Vernier Quick-Release Mount

The instructions below outline how to prepare the track and build a quick-release crumple mount for a Vernier cart. (If you have a Pasco cart, use these alternate directions: *Pasco Quick-Release Mount*.)

You need the following supplies if you are attaching this mount to a Vernier cart:

- 1 smart cart track (Either the Pasco or Vernier track works with either company's smart cart.)
- 1 magnetic bumper (available in a set of 2 from Pasco Scientific: Magnetic Bumper Set ME-9885)
- 1 steel double-wide mending plate (3.5" wide)
- 1 flat metal washer (⅜" outer diameter, 11/64" inner diameter)
- 1 push-pull spring scale (10 N)
- 1 piece of wood (4" x 10" x ¾")
- 4 pieces of sticky tack
- duct tape
- pliers

Safety Protocols:

When working with the lab materials, the following safety precautions are necessary.

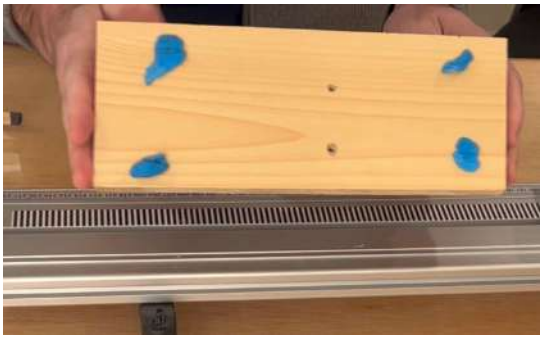
- Students must conduct the experiment under the supervision of qualified personnel who can respond quickly to any unforeseen circumstances.
- Students involved in setting up the equipment and conducting the experiment must be properly trained in handling the sensor carts and understand the experimental procedures.
- Wear appropriate personal protective equipment (PPE) including sanitized safety glasses with side shields during the setup, experimentation, and takedown segments of the activities.
- Secure loose clothing, wear closed-toe shoes, and tie back long hair.
- Clear the workspace of any obstacles or hazards that could interfere with the experiment or cause accidents during the collision.
- Make sure that all parts of the carts are properly secured and stabilized before conducting the collision test. Follow manufacturer guidelines for setup and operation.
- Immediately clean up anything that falls on the floor, so it does not become a slip or fall hazard.
- Maintain a safe distance from the collision area during the activity to avoid injury from flying debris or malfunctioning equipment.
- Following the activity, inspect all equipment for any damage or wear and tear. Repair or replace any damaged components before further use.
- Wash hands with soap and water once all equipment is put in appropriate storage areas.

Part 1: Selecting and aligning the track against a wall

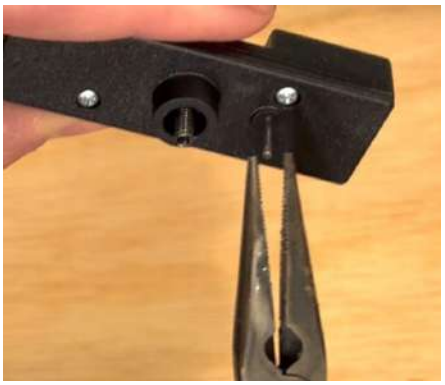
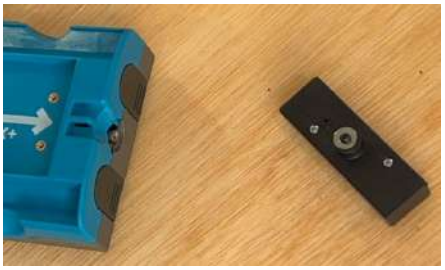
Select the smart cart track you intend to use (Pasco or Vernier). They both provide wheel slots appropriately spaced to accommodate a cart from either company. Line up one end of the track against a wall. This will be the stationary barrier the carts collide against. Level the track.	

Part 2: Mounting the external spring launcher

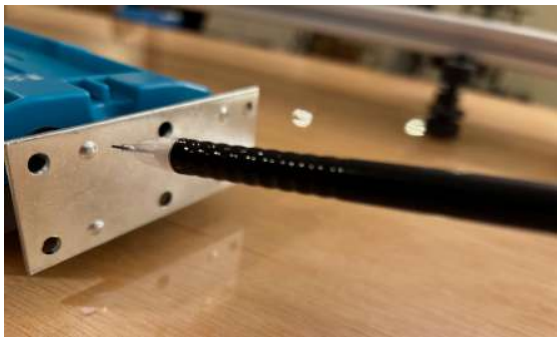
The Vernier cart has a weaker spring for launching the cart than the Pasco cart does. If you are using a Vernier cart, we recommend adding a stronger external spring launcher to the system to achieve a peak force in the control condition (close to 20 N). The steps in Part 2 outline how to mount an external spring launcher to the track.

