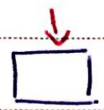
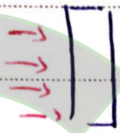
* Chapter (1) :

- construoud force — القوة التي تؤثر على الجسم

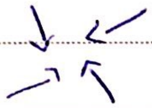


- distributed force

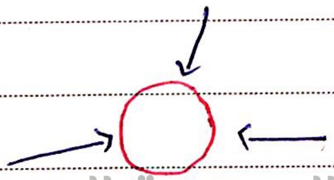


القوة التي تتوزع على الجسم كامل
مثل قوة الرياح

- partical — القوة التي تؤثر بالجسم وتلتقي بنقطة واحدة
لها (mass) وليس لها dimention



- Rigid body — القوة التي تؤثر بالجسم ولا تلتقي في نقطة واحدة
لها mass & dimention



* The international system of units ISU.

Length — mm, M

mass — Kg : 1000 g

time — sec

wight → mg → mass * 9.8

$Kg * \frac{m}{s^2} = n$

NO.

* force = n = m a

* pressure $= \frac{\text{force}}{\text{area}} = \frac{N}{m^2}$ باسكال (pa)

G => 10^9

M => 10^6

K => 10^3

n => 10^{-9}

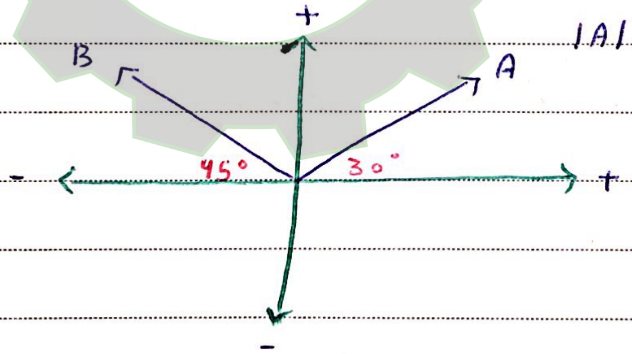
Micro => 10^{-6}

Mili => 10^{-3}

[1000 N
10 k N]

* force vector :
scaler : magnitude
vector : magnitude + direction

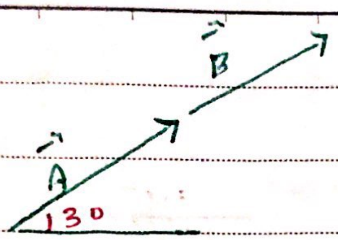
|A| = 50 N



* A → direction => 30 c.c.w the x-axis or 30° ∠30

* B → direction
45° c.w the x-axis or 45°

* vector apporation :
Addition of vector = Resultant



$\vec{A} = 30N$

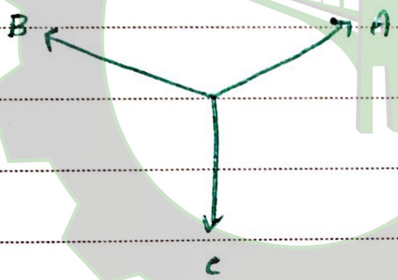
$\vec{B} = 40N$

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

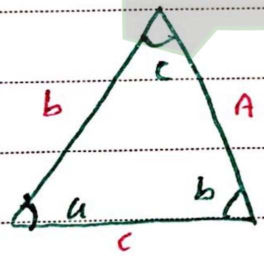
$\vec{C} = 30 + 40 = 70^{\circ} N$

$|C| = 70 N$, direction 30°

✓ ملاحظة !!! عند معرفة الزاوية يجب ان يكون راس الاول على ذيل الثاني



concurent vector coplanner (في بعدين)



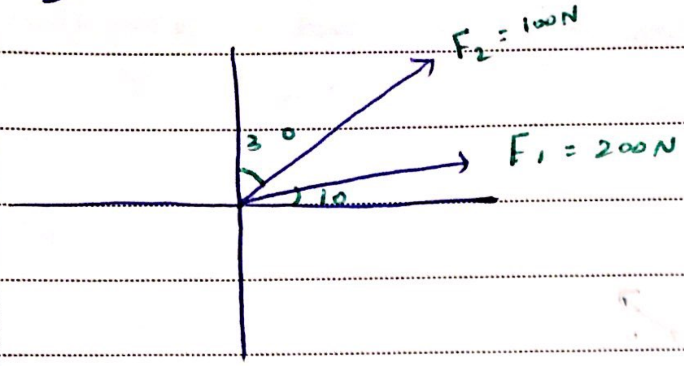
$\hat{a} + \hat{b} + \hat{c} = 180^{\circ}$

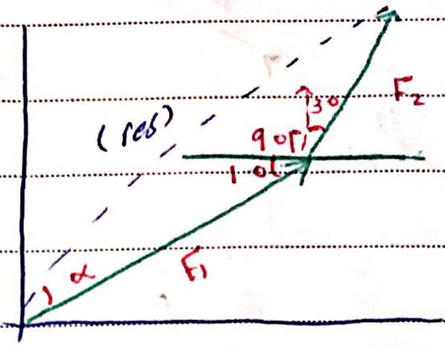
sin law :- $\dfrac{A}{\sin a} = \dfrac{B}{\sin B} = \dfrac{C}{\sin C}$

cos law :- $C = \sqrt{a^2 + b^2 - 2AB\cos c}$

NO.

* eg (2.1)





cos law :-

$$res = \sqrt{(200)^2 + (100)^2 - 2(100)(200)\cos 130}$$
$$= \sqrt{75.71}$$
$$= 8.7N$$

sin law =

$$\frac{100}{\sin\alpha} = \frac{8.7}{\sin 130}$$

$\alpha = 45.3^\circ$

$\theta = 10 + 45.3^\circ$

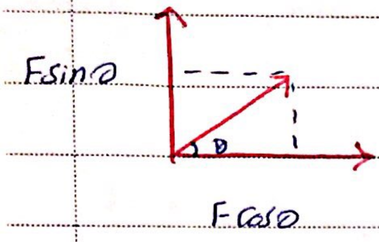
$= 55.3^\circ$

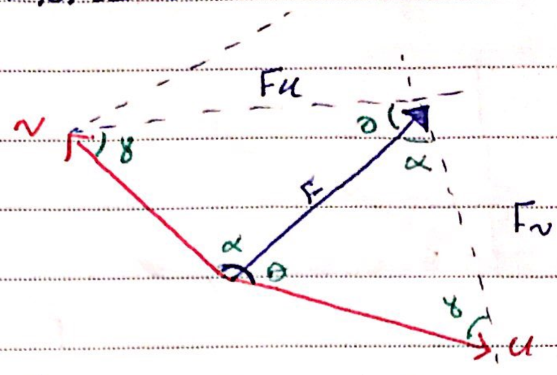
$|res| = 8.7N$

direction: 55.3°

NO. 5/2/2018

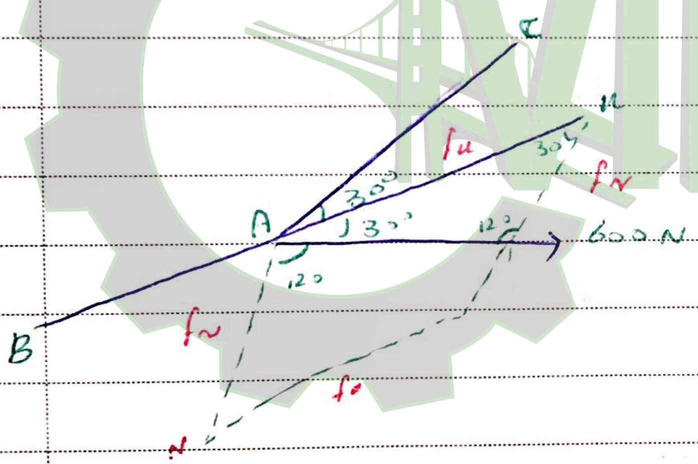
=> Find the component of a force :-





$$\frac{F}{\sin\gamma} = \frac{F_v}{\sin\theta} = \frac{F_u}{\sin\alpha}$$

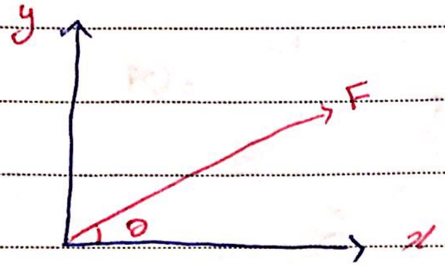
=> find the components along x-axis :-



① $\frac{600}{\sin 30} = \frac{f_u}{\sin 120}$ ∴ $f_u = 1039$

② $\frac{600}{\sin 30} = \frac{f_v}{\sin 30}$ ∴ $f_v = 600$

(2.4) Addition of vector coresian:



$F_x = F\cos\theta$

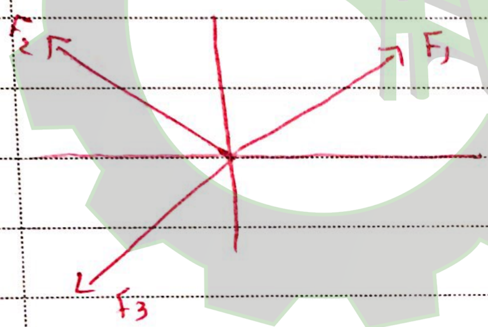
$F_y = F\sin\theta$

$\vec{F} = F_x\hat{i} + F_y\hat{j}$ ⇒ cortesion notation

$|F| = \sqrt{(F_x)^2 + (F_y)^2}$ ⇒ magnitude

$\tan\theta = \dfrac{dy}{dx}$ ⇒ direction

* Resultant force:

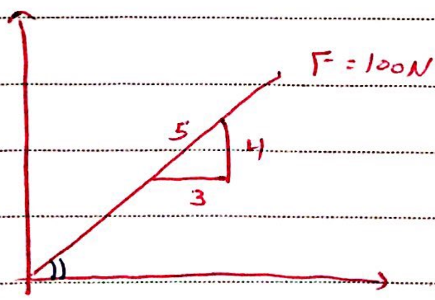


$\vec{F_R} = \Sigma F_x\hat{i} + \Sigma F_y\hat{j}$

$|F_R| = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$\tan\theta = \dfrac{\Sigma F_y}{\Sigma F_x}$

$\vec{F} = \underbrace{100\sin 20\,\hat{i}}_{F_x} + \underbrace{100\cos 20\,\hat{j}}_{F_y}$



$f_x = 100\cos 3/5\ \hat{i}$

$f_y = 100\sin 4/5\ \hat{j}$

$f_x = 100 \times 3/5 = 60$

$f_y = 100 \times 4/5 = 80$

* $\bar{F} = 100\hat{i} + 200\hat{j} + 50\hat{k}$. Find the unit vector F

$$|F| = \sqrt{100^2 + 200^2 + 50^2} = 229.1\,N$$

$$\frac{|F|}{F} = u = \frac{100\hat{i} + 200\hat{j} + 50\hat{k}}{229.1} = 0.3\hat{i} + 0.87\hat{j} + 0.21\hat{K}$$

$\cos\alpha = 0.3$, $\cos\beta = 0.87$, $\cos\gamma = 0.21$

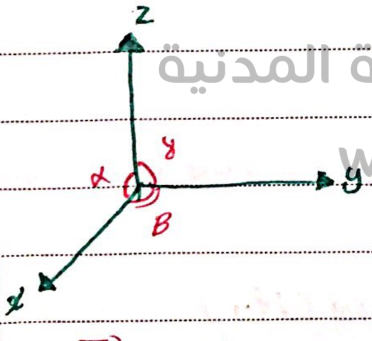
$\bar{u}$ = unit vector $|u| = 1$ نفس اتجاه F ومقداره 1

$$u = \cos\alpha\,\hat{i} + \cos\beta\,\hat{j} + \cos\gamma\,\hat{k}$$

$$\frac{\bar{F}}{F} = \frac{F\cos\alpha\,\hat{i} + F\cos\beta\,\hat{j} + F\cos\gamma\,\hat{k}}{F}$$

$$|u| = \sqrt{\cos^2\alpha + \cos^2\beta + \cos^2\gamma} = 1$$

3D (2.5)



$\alpha, \gamma, \beta \Rightarrow$ Direction angels

$F_x = F\cos\alpha$

$F_y = F\cos\beta$

$F_z = F\cos\gamma$

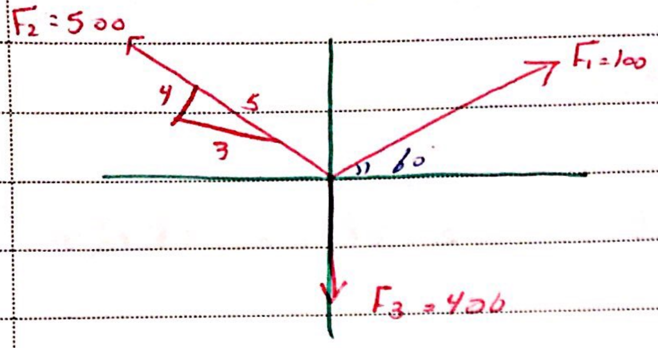
$$\vec{F} = F_x\,\hat{i} + F_y\,\hat{j} + F_z\,\hat{k} = F\cos\alpha\,\hat{i} + F\cos\beta\,\hat{j} + F\cos\gamma\,\hat{k}$$

$$|\vec{F}| = \sqrt{F_x^2 + F_y^2 + F_z^2}$$

Direction

$$\cos\alpha = \frac{F_x}{F} , \quad \cos\beta = \frac{F_y}{F} , \quad \cos\gamma = \frac{F_z}{F}$$

Find the components of force



$\Sigma F_x = 100\cos 60 - 500 \times \frac{3}{5} + 0$

$= -250$

$\Sigma F_y = 100\sin 60 + 500 \times \frac{4}{5} - 400$

$= 86.6 \uparrow$

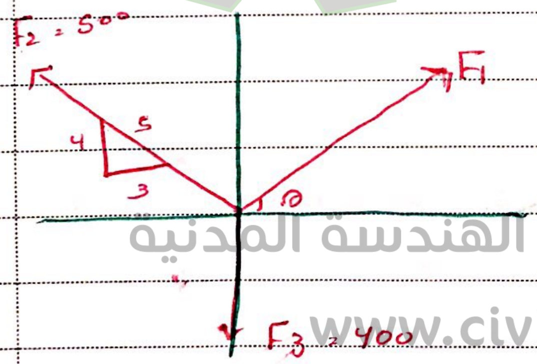
$\therefore F_R = -250\,\hat{i} + 86.6\,\hat{j}$

$|\vec{F_R}| = \sqrt{(250)^2 + (86.6)^2} = 264.5$

$\theta = \tan^{-1}\left(\frac{y}{x}\right) = \tan^{-1}\left(\frac{86.6}{250}\right) = 19.1$

$\theta = 180 - 19.1 = 160.9$

Find the θ and F_1 if the Resultant $= 264.5$ has direction 19.1 clock wise from the $(-)$ x-axis



$F\cos\theta = -249.9 + 300$

$\Sigma F_x = F\cos\theta - 500 \times 3/5 + 0 = -264.5 \times \cos(19.1)$

$\Sigma F_y = F\sin\theta + 500 \times \frac{4}{5} - 400 = 264.5 \times \sin(19.1)$

86.5

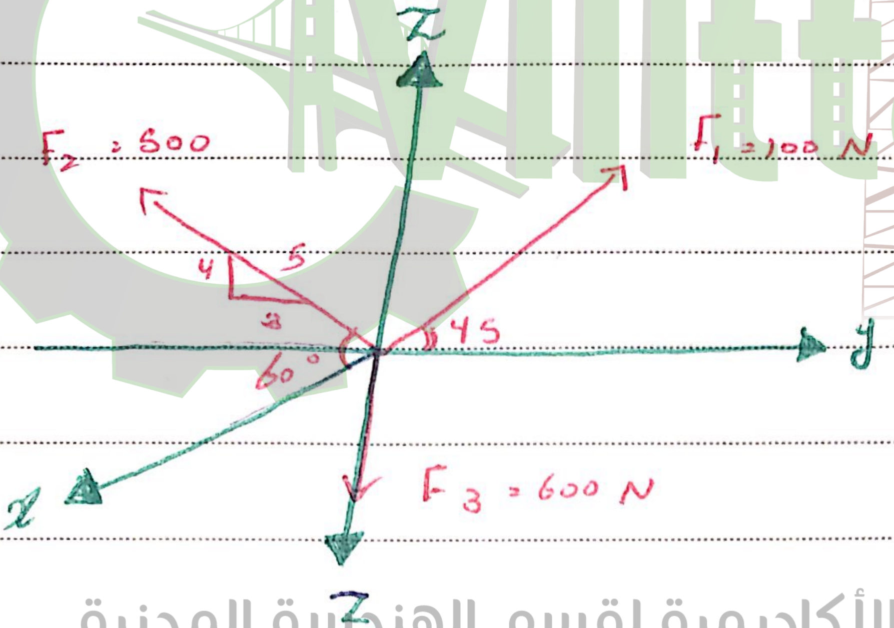
$\cancel{19.1} = \frac{\sin\theta}{\cos\theta} \Rightarrow \frac{86.5}{50} \Rightarrow \tan\theta = 1.73$

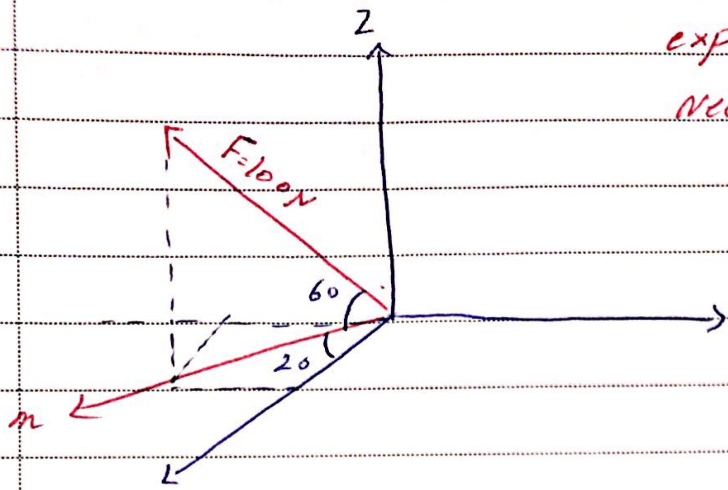
$\theta = 59.90$

$F\cos 60 = 50$

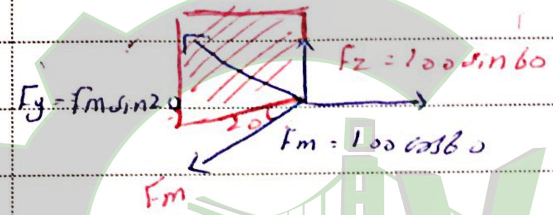
$F = 100\,N$

2.5 => Cartesian Vector (3-10)

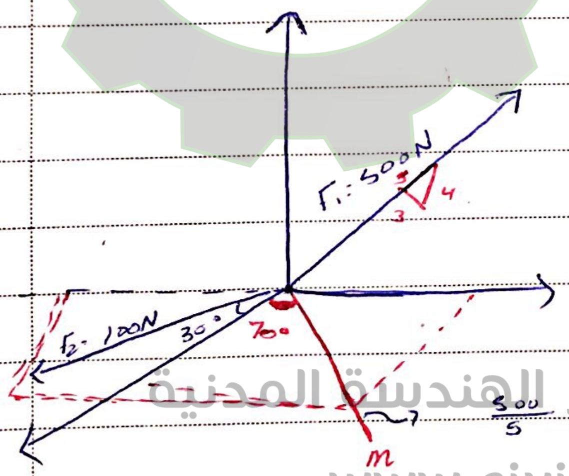




express force as a cartisian vector



$F = 100\cos 60 \cos 30\, \hat{i} - 100 \cos 60 \sin 20\, \hat{j} + 100 \sin 60\, \hat{k}$



=> Find the Resultant

$\bar{F}_1 = 300\cos 70\, \hat{i} + 300 \sin 70\, \hat{j} + \frac{500}{5} \times 4\hat{k}$ ($\frac{500}{5} \times 3$)

