L-1 / 28.02.2022 /

Fundamental Quantity	Derived Quantity
Length	Force
Time	Weight
Mass	Volume
Temp.	
Current	

* $10^{24} \longrightarrow$ Yotta

. . . .

. . . .

. . . .

. . . .

$\longrightarrow$ $\boxed{\text{Mid Question Must}}$

$10^{-24} \longrightarrow$ Yecto

* $E = \frac{1}{2} mv^2$

$= [ML^2T^{-2}]$

$E = mc^2$

$= [ML^2T^{-2}]$

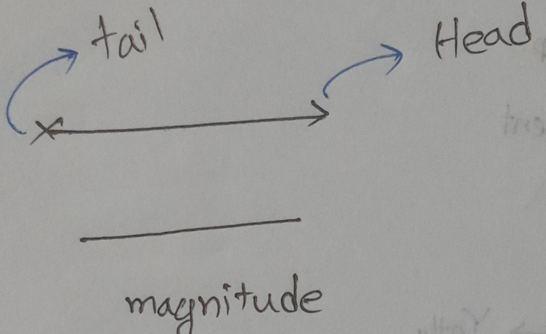
* Why current is not a vector?

$x = vt$ length

$= [LT^{-1} \cdot T]$

$= [L]$

Vector,

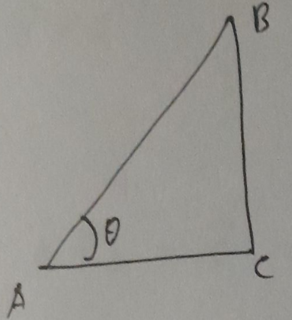


$\odot$ Coming toward me

$\otimes$ Going from me

|L-2 | 10.10.2022|

Pythagorian Theorem:



$AB^2 = BC^2 + AC^2$

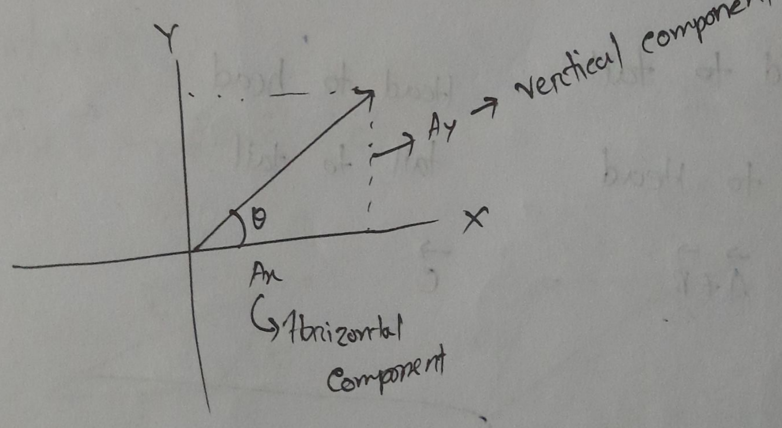
(i) Calculating unknown length

(ii) Checking Right Triangle

$$\cos\theta = \frac{AC}{AB}$$

$$\sin\theta = \frac{BC}{AB}$$

$$\tan\theta = \frac{BC}{AC}$$



$$\cos\theta = \frac{A_x}{A}$$

(i) $A_x = A\cos\theta$

(ii) $A_y = A\sin\theta$

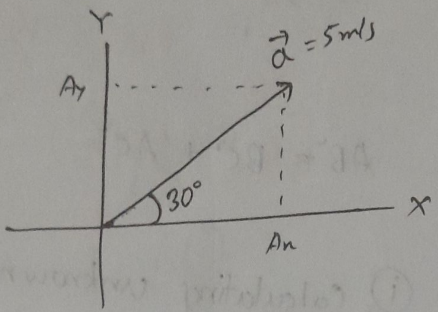
(iii) $\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$

$A_x^2 + A_y^2 = A^2$

$|A| = \sqrt{A_x^2 + A_y^2}$

$\tan\theta = \frac{A_y}{A_x}$

⊛

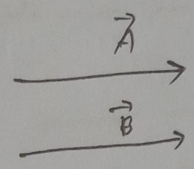


$$A_x = 5\cos\theta$$

$$A_y = 5\sin\theta$$

⊛

$\vec{A} = \vec{B}$

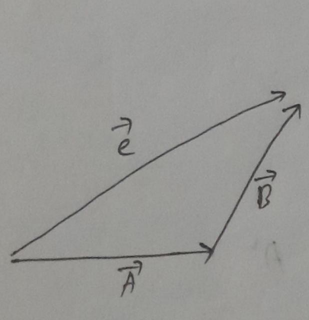


⊛

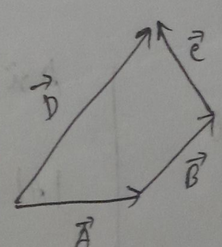
Head to tail — Head to head

tail to Head — tail to tail

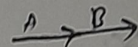
$$\vec{A} + \vec{B} = \vec{C}$$

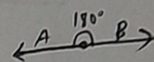


$$\vec{A} + \vec{B} + \vec{C} = \vec{D}$$



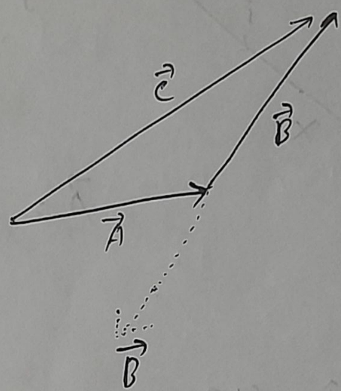
⊛ $\vec{A} = 5$, $\vec{B} = 6$, $\vec{C} = ?$

