Experience real-world design

- Build bridges, cranes, hydraulic lifts, and more
- Structures can be reconfigured quickly; students can explore different designs
- Measure tension and compression

The PASCO Capstone™ graph shows changes in the compression and tension in the supporting members as the car traverses the bridge.
Build bridges, cranes, catapults and roller coasters.

Experience real-world design building a large variety of structures. This reconfigurable system allows students to measure static and dynamic forces using load cells and still have time to redesign and test again.

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.

Load Cell & Amplifier Set
(See page 4)

SPARKlink

Motion Sensor

Large Slotted Mass Set

Graph shows displacement of bridge as a function of hanging mass.

Displacement vs Hanging Mass

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.

14.3 N
Diagonal Left

7.6 N
Diagonal Right

10.7 N
Left

15.2 N
Right

Numerical displays of load cell forces are generated in PASCO Capstone™ Software.
(See page 17)

SPARKlink

Motion Sensor

Large Slotted Mass Set

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Large Slotted Mass Set

Graph shows displacement of bridge as a function of hanging mass.

Displacement vs Hanging Mass

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.
Only PASCO allows students to construct an endless array of structures and measure forces on them in real time.

Imagine… Design… Analyze…

Trusses, bridges, roller coasters, cranes, booms, human models and much more can all be quickly built and analyzed. Far more advanced than toothpick models and much more hands-on than computer simulations, PASCO Structures are ideal for real-world design.

And the ease of use of PASCO Structures Systems allows students to quickly build, test and then redesign their structures quickly and efficiently which supports the engineering process.

1. Designing and building structures is simple and easy.
2. I-beams fit into connectors and are secured with thumb screws.
3. Load Cells measure the compression and tension…
4. …and may be placed anywhere in your structure.
5. Load Cells are then plugged into a Load Cell Amplifier which connects to a PASCO interface which is connected by USB or Bluetooth to a device running PASCO software. (See interfaces page 17)
6. PASCO software then allows students to view a graph of the forces in real-time and analyze the resulting data with a suite of powerful tools. PASCO Capstone runs on Mac or Windows Computers. SPARKvue software runs on computers, iPads, Android tablets, or Chromebooks. (See software page 17)
Choice of Load Cell Amplifiers:

Load Cell Amplifier (6 ports)
PS-2198

This Load Cell Amplifier can accommodate up to six load cells and only needs a single PS-2100A USB Link (p. 2) to connect to a computer. Useful for doing an extensive analysis of a bridge by inserting six load cells at various points in the structure.

The Amplifier accepts either the 100N load cell or the 5N load cell or a combination of both. The maximum data sample rate is 500 Hz for each port.

Dual Load Cell Amplifier
PS-2205

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

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

Two Ranges of Load Cells:

Load Cell 100N and 5N

Both load cells can be used with the same amplifier in any combination. The semi-transparent case lets students see the strain gauge and beam inside.

- Load Cell 100N..............PS-2200 $100
- Load Cell 5N.................PS-2201 $110

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Load Cell 100N</th>
<th>Load Cell 5N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PS-2200</td>
<td>PS-2201</td>
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<tr>
<td>Range</td>
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<td>-5 N to +5 N</td>
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<td>Accuracy</td>
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<td>±1% (±0.05 N)</td>
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<td>Resolution</td>
<td>0.02 N</td>
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<tr>
<td>Safe Overload</td>
<td>-150 N to +150 N</td>
<td>-7.5 N to +7.5 N</td>
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</tbody>
</table>
The Truss Set
ME-6990

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

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.

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

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

Truss Set Includes:
One package each of Truss Set Members and Truss Set Screws. See pages 22-23 for details.