$F_2 = 100\cos 30\, \hat{i} - 100 \sin 30\, \hat{j} + 0\hat{k}$

$\frac{500}{5} \times 3$

$F_R = 189.2\hat{i} + 231.9\hat{j} + 400\hat{k}$

$|F_R| = \sqrt{189.2^2 + 231.9^2 + 400^2}$

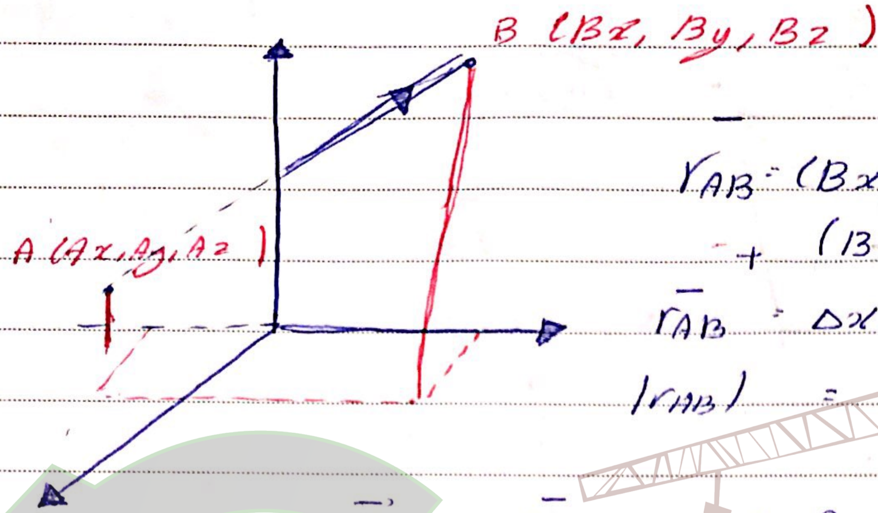
$= 499.5\ N$

=> Direction

$\cos\alpha = \frac{189.2}{499.5}$, $\cos\beta = \frac{231.9}{499.5}$

$\cos\gamma = \frac{400}{499.5}$

2-7 => position vector



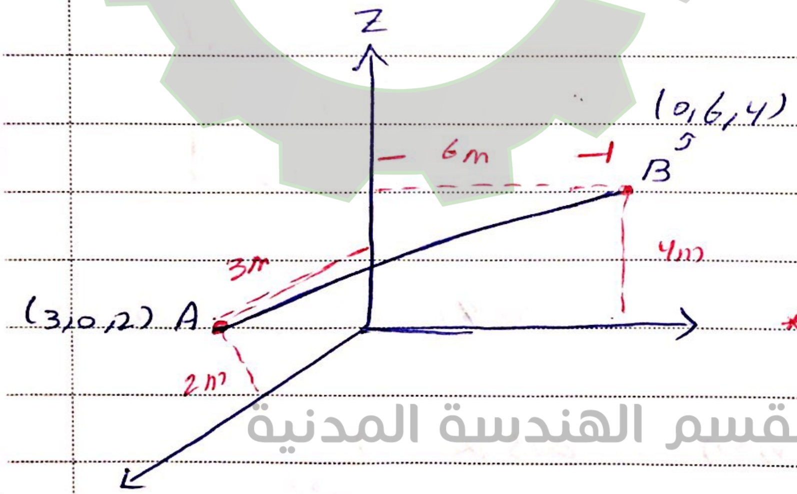
$$\bar{r}_{AB} = (B_x - A_x) + (B_y - A_y) + (B_z - A_z)$$

$$\bar{r}_{AB} = \Delta x \hat{i} + \Delta y \hat{j} + \Delta z k$$

$$|r_{AB}| = \sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}$$

$$\bar{u}_{AB} = \frac{\bar{r}_{AB}}{|r_{AB}|} = \frac{\Delta x \hat{i} + \Delta y \hat{j} + \Delta z K}{|r_{AB}|}$$

$$= \cos\alpha \hat{i} + \cos\beta \hat{j} + \cos\gamma K$$



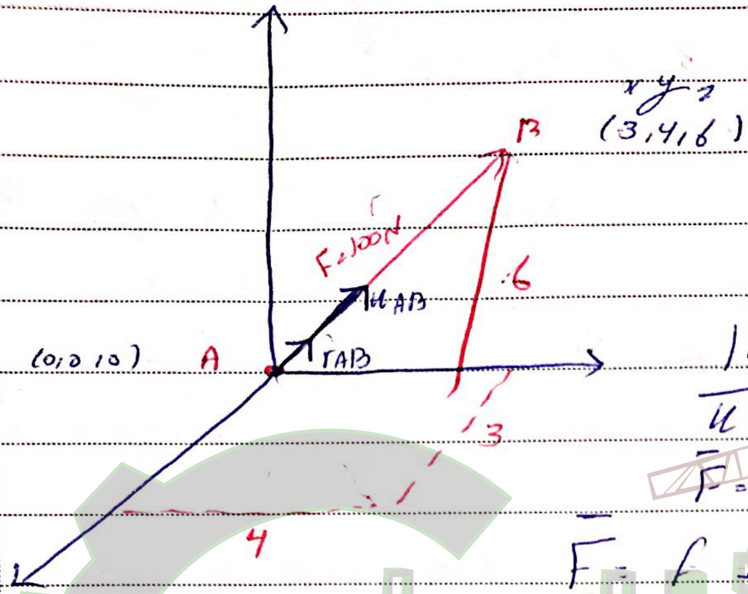
* Determine the position vector directed from A to B

* What is the length of AB

$$\bar{r}_{AB} = (0-3)\hat{i} + (6-0)\hat{j} + (4-2)K$$

$$= -3\hat{i} + 6\hat{j} + 2K$$

$$|r_{AB}| = \sqrt{3^2 + 6^2 + 2^2} = 7m$$



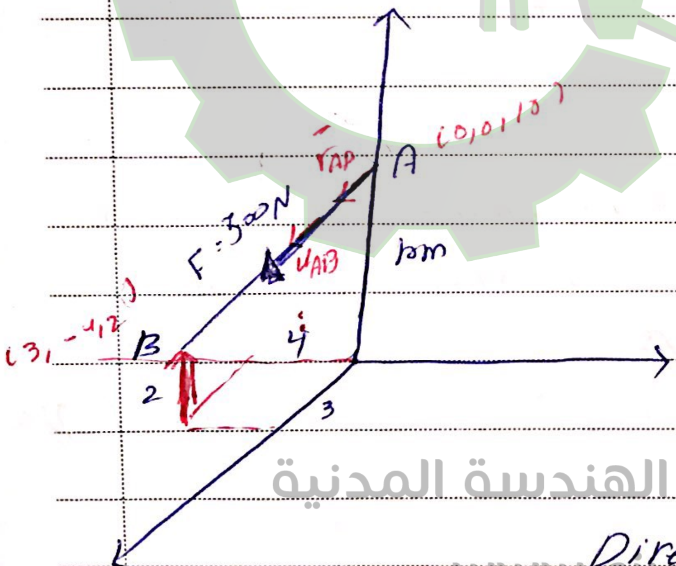
$\bar{r}_{AB}$

$|r_{AB}|$

$\bar{u}_{AB}$

$\bar{F} = f\,\bar{U}_{AB}$

$$\bar{F}_{AB} = f\,\frac{\bar{r}_{AB}}{|r_{AB}|} = f\,\bar{U}_{AB}$$



$$\bar{F}_{AB} = f\,\bar{U}_{AB} = f\,\frac{\bar{r}_{AB}}{|r_{AB}|}$$

$$= 300\left\{\frac{3\hat{i} - 4\hat{j} - 8k}{\sqrt{3^2 + 4^2 + 8^2}}\right\}$$

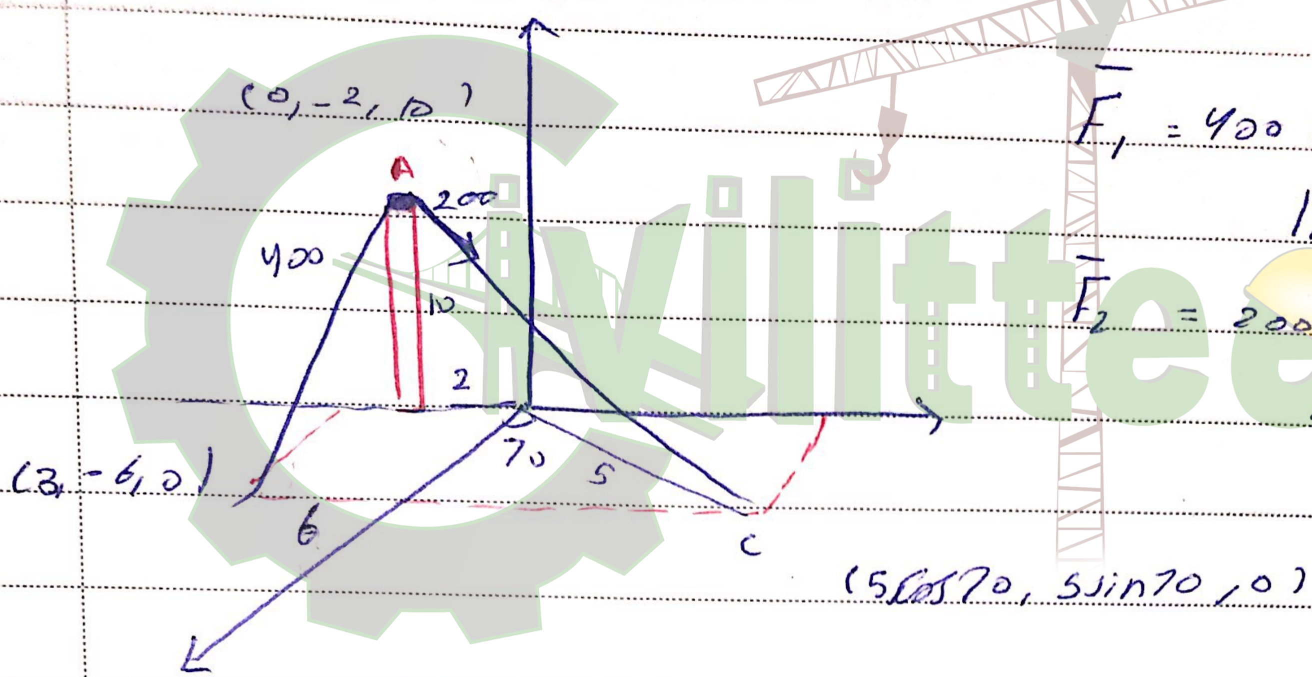
9.4

$$= 95.7\hat{i} - 127.6\hat{j} - 255.3\hat{k}$$

Direction => $\cos\alpha = \frac{95.7}{300}$

$\cos\beta = \frac{-127.6}{300}$

$\cos\gamma = \frac{-255.3}{300}$

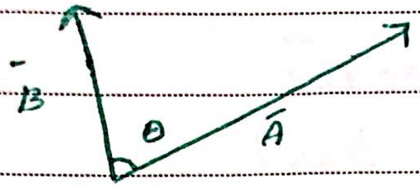


$$\bar{F}_1 = 400 \frac{\bar{r}_{AB}}{|r_{AB}|}$$

$$\bar{F}_2 = 200 \frac{\bar{r}_{AC}}{|r_{AC}|}$$

NO. 12/2/2018

محاضرة « 4 »



$\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k} \Rightarrow |A| = \sqrt{\quad}$

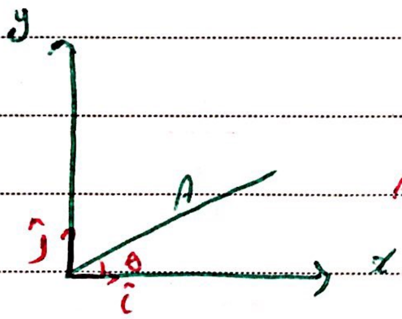
$\bar{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k} \Rightarrow |B| = \sqrt{\quad}$

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

$\cos\theta = \dfrac{\bar{A}\cdot\bar{B}}{|A||B|}$ $\qquad \theta = \cos^{-1}\left(\bar{A}\cdot\bar{B} / |A||B|\right)$

* scalar :-

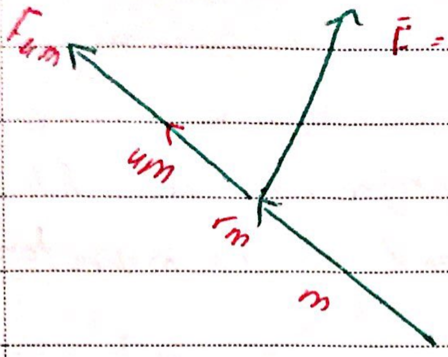
$\bar{A}\cdot\bar{B} = \bar{B}\cdot\bar{A} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})$



$A_{\parallel x} = A_x = A\cos\theta$

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

Scanned by CamScanner



$\bar{F} = f_x\hat{i} + f_y\hat{j} + f_z\hat{k}$

① $|F_{\parallel m}| = \bar{F} \cdot \bar{u}_m \Rightarrow$

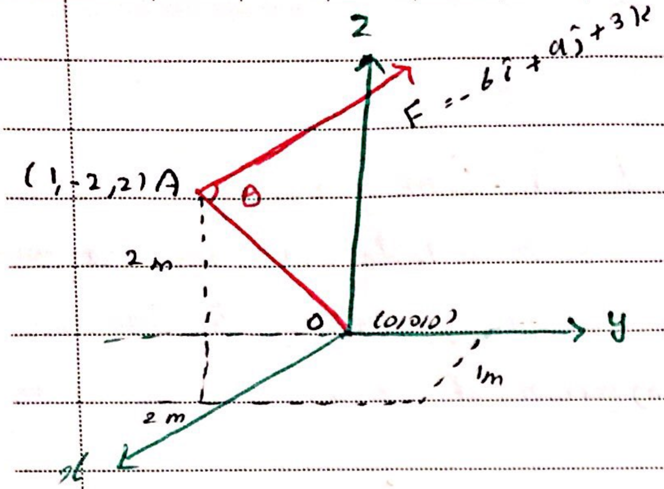
$\frac{\bar{F} \cdot \bar{r}_m}{|r_m|}$ ⇒ magnitude of the componant of parallel the line or projection of a force along a line

② $\bar{F}_{\parallel m} = |F_{\parallel m}| \cdot u_m$ ⇒ componant an carestion rotation vector

③ $|F_{\perp m}| \Rightarrow \sqrt{F^2 - F_{\parallel m}^2}$ ⇒ magnitude of the $\perp$ outh line

④ $F_{\perp m} = \bar{F} - \bar{F}_{\parallel m}$ ⇒ cartesian vector

NO.



- find θ
- find the projection of (F) along AO and Cartesian vector $\bar{F}_{\parallel AO}$
- find the prependicular componant AO ($F \perp AO$)

$F = -6\hat{i} + 9\hat{j} + 3\hat{k} \Rightarrow |F| = \sqrt{6^2 + 9^2 + 3^2} = 11.2\,N$

$\bar{r}_{AO} = -1\hat{i} + 2\hat{j} - 2\hat{k} \Rightarrow |r_{AO}| = \sqrt{1^2 + 2^2 + 2^2} = 3\,m$

$\cos\theta = \frac{\bar{F} \cdot \bar{r}_{AO}}{|F||r_{AO}|} = -6\hat{i} + 9\hat{j} + 3\hat{k} \cdot \frac{-1\hat{i} + 2\hat{j} - 2\hat{k}}{3}$, $\cos^{-1}(U_{AO} \cdot U_F) = \theta$

$\theta = 57°$

$|F_{\parallel AO}| = \bar{F} \cdot \bar{U}_{AO} = \vec{F} \cdot \bar{u}_{AO} = F \cdot \frac{\overline{rAO}}{|r_{AO}|}$

$= (-6\hat{i} + 9\hat{j} + 3\hat{k}) * \frac{(-1\hat{i} + 2\hat{j} - 2k)}{3}$

$= 6\,N$

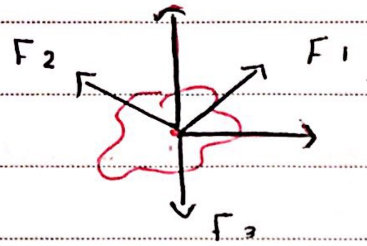
Scanned by CamScanner

NO. chapter "3"

equlibrium of a particle :-

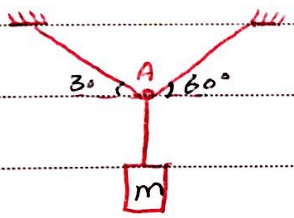
2-1 => eqiulibrium

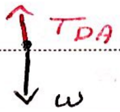
$$\bar{F}_R = \Sigma F = \Sigma F_x \hat{i} + \Sigma F_y \hat{j} = 0$$



3.2 Free Body Diagram "F.B.D"

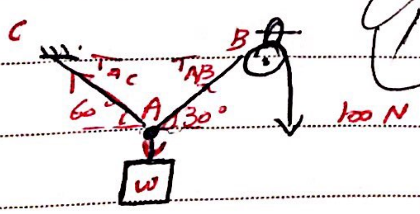
- Cable, cord, (Tension)



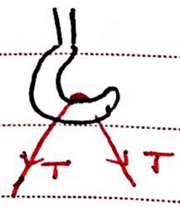


$\Sigma f_x = 0$

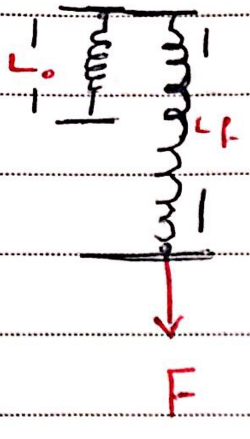
=> pulley :-



* اذا كان نفس الحبل
تكون قوة الشد نفسها



⇒ spring ٥٥ (Tension , compression)



L_0 : initial Length

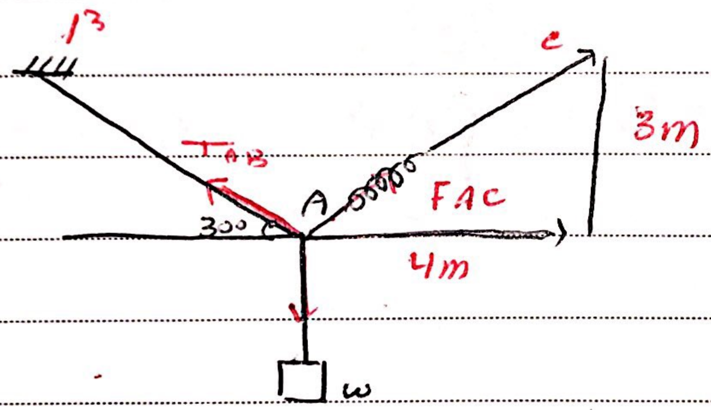
L_f : final length

$\Delta = L_f - L_0$ ⇒ streached , Deformation

$F \propto \Delta$, $F = K\Delta$

↳ spring constant

$K = \frac{F}{\Delta}$ N/m



Σf_x

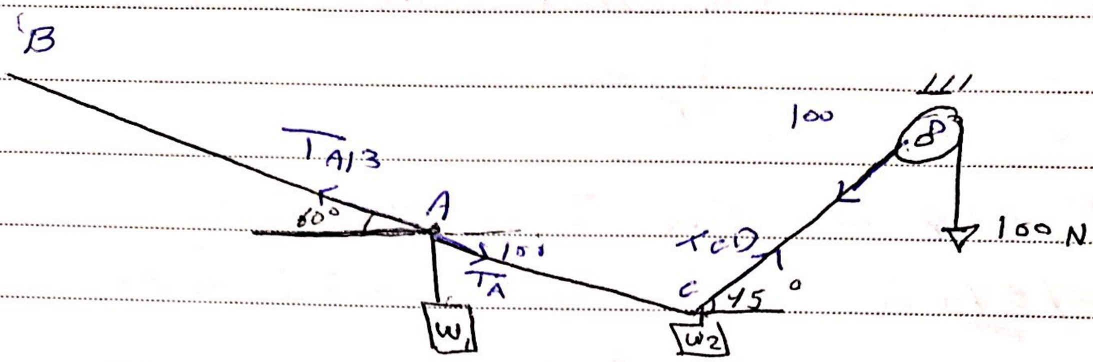
NO. 14/2/2018

« 5 » محاضرة

3.3 coplanar force system [2D]

$\Sigma f_x = 0$

$\Sigma f_y = 0$



- Find w_1, w_2
- find the Tension in each cable

$T_{CD} = 100\,N$ => poin D

$\Sigma f_x = 0 \Rightarrow 100\cos 45 - T_{CA}\cos 10 = 0 \Rightarrow T_{CA} = 71\,N$ => poin C

$\Sigma f_y = 0 \Rightarrow 100\sin 45 + 71.8\sin 10 - W_2 = ?$

point A

$\Sigma f_x = 0 \Rightarrow 71.8\cos 10 - T_{AB}\cos 60 = 0 \quad T_{AB} = 141.1$

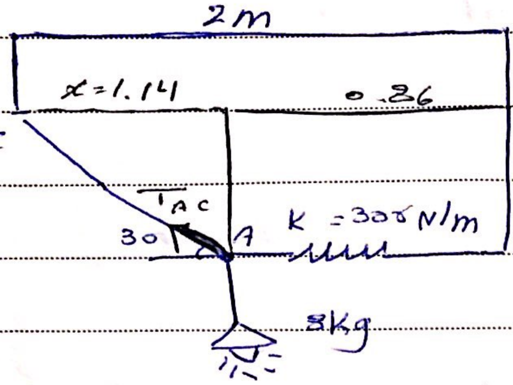
$\Sigma f_y = 0 \Rightarrow T_{AB}\sin 60 - 71.8\sin 10 - W_1 = 0$

$W_1 = ?$

H.W. [3-13]

NO.

e.g => 3.4



unstretched length of spring = 0.4m Find the length of AC = ?

$\xrightarrow{+} \Sigma F_x = 0 \Rightarrow F_{AB} - T_{AC} \cos 30 = 0$

$+\uparrow \Sigma F_y \Rightarrow T_{AC} \sin 30 - 80 = 0 \Rightarrow T_{AC} = 160N$

$F_{AB} = 13.8 N$

$* \; F = K\Delta \Rightarrow 138.5 = 300\Delta \Rightarrow \Delta = 0.46m$

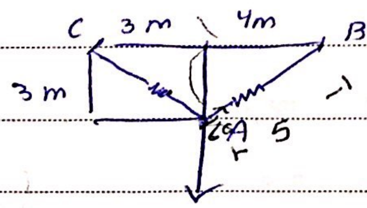
$l_f = 0.4 + 0.46$

$= 0.86m$

$l = 2 - 0.86 = 1.14$, $L_m = \frac{L}{x} \cos 30 \Rightarrow L_{AC} = 1.14/\cos 30$

$L_o, 3m$

=>



$F_{AB} = 60N$

K = 20 N/m

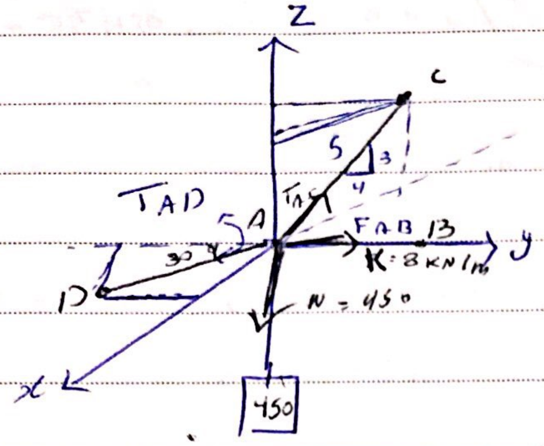
- what is the stiffness of AB

$F = K\Delta$

$60 = K(5-3) \rightarrow K = 30 N/m$

3.4 Three Dimentional force system. (3D) [e.g 3-5]

$$\left.\begin{aligned}\sum f_x &= 0\\ \sum f_y &= 0\\ \sum f_z &= 0\end{aligned}\right] = \sum \bar{f} = 0$$



Determine the tension in each cable and the stretch in the spring ::

_ force as cartesian vector

$\bar{T}_{AD} = T_{AD} \sin 30 \, \hat{i} - T_{AD} \cos 30 \, \hat{j} + 0 \hat{k}$

$\bar{F}_{AB} = 0 \hat{i} + F_{AB} \hat{j} + 0 \hat{k}$

$\bar{T}_{AC} = -\frac{4}{5} T_{AC} \hat{i} + 0 \hat{j} + \frac{3}{4} T_{AC} \hat{k}$

$W = 0 \hat{i} + 0 \hat{j} - 450 \hat{k}$

$\sum f_x = T_{AD} \sin 30 - 4/5 \, T_{AC} = 0$ ...... (1)

$\sum f_y = -T_{AD} \cos 30 + F_{AB} = 0$ — (2)

$\sum f_z = \frac{3}{5} T_{AC} - 450 = 0 \Rightarrow T_{AC} = 750 \, N$

_ sub in (1)

$T_{AD} \sin 30 - 4/5 \times 750 = 0 \Rightarrow T_{AD} = 1200 \, N$

sub in (2)

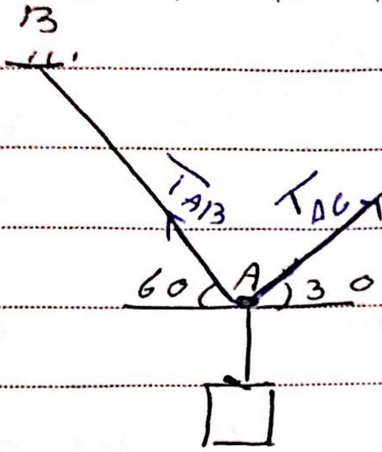
$-1200 \cos 30 + F_{AB} = 0 \Rightarrow F_{AB} = 1039 \, N$

$F_{AB} = K \Delta$

$1039 = 8000 \, \Delta$

$\therefore \Delta = \_\_\_ \, m$

NO.



