

# Vernier Dynamics System

(Order Code VDS)

The Vernier Dynamics System consists of a 1.2 m track, two carts, and related accessories. The system is designed for use in physics and physical science courses for motion and energy experiments. An optional Optics Expansion Kit (Order code OEK) converts the track to an optics bench. A Track to Track Coupler (Order code T2T-VDS) joins two tracks together. Some typical experiments done with the system include

- Motion under zero acceleration
- Motion under constant acceleration with the ramp inclined
- Inelastic collisions using the included Velcro tabs
- Elastic collisions using the included magnetic bumpers

The Vernier Dynamics System is designed for use with many data-collection tools, such as the Vernier Motion Detector, Go! Motion, Vernier Photogates, and the Vernier LabPro® interface. Appropriate software includes *Logger Pro*® for computers, DataMate and EasyData™ for calculators, and Data Pro for Palm OS.

## What is included with the Vernier Dynamics System?

The Vernier Dynamics System is shipped in two boxes. The long box contains the track and feet, while the other box contains the remaining parts.

Long box marked TRACK

- Track
- Single foot end stop
- Double foot end stop

Box marked VDS-KIT

- Standard Cart with two magnets and foam plugs for included end caps and Velcro™ tabs
- Plunger Cart with two magnets and foam plugs for included end caps, Velcro tabs
- Rod clamp
- Adjustable end stop with two magnets and foam plugs for included end caps
- Photogate brackets (two)
- Motion Detector bracket
- Mass
- T-Nuts, one large, two small



Note: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

## Carts

The Vernier Dynamics Carts are supplied with magnets and Velcro tabs. You may choose to install either or both on your carts.

The magnets are useful in studying collisions with the magnets positioned so that they are the same polarity on both sides and on both carts. This way the carts will repel one another, and you can arrange a collision in which the carts never actually touch. The collision will be very nearly elastic, unlike a collision using a spring or any kind of contact.



To prepare the carts for elastic collisions, remove the Philips screws from the two teardrop-shaped end plugs, and remove the plugs. Place a magnet in each plug, oriented to repel another magnet in another plug. Place the foam plug over the magnet, and replace the teardrop plug in the cart. Insert and tighten the screw. Test that the magnets repel one another and any magnetic accessories such as force sensor bumpers. The magnets can be removed at any time by reversing this process. Store the magnets away from computers.

To study totally inelastic collisions, place Velcro tabs on top of the teardrop-shaped plugs. Looking at the end of the cart, place a hook pad on the left-hand plug, and a pile pad on the right-hand side. Center the pad on the round part of the plug. This way any cart with Velcro pads will stick to any other. Velcro-equipped carts will stick together, creating a totally inelastic collision.

One cart includes a spring-loaded plunger for collisions. To use the plunger, simultaneously press the horizontal button above the plunger and press the plunger in until it locks. To release, press on the pin from the top of the cart. The plunger force can be adjusted. To adjust the plunger release force, rotate the plunger while it is extended.

Both the plunger and simple carts have a mass of 500 g. Adding accessories will change the mass.

## Photogate bracket

Photogate brackets are attached to the side of the track. With the nut loosely on the T-handled bolt, slide the nut into the side channel of the track. Attach the photogate using the supplied wing bolt in the long slot. Adjust the gate height so the beam intercepts the desired portion of the target.



## Motion Detector Bracket

Any Vernier Motion Detector with a hinged head can be attached to the supplied Motion Detector Bracket. The Motion Detector Bracket has a pin to locate the Motion Detector on the bracket. There is a knob, nut and bolt to attach the bracket to the track underside, and a threaded hole at the end near the pin. The threaded hole is used to store the screw used to attach the detector to the bracket when the detector is not in place. To assemble, place the Motion Detector with the back end over the pin of the bracket. Insert the screw through the slot into the threaded insert on the detector with the hinge toward the track, and tighten. Insert the bracket into the slot in the underside of the track as shown in the photo.



Newer Vernier Motion Detectors (green or black case with adjustable sensitivity) can be placed so that the sensor is 15 cm from the end of the track. The carts can then be detected properly all the way to the end. The track mode is appropriate for the dynamics system.

## Single foot end stop

The single foot end stop slides into the end of the track, with the nut in the center slot of the track underside. Adjust the height as desired.



## Double Foot Stand

The double foot stand slides into the end of the track, with the nut in the center slot of the track underside. Adjust the height as desired.

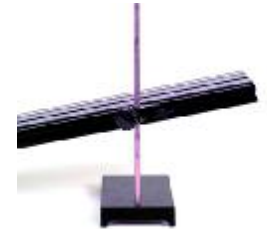


## Adjustable End Stop

The adjustable end stop slides into the end of the track. Adjust the position as desired. Insert magnets in the end stop if desired.

## Rod Clamp

The rod clamp is used to support the track with a user-supplied ring stand. Insert the rod clamp nut into the side of the track. Adjust the height as desired.



## Mass

The 500 g mass is used to double the mass of the cart. Attach the mass by removing the wing nut and bolt, and placing the bolt head in one of the off-center slots on top of the cart. Slide the mass over the bolt, and tighten the wing nut.



## T-Nuts

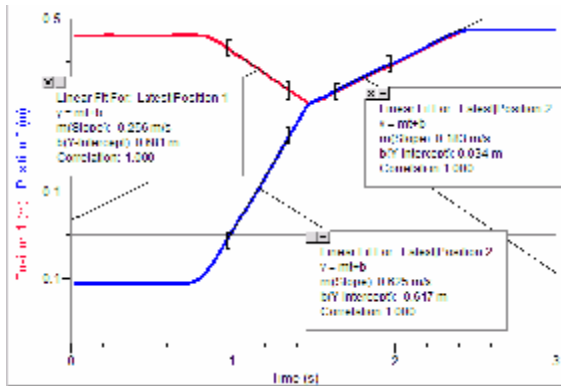
The supplied T-Nuts are used to attach devices to the cart. For example, you may want to attach a force sensor, accelerometer, or both, to the cart. The T-Nuts may be inserted any point along the slot length. To use, loosen but do not remove the nut from the shaft, and insert the nut parallel to the slot. Turn the shaft clockwise to tighten.



## Sample Experiment

An example of a typical experiment done with the Vernier Dynamics system is a two cart, inelastic collision for studying momentum conservation.

This experiment takes two motion detectors, since both carts are in motion. A Motion Detector is placed just a few centimeters from each end. For this experiment, in *Logger Pro* the direction of one detector was reversed, and then both detectors are zeroed with the carts stuck together near the middle of the track. This places the origin of the common coordinate system near the middle, and the two readings will then be the same when the carts are in contact.



The Vernier carts had the Velcro end caps in place to create a completely inelastic collision. After starting data collection, the carts were rolled toward one another, with one cart moving a bit faster than the other. On collision, the Velcro held the carts together as they roll on.

Note several features of the graph:

- Before the collision, the carts are moving with constant velocities of opposite sign, since they are moving toward one another.
- The carts move as a unit after the collision with a common, constant velocity.

Both carts are very nearly 0.500 kg; the total momentum before the collision is then 0.184 kg m/s. Afterward, the momentum is 0.183 kg m/s.

## Suggested Accessories

Dynamics Track Adapter (DTA-DFS)

Optics Expansion Kit (OEK)

Additional Track (TRACK)

Tracking joining kit (T2T-VDS)

## Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.



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