Conservation of Momentum (COρ)

- ***The momentum of any closed, isolated system does not change.***
- ***When objects collide linear momentum is conserved.***
- ***Total momentum before the collision equals the total momentum after the collision.***
- ***Total energy is also conserved***
  - ***Kinetic energy does not have to be conserved.***
  - ***Kinetic energy can be transformed to heat.***

(COρ)

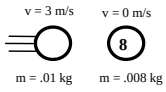
- ***Types of collisions (remember momentum is conserved):***
  1. ***Elastic – kinetic energy is conserved***
  2. ***Inelastic – kinetic energy is not conserved***
  3. ***Perfectly inelastic – kinetic energy is not conserved and the colliding objects stick together after the collision***

Sample

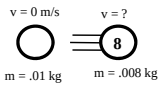
A 10 gram cue ball is moving at 3 m/s across a pool table toward a stationary 8 ball with a mass of 8 grams. After the collision the cue ball is no longer moving. How fast is the 8 ball traveling?

Draw a picture for before and after the collision

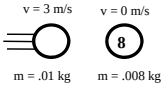
Before the collision:



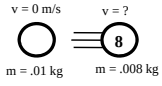
After the collision:



Before the collision:



After the collision:



Write a COρ equation

Total momentum before equals Total momentum after

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

$$(0.01kg)(3m/s) + (0.008kg)(0m/s) = (0.01kg)(0m/s) + (0.008kg)(v)$$

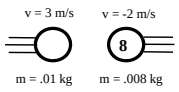
$$v = 3.75m/s$$

Practice

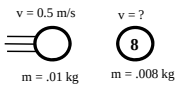
A 10 gram cue ball is moving at 3 m/s strikes an 8 gram 8 ball moving in the opposite direction at 2 m/s. If, after the collision, the cue ball's velocity is reduced to 0.5 m/s, how fast and in what direction is the 8 ball traveling?

Draw a picture for before and after the collision

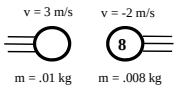
Before the collision:



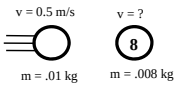
After the collision:



Before the collision:



After the collision:



Write a COρ equation

Total momentum before equals Total momentum after

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

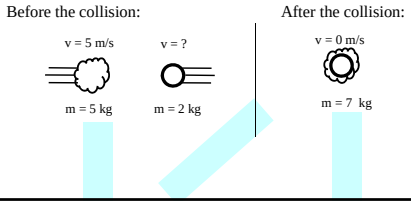
$$(0.01kg)(3m/s) + (0.008kg)(-2m/s) = (0.01kg)(0.5m/s) + (0.008kg)(v)$$

$$v = 1.125m/s \quad \textbf{To the right}$$

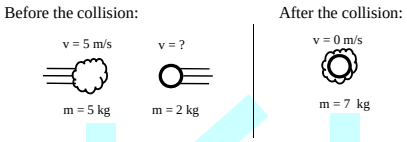
Sample

A 5 kg lump of clay moving at 5 m/s collides with a 2 kg stone moving in the **opposite direction**. If the combined clay-stone is brought to rest due to the collision how fast was the stone moving originally?

Draw a picture for before and after the collision



Sample



Write a COρ equation

Total momentum before equals Total momentum after

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

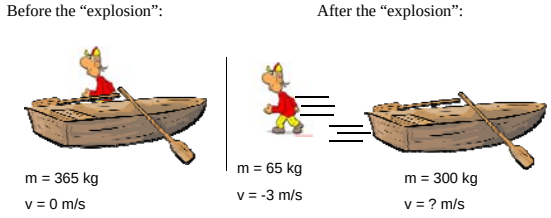
$$(5kg)(5m/s) + (2kg)v_{2i} = (7kg)(0m/s)$$

$$v_{2i} = -12.5m/s$$

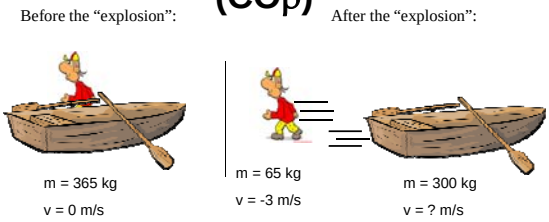
(COρ)

Linear momentum is also conserved in "explosions"

You (mass of 65 kg) are standing in a motionless boat (mass = 300 kg. If you jump out of the boat with a velocity of 3 m/s, how fast will the boat be traveling in the opposite direction?



(COρ)



$$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$$

$$(365\ kg)(0\ m/s) = (65\ kg)(-3\ m/s) + (300\ kg)(v_{2f})$$

$$0.65 m/s = v_{2f}$$

Practice

- A 26 kg cannon ball fired, by Captain Jack Sparrow aboard the Black Pearl (mass 95,750 kg) is moving east at 425 m/s.
  - ➢What was the velocity of the Black Pearl?

$$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$$

$$(26\ kg + 95{,}750\ kg)(0\ m/s) = (26\ kg)(425 m/s) + (95{,}750\ kg)(v_{2f})$$

$$-0.115 m/s = v_{2f}$$