→ Maximum = 11 → 

→ Minimum = 1 → 

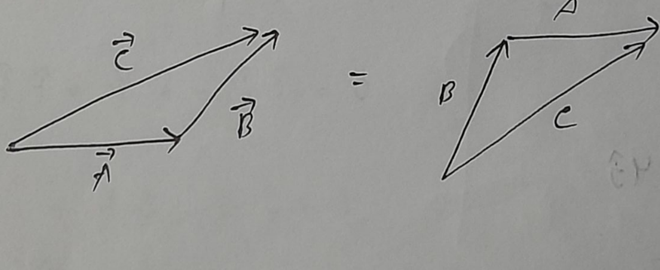
⊛ $\vec{A} - \vec{B} = \vec{C}$

$\vec{A} + (-\vec{B}) = \vec{C}$



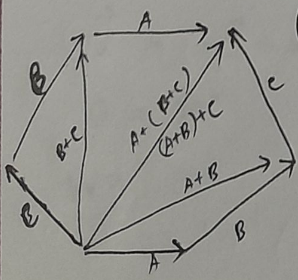
⊛ Commutative:

$\vec{A} + \vec{B} = \vec{B} + \vec{A} = \vec{C}$

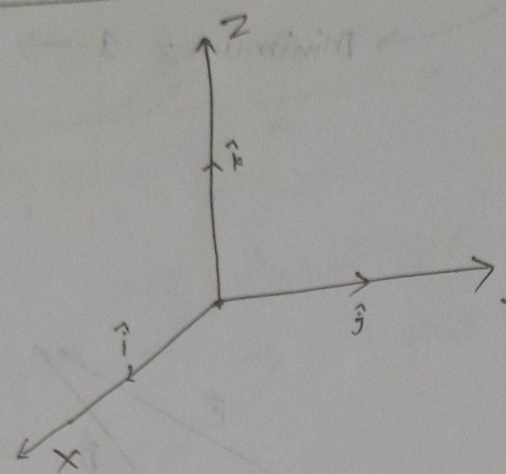


⊛ Associative Rule:

$(\bar{A} + \bar{B}) + C = \bar{A} + (\bar{B} + \bar{C})$

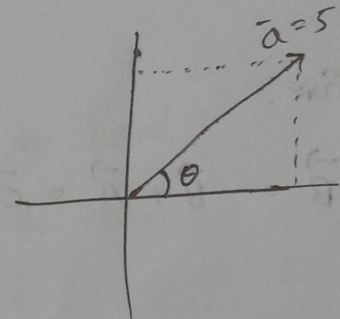


Unit vector



$$\vec{A} = A_x \cdot \hat{i} + A_y \cdot \hat{j}$$

$$\vec{A} = 3\hat{i} + 4\hat{j}$$



$$|\vec{A}| = \sqrt{3^2+4^2} = 5$$

$$\theta = \tan^{-1}\left(\frac{4}{3}\right) = 53.1^\circ$$

$$A = -3\hat{i} - 4\hat{j}$$

$$|\bar{A}| = \sqrt{3^2+4^2} = 5$$

$$\theta = \tan^{-1}\left(\frac{-4}{-3}\right) = 53.1^\circ + 180^\circ$$

L-3/12.10.2022

(*)

No relation with (A,B)

(i) $\bar{A}\cdot\bar{B} = C \longrightarrow \vec{F}\cdot\vec{d} = W \mid \vec{F}\cdot\vec{v} = P$

(ii) $\bar{A}\times\bar{B} = \vec{C} \longrightarrow \vec{r}\times\vec{F} = \vec{\tau}$

(*)

(i) $\bar{A}\cdot\bar{B} = |\bar{A}|\cdot|\bar{B}|\cdot\cos\theta$

$= A_x B_x + A_y B_y + A_z B_z$

$\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$\bar{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

(i) $\hat{i}\cdot\hat{j} = 1\cdot 1\cos 90^\circ = 0$

$\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$

(ii) $\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$

(*) $\vec{F} = 3\hat{i} + 3\hat{j} + \hat{k}$

$\vec{d} = -\hat{j} + 5\hat{k}$

$\theta = 30^\circ$

$W = ?$

$|F| = \sqrt{3^2+3^2+1^2} = \sqrt{19}$

$|d| = \sqrt{1+5^2} = \sqrt{26}$

$W = \sqrt{19}\cdot\sqrt{26}\cos 30^\circ$

$=$

$W = -3+5 = 2$

$$\boxed{\theta = \cos^{-1}\frac{|\bar{A}\cdot\bar{B}|}{|A|\cdot|B|}}$$

Cross Product

$$\bar{A} \times \bar{B} = |A|\,|B| \sin\theta$$

(i) $\hat{i} \times \hat{i} = 1 \times 1 \times \sin 0$

$= 0$

$\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0$

(ii) $\hat{i} \times \hat{j} = 1 \times 1 \times \sin 90$

$= 1\hat{k}$

$\hat{j} \times \hat{i} = -\hat{k}$

$$\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$\bar{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

$$\bar{A} \times \bar{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= \hat{i}(A_yB_z - A_zB_y) - \hat{j}(A_xB_z - A_zB_x) + \hat{k}(A_xB_y - A_yB_x)$$

$\vec{r} = \hat{i} + \hat{j} + 3\hat{k}$

$\vec{F} = 2\hat{i} + \hat{k}$

$\vec{\tau} = \vec{r} \times \vec{F}$

$$\boxed{\theta = \sin^{-1} \frac{|\vec{A} \times \vec{B}|}{|A|\,|B|}}$$

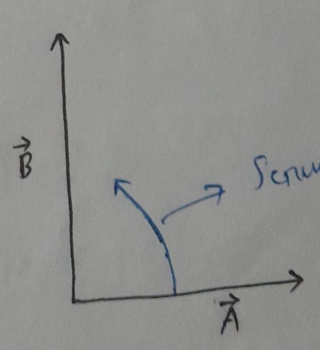
$$\vec{\tau} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 3 \\ 2 & 0 & 1 \end{vmatrix}$$

$$= \hat{i}(1-0) - \hat{j}(1-6) + \hat{k}(0-2)$$

$$= \hat{i} + 5\hat{j} - 2\hat{k}$$

$|\tau| = \sqrt{1+5^2+2^2} = \sqrt{30}$

$$\theta = \sin^{-1} \frac{\sqrt{30}}{\sqrt{11} \cdot \sqrt{5}}$$



Screw Rules
Anti Clock
Going outside

$\vec{A} \times \vec{B} = \odot \rightarrow$ Coming Toward me.

