- Thrust, Variable:** Approximately 0.01 N to 0.23 N

Order Information

Super Fan Cart	ME-6977	
<i>Includes: Fan Cart, Sail and Charger</i>		
Recommended:		
PAStack.....	ME-6960	p. 122
Compact Cart Mass	ME-6755	p. 113

Smart Fan Accessory

ME-1242

- ▶ Provides a Constant Force
- ▶ Hands-off Operation
- ▶ Sense and Control
- ▶ Manual Mode for Non-Smart Carts

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:

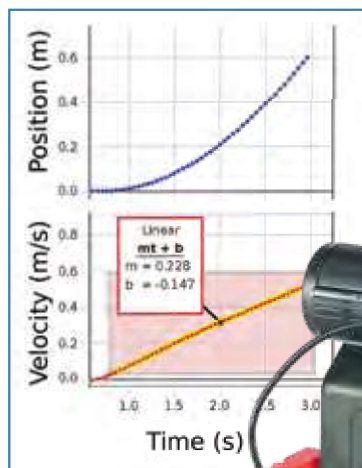
- **Hands-off Operation:** You can turn the Smart Fan on and off wirelessly from your computing device.
- **Adjust the Thrust:** Move the slider in the software and watch the fan respond.
- **Reverse the Spin of the Fan:** Input a negative thrust to make the fan blow in the opposite direction.
- **Set 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:
 $Thrust = -100 * [Position]$



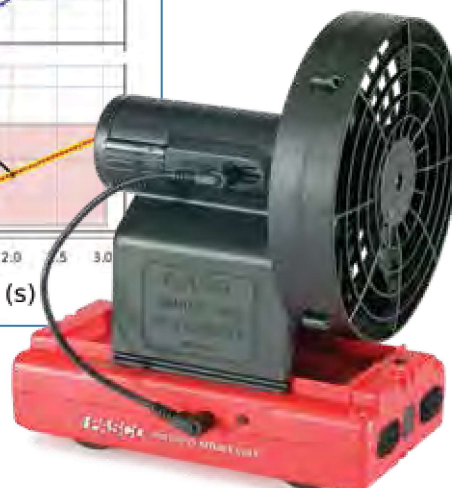
This will cause the fan to blow harder as the cart moves down the track, causing the cart to reverse, and eventually the fan will reverse when the Position becomes negative, accelerating the cart in the positive direction.

Specifications

- Push-button 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.



U.S. Patent Number
10,482,789



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



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

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)
- AA Alkaline Batteries (4)



Order Information

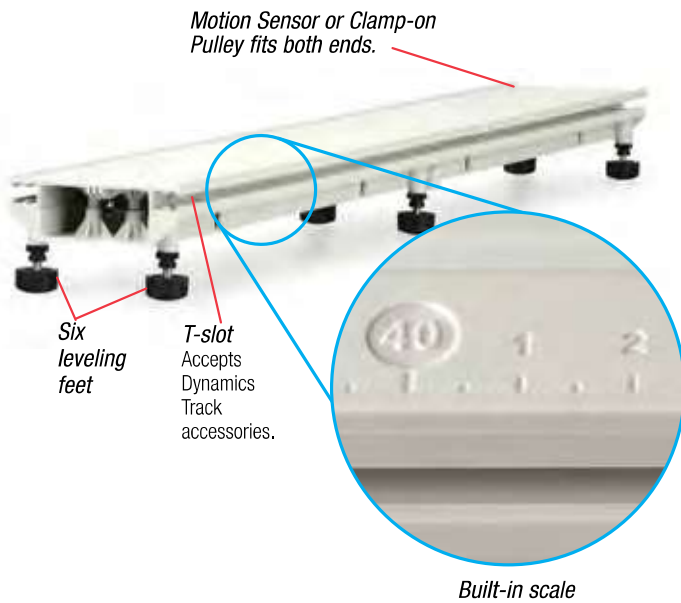
Smart Fan Accessory ME-1242
 Requires:
 Smart Cart or Dynamics Cart..... pp. 102-103
 PASCO Capstone Software..... pp. 72-75
 Suggested:
 Battery Charger with 8 AA Rechargeable Batteries SE-3570

Straight PATrack

ME-6960

- ▶ 1 m length dynamics track
- ▶ Two-piece molded construction
- ▶ Accepts dynamics track accessories

This two-piece track construction makes storage easy. Snap-on connector clip holds sections straight and rigid. Use the second clip (included) to connect multiple tracks! The track ends are designed to accept the Motion Sensor and Clamp-on Pulley, and the side T-slots accept Dynamic Track accessories, such as photogate brackets and end stops. Track includes six built-in leveling feet.



Includes

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



Order Information

Straight PATrack.....ME-6960

Inclined Plane Accessory

ME-6965

The Inclined Plane Accessory includes the hinge with angle scale and the rubber cord for the rubber bumper. A PATrack is required to make a complete inclined plane.



Includes

- Inclined Plane Accessory
- Rubber Cord, 1.5 mm square, 30 m

Order Information

Inclined Plane AccessoryME-6965
 Required:
 PATrack.....ME-6960

PATrack Inclined Plane

ME-6967

The PATrack Inclined Plane includes the Inclined Plane Accessory (ME-6965) and the PATrack (ME-6960).



Order Information

PATrack Inclined PlaneME-6967

Curved PAStack

ME-6841

- ▶ Attaches to Straight PAStack with same connector clip
- ▶ Put two curved pieces together
- ▶ One concave up and one concave down

Create hills, valleys and inclines. Molded PAStack system has straight and curved sections that just snap together. Connect multiple sets to make a track as long as you want.

Order Information

Curved PAStack.....ME-6841



Includes

1. Concave-up Curved Piece
2. Concave-down Curved Piece
3. PAStack Connector Clips (2)

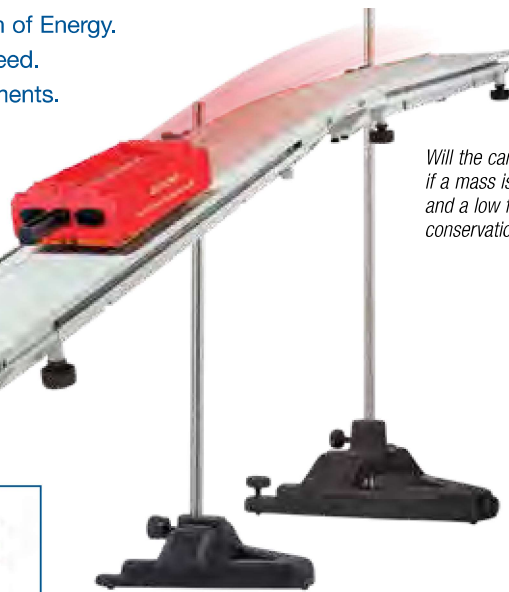
Conservation of Energy Experiments

Smart Cart Curved Track System

ME-5700B

- ▶ Explore all aspects of the Law of Conservation of Energy.
- ▶ Wireless Smart Cart has all the sensors you need.
- ▶ Use this system for all other dynamics experiments.

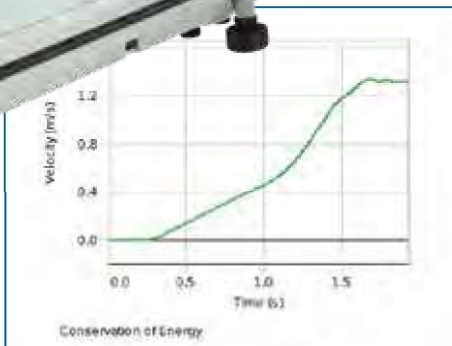
This unique system has curved track that allows your students to build hills and valleys for Conservation of Energy experiments. Data is collected using the sensors onboard the Smart Cart. Unlike when Motion Sensors are used to track the cart, the Smart Cart does not have to be in the direct line of sight of the sensor, so it can go over hills. And, the Smart Cart is wireless, so no extra friction is introduced.



Will the cart be going any faster at the bottom if a mass is added? With the Curved PAStack and a low friction cart, students can investigate conservation of energy and answer that question.



Smart Cart Rod Stand Adapter



The curved and straight track pieces can be combined to form a step, so the cart starts out on a nearly level upper step, travels down the step, and ends on a level straight section. This makes measuring the change in height very easy.

During the experiments, the mass of the cart is varied to see what effect, if any, it has on the results.

Another configuration forms a potential well so the cart oscillates back and forth.

This versatile system can also be used for regular dynamics experiments such as impulse and Newton's Second Law.

Includes

- | | |
|--------------------------------|----------|
| 2 PAStack (1 m) | ME-6960 |
| 2 Curved PAStack | ME-6841 |
| 4 Pivot Clamp | ME-9836 |
| 1 Endstops (set of 2) | ME-8971 |
| 2 60 cm Threaded Rod | ME-8977 |
| 2 Round Base with Rod | ME-8270 |
| 2 Small A-Base | ME-8976 |
| 1 2 Masses | ME-6757A |
| 1 Smart Cart (red) | ME-1240 |
| 1 Smart Cart Rod Stand Adapter | ME-1244 |

Order Information

Smart Cart Curved Track System.....ME-5700B

Required:

- PASCO Capstone software (see pages 72-75)
- Bluetooth 4.0 compatible computer

Experiments can be downloaded at www.pasco.com.

The Most Versatile Stand-Alone Timer Available

Smart Timer

ME-8930

- ▶ Portable timer for photogates and smart pulleys
- ▶ Measures time, speed and acceleration
- ▶ Counter for G-M Tubes
- ▶ Crystal-controlled 0.01% accuracy

The ME-8930 Smart Timer works with all PASCO timing devices

- ▶ Accessory Photogate
- ▶ Time-of-Flight Accessory
- ▶ Laser Switch
- ▶ Photogate/Pulley System
- ▶ Freefall Adapter
- ▶ G-M Tube

Measure Time:

- ▶ One Gate: Returns time from leading edge to leading edge
- ▶ Fence: Returns 10 time values
- ▶ Two Gates: Returns time between two gates
- ▶ Pendulum: Measures pendulum period
- ▶ Stopwatch: Returns time between pressing Start/Stop button

Measure Speed:

- ▶ One Gate: Single object speed using picket fence
- ▶ Collision: Initial and final speeds for one or two carts
- ▶ Pulley: Angular speed

Measure Acceleration:

- ▶ One Gate: Direct measurement of acceleration using picket fence
- ▶ Linear Pulley: Acceleration of string
- ▶ Angular Pulley
- ▶ Two Gates: Object's average acceleration between two photogates

Measure Counts:

- ▶ Three timing intervals
- ▶ Manual mode counts until Stop is pressed
- ▶ Up to 5,000 counts/second
- ▶ Up to 9,999,999 total counts

2-line, 16-character Alphanumeric LCD

Top Line: Measurement Description; Bottom Line: Numerical Values



It's as easy as 1-2-3.

1. Measurement

Press this button to select the quantity to be measured: "Time," "Speed," "Accel," "Count" or "Test" will appear on the display.

2. Mode

Press this button to select the type of experimental setup. Each mode is shown in words on the display.

3. Start/Stop

Press Start. The Smart Timer "beeps," and waits for an event to occur. After the event, the Smart Timer displays a result.

Features

- ▶ **Works with Two Photogates**
- ▶ **More Than Just a Timer:** Measures speed and acceleration as well as time.
- ▶ **Quick Setup:** Turn on the switch, plug in the photogates, and it's ready to use.
- ▶ **Portability or Plug-in:** The battery-operated (four "AA"s) Smart Timer can be used outside the classroom away from power outlets. It can also be operated on the 9 VAC adapter (included).
- ▶ **Calculation Lock-out Switch:** A switch inside the battery compartment disables the speed and acceleration modes. Timing modes are unaffected, and students are required to do their own calculations.

Specifications

Resolution: 100 μ s

Accuracy: 0.01% of full range of the measured time

Display: 2-line, 16-character, alphanumeric LCD

Inputs: Two 1/4" stereo phone jacks on side panel— TTL compatible

Power Requirements: Four "AA" batteries (not included) or AC adapter (9 VDC, 500 mA) included



Typical Experiments

1. Acceleration Due to Gravity*
 2. Newton's Second Law*
 3. Conservation of Momentum in Collisions*
 4. Rotational Inertia of a Disk & Ring*
 5. Acceleration Down an Incline
 6. Simple Harmonic Oscillator
 7. Oscillations on an Incline
 8. Springs in Series and Parallel
 9. Projectile Motion Using Photogates
 10. Time-of-Flight and Initial Velocity
 11. Determining the Acceleration Due to Gravity
 12. Counting Radiation with the G-M Tube
- *Experiments require accessories listed on pages 45-47.



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

Two Photogate Ports



Durable Positive-click Buttons



The microprocessor-based PASCO Smart Timer is the most versatile way to make time, speed, acceleration, and count measurements.



Speed of projectile—In Time: Two Gates mode; determine the speed of a ball fired by a Projectile Launcher through two photogates.



Speed of object through one gate—In Time: One Gate mode; timing begins when the photogate beam is first blocked and continues until the beam is blocked again. Use the fence supplied with the Smart Timer.



Speed before and after collision—In Speed: Collision mode; use two carts and two photogates with a single Smart Timer to measure initial and final speeds of both carts.



Rotary motion—In Acceleration: Linear Pulley mode; the Smart Timer measures the acceleration of the string over the Smart Pulley.

Smart Timer (ME-8930) includes

- Smart Timer
- 9 VAC Adapter
- Picket Fences (2)
- Lab Manual

Order Information

Smart Timer.....	ME-8930	
<i>Recommended:</i>		
Accessory Photogate	ME-9204B	p. 45
Smart Timer Fences (2)	ME-8933	
Freefall Adapter	ME-9207B	p. 47
Photogate/Pulley System	ME-6838A	p. 45
Time-of-Flight Accessory	ME-6810A	p. 47
G-M Tube/Power Supply	SN-7927A	p. 47
Phone Jack		
Extender Cord.....	PI-8117	p. 47

Smart Timer Photogate System

ME-8932

Comes with a full set of accessories for timing experiments. Attach the photogate to the Super Pulley to produce a "Smart Pulley."

Smart Timer Photogate System (ME-8932) includes

1. Smart Timer
 2. Accessory Photogate (2)
 3. Super Pulley
 4. Picket Fences (2)
- 9 VAC Adapter and Lab Manual (not shown)



Order Information

Smart Timer Photogate System ME-8932

Timers

Digital Photogate Timer System

ME-9403A

- ▶ High accuracy and resolution
- ▶ Four timing modes: gate, pulse, pendulum, and manual stopwatch
- ▶ Built-in memory

PASCO digital photogates are used in thousands of physics labs throughout the world. They are rugged and simple to operate.

Features

- ▶ **Built-in Photogate:** Timer serves as the base
- ▶ **0.1 ms Resolution** and 0.05% accuracy
- ▶ **Memory Function:** Allows two measurements in rapid succession, such as pre- and post-collision velocities
- ▶ **Easy Setup:** Turn it on and begin taking measurements
- ▶ **Portability or Plug-in:** Use four "C" cell batteries (not included) or 9 V AC adapter (included)

The Photogate Timers work with the following:

- ▶ Accessory Photogate
- ▶ Time-of-Flight Accessory
- ▶ Freefall Timer
- ▶ Laser Switch

Specifications

Modes: Gate, pulse, pendulum, manual stopwatch
Resolution: 0.1 ms (max time 19,9999 s)
Accuracy: 0.05% of full range of the measured time ± 1 digit
Display: 5-1/2 digit, 10 mm high LCD
Memory: Preserves displayed time while new time is measured
Photogate: 6.5 cm wide; fully adjustable swivel mount; LED trigger indicator; fall time <10 ns; spacial resolution <1 mm
Inputs: Accessory Photogates, or TTL-compatible signals; one photogate jack and a 9-V AC adapter jack (or four "C" size batteries) on back panel



ME-9215B Photogate Timer with Memory

Shown with the Freefall Timer Adapter ME-9207B.



Order Information

Digital Photogate Timer System	ME-9403A
Photogate Timer with Memory	ME-9215B
Accessory Photogate	ME-9204B

Freefall Apparatus

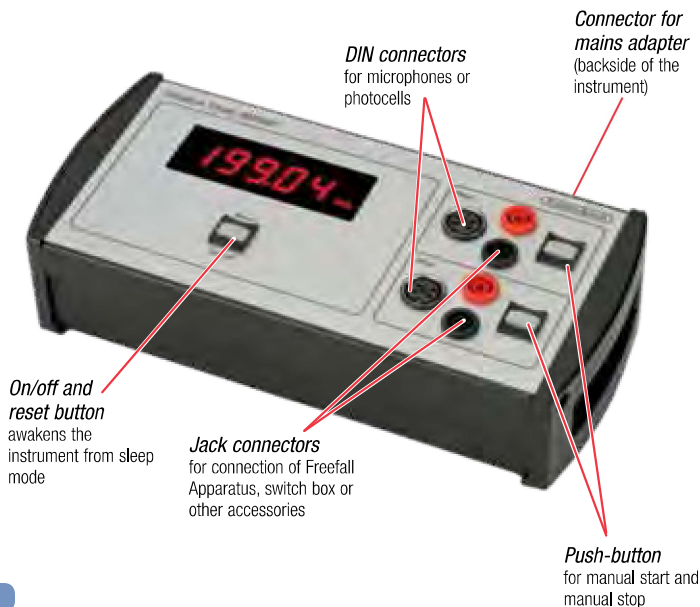
Student Timer

SF-7275

- ▶ Use with Freefall Apparatus (SF-7274)
- ▶ Also has manual start/stop
- ▶ Battery-powered

This student timer is designed to perform time measurements using photo cells, microphones, freefall equipment and other mechanical and electronic switches. The timer function can also be activated manually.

The student timer is supplied with batteries and a power adapter. The instrument turns itself off automatically after 5 minutes without any activity, both when battery powered and when powered with the power adapter.



Order Information

Student Timer	SF-7275
---------------------	---------

Tape Timer

ME-9283

- ▶ Crystal-controlled
- ▶ Two frequencies (10 Hz and 40 Hz)
- ▶ Easy-to-read dots



The Method

Provides students with a visual demonstration of speed and acceleration. A moving object pulls a paper tape through the timer. The timer prints dots on the tape at equal time intervals. The result is a series of dots on the paper tape, representing the position of the object as a function of time.

From the dots on the tape, the distance traveled can be measured, and the average speed for each time interval can be calculated. Plotting position versus time enables students to determine the average speed. Plotting the average speed for each time interval versus time enables acceleration to be determined.

The paper tape can be attached to air track carts, dynamics carts, falling masses or other objects.

Features

- ▶ **Two crystal-controlled, calibrated frequencies:** 10 Hz and 40 Hz, accurate to 0.1%. The 40-Hz frequency is ideal for freefall experiments. The slower 10-Hz frequency is best for most dynamics track experiments.
- ▶ **Includes an internal 9 V battery, or use an optional external 9 V AC adapter/power supply:** A single battery can last for up to a year's worth of normal experiments.
- ▶ **Low mass, small-pin printing head:** Driven by short millisecond pulses, produces sharp, round dots without smearing.
- ▶ **Plain paper:** Print on 12.5 mm (1/2 inch) wide, plain paper supplied in 150-meter (500 feet) rolls.
- ▶ **Carbon paper discs:** Used for printing. The disc holder allows the printing point to be adjusted, giving a long life to the discs.
- ▶ **Rod clamp:** Allows the Tape Timer to be mounted on a standard lab stand rod so that the paper path is either parallel or perpendicular to the rod. Rod sizes between 13 mm (1/2 inch) and 9 mm (3/8 inch) are accommodated.



Calculate the acceleration due to gravity by dropping a mass attached to the tape.

Includes

- Roll of paper (1)
- Carbon paper discs
- Battery
- Manual (not shown)



Order Information

Tape Timer.....	ME-9283
<i>Recommended:</i>	
9 V AC Adapter 120 V/500 mA	540-007
Tape Timer Supplies	ME-9284
<i>Includes five rolls of paper (each 150 m) and 10 carbon paper discs.</i>	

PASCO Stopwatch

ME-1234

- ▶ No alarm or clock
- ▶ Memory for stored event times
- ▶ Uses one AA battery
- ▶ Durable buttons

Are you tired of annoying stop-watch alarms going off all day? Are your students stuck in the clock mode and can't get their stopwatch back into the timing mode? Does your stopwatch stop working after changing that little watch battery? The PASCO Stopwatch solves all these problems!

This stopwatch was designed specifically for science timing. The modes of operation are intuitive and complete instructions are included. The buttons are built to last and it uses a single long-lasting AA battery, which is less expensive than a watch battery (and easier to install).



The PASCO Stopwatch fits comfortably in your hand.



The EVENT/RECALL button allows you to view the last time, in case students forget to write down their data. The EVENT/RECALL button is also used to store and recall up to nine event times. For example, record a series of events, such as times at which sandbags were dropped along the gym floor.

Specifications

- LED Display:** Visible indoors and outdoors
- Two Display Modes:** MM:SS.SS (01:25.34) or Decimal Sec (85.34 s)
- Precision:** 0.01 sec up to 59:59.99 (MM:SS.SS) or 3599.99 s
Then 1 sec to 99:59:59 (HH:MM:SS) or 359999 s
- Max Number of Event Times:** Nine
- Auto-off:** After one hour idle
- Can be used** with a lanyard (not included)
- Includes:** One AA battery and instruction sheet

Order Information

PASCO Stopwatch.....	ME-1234
PASCO Stopwatch (10-pack).....	ME-1235

PASCO Air Track

SF-9214

Variable Output Air Supply

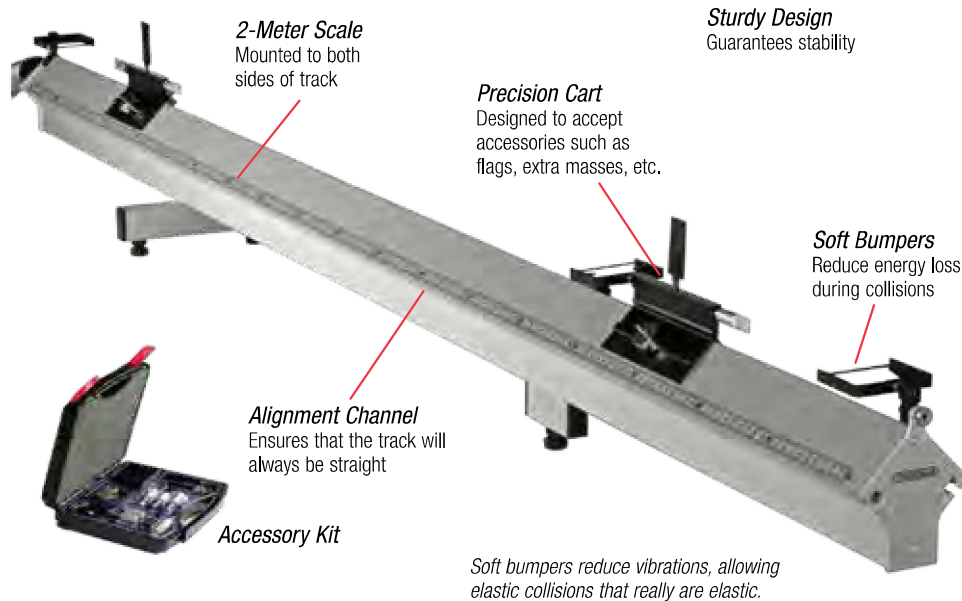
SF-9216

- ▶ Nearly frictionless linear motion
- ▶ Two meters long
- ▶ Complete accessories included

It's simple physics—a moving object will continue forever at a constant velocity unless it's acted on by an external force. To the physicist, Newton's First Law is second nature. Yet it's still fascinating to watch an air track glider moving endlessly back and forth on an air track.

It's even more fascinating for students, who are often seeing this simplest form of motion for the first time.

An air track glider provides the raw material for highly accurate investigations into the laws of motion. Add a timing system and investigate uniform motion, average and instantaneous velocities, uniform acceleration, elastic and inelastic collisions, impulse and change in momentum, conservation of momentum, conservation of energy and more. The data is precise and unambiguous. Frictional forces are negligible.



Sturdy Design
Guarantees stability

Precision Cart
Designed to accept accessories such as flags, extra masses, etc.

Soft Bumpers
Reduce energy loss during collisions

Alignment Channel
Ensures that the track will always be straight

Accessory Kit

Soft bumpers reduce vibrations, allowing elastic collisions that really are elastic.

Compared to other air tracks, the PASCO Air Track is:

- ▶ **Longer:** The 2-meter length provides more room for experimenting, yet it still fits on a standard lab table.
- ▶ **Straighter:** Straight to within 0.04 mm over its entire 2-meter length.
- ▶ **Quieter:** PASCO's Air Supply is exceptionally quiet. The air flow can be adjusted precisely for each experiment. Too little air causes friction; too much air causes energy loss due to glider "flutter."
- ▶ **Complete:** The PASCO Air Track comes with a complete set of accessories:
 - ▶ Two 170-gram gliders with soft bumpers. Glider collisions with hard bumpers can cause glider vibration, resulting in significant energy loss. Soft rubber-band bumpers eliminate vibration and allow students to control the force and duration of each collision by varying the band tension.
 - ▶ Air Track Accessory Kit (all items shown on page 125)
 - ▶ Mounting hardware (two single-leg screws, two double-leg screws, one 4 mm wrench, one 5 mm wrench)
 - ▶ One single leg
 - ▶ One double leg with adjustable feet
 - ▶ Two fixed-end stops

Specifications

Length: 2 m (working distance 1.9 m)

Base: Three-point with bilateral leveling screws

Millimeter Scales: 2 meters long on each side

Includes

- Gliders (2): 13 cm long; 170 g; with rubber-band bumpers
- Glider Flags (2): 25 mm
- Glider Masses (4): 50 g
- Glider Bumper (3)
- Inelastic Collision Kit (1): Needle with wax-filled receptacle
- Constant Acceleration Kit: Ball-bearing pulley, glider hook, mass hanger (2 g) and five acceleration masses: two 1 g; one 2 g; one 5 g; one 10 g
- Storage Case

Order Information

2.0 m Air Track SF-9214

Required:

Variable Output Air Supply SF-9216

Suggested:

Replacement Parts..... see opposite page

Air Track Accessory Kit



A set of accessories comes with every PASCO Air Track. All that's needed is a timing system. The pieces of the set may be ordered separately.

Order Information

- Air Track Accessory KitSF-9295
- Recommended:*
- Air Track Glider Kit.....SF-9224
- Air Track Air Supply Hose (2 m).....SF-9298
- Air Track T-Adapter and HoseSF-9217

Variable Output Air Supply

SF-9216



The PASCO Air Supply is exceptionally quiet. Its variable output lets students match the air flow to the experiment.

A 2-meter hose is included. By adding the T-Adapter and Hose (SF-9217), the Air Supply can operate two PASCO Air Tracks at the same time.

Note: This Air Supply produces 36 cfm at 0.122 psi for use with the Precision Air Track SF-9214. If used with another track, the total area of the air flow holes must be $\geq 2.6 \text{ cm}^2$, or the supply may overheat.

Order Information

- Variable Output Air SupplySF-9216

Rubber Cord (30 meters)

ME-8986

For Elastic Bumper (ME-8998) Also fits Air Track Bumpers



Order Information

- Rubber Cord (30 m spool).....ME-8986

Air Track Accessories and Replacement Parts

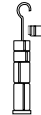
The Air Track includes accessories for standard air track experiments, from simple acceleration to elastic and inelastic collisions. To add more advanced experiments, a variety of additional accessories are available.



Included in the SF-9295 Kit

(Each item may be ordered separately. The number in parentheses indicates how many of each item is included in the Accessory Kit.)

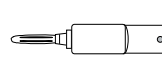
- 1. *Mass/Hanger Set-Air Track (1)*
SF-6300



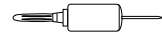
- 2. *Bumper with Holder-Air Track (3)*
SF-6301



- 3. *Bumper Set-Air Track (3)*
SF-6302



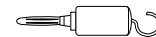
- 4. *Inelastic Collision Needle-Air Track (1)*
SF-6303



- 5. *Wax Receptacle (1)*
SF-6304



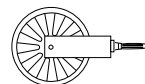
- 6. *Glider Hook (1)*
SF-6305



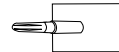
- 7. *Glider Mass (4)*
SF-6307



- 8. *Ball-Bearing Pulley-Air Track (1)*
SF-6308



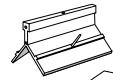
- 9. *25 mm Flag (2)*
SF-6311



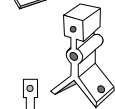
Not included in the SF-9295 Kit

(Must be ordered separately.)

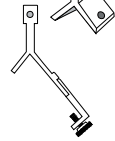
- 10. *Glider-Air Track SF-6306*



- 11. *Fixed End Stop-Air Track SF-6313*



- 12. *Adjustable End Stop-Air Track SF-6309*

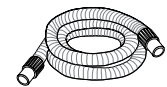


- 13. *Glider Kit-Air Track (see photo below) SF-9224*

(Includes one glider, two 50 g masses, bumper with holder, and bumper blade.)

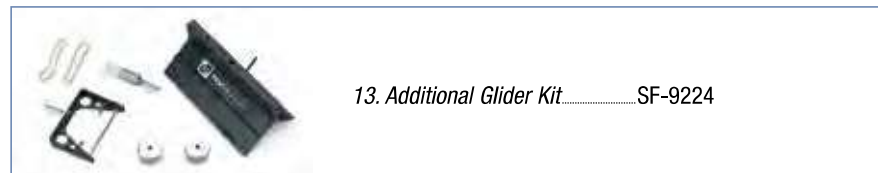
(The following two items are not pictured above and not included in the kit.)

- 14. *Air Supply Hose (2 m)-Air Track SF-9298*



- 15. *T-Adapter and Hose-Air Track SF-9217*

(Allows two air tracks to be operated from one air supply.)



13. Additional Glider Kit.....SF-9224

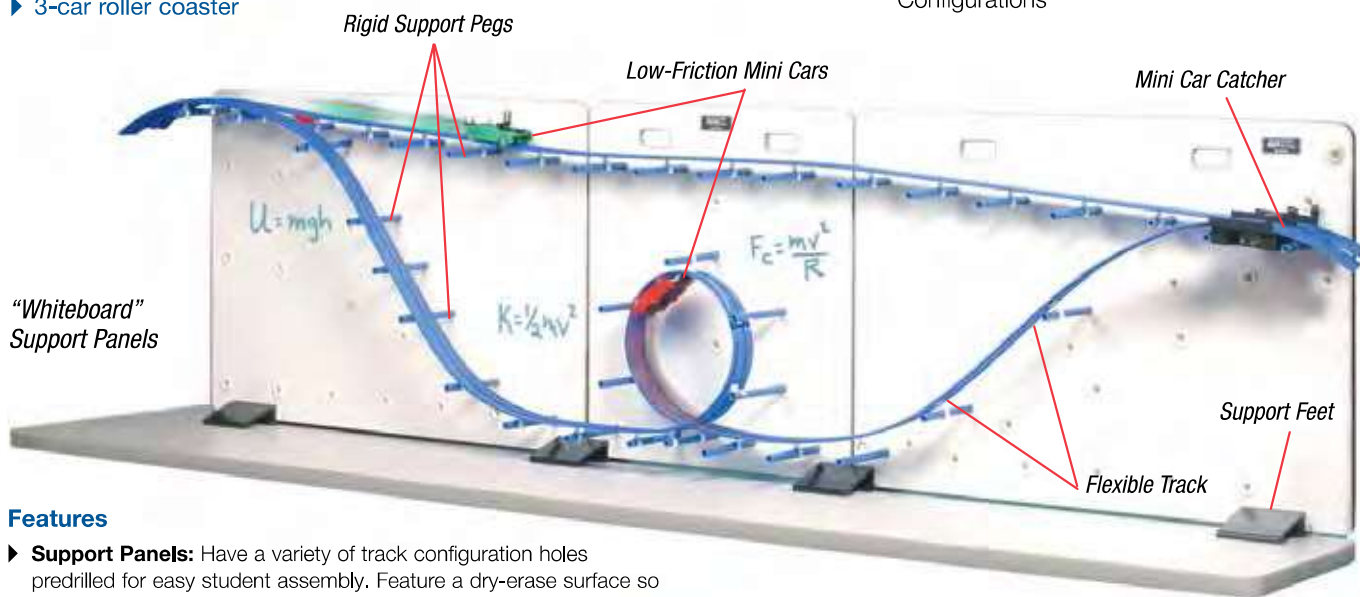
Roller Coaster

Roller Coaster Complete System

ME-9812

- ▶ Quantitative studies of Energy Conservation
- ▶ Easy to change track configurations
- ▶ 3-car roller coaster

Variety of Track Configurations



Features

- ▶ **Support Panels:** Have a variety of track configuration holes predrilled for easy student assembly. Feature a dry-erase surface so calculations can be performed at the point of interest on the track.
- ▶ **Mini Cars:** Feature low-friction ball bearings and ABS construction to withstand repeated impacts. One red, one yellow, and one green Mini Car included. Each car includes a slot for a supplied photogate flag, cup/mass holder, and cup. The body of the car extends just far enough below the wheels to protect them, if the car leaves the track.
 - ▶ The Roller Coaster's Mini Cars are low friction, yet rugged; mass can be added to the cars on top or in the ballast position.
 - ▶ Bumpers mount on Mini Cars to allow rubber band or clay collisions. Also used to couple Mini Cars into a train.
- ▶ **Ballast Mass:** Can be added to mass tray of Mini Car or hidden under Mini Car to increase the energy without changing the car's outward appearance.
- ▶ **Flexible Track:** Guides carts on their path, yet is flexible enough to form loops and hills, or can be rolled out flat on a table. Easily attaches to the support pegs using the twist-on track clips. Long pegs allow two tracks side-by-side for comparison.
- ▶ **Probeware Compatible:** Threaded support pegs and Mini Car photogate flags allow photogates to be used at many positions around the track to measure velocity and acceleration.

Roller Coaster Applications

- ▶ **Conservation of Energy:** Release the Mini Car and measure its velocity and height at several points along the track. Use these values to calculate total energy of the Mini Car. Frictional losses are less than 5%.
- ▶ **Constant Acceleration:** Several straight inclined sections can be used to measure and demonstrate constantly accelerated motion.
- ▶ **Projectile Motion/Conservation of Energy:** Use the initial height of the Mini Car to determine its speed as it flies off the end of the track. Using this speed and height above the ground when it leaves the track, predict where the Mini Car will land.
- ▶ **Multi-car Train:** Mini Cars can be coupled to form a train and the velocity of each car can be measured with a photogate and a Smart Timer. The velocities are not the same.
- ▶ **Brachistochrone:** A Mini Car traveling between two points along a brachistochrone path takes less time compared to the straight line path.

Includes



- Support panel (3 sections)
- Support feet (4)
- Flexible track (9.1 meters)
- Mini Cars (3)
- Support pegs for track (43)
- Photogate support pegs (4)
- Track clips (50)
- Mini Car catcher (2)
- Mini Car starter bracket (2)
- Mini Car collision accessory (3)
- Mini Car photogate flags (3)
- Water cup (3)
- Mini Car ballast mass (3)
- Photogate brackets (4)
- Track couplers (2)

Order Information

Complete Roller Coaster	ME-9812	
<i>Recommended:</i>		
Photogate Head	ME-9498A	p. 45
Photogate Bracket (2)	ME-9806	p. 107
Roller Coaster Spares Kit	ME-9815	
Mini Car Set.....	ME-9813	
Roller Coaster Track (9.1 meters).....	ME-9814	
Smart Timer.....	ME-8930	p. 124
or Computer Interface.....	pp. 26-27	

Loop-the-Loop

SE-7591

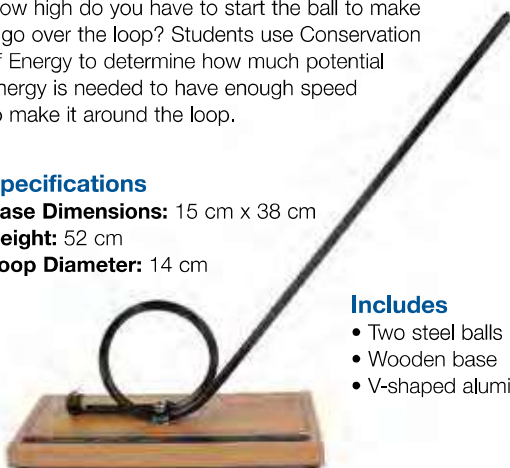
How high do you have to start the ball to make it go over the loop? Students use Conservation of Energy to determine how much potential energy is needed to have enough speed to make it around the loop.