Truss Set ........................................................................................................ ME-6990 $65

Recommended:
Load Cell and Amplifier Set.................................................. PS-2199 $650
includes four load cells. (See page 4)
Bridge Set
ME-6991

- Study the principles of bridge construction
- Build different scales
- Add Load Cells to see dynamic loading as car traverses bridge
- Design a roller coaster

Build different types of bridges

Howe

Pratt

Warren

Add load cells to measure static forces anywhere in the structure

Forces measured by Load Cells are displayed on a computer using PASCO Capstone™ Software (see page 17). A positive value represents compression.

Build different scale bridges

Students will learn the advantages of building taller bridges. Here, the larger bridge is constructed with a #4 I-beam on the diagonal, while the smaller bridge uses a #3 I-beam on the diagonal.

Both of these bridges can be built with the ME-6991 Bridge Set.
Design your own roller coaster

PASCO’s Bridge Set 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.

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

PASCO Capstone™ graph shows support forces exerted on the track as the car goes up and over the loop.

Position Accessory Photogate anywhere along the track to measure speed.

Load Cell and Amplifier Set

Recommended:

Includes four load cells. (See page 4)

Shown in use with:

Requires:

Interface

Bridge Set

| ME-6991 | $285 |

Recommended:

Load Cell and Amplifier Set

$650

Shown in use with:

Accessory Photogate

$70

Requires:

Interface

(See page 17)
The Advanced Structures Set includes more components to build larger structures. Axles and pulleys allow construction of cranes, cars and even a working catapult!

- Camelback Truss Bridge
  - 1.4 m long

- Arch Truss Bridge
  - 1.5 m long

- Angle Crane
  - 1.5 m tall

- Catapult
  - 60 cm tall
  - Throws a projectile over 10 meters!

- Additional connectors allow greater flexibility in design.

- Angle connector allows the I-Beam members to be joined at angles other than 45° and 90°.

- Wheels allow catapult to move.

- Add Load Cells to measure forces anywhere in the structure.
**The Advanced Structures Set**

**Human Leg Model**
The articulated leg shown below uses a rubber band (not included) for the quadriceps and has a load cell on the foot to measure the force that the “toe” exerts on the ball. The impulse (area under the curve) is equal to the resulting momentum of the ball.

**Rubber Band Car**
Build a working catapult, a car with rubber band suspension, and a rubber band-powered car. The “rubber band” car shown here uses the ME-8986 Rubber Cord (sold separately) and travels over 50 ft. in 10 seconds.

**Advanced Structures Set Includes**
- Truss Set Members (3 pkgs.)
- Truss Set Screws (4 pkgs.)
- Flexible I-Beams (1 pkg.)
- Cord Lock Spares (1 pkg.)
- Axle Spares (1 pkg.)
- Round Connector Spares (1 pkg.)
- Angle Connector Spares (1 pkg.)
- Flat Beams (1 pkg.)
- Structures Rod Clamps (1 pkg.)
- Force Platform Structures Bracket

See pages 22-23 for details.

**Advanced Structures Set**

Advanced Structures Set Set Includes 

- ME-6992B $550

**Shown in use with:**
- Load Cell and Amplifier Set includes four load cells. (See page 4) PS-2199 $650

- Additional Load Cell 100N PS-2200 $100

- Hooked Mass Set SE-8759 $55

- Large Slotted Mass Set ME-7566 $140

- Motion Sensor PS-2103A $90

- Rubber Cord (spool of 30 m) ME-8986 $15

**Requires:**
- Interface (See page 17)
Human Structures Set
ME-7001

- Build models that represent real life examples.
- Bring homework problems to life.

Human Arm Model
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 upper and lower arm, as well as the point of attachment of the muscle.

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.

Human Leg Model
Measure the force needed to support the leg at various angles.

Human Structures Set Includes
Five packages of Truss Set Screws
Two packages of Truss Set Members
Two packages of Connector Spares
One package each of #6 I-Beam Spares, Cord Lock Spares, Axle Spares, Round Connector Spares, Angle Connector Spares, roll of rubber cord.

See pages 22-23 for details.

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

Load cell represents the biceps muscle.

Axle allows arm to pivot freely.