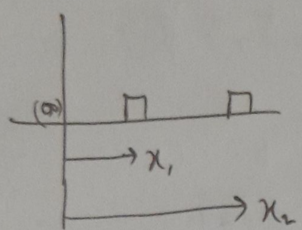
$\vec{B} \times \vec{A} = \otimes$

$$\begin{array}{ccccc} \vec{A} & \times & \vec{B} & = & \vec{C} \\ \downarrow & & \downarrow & & \downarrow \\ -Z & & \boxed{-X} & & Y \end{array}$$

$$\begin{array}{ccccc} \vec{C} & = & \vec{A} & \times & \vec{B} \\ \downarrow & & \downarrow & & \downarrow \\ -Z & & x & & \boxed{-Y} \end{array}$$

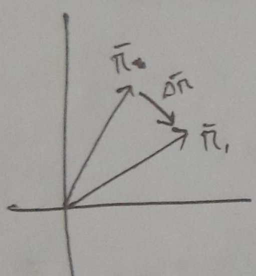
L-4 / 17. 10. 2022 /

kinetics
↳ kinema
↳ motion



$$\Delta \bar{x} = \bar{x}_2 - \bar{x}_1$$

$$\Delta t = t_2 - t_1$$



$$\bar{r} = x\hat{i} + y\hat{j} = 2\hat{i} + 3\hat{j}$$

$$\bar{r}_1 = x_1\hat{i} + y_1\hat{j} = 4\hat{i} + 5\hat{j}$$

$$\bar{r} + \Delta\bar{r} = \bar{r}_1$$

$$\Delta\bar{r} = \bar{r}_1 - \bar{r}$$

$$= (x_1\hat{i} + y_1\hat{j}) - (x\hat{i} + y\hat{j})$$

$$= (x_1 - x)\hat{i} + (y_1 - y)\hat{j}$$

$$= 2\hat{i} + 2\hat{j}$$

⊛ $x(t) = t^2 + 2t + 1$

$y(t) = t + 5$

$t = 5$ sec $\Rightarrow x(5) = 36$

$y(5) = 10$

$\vec{r} = x\hat{i} + y\hat{j}$

$= 36\hat{i} + 10\hat{j}$

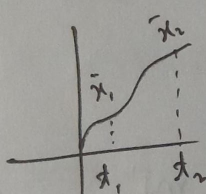
$|\vec{r}| = \sqrt{36^2 + 10^2}$

$\theta = \tan^{-1}\frac{y}{x} = \tan^{-1}\left(\frac{10}{36}\right) =$

$V_{avg} = \frac{\Delta \bar{x}}{\Delta t}$ m/s

$\Delta \bar{x} = \bar{x}_2 - \bar{x}_1$

⊛



$\Delta t = t_2 - t_1$

⊛ $x_1 = 2\hat{i} + 3\hat{j}$

$x_2 = 3\hat{i} + 4\hat{j}$

$t_1 = 5$ sec

$t_2 = 10$ sec

$\Delta \bar{x} = \hat{i} + \hat{j}$

$\Delta t = 10 - 5 = 5$

$V_{avg} = \frac{\Delta \bar{x}}{\Delta t} = \left(\frac{1}{5}\hat{i} + \frac{1}{5}\hat{j}\right) ms^{-1}$

$V = \lim_{\Delta t \to 0} \frac{\Delta \bar{x}}{\Delta t} = \frac{dx}{dt} = \dot{x}$ $\frac{d}{dt}$

$x(t) = t^2 + 2t + 1$

$\frac{dx}{dt} = 2t + 2$, $t = 2$ sec

$v = 2 \cdot 2 + 2 = 6 \ ms^{-1}$

$x(t) = t^2 + 2t + 5$

$y(t) = t + 10$

$t = 2$ sec

$v = ?$

$V_x = \frac{dx}{dt} = 2t + 2 = 6 \ ms^{-1}$

$V_y = \frac{dy}{dt} = 1 \ ms^{-1}$

$\vec{v} = V_x \hat{i} + V_y \hat{j}$

$= (6\hat{i} + \hat{j}) \ ms^{-1}$

$|\vec{v}| = \sqrt{6^2 + 1^2} \ ms^{-1}$

$= \sqrt{37} \ ms^{-1}$

$\theta = \tan^{-1}\left(\frac{1}{6}\right) =$

$V_{avg} = \frac{\Delta \bar{x}}{\Delta t} \ ms^{-1}$

$a_{avg} = \frac{\Delta \bar{v}}{\Delta t} \ ms^{-1}$

$a = \lim_{\Delta t \to 0} \frac{\Delta \bar{v}}{\Delta t} = \frac{d\bar{v}}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right)$

$= \frac{d^2x}{dt^2} = \ddot{x}$

$x(t) = t^2 + 2t + 5$

$y(t) = t^3 + 3t + 6$

$t = 2$ sec

$a = ?$

$v_x = \frac{dx}{dt} = 2t + t$

$a_x = 2 \; ms^{-2}$ ⟶ time independent

$v_y = 3t^2 + 3$

$a_y = 6t$ ⟶ time dependent

$= 12 \; ms^{-2}$

$\vec{a} = a_x\hat{i} + a_y\hat{j}$

$= (2\hat{i} + 12\hat{j}) \; ms^{-2}$

$|\vec{a}| = \sqrt{2^2 + 12^2} = \sqrt{148} \; ms^{-2}$

$v = v_0 + at$

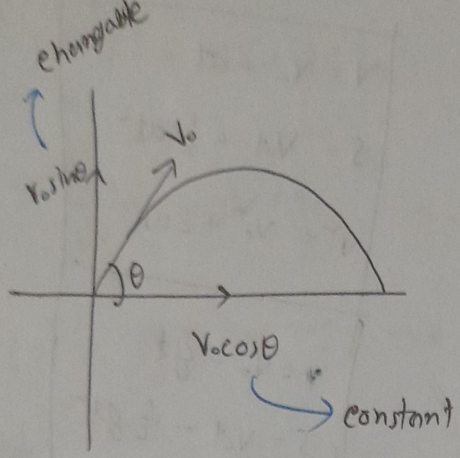
$s = v_0 t + \frac{1}{2} a t^2$

$v^2 = v_0^2 + 2as$

$v = v_0 - gt$

$s = v_0 t - \frac{1}{2} g t^2$

$v^2 = v_0^2 - 2gs$



$$s = v_0 t - \frac{1}{2} g t^2$$

Vertical

$$y - y_0 = (v_0 \sin\theta) t - \frac{1}{2} g t^2$$

$$y = (v_0 \sin\theta) t - \frac{1}{2} g t^2$$

$$y = v_0 \sin\theta \frac{x}{v_0 \cos\theta} - \frac{1}{2} g \left(\frac{x}{v_0 \cos\theta} \right)^2$$

