Vernier Dynamics Cart and Track System with Go Direct® Sensor Carts

(Order Code DTS-GDX and DTS-GDX-LONG)

The Dynamics Cart and Track System with Go Direct Sensor Carts is all the equipment needed to teach dynamics and kinematics. Each cart features built-in sensors to simplify experiment setup and to allow basic experiments to be conducted on or off the track.

What's Included

- Two Go Direct Sensor Carts (green and yellow)
- Combination 1.2 m Track/Optics Bench
- Adjustable End Stop
- Ultra Pulley
- Pulley Bracket
- Rod Clamp
- Go Direct Sensor Cart Accessory Kit

Dynamics Cart and Track System with Go Direct Sensor Carts and Long Track

The Dynamics Cart and Track System with Go Direct Sensor Carts and Long Track includes the parts listed above but substitutes a 2.2 m track for the 1.2 m track.

Go Direct Sensor Cart Information

Refer to the included Go Direct Sensor Cart manual for instructions for using the Sensor Carts, including connection instructions, information on compatible software, and troubleshooting tips.

NOTE: Vernier products are designed for educational use. Our products are not designed nor are they recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

Adjustable Leveling Feet

The Adjustable Leveling Feet slide into the end of the track, with the nut in the center slot of the track underside. Adjust the height as desired. Install the feet before attaching the Motion Detector Bracket.

Adjustable End Stop

The Adjustable End Stop slides into the top slot from the end of the track. Adjust the position as desired. Insert magnets in the End Stop if desired. The End Stop cannot be used at the same end as a Motion Detector or Motion Encoder Receiver.

Rod Clamp

The Rod Clamp is used to support the track with a user-supplied ring stand. A 12 mm rod is the maximum size accommodated. Insert the Rod Clamp nut into the side of the track. Adjust the height as desired.

Hoop Springs

Hoop spring bumpers are designed for collisions between carts and against fixed objects. The springs spread out a collision in time so that there is a clear distinction of before, during, and after the collision, both visually and in collected data.

Attach the hoop spring to the force sensor on the Sensor Cart. Light and heavy springs allow for different collisions. To configure cart-on-cart collisions, attach a rubber bumper to one cart, and a spring on the other.

Orient the hoop so that it is horizontal, and tighten one plastic nut against the hex barrel of the force sensor. Never remove the hex barrel of the force sensor.

Additional Mass

The four 125 g masses are used to change the mass of the cart for dynamics experiments. The cart mass is nominally 280 g, but additions such as magnets, hook-and-pile tabs, sensors, and the encoder system will increase the total mass. As a result, it is best to weigh the cart as used when the mass is important.

The four masses can be used one at a time or in combination on either cart. The mass trays on the sides allow the addition of masses without removing sensors. It is not necessary to keep the carts balanced with the same mass on each side.

Pulley Bracket and Pulley

The Pulley Bracket and Pulley can be attached to the end of the track to create a half-Atwood machine using user-supplied masses and string. It can be assembled with or without a Photogate for motion measurement.

Insert the oblong nut into the bottom slot of the track and tighten. To attach the pulley without a Photogate, use the short bolt to attach the pulley. Adjust the height of the pulley as needed to keep the string level. To include a Photogate, slide the plastic photogate mount over the vertical portion of the Pulley Bracket, with the open slot outward and upward. Insert the Vernier Photogate into the mount, and pass the long bolt through the bracket, and Photogate, capturing the threads of the bolt with the Pulley.

Collision Tabs

The carts are supplied with magnets and hook-and-pile tabs. These parts are attached using removable collision Ttabs. Since the magnets may interfere with certain experiments using force sensors on the carts, only install the magnets if you need them.

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.

The removable collision tabs have two sides. One is marked N, and the other is plain. The plain side is for use with hook-and-pile material on tabs without magnets.

The collision tabs can be inserted either way, exposing or concealing any hook-and-pile material. To quickly perform an experiment without magnets, remove the collision tabs.

The Adjustable End Stop will hold magnets as well. Note that only low-speed collisions with the End Stop will keep the cart on the track.

To install magnets on the Adjustable End Stop, use the following procedure:

1. Remove the teardrop from the cart end or the End Stop.
2. Insert the silver magnet into the teardrop, oriented so that the outside of the teardrop will attract the south-pointing end of a compass needle.
3. Insert a foam plug into the teardrop.
4. Reinsert the tear drop into the cart end or the End Stop, and fasten the screw.

If you like, test by holding the compass near the cart or End Stop, in the same position as an approaching cart, and verify that the south-pointing end of the compass is attracted to the cart.

The magnets can be removed at any time by reversing this process.