Attach the pieces of sticky tack to the piece of wood. This ensures that you don't leave glue on the track that you will mount the wood to next.	
Position the wood on the launching end of your track and press down on the wood to ensure a tight bond with the track below.	
Attach the push-pull spring scale to the top of the wood using 2 pieces of duct tape, so the entire push end of the plunger extends over the edge of the wood. This structure will be your launcher for the Vernier cart.	

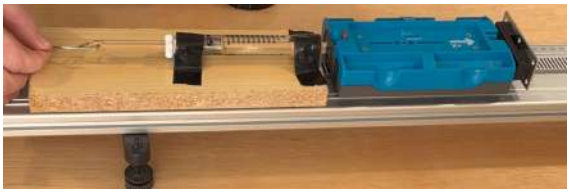
Part 3: Mounting the magnetic bumper to the cart

Use pliers to pull out the small metal pin on the back side of the magnetic bumper.	
Place the metal washer over the mounting screw on the back side of the bumper. The washer ensures that there is contact between the magnetic bumper case and the force sensor screw mount on this cart, which is smaller in diameter than on the Pasco cart.	
Tighten the mounting screw on the bumper. Make sure the washer is making contact with the bumper case and the force sensor.	

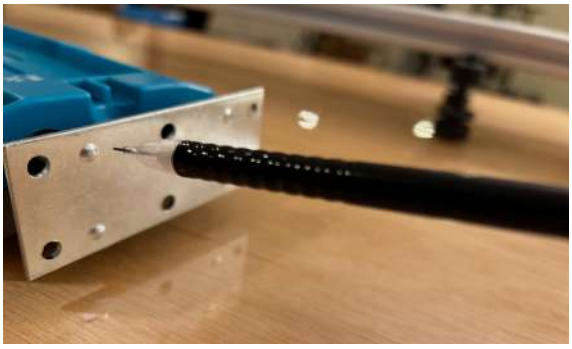
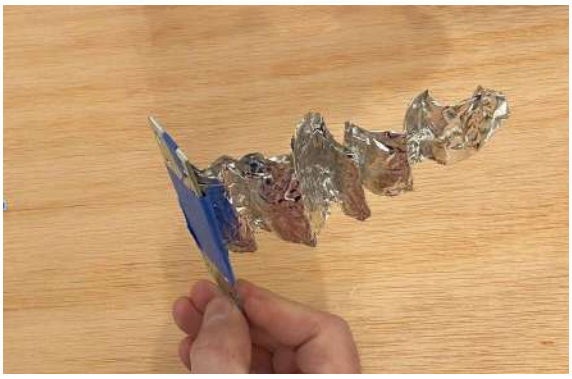
Part 4: Attaching the control condition bumper

Place the mending plate against the magnetic bumper so the bumps on the plate face outward. The plate will stick to the bumper. Slide the plate around to position it so there is adequate clearance for the track. The bottom of the mending plate should be no more than ⅛" above the bottom of the cart chassis. The cart now has the control condition bumper on it and is ready to test.	

Part 5: Launching the cart to test the control condition

Test this control condition by launching the cart using the external spring launcher you built on the end of the track. Pull the spring launcher all the way back. Lean the cart against it and release the spring to launch it.	

Part 6: Swapping in experimental condition crumple bumpers to test

When students build experiment condition crumple bumpers to test, instruct them to tape the structure they build to the steel zinc-plated double-wide mending plate you provide. The structure they design should extend from the side of the plate that has the raised bumps so the bumps are not on the back side, which would interfere with a close fit against the magnetic bumper.	
Students can secure their structure to the plate with transparent tape, masking tape, or painter's tape) The tape can wrap around the back side of the plate, but advise them to minimize the thickness of the tape on that side (as shown here). Too much material on the back side of the plate will create a gap between the plate and the magnetic bumper, which will compromise the bumper's relatively secure hold. Remind students to make sure to design their bumper so no part of it is touching the track. This may require them to bend or adjust the end of their bumper a bit.	

Slide one plate off (e.g., the control) and an experimental plate onto the magnetic bumper.

Place the cart on the track against the launcher.

Because first contact of the bumper with the track system should occur when it reaches the barrier, students may need to adjust the end of the bumper so it is elevated above the track, and not touching it, before the cart is launched.