Max tension in the cable

find max $W = ?$

$\xrightarrow{+} \sum F_x = 0 \quad T_{AC}\cos 30 - T_{AB}\cos 60 = 0$

$+\uparrow \sum F_y = 0 \Rightarrow T_{AC}\sin 30 + T_{AB}\sin 60 - W = 0$

$\Rightarrow T_{AC} = \dfrac{T_{AB}\cos 60}{\cos 30} = 0.57\, T_{AB}$

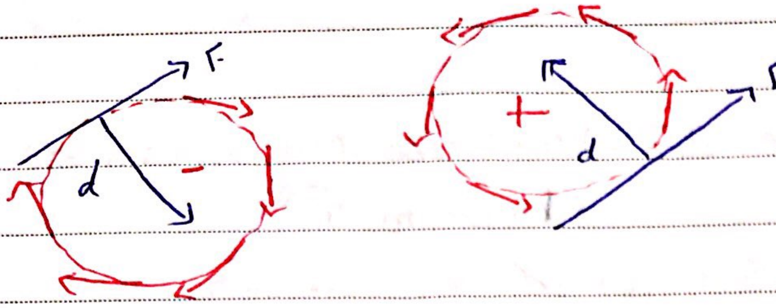
Assume $T_{AB} = 200\,N \quad T_{AC} = (0.57)(200) = 114 < 200$

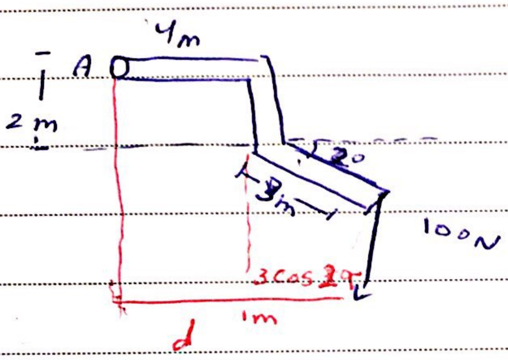
sub in ② $\Rightarrow 114\sin 30 + 200\sin 60 - W = 0$

$W = \_\_\_ N$

4.1 => Moment of a force scalar

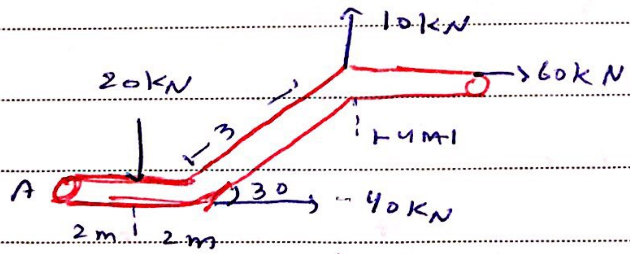
$|M_o| = F d_\perp$ vector (+) (-) N.m





Find M_A?

(+) $M_A = -(100)(4+3\cos 20)$
$= -681.9$ N.m



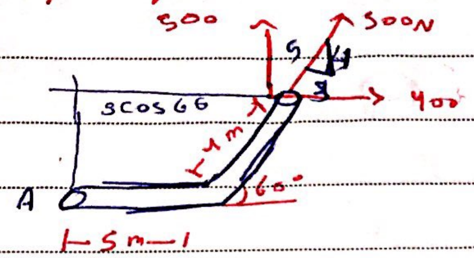
Find the resultant Moment about A

$M_R = \sum M_A$

(+) $M_A = -(20)(2) + (10)(4+3\cos 30) - (60)(3\sin 30)$

$= +115.9$ kN.m (+)

4.4 principle of Moment



Find M_A ?

$M_A = (+4m)(5+4\cos 60) - (300)(4\sin 60)$

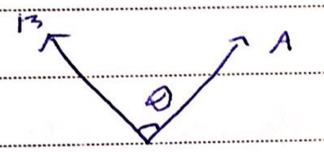
$= 1160\ N\cdot m$ (+)

Moment of a force = Σ Moment of the componant

Find d? $\Rightarrow M = Fd$

$$d = \frac{M}{F} = \frac{1160}{500}$$

4.2 $\Rightarrow$ cross product

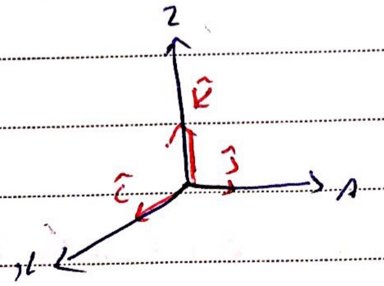


$\vec{A} \times \vec{B} = AB\sin\theta \Rightarrow$ vector

$\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$

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

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



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

$$+\begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix}\hat{i} - \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix}\hat{j} + \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}\hat{k}$$

$$= +(A_y B_z - B_y A_z)\hat{i} - (A_x B_z - B_x A_z)\hat{j} + (A_x B_y - B_x A_y)\hat{k}$$

$\vec{C} = C_x\hat{i} + C_y\hat{j} + C_z\hat{k}$

$\cos\alpha = \dfrac{C_x}{|C|}$, $\cos\beta = \dfrac{C_y}{|C|}$, $\cos\gamma = \dfrac{C_z}{|C|}$

$\vec{A} = 2\hat{i} - 1\hat{j} + 3\hat{k}$

$\vec{B} = -4\hat{i} + 3\hat{j} - 1\hat{k}$

Find $\vec{B} \times \vec{A}$

$8\hat{i} + 10\hat{j} - 2k$

$$\vec{B} \times \vec{A} = \begin{vmatrix} \hat{i} & \hat{j} & k \\ -4 & +3 & -1 \\ 2 & -1 & +3 \end{vmatrix}$$

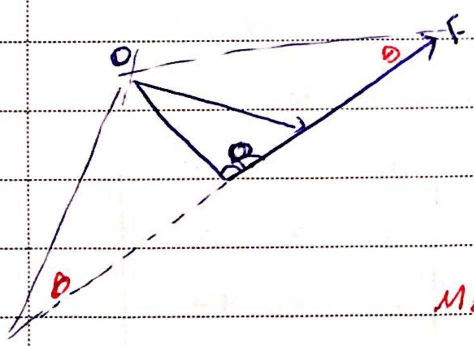
$$= +(9-1)\hat{i} - (-12+2)\hat{j} + (4-6)\hat{k}$$

$$8\hat{i} + 10\hat{j} - 2k$$

$|C| = \sqrt{8^2 + 10^2 + 2^2} = 12.9$

$\cos\alpha = \frac{9}{12.9}$, $\cos\beta = \frac{10}{12.9}$, $\cos\gamma = \frac{-2}{12.9}$

4.3 Moment of a force (Vector formulation):



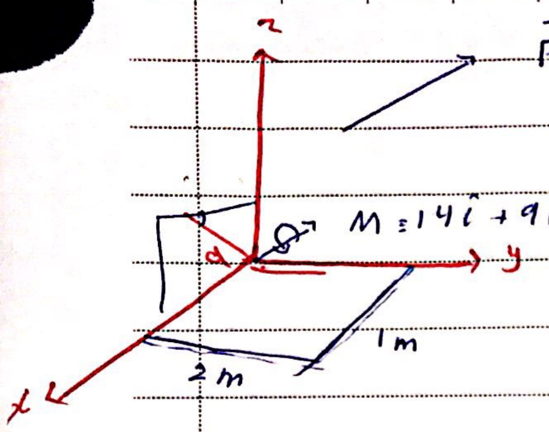
$$M_o = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ r_x & r_y & r_k \\ F_x & F_y & F_k \end{vmatrix}$$

any position vector from o to any point on the force

$\vec{r} \times \vec{F} \neq \vec{F} \times \vec{r}$

$M_o = M_x\hat{i} + M_y\hat{j} + M_z\hat{k}$

$\bar{F} = 6\hat{i} + 8\hat{j} + 10\hat{k}$



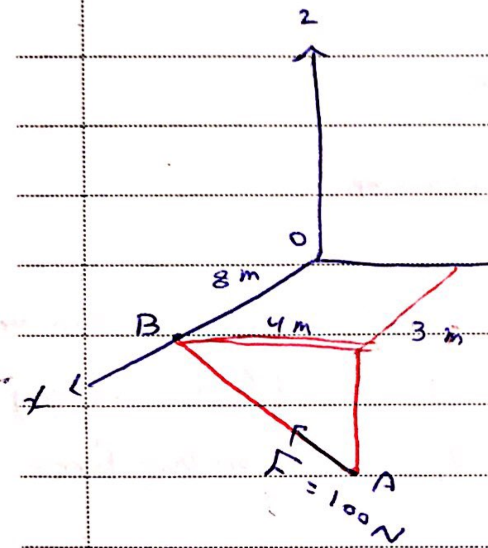
find d?

$d = \frac{M}{F}$

$|M| = \sqrt{14^2 + 9^2 + 2^2} = 16.29\ N.m$

$|F| = \sqrt{6^2 + 8^2 + 10^2} = 14.14\ N.m$

$d = \frac{16.29}{14.14} = 1.14m$



$M_o = ?$

$\vec{F} = F\vec{u}_{AB} = 100 \frac{0\hat{i} - 4\hat{j} + 2\hat{k}}{\sqrt{4^2 + 2^2}}$

$\{= 0\hat{i} - 0.89\hat{j} + 0.44\} \times 100$

$\vec{F} = 0\hat{i} - 89\hat{j} + 44\hat{k}$

$\vec{r}_{OB} = 3\hat{i} + 0\hat{j} + 0\hat{k}$

$$\begin{vmatrix} + & - & + \\ 3 & 0 & 0 \\ 0 & -89 & 44 \end{vmatrix}$$

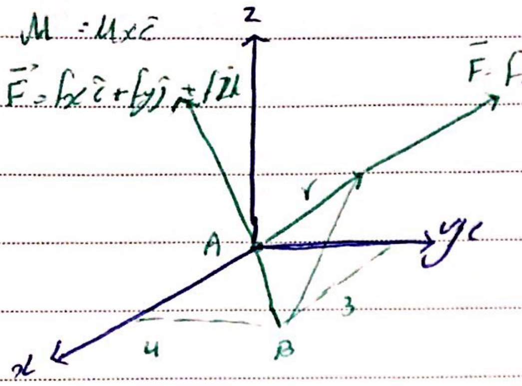
$\bar{M}_o = \bar{r}\bar{F}$

$M_o = 0 - (3)(44)\hat{j} - (3)(.89)\hat{k}$

NO. 21/2/2018

محاضرة «7»

4.5 Moment of a force about specified Axis:



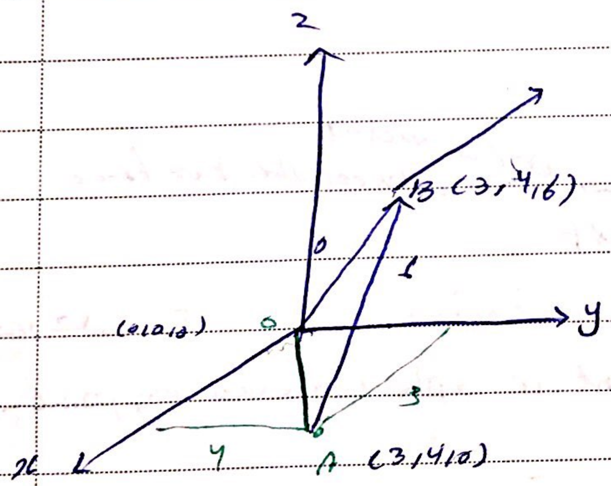
$F_{AB} = \bar{F} \cdot \bar{U}_{AB}$

$|M_{\perp AB}| = \bar{M}_A \cdot \bar{U}_{AB} = \{\bar{r} \times \bar{F}\} \cdot \bar{U}_{AB}$

$\bar{M}_{\parallel AB} = |M_{\parallel AB}| \bar{U}_{AB}$

$|M_{\perp AB}| = \sqrt{M_A^2 - M_{\parallel AB}^2}$

$\bar{M}_{\perp AB} = \bar{M}_A - \bar{M}_{\parallel AB}$



- Find the moment about member OA
- " " " " the y axis

$|M_{OA}| = \{\bar{r} \times \bar{F}\} \bar{U}_A$

$\bar{r} = 3\hat{i} + 4\hat{j} + 6\hat{k}$

$\bar{U}_{OA} = \dfrac{3\hat{i} + 4\hat{j} + 0\hat{k}}{\sqrt{3^2 + 4^2}} = 0.6\hat{i} + 0.8\hat{j} + 0\hat{k}$

$$|M_{OA}| = \begin{vmatrix} 0.6 & 0.8 & 0 \\ 3 & 4 & 6 \\ -10 & 5 & 70 \end{vmatrix} = -56 \text{ N.m}$$

$$|M_y| = \begin{vmatrix} 0 & 1 & 0 \\ 5 & 4 & 6 \\ -10 & 5 & 20 \end{vmatrix}$$

$= 120$

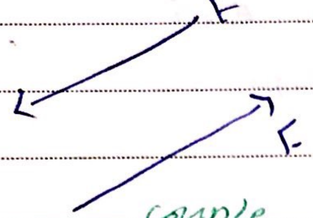
$\bar{M}_y = 0\hat{i} + 120\hat{j} + 0\hat{k}$

NO.

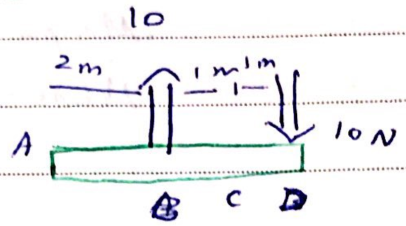
$|\overline{M}_{\parallel AB}| = -56\, U_{AB} = -56\{0.6\hat{i} + 0.8\hat{j} + 0k\}$

$$|M_y| = \begin{vmatrix} 0 & 1 & 0 \\ 3 & 4 & 6 \\ -15 & 5 & 20 \end{vmatrix} = 120$$

$\bar{M}_y = 0\hat{i} + 120\hat{j} + 0\hat{k}$



couple

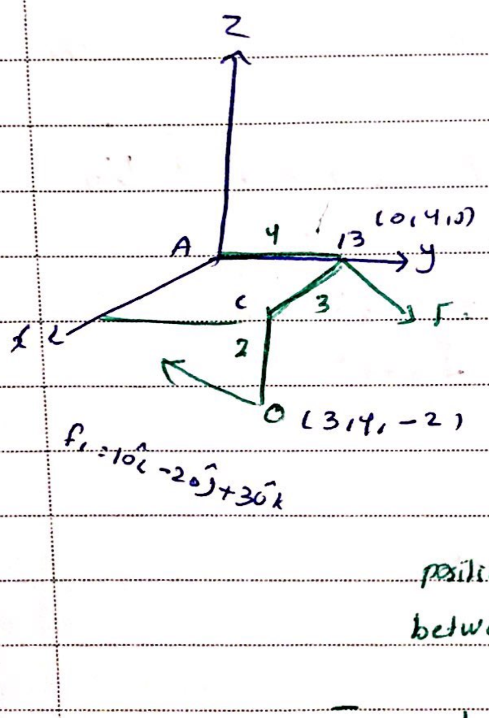


$\circlearrowleft + \;\; \Sigma M_A = (10)(2) - (10)(4) = -20\,N.m$

$\circlearrowleft + \;\; \Sigma M_B = -(10)(2) = -20\,N.m$

$\circlearrowleft + \;\; \Sigma M_C = (10)(1) - (10)(1) = -20$

$\circlearrowleft + \;\; \Sigma M_D = (10)(2) = -20\,N.m$



$f_1 = 10\hat{i} - 20\hat{j} + 30\hat{k}$

position vector between the two force

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

$F_2 = -10\hat{i} + 20\hat{j} + 30\hat{k}$ $\quad F_1$

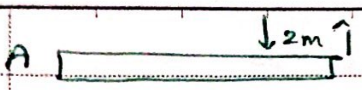
Moment in couple can taken any point

$\bar{\mu}_A = \bar{\mu}_B$

$\mu = r \times F$

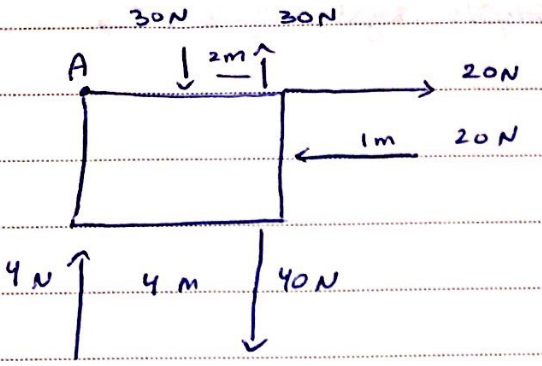
position vector between the two force

$$\bar{M}_B = \begin{vmatrix} + & - & + \\ 3 & 0 & -2 \\ 10 & -20 & 30 \end{vmatrix}$$

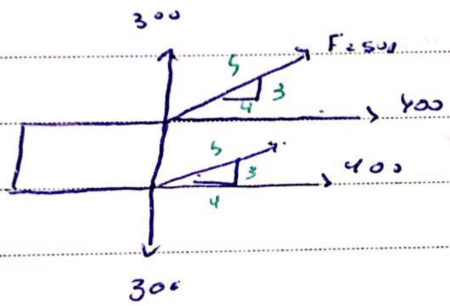


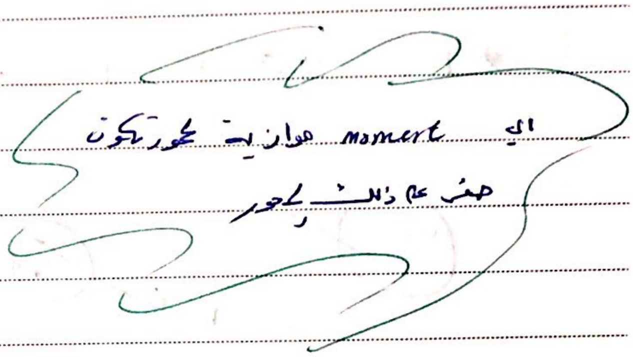
$\Sigma M_A = -20\ N.m$

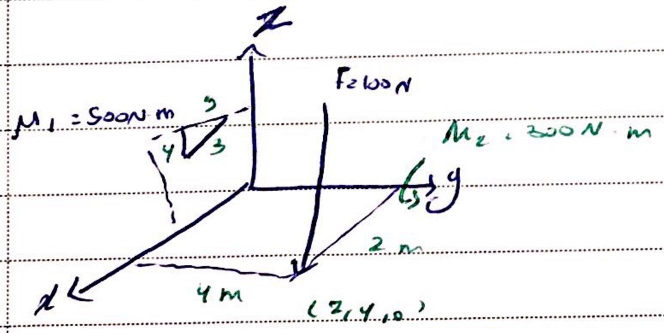
* resultant force = zero



$\Sigma M = +(30)(2) - 40(4) = \quad N.m$







* Find the resultant moment about O?

$\bar{M}_R = \Sigma \bar{M} = \Sigma \bar{M}_i + \Sigma \bar{r} \times \bar{F}$

$M_1 = \frac{3}{5} * 500\hat{i} + 0\hat{j} + \frac{4}{3}\ 500 k$

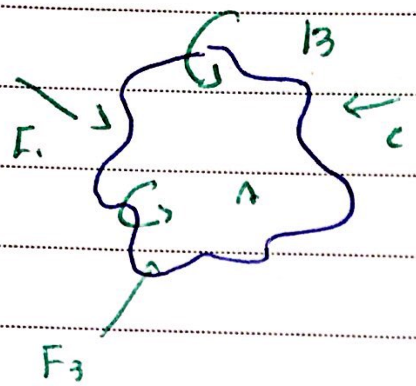
$M_2 = 0\hat{i} + 300\hat{j} + 0k$

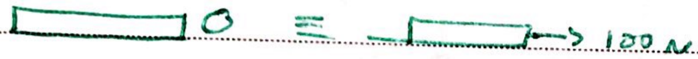
$$M_3 = \bar{r} \times \bar{F} = \begin{vmatrix} + & - & + \\ 2 & 4 & 0 \\ 0 & 0 & -100 \end{vmatrix} \Rightarrow -400\hat{i} + 200\hat{j} + 0\hat{k}$$

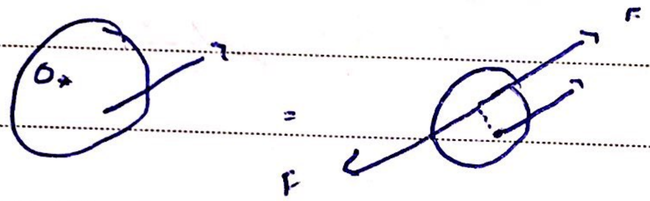
$M_R = \{-100\hat{i} + 500\hat{j} + 400\hat{k}\}\ N.m$, $|M_R| = \sqrt{(100)^2 + (500)^2 + (400)^2}$

$\Rightarrow \cos\alpha = \dfrac{100}{|M_R|}$, $\cos\beta = \dfrac{500}{|M_R|}$, $\cos\gamma = \dfrac{400}{M_4}$

* simpilication of aforce and cuple system : « 4.7 »



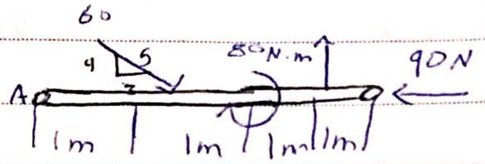
* 



- تأثير القوة عن النقطة لسه ع
خط عملها ثابت = F + M

NO. 24/2/2018

«8» محاضرة



⇒ Replace the loading by an equivalent force and moment at A.