To study totally inelastic collisions, place hook-and-pile tabs on the collision tabs without magnets. Looking at the end of the cart, place a hook pad on the

left-hand plug, and a pile tab on the right-hand side. Center the pad on the round part of the collision tab. This way any cart with hook-and-pile tabs will stick to any other. Hook-and-pile equipped carts will stick together, creating a totally inelastic collision.

General Tips for the Vernier Dynamics Cart and Track System

- Do not install the magnets unless you know you want to use them. They will interfere if you perform an experiment with a force sensor riding on the cart, since the force sensor will then not read the total force acting on the cart.
- The magnets are designed for fairly gentle collisions. If the cart is moving too quickly, the magnetic forces may cause the cart to jump off the track to the side. If this happens, use a lower initial velocity for the cart.
- Keep the track clean; if it is dirty the carts will not roll smoothly.
- Use lower speeds and lower inclines than you might initially choose; the physics is the same and students will have more time to observe what is happening.

Suggested Experiments

The Vernier Sensor Carts can be used wherever a Motion Detector could have been used with a cart and track.

Measure Cart Acceleration

The basic motion of a cart on a ramp can be studied. For example, perform Experiment 3 from *Physics with Vernier*, "Cart on a Ramp." Or, repeat Galileo's experiment of determining *g* using an object and a ramp. This is Experiment 4, "Determining *g* on an Incline," from *Physics with Vernier*.

Newton's Second Law

Use a force sensor on the encoder cart to record both applied force and acceleration. The two will be proportional.

Or, set up a half-Atwood machine with a hanging mass and a pulley at the track end opposite the receiver. Measure the acceleration of the encoder cart as a function of the hanging mass.

Measure Cart Acceleration with Friction

Add a Friction Pad (order code DTS-PAD) to the encoder cart and observe the motion of the cart with varying frictional forces.

Momentum-Impulse

Use the built-in force sensor and a hoop spring to observe the relationship between momentum and impulse. Set up an adjustable end stop, attach the hoop spring to the force sensor, and allow the cart to strike the end stop. Record the incoming and outgoing velocity from the slope of the position graph, and find the impulse by integrating under the force *vs.* time graph.

Conservation of Energy

Use two Sensor Carts to observe a change in energy due to a collision between two carts.

Conservation of Momentum

Use two Sensor Carts to observe a change in momentum due to a collision between two carts. Try different kinds of collision: elastic, inelastic, totally inelastic.

Products Related to the Vernier Dynamics Cart and Track System with Motion Encoder

Vernier Dynamics Cart and Track System (order code DTS)

Vernier Dynamics System is a low-friction 1.2 m track and optics bench combination designed for kinematics, dynamics, and optics experiments. It includes two carts. The hardware does not include the Motion Encoder Cart and Receiver.

Vernier Dynamics Cart and Track System with Long Track (order code DTS-LONG)

The long version of the Vernier Dynamics System includes a 2.2 m track instead of the 1.2 standard track.

Track (order code TRACK)

The Combination 1.2 m Track/Optics Bench comes with the Encoder System Strip installed.

Replacement Parts

Ultra Pulley (order code SPA)

The pulley can be attached to the end of a track using the Pulley Bracket to make a half-Atwood machine.

Pulley Bracket (order code B-SPA)

The pulley bracket allows easy attachment of an Ultra Pulley to the end of a Vernier track.

Suggested Accessories

Bumper Launcher Kit (order code BLK)

The Bumper Launcher Kit includes accessories to integrate the Dual-Range Force Sensor (DFS-BTA) with the Vernier Dynamics System or Vernier Motion Encoder System, allowing for many interesting experiments in momentum-impulse study.

DTS Cart Friction Pad (order code DTS-PAD)

The DTS Cart Friction Pad attaches to the cart end using the collision tab slots. It adds an adjustable pad that rubs on the track, adding a controlled amount of friction to the cart motion. Use it to study frictional forces.

Optics Expansion Kit (order code OEK)

The Vernier-Optics Expansion Kit extends the Vernier Dynamics System or Vernier Motion Encoder System for use in optics experiments.

Color Mixer (order code CM-OEK)

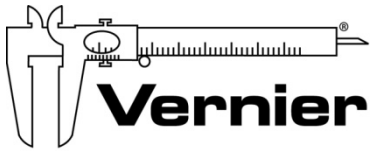
The Vernier Color Mixer Kit consists of a three-color LED illuminator with power supply, a lens, and a double-sided screen. Experiments in additive and subtractive color mixing can be easily and conveniently carried out using this kit. The intensity of the red, blue and green LEDs can be smoothly controlled from the light source.

Diffraction Apparatus (order code DAK)

Use the Diffraction Apparatus to map light intensity versus position for many-slit geometries.

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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