Specifications

Base Dimensions: 15 cm x 38 cm

Height: 52 cm

Loop Diameter: 14 cm



Includes

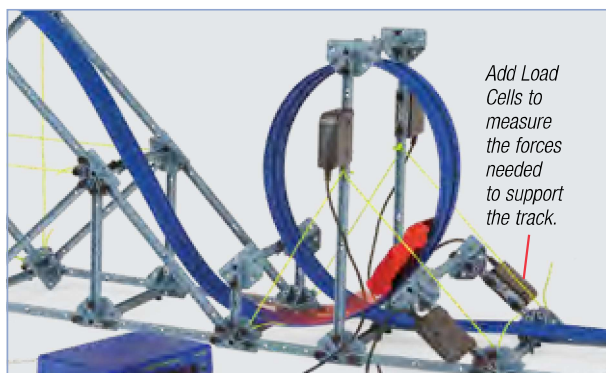
- Two steel balls (1.9 cm dia.)
- Wooden base
- V-shaped aluminum track

Order Information

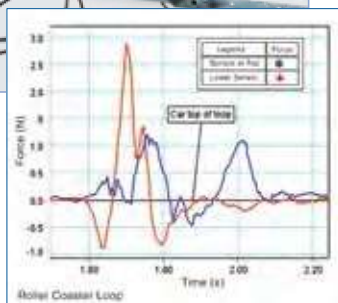
Loop-the-Loop SE-7591

Design your own roller coaster with PASCO's Structures System.

PASCO's Structures System allows students to design and build their own roller coaster for detailed studies of conservation of energy and centripetal force. The flexible track is perfect for building hills, valleys and even a loop! Car with low-friction, ball-bearing wheels minimizes energy losses. Measure the speed of the car using photogates or a Motion Sensor.



Add Load Cells to measure the forces needed to support the track.



Add a loop to your roller coaster

Investigate the effect of changing the size and shape.

Graph shows support forces exerted on the track as the car goes up and over the loop.

Order Information

Large Structures Set ME-7003 p. 156
 Shown in use with:
 Load Cell & Amplifier Set PS-2199 p. 40
 Accessory Photogate ME-9204B p. 45

Amusement Park Physics Kit

ME-9426A

- ▶ Extend your lab into the "real world"
- ▶ Complete kit for 15 students
- ▶ Developed in conjunction with AAPT*

They might lose their notes. They might even lose their nerve. But in one day at an amusement park, students will also gain a real "gut-level" appreciation for Newton's Laws. Using this kit, students don't observe a dynamics cart. They are the dynamics cart. This is the only kit that is:

- ▶ Approved by the safety officers of major amusement parks across the USA.
- ▶ Student-tested in amusement parks by hundreds of schools.
- ▶ Teacher-tested in hundreds of Amusement Park Physics Workshops.
- ▶ Made with a metal coil spring for the Vertical Accelerometer (far more accurate than the commonly used rubber band).
- ▶ Supporting physics education (for each set sold, \$2.50 is donated to the AAPT).



Students experience the thrill of scientific investigation.

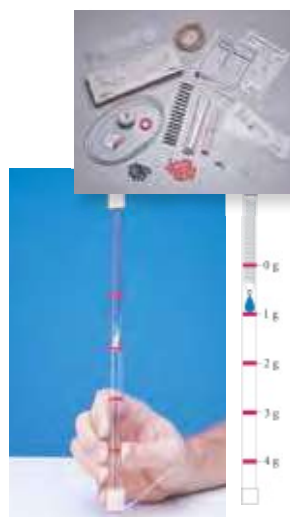
Photo courtesy of Paramount's Great America.

* American Association of Physics Teachers

Includes

- Brass Hanging Weights (19)
- Springs** k = 3 N/m (16)
- Plastic Tubing (2.5 m)
- Plastic Tubes, 30 cm long (16)
- Plastic Tube End Caps (32)
- Bumper Stickers (16)
- Horizontal Accelerometer
- Cards (16)
- Push Pins (5)
- No. 3 Paper Clips (17)
- Cotton String
- Metal Balls (60)
- Straws (16)
- Wire Ties
- Vinyl Tape
- Rubber Bands #117 (32)
- Rubber Bands #19 (6)
- Plastic Storage Bags (16)
- Instruction Manual

**Additional accelerometer springs may be purchased separately. See order information below.



The Vertical Accelerometer: The stretch of the spring measures the vertical acceleration in "g's."



The Horizontal Accelerometer: The angle to which the BBs rise measures the horizontal acceleration. This accelerometer doubles as a sextant to measure distances by triangulation.

Order Information

Amusement Park Physics Kit (15 pack) ME-9426A
 Recommended:
 Additional Accelerometer Springs (15 pack) ME-8734
 Scissors, pliers, masking tape, clear plastic tape

Hovercraft

Hovercraft

ME-9838

- ▶ Students experience Newton's Laws
- ▶ Durable nylon skirt
- ▶ Rubber bumper
- ▶ Optional cordless air supply

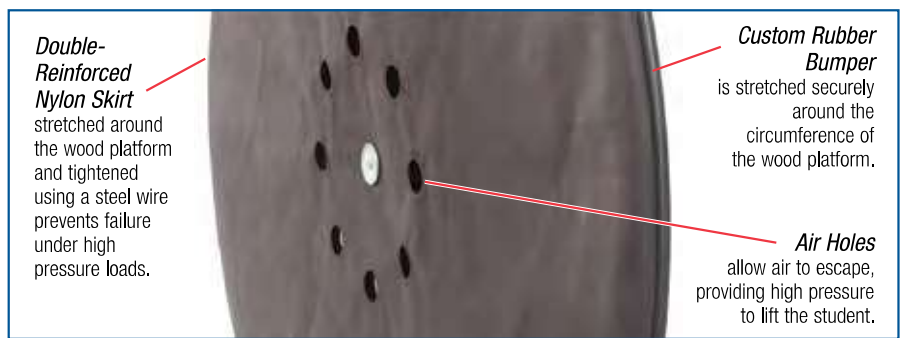
Our Hovercraft follows the classic design, with a rugged nylon skirt attached around a 1.2 m wood platform. Students can easily ride on the Hovercraft to experience firsthand the kinematics of frictionless motion.

How It Works

The nylon skirt is stretched around the wood platform and tightened using a steel wire. The center of the skirt is attached to the bottom of the wood platform. A custom rubber bumper is placed around the circumference of the wood platform. The bumper helps secure the skirt and also provides a soft cushion around the edge of the Hovercraft. A high-volume air source is used to force air through the platform and into the skirt. After sitting on the platform, the air source is turned on and the skirt inflates. Small holes in the skirt allow the air to escape, while providing the higher pressure needed to lift the rider. A built-in level helps students center their weight on the Hovercraft.

A Cordless Air Source (SE-8806) is orderable separately (below). In addition, most leaf blowers provide enough air flow to support the Hovercraft.

The PASCO Hovercraft is capable of supporting up to 300 lbs and comes completely assembled.



Includes

- Wood platform (1.2 m diameter, 1.9 cm thick)
- Nylon skirt with mounting hardware
- Rubber bumper
- Liquid level
- Connection hose for air source



Order Information

Hovercraft.....ME-9838
 Required:
 Cordless Air SourceSE-8806

Hover Puck

SE-7335B

- ▶ Hovers on a cushion of air
- ▶ Ideal for inertia activities

The Hover Puck glides on a self-generated cushion of air across any smooth surface, including low-pile carpet. The rubber bumper provides protection for the puck and other objects during collisions. Each puck includes four "AA" batteries.



Includes

- Hover Puck (Appearance may vary.)
- Four "AA" Batteries

Order Information

Hover Puck.....SE-7335B
 Recommended:
 Motion Sensor.....PS-2103A p. 34
 Motion Sensor II.....CI-6742A p. 34
 Wireless
 Motion Sensor.....PS-3219 p. 9

Cordless Air Source

SE-8806



Includes

- Rechargeable Battery
 - Charging Adapter
- Note:** 220 V version **not** available.

Order Information

Cordless
 Air Source.....SE-8806

Coin and Feather Tube

SE-9788

The "Coin and Feather" experiment is one of the best ways to dispel the "lighter objects fall more slowly" myth.

When the air inside the 75 cm tube is at atmospheric pressure, the feather (in this case a very visible piece of Styrofoam) falls significantly more slowly than the coin. The syringe vacuum pump (included) will bring the air inside the tube down to about 7% of atmospheric pressure, making the feather and the coin appear to drop at the same rate.



Includes

- 3.8 cm diameter clear plastic tube with end caps
- Coin and "feather" (Styrofoam)
- Syringe vacuum pump

Order Information

Coin and Feather Tube SE-9788

Constant Speed Buggy

SE-8028A

Turn on the Constant Speed Buggy and watch it go. When it reaches a wall, it flips over and changes directions. This low-cost solution features flashing lights and a sporty appearance. Requires two "C" batteries that are not included. Actual product may vary from picture.



WARNING
CHOKING HAZARD
 Small parts. Not for children under 3 years.

Order Information

Constant Speed Buggy SE-8028A

Constant Velocity Tubes (4)

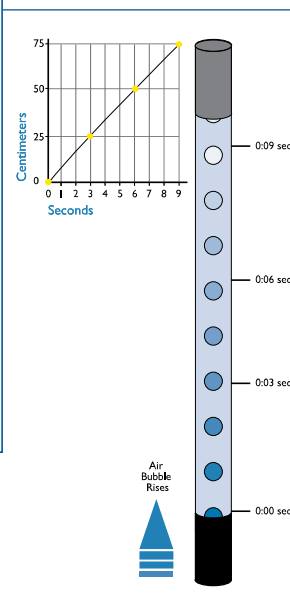
SE-9072



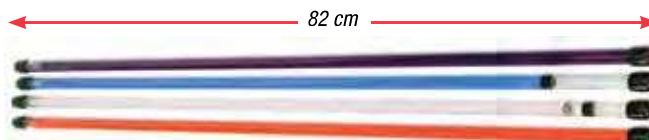
This set is unusual because it includes a tube with both a bubble, a plastic ball and a metal ball, giving the students the added twist of having an object with a negative velocity and thus a negative slope on the graph. Students can predict where the ball and the bubble will meet.

Constant Velocity Tubes effectively introduce the relationship between graphs and motion. Students can use a meter stick and a stopwatch to plot the position of the bubble as a function of time as it moves up the tube. Each tube has an obstruction that serves as the initial position for the bubble. The slope and vertical intercept from the graph yield the equation of motion.

This set includes three tubes with varying viscosities and initial starting points plus one tube with both a bubble and two balls. The red one and the colorless one have the same viscosity.



Includes both a bubble and a metal ball!



Order Information

Constant Velocity Tubes (4) SE-9072
 Required:
 Meter Stick (6 pack) SE-8827
 PASCO Stopwatch ME-1234

Gravity & Freefall

Discover Freefall System

ME-9889

- ▶ Determine g
- ▶ Investigate air resistance dependence on mass, volume, cross-sectional area

PASCO's Discover Freefall System can be used to drop almost any small object by attaching a small steel washer with a small adhesive pad (both are included in the system). Using an electric switch, timing is started automatically, just as the object is dropped. And the Time-of-Flight Pad stops timing when the object strikes it.

Students can investigate the effect of air resistance on acceleration. In addition, students can drop objects of the same size but different mass to study how object mass affects terminal velocity during freefall. The drop box has a magnetic mount for attaching to metal frames in ceilings.

Custom case with built-in rod clamp and magnets to fasten Drop Box to ceiling



Set includes six different balls

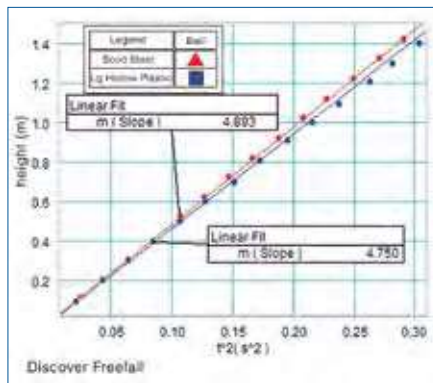
Active feedback loop measures the magnetic field and adjusts current to null field and release ball in less than 1 ms.

This system can also accept the Target Accessory, ME-6854, to perform the shoot-the-target demonstration. See page 139.



Includes

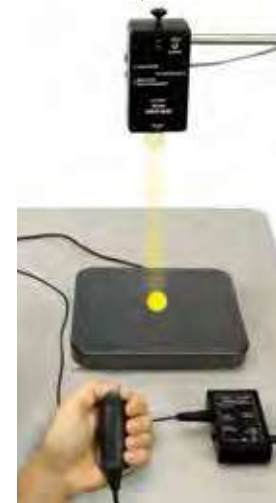
- Drop box
- Control cable
- Control box
- AC adapter
- Time-of-Flight receptor pad
- Timer Switch
- Release washers (10)
- Release labels for attaching washers to object (50)
- Small nylon ball
- Large plastic ball
- Golf ball
- Hollow golf ball
- 1" steel ball
- 5/8" steel ball



When the switch is pressed, the ball is dropped and the time of fall is measured for various balls. The graph shows height vs time-squared data for the 1 inch steel ball and the large hollow plastic ball. The slope of the line (equal to $1/2 g$) gives an acceleration for the steel ball of 9.79 m/s^2 . Note that the acceleration of the large hollow ball is considerably smaller and that its data is not linear.



Shown in use with rods and clamps sold on pages 186-189. The Drop Box also has built-in magnets to fasten directly to the ceiling.



The Discover Freefall System also works with the 850, PASPORT, or any ScienceWorkshop Interface. Shown here using a Digital Adapter.

Order Information

Discover Freefall System	ME-9889	
<i>Required:</i>		
Smart Timer.....	ME-8930	p. 124
850/550 Interface.....		p. 28
<i>Recommended:</i>		
Freefall Balls Accessory.....	ME-9890	p. 197
Rods and Clamps.....		pp. 191-193

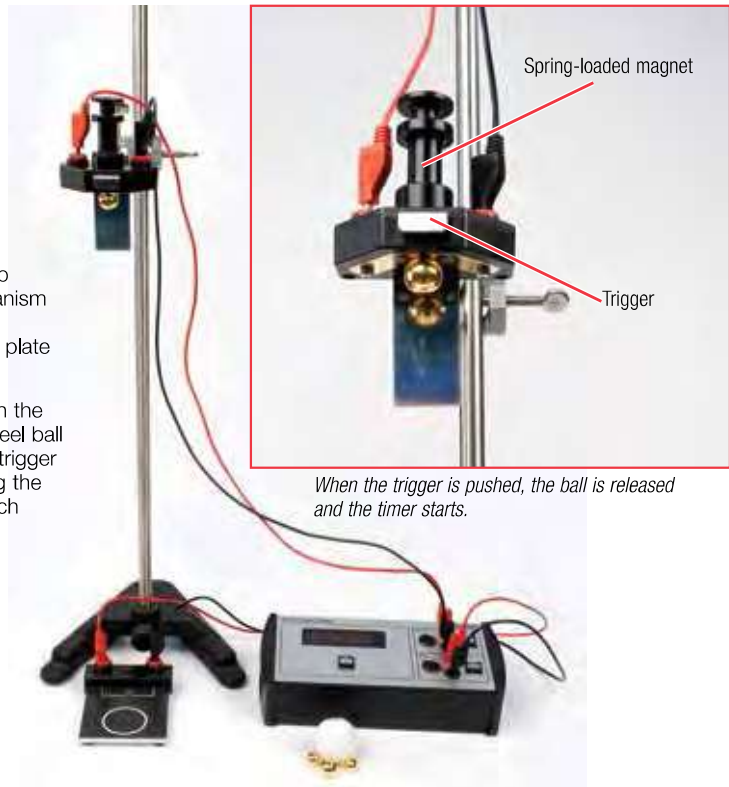
Freefall Apparatus

SF-7274

- ▶ Drop ball from rest and time the fall
- ▶ Explore effect of air drag on two different size balls with the same mass
- ▶ Precise and straight-forward device for measuring free fall

The acceleration of gravity g can be computed by measuring the drop distance and the fall time. The apparatus consists of a release mechanism that also acts as the start switch, a switch plate that acts as the stop switch, and conducting balls. The release mechanism and the switch plate are both connected to the Student Timer (not included).

The release mechanism has two contact plates that are shorted when the conducting ball being measured is in place and ready to drop. The steel ball is held in place by a spring-loaded neodymium magnet. Pushing the trigger will cause the ball to drop away from the contact plates, thus opening the counter start circuit just as the fall begins. When the ball hits the switch plate, the timer is stopped.



When the trigger is pushed, the ball is released and the timer starts.



When the ball hits the switch plate, the timer stops.

Order Information

Freefall Apparatus.....	SF-7274	
<i>Required:</i>		
Student Timer.....	SF-7275	p. 126
Small A-base.....	ME-8976	p. 190
120 cm Stainless Steel Rod.....	ME-8741	p. 190
2 m Patch Cord Set.....	SE-9415A	p. 232
<i>Replacement:</i>		
Replacement Free Fall Ball Set	SF-7280	

Includes

- Magnetic release mechanism with mirror
- Switch plate
- 4 gold-plated steel balls (diameters 12 mm and 16 mm)
- Ping pong ball with same mass as 12 mm steel ball

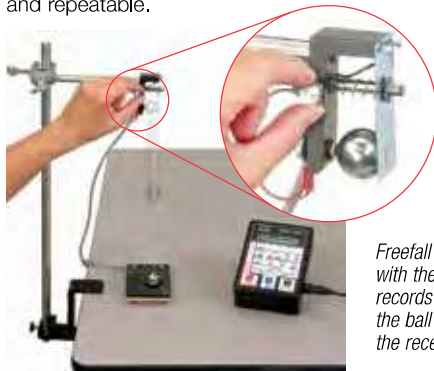


Freefall Timer Adapter

ME-9207B

How It Works

A steel ball is clamped into a spring-loaded release mechanism. At the instant the ball is released, the electronic timer automatically starts. The timer stops when the ball hits the receptor pad. With the accurate, high resolution timing and automatic start and stop, results are precise and repeatable.



Maximum distance of fall is 2 m.

Freefall Timer Adapter shown in use with the Smart Timer. The Smart Timer records the elapsed time from when the ball is dropped until the ball hits the receptor pad.

Includes

- Ball release mechanism with stereo phone plug and receptor pad
- Four steel balls (1.9 cm, 1.6 cm diameter)



Order Information

Freefall Timer Adapter.....	ME-9207B	
<i>Required:</i>		
Large Table Clamp.....	ME-9472	p. 193
Multi Clamp.....	ME-9507	p. 192
Rod (90 cm long).....	ME-8738	p. 190
Photogate Timer	ME-9215B	p. 126
or Smart Timer	ME-8930	p. 124
or 850/550 Interface.....		p. 28

Launchers

Projectile Launcher

ME-6800

- ▶ Accurate
- ▶ Durable



Add optional Smart Gate to measure launch velocity.

Three Repeatable Launch Ranges Visible through viewing ports.

2.5 cm Nylon Balls



Plumb Bob Indicates angle to 1/2°.

Stable Launcher Base Offers horizontal and variable angle launching positions.

Loading Rod

Unique Sights

Shoot-the-Target

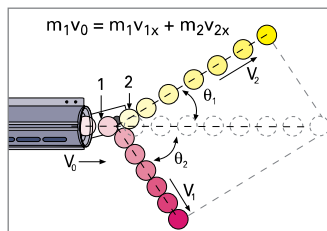
The "gun" is aimed directly at the target. Although the target "drops" the moment the projectile is fired, the ball still hits the target since the ball falls with the same acceleration.



Two bore sights simplify aiming the launcher.



2-D Collisions



The 2-D Collision Accessory (included with all PASCO launchers) allows the study of **Conservation of Momentum** in two dimensions. Use the points of impact with the floor of each of the two balls to determine relative velocities and angles.

Specifications

Ranges: 1.2, 3, 5 m

Launch Angles: 0 to +90°

Launcher Length: 21 cm

Features

- ▶ **Fixed Firing Height at Any Launch Angle:** Firing height of ball is same for any launch angle.
- ▶ **Unique Piston Design:** Minimizes projectile spin to ensure repeatability of impact position.

Includes

- Launcher with Base
- Projectile Balls
- Loading Rod
- Safety Glasses
- 2-D Collision Accessory
- Manual

Launcher Spares Kit

ME-6802

Includes

- Loading Rod (10)
- 2-D Collision Accessory (2)
- Plastic Balls (10 pack)
- Sights (5 pack)
- Angle Indicator
- Plumb Bobs (12 pack)
- Thumbscrew to attach launcher to base (10)



Order Information

Launcher Spares Kit ME-6802

Order Information

Projectile Launcher	ME-6800	
<i>Shown in use with:</i>		
Shoot-the-Target System	ME-6853	p. 139
Photogate Mounting Bracket	ME-6821A	p. 141
Smart Gate	PS-2180	p. 42
<i>Recommended:</i>		
Time-of-Flight Accessory	ME-6810A	p. 141
Large C-Clamp (6 pack)	SE-7285	p. 141
Plumb Bobs (10 pack)	SE-8728	p. 141

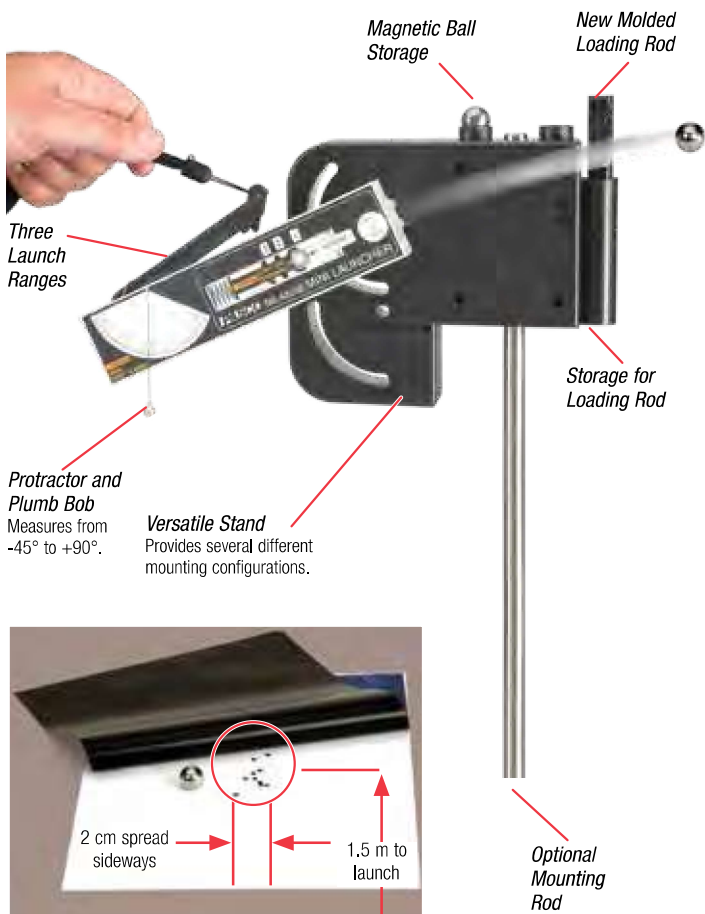
Mini Launcher

ME-6825B

- ▶ Ideal for tabletop projectile experiments
- ▶ Fires at downward angles
- ▶ Low cost

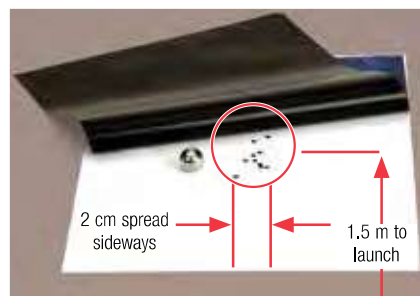
New bracket features include:

- ▶ Magnetic ball storage
- ▶ New plunger storage
- ▶ Shooting positions now labeled



Protractor and Plumb Bob
Measures from -45° to +90°.

Versatile Stand
Provides several different mounting configurations.



Typical pattern for Mini Launcher –
Ball was launched 10 times off 1 m high table at 30° angle. All 10 shots landed within 5 cm diameter circle.

2-D Collision



The 2-D Collision Accessory (included with all PASCO launchers) allows the study of **Conservation of Momentum** in two dimensions.



Shoot from table top level!



Negative launch angle!

Unique stand design allows ball to be launched from tabletop height. The ball lands on the table at the same height from which it was launched.

Magnetic Piston holds ball in place for launching at downward angles.

Specifications

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

Includes

- Launcher Base
- Loading Rod
- 2-D Collision Accessory
- Projectile Balls
- Safety Glasses
- Manual

Order Information

Mini Launcher.....	ME-6825B	
<i>Recommended:</i>		
Photogate Mounting Bracket.....	ME-6821A	p. 141
Smart Gate	PS-2180	p. 42
Time-of-Flight Accessory.....	ME-6810A	p. 141
Large C-Clamp (6 pack).....	SE-7285	p. 141
Steel Rod.....	ME-8736	p. 190
Plumb Bobs (10).....	SE-8728	p. 141
Carbon Paper (100 Sheets).....	SE-8693	p. 141
Metric Measuring Tape	SE-8712A	p. 196

Mini Launcher Spares Kit

ME-6824

Includes

- Loading Rod (10)
- 2-D Collision Accessory (2)
- Steel Balls (10 pack)
- Angle Indicator
- Plumb Bobs (12 pack)
- Thumbscrew to attach launcher to base (10)



Order Information

Mini Launcher Spares Kit..... ME-6824

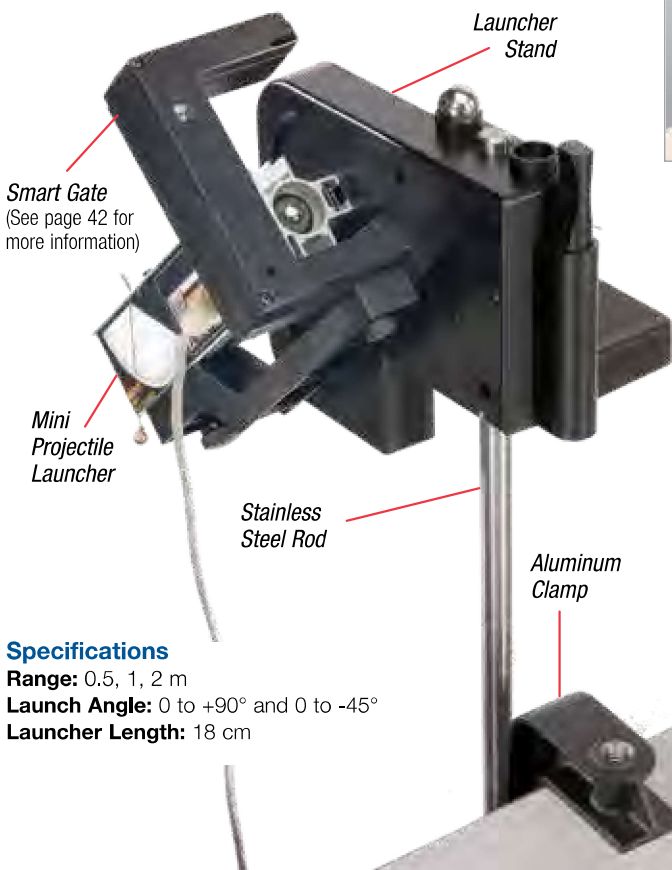
Launchers

Projectile Launcher Smart Gate System

ME-6798

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

With this combination, your students can study projectile motion and measure the initial speed with one economical Smart Gate, since it has two built-in photogate beams. The Mini Launcher and Smart Gate make the setup simple: Just clamp the launcher to the table and slide the Smart Gate on. All the components needed are included, even the rod and clamp.



Specifications

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

Includes

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



Order Information

Projectile Launcher Smart Gate System.....ME-6798
 Shown in use with:
 Time-of-Flight AccessoryME-6810A p. 139
 Required:
 PASPORT Interface

Add optional Time-of-Flight



Daisy-chain Time-of-Flight to Smart Gate.

Smart Gate connects directly to a PASPORT interface.

Projectile Launcher Wireless Smart Gate System

ME-6796

Choose this wireless option to eliminate cables between the computer and the projectile launcher. The Wireless Smart Gate has all the features of the Smart Gate (PS-2180), but it connects to your computing device via Bluetooth® or USB; it does not require an interface.



Includes

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

Order Information

Projectile Launcher
 Wireless Smart Gate SystemME-6796

Carbon Paper (100 sheets)

SE-8693

Use to mark the position of the ball.



Order Information

Carbon Paper (100 sheets) SE-8693

Time-of-Flight Accessory

ME-6810A

► For use with all PASCO launchers

Includes

- Time-of-Flight Accessory
- Instruction Manual
- Experiment Guide



Order Information

Time-of-Flight Accessory ME-6810A

Shoot-the-Target

ME-6853

► Demonstrate independence of x- and y-motion

► For use with all launchers

The PASCO Shoot-the-Target Accessory, in combination with a projectile launcher, demonstrates that acceleration is constant for all objects in freefall, regardless of initial velocity. A target is initially suspended near the ceiling, and a projectile launcher is aimed directly at it. As soon as the projectile is shot from the launcher, the target is released. The projectile hits the target as it falls, proving that both objects accelerate downward at the same rate.

Before it falls, the target is attached to the drop box by a permanent magnet so it can hang indefinitely, even when the drop box is not powered. A photogate detects the projectile as it leaves the launcher and triggers the drop box. The drop box releases the target by driving a current through a coil that cancels the field of the permanent magnet.

The "gun" is aimed directly at the target. Although the target "drops" the moment the projectile is fired, the ball still hits the target since the ball falls with the same acceleration.

Includes

- Drop Box & Control Box
- Control Cable
- High Impact Plastic Target (75 cm x 20 cm) ME-6852
- Photogate Head & Bracket
- AC Adapter (9 VDC, 500 mA)



Order Information

Shoot-the-Target System ME-6853
Recommended:
 Projectile Launcher ME-6800 p. 136
 Mini Launcher ME-6825B p. 137

Launcher Accessories

Drop-Shoot Accessory

ME-9859

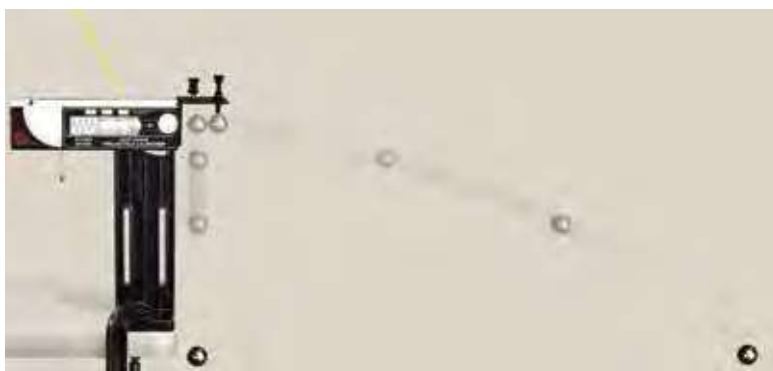
- ▶ Simultaneously drops one ball and launches a second ball horizontally
- ▶ Prove the independence of x- and y-motion
- ▶ Mounts on PASCO projectile launchers (short- and long-range)

The Drop-Shoot Accessory is an easy-to-use tool that helps students better understand the independence between the horizontal and vertical motion of a projectile. Connect the accessory to either the short or long range projectile launchers, hang one ball from the magnet and fire away. The fired ball strikes the hanging ball, causing one ball to shoot horizontally at the same instant the other ball falls straight down. Both balls hit the ground at the same time, regardless of the fired projectile's muzzle velocity, provided the Projectile Launcher is level. This device also provides an interesting demonstration of Conservation of Momentum in collisions.

When the (included) hollow steel ball is used, the two balls are both fired horizontally at two different speeds. A Photogate and Time-of-Flight Accessory can also be used to directly measure time of flight.

Includes

- Drop-Shoot Bracket
- 2.5 cm Steel Balls (2)
- 2.5 cm Hollow Steel Ball
- Mounting Hardware
- Loading Rod



When the solid ball hits the hanging solid ball, the hanging ball shoots out horizontally, while the ball shot out of the launcher drops straight down.



Either the solid steel ball or hollow steel ball is hung by a magnet.

Order Information

Drop-Shoot AccessoryME-9859
 Required:
 Projectile LauncherME-6800 p. 136

Ball Ramp

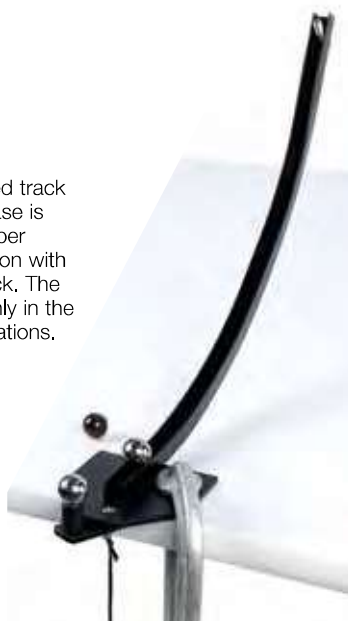
SE-7596

- ▶ Use for Projectile Motion
- ▶ Use for 2-D Collisions

This apparatus consists of a curved track with a base at one end. On the base is a support to hold a ball at the proper height for a center-to-center collision with a second ball rolling down the track. The track is level so collision occurs only in the horizontal plane, simplifying calculations.

Includes

- 25 cm one-piece track
- 3 balls (12 mm diameter):
2 steel, 1 glass
- Plumb bob



Order Information

Ball Ramp.....SE-7596

Drop-Shoot Demo

SE-7592

- ▶ Demonstrates the independence of horizontal and vertical components of projectile motion

Releasing the spring causes one ball to drop directly down while the other is projected horizontally. Listen and you'll hear that both hit the floor at the same time! The Drop-Shoot Demo is 25 cm long.

Includes

- Metal base with spring launcher
- Rod (10 cm long)
- Steel balls (2)



Order Information

Drop-Shoot Demo.....SE-7592

Time-of-Flight Accessory

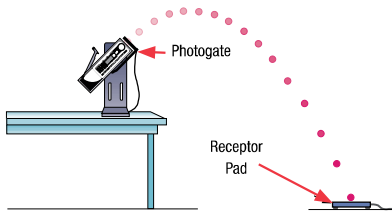
ME-6810A

▶ For use with all PASCO launchers

When the projectile is launched, the photogate mounted on the launcher starts timing.



When the projectile hits the receptor pad on the Time-of-Flight Accessory, an electric signal is sent to stop timing.



Includes

- Time-of-Flight Accessory
- Instruction Manual
- Experiment Guide

Order Information

Time-of-Flight Accessory..... ME-6810A

Photogate Mounting Bracket

ME-6821A



Mount one or two photogates on any Projectile Launcher. Compatible with Photogate Heads below.



Order Information

Photogate Mounting Bracket.....ME-6821A
 Photogate Head.....ME-9498A p. 45
 Accessory Photogate.....ME-9204B p. 45

Small Steel Balls (10 pack)

ME-9872

These 1.6 cm diameter steel balls are used with the Mini Launcher (ME-6825B).