Load cells directly measure forces exerted on back model.

Load cell represents quadriceps muscles.

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

Human Structures Set .......................................................... ME-7001 $450

Shown in use with:
Load Cell and Amplifier Set .................................................. PS-2199 $650
(includes four load cells)
Hooked Mass Set............................................................... SE-8759 $55
Large Slotted Mass Set......................................................... ME-7566 $140

www.pasco.com/structures
Large Structures Set
ME-7003

The Large Structures Set includes all the components contained in the Advanced Structures Set (ME-6992B) 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.

Large Structures Set Includes
Six packages of Truss Set Screws
Three packages of Truss Set Members
Two packages of Connector Spares
One package each of #6 I-Beam Spares, Flexible I-Beams, Cord Lock Spares, Axle Spares, Round Connector Spares, Angle Connector Spares, Flat Beams, Structures Rod Clamps, Mini Car Track Spares, Force Platform Structures Bracket, and one each Green Car, Yellow Car, 9.1 m Track, and Starter Bracket

Large Structures Set ........................................... ME-7003 $880

Shown in use with:
Load Cell and Amplifier Set
includes four load cells............................................ PS-2199 $650
Hydraulic/Pneumatic Structures .......................... ME-6984 $165
Slotted Mass Set................................................. ME-7589 $65

Requires:
Interface ................................................................ (See page 17)
Classic Statics Using the Advanced System

Forces on a Boom
Vary all parameters including length and angle of the boom. Directly measure the horizontal and vertical forces exerted by the pivot (axle) on the boom, and the tension in the supporting cord.

Support structure is built using parts from the Advanced Structures Set, and uses 1/2 kg masses from the ME-7566 Large Slotted Mass Set (sold separately) for counter balance.

Teeter Totter
Take “meter stick” torque to a new level! By building their own unique structures, students learn about center of mass, torque, and static equilibrium as never before.

A Lesson in Balance
Circus performer not included!

Stability and Center of Mass
The structures shown here are built with a foam core center (not included). Each object is hung from several different pivot points to locate the center of mass. Is the structure on the right stable or unstable?

Ladder Against Wall
How does the required frictional force (measured by the load cell at bottom) change as the location of the hanging mass is moved further up the ladder?

Advanced Structures Set.............................. ME-6992B $550

Shown in use with:
Load Cell and Amplifier Set........................ PS-2199 $650
(includes four load cells)
Additional 100 N Load Cell......................... PS-2200 $100
Hooked Mass Set................................ SE-8759 $55
Large Slotted Mass Set.......................... ME-7566 $140
Angle Indicator................................. ME-9495A $25
Mass and Hanger Set........................ ME-8979 $85
Large Table Clamp......................... ME-9472 $100
Steel Rod (90 cm).......................... ME-8738 $30

Requires:
Interface...................................................... (See page 17)

www.pasco.com/structures
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.

An Ideal Gas Law Apparatus (TD-8596A), which has an internal thermistor, is used to pump air into the cylinder. A Pressure/temperature Sensor (PS-2146) records the air pressure and temperature while the Rotary Motion Sensor (PS-2120) records the movement.

The weight is lifted using a syringe of water to fill the master cylinder. An Absolute Pressure Sensor (PS-2107) measures the pressure and a Rotary Motion Sensor (PS-2120) records the movement of the piston.

Valves are used with the syringe to pump up this fork lift. The use of different size syringes shows how a smaller force requires a greater number of pumps to do the same amount of work as a larger force.

This scissor lift uses pulleys to change the mechanical advantage.