$$y = x \underbrace{\tan\theta}_{a} - \underbrace{\frac{1}{2} g \frac{x^2}{v_0^2 \cos^2\theta}}_{b}$$

$$y = ax - bx^2$$

horizontal

$$x - x_0 = (v_0 \cos\theta) t$$

$$x = (v_0 \cos\theta) t$$

$$\boxed{t = \frac{x}{v_0 \cos\theta}}$$

$$t = \frac{R}{v_0 \cos\theta}$$

$y - y_0 = (v_0 \sin\theta)t - \frac{1}{2} g t^2$

$0 = v_0 \sin\theta \frac{R}{v_0 \cos\theta} - \frac{1}{2} g \left(\frac{R}{v_0 \cos\theta}\right)^2$

$R = \frac{2 v_0^2 \sin\theta \cos\theta}{g}$

$R = \frac{v_0^2 \sin 2\theta}{g}$

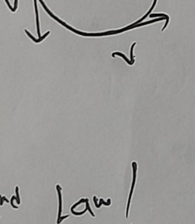
Earth

$v = 460 \ ms^{-1}$

$R = 6371 \times 1000 \ m$

$a = \frac{v^2}{R} = 0.03 \ ms^{-1} < 9.8$

Uniform circular Motion



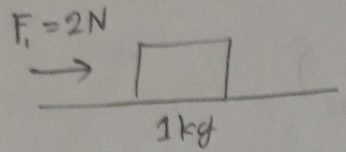
$|\vec{v}| = 10 \ ms^{-1}$

$a = \frac{v^2}{R}$

Nuton 2nd Law / $F = ma$

L-6/24.10.2022/

⊛



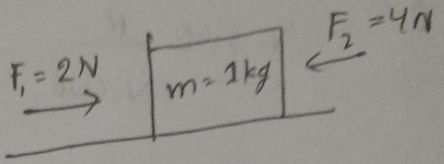
$\bar{F}_{net} = m\bar{a}$

$F_1 = ma$

$a = \frac{F_1}{m} = 2ms^{-2}$

$\longrightarrow$ x axis

⊛



$\bar{F}_{net} = m\bar{a}$

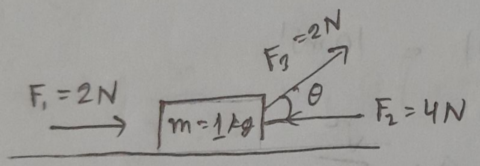
$F_1 - F_2 = m\bar{a}$

$2-4 = ma$

$a = \frac{2-4}{1} = -2\ ms^{-2}$

$\longrightarrow$ -x axis

⊛



$\bar{F}_{net} = m\bar{a}$

$F_1 - F_2 + F_3\cos\theta = ma$

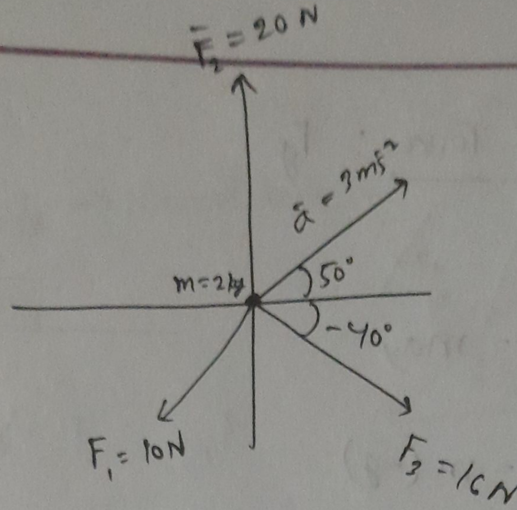
$a = \frac{F_1 - F_2 + F_3\cos\theta}{m}$

$= \frac{2 - 4 + 2\cos 30^\circ}{1}\ ms^{-2}$

$= -0.267\ ms^{-2}$

$\longrightarrow$ -x axis

X



$F_3 = ?$

$$\bar{F}_{net} = m\bar{a}$$

$$\bar{F}_1 + \bar{F}_2 + \bar{F}_3 = m\bar{a}$$

$$\bar{F}_3 = m\bar{a} - \bar{F}_1 - \bar{F}_2$$

<u>x- component:</u>

$$F_{3x} = ma_x - F_{1x} - F_{2x}$$

$$= ma\cos 50° - F_1\cos 210° - F_2\cos 90°$$

$$= 12.5\,N$$

<u>Y- component:</u>

$$F_{3y} = ma_y - F_{1y} - F_{2y}$$

$$= ma\sin 50° - F_1\sin 210° - F_2\sin 90°$$

$$= -10.4\,N$$

$$\therefore F_3 = 12.5\,\hat{i} - 10.4\,\hat{j}$$

$$F_3 = \sqrt{(12.5)^2 + (10.4)^2}$$

$$= 16N$$

$$\theta = \tan^{-1}\left(\frac{F_1}{F_2}\right)$$

$$= -40$$

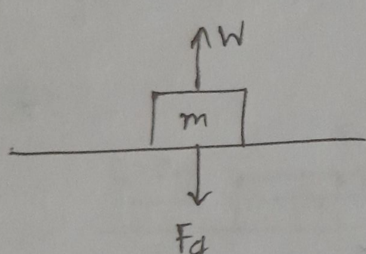
⊗ Gravitational Force : F_g

$$F_{net\,y} = m a_y$$

$$-F_g = m(-g)$$

$$\boxed{F_g = mg}$$

Weight:



$$\vec{F}_{net} = m\overset{0}{\vec{a}} = 0$$

$$\vec{W} - \vec{F}_g = 0$$

$$\vec{W} = \vec{F}_g = m\vec{g}$$

$$\boxed{W = mg}$$

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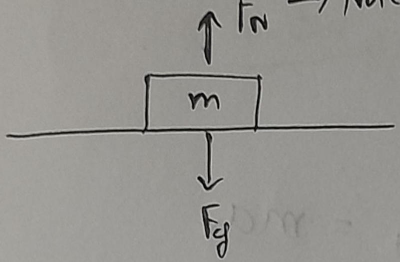
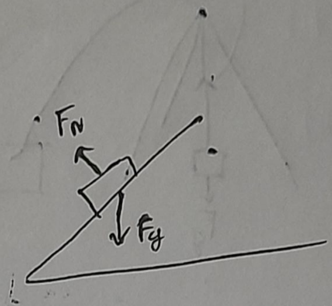
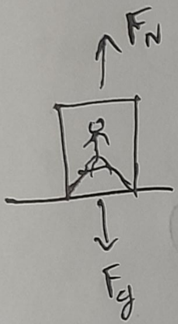
$F_N \rightarrow$ Normal Force







$F_{net} = ma_y$

$F_N - F_g = ma_y$

$F_N = F_g + ma_y$

$\boxed{F_N = m(g + a_y)} \rightarrow$ For moving

For Free Fall

$F_N = m(g - g)$

$= 0$

For stationary,

$a_y = 0$

$F_N = F_g = mg$

a_y = positive

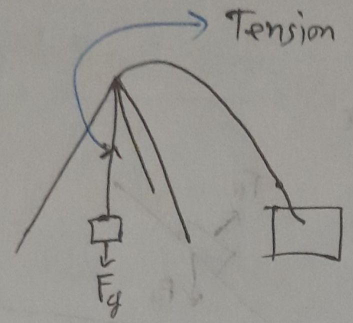
$\uparrow \Rightarrow F_N = m(9.8 + 2)$

$F_N > F_g$

$\downarrow \Rightarrow F_N = m(9.8 - a_y)$;

a_y = -ve

$F_N < F_g$



$F_{net} = ma_y$

$T - F_g = ma_y$

$T = F_g + ma_y$

$T = m(g + a_y)$

① Stationary:

$T = m(g + a_y)$

$T = F_g = mg$

ⅱ $\downarrow a_y = 1\ ms^{-2}$

$T = m(g - 1)$

$T < F_g$

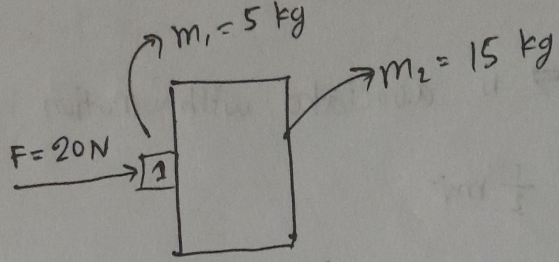
ⅲ $\uparrow a_y = 1\ ms^{-2}$

$T = m(g + 1)$

$T > F_g$

※ For nuton's third law, we need at least two object.

✻



$F_{net} = ma$

$20 = (m_1 + m_2)a$

$20 = (5+15)a$

$20 = 20a$

$a = 1\ ms^{-2}$

$\rightarrow +x$ axis

$\vec{F}_{12} = ?$

$F_{net} = ma$

$F_{12} = 15 \times 1$

$F_{12} = 15\ N$

$\vec{F}_{21} = ma$

$= 5 \times 1$

$= 5\ N?$

$F_{21} = ma$

$F - F_{21} = ma$

$F_{21} = F - ma$

$= 20 - 5 \times 1$

$= 15\ N$

$$\boxed{\therefore F_{12} = F_{21}}$$

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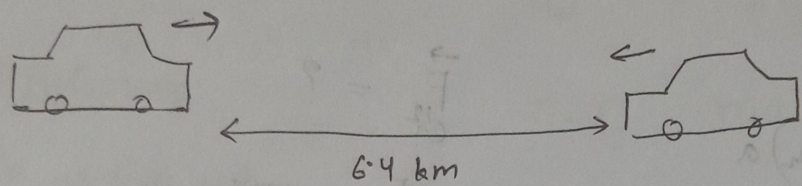
KE ⇒ is associated with motion

$KE = \frac{1}{2}mv^2$



$KE = \frac{1}{2}mv^2$

$W = 1.2 \times 10^6 N$

$a = 0.26 ms^{-2}$

$m = \frac{W}{g} = 1.22 \times 10^5 kg$

$v^2 = v_0^2 + 2as$

$= 0 + 2 \times 0.26 \times 3.2 \times 10^3 m$

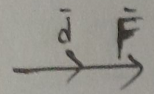
$v = 40.8 ms^{-1}$

For two car

$KE = 2 \times \frac{1}{2}mv^2$

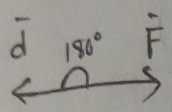
$= mv^2 = 2 \times 10^8 J$

⊛ Energy transfer by a force, then there will be work done.



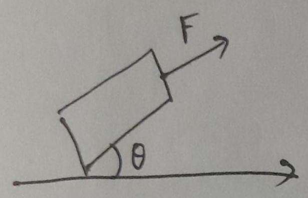
$W = \bar{F} \cdot \bar{d}$

$W \rightarrow +ve$



$W = Fd\cos 80°$

$= -ve$



$t_1 = 35$

$t_2 = 29$

$\Delta t = t_2 - t_1$

$= 29 - 36$

$= -6\ C. \rightarrow$ Losing energy

$F_x = m a_x$

$v^2 = v_0^2 + 2ad$

$a_x = \frac{v^2 - v_0^2}{2d}$

$F_x = m\left(\frac{v^2 - v_0^2}{2d}\right)$

$F_x d = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2 = k_f - k_i = \Delta k$