Order Information

Small Steel Balls (10 pack)..... ME-9872

Steel Balls (4 pack)

ME-9864

Purchase this 4 pack of 2.5 cm diameter balls for use with PASCO Short or Long-Range Projectile Launchers (ME-6800 or ME-6801).



Order Information

Steel Balls (4 pack)..... ME-9864

Plastic Balls

ME-6822

Extra brightly colored balls are available for the Projectile Launcher. Diameter is 2.5 cm (1 in.).



Order Information

Plastic Balls (10 pack).....ME-6822

Spherical Mass Set

ME-8968



This set includes four balls with a diameter of 2.5 cm each, but features various masses, including a hollow steel ball, solid steel ball, plastic ball and aluminum ball.

Order Information

Spherical Mass Set..... ME-8968

Projectile Launcher Sights (5 pack)

ME-9865

Purchase this 5 pack of aiming sights as a replacement for the Short-Range or Long-Range Projectile Launchers.



Order Information

Projectile Launcher Sights (5 pack)..... ME-9865

Projectile Launcher Plumb Bobs (12 pack)

ME-9868A

This kit includes 12 brass plumb bobs and 12 washers to replace lost or broken parts from any of PASCO's projectile launchers.



Order Information

Projectile Launcher Plumb Bobs (12 pack).....ME-9868A

"C" Clamps

SE-7285

These rugged clamps are perfect for attaching a variety of objects to a table. Size 10 cm (4 inch).



Order Information

"C" Clamp (6 pack)..... SE-7285

Plumb Bobs (10 pack)

SE-8728

Order Information

Plumb Bobs (10 pack) SE-8728



Carbon Paper (100 sheets)

SE-8693



For marking the position of the ball.

Order Information

Carbon Paper (100 sheets) SE-8693

Ballistic Pendulum

ME-6830

- ▶ Extremely accurate: $\pm 2.5\%$ of predicted values
- ▶ Both elastic and inelastic experiments
- ▶ Projectile launcher experiments
- ▶ Now includes ME-6800 bracket!

This classic physics experiment combines the laws of Conservation of Momentum and Conservation of Energy to determine the muzzle velocity of the projectile. Only simple mass and distance measurements are required to make this determination.

How It Works

A projectile is fired into a pendulum, causing it to rise.

Using the projectile mass, the pendulum mass, and the rise in pendulum height, students can calculate the gravitational potential energy of the system.

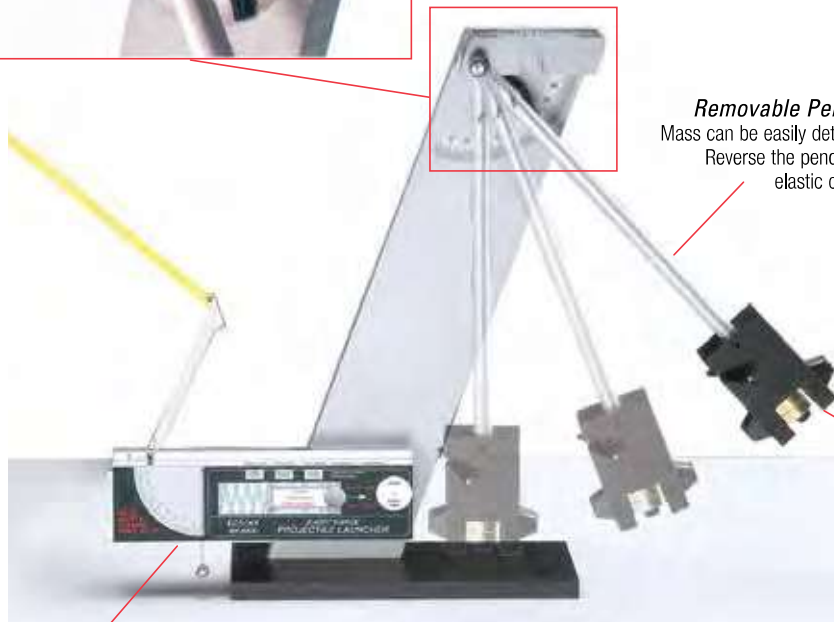
Since the potential energy is equal to the pendulum's kinetic energy at the lowest point, students can calculate the speed of the pendulum at impact.

Applying the Law of Conservation of Momentum, the projectile's speed is easily calculated.

An additional mounting bracket is included to perform the full range of projectile launcher experiments.



Unique Angle Measurement Design
Easily measures pendulum angle to 0.5° .
Low friction gives repeatable results.



Removable Pendulum
Mass can be easily determined.
Reverse the pendulum for elastic collisions.

Projectile Catcher
Securely captures ball.

Projectile Launcher
Durable with three repeatable launch settings.

Add Masses
Two 50 g masses (included) can be added to change the pendulum mass and rotational inertia.



Already own a PASCO Projectile Launcher?

The base and pendulum assembly can be purchased separately.

See Ballistic Pendulum (No Launcher) in the order block for more information.

PASCO's Ballistic Pendulum— A New Approach

The PASCO Ballistic Pendulum has the following unique features:

Repeatable: The three velocity settings on the Projectile Launcher produce consistent velocities.

Accuracy: The $0-80^\circ$ angle measurement scale resolves to $1/2^\circ$, leading to experimental results within 2.5% of predicted values.

Removable Pendulum: Remove the pendulum to determine its mass and center of mass. It can swing freely so students can determine its rotational inertia. Mount the pendulum backwards so the ball bounces away for elastic collision experiments.

Vary Ball and Pendulum Mass: Two 50 g masses can be added to the pendulum, and two steel and two plastic balls are included.

Projectile Launcher: Mount the Projectile Launcher on the other side of the base, and students have access to all the accessories that come with the Projectile Launcher ME-6800 (see page 136).

Includes

- Ballistic Pendulum and Base
- Projectile Launcher
- Projectile Launcher Base
- 2.5 cm Plastic Balls (2)
- 2.5 cm Steel Balls (2)
- Masses (2)
- 2-D Collision Accessory
- Safety Glasses (2 pairs)
- Operations and Experiment Manual



Order Information

Ballistic Pendulum ME-6830
Ballistic Pendulum (No Launcher) ME-6831

Recommended:

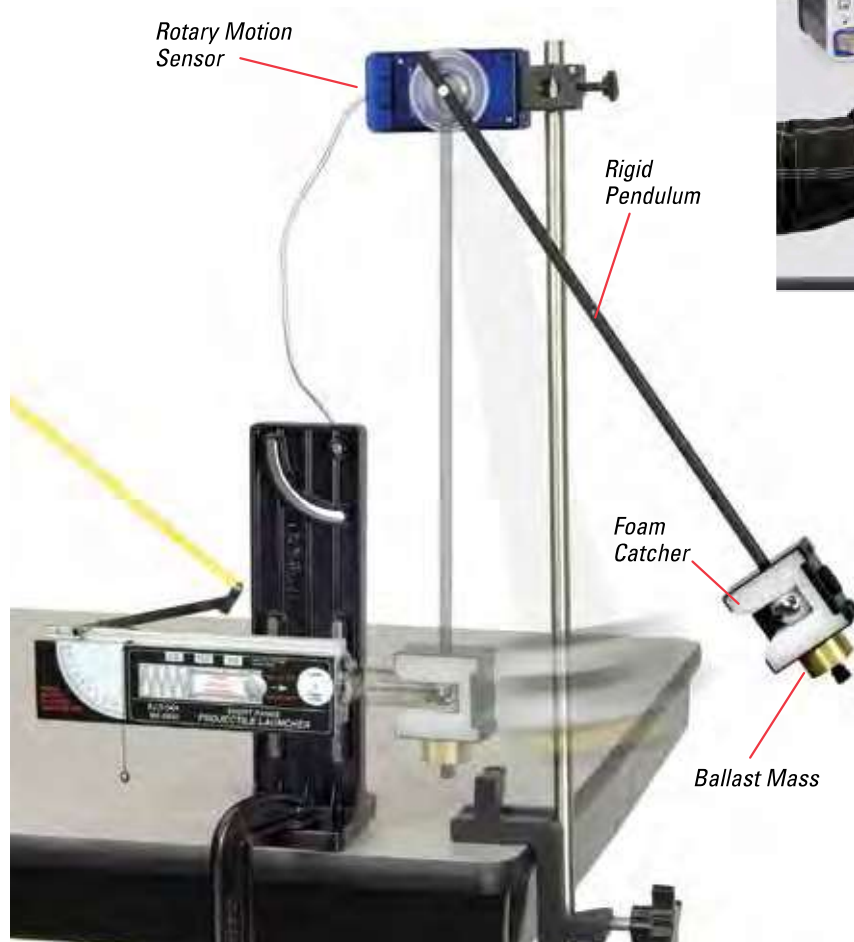
Spherical Mass Set..... ME-8968 p. 141
Shoot-the-Target ME-6853 p. 139
Time-of-Flight..... ME-6810A p. 139
Large C Clamp (6 pack) SE-7285 p. 141

Ballistic Pendulum Accessory

ME-9892 (for use with the ME-6800 Projectile Launcher on page 136)

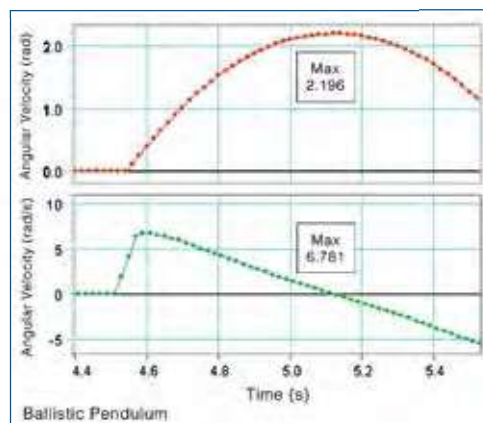
- ▶ Both are accessories to the Rotary Motion Sensor
- ▶ For elastic and inelastic experiments
- ▶ Low cost

Both of these ballistic pendulum accessories use a Rotary Motion Sensor to measure the speed of the catcher assembly immediately after the collision, as well as the maximum height to which the pendulum swings. The Rotary Motion Sensor can also be used to measure the rotational inertia of the pendulum for a detailed study of the collision using conservation of angular momentum.



Mini Launcher Ballistic Pendulum Accessory

ME-6829 (for use with the ME-6825B Mini Launcher on page 137)



Rotary Motion Sensor (required for use) allows measurement of instantaneous velocity of catcher immediately after collision, as well as total angle of rotation of the pendulum arm.

Both accessories include:

- Pendulum Arm with Catcher
- Ballast Mass
- Steel Ball



Order Information

Mini Launcher Ballistic Pendulum Accessory.....	ME-6829	
<i>Required:</i>		
Mini Launcher.....	ME-6825B	p. 137
Rotary Motion Sensor	PS-2120A	p. 35

Order Information

Ballistic Pendulum Accessory	ME-9892	
<i>Required:</i>		
Projectile Launcher.....	ME-6800	p. 136
Rotary Motion Sensor	PS-2120A	p. 35

Statics

Pulley Demonstration System

SE-8685

- ▶ Demonstrate the mechanical advantage of single or combination pulleys
- ▶ Complete stand-alone pulley apparatus
- ▶ Simple setup

Features

Stable Base: Easily attach two threaded 81 cm rods to the sturdy base. Includes an eye-hook and capstan to demonstrate an entire pulley system.

Comprehensive: Contains everything needed to effectively display the usefulness of pulleys, including slotted masses and mass hangers.

Several Pulley Types: Reveal the benefits of single pulleys and those of tandem pulleys, quadruple pulleys, and even the four-step pulley. Combine several of them for an efficient pulley system.



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. Observe that 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 (1)
- Slotted masses (13)
- Mass hangers (6)



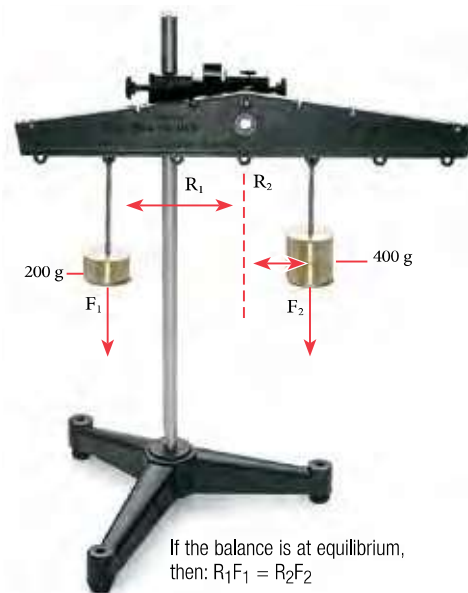
Equal Arm Balance

ME-8949

Developed for
Workshop Physics®
activities



The Equal Arm Balance was specially designed to simplify the study of torques. This balance has a ball-bearing pivot.



With 200 g and 400 g masses placed as shown above, the balance remains in equilibrium.

Specifications

- Total length:** 34 cm
- Maximum weight exerted on balance arm:** 1 kg or 10 N



Includes

- Balance Arm with Ball-Bearing Pivot

Order Information

- Equal Arm BalanceME-8949
- Required:
- Drilled Mass and Hanger SetME-8979

p. 201

Force Table

ME-9447B

- ▶ High accuracy
- ▶ Easy, compact storage
- ▶ Inexpensive!

Adjustable height

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

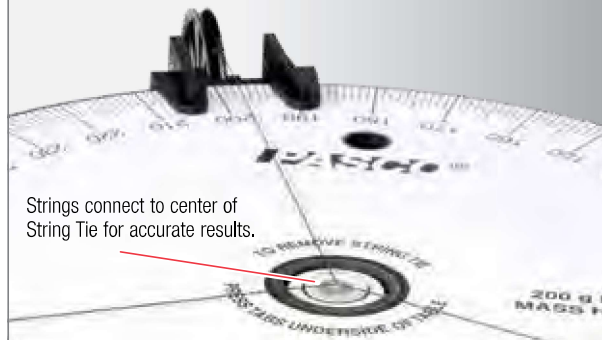


Dual Ball Bearings
For ultra-low friction.

Built-in Scale
Measure angles quickly and accurately.

String tie

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



Strings connect to center of String Tie for accurate results.

Compact, Easy Storage



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!



Stacking tab keys into recess in table-top

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

Mass and Hanger
(sold separately)

Includes

- 25 cm diameter table with detachable legs
- Adjustable Super Pulleys with Clamps (3)
- Spool of thread (1)



Mass and Hanger Set is sold separately.

Order Information

Force Table	ME-9447B	
Required:		
Mass and Hanger Set	ME-8979	p. 201
Additional Pulleys:		
Super Pulley with Clamp.....	ME-9448B	p. 194

Tension Protractor

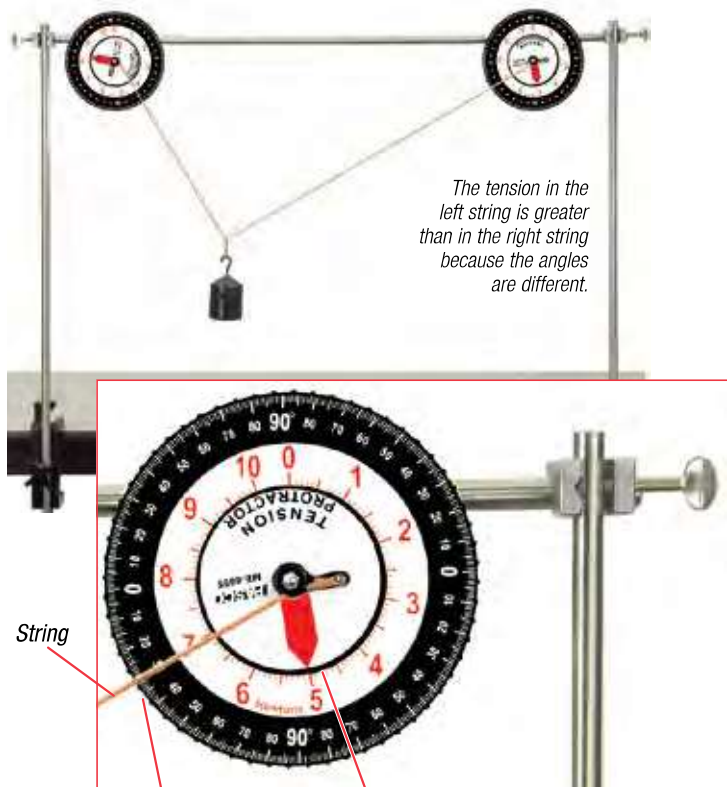
ME-6855

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

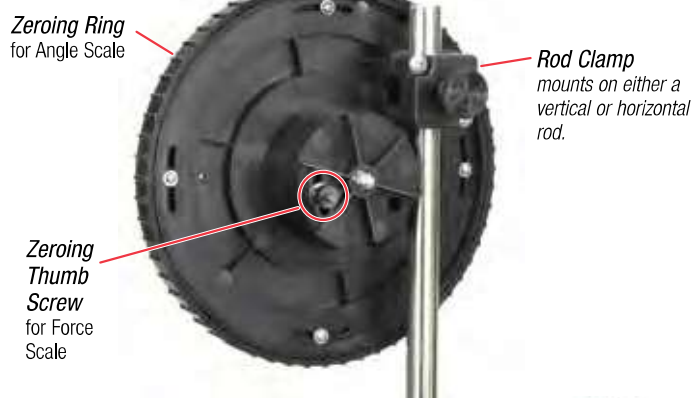
The Tension Protractor is a spring scale and a protractor integrated into one device. Perfect for static equilibrium experiments, the rotary dial indicates the tension in the string and the angle is read where the string passes over the degree scale on the outer ring. Since the Tension Protractor is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

The string is wrapped once around a small pulley that is spring-loaded. The torsion spring scale is carefully calibrated at the factory and can be zeroed by the user using the thumb screw on the back. The red arrow that indicates tension is color-coded to match the Newton scale.

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.



The tension in the left string is greater than in the right string because the angles are different.



String

Arrow indicates tension reading (5.0 N)

Specifications

- Force Range:** 0 N to 10 N
- Smallest Force Division:** 0.1 N
- Force Accuracy:** $\pm 4\%$ of Reading
- Angle Range:** $\pm 90^\circ$
- Smallest Angle Division:** 1°
- Diameter:** 15 cm

Includes

- One Tension Protractor

Order Information

Tension Protractor.....	ME-6855	
<i>Recommended:</i>		
Large Table Clamp.....	ME-9472	pp. 192-193
90 cm Long Rod.....	ME-8738	p. 191
Multi-clamp.....	ME-9507	pp. 192-193
Hooked Mass Set.....	SE-8759	p. 201



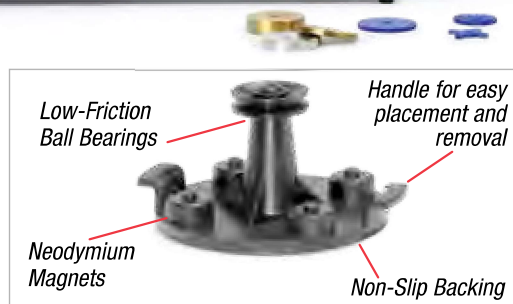
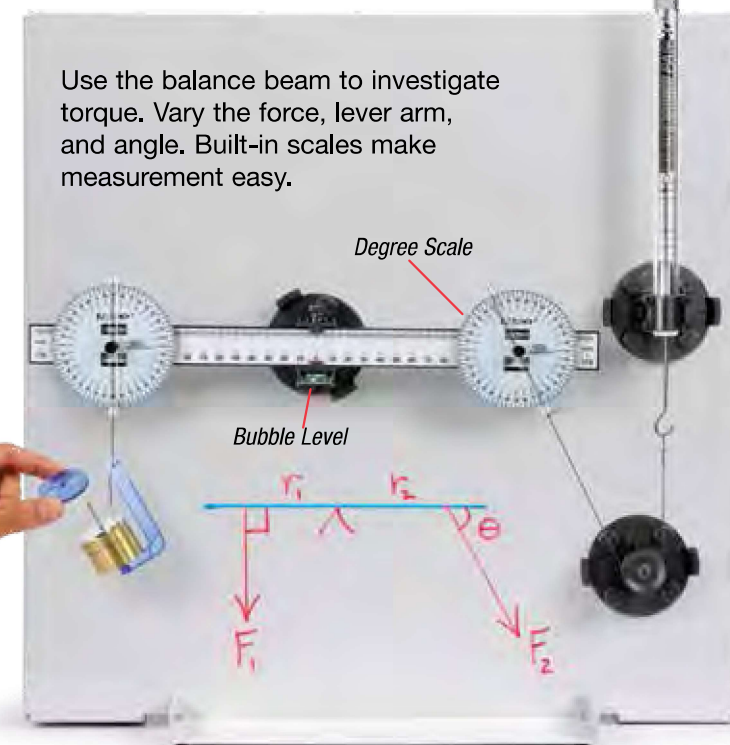
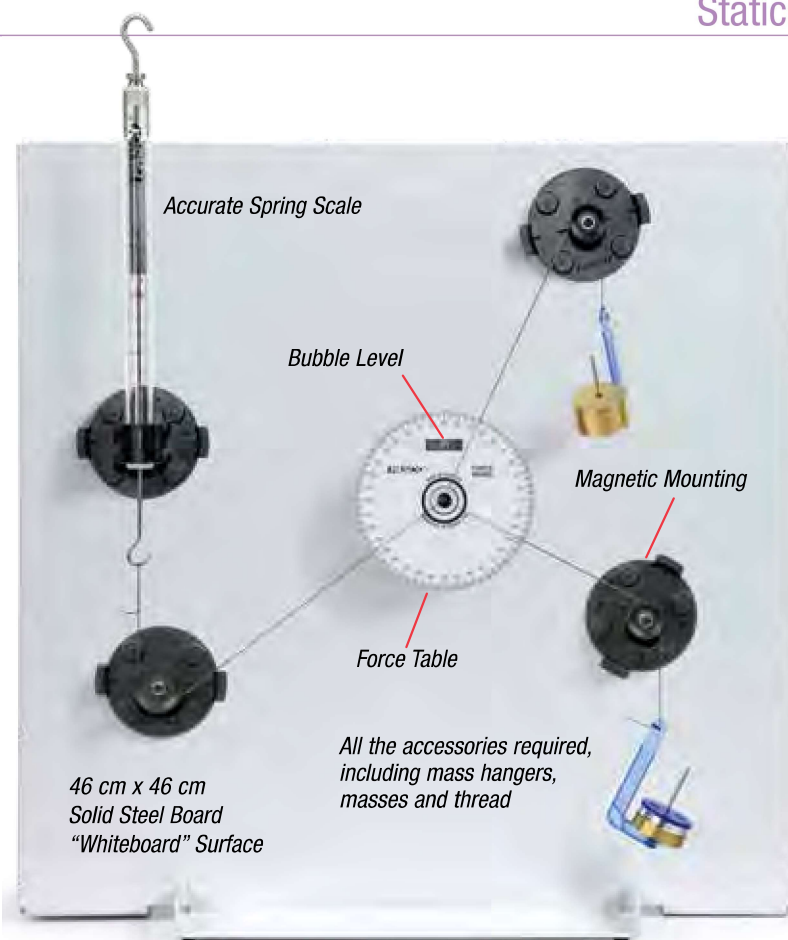
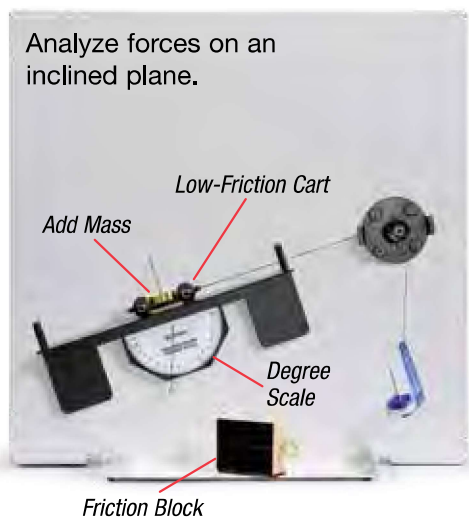
A 50 gram mass hangs vertically from the Tension Protractor: The tension reads 0.5 N as expected and the outer degree scale is dialed to align the 90° mark with the string. This compensates for unlevel tables or bent rods.

Statics System

ME-9502

- ▶ Everything required for 15 experiments
- ▶ Comprehensive — from vector addition to simple machines
- ▶ Easy Setup — magnetic mounting

Here is a versatile lab system for demonstrating the basic concepts of vector forces, torques, center of mass, simple machines, and more. The ME-9503 Statics Board (sold separately) doubles the width and is perfect for demonstrations.



Easy Storage

Store magnetic components on back of experiment board.

Includes

- Experiment Board
- Components
- Mass Set
- Comprehensive Manual

Order Information

Statics System.....	ME-9502
<i>Additional Equipment:</i>	
Statics Board.....	ME-9503
Spring Scale.....	ME-9824A
Statics Spares Package.....	ME-9504



Simple Machines

Simple Machines Teacher Resources

EP-6483

- ▶ A single teacher guide is all you need to outfit your class or lab.
- ▶ Complete with guided inquiry lab activities, suggested answers, and much more
- ▶ Requires Simple Machines Engineering Kit

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



Simple Machines Engineering Kit

EP-3577

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

Includes

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



Assembly shows included components.



Order Information

Simple Machines Teacher ResourcesEP-6483
 Required:
 Simple Machines Engineering KitEP-3577

Tripod Stand

EP-3572

Includes

- 68.6 cm extruded aluminum vertical rail
- Wide tripod base with aluminum legs and rubber feet
- Includes 5 sliding 14-20 inserts, already installed



Order Information

Tripod StandEP-3572

Weights

EP-3563

Includes

- 2 mass hangers
- 25 fender washer masses



Order Information

WeightsEP-3563

Super Pulley

ME-9450A

- ▶ 20 N max load
- ▶ Nearly frictionless
- ▶ Durable



The PASCO Super Pulley is the standard in physics labs. Its low-friction design produces excellent results. The precision spacing of the 10 spokes makes it ideal for photogate monitoring with PASCO's computer interfaces and photogate systems.

Features

- ▶ Low friction
- ▶ Lightweight
- ▶ Precision dimensions

Order Information

Super PulleyME-9450A

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.



Order Information

Pulley Mounting Rod (rod only)SA-9242

Smart Gate Pulley System

PS-3702

The Super Pulley attaches directly to the Smart Gate, providing a simple, low-friction system to measure position, velocity and acceleration. Additionally, with the pulley removed, the photogate can be used to perform standard photogate experiments.



Includes

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

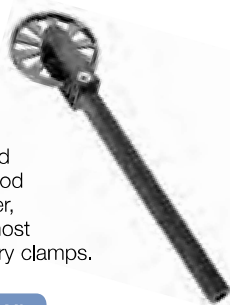
Order Information

Smart Gate Pulley System PS-3702

Super Pulley with Mounting Rod

ME-9499

This Super Pulley mounted on a rigid plastic mounting rod (12.7 mm diameter, 14 cm long) fits most standard laboratory clamps.



Order Information

Pulley with Mounting RodME-9499

Super Pulley with Clamp

ME-9448B



Upgrade your force table and inclined plane experiments. The Super Pulley with its integral clamp makes setup and alignment easy. The pulley height is fully adjustable, so you can skim the top of a force table for parallax-free readings. Yet you can keep the force parallel to the track on an inclined plane, as shown in the photo below. Fits tables up to 2.0 cm (13/16 in.) thick.



Order Information

Super Pulley with Clamp ME-9448B

Mounting Rods (10 pack)

ME-9483

These rigid plastic pulley handles (14 cm long, 1.27 mm diameter) screw into a Super Pulley.



Order Information

Mounting Rods (10 pack) ME-9483

Photogate/Pulley System

ME-6838A

The Super Pulley attaches directly to the Photogate Head, providing a simple, low-friction system to measure position, velocity and acceleration. Additionally, with the pulley removed, the photogate can be used to perform standard photogate experiments. See page 44.



Order Information

Photogate/Pulley SystemME-6838A

Atwood's Machine

SA-9241



Two Super Pulleys mounted on a 6.4 cm long rod produce a classic, low-friction introduction to Newton's Second Law. The instruction sheet fully describes both the experiment and the theory.

Includes

- Pulleys (2)
- Connecting Rod (1)

Order Information

Atwood's Machine SA-9241

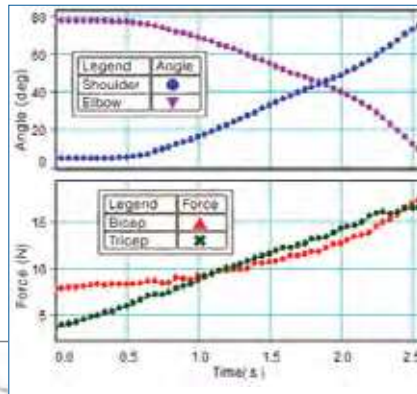
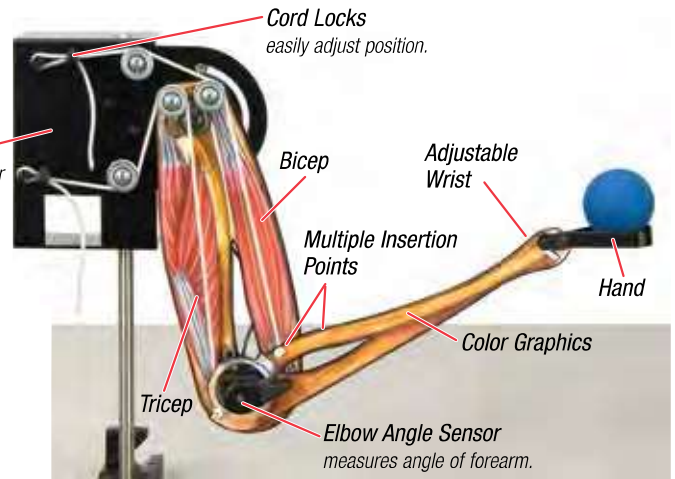
Human Arm Model

PS-2611

- ▶ Working model of the human arm
- ▶ Associate tricep/bicep 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. To activate the arm motion, students pull on the cord with a Force Sensor. Changes in position are measured at the shoulder and elbow using the two built-in potentiometers plugged into one Angle Sensor (PS-2139), included with PS-2611. From this information, the torque applied when lifting an object can be determined. Also, students can evaluate the work done by the arm in throwing a ball and the resulting kinetic energy delivered to the ball.

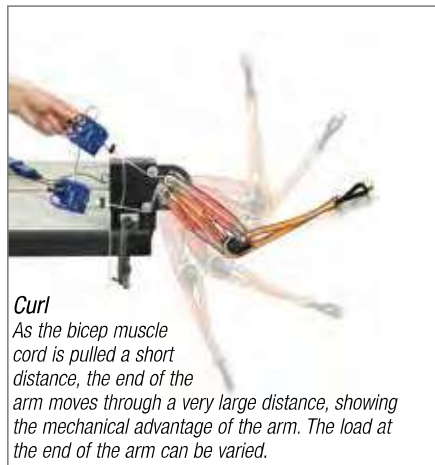
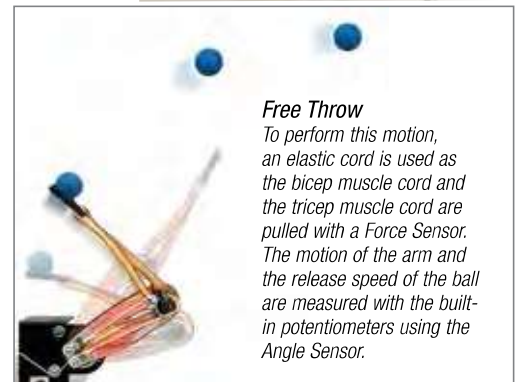
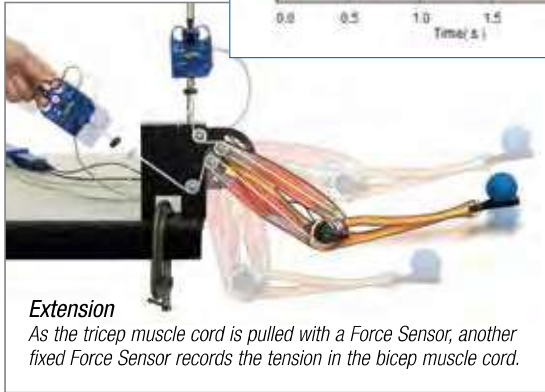
The Arm can perform many types of motion such as extending and lifting an object, curling, or throwing a ball overhand. Different arm muscles are activated depending on which pulleys are selected. Static force measurements can also be made to see how the muscle tension changes at various arm positions.



Removable Mass
Measure work and torque with and without mass.

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 at right. 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.



PS-2611 includes

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

Order Information

Human Arm Model PS-2611

Required:

“C” Clamp or Large Table Clamp

pp. 192-193

Force Sensor (2) PS-2104

p. 34

850 Universal Interface UI-5000

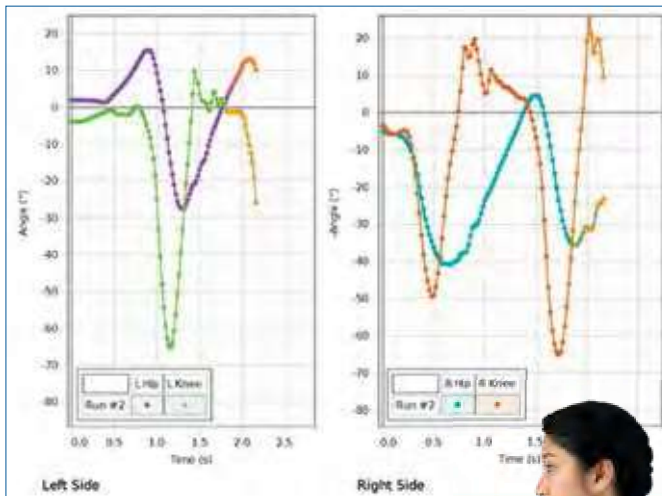
p. 28

Goniometer

PS-2137

- ▶ Accurately measures joint movements
- ▶ Flexible mounting options for hip, knee, and elbow

The SPARKlink Air Interface is used here with two Angle Sensors, part of the PS-2137 Goniometer System. The data is sent via Bluetooth® to a desktop computer and displayed live with the video being recorded by a web cam.



Data shows position of both left and right knee and hip joints during walking.

Capture data remotely!

The SPARKlink Air Interface records the sensor data and sends it to the computer via Bluetooth.



Goniometer Probes

The probes are fastened in place using the blue Velcro® straps and can be positioned to measure the motion of the knee, hip, or elbow.



Specifications

Range: 0 to 340°

Accuracy: ±1° (calibrated), ±3° (uncalibrated)

Resolution: 0.1°

Includes

- Goniometer Probe
- Angle Sensor
- Velcro Straps



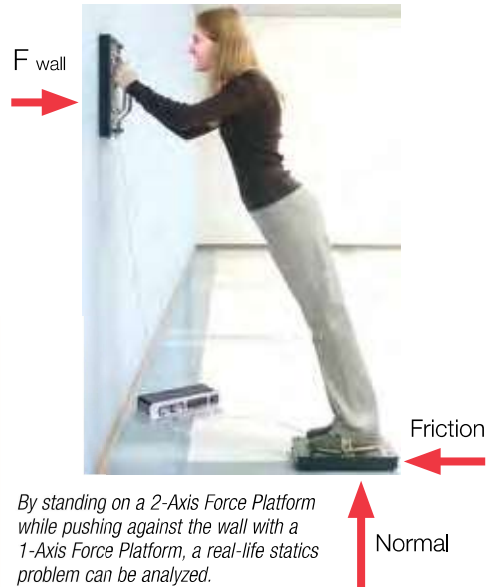
Order Information

Goniometer Sensor	PS-2137	
<i>Recommended:</i>		
SPARKlink Air	PS-2011	p. 32
Additional Velcro Straps	PS-2547	
Additional Goniometer Probe	PS-2138	

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.