<table>
<thead>
<tr>
<th>Includes</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td>Master Cylinder</td>
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<tr>
<td>Pressure Sensor “T”</td>
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<tr>
<td>Check Valves and Tubing</td>
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<tr>
<td>10 ml Syringe</td>
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<tr>
<td>20 ml Syringe</td>
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<tr>
<td>60 ml Syringe</td>
<td></td>
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<tr>
<td>Drive belt for Rotary Motion Sensor</td>
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<table>
<thead>
<tr>
<th>Hydraulic/Pneumatic Structures ..........</th>
<th>ME-6984</th>
<th>$165</th>
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<tbody>
<tr>
<td>Required</td>
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<tr>
<td>Advanced Structures Set</td>
<td>ME-6992B</td>
<td>$550</td>
</tr>
<tr>
<td>Steel Rod (90 cm)</td>
<td>ME-8738</td>
<td>$30</td>
</tr>
<tr>
<td>Absolute Pressure Sensor</td>
<td>PS-2107</td>
<td>$95</td>
</tr>
<tr>
<td>Rotary Motion Sensor</td>
<td>PS-2120A</td>
<td>$169</td>
</tr>
<tr>
<td>Pressure/temperature Sensor</td>
<td>PS-2146</td>
<td>$165</td>
</tr>
<tr>
<td>Ideal Gas Law Apparatus</td>
<td>TD-8596A</td>
<td>$95</td>
</tr>
</tbody>
</table>

Not shown but required for data collection: Interface and PASCO Capstone™ Software (see page 17)
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.

![Materials Testing Machine Image]

**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

**Materials Testing Machine Includes**
- Machine
- Compliance Calibration Rod
- Safety Shields
- Requires Capstone software (See page 17)
  
(does not include any samples)

![Tensile Stress vs Strain Graph]

Tensile stress versus 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.

**Materials Testing Machine**

**ME-8236**

$2500

**Tensile Samples** (set of 10 each)
- Aluminum ........................................... ME-8231 $49
- Brass ................................................. ME-8232 $49
- Annealed Steel ..................................... ME-8233 $49
- Steel ................................................ ME-8243 $49
- Acrylic ............................................. ME-8234 $49
- Polyethylene ..................................... ME-8235 $59

**Required:**
- PASCO Capstone™ Software .......................... (See page 17)
Comprehensive Materials Testing System
ME-8244

- 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.

Perform three-point and fourpoint bending.

Perform a fourpoint bend test on the ME-6983 Cast Beams from the PASCO Structures System. Quantities measured include the Flexural Elastic Modulus and the Modulus of Rupture for the material.

Comprehensive Materials Testing System Includes
Materials Testing Machine
Storage Base
Tensile Samples (10 of each): aluminum, brass, annealed steel, steel, acrylic, and polyethylene
Bending Accessory
Four-point Bending Load Anvil
Photoelasticity Accessory (with photoelastic beams)
Shear Accessory (with Shear Samples)
Structures Beam Fixture
Thin Beams
Cast Spares
Compression Accessory (with Compression Samples)
Flat Coupon Fixture
Plastic Flat Coupons
Metal Flat Coupons
Clevis Grip
10-32 Adapter
AirLink Interface
PASCO Capstone Software Single User License (See page 17)

Comprehensive Materials Testing System ME-8244 $5000
Cast Beams Set

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.

The graph of hanging mass versus displacement shows the relative strengths of three beams: one cast beam made with no pre-load; one cast beam made with 60N of pre-load; and one normal plastic I-beam. Notice that the traces for the cast beams show discontinuities when the beams cracked. Also notice that the pre-loaded cast beam is stronger than the plastic I-beam until the cast beam cracks.

Cast Beam Spares
Consumable replacement parts for Cast Beams; these can also be used with the Advanced Structures Set (page 8).

Includes
10 Reusable Plastic Molds
30 Rebar with Connectors

Cast Beam Spares .......... ME-6983 $29

Cast Beam Structures Set Includes
One package each of Truss Set Members, Cord Lock Spares, Axle Spares, Round Connector Spares, Angle Connector Spares and two packages of Truss Set Screws
See pages 22-23 for details.