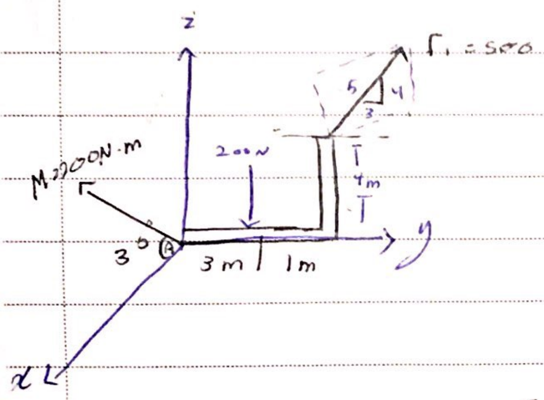
⇒

$\overset{+}{\rightarrow} \Sigma F_x = 30 - 90 = -60 \overset{N}{\leftarrow}$

$+\uparrow \Sigma F_y = \sqrt{-40 + 100} = 60\,N \uparrow$

$F_R = \sqrt{60^2 + 60^2} =$ $\qquad \theta = \tan^{-1}(60/60) = 45°$

$(\circlearrowleft +)\ M_R = \Sigma_A = (-40)(2) - 80 + 100(4) = \ldots\ N.m$



$F_R = ?$

$M_{R_A} = ?$

$\bar{F}_1 = -300\hat{i} + 0\hat{j} + 400k$

$\bar{F}_2 = 0\hat{i} + 0\hat{j} - 200k$

$F_R = -300\hat{i} + 0\hat{i} + 200k$

$|F_R| = \sqrt{300^2 + 200^2}$

$\cos\alpha = \dfrac{-300}{|F_R|} =$ $\qquad \cos\beta = \dfrac{000}{|F_R|} =$ $\qquad \cos\gamma = \dfrac{200}{|F_R|}$

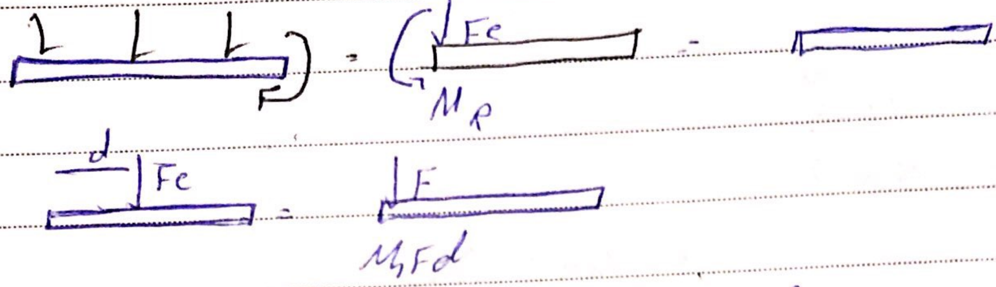
$\bar{M}_R = \Sigma \vec{M} + \Sigma \bar{r} \times \bar{F}$

$M_1 = 200\cos 30\hat{i} + 0\hat{j} + 200\sin 30 k$

$r_2 \times F_2 = \begin{vmatrix} \hat{i} & \hat{j} & K \\ 0 & 2 & 0 \\ 0 & 0 & -200 \end{vmatrix} = 400\hat{i} + 0\hat{j} + 0\hat{k}$

$r_1 \times F_1 = \begin{vmatrix} \hat{i} & \hat{j} & K \\ 0 & 3 & 4 \\ -300 & 0 & 400 \end{vmatrix} = (3 \times 400)\hat{i} - (300 \times 4)\hat{j} + 300(3)k$

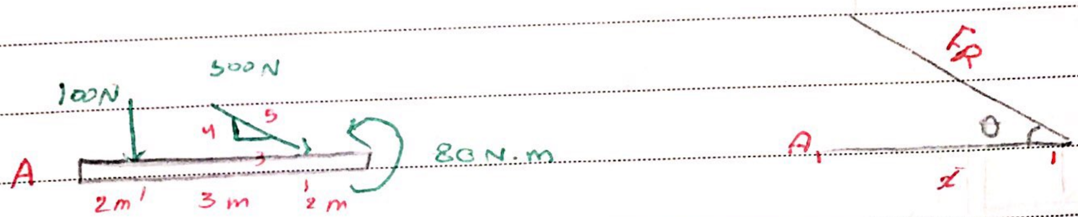
4.8 further simplification of force and couple system:



Replace the loading by single force and what to be located force:

$M = F * x$, $x = M/F$

e.4.18
4.19



$\Sigma F_x = 300\ N \rightarrow$

$\Sigma F_y = -100 - 400 = -500\ N \downarrow$

$F_R = \sqrt{(300)^2 + (500)^2} = 583.09\ N$

$\tan\theta = \frac{500}{300} \rightarrow \theta = 59.03^\circ$

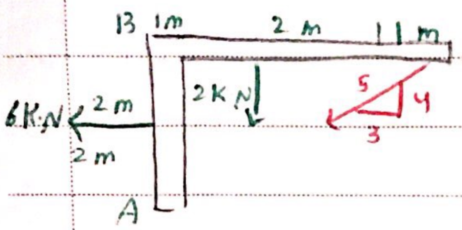
$\Sigma M_R = -100(2) - 400(5) + 80 = -2120\ N.m$

$-500\ \bar{x} = -2120$

$\bar{x} = 4.25$

NO.

ex(4-18)



- Resultant force as specifyc

$\Sigma f_x = -6-3 = -9 \text{ K.N}$

$\Sigma f_y = -2-4 = -6 \text{ K.N}$

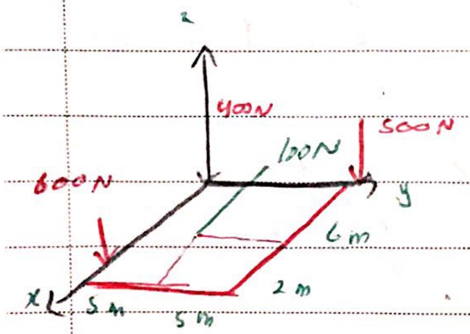
$F_R = \sqrt{9^2+6^2} = 10.81 \text{ K.N}$

$\tan^{-1}\left(\frac{6}{9}\right) = \theta = 33.69$

* $\Sigma M_A = (6)(2) - (2)(1) - 4(3) - 100 \text{ N.m}$

* for member (1) AB: $9\bar{y} - \bar{y} = \frac{10}{9}$ m

* for member (BC): $9(4) - (6)(\bar{x}) = x = -$ m

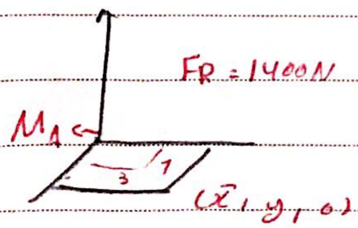


$F_R = -600-400-500+100$

$= -1400 \text{ kN}$

$\Sigma M_{xR} = +(100)(5) - (500)(10) = -4500\hat{i}$

$\Sigma M_{yR} = -(100)(6) + (600)(8) = +4200\hat{j}$



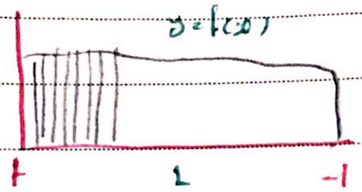
$\bar{M}_A = -4500\hat{i} + 4200\hat{j} + 0k$

$$M = \bar{r} \times \bar{F} = \begin{vmatrix} \hat{i}+ & \hat{j}- & k+ \\ \bar{x} & \bar{y} & 0 \\ 0 & 0 & -1400 \end{vmatrix} = -1400\bar{y}\,\hat{i} + 1400\bar{x}$$

NO. 27/2/2018

محاضرة ٢٨

* Reduction of simply Distributed loading

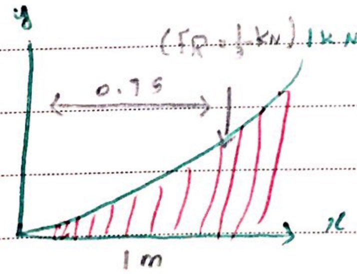


$x_i = x$

$dA = y\,dx = f(x)\,d(x)$

$* F_R = \int dA = \int_0^2 f(x) \cdot dx$

$$x = \frac{\int x_i \, dA}{\int dA} = \frac{\int x_i f(x) \cdot dx}{\int f(x)}$$



* Find the equivalant Resultant and its location from A ?

$dA = y\,dx = x^2\,dx$

$F_R = \int dA = \int_0^1 x^2 \cdot dx$

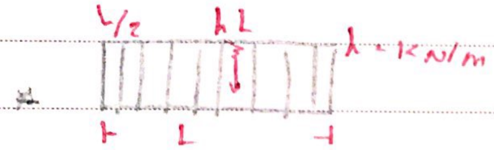
$= \frac{x^3}{3} \Big|_0^1 = \frac{1}{3}$ kn

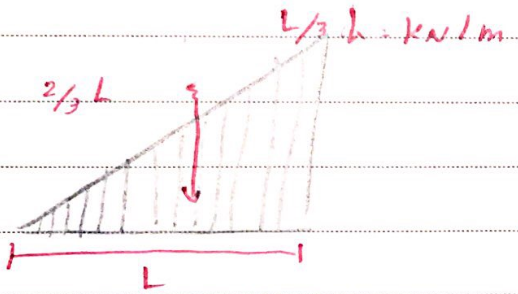
NO.

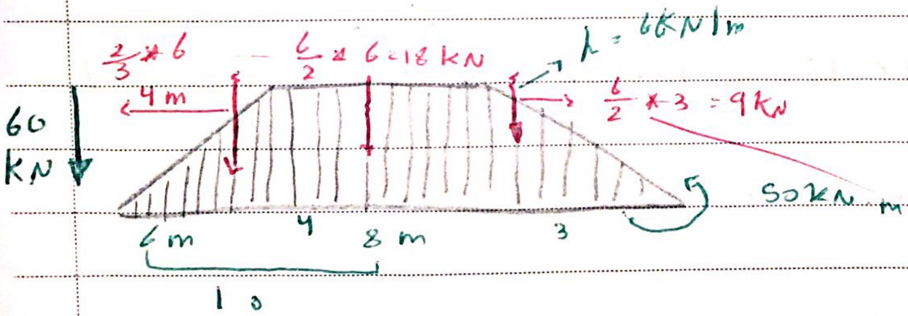
$\bar{X} : \int x_1 dA = \int_0^1 x(x^2 dx) = \int_0^1 x^3 dx$

$= \frac{x^4}{4}\Big|_0^1 = 1/4$

$\bar{X} = \frac{\int x dA}{\int dA} = \frac{1/4}{1/3} = \frac{3}{4} = 0.75m$







$8 \times 6 = 48$

$* F_R = \Sigma F_y = -60 - 18 - 48 - 9 = -135 kN \downarrow$

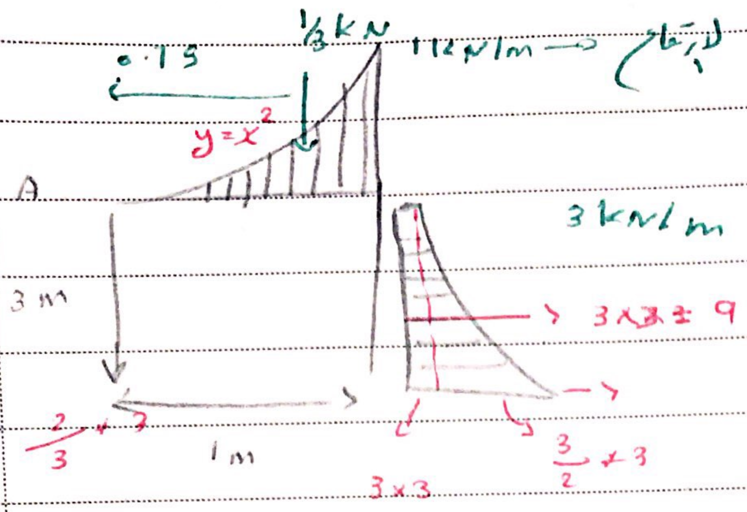
$* \Sigma M_A = -18 * 4 - 48(10) - 9(15) + 50 = -637 kN/m$

$-637 = -13.5 \bar{X}$

$\bar{X} = 4,7$

NO.

* Find resultant force and moment at A :-



$$* \ \Sigma F_x R = 9 + (1.5) * 3$$

$$\Sigma F_y = -1/3$$

$$\Rightarrow F_R = \sqrt{}$$

$$\tan\theta = F_y / F_x$$

$$* \ \Sigma M_A = -1/3\,(0.75) + 9(1.5) + (1.5)(3) * \left(\frac{2}{3} + 3\right)$$

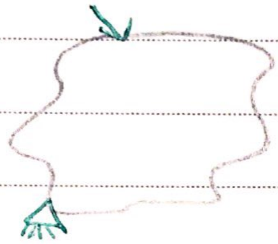
$$= \_\_\_ \ kN/m$$

NO.

ch (5):-

equilibrium of Rigid Body :-

$$\left.\begin{array}{l}\Sigma F_x = 0 \\ \Sigma F_y = 0 \\ \Sigma M = 0\end{array}\right] \rightarrow \text{equation of equilibrium}$$



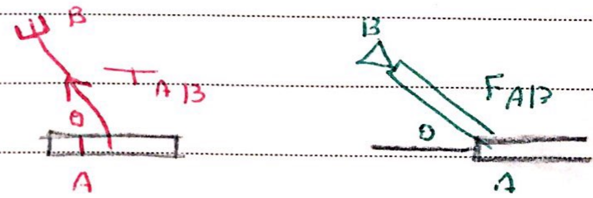
support → support Reaction

F.B.D → free body diagram → F.B.D

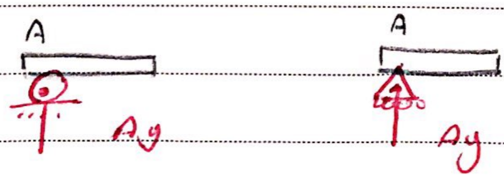
* 5.1 ⇒ conditions equilibrium in (2-D)

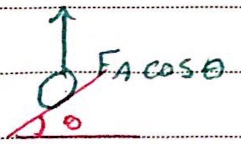
⇒ Type of support :-

① cable (tension)



② Roller

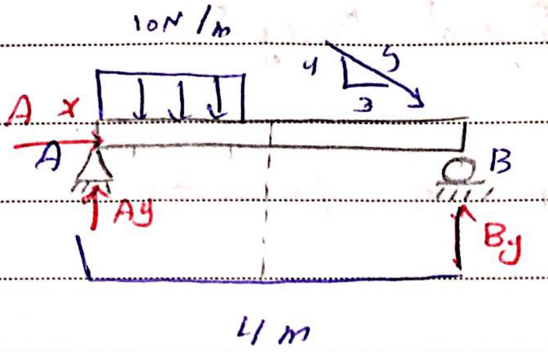




$\Sigma f_x = 0$

$\Sigma f_y = 0$

$\Sigma M = 0$



Find support reaction

① F.B.D

② Apply equ. equ $\begin{cases} \Sigma f_x = 0 \\ \Sigma f_y = 0 \\ \Sigma M = 0 \end{cases}$ start with Moment equation about the point of Max unknowing

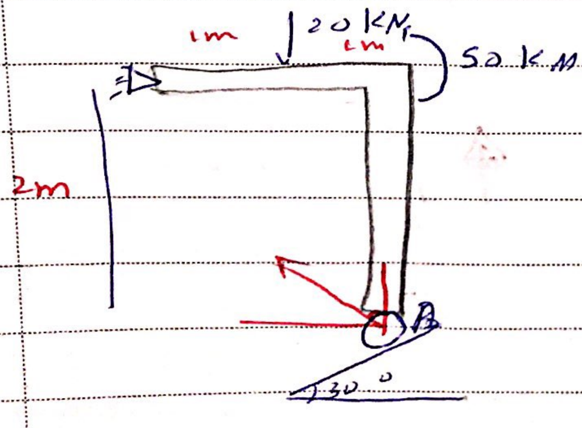
$\circlearrowleft + \; \Sigma M_A = -40(2) - 40(6) + 8By + 40 = 0$

$\Rightarrow By = +120N$

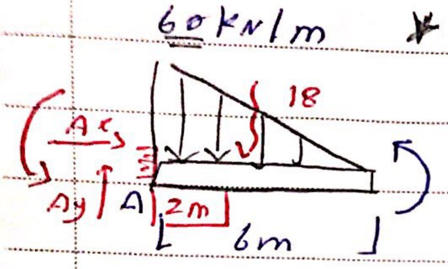
$\xrightarrow{+} \Sigma f_x = 0 \quad Ax + 30 = 0 \quad Ax = -30 \leftarrow$

← عكس الاتجاه المطلوب

$+\uparrow \Sigma f_y = -40 - 40 + By = 0 \quad Ay = \_\_ N$



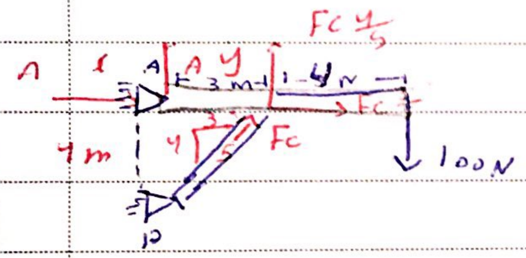
NO.



$\circlearrowleft + \sum M_A = 0 = M_A - 18(2) + 50 = 0 \Rightarrow M_A \ldots$

$\xrightarrow{+} \sum f_x = 0 \rightarrow A_x = 0$

$+\uparrow \sum F_y = A_y - 18 = 0 \quad A_y = 18\,kN$



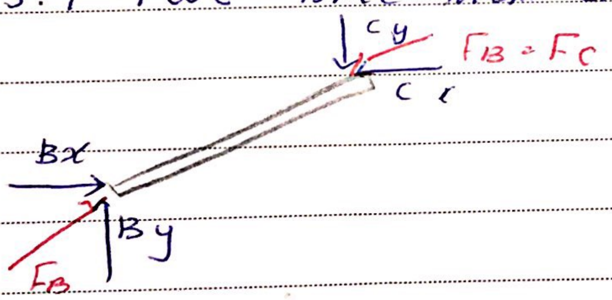
$\circlearrowleft + \sum M_A = 0 \Rightarrow + \left(\frac{4}{5} F_c\right)(3) - (7)(100) = 0$

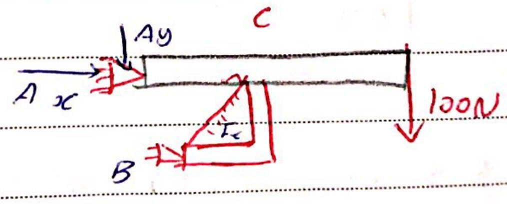
$F_c = 291.5\,N$

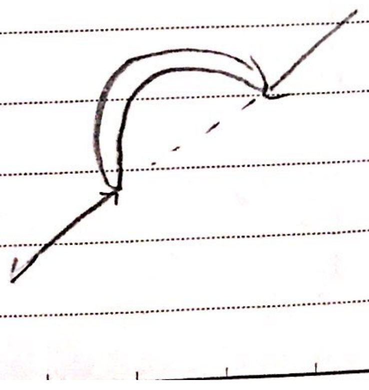
$\sum f_x = 0 \Rightarrow A_x + \frac{3 F_c}{5} = A_x = - \quad N \leftarrow$

$\sum f_y = 0 \rightarrow -A_y + \frac{4}{5} F_C - 100 = 0 \quad A_y = \ldots N$

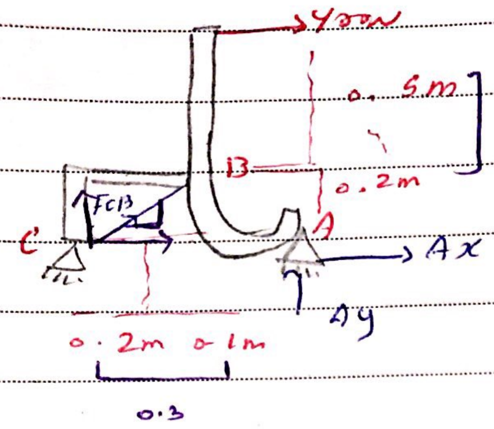
5.4 Two force Members :







NO.