$Fd\cos\theta = \Delta k$

$W = \bar{F} \cdot \bar{d} = \Delta k$

if, $k_f < k_i$

$W \rightarrow -ve$

$$\boxed{W = \bar{F} \cdot \bar{d} = k_f - k_i = \Delta k}$$

(i) $v_i = 3\ ms^{-1}$

$v_f = -2\ ms^{-1}$

$\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = W$

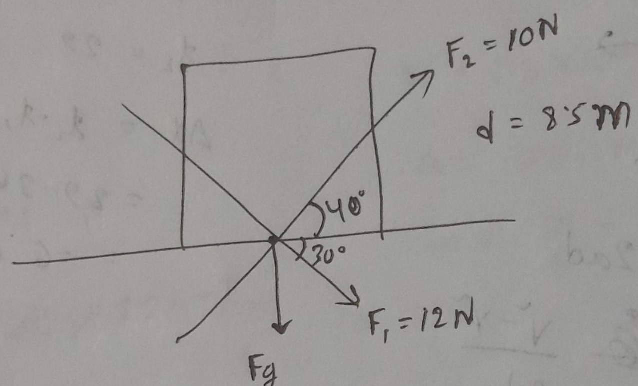
$\frac{1}{2}m(4-9) = -W$

(ii) $v_i = -2\ ms^{-1}$

$v_f = 2\ ms^{-1}$

$\frac{1}{2}m(2^2-2^2)$

$= 0$



$W = \bar{F}\cdot\bar{d}$

$W_1 = \bar{F_1}\cdot\bar{d}$

$= F_1 d \cos 30°$

$= 12 \times 8.5 \times \cos 30°$

$= 88.3\ j$

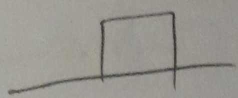
$W_2 = \bar{F_2}\cdot\bar{d}$

$= F_2 d \cos 40$

$= 65.12\ j$

$W = W_1 + W_2$

$= 153.4\ j$



$$\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$$

$\vec{d} = -3m\hat{i}$

$\vec{F} = 2N\hat{i} - 6N\hat{j}$

$k_i = 10j$

$W = -6j$

$k_f = ?$

$W = k_f - k_i$

$k_f = W + k_i$

$W = \vec{F}\cdot\vec{d}$

$= -6 + 10$

$\therefore k_f = 4j$

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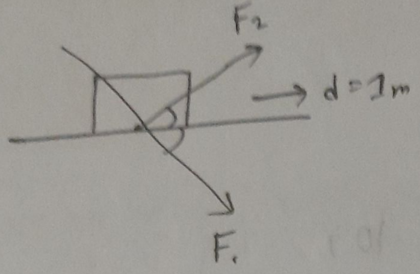
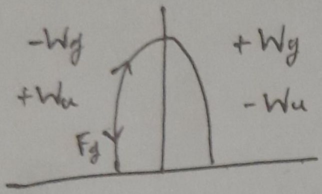
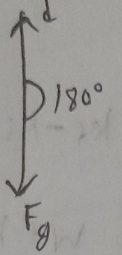
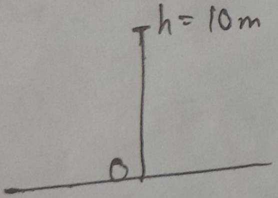




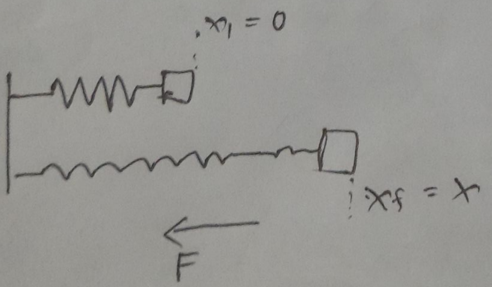


$$\uparrow W_g = \bar{F_g} \cdot \bar{d}$$
$$= F_g \, d \cos 180$$
$$= -mgd$$
$$\uparrow W_g = -mgh$$

$$\downarrow W_g = \bar{F_g} \cdot \bar{d}$$
$$= F_g d \cos 0°$$
$$\downarrow W_g = mgh$$



$$W_g = -mgh$$
$$= -0.1 \times 9.8 \times 10$$
$$= -9.8 \, j$$

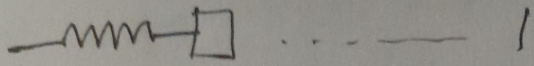


$F \propto -x$

$F = -kx$ → Spring Constant

$$k = \frac{F}{x} = \frac{N}{m} = Nm^{-1}$$

$x_i = 0$



$$\int dw = \int_{x_i}^{x_f} \vec{F} \cdot \vec{dx} = \int_{x_i}^{x_f} -F\,dx = -\int_{x_i}^{x_f} kx\,dx$$

$$= -k \int_{x_i}^{x_f} x\,dx$$

$$\boxed{\begin{aligned} \uparrow W_g &= -mgh \\ W_s &= -\tfrac{1}{2}kx^2 \end{aligned}}$$

$$= -k \left[\frac{x^2}{2}\right]_{x_i}^{x_f}$$

$$= -k \left[\frac{x_f^2}{2} - \frac{x_i^2}{2}\right]$$

$$= -k \frac{x_f^2}{2}$$

$$\boxed{W = -\frac{1}{2}kx}$$

$$= -\frac{1}{2}kx_f^2$$

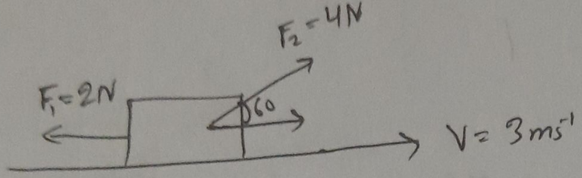
$$P = \frac{W}{t} = \frac{J}{sec} = \text{watt}$$

$$P = \frac{dw}{dt} = \frac{\vec{F} \cdot d\vec{x}}{dt} = \frac{F\,dx\cos\theta}{dt}$$