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). Handles bolt onto the Force Platform (1-axis or 2-axis) and can be mounted on one or both sides.

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

Order Information

2-Axis Force Platform	PS-2142	p. 42
Force Platform	PS-2141	p. 42
<i>Recommended:</i>		
Handle Set	PS-2548	p. 42

Build any structure and instrument it.

Load Cell & Amplifier Set (6-port)

PS-2199

Shown in use with Bridge Set ME-6991. Sold on page 154.

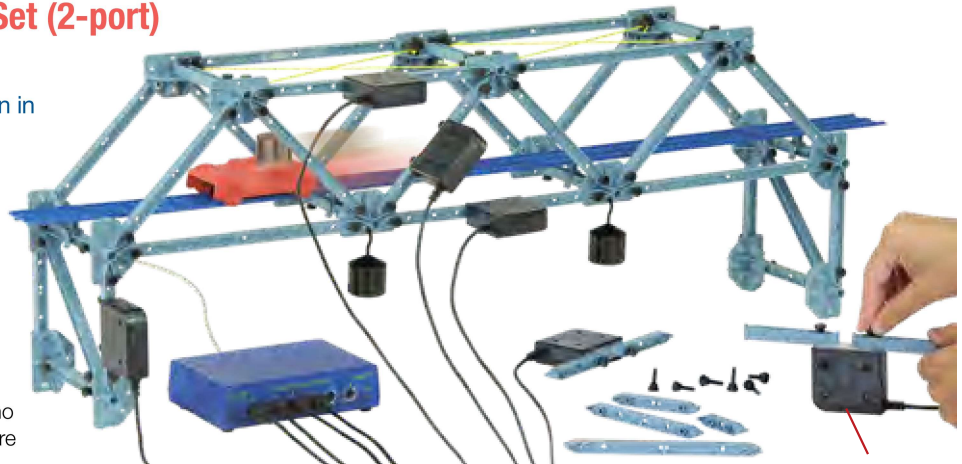
Dual Load Cell & Amplifier Set (2-port)

PS-2206

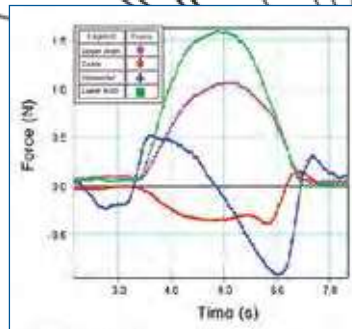
- ▶ Measure the compression and tension in the I-beam members
- ▶ Insert load cells into structures by substituting beams by substituting beams
- ▶ Use more than 6 load cells by connecting multiple amplifiers to one computer

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

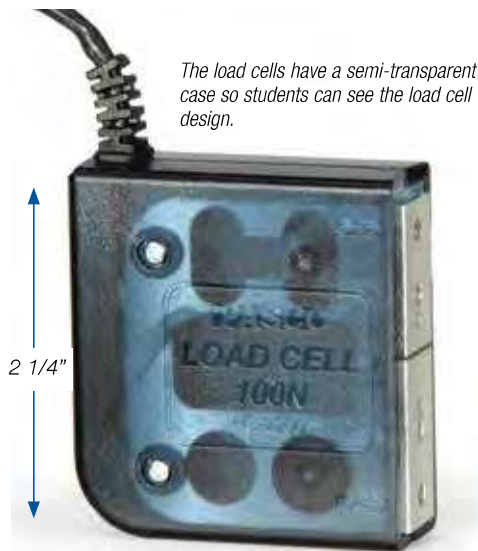
PS-2199 includes four 100 N Load Cells; additional load cells can be purchased separately. For more information, see page 36.



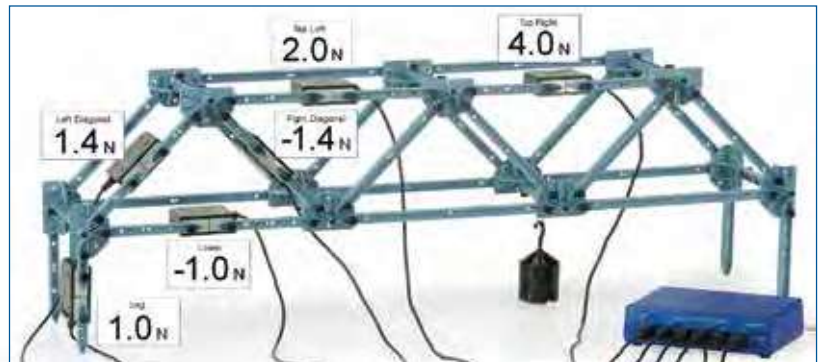
I-beams key into the load cell and are fastened with thumb screws.



As the car crosses the bridge, the forces measured by each load cell are graphed in real-time in PASCO Capstone™. Notice the diagonal member (green trace) switches from compression to tension as the car passes by.



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



Forces measured by Load Cells are displayed on a computer using PASCO Capstone software. A positive value represents compression.

Load Cell & Amplifier Set
PS-2199

Includes

- Load Cell Amplifier (6-port)
- 100 N Load Cell (4)

Dual Load Cell & Amplifier Set
PS-2206

Includes

- Load Cell Amplifier (2-port)
- 100 N Load Cell (1)



Order Information

Load Cell & Amplifier Set (6-port) (includes 4 load cells)	PS-2199	p. 40
Dual Load Cell & Amplifier Set (2-port) (includes 1 load cell)	PS-2206	p. 110
<i>Required:</i>		
PASPORT Interface to USB Computer		p. 24-25
<i>Recommended:</i>		
Additional 100 N Load Cell	PS-2200	p. 41
Load Cell 5 N.....	PS-2201	p. 41
Hooked Mass Set.....	SE-8759	p. 201

Truss Set

ME-6990

- ▶ Teach the basics of trusses
- ▶ Demonstrate the properties of I-Beams

Plastic I-Beams

Plastic Connectors

Steel Thumb Screws

Use the Truss Set to build a variety of structures to investigate the principles of trusses. The ABS plastic I-Beams fasten securely together using the provided connectors and thumb screws. Load cells can be inserted anywhere into the design by replacing one beam at a time. Students can load the truss by hanging weights.

Measure the compression and tension in the I-Beam members by adding optional Load Cells.

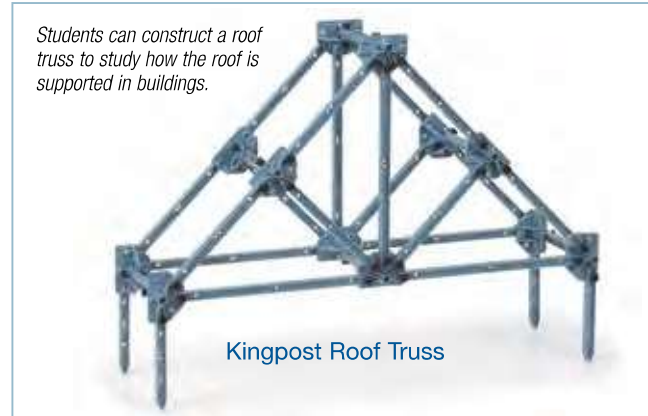
Through Truss
with Verticals

Construction is easy: I-Beams fit into the connectors and are secured with thumb screws. Thumb screws are also slotted so a screwdriver can be used.

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



Deck Truss Bridge



Students can construct a roof truss to study how the roof is supported in buildings.

Kingpost Roof Truss

Truss Set Includes

- I-Beam #5 (8) 24 cm long
- I-Beam #4 (18) 17 cm long
- I-Beam #3 (18) 11.5 cm long
- I-Beam #2 (8) 8 cm long
- I-Beam #1 (8) 5.5 cm long
- Connectors (14), Screws (75), and Instruction Manual



Order Information

Truss Set ME-6990

Recommended:

Load Cell & Amplifier Set
(includes four load cells) PS-2199

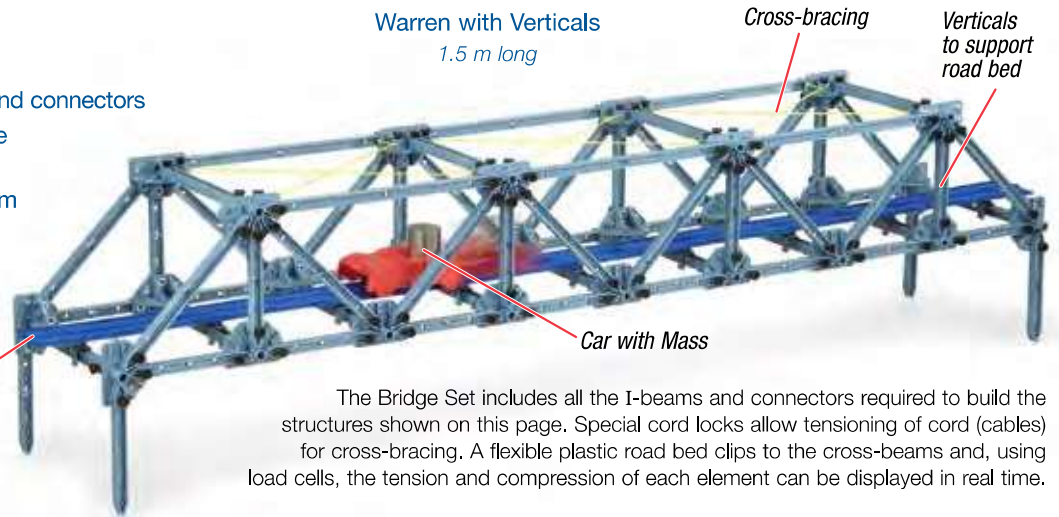
p. 40

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

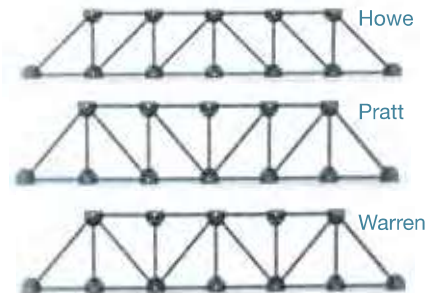
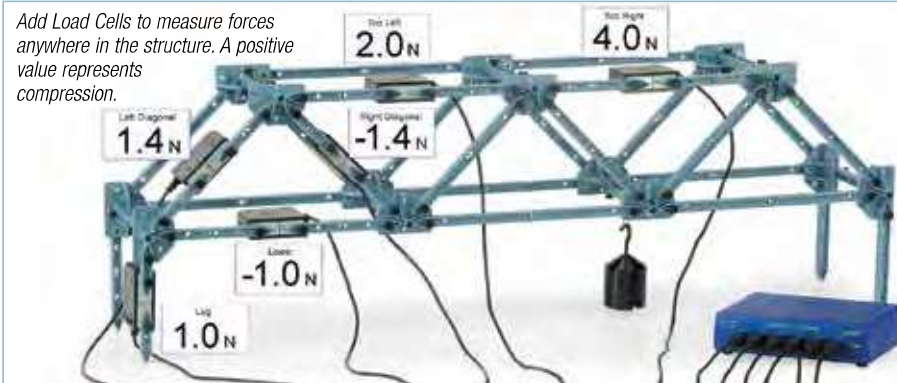
Bridge Set

ME-6991

- ▶ Larger quantity of I-beams and connectors
- ▶ Study the principles of bridge construction
- ▶ Road bed and car add realism to bridges
- ▶ Add Load Cells to see dynamic loading as car traverses bridge

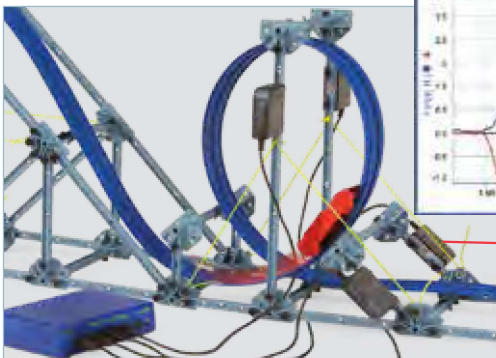


The Bridge Set includes all the I-beams and connectors required to build the structures shown on this page. Special cord locks allow tensioning of cord (cables) for cross-bracing. A flexible plastic road bed clips to the cross-beams and, using load cells, the tension and compression of each element can be displayed in real time.



Students can build several types of fundamental bridges including Howe, Pratt, and Warren bridges.

Design your own roller coaster!



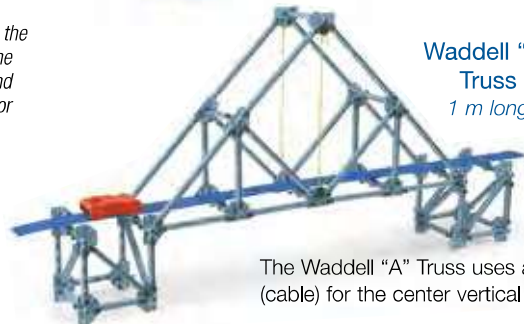
Deck Truss

80 cm long



Waddell "A" Truss

1 m long



The Waddell "A" Truss uses a cord (cable) for the center vertical member.

Bridge Set Includes

- I-beam #5 (16) 24 cm long
- I-beam #4 (36) 17 cm long
- I-beam #3 (36) 11.5 cm long
- I-beam #2 (16) 8 cm long
- I-beam #1 (16) 5.5 cm long
- Connectors (28)
- Screws (150)
- Flexible road bed (3 m)
- Track coupler
- Road bed clips (24)
- Car with flag and mass
- Starter bracket
- Cord tensioning clips (32)
- Yellow cord (1 roll)
- Instruction manual



Order Information

Bridge SetME-6991

Recommended:

Load Cell & Amplifier Set
(includes four load cells)PS-2199

p. 40

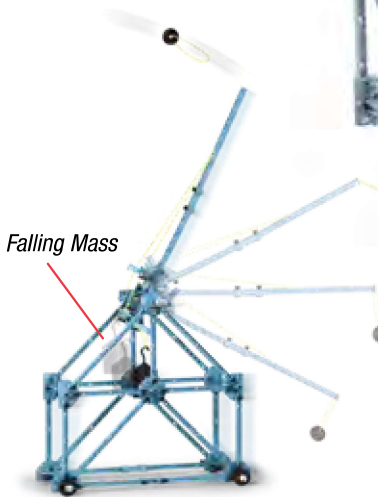
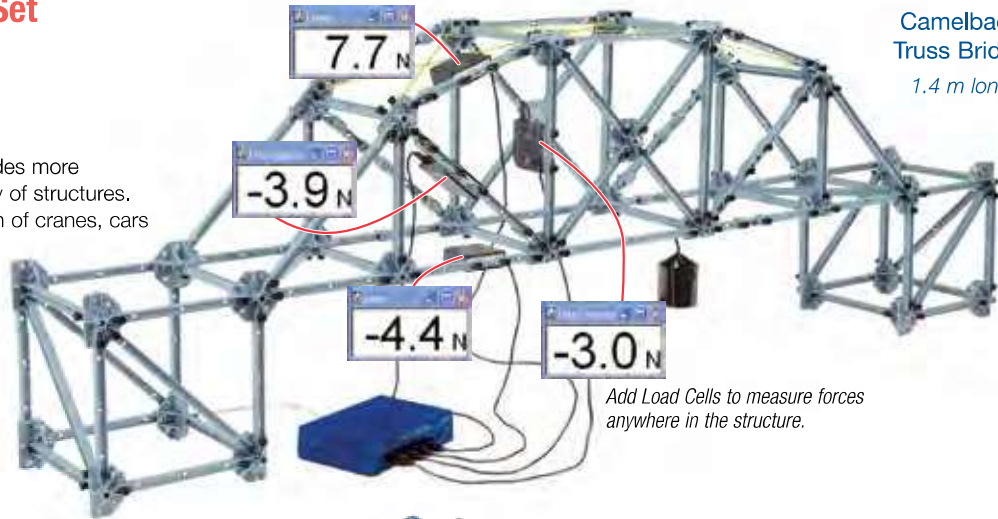
Advanced Structures Set

ME-6992B

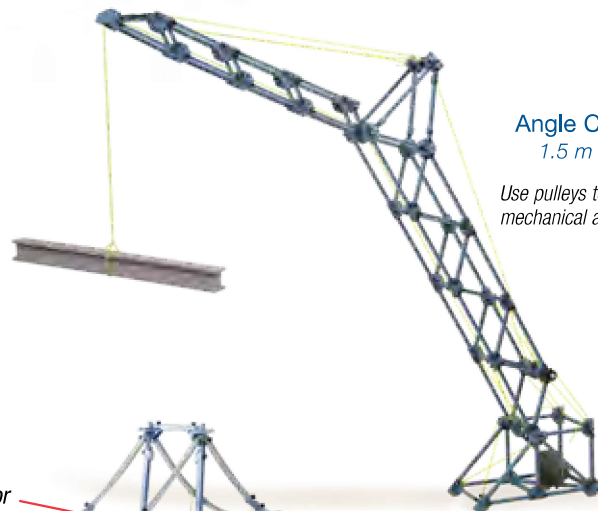
- ▶ Build larger bridges
- ▶ Build cranes, catapults, cars

The Advanced Structures Set includes more components to build a larger variety of structures. Axles and pulleys allow construction of cranes, cars and even a working catapult!

Camelback
Truss Bridge
1.4 m long

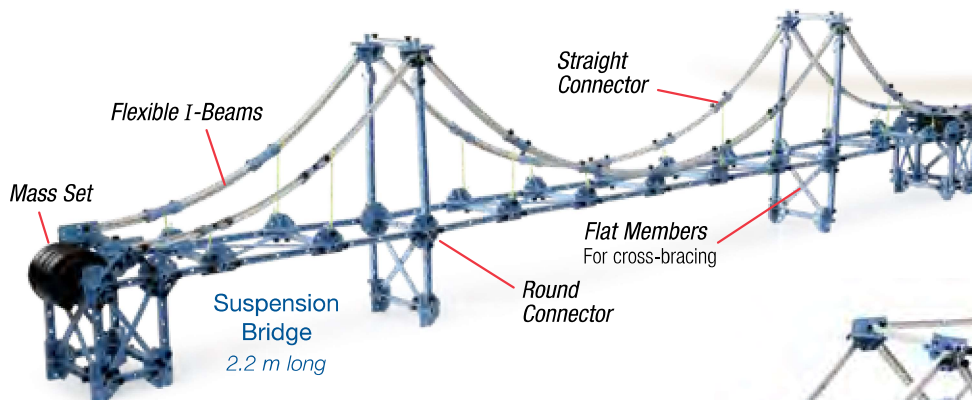


Catapult
60 cm tall
Throws a projectile over 10 meters!
Wheels allow catapult to move.

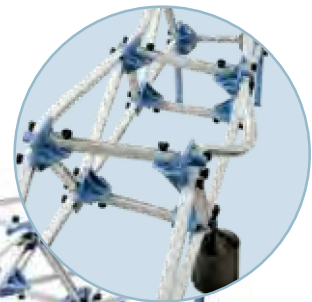


Angle Crane
1.5 m tall

Use pulleys to investigate
mechanical advantage.



**Suspension
Bridge**
2.2 m long



Flexible I-Beams
Dramatically demonstrate
structural failure.

Advanced Structures Set Includes:

- Force Platform Bracket (2)
- I-Beam #5 (24) 24 cm long
- I-Beam #4 (54) 17 cm long
- I-Beam #3 (54) 11.5 cm long
- I-Beam #2 (24) 8 cm long
- I-Beam #1 (24) 5.5 cm long
- Flex I-Beam #5 (10) 24 cm long
- Flex I-Beam #4 (18) 17 cm long
- Flex I-Beam #3 (18) 11.5 cm long
- Flat Beams (16 ea. of 3 lengths)
- Axles (2 ea. of 3 lengths)
- Connectors (42)
- Cord Tensioning Clips (32)
- Round and Flat Connectors (6 ea.)
- PASTrack Fasteners (6)
- Angle and Straight Connectors (24 ea.)
- Sliding Connector (12)
- Pulleys, O-rings, Spacers (12 ea.)
- Collets (24)
- Drive Wheel with Rubber Tire (4)
- Structures Rod Clamps (2)
- Screws (300)
- Yellow Cord (1 roll)
- Instruction Manual



Order Information

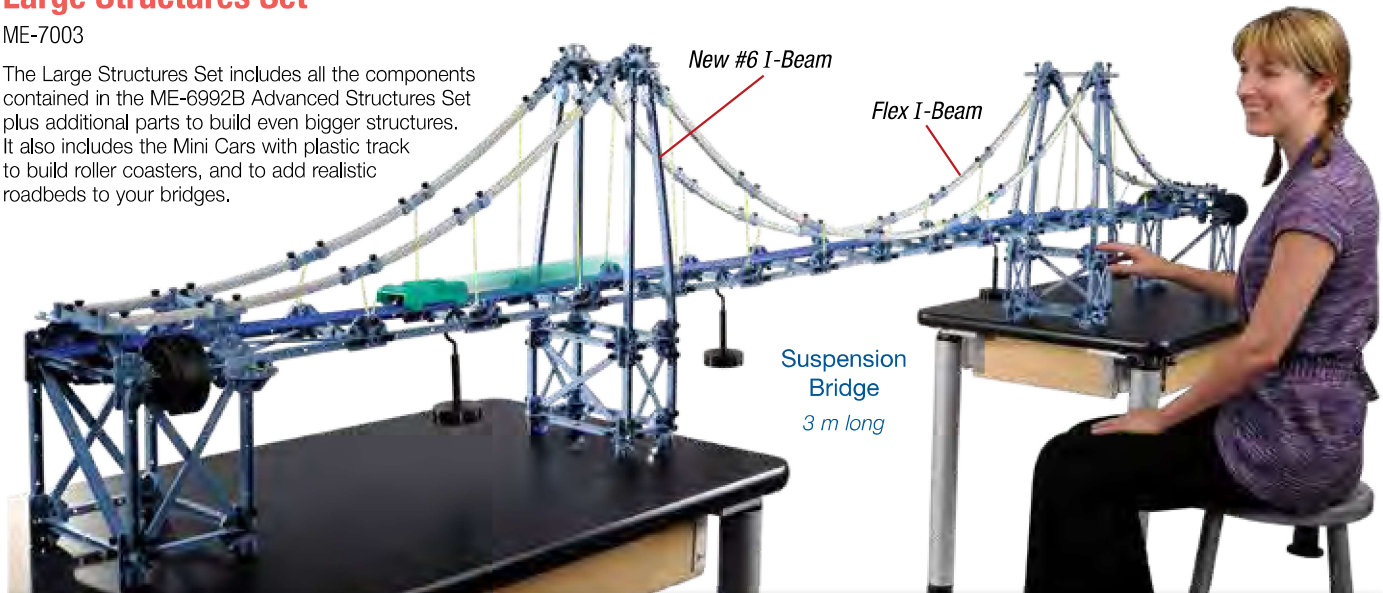
Advanced Structures SetME-6992B
Shown in use with:
Load Cell & Amplifier Set
(includes four Load Cells).....PS-2199
Hooked Mass Set.....SE-8759
Large Slotted Mass Set.....ME-7566

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Large Structures Set

ME-7003

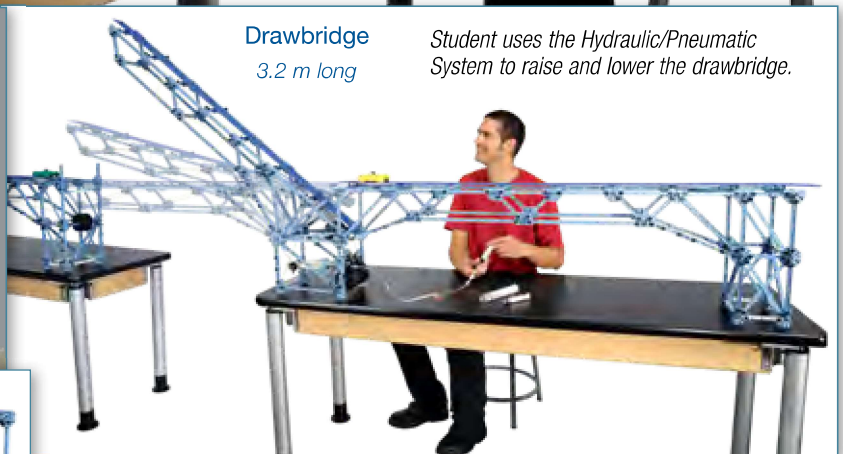
The Large Structures Set includes all the components contained in the ME-6992B Advanced Structures Set plus additional parts to build even bigger structures. It also includes the Mini Cars with plastic track to build roller coasters, and to add realistic roadbeds to your bridges.



Suspension Bridge
3 m long

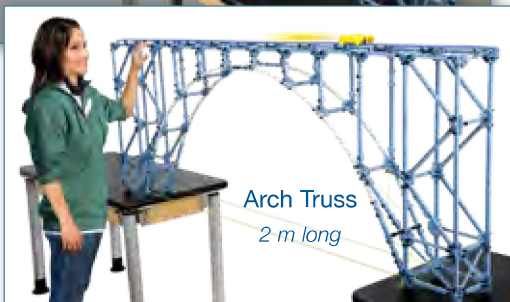


Double Tied Arch Bridge
2.8 m long



Drawbridge
3.2 m long

Student uses the Hydraulic/Pneumatic System to raise and lower the drawbridge.



Arch Truss
2 m long

Add load cells to measure forces anywhere in the structure.



Cable Stayed
3.8 m long

Large Structures Set Includes

- I-Beam #6 (24) 35 cm long
- I-Beam #5 (24) 24 cm long
- I-Beam #4 (54) 17 cm long
- I-Beam #3 (54) 11.5 cm long
- I-Beam #2 (24) 8 cm long
- I-Beam #1 (24) 5.5 cm long
- Flex I-Beam #5 (10) 24 cm long
- Flex I-Beam #4 (18) 17 cm long
- Flex I-Beam #3 (18) 11.5 cm long
- Flat Beams (16 ea. of 3 lengths)
- Axles (2 ea. of 3 lengths)
- Connectors (70)
- Cord Tensioning Clips (32)
- Yellow car and green car, each with ballast mass and flag
- Force Platform Bracket (2)
- Round and Flat Connectors (6 ea.)
- Angle and Straight Connectors (24 ea.)
- Drive Wheel with Rubber Tire (4)
- Pulleys, O-rings, Spacers (12 ea.)
- Structures Rod Clamps (2)
- Sliding Connector (12)
- PAStack Fasteners (6)
- Collets (24)
- Screws (450)
- Yellow Cord (1 roll)
- Flexible road bed (9.1m)
- Road bed clips (24)
- Starter bracket (1)
- Track coupler (2)
- Instruction Manual



Order Information

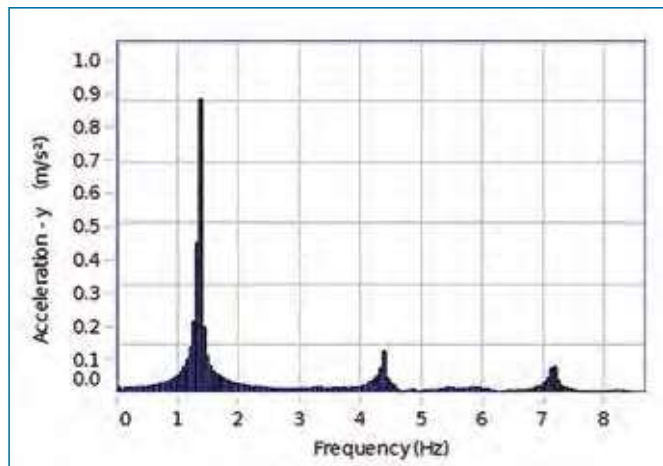
- Large Structures Set.....ME-7003
 Shown in use with:
 Hydraulic/Pneumatic Structures.....ME-6984
 Load Cell & Amplifier Set (includes four Load Cells).....PS-2199 p. 40
 Slotted Mass SetME-7589 p. 200

Shaking Tower Kit

ME-7018

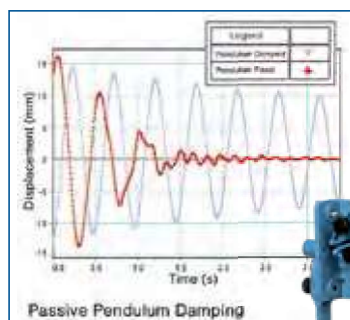
- ▶ Explore the resonance modes
- ▶ Measure accelerations with wireless sensors
- ▶ Demonstrate passive damping

Built from PASCO Structures beams, this tower is made to oscillate in its various resonance modes by a driver attached by a rubber band to the first floor of the tower. Wireless Load Cells with Accelerometers are attached to each floor to record how much shaking each floor experiences.

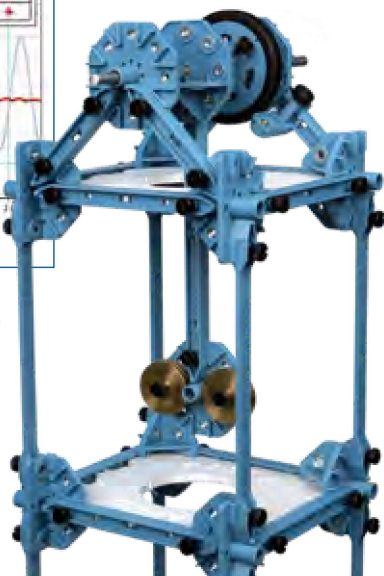


This FFT, generated in PASCO Capstone software, shows the frequency responses of the top Wireless Load Cell/Accelerometer.

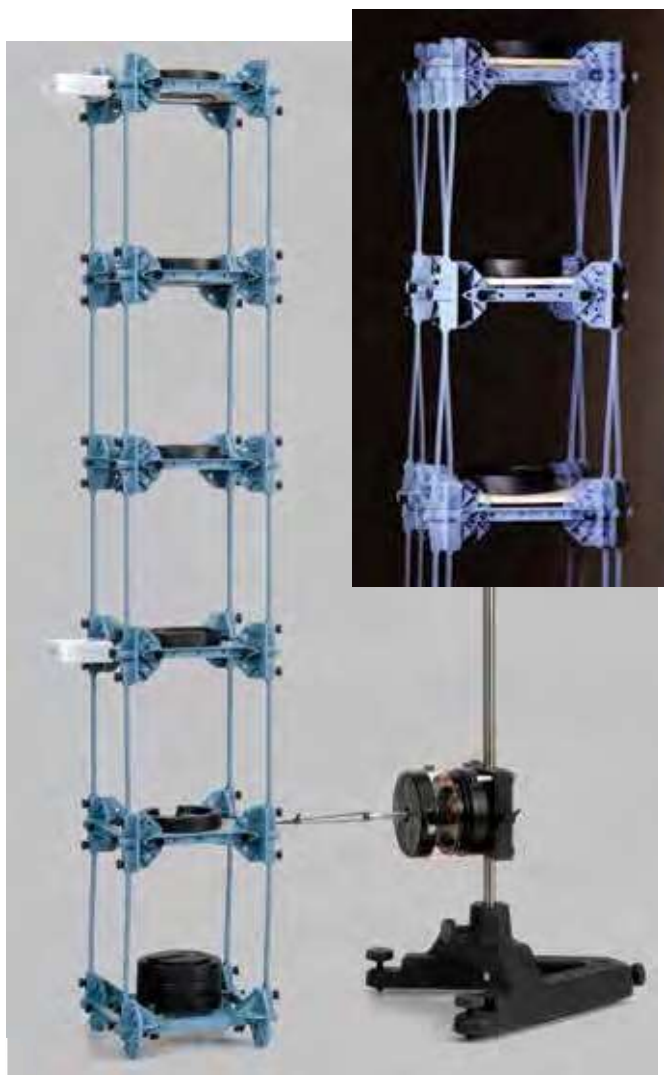
See the Shaking Tower Experiment (EX-5555) on page 353.



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



In modern buildings, passive damping mechanisms are installed to damp out oscillations during earthquakes. The damping pendulum in this tower quickly stops oscillations.



The tower is shaken by the Mechanical Wave Driver, which is powered by an 850 Universal Interface or Function Generator.

ME-7018 Includes:

- #1 I-beams (10)
 - #2 I-beams (8)
 - #3 I-beams (24)
 - #4 I-beam
 - Nylon Spacers (2)
 - Connectors (20)
 - (F4) Flat Beams (20)
 - Flat Round Connector (4)
 - Full Round Connectors (5)
 - Floors (5)
 - Medium Shaft, Structures
 - 2 Sets Screws (75 ea.)
 - Sliding Connector
 - Tire, Structures
 - Wheel, Structures
 - Masses: 0.5 kg (10); 20 g (2); 50 g (2)
- (Large Slotted Mass Set, shown in picture above, not included.)

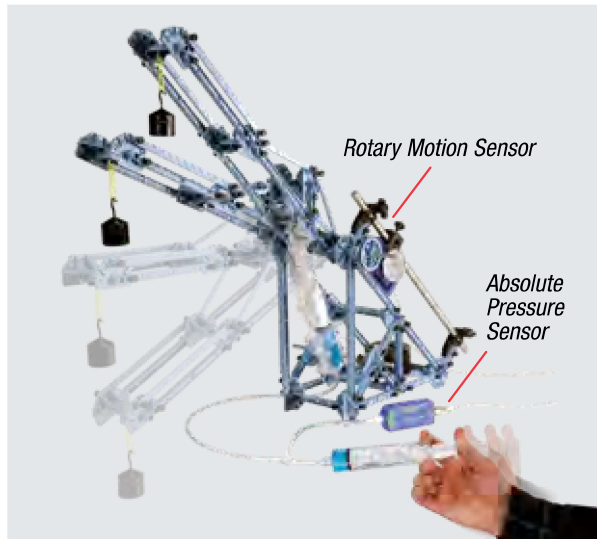
Order Information

Shaking Tower Kit.....	ME-7018
<i>Required:</i>	
Large Slotted Mass Set.....	ME-7566
Mechanical Wave Driver	SF-9324
2 m Patch Cord Set	SE-9415A
Large Rod Base	ME-8735
Threaded Rod 25 cm	ME-8988
Wireless Load Cells (4)	PS-3216
850 Universal Interface	UI-5000
PASCO Capstone Software.....	pp. 72-75

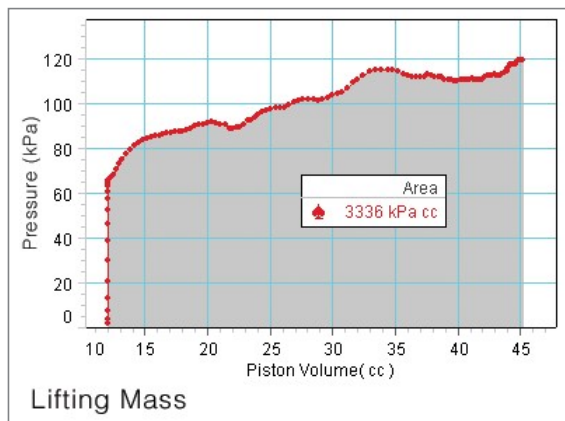
Hydraulic and Pneumatic Structures

ME-6984

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



The weight is lifted using a syringe of water to fill the master cylinder. An Absolute Pressure Sensor measures the pressure and a Rotary Motion Sensor records the movement of the piston.



Pressure and volume are recorded as the weight is lifted, and the work done is the area under the curve.