Cast Beam Structures Set .......... ME-7009 $275

Also shown:
Displacement Sensor .............. PS-2204 $220
Large Slotted Mass Set ............ ME-7566 $140
Round Base with Rod ............. ME-8270 $35

Not shown but required for data collection:
Interface and PASCO Capstone™ Software .......... (see next page)
PASCO’s Data Collection and Analysis Software

PASCO Capstone™ Software

- Compatible with all PASCO USB interfaces
- For use with Mac® and Windows® computers

Whether you want your students to explore and create lab write-ups on their own, or you want to tailor a lab write-up with very specific instructions, PASCO Capstone™ has the power and flexibility to meet the needs of your lab.

Fast, Flexible and Powerful!
The PASCO 550 Universal Interface

- 1 MHz sampling rate
- 2 high-speed analog inputs
- 2 digital inputs for photogates and other timing sensors
- 2 PASCO PASPORT sensor inputs
- Signal generator with built-in Voltage and Current sensors
- Runs on Capstone or SPARKvue
- Bluetooth® connectivity

550 Universal Interface ............................................. UI-5001 $489

Requires:
PASCO Capstone Software OR SPARKvue Software

The Ultimate Sensor Interface for Physics and Engineering

850 Universal Interface

- Rugged design
- Fully compatible and expandable
- An incredible value
- Runs on PASCO Capstone™

Here’s the most powerful educational lab interface in the world. Compatible with over 120 PASCO PASPORT® and ScienceWorkshop® Sensors.

850 Universal Interface ............................................. UI-5000 $999

Requires:
PASCO Capstone Software OR SPARKvue Software

For more information visit www.pasco.com/capstone

Connect PASPORT Sensors to a Computer

AirLink, has one PASPORT sensor port and is compatible with our full line of sensors. It has USB and Bluetooth™ 4.0 connectivity and comes with a USB cable.

AirLink ...................... PS-3200 $60

For more information visit www.pasco.com/capstone

SPARKvue® Software

- For use with mobile devices or Chromebooks
- Free app for iPads, Android tablets and Chromebooks

SPARKvue

(SPARKvue (single user license)................................. PS-2401 $89
(site license) ........................................... PS-2400 $200

Free mobile apps. Visit pasco.com/downloads

For more information visit www.pasco.com/sparkvue
Measure support forces with a Force Platform

Force Platform
PS-2141

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

Measure passive damping with a Motion Sensor

This building frame is built with an Advanced Structures Set using the Flat Beams. A pendulum with drag caused by strings is suspended from the top of the building. The Motion Sensor is positioned to record the oscillation of the building.

Measure bridge deflection with a Displacement Sensor

Displacement Sensor
PS-2204

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

Specifications
- Maximum Travel: 10 mm
- Maximum Sample Rate: 5 Hz
- Resolution: 0.013 mm (0.0005 in)

Displacement Sensor....................... PS-2204 $220

Shown in use with:
- Hooked Mass Set................................. SE-8759 $55
- Small “A” Base..................................... ME-8976 $40
- 60 cm long Steel Rod (threaded).............. ME-8977 $35

Required:
Interface.............................................. (See page 17)
Combine the rigid, plastic PASTrack sections with components from the Structures System to build truss and cable-stayed bridges with realistic rigid decks.

**PASTrack Cable-Stayed Bridge**
The cable-stayed bridge shown here was constructed using components from the Advanced Structures Set and two ME-6997 Round Connector Spares sets. The roadbed uses four sets of PASTrack and four sets of curved PASTrack. The bridge is built starting with the center column and working symmetrically outward, always keeping the bridge in balance. As each 50 cm section of rigid deck is added to each side, new supporting cable is added.

**PASTrack Truss Bridge**
Combine the plastic PASTrack sections with the components from the Advanced Structures Set (page 8) to build a rigid deck to support dynamics carts. Use load cells (page 4) to directly measure the forces as the cart traverses the bridge.

**Dynamics Track Support Reactions**
Combine the plastic PASTrack sections with the components from the Advanced Structures Set (page 8) to measure the support reactions as the Motorized Cart climbs the hill. The Load Cell and Amplifier Set (page 4) directly measures the forces in the structure as the Motion Sensor measures the cart’s position.

