

Tailgated by a Dart

Lab 8.03

Purpose

To estimate the speed of an object by applying conservation of momentum to an inelastic and elastic collision.

Required Equipment

- Meter stick
- Stop watch

Inelastic Collision: The Theory

A ball is launched horizontally and embeds in the catcher mounted on the dynamics cart. The cart and ball then move off at a constant velocity. See Figure 3.1.

Momentum is conserved during the collision, but energy is not conserved. The momentum before the collision is equal to the momentum after the collision:

$$P_{\text{before}} = P_{\text{after}}$$

$$m_b v_o = (m_b + m_c) v_c$$

where m_b is the mass of the ball, v_o is the muzzle velocity of the ball, m_c is the mass of the catcher and cart, and v_c is the velocity of the cart and ball immediately after the collision. An inelastic collision is one in which two separate objects collide and stick together.

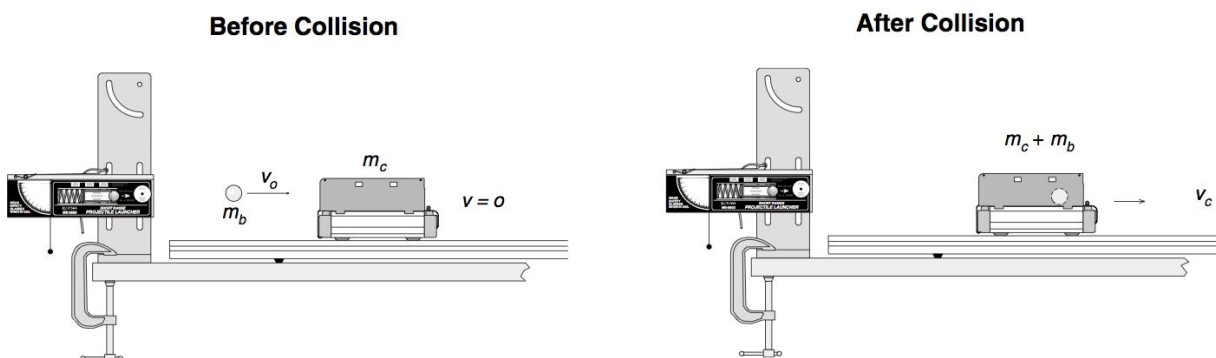
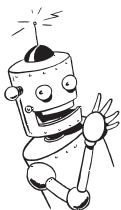


Figure 3.1: Conservation of Momentum in the Inelastic Collision

Getting Started

1. Setup a dynamic track as demonstrated by your instructor.
2. Attach a projectile launcher to one end of the track as demonstrated.
3. Obtain a dynamic cart with a catch and a steel ball from your instructor.
4. Place the cart on the track and line it up the catch with the spring gun.



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- If you are using photogates, setup two photogates so that they are spaced 0.1 m (10-cm) apart and right in front of the carts starting position.
- Load the bullet into the spring gun. Only use the setting give by your instructor. Using the wrong setting can damage the cart and track.
- After the bullet is loaded, place the cart against the end stop and fire the gun.
- If you are not using photogates, immediately begin timing the cart over a 1-m coasting distance. Record your results in data table A.
- Record the mass of the cart bellow.

Mass of cart (kg): _____

- Record the mass of the ball bellow.

Mass of cart (kg): _____

Data Table A

Coasting Distance (m)	Time (s)				Velocity of cart upon impact (m/s)	Initial velocity of bullet (m/s)
	trial #1	trial #2	trial #3	Ave Time		

Calculating Velocity of Cart

- Use the formula bellow to calculate the velocity of the cart with the ball after the collision.

$$v = \frac{\Delta d}{\Delta t} \qquad v_{cart+ball} = \frac{d_{coasting}}{t_{ave}}$$

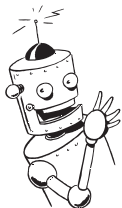
Show your work:

Calculating Initial Velocity of Bullet

- Use the formula bellow to calculate the velocity of the cart and the ball together.

$$m_b v_o = (m_b + m_c) v_c \qquad v_b = \frac{(m_b + m_c) v_{c+b}}{m_b}$$

Show your work:



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Break Apart: The Theory

Two dynamic carts are placed together and a spring plunger launches the two carts away from one another.

The momentum before the collision is equal to the momentum after the collision:

$$P_{before} = P_{after}$$

$$(m_1 + m_2)v_o = m_1v_{1f} + m_2v_{2f}$$

where m_1 is the mass of one car and m_2 is the second cart. v_o is the original velocity of the two carts before the break apart, and v_{1f} is the velocity of the cart 1 and v_{2f} is the velocity of car 2 after they break apart.

If the original velocity of the two carts together is zero, then the momentum of cart 1 and cart 2 will be equal to each other.

$$0 = m_1v_{1f} + m_2v_{2f} \qquad m_1v_{1f} = m_2v_{2f}$$

- 13. Obtain a plunger cart from your instructor.
- 14. Record the mass of each cart bellow.

Mass of cart 1 (kg): _____

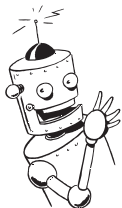
Mass of cart 2 (kg): _____

- 15. Place the two carts in the middle of the track with the plunger pushing on both carts.
- 16. Push the plunger down three clicks.
- 17. When ready, release the plunger and begin timing both carts over a 1-m distance. Have one group member time cart 1 and a second group member time cart 2. Record in data table B.

Data Table A

Cart #	Coasting Distance (m)	Time (s)				Velocity after breakup (m/s)	Momentum after breakup (kg*m/s)
		trial #1	trial #2	trial #3	Ave Time		
1							
2							

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Tailgated by a Dart**Lab 8.03****Calculating Velocity each Cart**

18. Calculate the momentum of each cart after they break apart. and record in data table B.

$$v = \frac{\Delta d}{\Delta t} \qquad v_{cart} = \frac{d_{coasting}}{t_{ave}}$$

Show your work:

Calculating Momentum

19. Momentum is mass in motion. Calculate the momentum of each cart after they break apart and record in data table B.

$$p = mv$$

Show your work:

Conservation of Moment

20. Compare the momentum of each cart after they break apart and see if their momentum is the same.

If the original velocity of the two carts together is zero, then the momentum of cart 1 and cart 2 will be equal to each other.

$$0 = m_1v_{1f} + m_2v_{2f} \qquad m_1v_{1f} = m_2v_{2f}$$