Includes

- Master Cylinder
- Pressure Sensor "T"
- Check Valves and Tubing
- Syringes (10, 20, 60 ml)
- Drive Belt for Rotary Motion Sensor (not shown)



Order Information

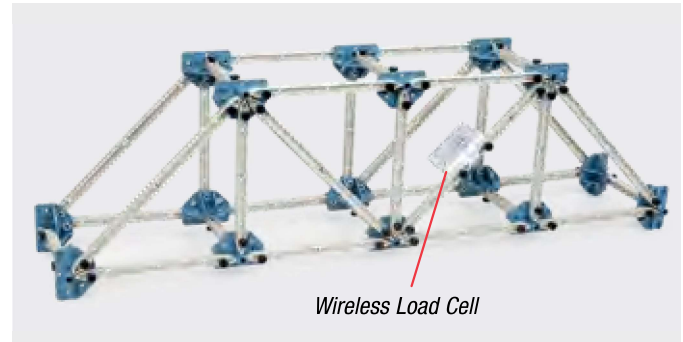
Hydraulic/Pneumatic Structures.....	ME-6984	
Advanced Structures Set.....	ME-6992B	p. 155
Steel Rod (45 cm).....	ME-8736	p. 190
Absolute Pressure Sensor.....	PS-2107	p. 48
Rotary Motion Sensor.....	PS-2120A	p. 35

Building Better Bridges Kit

ME-3581

- ▶ A complete STEM kit to teach bridge-building
- ▶ Compatible with PASCO Structures System

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



The kit has flexible I-beams, and the Wireless Load Cell measures up to 50 N.



Includes

- Lab Activities
- Wireless Load Cell (with Bluetooth® Low Energy)
- Flexible I-Beams (various sizes)
- Connectors
- Truss Screws
- Weight Set
- Grattells® Storage Tray

Lab Activities:

- Forces in Equilibrium
- Internal Forces
- Moments in Equilibrium
- Strength of Members
- Truss Analysis

Order Information

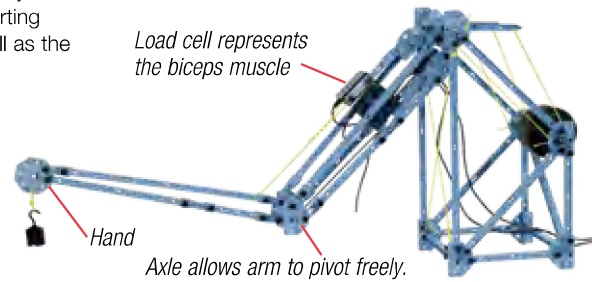
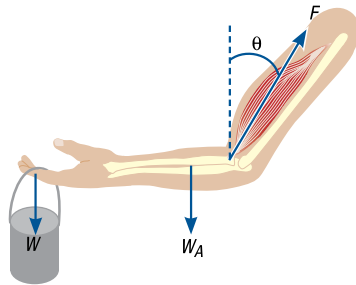
Building Better Bridges Kit.....	ME-3581	
Want an additional load cell?		
Wireless Load Cell.....	PS-3216	p. 10

Human Structures Set

ME-7001

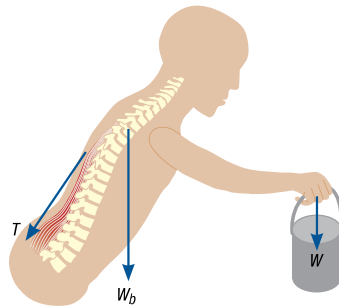
- ▶ Build models that represent real life examples.
- ▶ Construct all three models concurrently with this set.
- ▶ Bring homework problems to life!

Human Arm Model: Students build a realistic arm model and directly measure the forces exerted by the biceps muscle (tension in supporting cord). Vary the length and angle of the upper and lower arm, as well as the point of attachment of the muscle.

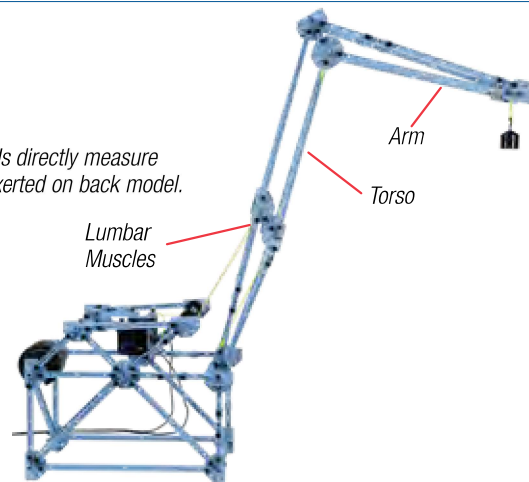


Support structure allows the angle of the upper arm to be easily adjusted.

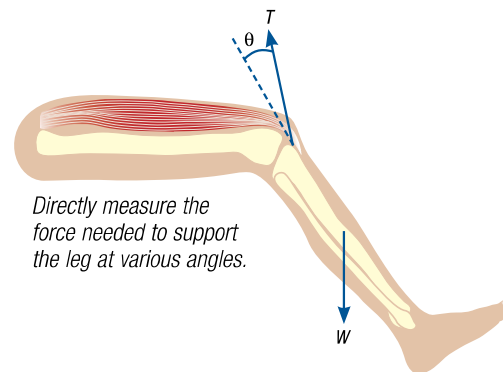
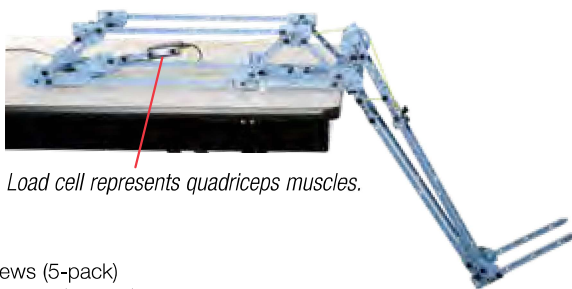
Human Back Model: Model the forces acting on a human back. Vary all parameters including position of back muscle attachment and angle of the torso. Directly measure the force exerted by the back muscles.



Load cells directly measure forces exerted on back model.



Human Leg Model: The leg model shown below uses a load cell for the quadriceps muscle to directly measure the force needed to support the leg at various angles.



Directly measure the force needed to support the leg at various angles.

Includes

- Truss Set Screws (5-pack)
- Truss Set Members (2-pack)
- Connector Spares (2-pack)
- One package each:
 - #6 I-Beam Spares
 - Cord Lock Spares
 - Axle Spares
 - Round Connector Spares
 - Angle Connector Spares
- Roll of rubber cord

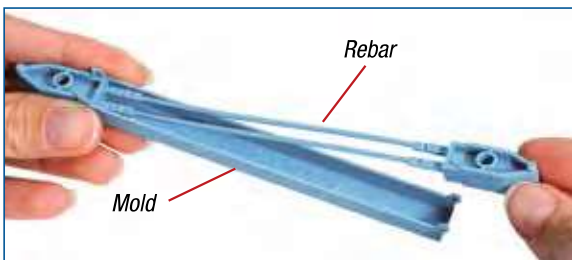
Order Information

Human Structures Set	ME-7001	
<i>Shown in use with:</i>		
Load Cell & Amplifier Set (includes four load cells).....	PS-2199	p. 40
Hooked Mass Set.....	SE-8759	p. 201
Large Slotted Mass Set.....	ME-7566	p. 201

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Cast Beam Structures Set

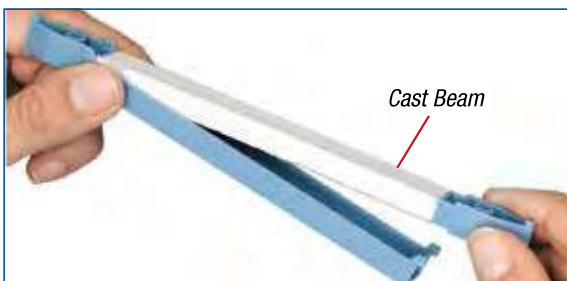
ME-7009



Step 1: The rebar with connecting ends snaps into the plastic mold.



Step 2: Insert rebar into tensioning apparatus and pour a mixture of sand and plaster of Paris into the mold.



Step 3: After it dries, it is easy to remove the flexible plastic mold from the cast beam.

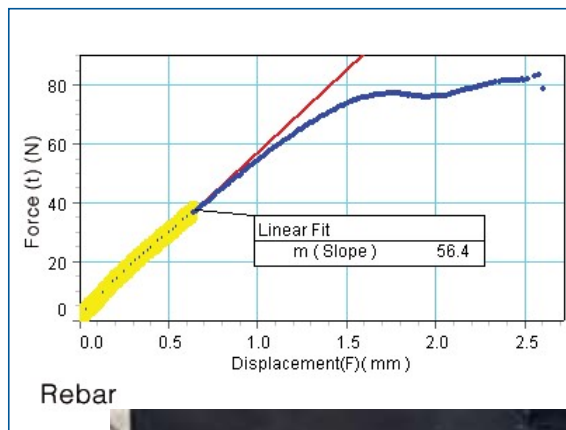
Cast Beam Structures Set ME-7009 Includes

- I-Beam #5 (8) 24 cm long
- I-Beam #4 (18) 17 cm long
- I-Beam #3 (18) 11.5 cm long
- I-Beam #2 (8) 8 cm long
- I-Beam #1 (8) 5.5 cm long
- Axles (2 ea. of 3 lengths)
- Connectors (14)
- Cord Tensioning Clips (32)
- Round and Flat Connectors (6 ea.)
- PAStack Fasteners (6)
- Angle and Straight Connectors (24 ea.)
- Collets (24)
- Screws (150)
- Pulleys, O-rings, Spacers (12 ea.)
- Sliding Connector (12)
- Reusable Plastic Molds (10)
- Rebar (30)
- Yellow Cord (1 roll)
- Instruction Manual

Required but not included:

- Sand and Plaster of Paris

Make your own cast beams that look like pre-stressed concrete beams. Test them and you'll find they perform like them, too. These beams are cast with a mixture of sand and plaster of Paris (not included). The rebar is made of the same plastic used for the I-beams. Students can explore how the strength of the beam is affected by the amount of tension put on the rebar, the mixture of sand and plaster of Paris, or using one or two rebar.



Rebar



Measure Young's Modulus for the rebar.

The connecting ends can be cut off from the rebar allowing the rebar to fit into the Material Testing Machine (ME-8236) with Flat Coupon Adapter (ME-8238).



Cast Beam Spares

ME-6983

Consumable replacement parts for Cast Beams. These can also be used with the Advanced Structures Set (page 155).

Includes

- 10 Reusable Plastic Molds
- 30 Rebar with Connectors



Order Information

Cast Beam Spares ME-6983

Order Information

Cast Beam Structures Set.....ME-7009

Also shown:

Displacement Sensor.....PS-2204 p. 41

Cast Beam Spares

(Includes 30 rebar members, 10 cast beam molds with connectors).....ME-6983

Large Slotted Mass Set.....ME-7566 p. 201

Round Base with RodME-8270 p. 191

60 cm Threaded RodME-8977 p. 190

Structures Flexible I-Beam

ME-6985

Use these flexible I-Beams to make a bridge that dramatically demonstrates how a bridge fails and yet the beams return to their original shape when the load is removed.



Dramatically demonstrate structural failure.



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)

Order Information

Structures Flexible I-Beam..... ME-6985
 Shown in use with:
 Truss Set ME-6990 p. 153

Mini Car Track Spares

ME-6974



Includes two gates, two track couplers and one bag (24) of roadbed clips.

Order Information

Mini Car Track Spares.....ME-6974

Axle Spares

ME-6998A

Includes drive wheel with rubber tire (4), pulleys with "O" rings (12 each), axles (two each of three lengths), spacers (12) and collets (24).



Order Information

Axle SparesME-6998A

Cord Lock Spares

ME-6996

Includes 32 cord-tensioning clips and a spool of yellow cord.



Order Information

Cord Lock SparesME-6996
 Yellow Cord (2 pack).....ME-9876

Roadbed Spares

ME-6995

Mini Car Starter Bracket



Roller Coaster Track

Includes flexible roadbed (3 m), roadbed clips (24), car with flag, extra mass, mini car starting bracket, and track couples (2).

Order Information

Roadbed SparesME-6995
 Sold Separately:
 Roller Coaster
 Track (9.1 m).....ME-9814

Force Platform Structures Bracket

ME-6988A

Includes two brackets and four screws.



Order Information

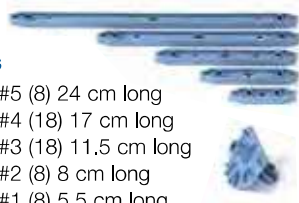
Force Platform Structures Bracket.....ME-6988A

Truss Set Members

ME-6993

Includes

- I-Beam #5 (8) 24 cm long
- I-Beam #4 (18) 17 cm long
- I-Beam #3 (18) 11.5 cm long
- I-Beam #2 (8) 8 cm long
- I-Beam #1 (8) 5.5 cm long
- Connectors (14)



Order Information

Truss Set Members.....ME-6993

Truss Set Screws

ME-6994

Includes 75 screws. All components in the Structures System use this same 6-32 thumb screw.



Order Information

Truss Set Screws.....ME-6994

Structures Rod Clamps

ME-6986

Connects structure members to 1/2"rod. Includes a set of two.



Order Information

Structures Rod Clamps (2) ME-6986

Beams

1. Thin I-Beams (ME-7012)



2. Flexible I-Beams (ME-6985)



3. Flat Beams (ME-6987)



4. #6 I-Beam Spares (ME-7008)



5. #5 I-Beam Spares (ME-7017)



6. Photoelastic Beams (ME-7011)



1. Includes Thin I-beam #4 (24) 17 cm long, Thin I-beam #3 (24) 11.5 cm long.
2. Includes Flex I-beam #5 (10) 24 cm long, Flex I-beam #4 (18) 17 cm long, and Flex I-beam #3 (18) 11.5 cm long.
3. Includes 16 each 2x3 beams 12 cm long, F4 beams 17 cm long, and 3x4 beams 19 cm long.
4. Includes 24 of the #6 I-beams, 35 cm long.
5. Includes 24 of the #5 I-beams, 24 cm long.
6. Includes Clear, Polycarbonate Thin I-beams #4 (24) 17 cm long, and #3 (24) 11.5 cm long.

Order Information

Thin I-Beams.....ME-7012
 Flexible I-Beams.....ME-6985
 Flat BeamsME-6987
 #6 I-Beam Spares.....ME-7008
 #5 I-Beam Spares.....ME-7017
 Photoelastic I-Beams.....ME-7011

Connectors

- | | | |
|-------------------------------|--------------------------------------|-------------------------------------|
| 1. Connector Spares (ME-7002) | 2. Angle Connector Spares (ME-6999A) | 3. Round Connector Spares (ME-6997) |
|-------------------------------|--------------------------------------|-------------------------------------|



1. Set of 14 connectors used to join truss members
2. Includes sliding connectors (12), angle connectors (24), and straight connectors (24).
3. Includes round connectors (6), flat connectors (6), and six bolts with nuts.

Order Information

Connector SparesME-7002
 Angle Connector SparesME-6999A
 Round Connector SparesME-6997

Materials Testing

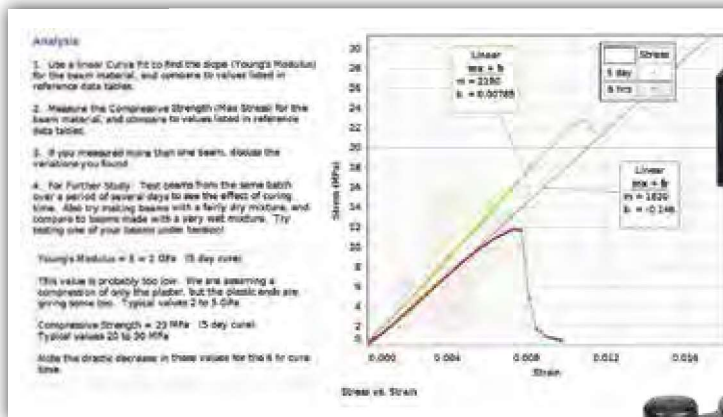
Comprehensive Materials Testing System

ME-8244

With this one system, your students can investigate:

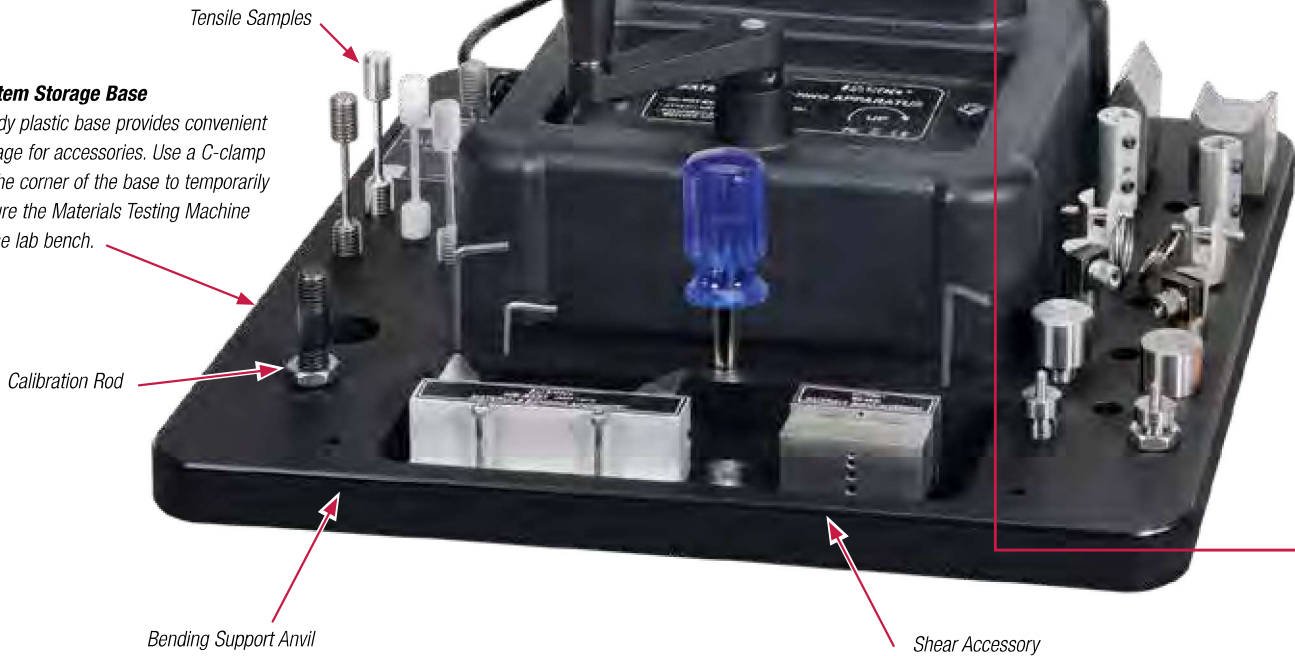
- ▶ Compression and tensile testing
- ▶ Column buckling
- ▶ Three and four-point bending
- ▶ Shear testing
- ▶ Stress lines with photoelasticity

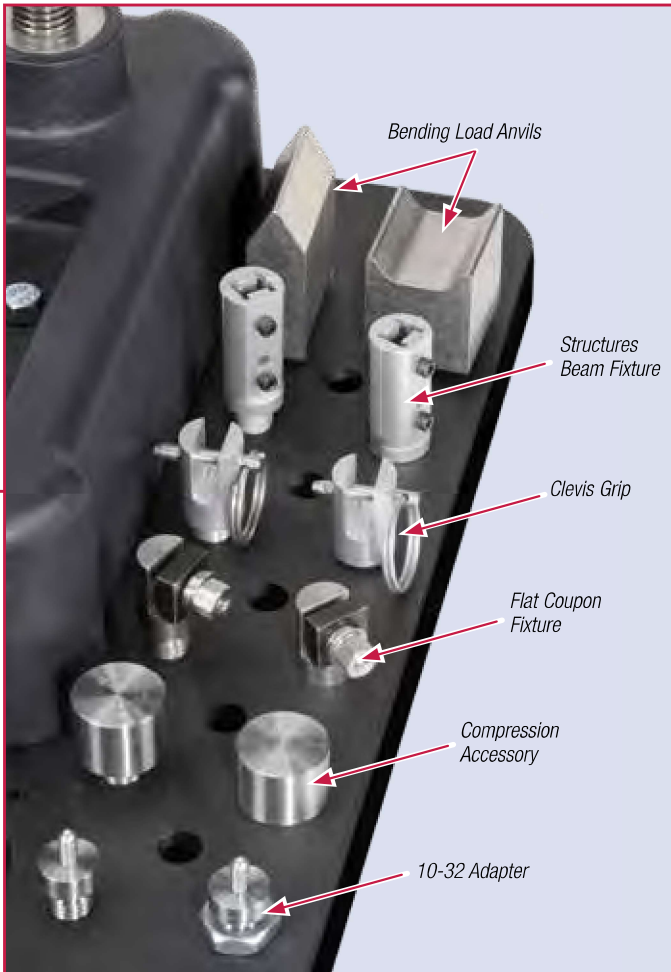
System includes everything needed to study material testing: Testing Machine with attachments, test samples, and computer software. PASCO Capstone Workbooks include setup instructions, theory, and detailed analysis questions. Download experiments at pasco.com/MTS



System Storage Base

Sturdy plastic base provides convenient storage for accessories. Use a C-clamp on the corner of the base to temporarily secure the Materials Testing Machine to the lab bench.





Comprehensive Materials Testing System Includes:

- ME-8236 Testing Machine (with Safety Shields and Calibration Rod)
- Tensile Samples (10 of each):
ME-8231 Aluminum, ME-8232 Brass, ME-8233 Annealed Steel, ME-8243 Steel, ME-8234 Acrylic, ME-8235 Polyethylene
- ME-8237 Bending Accessory
- ME-8249 Four-point Bending Load Anvil
- ME-8241 Photoelasticity Accessory (with Photoelastic Beams)
- ME-8239 Shear Accessory (with Shear Samples)
- ME-8229 Storage Base
- ME-8242 Structures Beam Fixture
- ME-7012 Thin Beams
- ME-6983 Cast Spares
- ME-8247 Compression Accessory (with Compression Samples)
- ME-8238 Flat Coupon Fixture
- AP-8222 Plastic Flat Coupons
- AP-8223 Metal Flat Coupons
- ME-8245 Clevis Grip
- ME-8246 10-32 Adapter
- PS-2100A USB Link
- UI-5401 PASCO Capstone Software Single User License



See complete experiments:
Tensile Testing of Metals..... Page 355
Column Buckling Page 356
Bending: 3-Point and 4-Point..... Page 357

Order Information

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

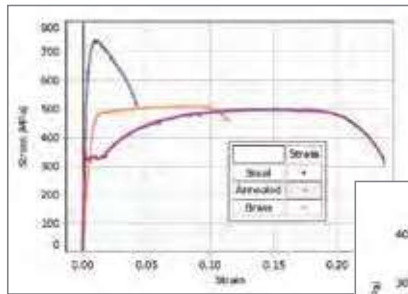
Materials Testing Machine

ME-8236

- ▶ 7100 N max load
- ▶ Hand-cranked so students can feel samples break
- ▶ Inexpensive samples make it possible for each student to experience it firsthand

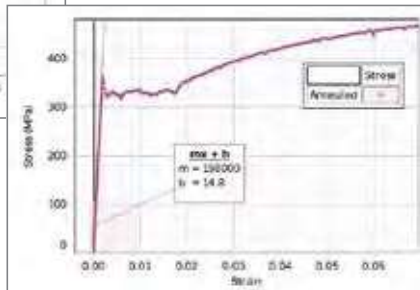
Measure force and displacement for various materials as they are stretched, compressed, sheared, or bent. Investigate material properties including Young's Modulus, Tensile Strength, Yield Strength, Ductility and Modulus of Resilience.

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 and has all the tools to record and display stress vs. strain, apply linear fits to find Young's Modulus, and to record and play back webcam movies of the breaking samples, synced to the data. See page 72.



Tensile Stress vs. Strain is plotted in PASCO Capstone software for steel, annealed steel, and brass.

For annealed steel, a linear fit is applied to find Young's Modulus.

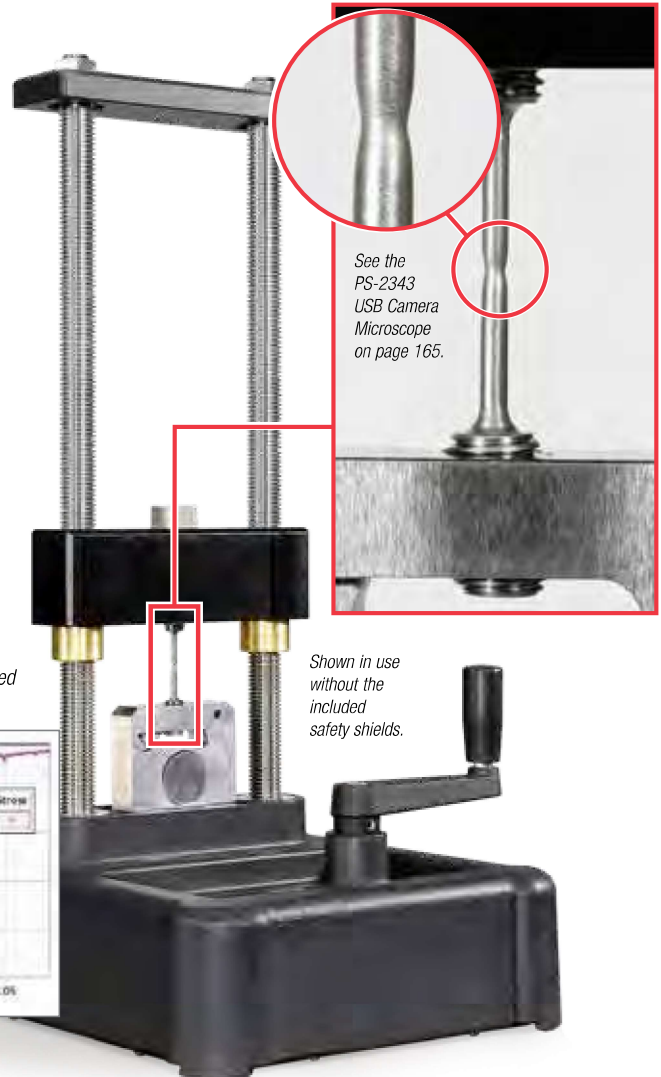


Specifications

- Load cell capacity:** 7100 N (1600 lbs)
- Machine weight:** 20 lbs (9 kg)
- Footprint:** 24 wide x 25 depth x 51 cm height
- Lead screw length:** 38 cm
- Sturdy base:** cast aluminum
- Mounting holes:** for bolting to table

ME-8236 Includes

- Machine
 - Compliance calibration rod
 - Safety shields
- (Requires Capstone software)

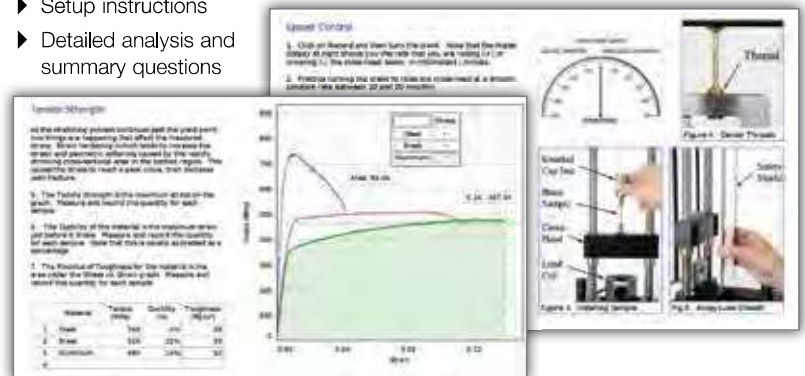


See the PS-2343 USB Camera Microscope on page 165.

Shown in use without the included safety shields.

Workbooks include all instructions needed to perform the experiment:

- ▶ Introduction and theory [Download FREE www.pasco.com/MaterialsTester](http://www.pasco.com/MaterialsTester)
- ▶ Setup instructions
- ▶ Detailed analysis and summary questions



Tensile Samples

Set of 10 each



Order Information

Tensile Sample Aluminum (10).....	ME-8231
Tensile Sample Brass (10)	ME-8232
Tensile Sample Annealed Steel (10)	ME-8233
Tensile Sample Steel (10)	ME-8243
Tensile Sample Acrylic (10).....	ME-8234
Tensile Sample Polyethylene (10).....	ME-8235

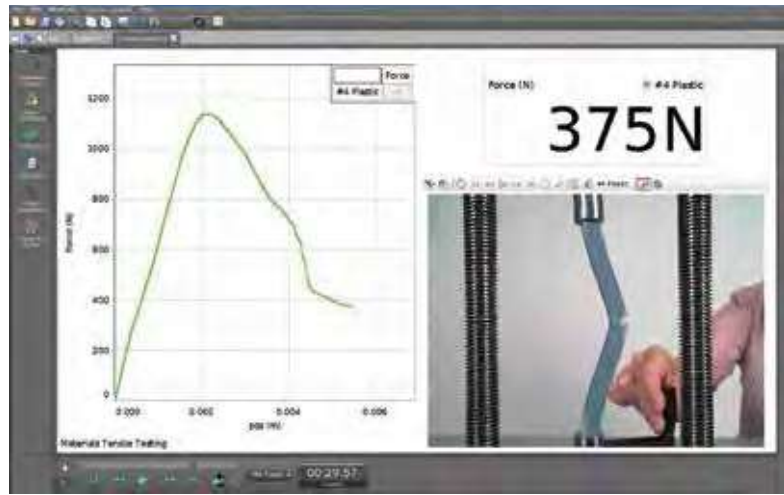
Order Information

Materials Testing Machine	ME-8236
Required:	
PASCO Capstone Software.....	pp. 72-75
AirLink.....	PS-3200 p. 32
Tensile Samples (at left)	

PASCO Capstone™ Software

Combining video with simultaneous data graphs is a very powerful tool.

- ▶ PASCO Capstone is data collection and analysis software that has a special built-in compliance calibration routine for the Materials Tester.
- ▶ It is shown here plotting a graph and recording a video that are synced together in real time. Data analysis tools such as curve fits and area under the curve are available.
- ▶ With any of PASCO's interfaces, you can take advantage of the power of PASCO Capstone by using some of the 80+ sensors from PASCO.



Enhance student understanding of the behavior of materials. PASCO Capstone software has the ability to embed live video from a webcam and sync the Materials Tester data to the recorded video. Then you can play back the video along with the data on the graph, stepping through one frame at a time to see the exact breaking point.

Order Information

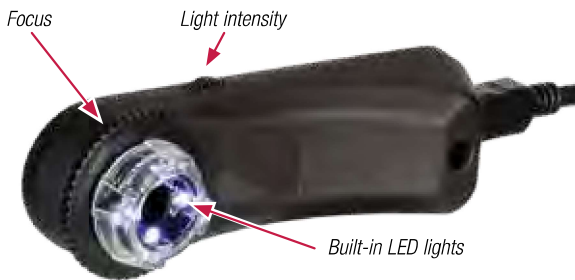
PASCO Capstone Software	
Single User License	UI-5401
Site License	UI-5400

Download PASCO Capstone Trial Version at www.pasco.com/capstone

USB Camera Microscope

PS-2343

- ▶ Use as a web camera
- ▶ Optical zoom from 1x to 60x
- ▶ Built-in LED lighting



This 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. And you can use it to take pictures showing lab setups, and document the appearance of materials before and after an experiment.

How It Works

Use with the video and image capture features in PASCO Capstone. Magnification of specimens can be changed by adjusting the dial located on the front of the camera.



Image of broken steel tensile sample taken with the microscope

As the tensile sample is being stretched, the force vs. time data is graphed in sync with the movie.



Included stand

Includes

- Camera
- Microscope
- Stand

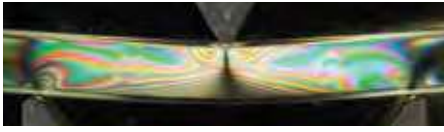
Order Information

USB Camera Microscope	PS-2343
-----------------------------	---------

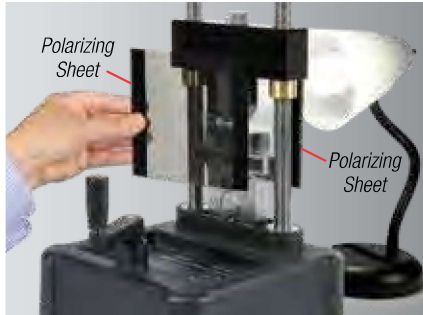
Photoelasticity Accessory

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.



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.



Lamp not included

Includes

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

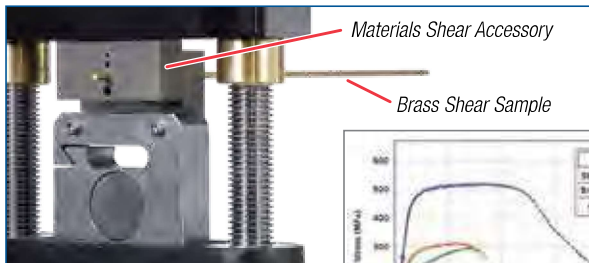
Order Information

Photoelasticity Accessory..... ME-8241
 Photoelastic I-Beam Set ME-7011
 Shown in use with:
 Bending Accessory ME-8237

Materials Shear Accessory

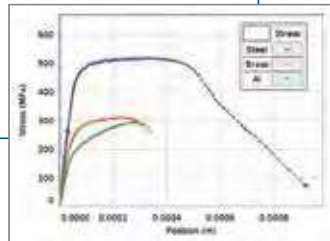
ME-8239

Perform shear tests for a variety of wires. Accessory accepts diameters of 1/16", 3/32", 1/8," and 5/32". The Shear Accessory includes the ME-8240 Shear Samples, three each of 1/8" diameter, 12" long, aluminum, brass and mild steel.



Shown shearing a brass wire

The graph shows shearing of steel, brass, and aluminum rods, all having an 1/8" diameter. The shear strength of each material is measured.



Includes

- Shearing Block and Shear Samples (ME-8240),
- 3 each of three types of wire.

Order Information

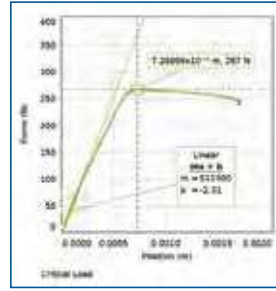
Materials Shear Accessory..... ME-8239
 Replacement Supplies:
 Shear Samples (set of 9) ME-8240

Structures Beam Fixture

ME-8242

The Structures Beam Fixture allows any of the I-beams from PASCO's Structures System to be stretched or compressed in the Materials Testing Machine.

Find the critical load that causes the beam to buckle.



Includes

- Clamps (2)



Plastic I-Beam

Structures Beam Fixture

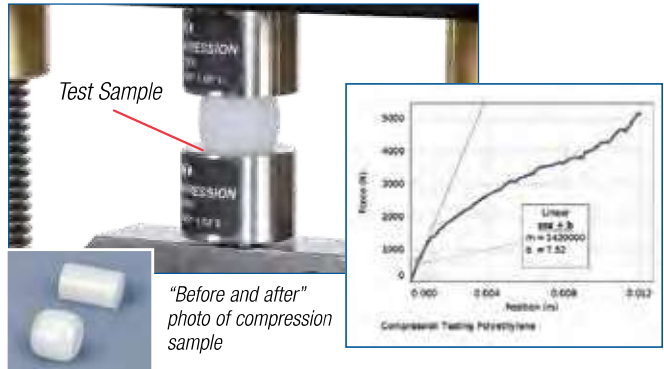
Order Information

Structures Beam Fixture ME-8242

Compression Accessory

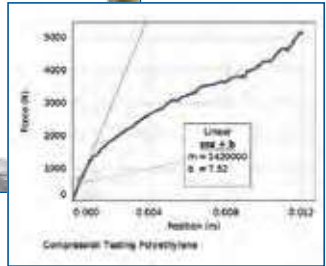
ME-8247

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.