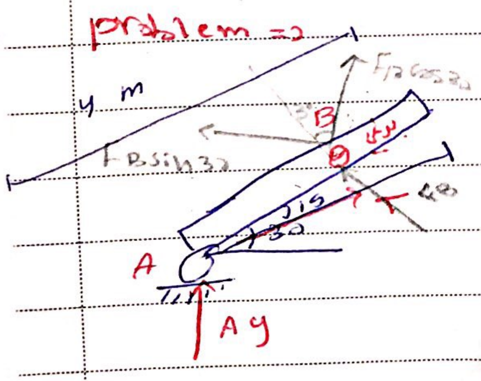
$\sum M_A = 0 \rightarrow -(400)(0.7) - \left(\frac{F_B}{\sqrt{2}}\right)(0.3) = 0 \quad F_B = -1319.9N$

نعوضها حولها

$\rightarrow \sum f_x = 0 \Rightarrow \frac{F_B}{\sqrt{2}} + Ax + 400 = 0 \quad Ax = -- N$

$\uparrow \sum f_y = 0 \rightarrow \frac{F_B}{\sqrt{2}} + Ay = 0 \quad Ay = ---- N$

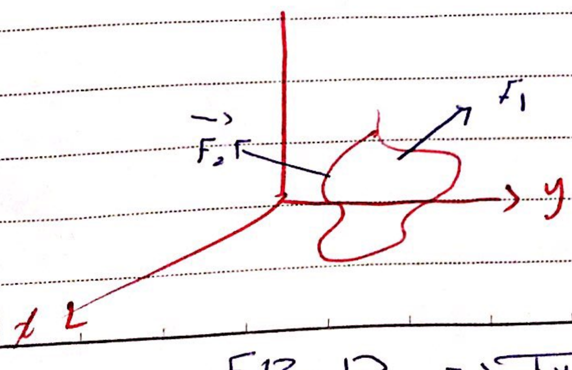
problem =>



mass = 25kg

weight = 250N

5.5 equilibrium in 3D



$\sum f = 0$

$\sum M = 0$

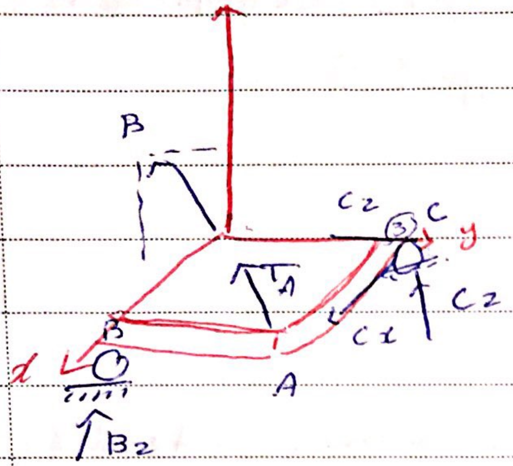
$\begin{cases} f_x = 0 \\ \sum f_y = 0 \\ \sum f_z = 0 \end{cases}$

$\begin{cases} \sum M_x = 0 \\ \sum M_y = 0 \\ \sum M_z = 0 \end{cases}$

F.B.D => Type of support

Type of support :

(1) cable (T) = T_A / TU_{AB}

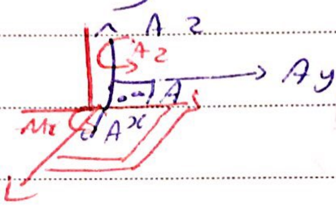


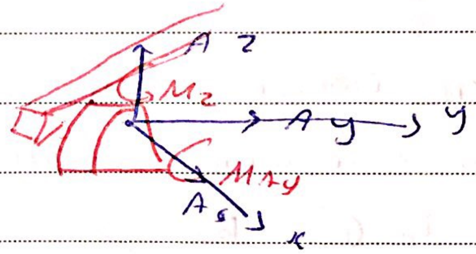
(2) Roller
one unknown

(3) Roller socket

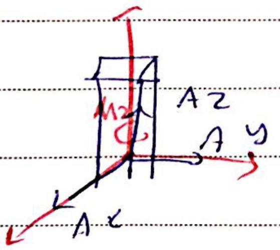
3 unknown

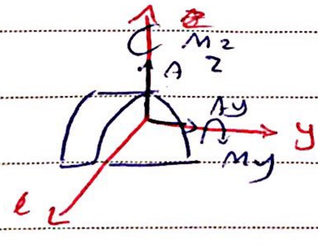
(4) Hing مفصل بيبان

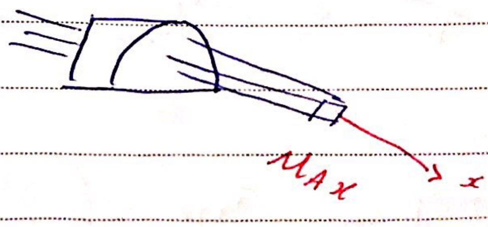




(5) fixed support 6 unknown

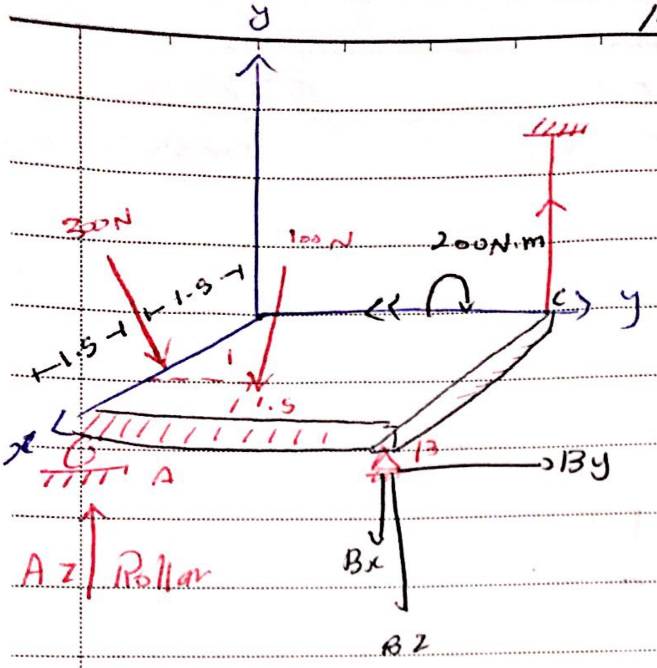






NO. ٤ ١٠ محاضرة ٤

14/3/2018



mass of plate $= 100 kg \times 10 = 1000 N$

find support Reaction

$\sum f_x = 0 \Rightarrow B_x = 0$

$\sum f_y = 0 \Rightarrow B_y = 0$

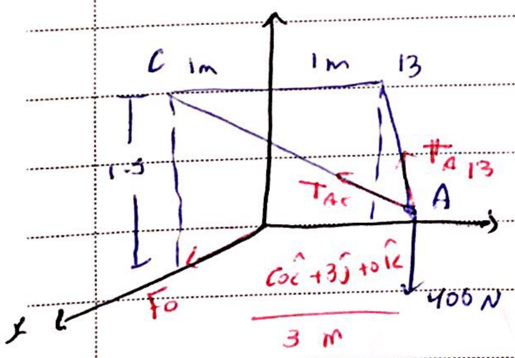
$\sum f_z = 0 \rightarrow -300 - 1000 + T_C + A_z + B_z = 0$

$\sum M_{CB} = (100)(1) + (300)(2) - 2A_z = 0 \Rightarrow A_z = 800N$

$\sum M_{AB} = -(300(1.5)) - (1.5)(1000) + 3T_C - 200 = 0$

sub in ① $B_z = ??$

=> find the tension in each cable



C (1, 0, 1.5)

B (−1, 0, 1.5)

A (0, 3, 0)

$$\bar{T}_{AB} = T_{AB} \left\{ \frac{-1\hat{i} - 3\hat{j} + 1.5\hat{k}}{\sqrt{1^2 + 3^2 + 1.5^2}} \right\} = T_{AB} \{-0.28\hat{i} - 0.85\hat{j} + 0.43\hat{k}\}$$

$$\bar{T}_{AC} = T_{AC} \left\{ \frac{1\hat{i} - 3\hat{j} + 1.5\hat{k}}{\sqrt{1^2 + 3^2 + 1.5^2}} \right\} = T_{AC} \{0.28\hat{i} - 0.85\hat{j} + 0.43\hat{k}\}$$

$W = 0\hat{i} + 0\hat{j} - 400\hat{k}$

$\bar{F}_0 = F_{0x}\hat{i} + F_{0y}\hat{j} + F_{0z}\hat{k}$

$\sum \bar{M}_0 = 0 \Rightarrow \sum r \times F = 0$

NO.

$$\sum \bar{r} \times \bar{F} = T_{AB} \begin{vmatrix} \hat{i} & \hat{j} & k \\ 0 & 3 & 0 \\ -0.28 & -0.85 & 0.43 \end{vmatrix} + T_{AC} \begin{vmatrix} \hat{i} & \hat{j} & k \\ 0 & 3 & 0 \\ 0.28 & -0.85 & 0.43 \end{vmatrix}$$

$$+ \begin{vmatrix} \hat{i} & \hat{j} & k \\ 0 & 3 & 0 \\ 0 & 0 & -400 \end{vmatrix}$$

$$= (3)(0.43)\,T_{AB}\,\hat{i} + (0.28)(3)T_{AB}\,k + (3)(0.43)\,T_{AC}\,\hat{i} - (0.28)(3)\,T_{AC}\,k$$

$$+ 3(-400)\hat{i} = 0$$

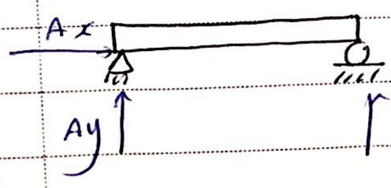
$(3)(0.43\,T_{AB} + (3)(0.43)\,T_{AC} - (400)(3) = 0$ —— ①

$(0.28)(3)\,T_{AB} - (0.28)(3)\,T_{AC} = 0$

$T_{AB} = T_{AC} = T$ sub in ①

5.7 constrouns and static Deleminancy 8-

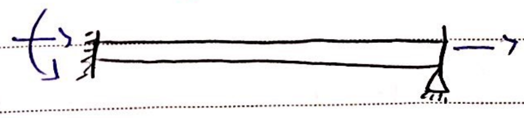
statically Determinate



3unknown

2equ. equ

statically Indeterminate



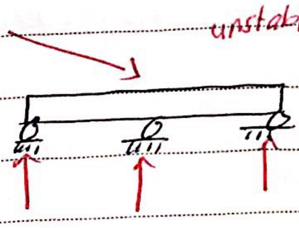
5unknown

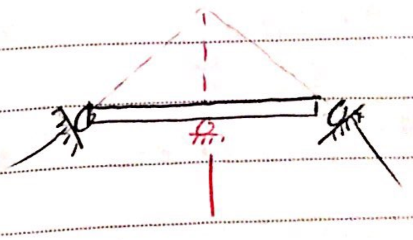
3equ equ

$5 - 3 = 2$

* Improper costrains:-

unstable





2unk

3equ

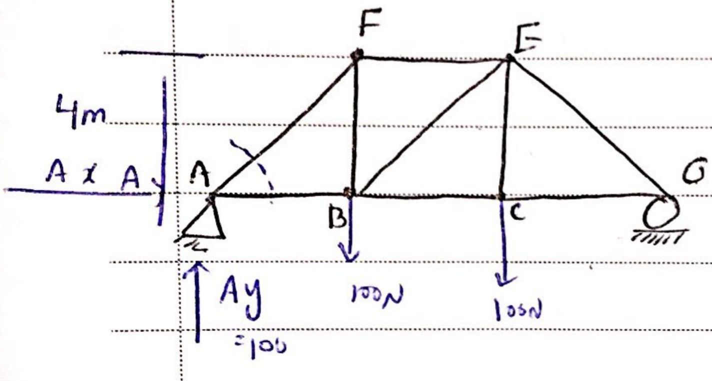
$\sum F_x \neq 0$ $\quad \sum M_o \neq 0$

NO.

Chapter (6) Structural Analysis

6.1 Simple Truss

- Frictionless pin joints
- Load Applied and joints
- To find the force in each Meat and specify if (T or C)



1- F.B.D

2- find support Reaction

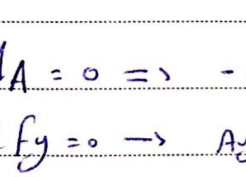
$\circlearrowleft + \sum M_A = 0 \Rightarrow -(3)(100) - (6)(100) + 9 D_y = 0 \quad \therefore D_y = 100N$

$+\uparrow \sum F_y = 0 \rightarrow A_y - 100 - 100 + D_y = 0 \quad \therefore A_y = 100N$

$\sum F_x = 0 \rightarrow A_x = 0$

3. Draw F.B.D on each point: start with the one of Two members assue Tension in the ~~memb~~ meanbe

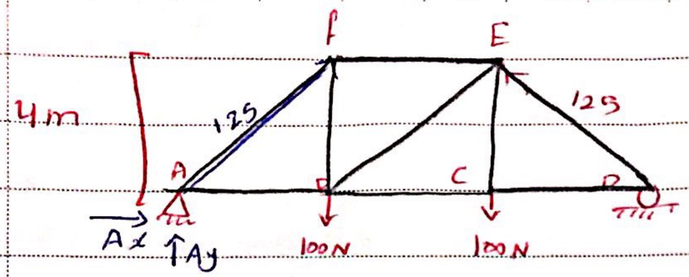
4. Apply equ. equ

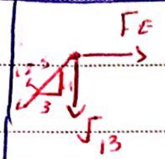
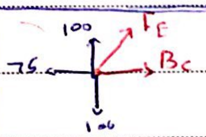
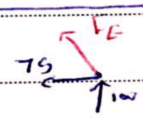
Joint	F.B.D	equ.equ
		$+\uparrow \sum F_y = 0 \rightarrow \frac{4 F_A}{5} + 100 = 0 \quad F_A = -125N$ $\xrightarrow{+} \sum F_x = 0 \rightarrow AB + \frac{3AF}{5} = 0 \Rightarrow AB = 75N$

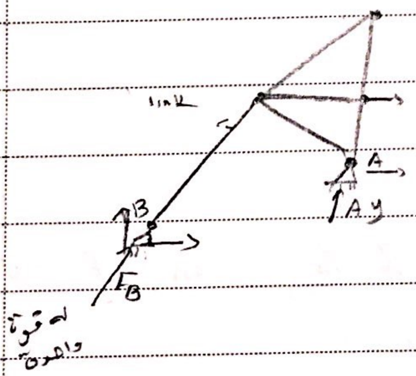
[H.W 6.14]

NO. محاضرة

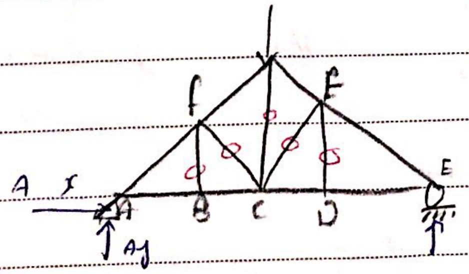
19/3/2017

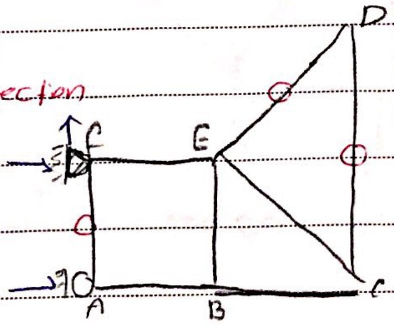


joint	F.B.D	E.q equ
F		$\xrightarrow{+}\Sigma F_x = F_E + \frac{125}{5}\times 3 = 0 \Rightarrow F_E = -75$ (c) $+\uparrow\Sigma F_y = 0 \Rightarrow \frac{125}{5}\times 4 - F_B = 0 \Rightarrow F_B = +100N$ (T)
B		$+\uparrow\Sigma F_y = 0 \Rightarrow \frac{4BE}{5} + 100 - 100 = 0 \Rightarrow BE = 0$ $\xrightarrow{+}\Sigma F_x = 0 \Rightarrow -75 + BC + \frac{3BE}{5} = 0 \Rightarrow BC = +75$ (T)
D		$\xrightarrow{+}\Sigma F_x = 0 \Rightarrow -75 - \frac{3DE}{5} = 0 \Rightarrow DE = -125N$ (C)



6.3 Zero force member => By inspection





NO.

joints

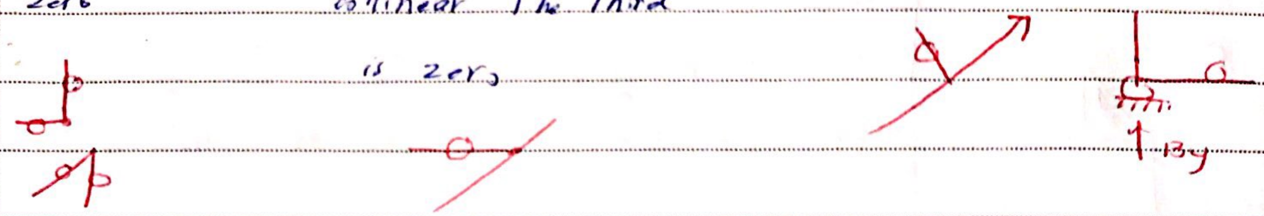
Joint with no load

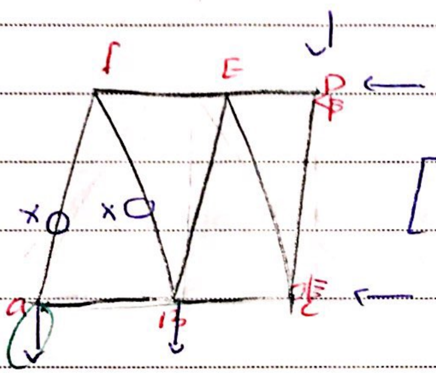
2member not colinear Both at zero

3member 2 of 1/ter are collinear The third is zero

Joint with load

2members one of there is colinear with the load The second is zero

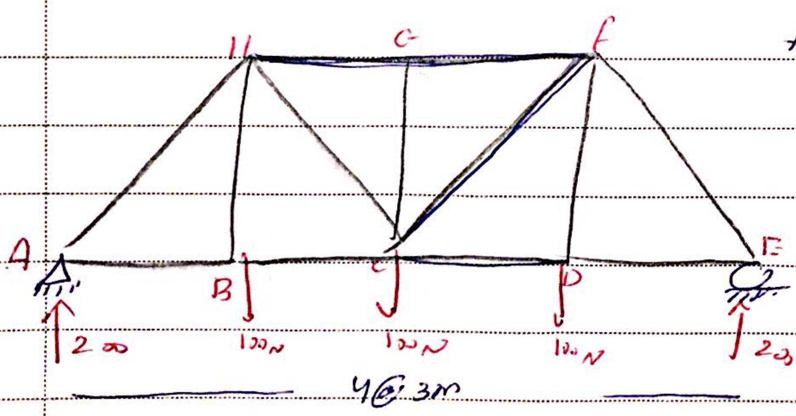




[no zero force member]

6.4 Section method

force in few member



find the force in GF, CF, CD

1. F.B.D

2. Support reaction (not always)

$\Sigma F_x = 0 \quad A_x = 0$

$\Sigma M_A = 0 \quad E_y = 200N$

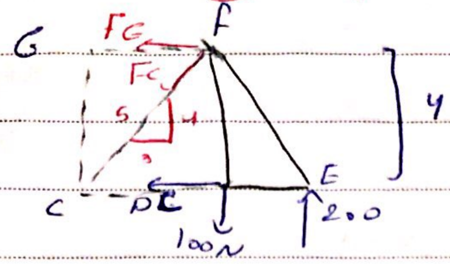
$\Sigma F_y = 0 \quad A_y = 200N$

3. Make section passing thru the member not more than Three member (not always)

NO.

4 Draw F.B.D of either part. Assume Tension in the member

F.B.D of the Right part

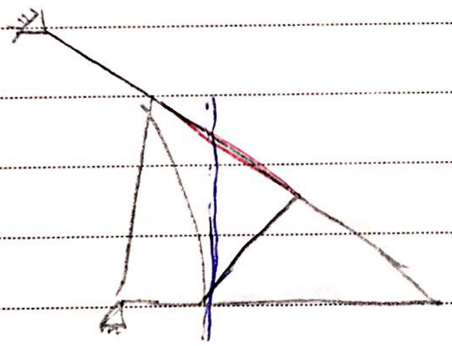


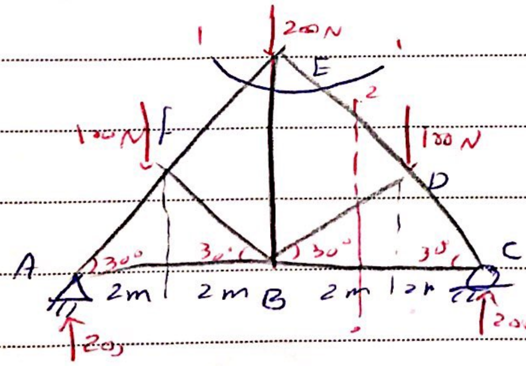
$\circlearrowleft + M_A = 0$

$-4DE + (3)(200) = 0 \Rightarrow DE = +125 (T)$

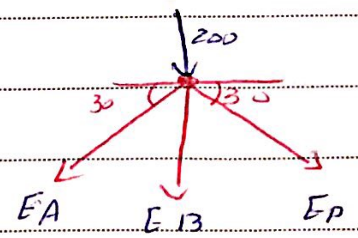
$\Sigma F_y = 0 \quad -\frac{4F_C}{5} - 100 + 200 = 0 \Rightarrow F_C = 125 (T)$

$\circlearrowleft + M_C = 0 \Rightarrow 4F_G - (100)(3) + (6)(200) = 0 \rightarrow F_G = \dots N$





Find the force in EB



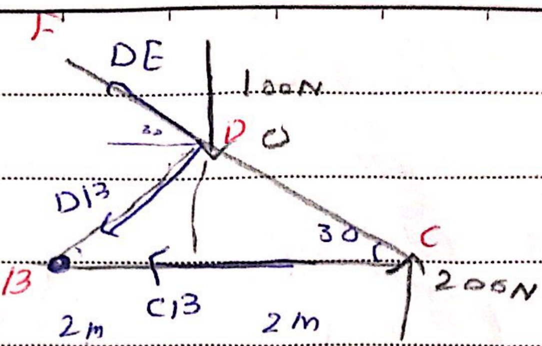
$\Rightarrow$ 3 unknown

Section 2-2

$\circlearrowright + \sum M_{B} = 0$

$-100(2) + 200(4) + DE\sin 30(4)$

$DE = (-) \text{---} N\ (C)$



[example 6.7]

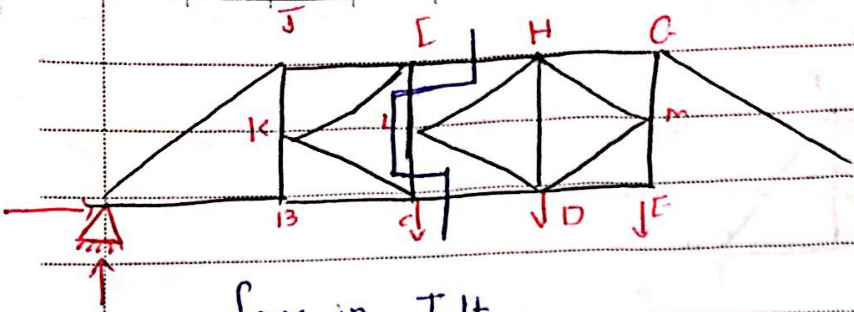
Go to section 1

$\sum f_x = 0$

$\sum f_y = 0 \Rightarrow EB = 0$

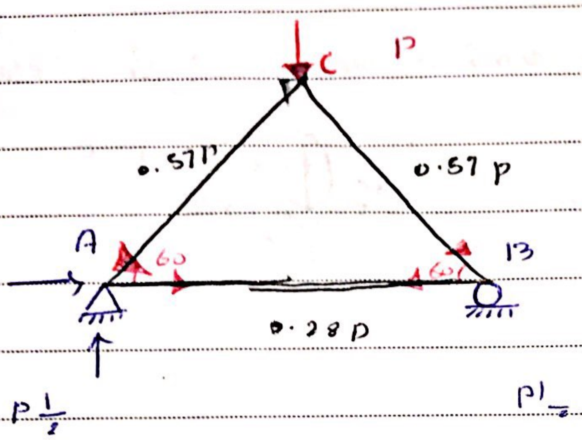
NO. محاضرة 11

21/3/2018



force in IH

$\Sigma M_C = 0 \rightarrow IH$



P = ? if the members can support Max (T) = 2 KN, Max (C) = 1.25 KN

joint (A)   AC   AB

60

P/2

$\rightarrow \Sigma f_x = 0$

$AB + AC\cos 60 = 0$

$AB = 0.28p\ (T)$

$\uparrow \Sigma f_y = 0$

$AC\sin 60 + P/2 = 0$

$AC = \frac{-P}{2\sin 60} = -0.57\ (C)$

joint (B)   BC   BA   60

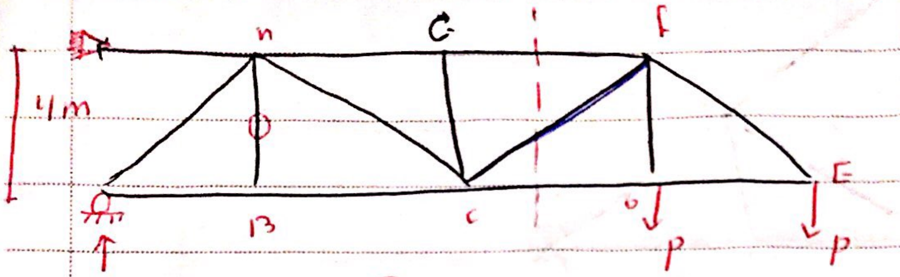
$BC = -0.57p\ (C)$

$1.25 = 0.57p\ (C)$

$p = 2.19\ KN$

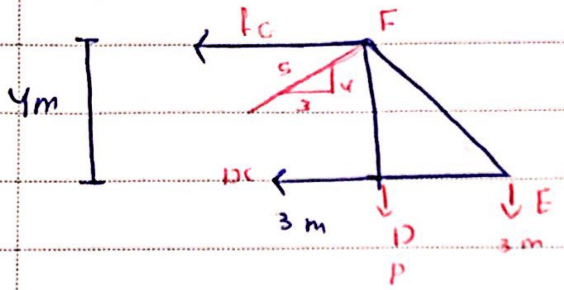
$2 = p * 0.25$

$\therefore p = 7.14\ KN$



find (p) if member cf can support
- Max (t) = 200N
- Max (C) = 150N

4 (a) 3



$+\uparrow \Sigma F_y = 0$

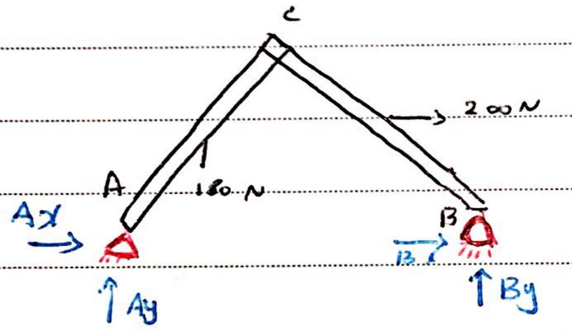
$-\frac{4Fc}{5} - p - p = 0$

$Fc = \frac{-2p \times 5}{4}$

$2.5p = 150$

$p = 60N$

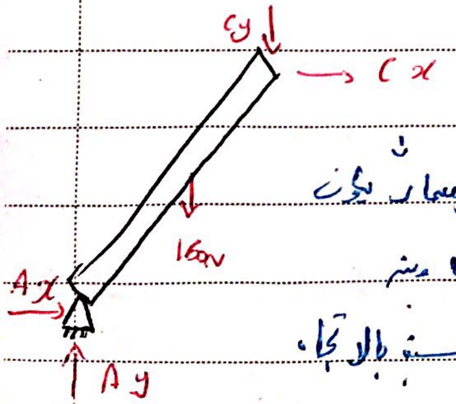
6.6 => frames and machines



4 unkown

3 equ

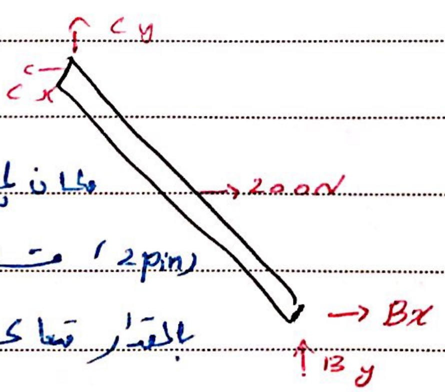
F.B.D of each member



طالما ان العمار يكون

(2pin) فقط منه

بالمقدار تماما عكسه بالاتجاه.

