Announcements

PRACTICE	LABS	TESTS
Practice problems (1-14,16)	• Exploding carts interactive • Collisions Interactive • Roller Coaster Lab	Unit 11 Test Thursday 2/28

Elastic Collisions

LEARNING TARGET	DESCRIPTION
11.2	I can define, interpret, and solve problems involving the Law of Conservation of Momentum.
11.3	I can define, analyze, and solve problems involving two particle collision.

Review Momentum and Impulse

Momentum

$$p = m v$$

Impulse-Momentum Theorem

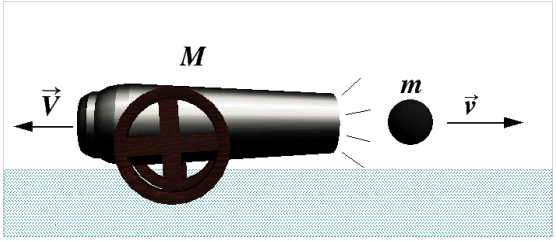
$$F \Delta t = \Delta p = p_f - p_i$$

Conservation of Momentum

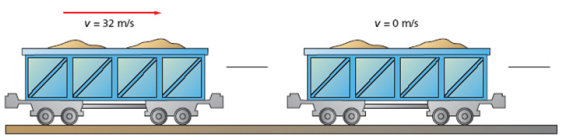
If the net external force acting on an object, or system, is zero, its momentum is conserved.

$$\vec{p}_i = \vec{p}_f$$

Conservation of Momentum



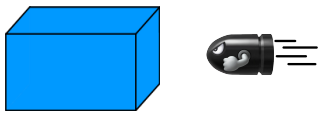
Inelastic Collisions in One Dimension



$$M_1 V_{1,i} + M_2 V_{2,i} = (M_1 + M_2) V_f$$

Through and Through

Bullet Bill has a mass of 350.0 g and is traveling toward a block of ballistics gel at 900 mph. Bill travels all the way through the 5.0 kg block of gel, and exits going half his original speed. How fast is the ballistics gel traveling after the collision?



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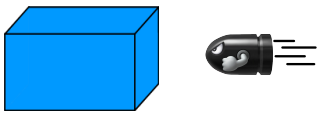
OBJECTS	MOMENTUM BEFORE (kg·m/s)	MOMENTUM AFTER (kg·m/s)
BILL		
GEL		
TOTAL		



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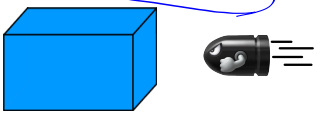
Bullet Bill has a mass of 350.0 g and is traveling toward a block of ballistics gel at 900 mph. Bill travels all the way through the 5.0 kg block of gel, and exits going half his original speed. How fast is the ballistics gel traveling after the collision?

OBJECTS	MOMENTUM BEFORE (kg·m/s)	MOMENTUM AFTER (kg·m/s)
BILL	(0.350 kg)(402 m/s) = **141 kg·m/s**	(0.350 kg)(201 m/s) = **70 kg·m/s**
GEL	(5.0 kg)(0 m/s) = **0 kg·m/s**	(5.0 kg)(v_f)
TOTAL	**141 kg·m/s**	**141 kg·m/s**

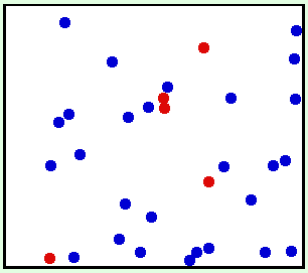
$70\ \frac{kg \cdot m}{s} + (5\ kg)v_f = 141\ \frac{kg \cdot m}{s}$

$v_f = 14\ m/s$



2 Types of Collisions

Elastic collisions are when objects bounce, and do not stick together on impact.



Elastic Collisions

- Physicsclassroom.com
- Interactives
- Momentum and Collisions
- Collision Carts

Elastic Collisions

One cart (mass = m) moves with a velocity *v* and collides elastically with another cart (mass = M) that is stationary. What is the result of the collisions in the following situations:

1. m = M
2. m > M
3. m < M

Elastic Collisions

4. One cart (m_1 = 1.50 kg) moves with a velocity v = 5.30 m/s and collides elastically with another cart (M_2 = 5.00 kg) that is stationary. The collision is completely elastic and cart M_2 has a speed of 2.45 m/s after the collision. What is the speed and direction of cart m_1 after the collision?
   a) What is the speed and direction of cart m_1 after the collision?
   b) What is the change in kinetic energy after the collision?

Elastic Collisions

4. One cart (m_1 = 1.50 kg) moves with a velocity v = 5.30 m/s and collides elastically with another cart (M_2 = 5.00 kg) that is stationary. The collision is completely elastic and cart M_2 has a speed of 2.45 m/s after the collision. What is the speed and direction of cart m_1 after the collision?

OBJECTS	MOMENTUM BEFORE (kg·m/s)	MOMENTUM AFTER (kg·m/s)
m_1	(1.50 kg)(5.30 m/s) = 7.95 kg·m/s	(1.50 kg)($v_{1,f}$)
M_2	(5.0 kg)(0 m/s) = 0 kg·m/s	(5.0 kg)(2.45 m/s) = 12.25 kg·m/s
TOTAL	7.95 kg·m/s	7.95 kg·m/s

$(1.50\text{ kg})(v_{1,f}) + 12.25\text{ kg m/s} = 7.95\text{ kg m/s}$

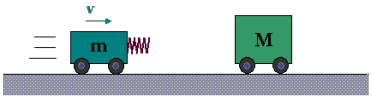
$(1.50\text{ kg})(v_{1,f}) = -4.30\text{ kg m/s}$

$v_{1,f} = -2.90\text{ m/s}$

$K_i = \frac{1}{2}(1.50\text{ kg})(5.30)^2 = 21.1\text{ J}$

$K_f = \frac{1}{2}(1.5\text{ kg})(2.90)^2 + \frac{1}{2}(5\text{ kg})(2.45)^2 = 21.3\text{ J}$

Elastic Collisions



Momentum

$m_1v_1 + m_2v_2 = m_1v_{1,f} + m_2v_{2,f}$

Kinetic Energy

$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_{1,f}^2 + \frac{1}{2}m_2v_{2,f}^2$

Elastic Collisions In One Dimension

Initial Conditions

$v_{1,i} = v_o$ and $v_{2,i} = 0$

$$v_{1,f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_0$$

$$v_{2,f} = \left(\frac{2m_1}{m_1 + m_2}\right)v_0$$

Science Practice

PROBLEMS

(17-19)