Test Sample

"Before and after" photo of compression sample



Includes

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



Order Information

Compression Accessory ME-8247
 Replacement Supplies:
 Compression Samples (20) ME-8248

System Storage Base

ME-8229

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



Order Information

System Storage Base ME-8229

Bending Accessory

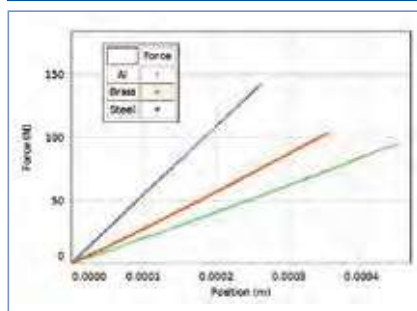
ME-8237

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



See EX-5559 Bending Experiment on p. 357.

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.

Four-Point Bending Accessory

ME-8249

Add the optional Four-Point Bending Accessory to the ME-8237 to perform both three-point and four-point bending.

Perform a Four-Point Bend Test on the Cast Beams from the PASCO Structures System. Quantities measured include the Flexural Elastic Modulus and the Modulus of Rupture for the material.



ME-8237 Includes

- Base
- Adjustable support anvil
- Load anvil



ME-8249 Includes

- A two-point fixture that, when added to the Bending Accessory, allows four-point bending.



Order Information

Bending Accessory ME-8237
 Four-Point Bending Accessory ME-8249

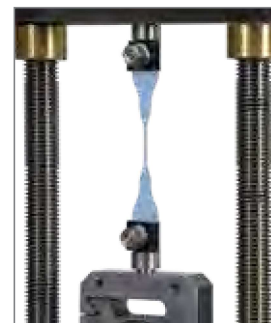
Shown in use with:

Shear Samples (set of 9) ME-8240
 Thin I-Beams ME-7012
 Cast Beams Spares ME-6983
 (includes 30 rebar members, 10 cast beam molds)

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 (1)

Order Information

Flat Coupon Fixture ME-8238
 Plastic Test Coupons (40 coupons) AP-8222
 Metal Test Coupons (50 coupons) AP-8223

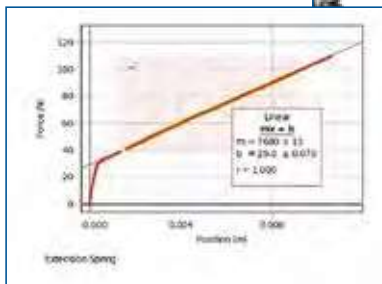
Clevis Clip

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).



Spring not included.



Includes

- Clevis adapter and pin. Pin diameter is 0.187 in. Max width of sample is .300 in.

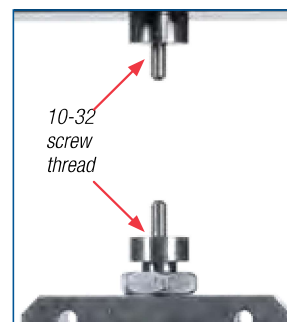
Order Information

Clevis Clip ME-8245

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.

Order Information

10-32 Adapter ME-8246

Rotational Inertia

Looking for Tensile Samples for the legacy Stress/Strain Apparatus?



Although the AP-8214A Stress/Strain Apparatus is obsolete, we will continue to supply the test coupons indefinitely to accommodate current users. These coupons are also useful in PASCO's new Materials Testing Machine (ME-8236). Please see pages 162-165 for this new Materials Testing Machine. There is a new adapter, the Flat Coupon Fixture (ME-8238), which allows these coupons to be tested in the new machine.

Plastic Test Coupons

AP-8222



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



Five types of samples, 10 pieces per sample (sample containers labeled with thickness in inches)

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

Order Information

Replacement Plastic Test Coupons Full Set (40 coupons)AP-8222
 Replacement Metal Test Coupons Full Set (50 coupons)AP-8223

Super-Flex I-Beam

ME-8987

- ▶ Demonstrate the difference in stiffness between the two directions of bending
- ▶ Show that I-beams twist easily
- ▶ Show torsion and buckling
- ▶ Grid shows deformation

This Super-Flex I-Beam is made of plastic, so it can be visibly bent by hand. It shows the basic reasons for using this cross-section in construction. It is four times as stiff in the upright orientation as it is sideways.



Column buckling



Demonstrate lack of torsional strength.

Includes

- Super-Flex I-Beam (24 inches long, 2 inches high)
- Instructions



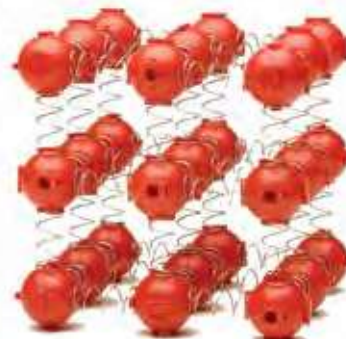
Order Information

Super-Flex I-Beam..... ME-8987

Matter Model

ME-9825A

The atoms of the Matter Model are brightly colored spheres with the bonds between the atoms modeled by springs, so that when forces are applied, the atoms can move in response.



Demonstrate the normal force response as a material is compressed.



Includes

- Atoms (4.5 g each) (40)
- Heavy, light and long springs (60 each)
- Nuts (to increase the atom mass) (30)
- 90 cm brass rod (for longitudinal waves)



The Matter Model is shipped in component pieces, ready for assembly.

Order Information

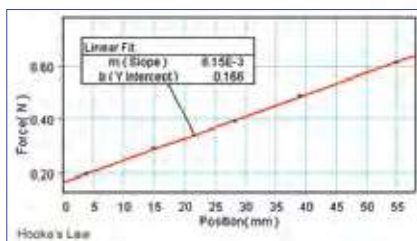
Matter Model..... ME-9825A

Hooke's Law Set

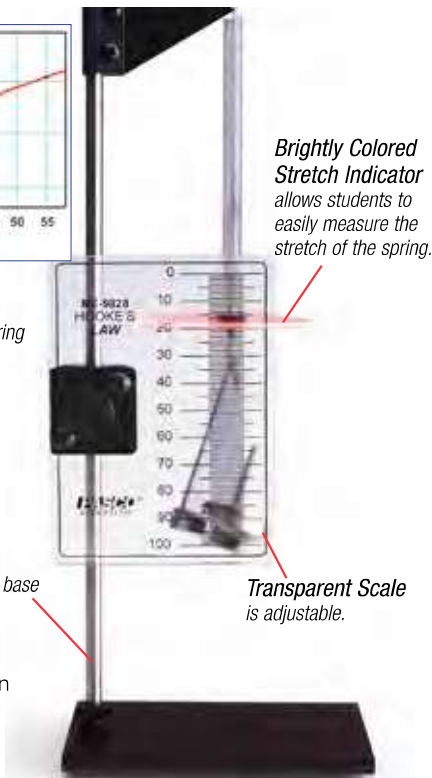
ME-9827

- ▶ Brightly colored stretch indicator
- ▶ Transparent measuring scale
- ▶ Compatible with PASCO mass sets

The Hooke's Law Set allows students to investigate the relationship between the force applied to a spring and the amount of stretch on the spring. This rugged set features a heavy base, so you can stretch the springs without toppling the unit. The transparent scale can be moved vertically to align zero with the brightly colored stretch indicator.



As a force is applied to the spring by placing mass on the hanger, the spring stretches. Students can graph the Applied Force vs. Spring Stretch. The slope of this graph is the spring constant of the spring. The vertical intercept shows the initial force required to begin stretching the spring.



Includes

- Stand with heavy base
- Transparent scale with mm resolution
- Horizontal support for spring
- Brightly colored stretch indicator
- Three springs with identical diameter and length, but different spring constants
- Three of each spring included, for a total of nine springs: spring constants are 5 N/m, 8 N/m, 70 N/m



Order Information

Hooke's Law Set.....ME-9827

Recommended:

Mass and Hanger SetME-8979 p. 201

Hooke's Law Spring Set

SE-8749

Includes three springs with the same diameter and length, but different spring constants. Three of each type of spring are included, and the springs fit nicely on PASCO mass hangers. All springs are 55 mm long and 7 mm in diameter. Spring constants are 5 N/m, 8 N/m and 70 N/m.



Order Information

Hooke's Law Spring Set.....SE-8749

Dropper Popper

SE-7304

Invert this half rubber ball and drop it. It will bounce up higher than the release point. Discuss conservation of energy with your students.



There is a minimum height required to trigger the popper that can be related to barrier potentials.



Order Information

Dropper PopperSE-7304

Springs & Oscillations

Series/Parallel Spring Set

ME-6842

The set of six springs consists of two each of three different spring constants. These springs are 15 cm long, half the length of the Equal-Length Spring Set, making it possible to combine two series short springs in parallel with one long spring.

Shown in use with the Parallel Spring Bracket and the Hooked Mass Set.



Specifications

The six color-coded springs, two of each color, have different spring constants:

10 N/m, 20 N/m, 40 N/m ($\pm 5\%$)

Includes

- White storage box
- Six (color-coded) springs 15 cm long



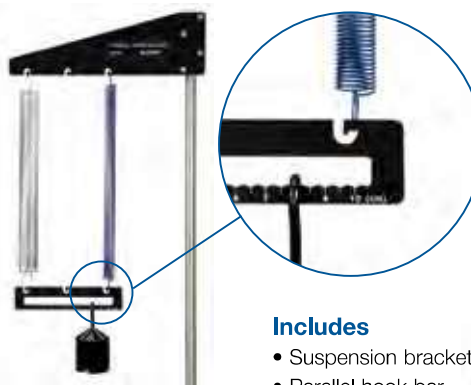
Order Information

Series/Parallel Spring Set	ME-6842
<i>Recommended:</i>	
Hooked Mass Set.....	SE-8759 p. 201

Parallel Spring Bracket

ME-6844

This unique bracket allows springs of different spring constants to be hung in series and parallel. The masses can be hung in an offset position to compensate for the stronger spring.



Parallel Hook Bar has cm markings to allow calculation of the applied torques.

Includes

- Suspension bracket
- Parallel hook bar



Order Information

Parallel Springs Bracket.....	ME-6844
-------------------------------	---------

Equal-Length Spring Set

ME-8970

The five color-coded equal-length springs in this set have different spring constants: 25 N/m, 30 N/m, 35 N/m, 40 N/m, 50 N/m ($\pm 5\%$)



The five color-coded springs stretch different amounts when a 1 kg mass is hung from each spring.

These springs appear to be the same except for their colors. But, when equal masses are hung on them, each stretches a different amount. These extension springs are made of steel and are closed, requiring a slight initial force to separate the coils. The unstretched length of each spring is 30 cm and the approximate diameter is 1.4 cm.

These springs are supplied with a white storage box with cardboard separators to keep the springs from touching each other.

Includes

- White storage box
- Five (color-coded) springs
- 30 cm long



Order Information

Equal-Length Spring Set.....	ME-8970
<i>Recommended:</i>	
Pendulum Clamp	ME-9506 p. 192
Hooked Mass Set.....	SE-8759 p. 201

Demonstration Spring Set

ME-9866



This set includes four large springs for the demonstration of Hooke's Law or Conservation of Energy. Each spring is constructed of rugged spring steel with large loops that hang from a pendulum clamp or stretch with hanging masses. Spring constants range from 4 N/m to 14 N/m. Spring lengths vary between 11 cm and 22 cm.

Order Information

Demonstration Spring Set.....	ME-9866
<i>Recommended:</i>	
Pendulum Clamp	ME-9506
Hooked Mass Set.....	SE-8759 p. 201

Double-Length Slinky

SE-8760



The Slinky® is an excellent tool for demonstrating transverse and longitudinal wave phenomena. This Double-Length Slinky is twice as long as a traditional Slinky, allowing students to create well-defined wave pulses and standing wave patterns. The tension in the Slinky is very low, causing wave pulses to travel slowly throughout its length.

Order Information

Double-Length SlinkySE-8760

Snakey

SE-7331



This extra-long metal spring is ideal for studying mechanical waves. The Snakey has an unstretched length of 2 meters. Pull the convenient end loops more than 10 meters apart to demonstrate transverse, longitudinal, and standing waves.

Order Information

Snakey SE-7331

Longitudinal Wave Spring

WA-9401



This spring has a 1.6 cm diameter and is 13.5 cm long. The approximate spring constant is 0.85 N/m.

Order Information

Longitudinal Wave Spring WA-9401

Photogate Pendulum Set

ME-8752

- ▶ Great for classic pendulum experiments



The Photogate Pendulum Set is a unique set of four pendulums that have the same shape and size, but different masses. Due to their cylindrical shape, these pendulums are ideal for use in timing experiments with the photogate. One pendulum each of brass, plastic, wood, and aluminum is included.

Typical Applications

- ▶ Determine relationship between period and mass
- ▶ Determine relationship between period and amplitude
- ▶ Determine relationship between period and length



Cylindrical shape allows easy calculation of the speed of the pendulum using the time it blocks the photogate. Photogate not included.

Order Information

Photogate Pendulum Set ME-8752

Dynamics Track Spring Set

ME-8999



Includes 12 springs (1.6 cm diameter) with approximate spring constants of:
 3.4 N/m (3 short and 3 long springs)
 6.8 N/m (3 short and 3 long springs)

Order Information

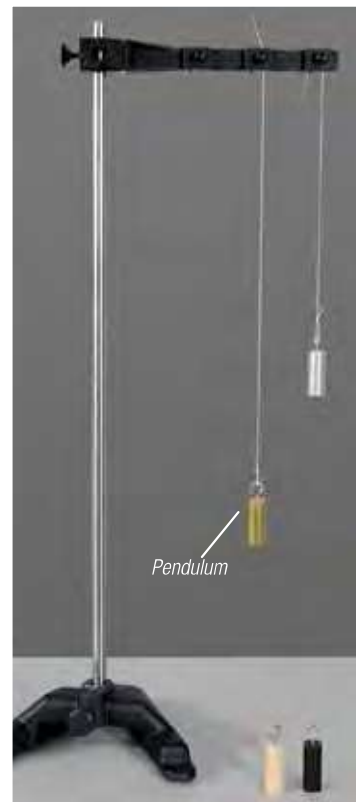
Dynamics Track Spring Set (12).....ME-8999

Pendulum Clamp

ME-9506



Hang up to three springs or pendulums. Suspension points are 54 mm apart. Fits rods up to 16 mm (5/8 inch) in diameter.



See page 144 for more information.



Easily adjust length of pendulum.

Order Information

Pendulum Clamp ME-9506
 Shown in use with:
 Photogate Pendulum Set ME-8752
 Small "A" Base ME-8976 p. 190
 Stainless Steel Rod (45 cm.) ME-8736 p. 190

Rotation

PASCO's Complete Rotational System

ME-8950A

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

The unit features a cast iron base, dual ball bearings and stainless steel shaft. The moments of inertia are large enough to be sensed by the student when rotating the system by hand. Computer monitoring of angular velocity and a motorized drive are also possible.

PASCO's Complete Rotational System provides a range of experiments in centripetal force, angular momentum, and rotational motion. A unique set of accessories makes it an ideal tool for experiments in torques, friction, magnetic levitation, and Faraday's Law.



Included Experiments

1. Rotational Inertia of Disk and Ring, Two Axes
2. Centripetal Force
3. Rotational Inertia of Off-Axis Disk (fixed and rotating)
4. Conservation of Angular Momentum, Using a Point Mass

Experiments not shown:

5. Rotational Inertia of a Point Mass
6. Conservation of Angular Momentum, Projectile Version
7. Conservation of Angular Momentum, Using Disk and Ring

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

Components of this system

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.

Order Information

Complete Rotational SystemME-8950A
Required:
 Mass and Hanger Set ME-8979 p. 201

Interfacing Options

It is easy to use a computer to monitor rotational motion with the PASCO Rotational System. Here are two methods:

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).



Order Information

Recommended:
 Photogate Head ME-9498A p. 45

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.



Order Information

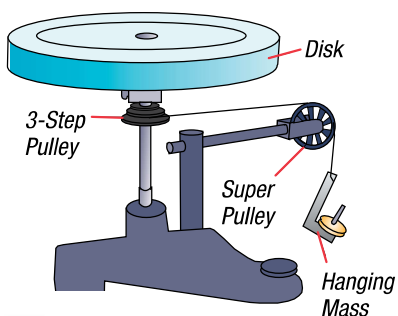
Required for use with ScienceWorkshop:
 Rotary Motion Sensor CI-6538
Required for use with PASPORT:
 Rotary Motion Sensor PS-2120A
 "A"-base Rotational Adapter CI-6690 p. 175

Experiments you can do with this rotational system:

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, the radius, and angular acceleration, the rotational inertia of the disk can be determined.



Radial axis

The disk can also be mounted on 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.

Accurate Radius Indicator

Can be monitored throughout the cycle of rotation.

Mass Support

Can be easily moved to change radius continuously from 2 to 20 cm.

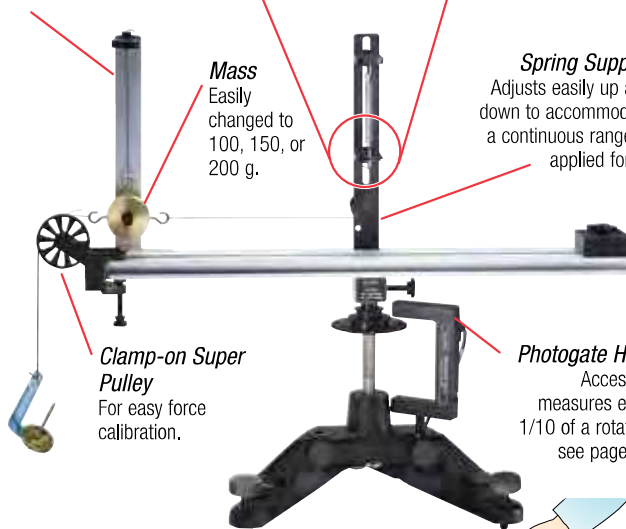


Mass

Easily changed to 100, 150, or 200 g.

Spring Support

Adjusts easily up and down to accommodate a continuous range of applied force.



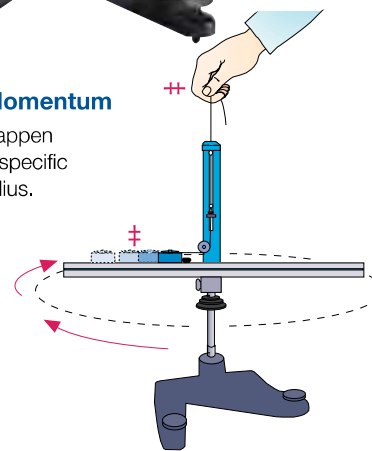
Rotational Inertia of Off-axis Disk

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.



Rotational System Components and Accessories Pages 174-175



Rotating Platform and Rotational Inertia Accessory p. 174



Centripetal Force Accessory p. 174



Rotational Motor Drive p. 175

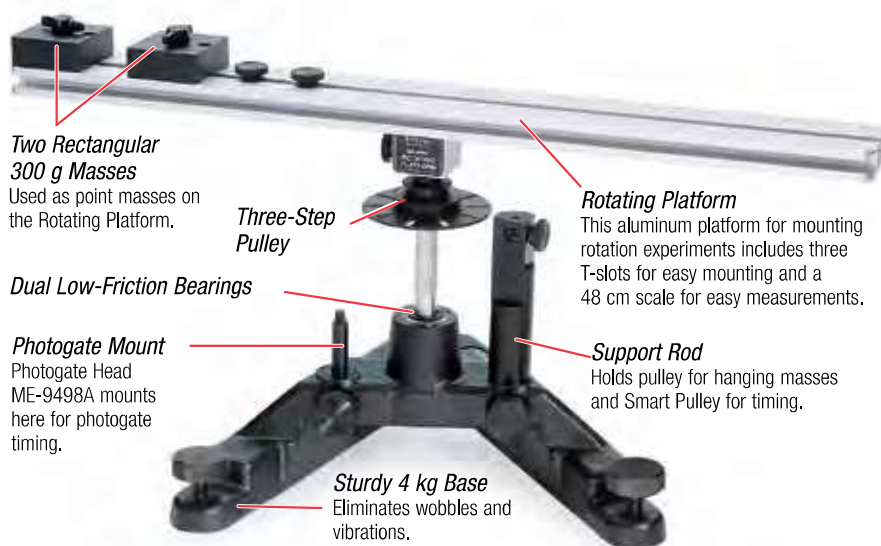


"A"-base Rotational Adapter p. 175



Rotational System Components

Rotating Platform ME-8951



Two Rectangular 300 g Masses
Used as point masses on the Rotating Platform.

Three-Step Pulley

Rotating Platform
This aluminum platform for mounting rotation experiments includes three T-slots for easy mounting and a 48 cm scale for easy measurements.

Dual Low-Friction Bearings

Photogate Mount
Photogate Head ME-9498A mounts here for photogate timing.

Support Rod
Holds pulley for hanging masses and Smart Pulley for timing.

Sturdy 4 kg Base
Eliminates wobbles and vibrations.

A Versatile Base

The stable base and precision bearings of the Rotating Platform are the foundation of PASCO's Rotational System. It serves as an excellent base for general rotation experiments.

Order Information

Rotating Platform.....	ME-8951	
<i>Recommended:</i>		
Rotational Inertia Accessory.....	ME-8953	
Centripetal Force Accessory.....	ME-8952	
Rotational Motor Drive.....	ME-8955	p. 175

Rotational Inertia Accessory ME-8953

A disk and a ring permit several experiments in rotational inertia. The disk may be rotated about several axes. When used in conjunction with the adapter, experiments using the parallel-axis theorem may be performed by moving the disk off from the center of rotation. The ball bearing on one side of the disk permits it to rotate freely for some experiments, while a "D" hole on the other side prevents rotation about the disk axis.

Includes

- Heavy-Grade Plastic Disk (22.9 cm diameter, 1500 g)
- Metal Ring (12.7 cm outside diameter, 1420 g)
- Disk Adapter
- Super Pulley and Support Rod



Centripetal Force Accessory ME-8952

With traditional centripetal units, the ability to change the variables is either impossible or limited. The PASCO Centripetal Force Accessory is designed to make changing the mass, radius, or force quick and easy.



Features

- ▶ **Vary Parameters Independently:** Change the centripetal force, mass, and radius independently of each other.
- ▶ **Change Variables Over a Wide Range:** Radius can be varied continuously from 2 to 20 cm, and the rotating mass can be 100, 150, or 200 g.
- ▶ **Observe the Radius Indicator Throughout the Cycle:** PASCO's design has the indicator at the center of rotation, allowing continuous observation throughout the rotation cycle, which results in more accurate measurements.



Includes

1. Spring Support and Radius Indicator Assembly
2. Mass Support
3. Masses (100 g and two 50 g)
4. Super Pulley with Clamp

Order Information

Centripetal Force Accessory.....	ME-8952
----------------------------------	---------

Rotational Motor Drive

ME-8955

The Motor Drive is used with the Rotational Platform to power continuous rotational motion demonstrations. Use this motor to drive the Rotational Acceleration Tank at a constant speed. Power the Motor Drive with a ramp function using the DC Power Supply to smoothly increase the angular speed of the Centripetal Force Accessory. The motor requires a 12 V DC power supply or a function generator.



Easily change the gear ratio of the motor drive by moving the drive belt to one of the three possible pulley steps.

Specifications

Motor: 12 V maximum, 0.2 A minimum

Base Spindle Speed Range: 10 to 600 rpm

Three-Step Pulley

Includes

- Motor
- Three-Step Pulley
- Drive Belt



Order Information

Rotational Motor Drive	ME-8955	
<i>Required:</i>		
Rotating Platform	ME-8951	p. 174
850 Universal Interface	UI-5000	p. 28
<i>or</i>		
Function Generator	PI-8127	p. 255
<i>or</i>		
DC Power Supply	PI-9880	p. 249

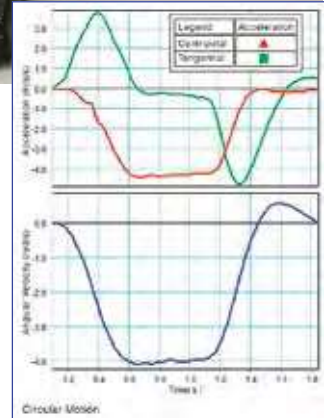
"A"-base Rotational Adapter

CI-6690

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



The platform is quickly rotated (from rest) and then brought to a stop. Both the tangential and centripetal acceleration is measured (using the 2-Axis Acceleration Sensor), while the platform's angular velocity is measured by the Rotary Motion Sensor.



Close-up of Rotary Motion Sensor mounted on "A"-base



Includes

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



Order Information

"A"-base Rotational Adapter	CI-6690	
<i>Required:</i>		
Rotating Platform	ME-8951	p. 174
Rotary Motion Sensor ScienceWorkshop	CI-6538	
<i>or</i>		
Rotary Motion Sensor PASPORT	PS-2120A	

Rotational System Components

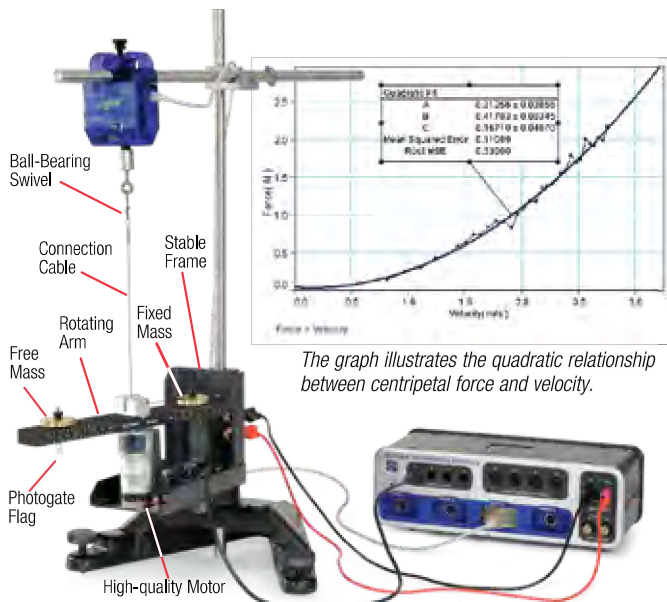
Centripetal Force Apparatus

ME-8088

- ▶ Empirically determine centripetal force
- ▶ Easy to set up ▶ Repeatable results

Features

- ▶ **Stable Frame:** The metal frame can be easily attached to a ring stand using the included clamp. The frame may also be attached to a tabletop with a large table clamp.
- ▶ **High-quality Motor:** Will withstand years of student use.
- ▶ **Computer-based Measurements:** The Force Sensor and photogate facilitate accurate and repeatable measurements of force, angular velocity, and tangential velocity.



The graph illustrates the quadratic relationship between centripetal force and velocity.

How It Works

The rotating arm features a groove with two captured masses along its length. One of the masses is free to move along the length of the groove. The free mass is connected to a small cable that runs under a pulley in the center of the arm and up to a Force Sensor. A ball-bearing swivel is used to ensure the cable does not tangle as the arm rotates. The other mass is placed the same distance from the center as the free mass, thereby balancing the arm. A flag attached to the bottom of the fixed mass passes through the photogate once per revolution, allowing a calculation to be made of the angular and tangential velocity of the mass.

Includes

- Frame with Mounted 12 VDC Electric Motor
- Connecting Cable
- Ball-Bearing Swivel
- Connecting Hardware for Photogate
- Mass Holder for Free Mass
- Mass Holder for Fixed Mass
- 5 g Mass (2)
- 10 g Mass (2)
- 20 g Mass (2)



Order Information

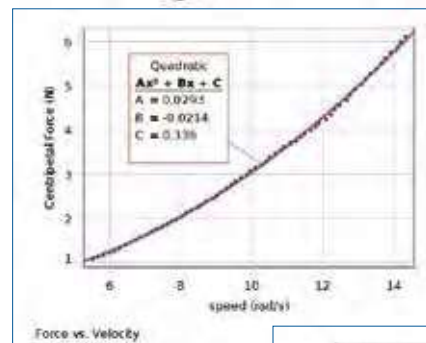
Centripetal Force Apparatus.....	ME-8088
<i>Required:</i>	
Force Sensor	p. 38
Photogate Head	p. 45
Triple Output Power Supply.....	SE-8587 p. 250
Large Rod Base	ME-8735 p. 190
45 cm Steel Rod.....	ME-8736 p. 190
120 cm Steel Rod.....	ME-8741 p. 190
Multi Clamp.....	ME-9507 p. 192

Wireless Centripetal Force Accessory

ME-8094

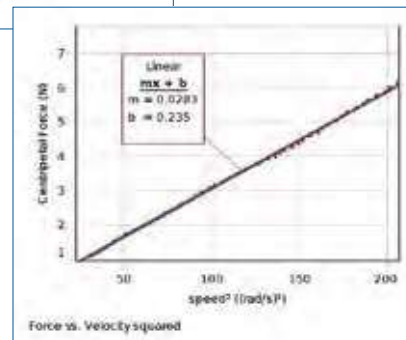
- ▶ Transmitting data wirelessly eliminates friction
- ▶ Uses Wireless Force Acceleration Sensor
- ▶ Vary speed, radius, and mass

The Wireless Centripetal Force Accessory is a low friction sliding mass holder that connects to a Wireless Force Acceleration Sensor (PS-3202). When installed on a Rotating Platform (ME-8951), it provides a simple and direct measurement of centripetal force and acceleration. Vary the mass using the holed masses in the Mass and Hanger Set (ME-8979). The string length is easily adjusted to vary the radius.



This PASCO Capstone graph shows the Centripetal Force (measured directly by the Wireless Force Acceleration Sensor) versus Angular Speed as the platform slows down.

In this PASCO Capstone graph, a "QuickCalc" of speed squared has been chosen on the horizontal axis, resulting in a straight line.



Includes

- Low-friction sliding mass holder
- Mounting post for force sensor

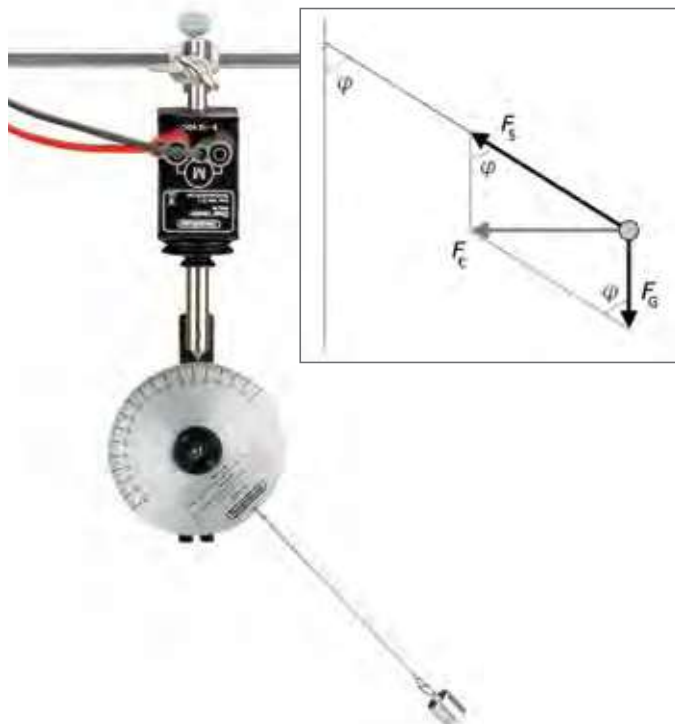
Order Information

Wireless Centripetal Force Accessory.....	ME-8094
<i>Required:</i>	
Wireless Force Acceleration Sensor	PS-3202
Mass and Hanger Set	ME-8979
Rotating Platform.....	ME-8951
PASCO Capstone.....	pp. 72-75

Conical Pendulum

SF-7206

- ▶ Study effects of speed and radius on centripetal force.
- ▶ Determine g from the angle.



Powered with a 12 V DC power supply (not included), the apparatus rotates and the bob flies out, causing the angle indicator to rotate. The angle with the vertical is read on the graduated disk. The pendulum's length can be varied using four interchangeable wires with hooks. The Conical Pendulum is specially designed for Gear Motor SF-7204 (not included; see at right).



- Includes**
- Conical Pendulum
 - 4 different length cables

Order Information

Conical Pendulum.....	SF-7206
<i>Required:</i>	
DC Gear Motor.....	SF-7204
DC Power Supply.....	SE-9720A
Large Table Clamp.....	ME-9472
Multi Clamp.....	ME-9507
Stainless Steel Rod 90 cm (2).....	ME-8738

DC Gear Motor

SF-7204



The gear motor operates on 0 to 12 V DC and yields gearing of 21:1 with a stable, slow motion. The motor is fitted with a removable winding shaft. With a thread, it can be used for slow, linear motion. The motor is suitable for use with the Conical Pendulum SF-7206.

Specifications

- Voltage:** 12 V DC
- Current:** 20 mA at 12 V (no load)
- Gear Ratio:** 21:1
- Max Speed:** 80 rpm

Order Information

DC Gear Motor.....	SF-7204
<i>Required:</i>	
DC Power Supply.....	SE-9720A

Circular Motion Apparatus

SF-7205

For demonstrating the laws of uniform circular motion, this small motor is fitted with a disk for attaching a rubber ball on a chain. The speed can be varied.



Includes

- Motor
- Special suspension rod (53 cm long)
- Three different rubber balls
- Suspension chains (different lengths)

Order Information

Circular Motion Apparatus.....	SF-7205
<i>Required:</i>	
DC Power Supply.....	SE-9720A
Large Table Clamp.....	ME-9472
Multi Clamp.....	ME-9507
Stainless Steel Rod 90 cm (2).....	ME-8738

Centripetal Force

Handheld Centripetal Force

Discover Centripetal Force Kit

ME-9837A



As the stopper is swung around in a circle by hand, the Force Sensor directly measures the centripetal force. This handheld method allows students to feel the centripetal force.

The Motion Sensor detects the stopper on each rotation and is used to calculate its speed.

Use the traditional method with hanging masses, or use with a Force Sensor to continuously measure the centripetal force. Adding sensors to this classic experiment creates a dynamic, quantitative lab that your students will never forget.

Includes

- Rubber Stoppers (sizes 6, 8, 10)
- Plastic Ties (10)
- Yellow String (73 meters)
- Hollow Tube



Order Information

Discover Centripetal Force Kit.....	ME-9837A	
<i>Shown in use with:</i>		
High Resolution Force Sensor	PS-2189	p. 38
Motion Sensor	PS-2103A	p. 34
<i>Required for Classic Approach:</i>		
Hooked Mass Set.....	SE-8759	p. 201
Stopwatch	ME-1234	p. 127

Flying Airplane

SE-6673



This classic centripetal force experiment is used in high school AP® Physics 1 curriculum*. Hang it from the ceiling, give it a push, and it flies in a circle.

Order Information

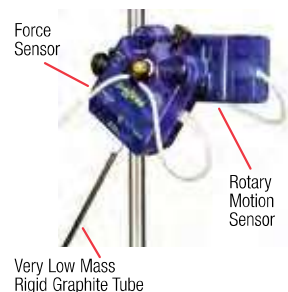
Flying Airplane.....	SE-6673
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* AP is a trademark registered and/or owned by the College Board, which was not involved in the production of, and does not endorse, this product.

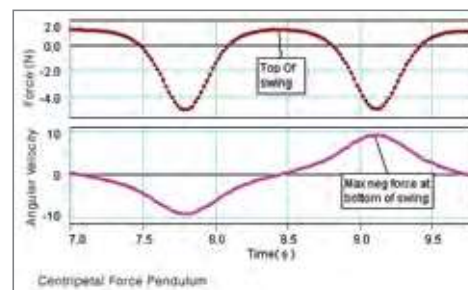
Centripetal Force Pendulum

ME-9821

- ▶ Quantitative force vs. velocity data
- ▶ Repeatable results
- ▶ Vary pendulum length and mass



When used with Force and Rotary Motion Sensors, the Centripetal Force Pendulum allows students to collect accurate circular motion data.



The Centripetal Force Pendulum is used to produce graphs of force and angular velocity vs. time. Note that the force changes direction at the top of the swing for large amplitudes.