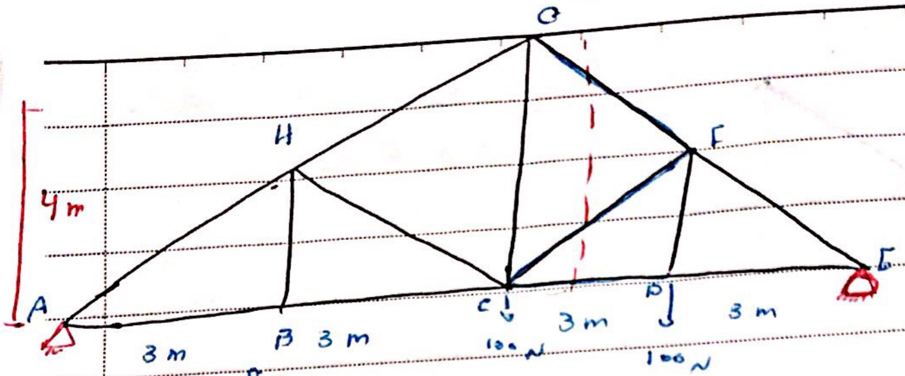


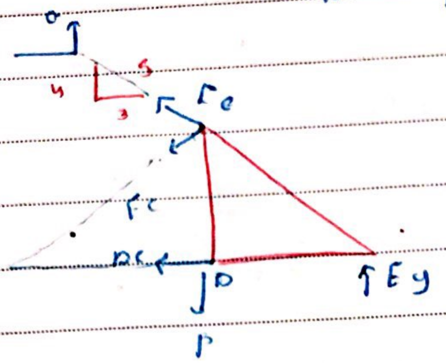
6 unkown

2 member X 3 eq = 6

NO.

Find GF, FC, CD



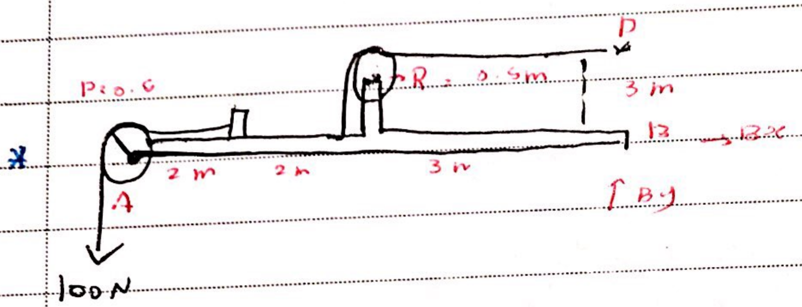


$\Sigma M_F = 0$

$DC = ?$

$\Sigma F_y = 0$

F_C



support reaction :-

$\circlearrowleft + \Sigma M_B = 0$

$-3.5\, T_D + 100\,(7.5) = 0$

$T_D =$

$\Sigma F_y = 0$

$-100 + B_y = 0$

$B_y = ?$

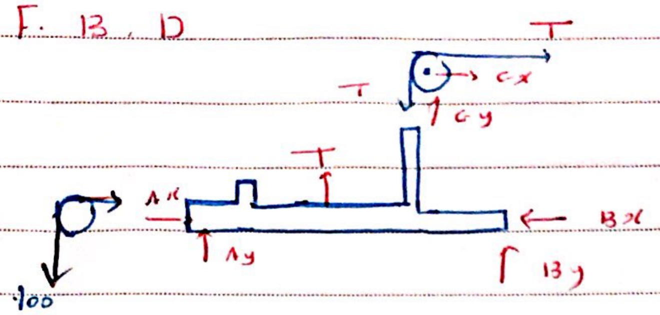
$\Sigma F_x = 0$

$T_D + B_x = 0$

$B_x = ?$

NO.

* F. B. D



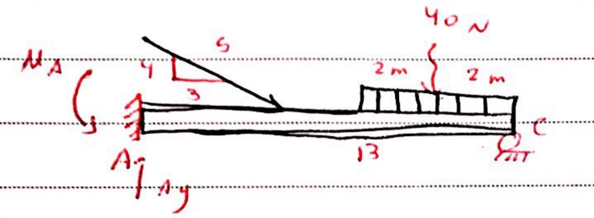
* $\Sigma F_x = 0$

$-Ax + 100 = 0$

$Ax = 100 \leftarrow$

* $\Sigma F_y = 0$

$Ay = 100 \uparrow$



Whole force:-

* $\xrightarrow{+} \Sigma F(x) = 0$

$Ax + 30 = 0$

$Ax = -30 \, N \leftarrow$

* member BC

$\circlearrowleft + M_B = 0$

$(-40)(2) + 4Cy = 0$

$Cy = 20N \uparrow$

$\Sigma Fx = 0$

$Bx = 0$

$+\uparrow \Sigma Fy = 0$

$-By - 40 + \overset{(20)}{Cy} = 0$

$By = -20N\uparrow$

member AB:-

$\circlearrowleft + M_A = 0$

$M_A - 40(2) + 4\overset{-20}{By} = 0$

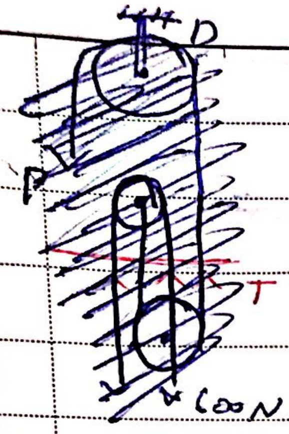
$M_A = N.m$

$+\uparrow \Sigma Fy = 0$

$Ay - 40 + By = 0$

$Ay = N$

NO. 26/3/2018



- find the tension in the caple?
- Find p

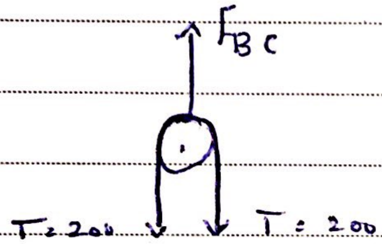
P = 200N

(A)

$\Sigma f_y = 0$

$3T - 600 = 0$

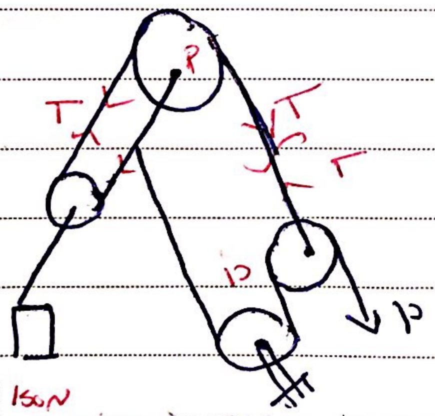
$T = 200N$



$\Sigma f_y = 0$

$F_{BC} - 400 = 0$

$F_{BC} = 400N$



$2T = 150$

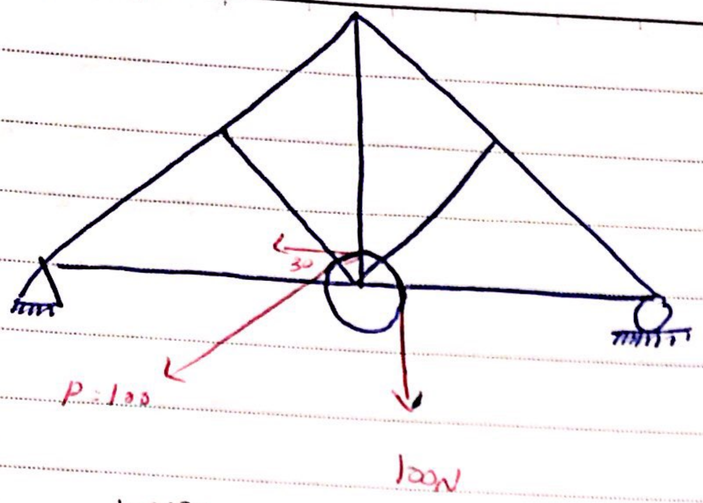
$T = 75$

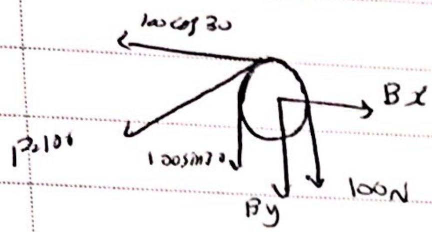
$2p = T$

$2P = 75$

$P = 37.5$

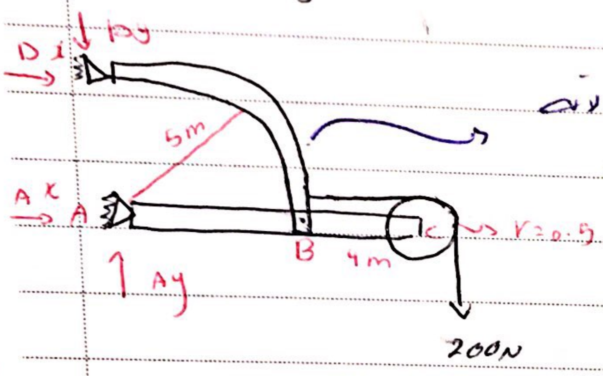
NO.





$\Sigma f_x = 0$

$\Sigma f_y = 0$



لأقوس line لانه
عليها load

* Find support reaction
* force at pin C, B

① F.B.D of whole frame

① $\Sigma M_A = 0$

$-3Dx - 200(7.5) = 0$

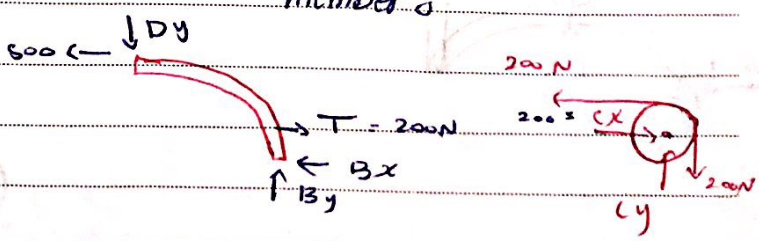
$Dx = -500N$

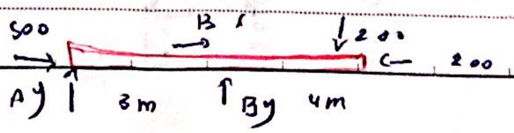
② $\Sigma f_x = 0$

$Ax + Dx = 0$

$Ax = 500$

Free body Digram of each member:





member ABC :-

$\circlearrowleft + \Sigma M_A = 0$

$-3A_y - 200(4) = 0$

$A_y = -266.6\,N \downarrow$

$\xrightarrow{+} \Sigma F_x = 0$

$500 + B_x - 200 = 0$

$B_x =$

$+\uparrow \Sigma F_y = 0$

$A_y + B_y - 200 = 0$

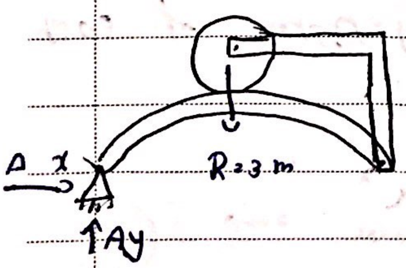
$B_y =$

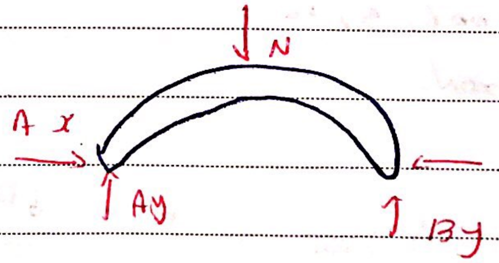
$\Rightarrow$ Take whole frame or member DB

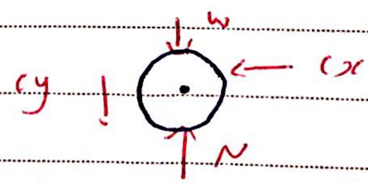
$+\uparrow \Sigma F_y = 0$

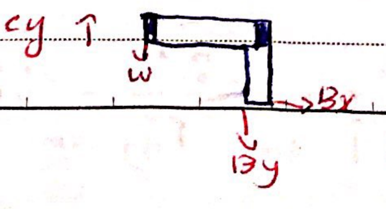
$A_y - D_y - 200 = 0$

e.g (6-20)









NO.

* $\Sigma M_A = 0$

$-20(3) + 3.5(Dx) = 0$

$Dx = 17.1\,kN$

* $\Sigma fx = 0$

$Ax - Dx = 0$

$Ax = 17.1\,kN$

* $\Sigma fy = 0$

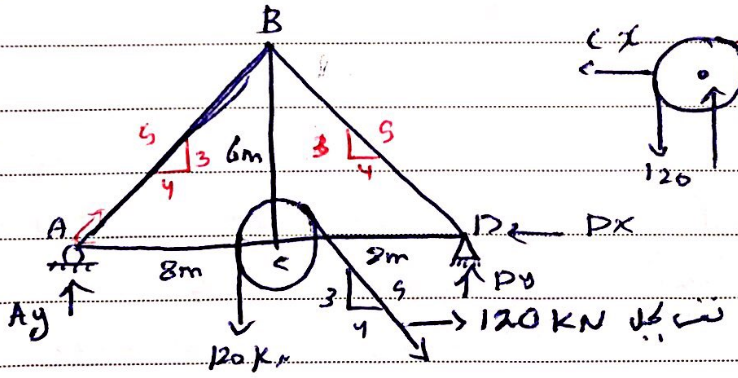
$Ay - 20 = 20N$

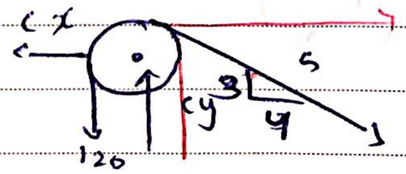
member AB :-

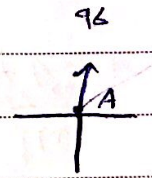
$\Sigma M_B = 0$

$\Sigma fx = 0$

$\Sigma fy = 0$







$\xrightarrow{+} \Sigma Fx = 120\left(\frac{4}{5}\right) - Cx = 0$

$cx = 96$

$+\uparrow \Sigma fy = -120 - 120\left(\frac{3}{5}\right) + cy = 0$

$cy = 120$

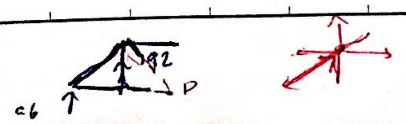
$\circlearrowleft + \Sigma M_D = 0$

$-Ay(16) + 192(8) = 0$

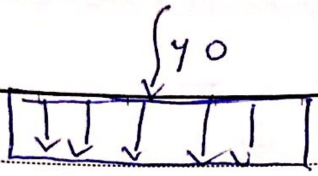
$Ay = 96$

$Dy = 96$

$Dx = 96$

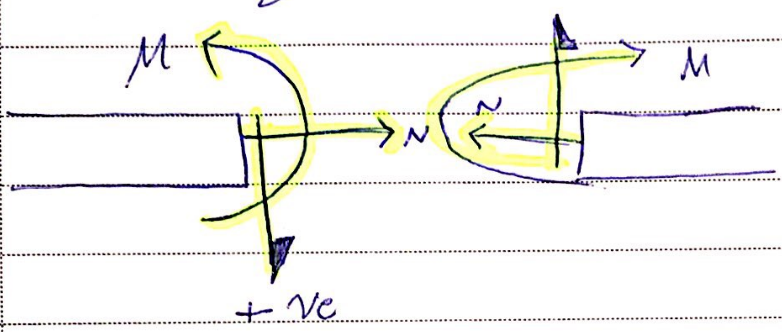


NO. 28/3/2018



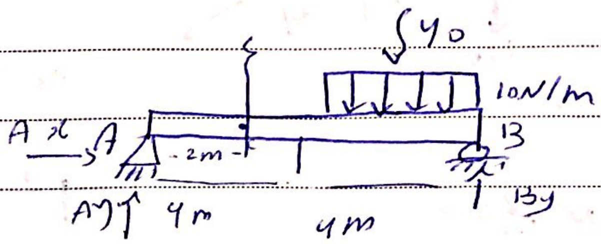
chapter «7» : Internal force [7.1]

N: Normal force ($\overset{+}{T}$ or $\overset{-}{C}$)
V: shear force
M: Bending Moment



«Find the Internal force of point C»

=>



① F.B.D whole digrame
② support reaction

$\Sigma f_x = 0 \rightarrow A_x = 0$

$\Sigma M_A = 0 \rightarrow -(6)(40) + 8B_y = 0$

$B_y = 30N \uparrow$

$+\uparrow \Sigma f_y = 0 \rightarrow A_y - 40 + 30 = 0 \Rightarrow A_y = 10N \uparrow$

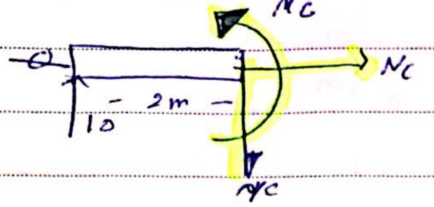
« show them on the structure »

③ Make section passing through the point

④ Draw F.B.D of each part

NO.

left part =>



⑤ show the positive internal force on the section

⑥ Apply equ. equ.