$$= F\cos\theta \frac{dx}{dt}$$

$$= F\cos\theta\, V$$

$$P = \vec{F} \cdot \vec{V}$$



$P_1 = \bar{F_1} \cdot \bar{V} = F \cdot V \cos 180$

$= 2 \cdot 3 \cdot (-1) = -6 W$

System is loosing energy per unit second

$P_2 = \bar{F_2} \cdot \bar{V} = F \cdot V \cos 60$

$= 4 \cdot 3 \cdot \frac{1}{2}$

$= 6 W$

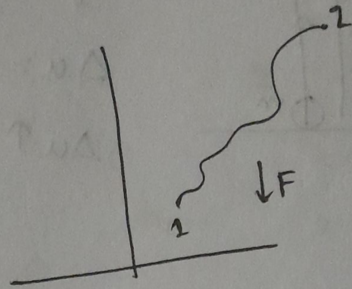
$P = P_1 + P_2 = -6 + 6 = 0 W$

L-10 / 07.11.2022 /

$\Delta U = -W$ → Potential energy

$W = \Delta k$

$E = k + U$ → Mechanical Energy



$W = \int_1^2 dW$

$= \int_1^2 \vec{F} \cdot d\vec{y}$

$= \int_1^2 F\,dy \cos 180$

$= -\int_1^2 F\,dy$

$= -mg \int_1^2 dy$

$= -mgh$

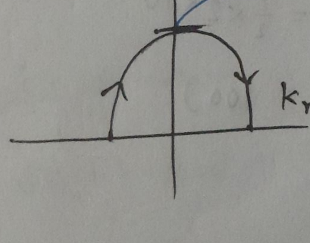
$= -mg[y_2 - y_1]$

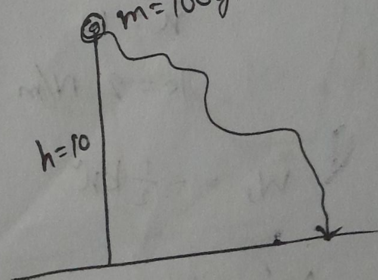
$W = -mg[y_2 - y_1] = \Delta k = k_2 - k_1$

$k_1 + mgy_1 = k_2 + mgy_2$

$$\boxed{k_1 + U_1 = k_2 + U_2}$$

$$\boxed{E_1 = E_2}$$

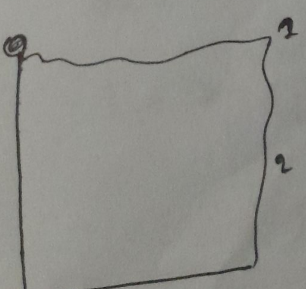




$W_g = mgh$

$= 0.1 \times 9.8 \times 10$

$= 9.8\,J$

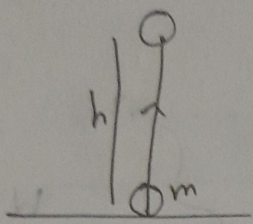


$W_{g_1} = \vec{F} \cdot \vec{d} = F \cdot d \cos 90° = 0$

$W_{g_2} = \vec{F} \cdot \vec{d} = F_g d \cos 0° = 9.8\,J$

$\therefore W_g = W_{g_1} + W_{g_2} = 9.8\,J$

⊛

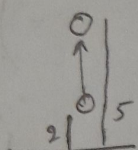


$W_g = mgh$

$\Delta u = -W$

$\Delta u \uparrow = -(-mgh)$

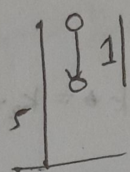
$= mgh$



$u = mgh$

$= 0.5 \times 9.8 \times 3$

$= \ldots$

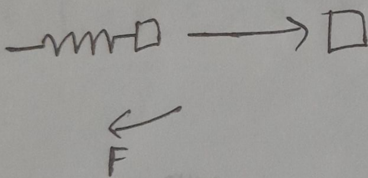


$u = -mgh$

$= -0.5 \times 9.8 \times 1$

$= -4.7 j$

⊛



$x = 10$

$k = 2 \ N/m$

$W_s = -\frac{1}{2} k x^2$

$\Delta u = -W$

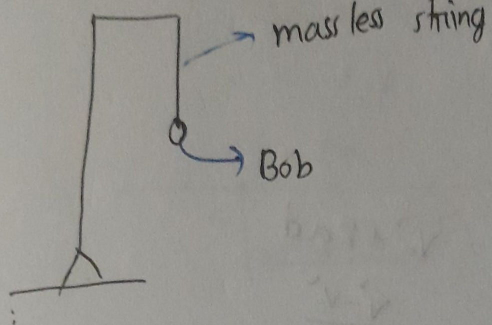
$= -(-\frac{1}{2} k x^2)$

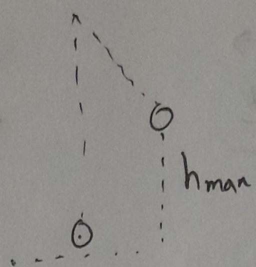
$\Delta u = \frac{1}{2} k x^2$

$u = \frac{1}{2} k x^2$

$= \frac{1}{2} \times 2 \times 10^2$

$= 100 j$

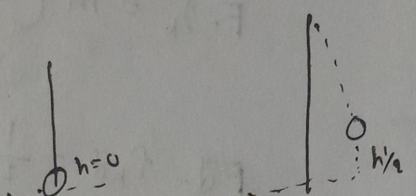




$E = U + K = 5$ jul

$K = 0$

$U = max = 5$



$K = U = 5$ jul

$K = max = 5$

$U = 0$

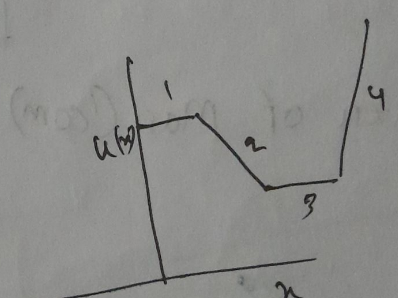
calculate 'v'