The Centripetal Force Pendulum attaches to a Force Sensor and allows students to directly measure the forces involved in circular motion. By attaching the Force Sensor/pendulum combination to the Rotary Motion Sensor, the relationship between force, mass, and velocity in a circular path can be investigated.

Includes

- Graphite Pendulum Rod with Threaded Connector
- Sliding Mass (100 g)
- Mount with Cord Clip



Order Information

Centripetal Force Pendulum.....	ME-9821	
<i>Required:</i>		
Large Rod Base	ME-8735	p. 191
45 cm Steel Rod.....	ME-8736	p. 191
90 cm Steel Rod.....	ME-8738	p. 191
Multi Clamp	ME-9507	p. 192
Rotary Motion Sensor	PS-2120A	
Force Sensor	PS-2104	

Rotational Inertia Set

ME-9774



Release two different sized objects simultaneously.



How It Works

Compare rotational inertias of objects with different shapes and sizes. Students learn that the speed of an object rolling down the ramp is not affected by its mass or radius. The shape or distribution of the mass determines the outcome. The sphere will reach the bottom first, followed by the disk. The ring will be last.

Includes

- 10 cm outer diameter set
 - Solid Sphere (810 g)
 - Ring (Aluminum, 230 g)
 - Disk (Plastic, 370 g)
- 5 cm outer diameter set
 - Solid Sphere (110 g)
 - Ring (Aluminum, 90 g)
 - Disk (Plastic, 70 g)
- Release Mechanism



Order Information

Rotational Inertia Set ME-9774

Spherical Mass Set

ME-8968

Hollow Steel Ball



This set includes four balls with a diameter of 25 mm each, but featuring various masses and rotational inertias.

Typical Applications

- ▶ Race the hollow steel ball and solid aluminum ball down an incline. They have about the same mass, but the solid aluminum ball has a much larger acceleration down the ramp.
- ▶ Fire the yellow plastic, solid steel, and hollow steel balls from a PASCO Projectile Launcher.

Includes

- Solid Yellow Nylon Ball (10 grams)
- Solid Steel Ball (66 grams)
- Hollow Steel Ball (21 grams)
- Solid Aluminum Ball (24 grams)
(release mechanism not included)



Order Information

Spherical Mass Set ME-8968

Rotational Inertia Wands

ME-9847

The red and blue wands have the same mass but the red wand is easier to rotate because the red wand has less rotational inertia.

These two wands have the same mass and the same dimensions and yet the red wand is easier to rotate. This is because the red wand has two metal slugs near its center, while the blue wand has two similar metal slugs at its ends. This demonstrates that rotational inertia depends on the distribution of the mass.

These sturdy plastic wands have small holes near the center and at the ends to enable students to see where the metal is located in each wand. What initially seems a mystery can be explained to the students by allowing them to examine the wands more closely.



To demonstrate the difference in rotational inertia of the two rods, ask two students to grab the center of a wand and instruct them to rotate the wand back and forth as rapidly as they can. No matter how strong the student with the blue wand is, he or she is not able to rotate it as fast as the student with the red wand.

Specifications

- Length:** 1 m
- Diameter:** 4 cm
- Ratio of Blue Rotational Inertia to Red:** Approx. 6

Includes

- Red Wand (1)
- Blue Wand (1)



Order Information

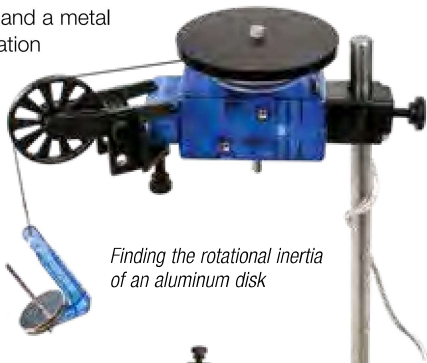
Rotational Inertia Wands ME-9847

Rotational Motion Accessories

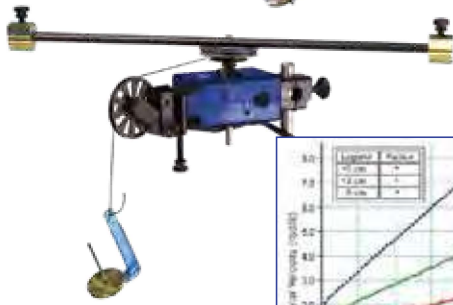
Rotational Inertia Accessory

ME-3420

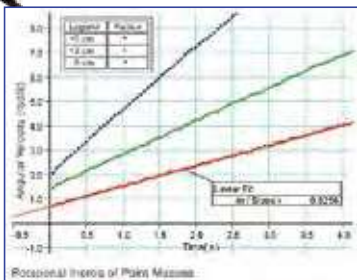
Add the Rotational Inertia Accessory to the Rotary Motion Sensor (PS-2120A) to study the oscillations of a pendulum, the rotational inertia of an aluminum disk, a steel ring and a metal rod, as well as the conservation of momentum during a rotational collision. The clamp-on Super Pulley allows students to apply a torque by hanging a mass over the pulley.



Finding the rotational inertia of an aluminum disk

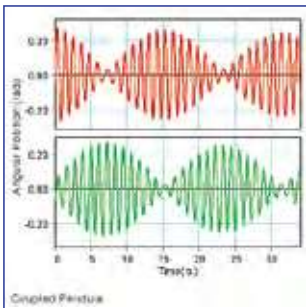


Finding the rotational inertia of point masses using the graph of Angular Velocity vs. Time



Coupled Pendulums

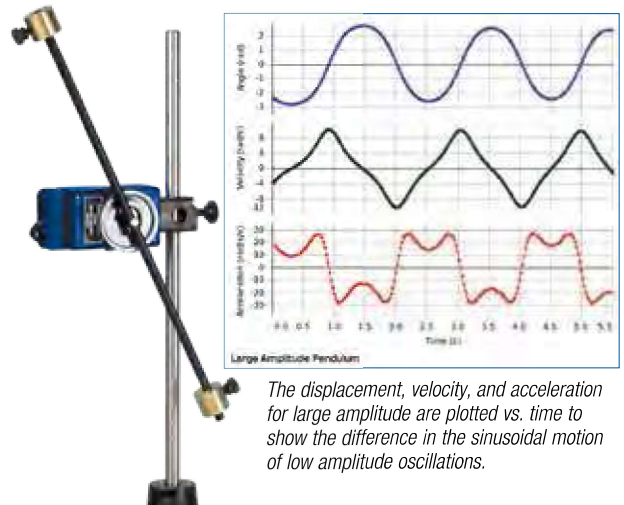
Couple two pendulums with a rubber band and plot the Position vs. Time for each pendulum. The result is a vivid example of energy transfer between the pendulums.



Large Amplitude Pendulum

See page 348 for complete experiment.

By placing one mass on each end of the tube, the pendulum will oscillate slowly. Students will have time to view the motion of the pendulum, while also watching the real-time graph of displacement, velocity, and acceleration vs. time. The period can be measured as a function of the amplitude of the pendulum and compared to theory.

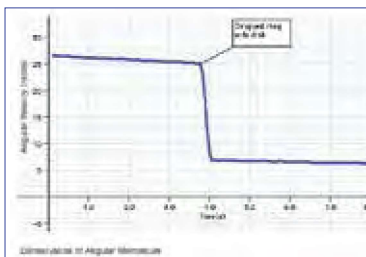


The displacement, velocity, and acceleration for large amplitude are plotted vs. time to show the difference in the sinusoidal motion of low amplitude oscillations.

Conservation of Angular Momentum

See page 347 for complete experiment.

To demonstrate conservation of angular momentum, a non-rotating ring is dropped onto a rotating disk. The angular velocity of the disk is recorded in real time, and students can easily determine the angular velocities of the disk just before and after the ring is dropped. Combining these velocities with the rotational inertia of the disk and ring, students can confirm that angular momentum is conserved.



The angular speed of the disk decreases when the ring is dropped onto the spinning disk.



Includes

- Disks (2): 8.9 cm diameter, 100 g
- Thin Ring: 8.9 cm o.d., 7.9 cm i.d., 100 g
- 38 cm Pendulum Rod (27 g)
- 75 g Mass (2)
- Clamp-on Super Pulley
- Alignment Guides (3): 3.9 cm radius, 1.7 g

Order Information

Rotational Inertia Accessory..... ME-3420

Also available:

Ring and Disk Set..... ME-3419
(Includes ring, 2 disks, and 3 alignment guides)



Pendulum Accessory

ME-8969

The pendulum rod and masses can be purchased separately.

Includes

- 38 cm Pendulum Rod (27 g)
- 75 g Mass (2)

Order Information

Pendulum Accessory..... ME-8969



Chaos/Driven Harmonic Accessory

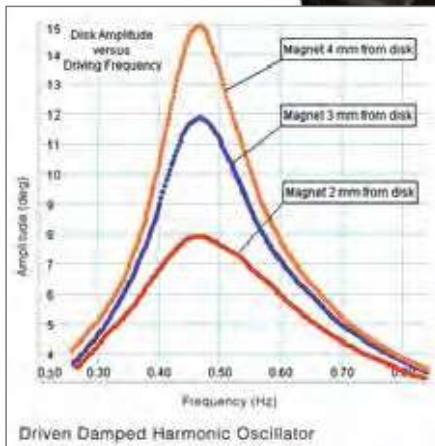
CI-6689A

The Chaos/Driven Harmonic Accessory allows students to study the behavior of a physical pendulum in either harmonic or chaotic motion. The disk mounts to a Rotary Motion Sensor, allowing PASCO Capstone™ to monitor and plot the pendulum's angular position and velocity.



Mechanical Oscillator/Driver ME-8750

See full experiments: EX-5522A Driven Damped Harmonic Oscillator on page 351 and EX-5523A Chaos Experiment on page 349.



Angular Velocity vs. Frequency graph shows effects of magnetic damping on amplitude of resonance peak.

Includes

- Rotating Disk (9.5 cm diameter, 120 g)
- Eccentric Mass (15 g)
- Springs
- Adjustable Magnet for Damping



Order Information

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

Physical Pendulum Set

ME-9833

This set of six objects is perfect for studying Physical Pendulums, Moments of Inertia, and the Parallel Axis Theorem. Each piece fastens directly to a Rotary Motion Sensor to measure the object's acceleration due to an applied torque, or the period when the pendulum freely oscillates.

Each piece is made from 1/4 inch-thick aluminum plate.



The Pendulum Bar has holes spaced at 2 cm intervals. A graph of Oscillation Period vs. Pivot Hole Position shows that there is a unique placement that gives a minimum period. This location can be verified using calculus.

Unique design allows pivot exactly at the edge. Measure the period of the thick ring oscillating at either the inner or outer radius.



Includes

- Solid Disk
- Thick Ring
- Thin Ring
- Offset Hole
- Pendulum Bar
- Irregular Shape
- Six Mounting Screws



Order Information

Physical Pendulum SetME-9833

Gyroscopic Motion

Demonstration Gyroscope

ME-8960

- ▶ All components accessible
- ▶ Excellent demonstration tool
- ▶ Precision angle indicator

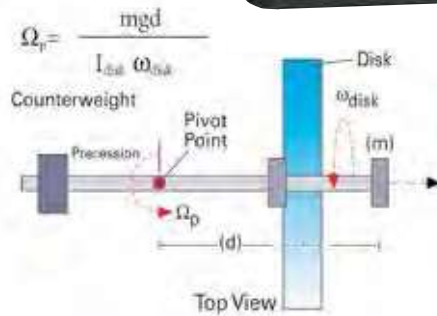
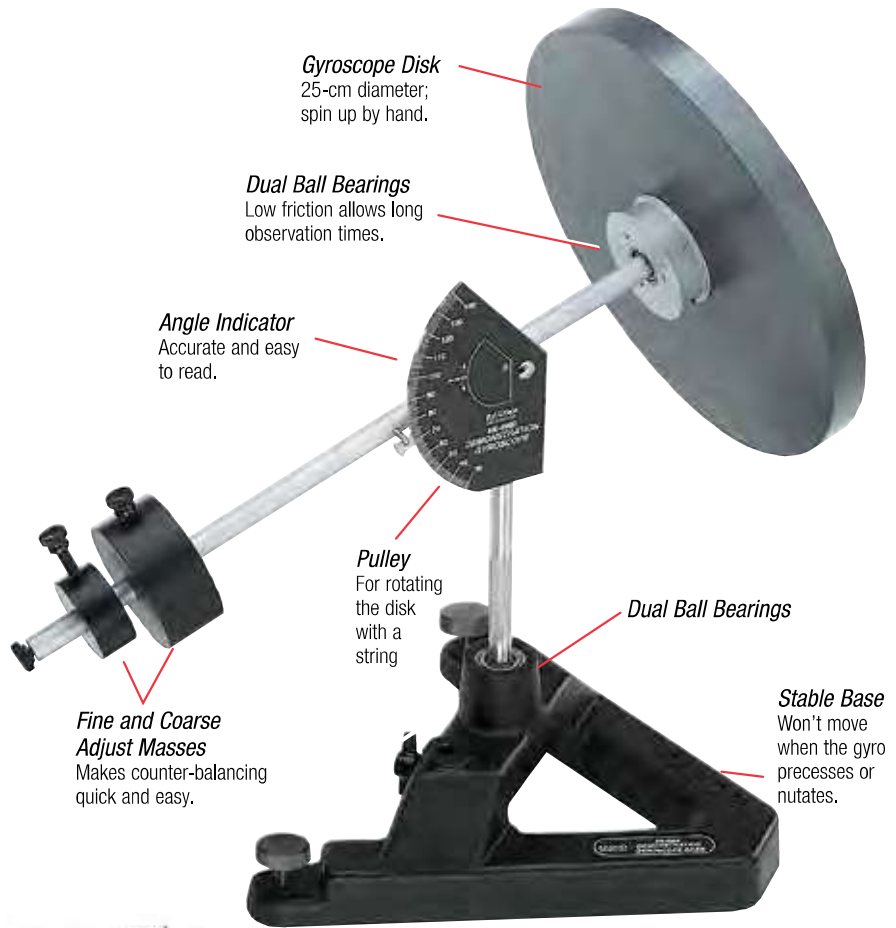
The unique low friction and open design of PASCO's Gyroscope allow studies of rotational motion never before possible with a commercial unit. The completely open design lets students stop precession by grabbing the vertical shaft and observing that the gyroscope dips. Rotational mathematics predicts the dipping action, but it could never be confirmed with traditional enclosed units.

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 responds with a predictable precession. Many features make this an exceptional demonstration tool for rotational motion concepts.

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.



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.

Order Information

Demonstration Gyroscope..... ME-8960
 Recommended:
 Accessory Disk and Mass..... ME-8961



Accessory Disk
 Add a second disk spinning in same or opposite directions.

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.

Accessory Disk and Mass

ME-8961



Includes

- Accessory Disk
- Extra Counter Mass

Order Information

Accessory Disk and Mass.....ME-8961

Sensor Mounting Accessories

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.

PASPORT Rotary Motion Sensor

Wireless Rotary Motion Sensor

Quantitative Measurements

Gyroscope

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.

Rotary Motion Sensor/Gyroscope Mounting Bracket

ME-8963

With the Mounting Bracket and the “A”-base Rotational Adapter (CI-6690), the Demonstration Gyroscope becomes a quantitative instrument for advanced rotational motion experiments. With two Rotary Motion Sensors, students obtain a graphical picture of the Gyroscope’s nutation and precession motions.



Order Information

For Recording Nutation Data:

Rotary Motion Sensor/Gyroscope Mounting Bracket ME-8963

Required:

Rotary Motion Sensor PS-2120A p. 35
Interface pp. 24-25

OR:

Wireless Rotary Motion Sensor PS-3220 p. 9

“A”-base Rotational Adapter

CI-6690

Mounts a Rotary Motion Sensor to the base to monitor the Gyroscope’s precession rate.

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



Order Information

For Recording Precession Data:

“A”-base Rotational Adapter CI-6690

Required:

Rotary Motion Sensor PS-2120A p. 35
Interface pp. 24-25

Gyroscope

Bicycle Gyroscope

ME-6837

- ▶ Solid 1/2" steel shaft
- ▶ Cushioned hand-grips
- ▶ Precision ball bearings for low friction
- ▶ Non-marking rubber tire

The newly redesigned Bicycle Gyroscope is perfect for getting your students engaged in understanding rotational motion. Unlike other bicycle gyroscopes, the PASCO model is extremely rugged for years of use, but also lightweight at just 6 lbs. Cushioned hand-grips, a pull-cord with handle, and an included suspension cord (to demonstrate precession) make it simple and easy to use.

Precision ball bearings result in extremely low friction for both the Bicycle Gyroscope and the Rotating Chair.

Non-marking Rubber Tire



This 2.8 kg (6 lb.) Bicycle Gyroscope has a solid 12.7 mm (1/2") steel shaft with cushioned hand-grips.

Attach cord (included) to hole in handle to demonstrate precession.



The Bicycle Gyroscope with the Rotating Chair gives you a perfect demonstration of the conservation of angular momentum.



Use the included pull-cord with handle to spin up the wheel.



Includes

- Bicycle Gyroscope
- Two Cords with Handles



Order Information

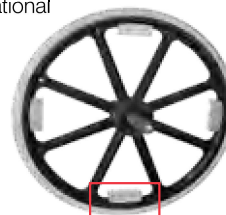
Bicycle Gyroscope.....ME-6837
 Shown in use with:
 Rotating Chair.....ME-6856

Bicycle Gyroscope Mass Set

ME-6972

Adding all four of the masses adds 1.6 kg to the wheel's approximate 2.8 kg mass and increases its rotational inertia by over 60%.

Mass securely clamps to the wheel rim using included screws.



Includes

- Four 400 g masses

Order Information

Bicycle Gyroscope Mass SetME-6972
 Required:
 Bicycle Gyroscope.....ME-6837

Rotating Chair

ME-6856

Rugged design and incredibly low friction make this far superior to any office chair.

Sturdy 45 cm diameter rotating platform can be used with or without included chair.

Wrap rope around groove to apply torque.



Includes

- Chair
- Rotating Platform with Leveling Feet



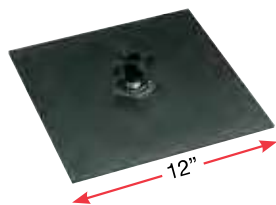
Order Information

Rotating Chair.....ME-6856
 Shown in use with:
 Photogate HeadME-9498A

Atmospheric Pressure Demonstrator

ME-8966A

Demonstrate the effect of a pressure differential. Easily lift a box or stool by simply placing the rubber sheet on a smooth surface of the object and lifting up on the handle.



As you pull up on the handle, a low-pressure region is created.



Order Information

Atmospheric Pressure Demonstrator.....ME-8966A

Air Cannon

SE-7370

The Air Cannon uses a vortex of air for ammunition. Its unique shape creates a stable toroidal vortex. Pull back the flexible membrane, release, and the invisible wave front of air can hit a target 20 feet away. Here is a great demonstration of the energy that can be stored in waves.



Order Information

Air Cannon.....SE-7370

Student Bell Jar

SE-9790



This bell jar provides a vacuum chamber for students to perform many experiments including:

- ▶ Watching a balloon expand or warm water boiling as air is pumped from the chamber
- ▶ Observing that a suction cup no longer sticks when the jar is evacuated.



Water boils as air is evacuated from the Bell Jar.

Includes

- 8 cm x 6 cm dia. clear plastic bell jar with base
- Plastic vial, balloons and suction cup
- 60 cc syringe and valves for evacuating the jar



Order Information

Student Bell JarSE-9790

PhiTOP

SE-7594

The PhiTOP is an egg-shaped top (a prolate ellipsoid) that can be spun by hand to stand up on end. This is a fascinating demonstration used by Nikoli Tesla in 1893.



When spun with a magnetic stirrer, the PhiTOP replicates Tesla's famous Egg of Columbus demonstration. An alternating magnetic field will spin the PhiTOP from rest along its minor axis due to Lenz's law of electromagnetic induction. As the angular speed increases, the center of mass will rise, and the PhiTOP will spin along its major axis.

Includes

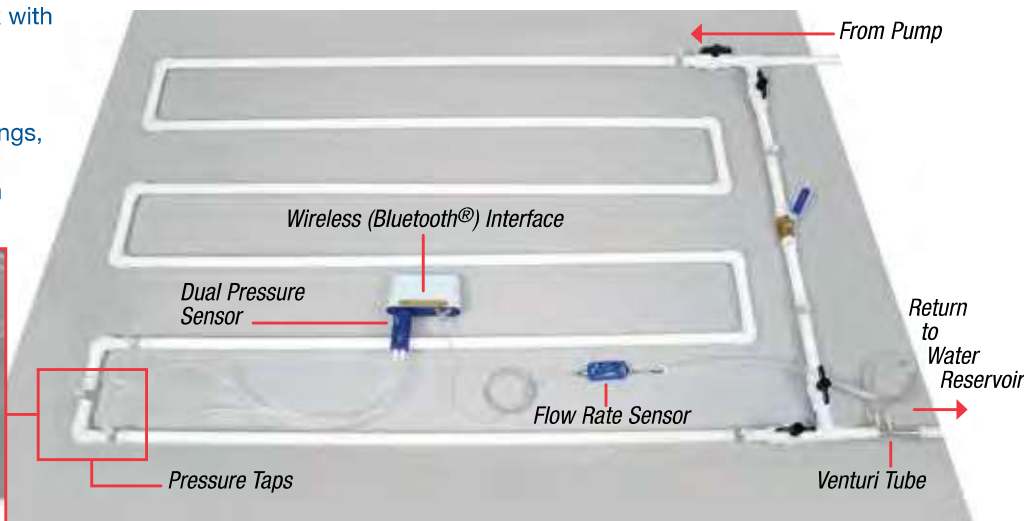
- PhiTOP
- Mirror Stand

Order Information

PhiTOP.....SE-7594

Pipe Network: Build it your way and instrument it inexpensively.

- ▶ Instrument your pipe network with pressure and flow sensors
- ▶ Transparent Venturi Tube and pressure taps
- ▶ Study head loss in pipes, fittings, and valves
- ▶ Find the relationship between pump head and flow rate



Measure pressure

When constructing a pipe network, it is useful to know the pressure in the fluid at numerous places along the pipe. 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, it is possible to move the pressure sensor around the network to determine the pressures at different positions, rather than having a separate pressure sensor for each position.

Measure flow rate

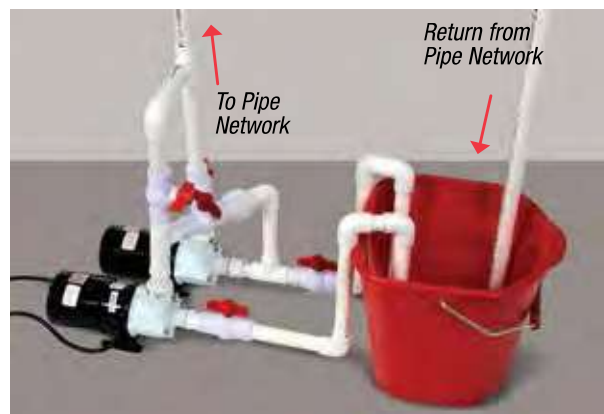
The General Flow Sensor measures the difference in fluid pressure between the two different cross-sectional areas, and the software does a calculation to convert this pressure difference into a velocity or volumetric flow rate. The Venturi Tube slip joints are designed to be glued into any 3/4" PVC pipe network. 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 (PS-2225) by the matching couplers.

Create pump curves

Create a plot of pressure vs. flow rate for a pump and determine the maximum head and flow rate. Study how these change when two pumps are connected in series or parallel.

Portable interface

Use the SPARKlink Air (PS-2011) with a Dual Pressure Sensor (PS-2181) as a great portable pressure measurement system. The SPARKlink Air has two PASPORT sensor ports and can accommodate a General Flow Sensor to measure the volume flow rate and a Dual Pressure Sensor to measure the pressures along the pipe.



Study one pump or two pumps in series and parallel.



See Our Experiments:

Piping Systems on p. 342
Pumping Systems on p. 343

Pressure Taps are installed before and after elbow joints to measure the pressure loss. The Venturi Tube measures the velocity.

General Flow Sensor

PS-2222



The General Flow Sensor determines fluid velocity in air or water by measuring the difference in pressure between the two input tubes. Either the Venturi Tube or the Pitot Tube ME-2221 (see page 47) must be connected to the General Flow Sensor.

Dual Pressure

PS-2181



► Measure pressure at two pipe pressure taps at once

The Dual Pressure Sensor is capable of reading two absolute pressures, one gauge pressure, or one differential pressure.

Specifications

Absolute Pressure: 0 to 200 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (displays pressure in kPa, N/m², and psi)

Differential Pressure: ±100 kPa, 0.01 kPa resolution at 10 Hz and 1 kPa repeatability (displays pressure in kPa, N/m², and psi)

Maximum Sample Rate: 1000 Hz

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.

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, it is possible to move the pressure sensor around the network to determine the pressures at different positions, rather than having a separate pressure sensor for each position.

Includes

- Pressure Taps (5)
- 1/8" ID Tubing (4.5 m)
- Couplings (10)

Wireless Interface

The SPARKlink Air (PS-2011) is a Bluetooth® interface that allows the computer to be away from water spills. See page 32 for more information.



Order Information

General Flow Sensor.....	PS-2222	
Venturi Tube.....	ME-2220	
Pressure Taps (set of 5)	ME-2224A	
Dual Pressure Sensor	PS-2181	p. 49
<i>Required:</i>		
PASPORT Interface.....		pp. 20-32
PASCO Capstone Software.....		pp. 72-75
PVC Pipe and Fittings (supplied by user)		
Pumps (2) (supplied by user)		
<i>Shown in Use with:</i>		
SPARKlink Air	PS-2011	p. 32
Optional Pitot Tube.....	ME-2221	p. 49

Water Pump

SE-7727

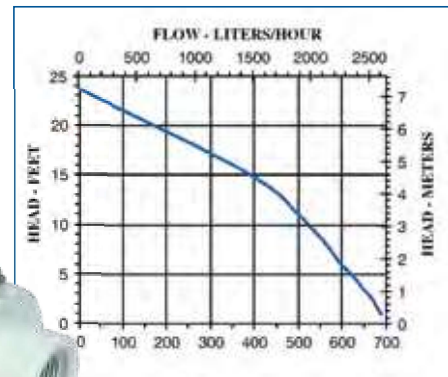
► Ideal for pipe network experiments

Features

- Little Giant Pump 4-MD Non-Submersible, In-line Use
- 1/12 hp open FC motor
- Glass-filled polypropylene magnet housing
- Glass-filled polypropylene volute
- Magnetic drive
- Nitrile O-ring
- Titanium thrust washers and shaft



Picture shows 12-inch (30 cm) ruler (not included) to indicate size.



Order Information

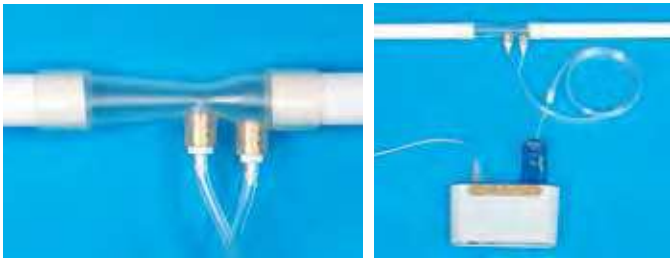
Water Pump..... SE-7727

Explore the Equations for Fluid Flow Using Sensors

General Flow Sensor with Venturi Tube

PS-2225

- ▶ Measure fluid velocities and confirm the Continuity Equation
- ▶ Use Bernoulli's Equation to determine pressure difference
- ▶ Show faster moving fluids have lower pressures



The Venturi Tube has pressure taps at the narrow diameter and the larger diameter.

The General Flow Sensor connects to the Venturi Tube to measure the pressures.

Continuity Equation: $A_1 v_1 = A_2 v_2$

Bernoulli's Equation: $P_1 + \frac{1}{2} \rho v_1^2 = P_2 + \frac{1}{2} \rho v_2^2$
(at constant height)

In this apparatus, the Venturi Tube has pressure taps at the narrow diameter and the larger diameter. The General Flow Sensor connects to the Venturi Tube to measure the different pressures due to different fluid velocities. You supply the 3/4 inch PVC pipe and the water. It is suggested that you connect the pipe to a faucet with flexible tubing and, at the other end, let the water flow into a bucket resting on a Force Platform (PS-2141). As the water flows, the velocity can be determined by the changing weight of the bucket as measured by the Force Platform.

The recommended interface is the SPARKlink Air because two ports are required and it is convenient to have a wireless interface so your laptop can be away from the water. However, two AirLinks (PS-3200) or a 550 or 850 Universal Interface will do as well.

The experiments can be downloaded at www.pasco.com/fluids.

Order Information

- General Flow Sensor with Venturi Tube PS-2225
- Force Platform PS-2141
- SPARKlink Air PS-2011
- PASCO Capstone Software..... See pages 72-75
- Supplied by User:
- PVC Pipe (3/4 inch), water, bucket
- Recommended (for velocity verification):
- Pitot Tube ME-2221

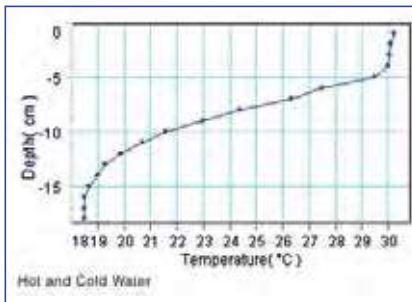
Density Circulation Model

ME-6816

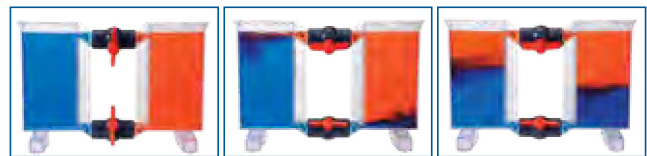


- ▶ Model density-driven circulation based on temperature, dissolved substances, or different liquids
- ▶ Demonstrate the driving forces of vertical ocean currents
- ▶ Measure temperature inversions based on density difference

The PASCO Density Circulation Model allows students to model, measure and understand the complex density-driven circulation associated with heat transfer through convection. Students can recreate vertical ocean currents driven by water bodies with density differences. They can extend this learning by using sensors to collect data and create graphs showing the thermocline, halocline and pycnocline using a Salinity Sensor PS-2195 (page 66).

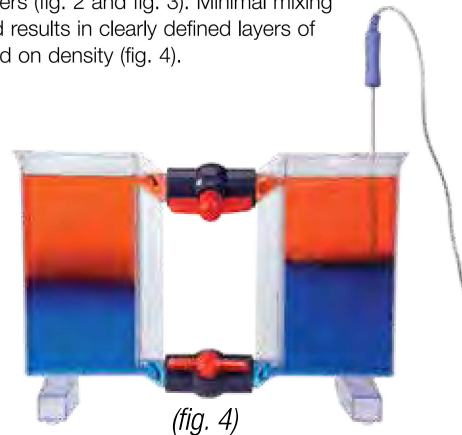


Here is data showing Temperature vs. Depth. Rapid temperature change occurs in the region where the two water bodies mix.



(fig. 1) (fig. 2) (fig. 3)

With the valves closed (fig.1), two bodies of liquid can be created that differ in temperature, dissolved materials, or other properties. When the valves are opened, a smooth flow of liquid occurs between the chambers (fig. 2 and fig. 3). Minimal mixing occurs and results in clearly defined layers of liquid based on density (fig. 4).



(fig. 4)

Order Information

- Density Circulation Model ME-6816
- Shown in use with:
- Stainless Steel Temperature Probe p. 52

Density Set

ME-8569A

Use this versatile set of materials with the Overflow Can to investigate Archimedes' Principle of displacement, specific heats, and basic length/volume relationships.

Includes pieces that have the same shape, volume, density, and mass, so the variable of interest can readily be isolated.

Each piece has a hole, so it can be suspended from a string.



Includes

- Three cylinders: aluminum, brass, plastic; 2.2 cm dia. x 6.4 cm long (plastic is less dense than water)
- Two blocks: aluminum (1.9 x 3.2 x 4.1 cm) and brass (1.6 x 1.9 x 2.8 cm); The mass of each block equals that of the aluminum cylinder.
- One irregular shape: aluminum
- Instruction manual

Order Information

Density Set.....ME-8569A

Discover Density Set

SE-9719A

This set of 22 separate pieces allows students to discover the relationship between density, volume, and dimensions. Two unique series of pieces hold one dimension constant while varying another.



Includes

- Cylinders of same length and different diameters (4)
- Cylinders of same diameter and different lengths (4)
- Spheres with different diameters (4)
- Rectangular shapes of various sizes and materials (10)
- Instruction manual

Order Information

Discover Density Set.....SE-9719A

Mole Set

SE-7586A

The Mole Set contains four element specimens: Copper, Iron, Zinc and Aluminum. Each sample contains approximately one mole, 6.02×10^{23} atoms of the element.



Includes

- Mole samples: Zinc, Aluminum, Iron, Copper
- Teaching Suggestions

Order Information

Mole Set.....SE-7586A

Overflow Can

SE-8568

This aluminum Overflow Can provides direct volume measurements for the materials supplied in the Density Set, as well as displacement measurements for buoyancy experiments. It has a 76 mm diameter, a usable volume of 477 cm³, and an angled downspout. Requires a graduated cylinder or a gram balance to measure the displaced volume.



Includes

- Can only

Order Information

Overflow Can.....SE-8568

Classroom Density Set

SE-7226

The Classroom Density Set includes 12 sets of materials to study the density concept. Each material set includes four pieces of various sizes in a plastic storage tube. This selection of materials allows twelve lab groups to perform a density experiment at the same time.



For each set, students measure the mass and volume of each piece and produce a mass vs. volume graph. Students will better understand density as a mathematical concept and realize that density is constant for a given material.

Includes

- Four different sizes of each:

Maple	Polystyrene	PVC	CPVC
Polypropylene	Nylon	PETG	Teflon
HDPE	Acrylic	Acetal	Aluminum

Order Information

Classroom Density Set.....SE-7226

Glassware

Rugged borosilicate glassware for use in the physics lab



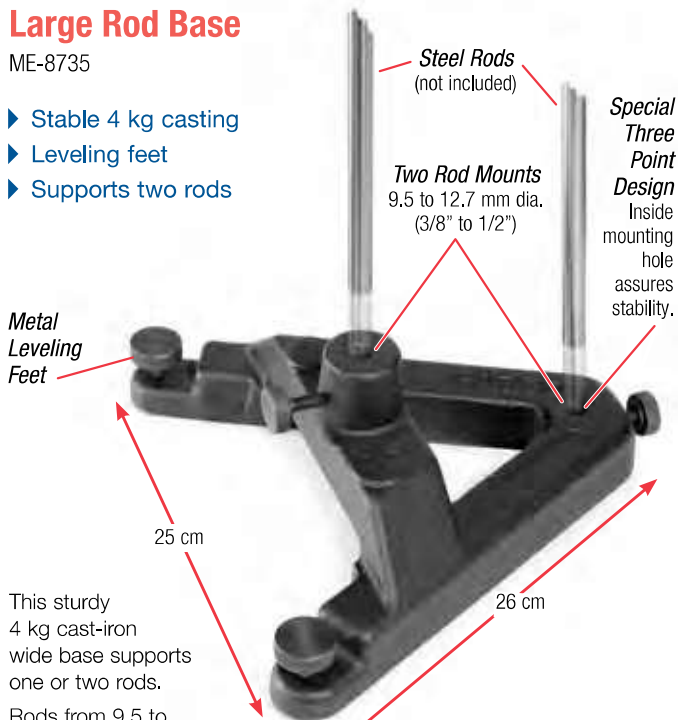
Order Information

100 ml Beaker (12 pack).....SE-7287
 1000 ml Beaker (6 pack).....SE-7288
 50 ml Graduated Cylinder (12 pack).....SE-7289

Large Rod Base

ME-8735

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



This sturdy 4 kg cast-iron wide base supports one or two rods.

