

Physics 112

Thursday Nov 16<sup>th</sup>.

Work

Energy

Momentum

Impulse

Springs

## Momentum

$$p = m v$$

momentum = mass  $\times$  velocity

$p \rightarrow$  momentum  $\rightarrow$  kg·m/s

$m \rightarrow$  mass  $\rightarrow$  kg

$v \rightarrow$  velocity  $\rightarrow$  m/s

Calculate the momentum of a 3.50 kg block moving at 2.34 m/s

$$p = m v$$

$$= 3.50 \text{ kg} \times 2.34 \text{ m/s}$$

$$p = 8.19 \text{ kg}\cdot\text{m/s}$$

• The momentum of the block is 8.19 kg·m/s

## Conservation of Momentum

The total combined momentum of two objects before they collide is equal to the total momentum of the two objects after they collide in a collision.

- Momentum cannot be gained or lost in a collision.

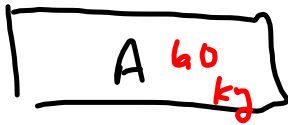
Momentum Before  
collision = Momentum After  
collision

$$A + B = A + B$$

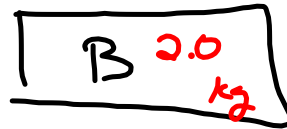
$$P_A + P_B = P'_A + P'_B$$

$$m_A v_A + m_B v_B = m_A v'_A + m_B v'_B$$

Example:



$$V_A = 5.0 \text{ m/s}$$



$$V_B = 0 \text{ m/s}$$

Block A and B collide. After the collision, B moves right at 2.0 m/s. What is the after collision velocity of Block A.

$$\begin{aligned}
 \text{Before} &= \text{After} \\
 A + B &= A + B \\
 6(5) + 2(0) &= 6V_A + (2)(2) \\
 30 \text{ kg}\cdot\text{m/s} &= 6V_A + 4 \text{ kg}\cdot\text{m/s} \\
 26 \text{ kg}\cdot\text{m/s} &= 6V_A \\
 \frac{26}{6} &= V_A \\
 4.3 \text{ m/s} &= V_A
 \end{aligned}$$

Block B moves off at

4.3 m/s in the same direction (right) that it was originally moving.

Example 2

A 35.0 g bullet moving at 205.0 m/s strikes a 5.0 kg block at rest. Determine the speed of the block if.

- a) The bullet come out the other side at 111 m/s
- b) Bullet gets stuck in block
- c) Bullet bounce off at 25 m/s.



a) Before = After

$$A + B = A + B$$

$$\text{Bullet} + \text{Block} = \text{Bullet} + \text{Block}$$

$$(0.035)(205) + 5(0) = 0.035(111) + 5v$$

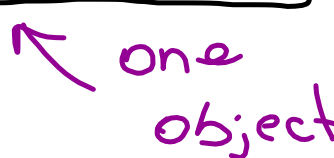
$$7.175 + 0 = 3.885 + 5v$$

$$3.29 = 5v$$

$$\boxed{+ 0.658 \text{ m/s} = v}$$

The block is moving at 0.658 m/s in the same direction that the bullet was originally moving. A negative velocity would mean the opposite direction.

$$\begin{aligned}
 \text{(b) Before} &= \text{After} \\
 A + B &= A + B \\
 \text{Bullet} + \text{Block} &= \boxed{\text{Bullet} + \text{Block}}
 \end{aligned}$$


 one object

$$\begin{aligned}
 0.035(205) + 5(0) &= 5.035(v) \\
 7.175 &= 5.035v
 \end{aligned}$$

$$\boxed{+1.43 \text{ m/s} = v}$$

The bullet & block move off at 1.43 m/s in the same direction that the bullet was originally moving.

(c) Before = After

$$A + B = A + B$$

$$\text{Bullet} + \text{Block} = \text{Bullet} + \text{Block}$$

$$(0.035)(205) + 5(0) = 0.035(-25) + 5v$$

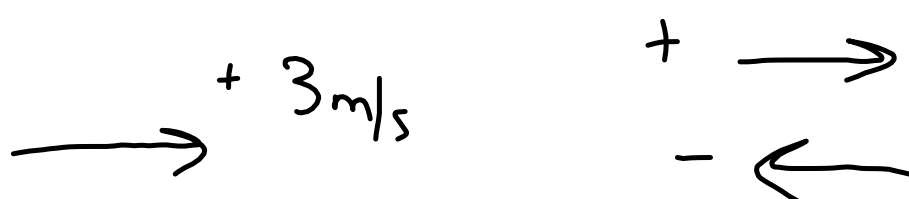
$$7.175 + 0 = -0.875 + 5v$$

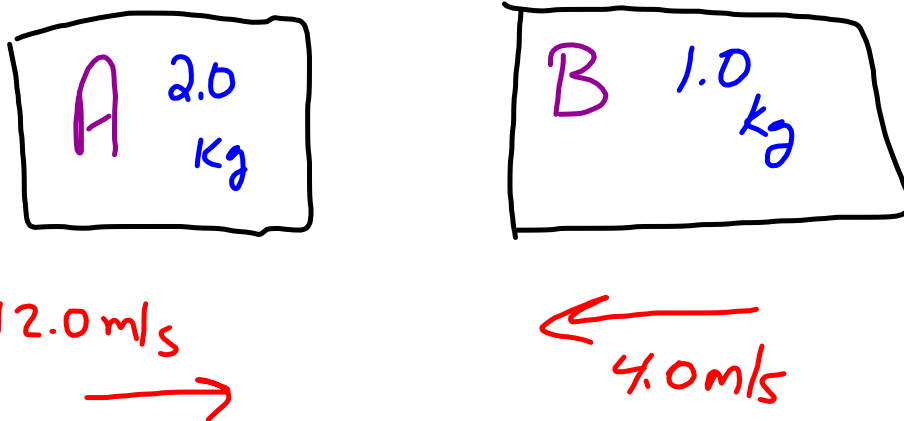
$$8.05 = 5v$$

$$+ 1.61 \text{ m/s} = v$$

The block moves off at 1.61 m/s in the same direction that the bullet was originally moving.

For Conservation of Momentum





Block A and B hit. After the collision, Block A moves to the right at 5.0 m/s. Determine Block B's velocity.

$$\begin{aligned} \text{Before} &= \text{After} \\ A + B &= A + B \\ 2(12) + 1(-4) &= 2(5) + 1V \end{aligned}$$

$$\begin{aligned} 24 - 4 &= 10 + V \\ 20 &= 10 + V \\ +10 &= V \end{aligned}$$

$$\boxed{10 \text{ m/s} \rightarrow = V}$$

We know that block B is moving right because  $v = +10 \text{ m/s}$  and we put the  $12 \text{ m/s}$  in as a positive, so anything moving in the same direction would have a velocity moving to the Right !!