## §5.4 Momentum & Newton's Laws (p195)

momentum depends on the mass of the object (direct prop)

momentum depends on the velocity of the object (direct prop)

* momentum is the product of mass and velocity

$$\vec{p} = m\vec{v}$$

where $\vec{p}$ is the momentum (kg·m/s)
$m$ is the mass (kg)
$\vec{v}$ is velocity (m/s)

**mp|197**

$m = 0.300\ kg$
$\vec{v} = 55.5\ m/s\ [N]$
$\vec{p} = ?$

$\vec{p} = m\vec{v}$
$\vec{p} = (0.300\ kg)(55.5\ m/s\ [N])$
$\vec{p} = 16.65\ kg \cdot m/s\ [N]$
$\vec{p} \doteq 16.6\ kg \cdot m/s\ [N]$

# Impulse

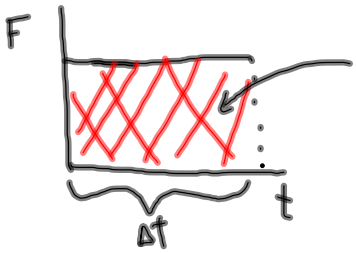
Impulse is related to the force acting on an object and the duration of the interaction.

- impulse is directly proportional to the force
- impulse is directly proportional to the duration

* Impulse is the product of the force and the duration

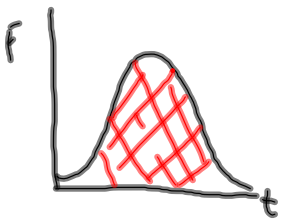
$$\vec{J} = \vec{F}\Delta t$$

where $\vec{J}$ is the impulse $(N \cdot s)$
$\vec{F}$ is the face acting on the object $(N)$
$\Delta t$ is the duration of the interaction $(s)$




area of rectangle = b x h

area = $F\Delta t$




area under a F · t graph = Impulse

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$\vec{F} = 5.25 \times 10^3 N [W]$

$\Delta t = 5.45 \times 10^{-4} s$

$\vec{J} = ?$

$\vec{J} = \vec{F}\Delta t$

$\vec{J} = (5.25 \times 10^3 N [W])(5.45 \times 10^{-4} s)$

$\vec{J} = 2.86125 N \cdot s [W]$

$\vec{J} = 2.86 N \cdot s [W]$

# Impulse & Momentum

If there is impulse $\Rightarrow$ force $\Rightarrow$ acc $\Rightarrow$ $\Delta v \Rightarrow$ change in mom.

RECALL NEWTON'S SECOND LAW:

$$\vec{F} = m\vec{a}$$

$$\vec{F} = m\frac{\Delta \vec{v}}{\Delta t}$$

$$\boxed{\vec{F}\Delta t = m\Delta \vec{v}} \quad *$$

$$\vec{F}\Delta t = m(\vec{v}_2 - \vec{v}_1)$$

$$\vec{F}\Delta t = m\vec{v}_2 - m\vec{v}_1$$

$$\vec{F}\Delta t = \vec{p}_2 - \vec{p}_1$$

$$\boxed{\vec{F}\Delta t = \Delta \vec{p}} \quad *$$

Impulse = change in momentum

This is called the Impulse-Momentum Theorem

$$\vec{F}\Delta t = \Delta \vec{p} = m\Delta \vec{v}$$

$$\vec{J}$$

MP|201

$m = 0.060\ kg$

$\vec{v}_1 = 48\ m/s$ [toward] (+)

$\vec{v}_2 = 35\ m/s$ [away] (−)

a) $\vec{J} = ?$

b) $\vec{F} = ?$ (25 ms)

$$\vec{J} = \Delta \vec{p}$$

$$\vec{J} = m\Delta \vec{v}$$

$$\vec{J} = m(\vec{v}_2 - \vec{v}_1)$$

$$J = 0.060\ kg\ (-35\ m/s - 48\ m/s)$$

$$J = 0.060\ kg\ (-83\ m/s)$$

$$J = -4.98\ kg \cdot m/s$$

a) $\vec{J} = 5.0\ kg \cdot m/s$ [away]

b) $\vec{J} = \vec{F}\Delta t$

$$\vec{F} = \frac{\vec{J}}{\Delta t}$$

$$\vec{F} = \frac{4.98\ kg \cdot m/s\ [away]}{0.025\ s}$$

$$\vec{F} = 199.2\ N\ [away]$$

$$\vec{F} = 2.0 \times 10^2\ N\ [away]$$

← the force of the wall on the ball.

TO DO

① PP|197, 200, 203

② Calculator Pad

The force of the ball on the wall is $2.0 \times 10^2$ N [toward] (Newton's 3rd Law)

Nov 4-9:26 AM