Rods from 9.5 to 12.7 mm (3/8 to 1/2 inches) diameter can be supported. Two adjustable feet provide the necessary leveling capabilities.

Order Information

Large Rod Base ME-8735

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.



Order Information

Metal Knobs and Feet ME-8954

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. Non-threaded rods from 9.5 to 13 mm (3/8 to 1/2 inches) diameter can be supported. 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.



Order Information

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.

Three different lengths are available in the non-threaded version: 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.)

120 cm Long
ME-8741

90 cm Long
ME-8738

60 cm Long
Threaded Rod
ME-8977

Shown with
Small "A" Base
(ME-8976)

45 cm Long
ME-8736

Shown with
Large Rod Base
(ME-8735)

25 cm Long
Threaded Rod
ME-8988

Shown with
Round Base
(ME-8270)

Order Information

Stainless Steel Rods 12.7 mm (1/2 in.) in diameter:

45 cm Long (non-threaded)	ME-8736
90 cm Long (non-threaded)	ME-8738
120 cm Long (non-threaded)	ME-8741
25 cm Long (threaded)	ME-8988
60 cm Long (threaded)	ME-8977

PASCO's Flex Rod

ME-8978A

► Flexible rod holds objects in any orientation.

The Flex Rod provides the freedom to place equipment where it's needed. Simply connect the object to the end of the 46 cm long flexible tubing and move it to the desired location. The tubing has enough rigidity to hold many common items in any orientation. In addition, two convenient clamps are included.



The Flex Rod with rod clamp attachment fits sensor handles.

Flex Rod holds photogate for Acceleration Due to Gravity experiment using a picket fence (shown with Table Clamp, not included).



Laser pointer

The Flex Rod holds a green laser pointer. Shown with Small "A" Base (not included).



Includes

- Flex Rod attached to rigid section
- Rod Clamp attachments (2)
- 3-Finger clamp attachment (Base support not included.)

Order Information

Flex Rod	ME-8978A	
Suggested Base Supports:		
Small "A" Base	ME-8976	p. 190
Aluminum Clamp	ME-8995	p. 193

Base and Support Rod

Large
ME-9355

Round
ME-8270



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

Order Information

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

How to choose the best mounting rod



ME-9483

SA-9242

Both of these rods are useful for mounting sensors, particularly photogates. They also work well as 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 plastic rod 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, 12.7 mm diameter) have a 1/4"-20 metal stud that screws into a Super Pulley.



Order Information

Mounting Rods (10 pack).....ME-9483

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.



Order Information

Pulley Mounting Rod.....SA-9242

Clamps

Right Angle Clamp

SE-9444



Buret/Utility Clamp

SE-9446



Three-finger Clamp

SE-9445



Right Angle Clamp (SE-9444)

This standard right angle clamp fits rods up to 18 mm (11/16 inch) in diameter.

Buret/Utility Clamp (SE-9446)

The V-shaped, plastic-coated jaws of this Buret Clamp open from 5 to 35 mm, rotate 360°, and lock in position at any angle. Fits rods up to 16 mm (5/8 inch) in diameter.

Three-finger Clamp (SE-9445)

Clamp tubes, rods, and irregularly shaped objects. The jaws extend 19 mm, open to 57 mm, rotate 360°, and lock securely at any angle. Fits rods up to 19 mm (3/4 inch) in diameter.

Order Information

Right Angle Clamp	SE-9444
Buret/Utility Clamp.....	SE-9446
Three-finger Clamp.....	SE-9445

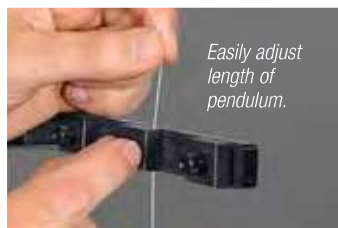
Pendulum Clamp

ME-9506

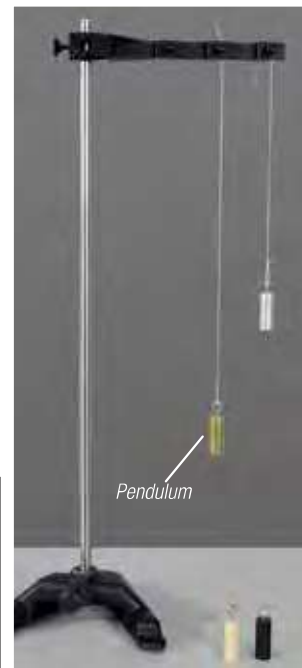


Hang up to three springs or pendulums. Suspension points are 54 mm apart. Fits rods up to 16 mm (5/8 inch) in diameter.

See page 171 for more information.



Easily adjust length of pendulum.



Pendulum

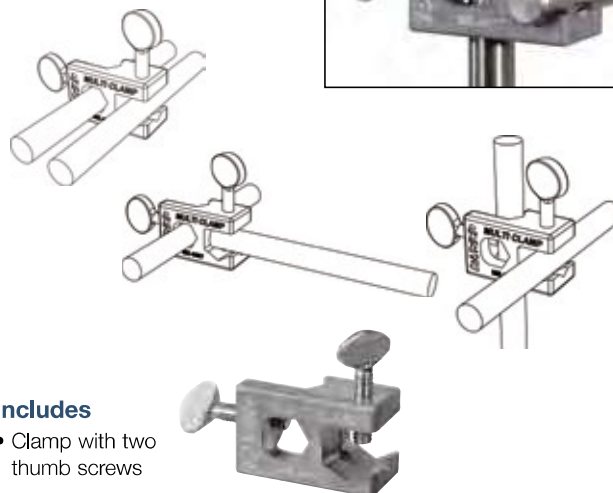
Order Information

Pendulum Clamp	ME-9506	
<i>Shown in use with:</i>		
Photogate Pendulum Set.....	ME-8752	p. 171
Small "A" Base	ME-8976	p. 190
Stainless Steel Rod (45 cm.).....	ME-8736	p. 190

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

Order Information

Multi Clamp	ME-9507
-------------------	---------

Table Rod Clamps

These clamps hold up to 12.7 mm (1/2 inch) diameter rods that can be mounted either horizontally or vertically.



Order Information

Large Table Clamp ME-9472
 10 cm grip range
 Aluminum Table Clamp ME-8995
 6 1/2 cm grip range
 Universal Table Clamp ME-9376B
 6.0 cm grip range

“C” Clamps

SE-7285 Large

This rugged clamp is perfect for attaching a variety of objects to a table. Available in 10 cm (4-inch) size.



Appearance may vary.

Order Information

Large “C” Clamp (6 pack) SE-7285

Laboratory Jacks

Raise, support, and align equipment with these lab jacks. They’re rugged, stable, and ensure precise height adjustment. Two sizes are available.

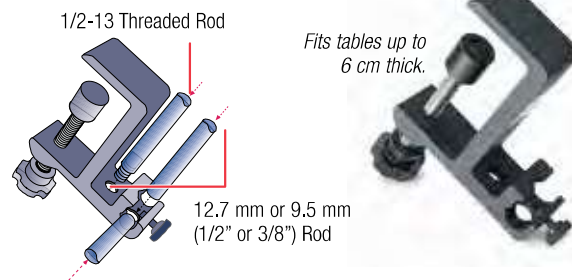


Order Information

Laboratory Jack	Model	Platform (cm)	Height (cm)	Load (kg)
Medium	SE-9373	15x15	7 - 25	25
Large	SE-9372	20x20	7 - 25	25

Universal Table Clamp

ME-9376B



Attach this Universal Table Clamp to tables or shelves up to 6.0 cm (2 3/8 inch) thick. Can also be mounted on a ring stand.

Mount rods in the clamp either vertically or horizontally. The rods are held securely by stable three-point contacts. Use standard unthreaded lab rods — 9.5 mm (3/8 inch) to 12.7 mm (1/2 inch) — vertically or horizontally. Use 1/2-13 threaded lab rod vertically.

Order Information

Universal Table Clamp ME-9376B

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.



Order Information

Double Rod Clamp (3 pack) ME-9873

Swivel Clamp (2 pack)

ME-8743

Clamp two rods at any angle or clamp the two rods parallel to each other. Accepts 12.7 mm (1/2 inch) rods.

Includes

- Two Clamps



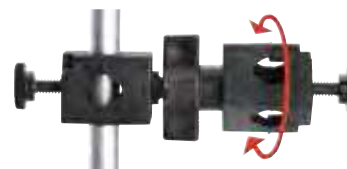
Order Information

Swivel Clamp (2 pack) ME-8743

Adjustable Angle Clamp

ME-8744

This unique clamp fits any rod up to 12.7 mm (1/2 inch) diameter and can lock the rod in place at any angle.



Order Information

Adjustable Angle Clamp ME-8744

Pulleys

Super Pulley

ME-9450A

- ▶ 20 N max load
- ▶ Nearly frictionless
- ▶ Durable

The PASCO Super Pulley is the standard in physics labs. Its low-friction design produces excellent results. The precision spacing of the 10 spokes makes it ideal for photogate monitoring with PASCO's computer interfaces and photogate systems.



Features

- ▶ Low-friction
- ▶ Lightweight
- ▶ Precision dimensions

Order Information

Super Pulley ME-9450A

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.



Order Information

Pulley Mounting Rod (rod only) SA-9242

Smart Gate Pulley System

PS-3702

The Super Pulley attaches directly to the Smart Gate, providing a simple, low-friction system to measure position, velocity and acceleration. Additionally, with the pulley removed, the photogate can be used to perform standard photogate experiments.



Includes

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

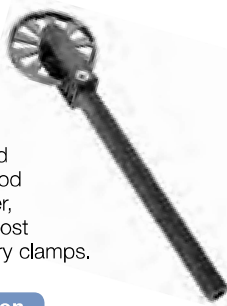
Order Information

Smart Gate Pulley System PS-3702

Super Pulley with Mounting Rod

ME-9499

This Super Pulley mounted on a rigid plastic mounting rod (12.7 mm diameter, 14 cm long) fits most standard laboratory clamps.



Order Information

Pulley with Mounting Rod ME-9499

Super Pulley with Clamp

ME-9448B



Upgrade your force table and inclined plane experiments. The Super Pulley with its integral clamp makes setup and alignment easy. The pulley height is fully adjustable, so you can skim the top of a force table for parallax-free readings. Yet you can keep the force parallel to the track on an inclined plane, as shown in the photo below. Fits tables up to 2.0 cm (13/16 in.) thick.



Order Information

Super Pulley with Clamp ME-9448B

Mounting Rods (10 pack)

ME-9483

These rigid plastic pulley handles (14 cm long, 1.27 mm diameter) screw into a Super Pulley.



Order Information

Mounting Rods (10 pack) ME-9483

Photogate/Pulley System

ME-6838A

The Super Pulley attaches directly to the Photogate Head, providing a simple, low-friction system to measure position, velocity and acceleration. Additionally, with the pulley removed, the photogate can be used to perform standard photogate experiments. See page 44.



Order Information

Photogate/Pulley System ME-6838A

Atwood's Machine

SA-9241



Two Super Pulleys mounted on a 6.4 cm long rod produce a classic, low-friction introduction to Newton's Second Law. The instruction sheet fully describes both the experiment and the theory.



Includes

- Two Pulleys
- Connecting Rod

Order Information

Atwood's Machine SA-9241

Metric Spring Scales

(Five different ranges)

These high-quality metric spring scales are precise, durable, and calibrated in Newtons. Five different scales are available. Students can measure forces from a fraction of a Newton to 20 Newtons with excellent accuracy.

Features

- ▶ **Accurate:** The precision springs provide excellent linearity, and the 10 cm long scales are sharp and clear for superior resolution.
- ▶ **Sealed Spring:** Can't get tangled, over-stretched, or lost.
- ▶ **Zero Adjust:** Turn the knob to zero the balance.
- ▶ **Scales on Inside:** They won't wear off.
- ▶ **Five Color-coded Ranges:** Measure almost any force from 0.1 N to 20 N.

Graduations are easy to read, and the resolution is 2% of full scale.



PASCO Spring Scales: Five metric spring scales provide accurate measurements over a wide range of forces.

Order Information

Metric Spring Scales

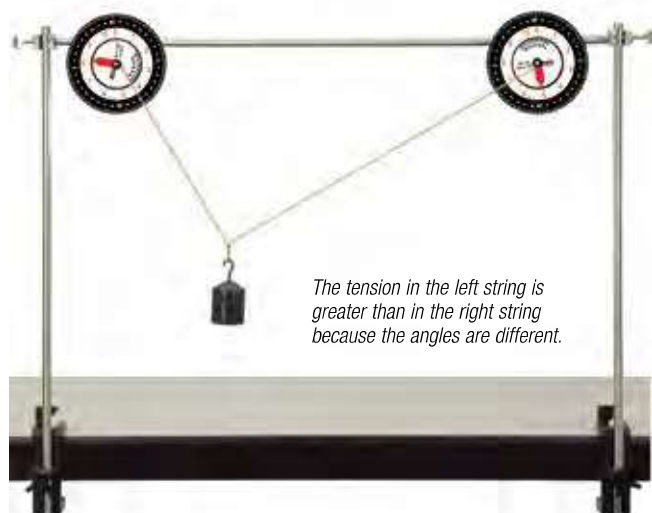
Model	Range	Resolution	Color
ME-9509	1.0 N	0.02 N	Red
ME-9510	2.0 N	0.04 N	Lt. Green
ME-9511	5.0 N	0.1 N	Brown
ME-9512	10 N	0.2 N	Dk. Green
ME-9513	20 N	0.4 N	Orange

Tension Protractor

ME-6855

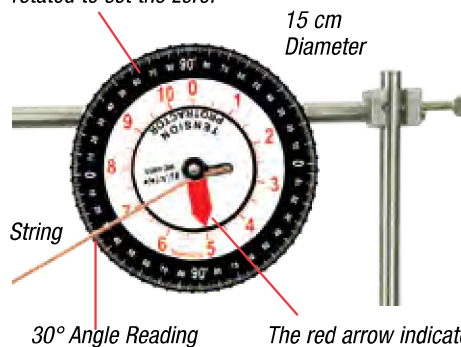
- ▶ Measure tension and angle with one device
- ▶ Large scale for viewing demonstrations
- ▶ Zero-adjust for torsion spring scale
- ▶ Built-in rod clamp

See page 146 for more information.



The tension in the left string is greater than in the right string because the angles are different.

Outside degree scale can be rotated to set the zero.



15 cm Diameter

String

30° Angle Reading

The red arrow indicates tension reading (5.0 N) of the torsion spring scale.

Includes

- One Tension Protractor



Order Information

Tension Protractor.....	ME-6855	
<i>Recommended:</i>		
Large Table Clamp.....	ME-9472	p. 193
90 cm Long Rod.....	ME-8738	p. 190
Multi Clamp.....	ME-9507	p. 192
Hooked Mass Set.....	SE-8759	p. 201

Lab Supplies

Metric Measuring Tape

SE-8712A



This 30-meter woven fiberglass measuring tape reads metric on one side and English on the other.

Order Information

Metric Measuring Tape SE-8712A

Digital Calipers

SE-8710



This metric/English (15 cm/6 in.) digital caliper measures to 0.01 mm (0.0005 in.). It has auto power-off and includes a sturdy plastic storage case.

Order Information

Digital Calipers SE-8710

Stainless Steel Calipers

SF-8711



These metric/English (18 cm/6 in.) calipers have an expanded Vernier scale of 20 divisions (instead of the usual 10), so it's easier to read and more accurate. The sliding mechanism is smooth and durable. A case is included for added protection.

Order Information

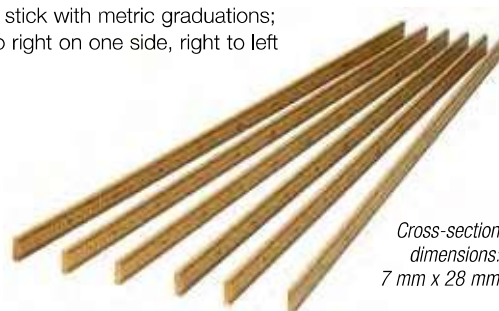
Stainless Steel Calipers SF-8711

High Quality Meter Sticks (6 pack)

SE-8827



Hardwood meter stick with metric graduations; scale reads left to right on one side, right to left on the other.



*Cross-section dimensions:
7 mm x 28 mm*

Order Information

Meter Stick (6 pack) SE-8827

Four-Scale Meter Stick

SE-8695



The Four-Scale Meter Stick is constructed of plastic square channel. One side has millimeter markings, one has centimeter markings, one has decimeter markings, and the last side has only a one-meter mark.

Order Information

Four-Scale Meter Stick SE-8695

Micrometer

SE-7337



This low-cost micrometer provides measurements from 0 to 25 mm with 0.1 mm resolution. The wooden box is form-fitted to protect the micrometer during storage.

Order Information

Micrometer SE-7337

Freefall Balls Accessory

ME-9890

This set of balls is used with the Discover Freefall system shown on page 134. The special stickers are used to attach the metal washers to the plastic balls, allowing them to be suspended from a magnet.

WARNING
CHOKING HAZARD
Contains small balls. Not for children under 3 years.



Includes

- Small Nylon Ball (2.5 cm)
- Large Plastic Ball (10 cm)
- Golf Ball (4.4 cm)
- Hollow Golf Ball (4.2 cm)
- Steel Ball (2.5 cm)
- Steel Ball (1.6 cm)
- Release Washers (10)
- Release Stickers (50)

Order Information

Freefall Balls
Accessory ME-9890

Bounce/No Bounce Ball Set (3 sets)

SE-7571

WARNING
CHOKING HAZARD
Contains small balls. Not for children under 3 years.



These two black balls look and feel identical, but drop them side by side and students will notice a big difference in their elasticity. One bounces close to the original drop height, while the other doesn't bounce at all. Includes three sets of the Bounce/No Bounce Balls. Each ball has a diameter of 2.5 cm.



Order Information

Bounce/No Bounce Ball Set (3 sets) SE-7571

Small Steel Balls

ME-9872

WARNING
CHOKING HAZARD
Contains small balls. Not for children under 3 years.



These 1.6 cm diameter steel balls are used with the Mini Launcher (ME-6825).

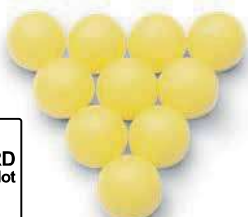
Order Information

Small Steel Balls
(10 pack) ME-9872

Plastic Balls

ME-6822

WARNING
CHOKING HAZARD
Contains small balls. Not for children under 3 years.



Extra brightly colored balls are available for the Projectile Launcher. Diameter is 2.5 cm (1 in.).

Order Information

Plastic Balls
(10 pack) ME-6822

Steel Balls

ME-9864

WARNING
CHOKING HAZARD
Contains small balls. Not for children under 3 years.



Four pack of 2.5 cm diameter balls for use with the PASCO Projectile Launcher (ME-6800)

Order Information

Steel Balls
(4 pack) ME-9864

Spherical Mass Set

ME-8968

This set includes four balls with a diameter of 2.5 cm each, but features various masses, including a hollow steel ball.

WARNING
CHOKING HAZARD
Contains small balls. Not for children under 3 years.



Includes

- Solid Yellow Nylon Ball (10 grams)
- Solid Steel Ball (66 grams)
- Hollow Steel Ball (21 grams)
- Solid Aluminum Ball (24 grams)

Typical Applications

- ▶ Race the hollow steel ball and solid aluminum ball down an incline. They have about the same mass, but the solid aluminum ball has a much larger acceleration down the ramp.
- ▶ Fire the yellow plastic, solid steel, and hollow steel balls from a PASCO Projectile Launcher.

Order Information

Spherical Mass Set ME-8968

Lab Supplies

Braided Physics String

SE-8050

▶ 30-lb. Test

This braided Dacron® string is tough, resists stretching, and won't unravel. Withstands up to 133 Newtons of force (equivalent to 13.6 kg). Each roll provides 320 meters of string.



Order Information

Braided Physics StringSE-8050

Elastic Wave Cord

SE-9409



Unlike a Slinky®, the tension can be varied. In addition to the Slinky, this Elastic Wave Cord is great for wave demonstrations. The cord is 3 mm in diameter. Each roll provides 90 meters of cord.

Order Information

Elastic Wave CordSE-9409

Yellow Cord

ME-9876



Two rolls of highly visible braided yellow cord. Total length of 140 meters.

Order Information

Yellow Cord (2 pack)ME-9876

Rubber Cord (30 meters)

ME-8986



For Elastic Bumper (ME-8998)
Also fits Air Track Bumpers (page 129)

Order Information

Rubber Cord (Spool of 30 m) ME-8986

Glow String (2 pack)

SE-8690



Color may vary.



This stretchy "string" glows in the dark after being exposed to light. Use it to demonstrate wave motion, including resonance and standing wave patterns. Two rolls are included, totaling over 15 meters of string.

Order Information

Glow String (2 pack) SE-8690

Black Thread

ME-9875



Includes three spools of black Nylon thread.

Order Information

Black Thread (3 pack) ME-9875

Plumb Bobs (10 pack)

SE-8728



These finished steel plumb bobs are precision-machined to a fine point. Just slide a string through the hole in the top and tie a knot. The plumb bob hangs precisely centered.

Order Information

Plumb Bobs (10 pack)SE-8728

No-Bounce Pad

SE-7347



Stop falling objects from bouncing with PASCO's No-Bounce Pad. The 30 cm x 30 cm x 2.5 cm dimensions of the pad provide an ample target for gravity demonstrations. Prevents heavy objects from damaging the floor and prevents falling objects from being damaged on impact.

Order Information

No-Bounce Pad.....SE-7347

Carbon Paper (100 pack)

SE-8693



Carbon paper is ideal for marking the position of an object as it strikes the floor or other surface.

Order Information

Carbon Paper (100 sheets)SE-8693

Spirit Levels (10 pack)

SE-8729



These 23 cm long Spirit Levels have three vials with striped gradations to indicate vertical, horizontal, and 45° alignment. The frame is a durable plastic with tough acrylic vials. A magnetic tape allows hands-free leveling.

Order Information

Spirit Levels (10 pack) SE-8729

Gratnells® Rolling Carts

EP-3574 (2-column) EP-3575 (3-column)

These movable storage rack carts have been designed for Gratnells trays (sold separately). With this rack system, you can transport materials to and from the classroom. They include large castors with brakes for added stability.

Here is an ideal way to store PASCO sensors and equipment. These rolling carts can be configured for whatever size trays you need.

These carts can be used to store the equipment kits from the *Essential Physics* or *Essential Chemistry* curriculum, the storage trays we offer for wireless sensors, or any of the four sizes of empty trays that we offer for whatever you would like to store.



EP-3574



EP-3575

EP-3574:

Stores up to 8 Gratnells F2 trays
24 pairs of runners
Dimensions: 107 cm high, 70 cm wide, 43.5 cm deep

Assembly is required.
Trays not included.

EP-3575:

Stores up to 12 Gratnells F2 trays
16 pairs of runners
Dimensions: 107 cm high, 102 cm wide, 43.5 cm deep

Order Information

Gratnells Rolling Carts (2 col.).....EP-3574
Gratnells Rolling Carts (3 col.).....EP-3575

Gratnells® Storage Trays with Lids

These empty Gratnells storage trays with lids have a length of 427 mm and width of 312 mm. The depth of each follows:

F1: 75 mm

F2: 150 mm

F25: 225 mm

F3: 300 mm



Order Information

Gratnells Storage Tray (F1) ShallowPS-3326
Gratnells Storage Tray (F2) Deep.....PS-3327
Gratnells Storage Tray (F25) Extra DeepPS-3328
Gratnells Storage Tray (F3) JumboPS-3329

Storage Bins

SE-7560

These stackable plastic bins with lids are useful for storing sensors. 14" L x 9.5" W x 6.9" D



Order Information

Storage Bins (set of 5).....SE-7560

3.8 Liter Plastic Container Set

ME-7559

These containers are great for experiments needing ice-water baths. See the Heat Engine Experiment on page 362 for an example.

14 cm x 14 cm x 19.5 cm tall

Order Information

3.8 Liter Plastic Container Set (set of 2)..... ME-7559



Glassware

This rugged borosilicate glassware is for use in the physics lab. It is particularly useful for buoyancy labs (shown on page 344).



Order Information

100 ml Beaker (12 pack)SE-7287
1000 ml Beaker (6 pack)SE-7288
50 ml Graduated Cylinder (12 pack)SE-7289

Discover Pi Set (10 pack)

ME-6819A

The Discover Pi Set allows students to derive the meaning of π directly from their measurements. This activity transforms π from a constant with unknown origin to a fundamental characteristic of all circular objects.



Includes

- Each pack includes 4 Pi Circles: 5.2, 6.4, 8.9, 10.0 cm diameter
- Transparent Measuring Tape

Order Information

Discover Pi Set (10 pack).....ME-6819A

Water Reservoir

ME-8594

This calibrated 1000 ml cylinder is useful for experiments (as shown on page 237), requiring either a specific amount of water, a constant flow of water, or water at a constant pressure. The cylinder has three hose connections: one for connection to a source of water, one for overflow, and an outlet near the bottom. The unit comes with six meters of tubing and two restriction clips.



Order Information

Water Reservoir ME-8594

Balances

Ohaus Electronic Balances

- SE-8823A (220 g)
- SE-8756B (420 g)
- SE-8757B (2200 g)
- SE-8758B (8200 g)



The Ohaus Scout SKX digital electronic balances combine range, resolution, and low cost, making them ideal for the student physics lab.

Simple two-button operation and visual menu prompts allow students to begin weighing with minimal instruction. The large, crisp display is easily viewed from any angle, so teachers can quickly check student results. A sealed front panel, molded spill ring, and removable stainless steel platforms provide protection from spills and make these balances easy to keep clean.

Specifications

Catalog #	SE-8823A	SE-8757B	SE-8758B	SE-8756B
Capacity:	0-220 g	0-2200 g	0-8200 g	0-420 g
Resolution:	0.01 g	0.1 g	1.0 g	0.01 g
Pan Size:	12 cm dia	16.5 x 4.2 cm	16.5 x 14.2 cm	12 cm dia.

Make these balances work with PASCO Capstone and SPARKvue on your computer via Bluetooth® or USB with:

- Ohaus Bluetooth Device AdapterSE-8822
- Ohaus USB Device AdapterSE-8821

Order Information

- Ohaus Scout SKX Balances
- 220 gSE-8823A
- 420 gSE-8756B
- 2200 gSE-8757B
- 8200 gSE-8758B

Ohaus Triple-Beam Balance

- SE-8723 (without tare)
- SE-8707 (with tare)



Ohaus Cent-o-Gram Balance

SE-8725



Ohaus mechanical balances have been the standard weighing instruments in student laboratories for decades. They're accurate, easy to use, durable, and inexpensive.

Features

- ▶ Precision-Ground Steel Knives: for exact measurements and a long balance life
- ▶ Stainless Steel Weighing Pan: easy to clean, lasts indefinitely
- ▶ Magnetic Damping: for quick, true measurements
- ▶ Simple Zero-Adjustment: just zero the masses, then rotate the knob
- ▶ Capacities: see table below

Specifications

Product #	SE-8723	SE-8707	SE-8725
Ohaus #	750-S0	760-00	311-00
Type:	Triple-Beam	Triple-Beam	Cent-o-Gram
Capacity:	610 g	610 g	311 g
w/add'l. mass set:	2610 g	2610 g	N/A
Readability:	0.1 g	0.1 g	0.01 g
Tare:	None	225 g	None

Order Information

- Ohaus Triple-Beam Balance (without tare).....SE-8723
- (with tare).....SE-8707
- Ohaus Cent-o-Gram BalanceSE-8725
- Recommended:*
- Ohaus Additional Mass SetSE-8708

Ohaus Additional Mass Set

SE-8708

(for Triple-Beam Balances)



These additional masses can increase the range of the Ohaus Triple-Beam Balances (SE-8723 and SE-8707) by an additional 2 kg. Included are a 0.5 kg and two 1 kg masses.

Order Information

- Ohaus Additional Mass Set SE-8708

Slotted Mass

- SE-8726A Set (10 g resolution)
- SE-8704A Set (1 g resolution)
- SE-8703A Hanger (50 g)

This 50 gram mass hanger is the standard hanger for the slotted masses shown.



These slotted masses provide medium to heavy mass (up to 1.110 kg) with 1 g or 10 g resolution.

The SE-8726A Set Includes

- Masses: 1 x 500 g 2 x 200 g 1 x 100 g
1 x 50 g 2 x 20 g 1 x 10 g

The SE-8704A Set Includes

- The above masses plus a 5 g, 1 g, and two 2 g. Mass hangers available separately.

Order Information

- 10 g Slotted Mass SetSE-8726A
- 1 g Slotted Mass SetSE-8704A
- Slotted Mass HangerSE-8703A

Mass and Hanger Set

ME-8979 (1/2 g resolution)

PASCO's Mass and Hanger Set features precision 5 g mass hangers with steel posts and "holed" masses that will not fall off the hanger. All the masses have their values marked, and each hanger can hold up to 250 g.



Includes

- Four mass hangers (5 g each) $\pm 2\%$
- Brass masses: $\pm 1\%$
 3 x 100 g 3 x 50 g 6 x 20 g
- Aluminum masses: $\pm 1\%$
 3 x 10 g 3 x 5 g
- Plastic masses: $\pm 2\%$
 3 x 2 g 3 x 1 g 3 x 0.5 g
- Molded storage case

Order Information

Mass and Hanger Set ME-8979
Recommended:
 Mass and Hanger Spares Kit..... ME-8980
 (Contains four mass hangers and 10 each of 2 g, 1 g, and 0.5 g plastic masses)
Replacement Mass Sets for ME-8979:
 5-gram Mass Set (set of 6)..... ME-8981
 10-gram Mass Set (set of 6)..... ME-8982
 20-gram Mass Set (set of 6)..... ME-8983
 50-gram Mass Set (set of 6)..... ME-8984
 100-gram Mass Set (set of 6)..... ME-8985

Large Slotted Mass Set

ME-7566 (5 kg Set)

Includes

- One 0.5 kg mass hanger
- Nine 0.5 kg slotted masses
- Diameter of masses: 8 cm
- Height of hanger: 36 cm



Order Information

Large Slotted Mass Set (5 kg Set).....ME-7566

Short Slotted Mass Set

ME-7589 (2 kg Set)

Includes

- One 0.5 kg mass hanger
- Three 0.5 kg slotted masses
- Diameter of masses: 8 cm
- Height of hanger: 15 cm



Order Information

Short Slotted Mass Set (2 kg Set).....ME-7589
 Short Mass Hanger ME-7590

Hooked Mass Set

SE-8759



This rugged Hooked Mass Set is made from cast iron and coated with enamel.

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

Order Information

Hooked Mass Set.....SE-8759

1 kg Mass and Hanger Set

ME-9337 (1 kg set)

Set features a 200 g cast aluminum mass hanger with a steel post, and four "holed" 200 g brass masses that will not fall off the hanger. Multiple mass hangers can be used by hooking the top of one into the bottom of another.



The flat bottom on the mass hanger makes it perfect for use with a Motion Sensor when performing Hooke's Law and spring oscillation experiments.



Can be used in conjunction with the entire set of smaller brass and plastic masses in the ME-8978 Mass and Hanger Set.

Includes

- Mass hanger (ME-9350)
 Height of hanger: 16 cm
- Set of four masses (ME-9351)
 Diameter of masses: 5 cm
- Steel pin
 8 cm height, 3.6 mm diameter

Order Information

1 kg Mass and Hanger SetME-9337
 Mass Hanger (200g)ME-9350
 200g Masses (set of four).....ME-9351
Shown in use with:
 Base and Rodsp. 190
 Equal Length Spring SetME-8970
 Pendulum ClampME-9506
 Motion SensorPS-2103A

Stopwatches

PASCO Stopwatch

ME-1234

- ▶ No alarm or clock
- ▶ Memory for stored event times
- ▶ Uses one AA battery
- ▶ Durable buttons

Are you tired of annoying stopwatch alarms going off all day? Are your students stuck in the clock mode and can't get their stopwatch back into the timing mode? Does your stopwatch stop working after changing that little watch battery? The PASCO Stopwatch solves all these problems.

This stopwatch was designed specifically for science timing. The modes of operation are intuitive and complete instructions are included. The buttons are built to last and it uses a single long-lasting AA battery, which is less expensive than a watch battery (and easier to install).



The PASCO Stopwatch fits comfortably in your hand.



Two Display Modes:
MM:SS.SS (00:25.18) or
Decimal Seconds (25.18s)

The EVENT/RECALL button allows you to view the last event time, in case students forget to write down their data. The EVENT/RECALL button is also used to store and recall up to nine event times. For example, record a series of events such as times at which sandbags were dropped along the gym floor.



It also sits on the table at a convenient viewing angle.

Order Information

PASCO Stopwatch..... ME-1234

Specifications

LED Display: Visible indoors and outdoors

Two Display Modes: MM:SS.SS (01:25.34) or Decimal Sec (85.34 s)

Precision: 0.01 sec up to 59:59.99 (MM:SS.SS) or 3599.99 s
Then 1 sec to 99:59:59 (HH:MM:SS) or 359999 s

Max Number of Event Times: Nine

Auto-off: After one hour idle

Includes: One AA battery and instruction sheet
Can be used with a lanyard (not included).

PASCO Stopwatch (10 pack)

ME-1235

- ▶ Includes fitted foam storage box



Order Information

PASCO Stopwatch (10 pack) ME-1235

Student Timer

SE-8768

Features

- ▶ Inexpensive
- ▶ 0.01 Second Resolution
- ▶ Easy Operation: Start/Stop, Reset and Lap

Appearance may vary.



Order Information

Student Timer SE-8768

Strobe

ME-6978

- ▶ 1 Hz to 500 Hz
- ▶ Variable intensity
- ▶ Low cost

Unique modular design makes it easy to light any geometry. The Strobe includes the Strobe Control Box and one Strobe Module. Additional Strobe Modules can be purchased separately (see below) for up to a total of four lamp modules per controller. And multiple control boxes can be connected together using the External Trigger. The Strobe Modules have a tilting lamp head on a sturdy base that sits on the table or fastens to a rod stand.



Shown using Strobe (with Strobe Module) and three additional Strobe Modules

Specifications

- Frequency Range:** 1 Hz to 500 Hz
- Resolution:** 0.1 Hz
- Accuracy:** 0.1%
- Lamp Life:** 50,000 hours
- Brightness:** 230 lumens (peak) per module

Features

- ▶ Display frequency in Hz or rpm
- ▶ Adjustable light intensity
- ▶ External trigger daisy-chains multiple controllers together
- ▶ Trigger strobe using external input such as the photogate ME-9498A

Order Information

Strobe.....	ME-6978	
(Includes Control Box and one Strobe Module)		
Additional Strobe Modules	ME-6982	
<i>Shown in use with:</i>		
String Vibrator.....	WA-9857A	p. 260
Sine Wave Generator	WA-9867	p. 261

Stroboscope

SF-7202

- ▶ Bright xenon lamp has short flash duration
- ▶ Digital frequency display on back

The flash rate of this xenon strobe can be adjusted from 1 to 300 flashes per second (60 to 18,000 flashes per minute). The display can be switched between impulses per second, impulses per minute, and external triggering. There is an option to connect an external triggering device to the safety sockets to control the flash rate or connect an external digital counter to measure the impulse output. There is a threaded hole in the base to attach a tripod.

Specifications

- Flash Rate Range:** 1 to 300 Hz
- Trigger Input Max:** 300 Hz.
- Dimensions:** 18 x 24 x 12 cm



Order Information

Stroboscope	SF-7202
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