Inelastic Collisions

The forces are internal so linear momentum is conserved.

Kinetic energy is NOT conserved (converted into sound & internal energy)

The two objects colliding will become one moving mass after the collision, meaning they have the same final velocity.

$$m_1v_{1,i} + m_2v_{2,i} = (m_1 + m_2)v_f$$

Ex. 1

A 0.05 kg bullet is shot at 50 m/s towards a stationary 1.95 kg wooden block. When the bullet makes contact, it becomes embedded in the block.

Find the speed of the bullet-block system after the collision.

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

$$(0.05)(50) + (1.95)(0) = (0.05 + 1.95) v_f$$

$$2.5 = 2 v_f$$

$$\boxed{v_f = 1.25 \text{ m/s}}$$

Ex. 2

A 2 kg block is moving 10 m/s to the east. A 3 kg block is moving 5 m/s to the west. If the blocks stick together after the collision, (a) find their final velocity.

$$2(10) + 3(-5) = (2+3)v_f$$

$$\boxed{v_f = 1 \text{ m/s}}$$

b) What is the change in kinetic energy of the system?

$$\Delta KE = KE_f - KE_i$$

$$KE_f = \frac{1}{2}mv_f^2$$

$$= \frac{1}{2}(3+2)(1)^2$$

$$= 2.5 \text{ m/s}$$

$$KE_i = \frac{1}{2}mv_i^2$$

$$= \frac{1}{2}(2)(10)^2 + \frac{1}{2}(3)(-5)^2$$

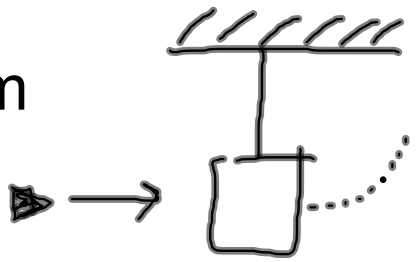
$$= 100 + 37.5$$

$$= 137.5$$

$$2.5 - 137.5$$

$$\boxed{\Delta KE = -135 \text{ J}}$$

Ballistic Pendulum



Ex. 3

A 0.08 kg bullet is shot at 60 m/s towards a stationary 10 kg wooden block hanging from the celing. When the bullet makes contact, it becomes embedded in the block.

a) Find the speed of the bullet-block system after the collision.

$$(0.08)(60) + (10)(0) = (10+.08)v_f$$

$$4.8 = 10.08 v_f$$

$$v_f = 0.48 \text{ m/s}$$

b) Find the height reached by the bullet-block system

$$ME_i = ME_f$$

$$KE_i + PE_i = KE_f + PE_f$$

$$\underbrace{\tfrac{1}{2}(10+.08)(.48)^2}_{KE_i} + \underbrace{0}_{PE_i} = \underbrace{0}_{KE_f} + \underbrace{(10+.08)(9.81)h}_{PE_f}$$

$$h = .012 \text{m}$$

Ex. 4

A 0.09 kg bullet is shot at towards a 5 kg wooden block hanging from rest. When the bullet makes contact, it becomes embedded in the block and reaches a height of 0.3 m.

Find the initial velocity of the bullet.

$$ME_i = ME_f$$

$$\frac{1}{2}(5+0.09)v^2 = (5+0.09)(9.81)(0.3)$$

$$v = 2.42 \text{ m/s}$$

$$p_i = p_f$$

$$(.09)v_i + (5)(0) = (5+0.09)2.42$$

$$\boxed{v_i = 137 \text{ m/s}}$$

Elastic Collisions

Momentum and Kinetic Energy are conserved

The two objects collide and will return to their original shapes with no loss of KE

$$m_1v_{1,i} + m_2v_{2,i} = m_1v_{1,f} + m_2v_{2,f}$$

Ex. 5

A 0.015 kg marble moving 0.225 m/s right has an elastic collision with a 0.30 kg marble moving 0.18 m/s left. After colliding, the 0.015 kg marble moves 0.315 m/s left. What is the velocity of the 0.30 kg marble after the collision?

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$(0.015)(0.225) + (.3)(-.18) = (0.015)(-0.315) + (.3) v_{2f}$$

$$v = 0.09 \text{ m/s right}$$

Ex. 6

A 1 kg block moves right at 10 m/s towards a 2 kg block at rest. If their collision is elastic, what are their velocities after the collision?