Class 9 - Oct 12/05

Derivatives of trig functions:

MAT 135 - next week -

CHAPT 9. Momentum & Impulse

No new physics

§9.1 - Impulse & Momentum

momentum $\vec{p} \equiv m\vec{v}$

2nd Law Improved

$$\vec{F} = \frac{d\vec{p}}{dt} = \frac{d(m\vec{v})}{dt}$$

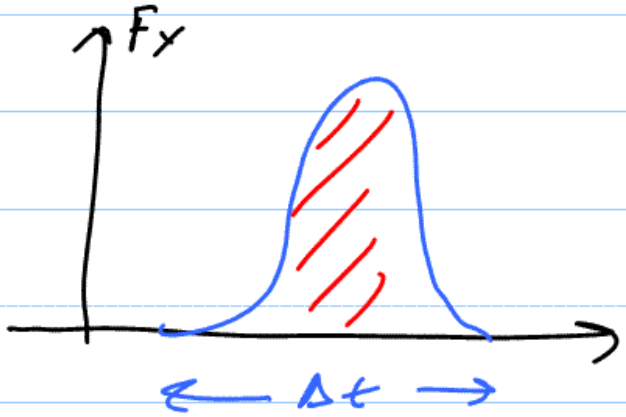
$m = \text{const} \Rightarrow \vec{F} = m\vec{a}$

$m \neq$ constant

Next week in MAT 33 "Product Rule"

$$\frac{d}{dz}(xy) = x\frac{dy}{dz} + y\frac{dx}{dz}$$

$$\vec{F} = \frac{d}{dt}(m\vec{v}) = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dt}$$



Impulse

$J_x \equiv$ area under curve

$$= \int_{t_1}^{t_2} F_x\, dt$$

$$= F_{avg,x}\, \Delta t$$

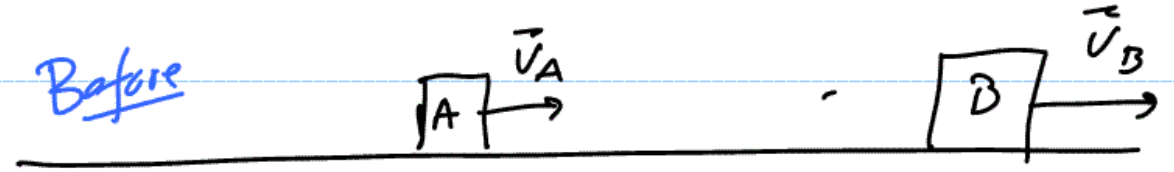
text shows: (Newton's 2nd Law)

$$J_x \equiv \Delta p_x = p_{x,f} - p_{x,i}$$

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

General Case

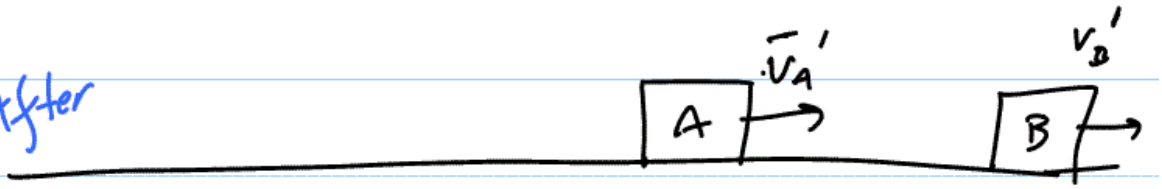
Before



$v_B < v_A$ $\quad v_B = 0$?

< 0 ?

After



$$J_{A \text{ on } B} = -J_{B \text{ on } A}$$

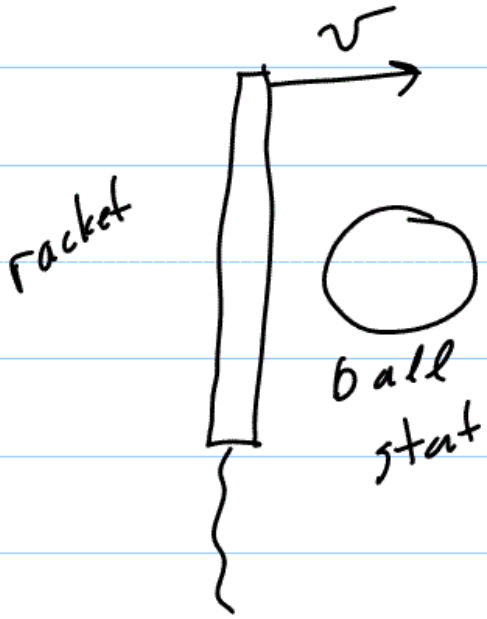
(3rd Law)

$$\Delta p_B = - \Delta p_A$$

$p_A + p_B$ = constant before & after the collision

Isolated system, $\vec{p}_{tot}$ conserved

Example: tennis serve



maximise v to get the ball going fast

$v = \omega r$

Damage to people in collisions

① $\Delta t \lesssim 100$ ms

const $J \Rightarrow$ const damage

② $\Delta t > 100$ ms

damage $\propto a = \frac{F_{net}}{m}$

withstand $a \sim 15g$

for a few seconds

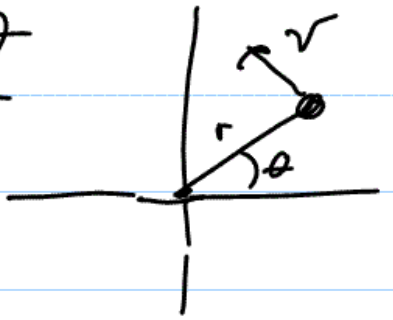
$a > 15g$

aorta ripped from heart

§9.6 $\vec{p}$ is a vector

NTA

§9.7



$v = \omega t$

Angular momentum $L \equiv mvr$

If $F_{net,t} = 0$

L_{tot} is conserved

proof in Chapt 13

$L = mvr$ $\quad\quad$ $v = \omega r$

$L = m(\omega r)r$

$L = mr^2\omega$ $\quad\quad$ $p = mv$