Newton's First Law

Equipment

1	Motion Sensor	PS-2103A
1	Dynamics Track	ME-6955
1	Elastic Bumper	ME-8998
1	Magnetic Damping	ME-6828
	Useful, but not included:	
1	Calipers	SE-8710

Introduction

The purpose of this experiment is to determine how external forces affect an object's motion. This concept is summarized by Newton's 1st Law of Motion, which can be stated as:

"An object at rest will remain at rest, or an object that is moving will continue moving with constant velocity, only if the net force acting on the object is zero."

Setup

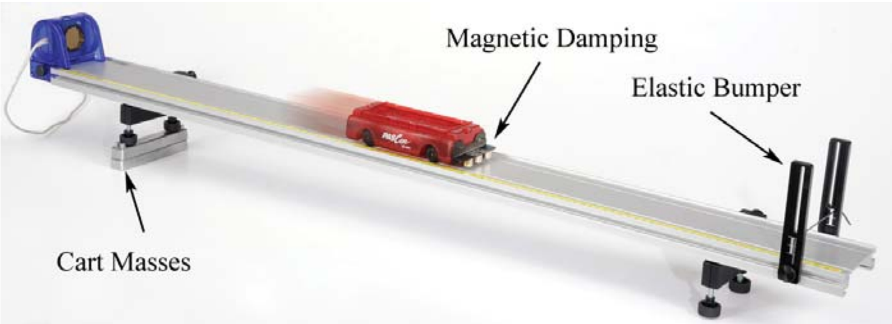

Figure 1. Cart moving at constant velocity down the inclined plane

1. Set up the track as shown in Figure 1 with the Elastic Bumper and feet. Note that the Motion Sensor is on the end of the track that is the zero point for the yellow rule.

2. Plug the Motion Sensor into the interface and make sure the range switch is on the "Cart" icon. In PASCO Capstone, create a graph of Velocity vs. Time. Keep the sampling rate for the Motion Sensor at the default rate of 20 Hz.
3. Create a Start Condition based on the Position measurement so recording will begin when the position is above 0.20 m. Also make a Stop Condition based on the Position measurement so recording will stop when the position is above 1.0 m.

4. Do not install the Magnetic Damping Accessory or incline the track yet!

5. Place the cart at rest on the level track (NOT inclined). If the cart moves, use the adjustable feet to level the track.

6. Install the Magnetic Damping Accessory. It attaches to the end of the cart that does NOT have the plunger. The steel bracket is held in place by the magnets inside the cart, and slides up and down to adjust the amount of drag.

7. Use the two Cart Masses (see Fig. 1) to incline the track.

Procedure – Constant Speed

1. Use some type of spacer (any non-magnetic material will work) to set the magnet spacing to about 4 mm. Slide the bracket down (see Fig. 2) until the magnets are flush with the spacer, then remove the spacer.

2. Position the back of the cart (closest to the Motion Sensor) at the 15 cm mark. This is the starting position for the cart.

3. Click on Record, and then release the cart from rest. Data collection will NOT start until the cart reaches a position of 30 cm, due to an initial starting condition. This will give you better looking data.

4. You can stop recording at any time, but there is an automatic stop condition that stops the recording when the cart reaches 1.0 m.

5. You want to adjust the drag so that the cart speed stays relatively constant. Look at the velocity graph. If the speed is increasing, move the magnets closer to the track by about 1/2 mm.

6. Take another run of data. Is the speed relatively constant? Keep moving the magnet closer until the speed is constant.

7. Get one good run of data. Open up the Data Summary and re-name this run Constant Velocity.

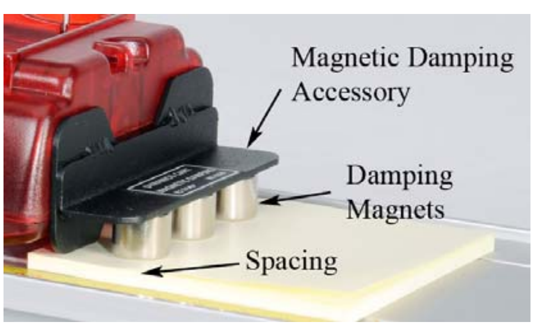

Figure 2. Adjusting Magnetic Damping

Analysis

1. Add a plot area to the v vs. t graph and select Position on the second plot area.
2. What do the position and velocity graphs tell you about the motion of the cart?
3. If the velocity is constant, what is the acceleration?
4. If the acceleration is zero, what is the net force?
5. If the net force is zero, does this mean there are no forces acting on the cart?
6. Identify the two major forces acting on the cart. What do you know about the magnitude and direction of these two forces?

Procedure: Level Track

1. Remove the two cart masses and return the track to level.
2. Change the Start Condition to above 0.30 m and change the Stop Condition to Time-based for 3 seconds.
3. Position the cart at the 15 cm mark, and start recording. Give the cart a quick push away from the Motion Sensor.
4. You can stop recording at any time, but there is an automatic stop condition that stops the recording after 3 seconds.
5. Get one good run of data. Open up the Data Summary and re-name this run Level Track.
6. What do your position and velocity graphs tell you about the motion of the cart? Is the velocity is constant? Is the acceleration constant?
7. Why is the force of gravity no longer a factor?
8. Identify the major force acting on the cart. What do you know about the direction of this force?

Procedure: Object at Rest

1. Place the cart at 40 cm and start recording. You can stop recording at any time, but there is an automatic stop condition that stops the recording after 3 seconds. Re-name this run At Rest.

2. What do your position and velocity graphs tell you about the motion of the cart?

3. What is the acceleration and net force?

4. In general, what happens to an object at rest if the net force applied is zero?

5. In general, what happens to an object in motion if the net force applied is zero?