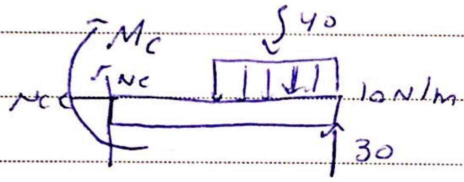
$\Sigma f_x = 0 \quad \rightarrow N_C = 0$

$+\uparrow \Sigma f_y = 0 \quad 10 - V_C = 0 \quad V_C = 10N \ +ve$

$\circlearrowleft + \Sigma M_C = 0 \quad -(2)(10) + M_C = 0 \rightarrow M_C = 20N \cdot m \, (c)$

OR

right part



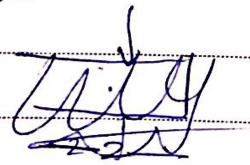
$\Sigma f_x = 0 \quad \rightarrow N_C = 0$

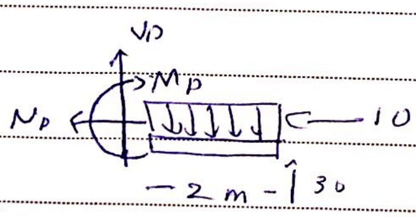
$+\uparrow \Sigma f_y = 0 \quad V_C - 40 + 30 = 0 \rightarrow V_C = 10N +$

$\circlearrowleft + \Sigma M_C = 0 \Rightarrow -M_C - 40(4) + 6(30) = 0$

$M_C = 20N.m \, (+)$

point (D)



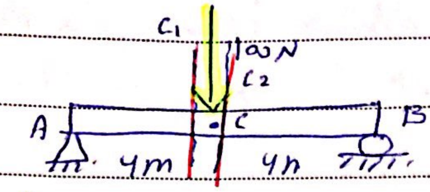


$+\uparrow \Sigma f_y = 0$

$V_D - 20 + 30 = 0$

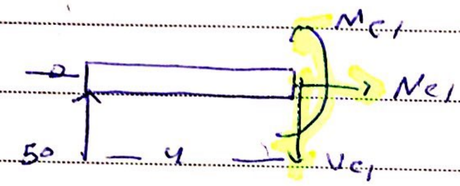
$V_D = -10 \ N$

$\circlearrowleft + \Sigma M_D = 0 \quad (-20)(1) + (2)(30) - M_D = 0$



① for concentrated load or moment → Make 2-section one just to the left of the load and other just to the right of the load

section $C_1 - C_1$



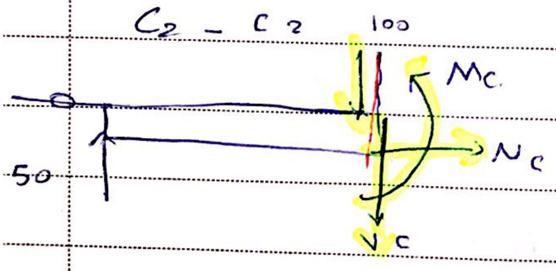
$\Sigma F_x = 0 \therefore N_{c_1} = 0$

$\Sigma F_y = 0 = 50 - V_{c_1} = 0$

$V_{c_1} = 50\ N$

$\circlearrowleft + \Sigma M_{c_1} = 0 = -(50)(4) + M_c = 0 \Rightarrow M_c\ 200\ N.m$

$C_2 - C_2$



$\Sigma F_x = 0 \qquad N_C = 0$

$+\uparrow \Sigma F_y = 0 \rightarrow 50 - 100 - V_C \Rightarrow$

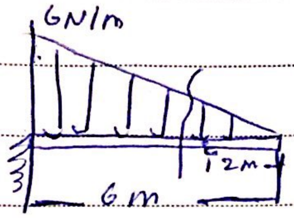
$V_C = -50N$

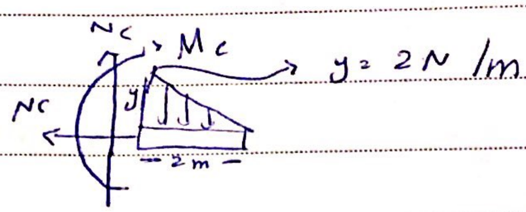
$\circlearrowleft + \Sigma M_c = 0 = (-50)(4) + M_c = 0$

$N_c = +200\ N.m$

$M_{befor} = M_{after}$

example ⇒





$$\frac{y}{2} = \frac{6}{6}$$

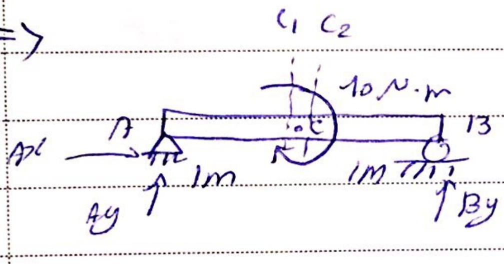
$$y = 2$$

$\Sigma f x = 0 \rightarrow N_C = 0$

$+\uparrow \Sigma f y = 0 \Rightarrow V_C - 2 = 0 \qquad V_C = 2$

$\circlearrowleft + \Sigma M_C = 0 \Rightarrow -M_C - (2)(\frac{2}{3}) = 0 = M_C = \ldots N.m$

⇒

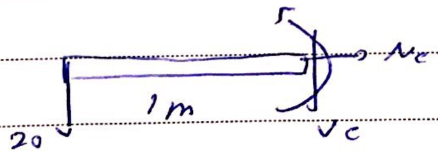


$Ax = 0$

$Ay = -20 = 20 \downarrow$

$By = 20$

C_1 M_1



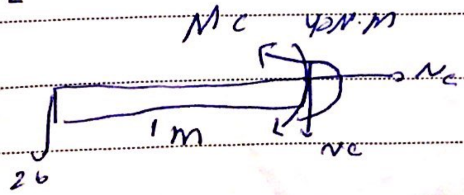
$\Sigma f x = 0 \quad N_C = 0$

$\Sigma f y = 0 \Rightarrow -20 - V_C = 0 \Rightarrow V_C = -20$

$\Sigma M_{C_1} = 0 \quad (20)(1) + M_C = 0$

$M_C = -20 N.m$

C_2



$N_{C_2} = 0$

$\Sigma f y = 0 \Rightarrow -20 - V_{C2} = V_{C_2} = -20$

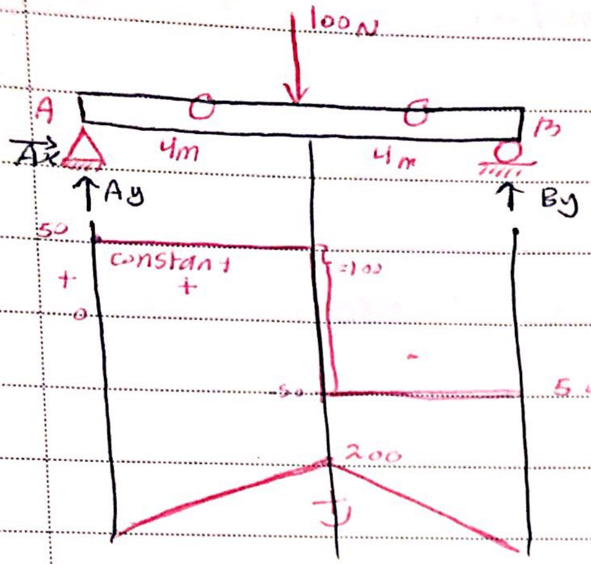
$\Sigma M_C = 0$

$(20)(1) - 40 + M_{C2} = 0$

$M_C = +20$

NO. 2/4/2018

7.2 Shear and Moment Diagrams:-



=> zero

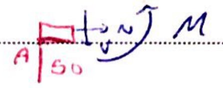
zero shear => Max moment

S.D (N) => constant

M.D (N.m) 1st order

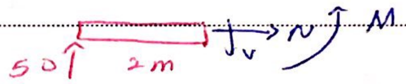
$\Sigma F_y = 0$ $\quad 50 - V = 0 \rightarrow V = 50\ N$

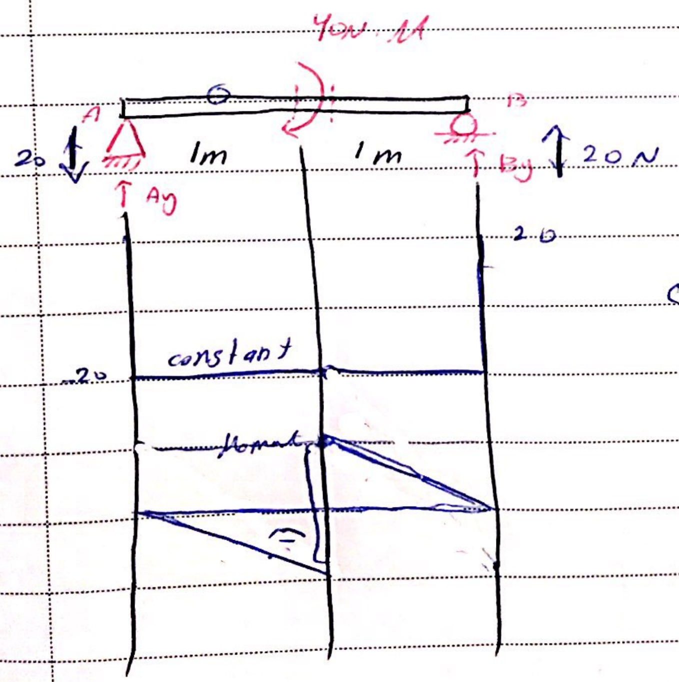
$\Sigma M = 0 \rightarrow M = 0$



$\Sigma F_y = 0$ $\quad 50 - N = 0 \rightarrow V = 50$

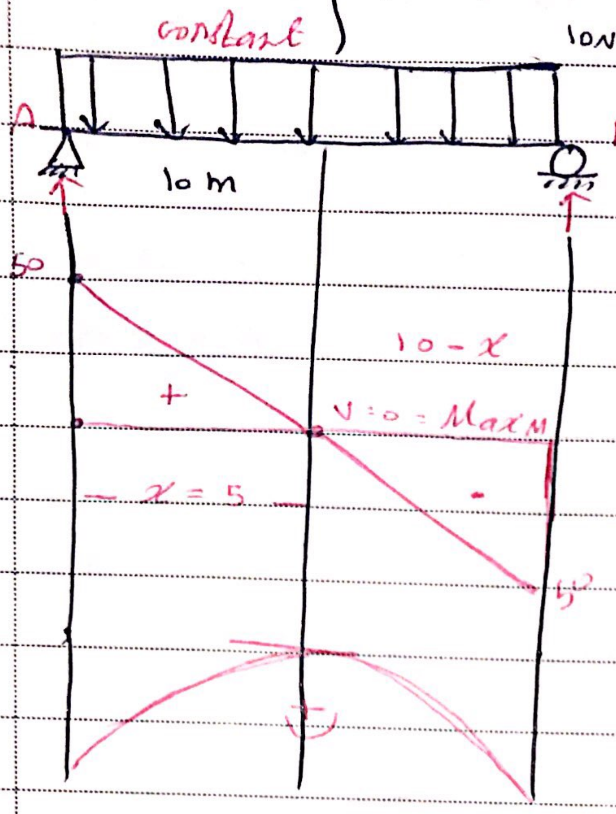
$\Sigma M = 0$ $\quad : -50(2) + M \quad \therefore M = 100$





c.w ↻ ↑ M_D ↓ ↺ c.c.w

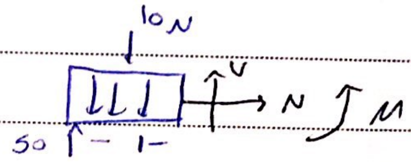
100N NO.



=> constane

S.D(N) => 1st order

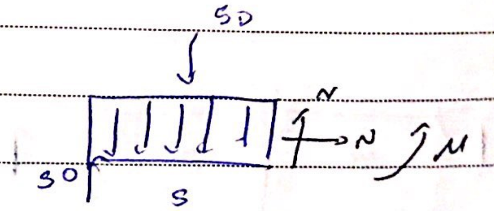
2nd order



$\Sigma F_y = 0 \Rightarrow 50 - 10 - V = 0$

$V = 40\,N$

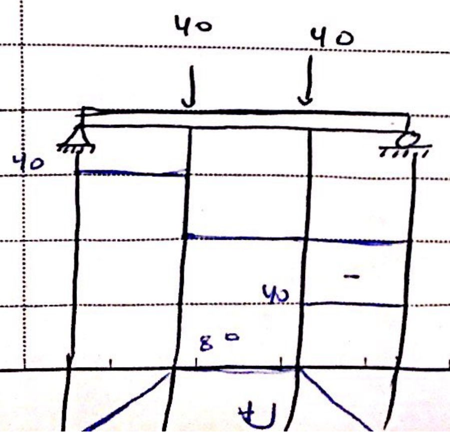
$\circlearrowleft + \Sigma M = (-50)(1) + (10)(0.5) + M = 0 \Rightarrow M = 46\,N.m$



$\Sigma F_y = 0 \Rightarrow 50 - 50 - V = V = 0$

$\circlearrowleft + M = 0 \quad (-5)(50) + (50)(2.5) + M = 0$

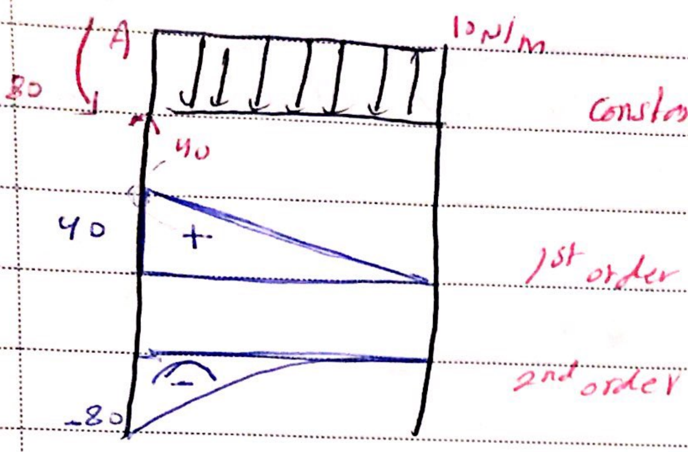
$M = 125\,N.m$



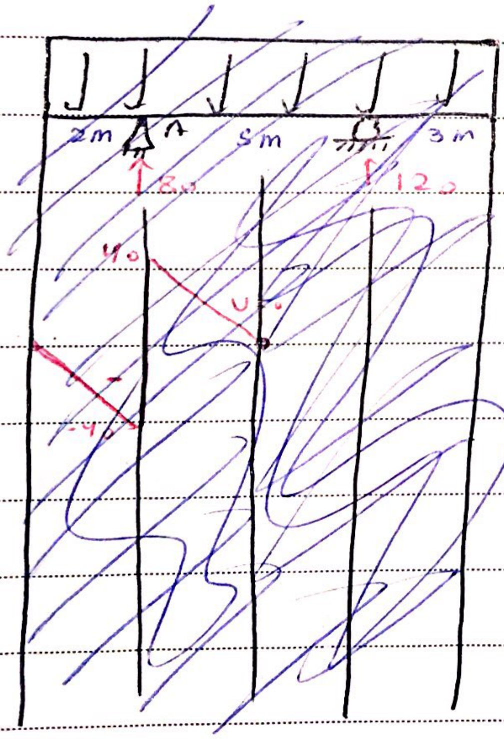
S.D (N)

M.D. (N.M)

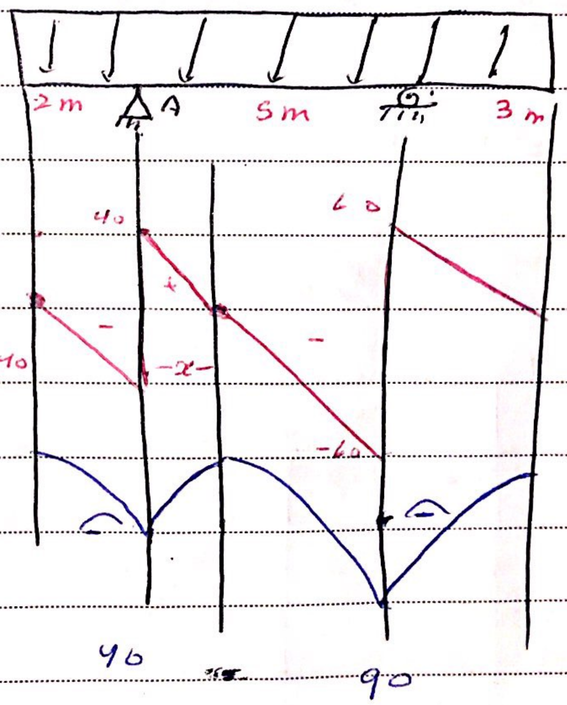
NO.



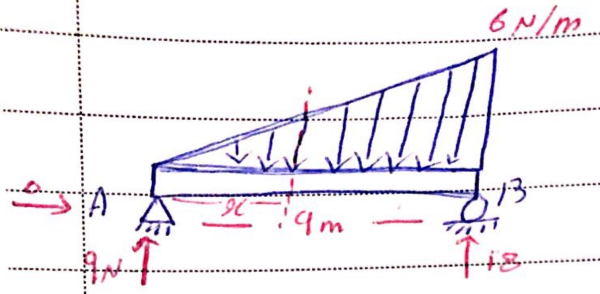
سؤال التالي



«السؤال اتقان»



7.3 Relation between load, shear, and moment

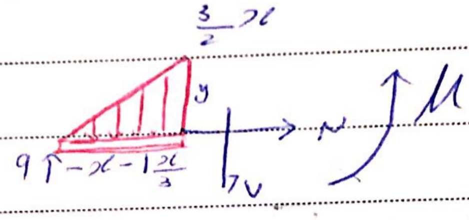


- Derive the shear and Moment equation

- Draw S.D, M.D

$$\frac{y}{x} = \frac{6}{9}$$

$$y = \frac{2}{3}x$$



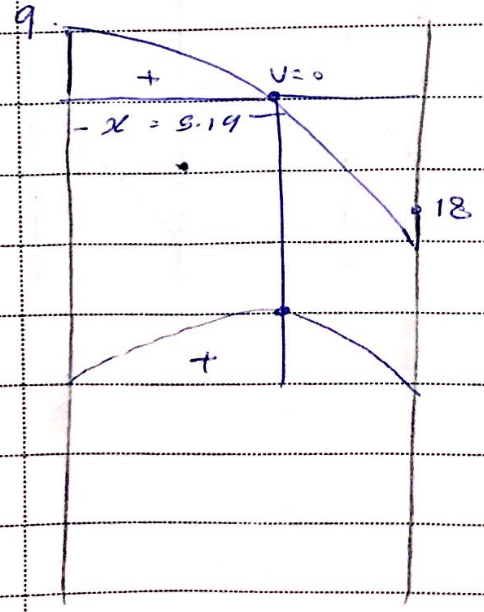
$$\Rightarrow V = 9 - \frac{x^2}{3}$$

$$+\uparrow \Sigma F_y = 0$$

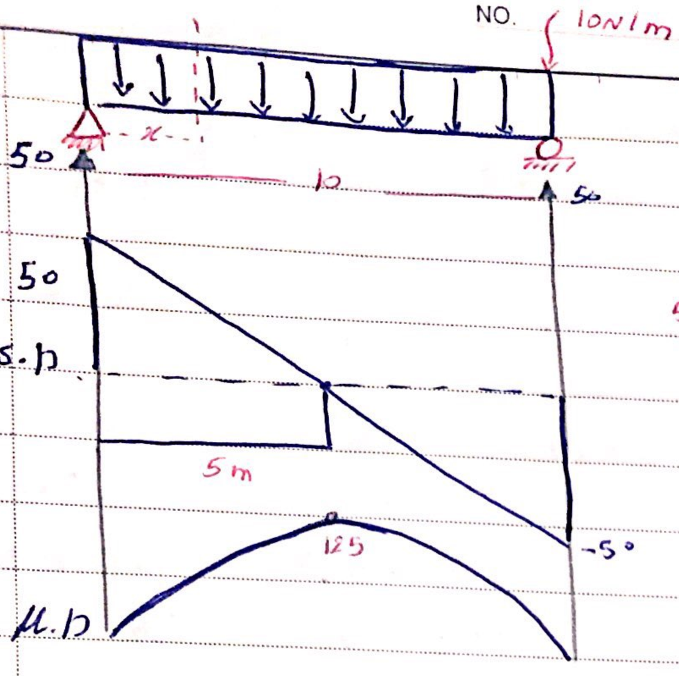
$$9 - \frac{x^2}{3} - V = 0$$

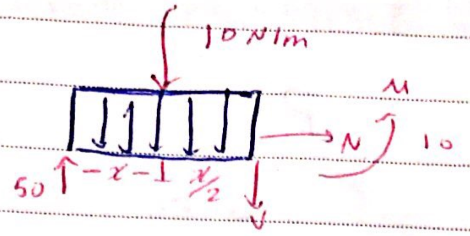
$$M = -x^3/9 + 9x$$

$$V = 9 - x^2/3$$



NO.





$\uparrow \Sigma F_y = 0 \rightarrow 50 - 10x - V = 0$

$V = 50 - 10x$

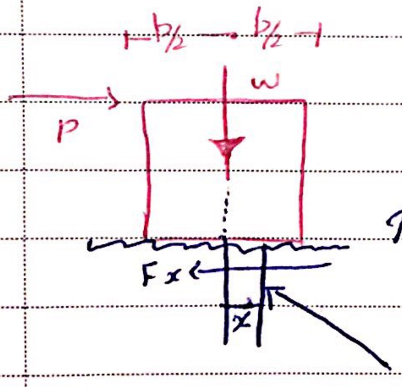
$\circlearrowleft^{+} \Sigma M = 0 \rightarrow -50x + \frac{10x^2}{2} + M = 0$

$M = 50x - 5x^2$

$\frac{dM}{dx} = V \quad , \quad \frac{dV}{dx} = w$

chapter "8" Friction

8.2 problems involving Dry friction



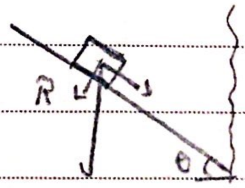
Rough surface

$x > b/2 \rightarrow$ Tipping

$x < b/2$

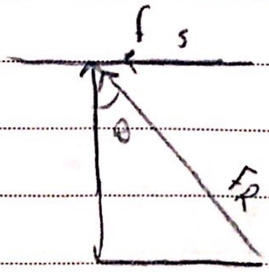
F x > friction force $= \mu_s N$

(coefficient of friction)



μ_s

$\mu_k < \mu_s$



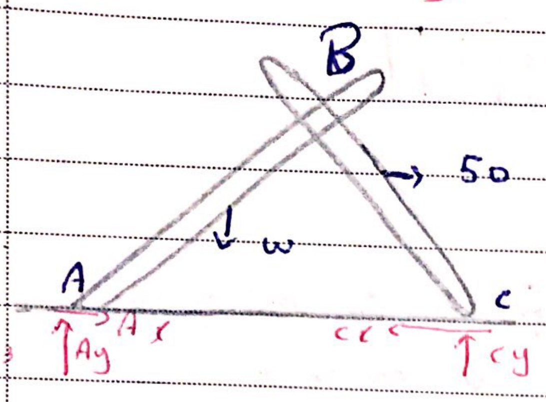
$\tan\theta = \frac{f_s}{N} = \frac{\mu_s \cancel{N}}{\cancel{N}} = \mu_s$

θ = Angle of Repose

[3 type of case]

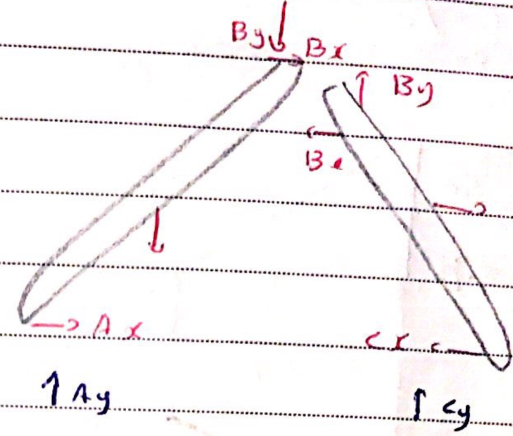
NO.

