Momentum & Collisions

momentum = mass x velocity

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

*Vector quantity!

→ kgm/s

↑ mass @ constant v = ↑ momentum

* However, a small mass w/ very high v may have more p than large object moving slowly.

Ex 1.

Find the momentum of a block of 0.025kg moving @ 150 m/s

$\vec{p} = (0.025)(150) = 3.75 \text{ kgm/s}$

Impulse

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

Ex: 2

A baseball bat exerts an avg. force of 150 N on a ball for 5 s. What magnitude of impulse was delivered to the ball?

$I = Ft$

$= (150N)(5s)$

$= 750\ N \cdot s$

Impulse-Momentum Theorem

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

$$\vec{F}t = \vec{p}_f - \vec{p}_i$$

Ex 3: A ball initially at rest is dropped a distance of 0.9m. When the ball strikes the floor it bounces up a distance of 0.7m. If the ball has a mass of 0.15kg, what impulse did it deliver to the floor?

$$v_f^2 = v_i^2 + 2a\Delta x$$

pre-bounce

$v_i = 0$ m/s

$m = 0.15$ kg

$a = 9.81$ m/s^2

$\Delta x = 0.9$ m

$v_f^2 = 0 + 2(9.81)(.9)$

$v_f = \pm 4.2$ m/s

$v_f = -4.2$ m/s

use as v_i for I

past bounce

$v_i = 0$ m/s

$m = 0.15$ kg

$a = 9.81$ m/s^2

$\Delta x = 0.7$ m

$v_f^2 = 0 + 2(9.81)(.7)$

$v_f = \pm 3.7$ m/s

$v_f = +3.7$ m/s

use as v_f for I

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

$$= mv_f - mv_i$$

$$= (0.15)(3.7) - (0.15)(-4.2)$$

$$* \boxed{I = 1.2 \text{ N} \cdot \text{s}} *$$

Ex 4:

A 10 kg block moves at 5 m/s. What is the momentum? Find the KE.

$p = mv$
$= (10)(5)$
$= 50 \text{ kgm/s}$

$KE = \frac{1}{2}mv^2$
$= \frac{1}{2}(10)(5)^2$
$= 125 \text{ J}$

* Find the speed of a 10 g block with the same momentum as above. Find it's KE.

$v = 5000 \text{ m/s}$
$KE = 125{,}000 \text{ J}$

10 g