---

**Equipment Shown:**

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<thead>
<tr>
<th>Item</th>
<th>Code</th>
<th>Price</th>
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</thead>
<tbody>
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<td>Advanced Structures Set</td>
<td>ME-6992B</td>
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<tr>
<td>PAScar (set of 2)</td>
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<td>$100</td>
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<td>PASTrack (2 sections)</td>
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<td>Curved PASTrack</td>
<td>ME-6841</td>
<td>$75</td>
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<td>Motorized Cart</td>
<td>ME-9781</td>
<td>$220</td>
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<tr>
<td>Adjustable Endstop</td>
<td>ME-8971</td>
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<td>PAScar Cart Mass (set of 2)</td>
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<td>Round Connector Spares</td>
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<td>Load Cell &amp; Amplifier Set (includes four load cells)</td>
<td>PS-2199</td>
<td>$650</td>
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<td>Motion Sensor</td>
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<td>PASCO Capstone Software</td>
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877.373.0300 (inside US) 916.462.8383 (outside US)
Structures Resonance

PASCO’s Structures System is perfect for demonstrating resonance in complex systems. The plastic I-Beams clearly show two different bending moments and can be connected together to build a variety of structures.

The long plastic I-Beam is constructed of components from the Advanced Structures Set (page 8). It is driven using the Mechanical Wave Driver and the Function Generator, demonstrating the three lowest harmonics.

Equipment Shown:
Advanced Structures Set ........... ME-6992B $550
Function Generator ................ PI-8127 $775
Mechanical Wave Driver .............. SF-9324 $180
Large Slotted Mass Set ............ ME-7566 $140
5N Load Cell....................... PS-2201 $110
45cm Stainless Steel Rod ........... ME-8736 $25
Large Rod Base ................. ME-8735 $85

Measure acceleration with a 5N Load Cell
Connect one end of a load cell to the structure and attach a mass to the other end of the load cell. The acceleration of the structure is measured in real time as the structure shakes.

This building frame is built with an Advanced Structures Set that includes Flat Members. The building is being shaken with the Mechanical Wave Driver. Additional mass is added to the foam core floors (not included).
Bridge Vibrations

Concepts:
- Study resonance in complex systems
- Compare driven vs. free vibrations

The resonance of the bridge is characterized by driving the bridge at different resonant frequencies. Note how different the amplitudes are at different locations on the bridge.

Experiment Includes
- Large Structures Set ME-7003 $880
- Load Cell Amplifier PS-2198 $300
- 100N Load Cell PS-2200 $100
- 5N Load Cell (5) PS-2201 $110
- Mechanical Wave Driver SF-9324 $180
- 4 mm Banana Plug Cords SE-9750 $20
- Rubber Cord ME-8986 $15
- Large Slotted Mass Set (4) ME-7589 $65
- Short Mass Hanger (2) ME-7590 $20
- 20 g Masses (3 sets of 6) ME-8983 $22

The bridge is struck by hand and allowed to freely oscillate. The FFT (using PASCO Capstone™) shows several resonant frequencies.

The resonance of the bridge is characterized by driving the bridge at different resonant frequencies. Note how different the amplitudes are at different locations on the bridge.

Download This Experiment
The FREE experiment files include instructions in Microsoft Word™, PASCO Capstone™ workbook files with sample data, and graphics. Download these experiments at www.pasco.com/CapstoneExperiments.