① No Impending Motion



whole force

Ay, Cy



member AB

$\Sigma M_B = 0 \rightarrow Ax$

member BC

$\Sigma M_B = 0 \rightarrow Cx$

use friction equation for check

$Ax \; ? \; \underbrace{\mu_A}\, Ay$

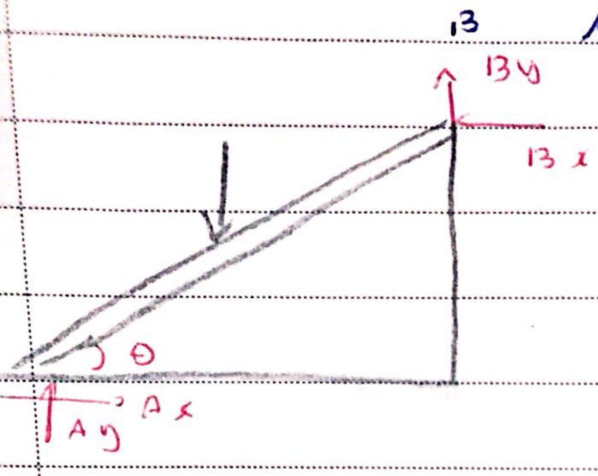
friction at A

$Ax > \mu_A Ay \rightarrow$ sliding

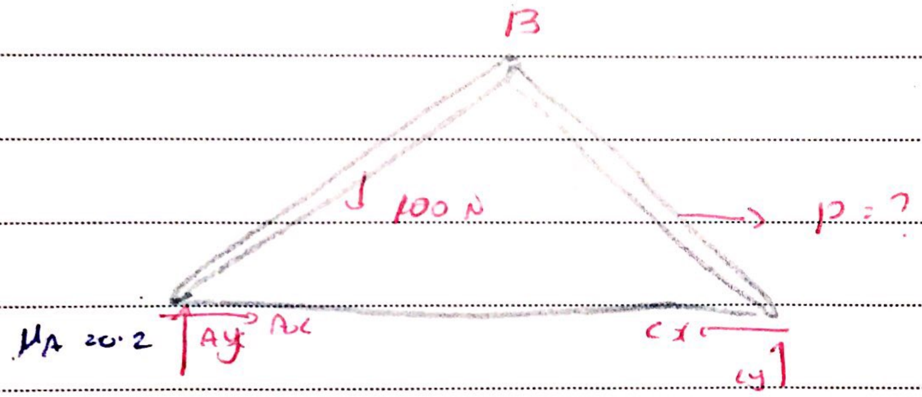
$Ay < \mu_A Ay \rightarrow$ check

$Cx \; ? \; \mu_C Cy$

(2) Impending Motim at all points



5 unknowing
3 equ eqa
+ 2 friction equatio

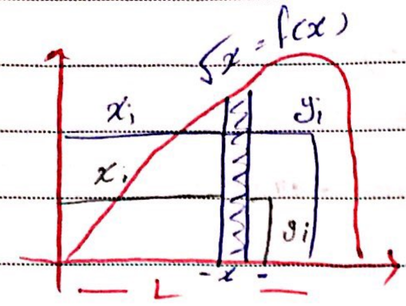


$\mu_C = 0.3$

7 unknow
6 equilibrim
1/2 friction

9 Center of Gravity, Centroid

9.1 centroid of an Area



find centroid of the Area

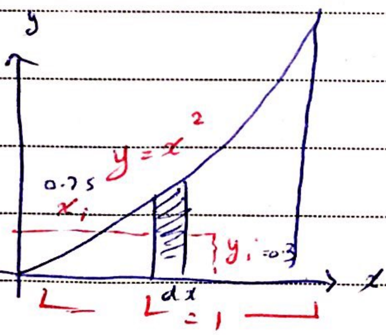
$$dA = y\,dx = f(x)\,dx$$

$$x_i = x$$

$$y_i = y/2 = \frac{f(x)}{2}$$

$$\bar{x} = \frac{\int x_i\,dA}{\int dA}$$

$$\bar{y} = \frac{\int y_i\,dA}{\int dA}$$



$$dA = y\,dx = x^2\,dx$$

$$x_i = x$$

$$y_i = y/2 = \frac{x^2}{2}$$

$$\int dA = \int_0^1 x^2\,dx = \left.\frac{x^3}{3}\right]_0^1 = 1/3\ m^2$$

$$\int x_i\,dA = \int_0^1 x\,(x^2\,dx) = \int_0^1 x^3\,dx = \left.\frac{x^4}{4}\right]_0^1 = 1/4$$

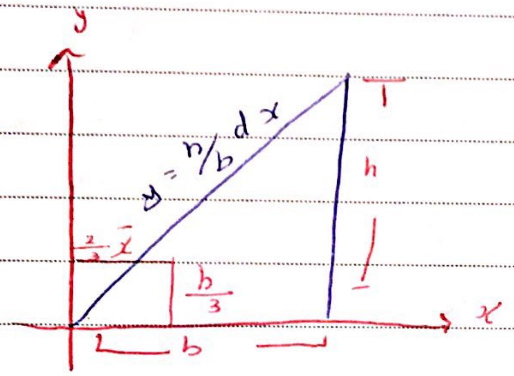
$$\bar{x} = \frac{\int x\,dA}{\int dA} = \frac{1/4}{1/3} = 0.75\ m$$

NO.

$$\int_0^1 y_i \, dA = \int_0^1 \left(\frac{x^2}{2}\right)(x^2 dx) = \int_0^1 x^4/_2 \, dx$$

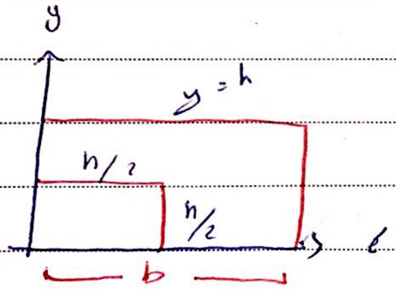
$$= \left.\frac{x^5}{10}\right]_0^1 = \frac{1}{10}$$

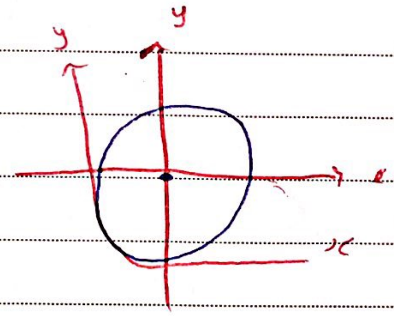
$$\bar{y} = \frac{\int y_i \, dA}{\int dA} = \frac{1/10}{1/3} = \frac{3}{10} = 0.3$$



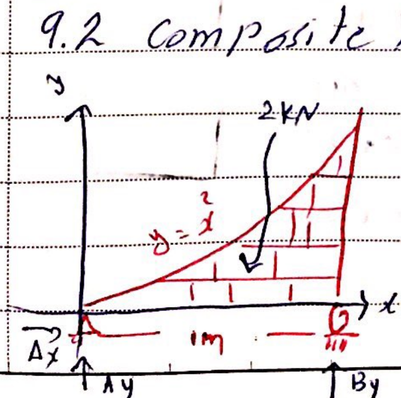
$$\bar{x} = \frac{2}{3} b$$

$$\bar{y} = \frac{h}{3}$$





9.2 Composite Area



$\gamma = 6 \, \mathrm{Km/m^2}$

Find support reaction

$$\text{weight} = \frac{6 \, \mathrm{Km}}{m^2} \times \frac{1}{3} m^2 = 2 \, \mathrm{KN}$$

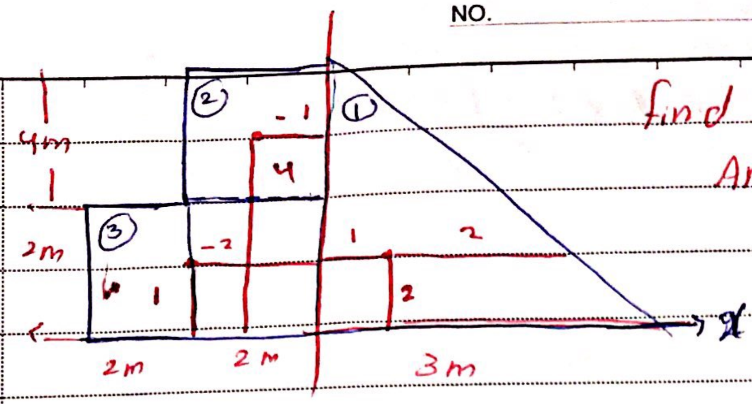
$$\Sigma M_A = -2(0.75) + B_y = 0$$

B_y

$$\Sigma F_x = 0 \;\; -A_x = 0$$

$$\Sigma F_y = 0 \rightarrow A_y + 2 + B_y = 0 \Rightarrow A_y$$

NO.



find the centroid of the Areas - from the shown axsis

1- Defind the Refrence Area
2. " the Area into simple shape
3. find the Area of each part
4. " " centroid of each part from the Refrence
(x_i, y_i)

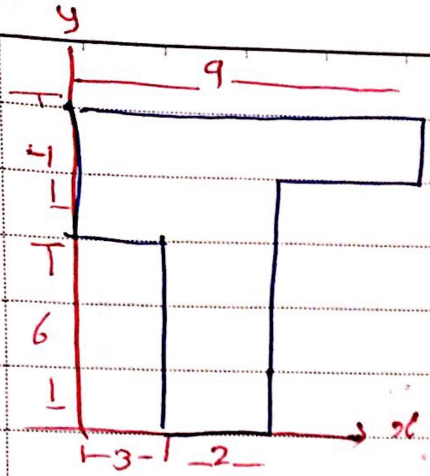
$\bar{x} = \frac{\Sigma x_i A_i}{\Sigma A_i}$, $\bar{y} = \frac{\Sigma y_i A_i}{\Sigma A_i}$

$$\bar{x} = \frac{(1)(\frac{6}{2} \times 3) + (-1)(4 \times 2) + (-2)(2 \times 3)}{(\frac{6}{2})(3) + (4 \times 2) + (4 \times 2)} =$$

$$\bar{y} = \frac{(2)(\frac{6}{2} \times 3) + (4)(4 \times 2) + (1)(4 \times 2)}{(\frac{6}{2})(3) + (4 \times 2) + (4 \times 2)} =$$

	Area	x_i	y_i	$x_i A_i$	$y_i A_i$
1	$(\frac{6}{2})(3)=9$	1	2	(1)(4)	(2)(4)
2	$(2 \times 4)=8$	-1	4	(8)(-1)	(4)(8)
3	$(2 \times 4 = 8$	-2	1	(-2) 8	(8) (1)

NO.



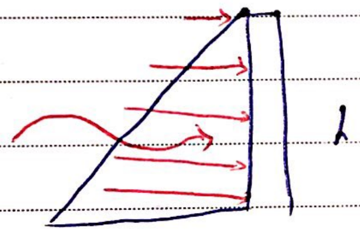
find the centroid

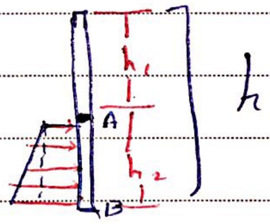
9.5 fluid pressure

$\gamma_{w} = \ldots N/m^3$ $\gamma = \rho \times 9.81$

$\rho_{w} = kg/m^3$

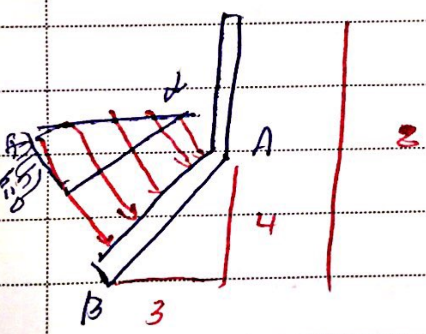
density



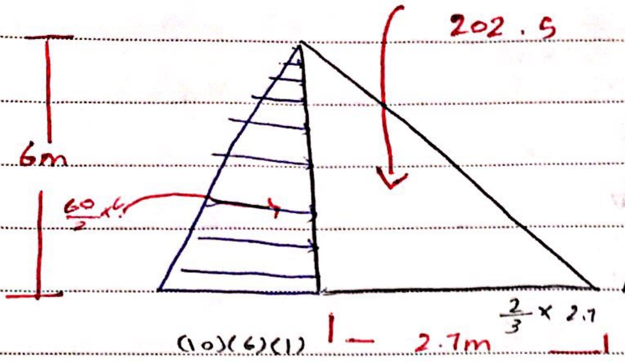


pressure on AB

$P_B > P_A$



NO.



$(10)(6)(1) = 60$

$\gamma_w = 10 kN/m^3$

$\gamma_c = 25 kN/m^3$

$w = (25)\left(\frac{2.7}{2}\right)(6) = 202.5 kN$

=> what is the Resaltant force and Moment at A due to the water pressure the weight of the Damm?

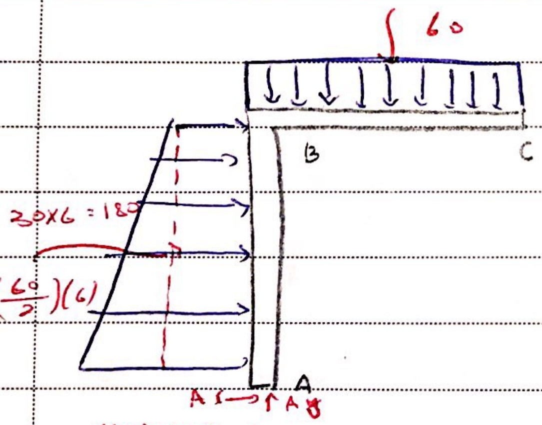
$\Sigma f_x =$

$\Sigma f_y =$

$F_R = \sqrt{\Sigma f_x^2 + \Sigma f_y^2}$

$\theta = \tan^{-1}\left(\Sigma f_y / \Sigma f_x\right)$

$\Sigma M_A =$ ____



$(10)(9) = 90$

$\gamma = (10)(3) = 30$

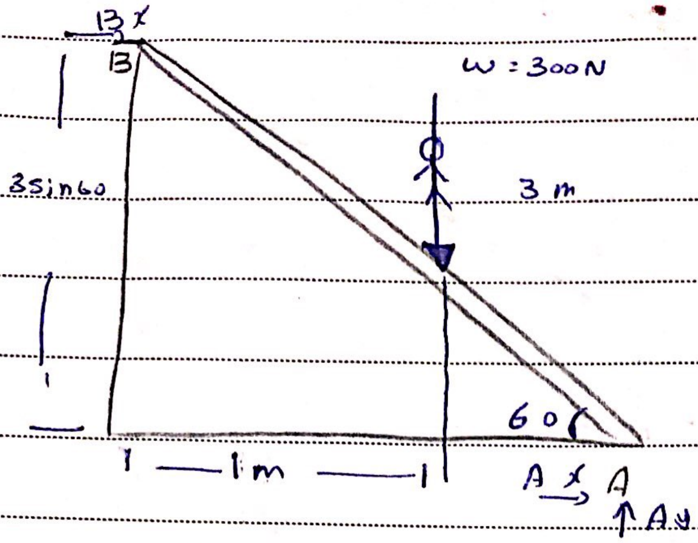
$\gamma_w = 10 kN/m^3$

=> find suppat Reaction due to wale pressure

$\Sigma f_x = 0 \rightarrow A_x$

$\Sigma f_y = 0 \rightarrow A_y$

$\Sigma M_A = 0 \rightarrow M_A$



- 80 kg
- smooth at B

$M_A = ?$

$\circlearrowleft \sum M_A = 0$

$(800)(3\cos 60 - 1) - Bx(3\sin 60) = 0 \qquad Bx = $ —

$\sum f_x = 0 \rightarrow Ax$

$\sum f_y = 0 \rightarrow Ay$

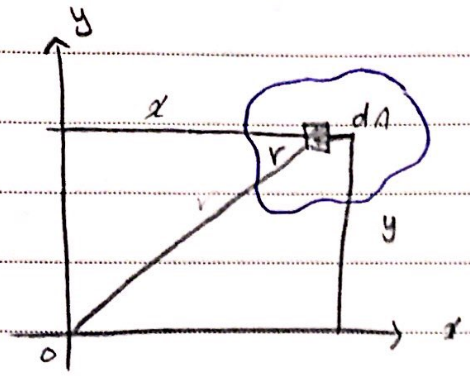
$Ax = M_A A_y$

$M_A =$ —

NO.

Chapter «10» Moment of Inertia (MoI)

second Moment of an Area

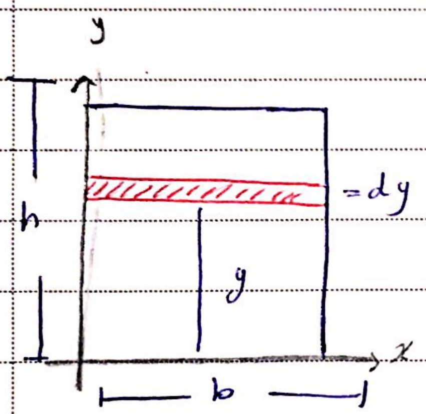


$$I_x = \int y^2 \, dA$$

$$I_y = \int x^2 \, dA$$

$$I_o = \int r^2 \, dA = \int (x^2 + y^2) \, dA$$

$$= \int x^2 \, dA + \int y^2 \, dA = I_x + I_y$$



⇒ element parallel to x-axis

$$I_x = \int y^2 \, dA$$

$$dA = b\,dy$$

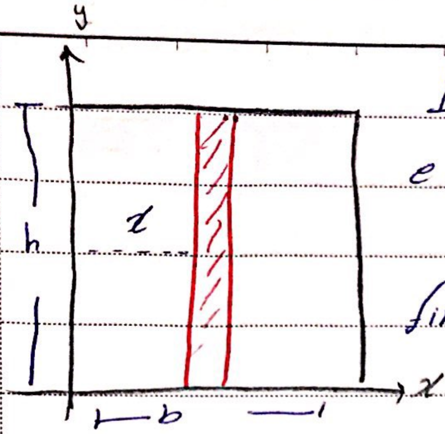
$$y_i = y$$

$$I_x = \int y^2 \, dA = b \int_0^h y^2 \, dy = \frac{by^3}{3}\Big]_0^h = \frac{bh^3}{3} \; m^4$$

$$I_y = \int x^2 \, dA = h \int_0^b x^2 \, dx = \frac{hx^3}{3}\Big]_0^b = \frac{hb^3}{3} = m^4$$

$$I_o = I_x + I_y = \frac{bh^3}{3} + \frac{hb^3}{3}$$

Scanned with CamScanner



I_y

element parallel to y-axis

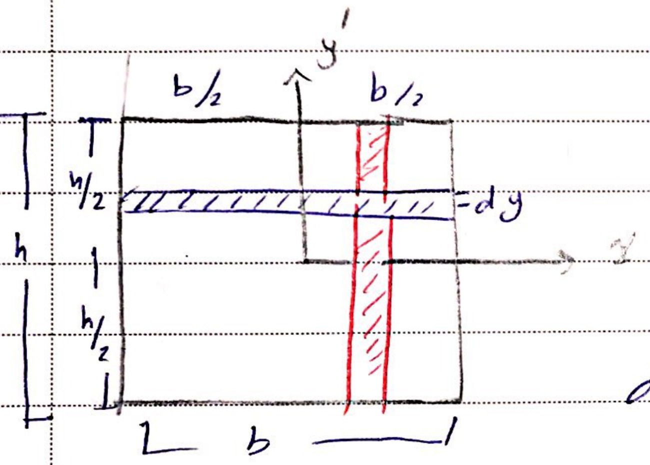
find I_x

I_y

I_M

$dA = h\,dx$

$x_i = x$



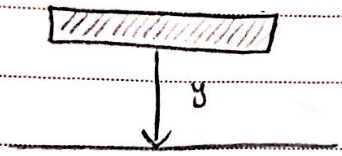
Determine MoI about centroidal

$dA = b\,dy$

$$I_{x'} = \int y^2 dA = b\int_{-h/2}^{h/2} y^2\,dy$$

$$= \frac{by^3}{3}\Big]_{-h/2}^{h/2}$$

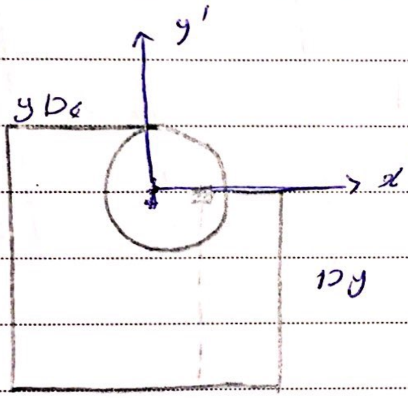
$$I_{y'} = \frac{hb^3}{12}$$



$$I = Ay^2 \qquad K_x = \sqrt{\frac{I_x}{A}}$$

$$y = \sqrt{\frac{I}{A}} \qquad K_y = \sqrt{\frac{I_y}{A}}$$

$$K_o = \sqrt{\frac{I_o}{A}}$$



$$I_{x'} = \int y'^2 \, dA$$

$$\bar{y}' = \frac{\int y' \, dA}{\int dA}$$

$$I_x = \int y^2 \, dA = \int (y' + D_y)^2 \, dA$$

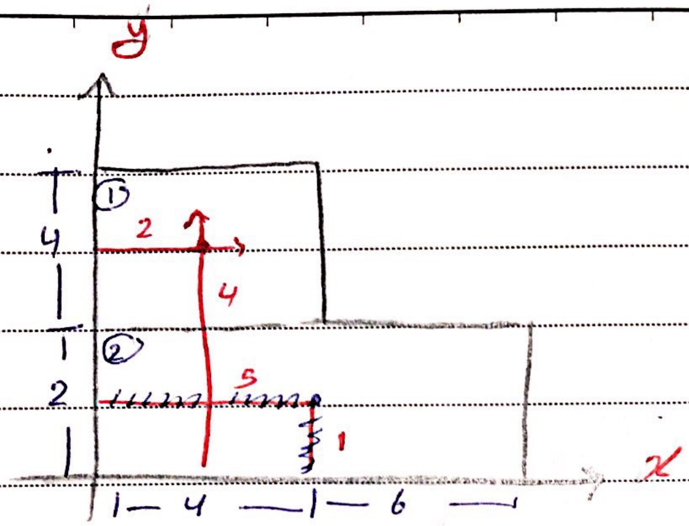
$$= \int y'^2 \, dA + 2\int y' D_y \, dA + \int D_y^2 \, dA$$

$$= \int y'^2 \, dA + 2 D_y \overset{0}{\cancel{\int y' \, dA}} + D_y^2 \int dA$$

مهم $\Leftarrow$ $I_x = I_{x'} + D_y^2 A$

$$I_y = I_{y'} + A D_x^2$$

NO.



$I_x = \sum I_x$

$I_x = \sum I_x' + \sum A_i D_x^2$

	A_i	I_x'	I_y'	D_y	D_x	AD_y^2	AD_x^2
1	4×4 16	$\frac{4(4)^3}{12}$	$\frac{(4)(4)^3}{12}$	4	2	$16(4)^2$	$16(2)^2$
2	2×10 20	$\frac{(10)(2)^3}{12}$	$\frac{2(10)^3}{12}$	1	5	$20(1)^2$	$20(5)^2$
		$\sum I_x'$	$\sum I_y'$			$\sum AD_y^2$	$\sum AD_y^2$