$E = K = \frac{1}{2}mv^2$

$E = 5\,J$

$m = 100\,g$

$E = K = \frac{1}{2}mv^2$



$\Delta U = -W$

$dU = -dW$

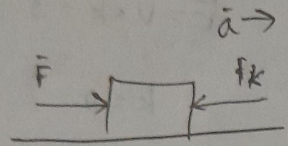
$dU = -F\,dx$

$F = \boxed{-\frac{dU}{dx}}$

Slope

$F_4 > F_2 > F_1 = F_3$

$E_{mec} = U + k$



$v^2 = v_0^2 + 2ad$

$a = \dfrac{v^2 - v_0^2}{2d}$

$F_{net} = ma$

$F - f_k = ma$

$F - f_k = m\left(\dfrac{v^2 - v_0^2}{2d}\right)$

$Fd - f_k d = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$

$Fd - f_k d = E_{mec}$

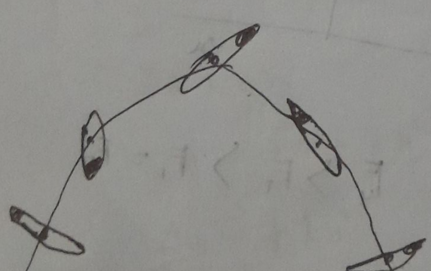
$E_{mec} \to U + k$ max

$U \to 0$

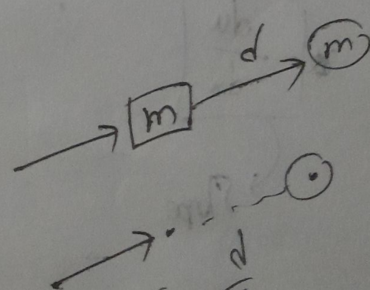
$Fd = f_k d + E_{mec}$

$$\boxed{E = E_{th} + E_{mec} + E_{int}}$$

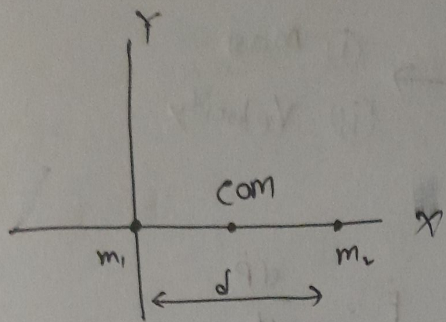
(*) Center of Mass (com)



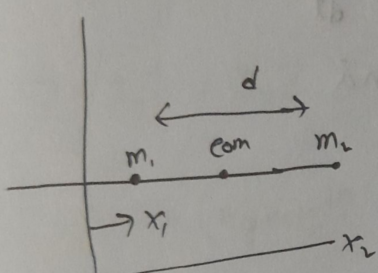
$\bar{v}\bar{a}$



$\bar{v} = \dfrac{d}{a}$



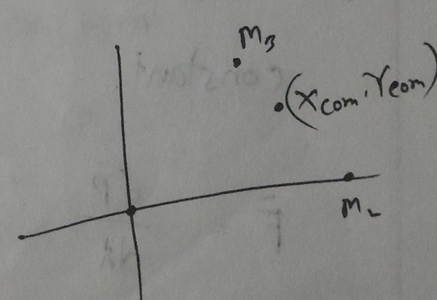
$$X_{com} = \frac{m_2 d}{m_1 + m_2}$$



$$X_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$$\sum X_{com} = \frac{1}{M} \sum_{i=1}^{i=n} m_i x_i$$

Particle	Mass	X_{com}	Y_{com}
1	1.2	0	0
2	2.5	140	0
3	3.4	70	12



$$X_{com} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3} = \frac{0 + 2.5 \times 140 + 3.5 \times 70}{1.2 + 2.5 + 3.5} = 83 \text{ cm}$$

$$Y_{com} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3}{m_1 + m_2 + m_3} = \frac{0 + 0 + 3.5 \times 120}{1.2 + 2.5 + 3.5} = 58 \text{ cm}$$

$\therefore$ COM $= (83, 58)$

Linear momentum, $p \rightarrow$ (i) Mass
(ii) Velocity

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

$$\bar{F} = \frac{d\bar{p}}{dt}$$

Force

$$F = \boxed{\frac{d\bar{p}}{dt}} \rightarrow \text{Slope}$$

$$= \frac{d(m\bar{v})}{dt}$$

$$= m\frac{d\bar{v}}{dt}$$

$$F_{net} = 0$$

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

$$\boxed{\frac{d\bar{p}}{dt} = 0}$$

$\rightarrow$ $p =$ constant

$$p_i = p_f$$

$\therefore$ if there is no net force, the momentum will be constant.

$$\bar{F} = \frac{d\bar{p}}{dt}$$

$$\int_{p_i}^{p_f} d\bar{p} = \int_{p_i}^{p_f} \bar{F}\, dt$$

$$d\bar{p} = \bar{F}\, dt$$

Linear momentum impulse theorem

$$\boxed{\Delta p = \bar{J}}$$

impulse

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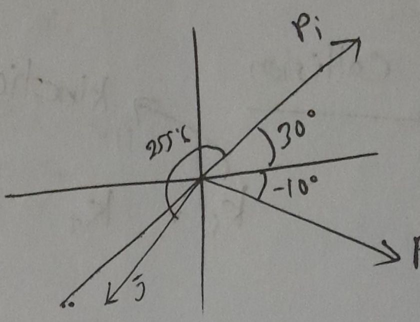
impulse

$$\vec{J} = \int_{t_i}^{t_f} \vec{F} \cdot dt$$

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

$$\bar{P}_f - \bar{P}_i = \bar{J}$$



$m = 80\ kg$

$v_i = 70\ ms^{-1}$

$v_f = 50\ ms^{-1}$

$$\bar{J} = J_x \hat{i} + J_y \hat{j}$$

$$= -910\ (kgms^{-1})\hat{i} - 3500 (kgms^{-1})\hat{j}$$

$$J_x = P_{fx} - P_{ix}$$

$$= mv_{fx} - mv_{ix}$$

$$= mv_f \cos(-10) - mv_i \cos 30°$$

$$= -910\ kgms^{-1}$$

$$|\bar{J}| = \sqrt{J_x^2 + J_y^2}$$

$$= 3600\ kgms^{-1}$$

$$\theta = \tan^{-1}\left(\frac{J_y}{J_x}\right)$$

$$= 75.6°$$

$$\theta = 180° + 75.6$$

$$= 255.6°$$

$$J_y = P_{fy} - P_{iy}$$

$$= mv_{fy} - mv_{iy}$$

$$= mv_f \sin(-10) - mv_i \sin 30$$

$$= -3500\ kgms^{-1}$$

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

$\Delta t = 16\ ms$

$$\therefore F_{avg} = \frac{J}{\Delta t}$$