Required:
- 850 Universal Interface (see page 17)
- PASCO Capstone Software (see page 17)
Replacement Spares Sets

Truss Set Members
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)
Truss Set Members............ME-6993 $59

Truss Set Screws
Includes:
- 75 screws
All components in the Structures System use this same 6-32 thumb screw.
Truss Set Screws .............ME-6994 $28

Connectors Spares
Set of 14 connectors used to join truss members. This is the same connector included in the Truss Set ME-6990.
Connector Spares.............ME-7002 $30

Angle Connector Spares
Includes:
- Sliding connectors (12), Angle connectors (24), Straight connectors (24).
Angle Connector Spares........ME-6999A $45

Round Connector Spares
Includes:
- Round connectors (6)
- Flat connectors (6)
- Six bolts with nuts.
Round Connector Spares..........ME-6997 $45

Cord Lock Spares
Includes:
- 32 cord-tensioning clips and a spool of yellow cord.
Cord Lock Spares.............ME-6996 $25
Yellow Cord (2 pack)........ME-9876 $19

Axle Spares
Includes:
- Drive wheel with rubber tire (4), pulleys with “O” rings (12 each), axles (two each of three lengths), spacers (12) and collets (24).
Axle Spares.............ME-6998A $80

Thin I-Beams
Includes:
- Thin I-beam #4 (24) 17 cm long
- Thin I-beam #3 (24) 11.5 cm long
Thin I-Beams.............ME-7012 $40

Photoelastic Beams
Includes:
- Clear, Polycarbonate Thin I-beams #4 (24) 17 cm long, and #3 (24) 11.5 cm long.
Photoelastic Beams........ME-7011 $40

Flexible I-Beams
Includes:
- 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
Flexible I-Beams............ME-6985 $49

Flat Beams
Includes:
- 2x3 beams 12 cm long
- F4 beams 17 cm long
- 3x4 beams 19 cm long
Flat Beams.............ME-6987 $29

#6 I-Beam Spares
Longer beam to supplement the Truss Set ME-6990. Has the same cross section as the shorter beams.
Includes:
- 24 of the #6 I-beams, 35 cm long.
#6 I-Beam Spares............ME-7008 $40

Cast Beam Spares
Consumable replacement parts for Cast Beams ME-7009. Includes 10 Reusable Plastic Molds and 30 Rebar with Connectors. These can also be used with the Advanced Structures Set ME-6992B.
Cast Beam Spares...........ME-6983 $29
Roller Coaster Track (9.1 m)

Longer replacement roll of flexible plastic track for use with the Bridge Set ME-6991, Physics Structures Set ME-6989, Large Structures Set ME-7003, and Roadbed Spares ME-6995.

Roller Coaster Track ..........ME-9814 $89

Roadbed Spares

Starter Bracket

Includes:
Flexible roadbed (3 m)
Roadbed clips (24)
Car with flag
Extra mass, mini car starting bracket, and track couples (2).

Roadbed Spares ...............ME-6995 $125

Force Platform Structures Bracket

Includes:
Brackets (2)
Screws (4)

Force Platform Structures Bracket ..........ME-6988A $39

Mini Cars (Set of 3)

These 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 should the car leave the track.

Mini Cars (Set of 3) ..........ME-9813 $130

Includes:
Mini Cars (3)
Decals
Elastic Bumpers (3)
Flags (3)
Rubber Bands

Large Slotted Mass Set

Consists of nine iron disks of 0.5 kg each. The hanger is 0.5 kg. Each piece cast and machined to 1 gram accuracy. The 2 kg Mass Set is similar in mass and hanger weight to the Large Slotted Mass Set, but this more compact set includes a shorter 1/2 kg hanger and three 1/2 kg slotted masses. The size and weight of these sets make both ideal for creating loads on the Structures Systems.

Large Slotted Mass Set ............ME-7566 $140

Hydraulic and Pneumatic Structures

Mini Car Track Spares

Includes:
Two gates
Two track couplers
One bag (24) of roadbed clips

Mini Car Track Spares ..........ME-6974 $29

Structures Rod Clamps (Set of 2)

Connects structure members to 1/2 inch rod.

Structures Rod Clamps (2) ..........ME-6986 $20
Connect your students to the real world!

This model of the Louisville 2nd Street Bridge was built using the PASCO Structures System. The section shown here is approximately 4 m long.