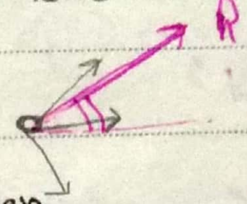
SUN. MON. TUES. WED. THUR. FRI. SAT. NO. DATE / /

L2: Statics of Particles

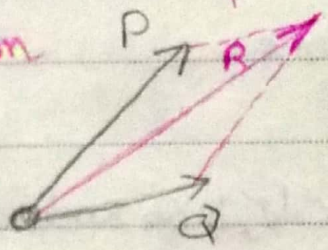
ايجاد ال resultant force



* equilibriam → $\Sigma F = 0$

F = Vector → magnitued [X N], direction

- لإيجاد المحصلة ← لازم أوجد magnitued المحصلة
- direction المحصلة



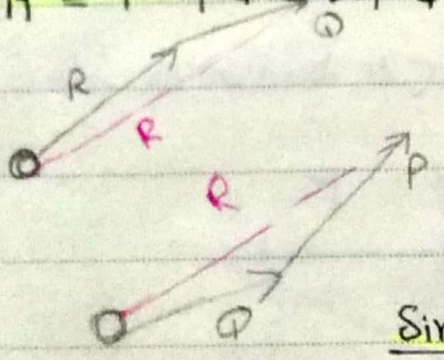
graphical

① Triangle rule + Trapazoid ⇒ graphical.

② Law of cosines :-

- $R^2 = P^2 + Q^2 - 2PQ\cos B$ → الزاوية بين P, Q ∠2

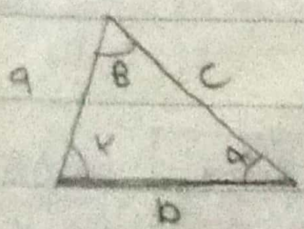
ارسمهم head to tail



③ Law of sines :

$$\frac{\sin A}{Q} = \frac{\sin B}{Q} = \frac{\sin C}{P}$$

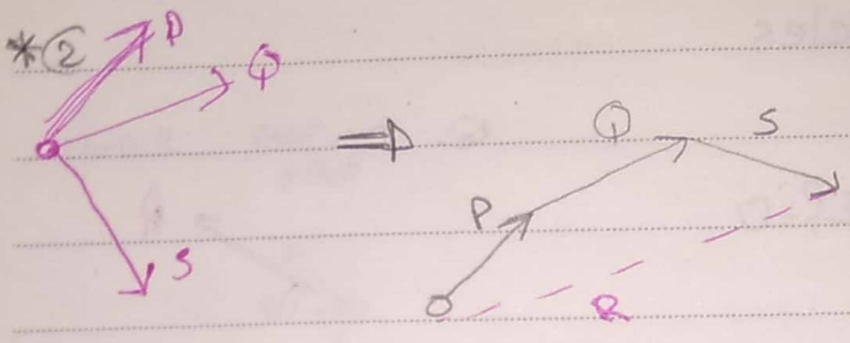
∘ $\vec{P} + \vec{Q} = \vec{Q} + \vec{P}$, $\vec{P} - \vec{Q}$ → عكس الاتجاه Q



$$\Rightarrow \frac{a}{\sin\alpha} = \frac{b}{\sin B} = \frac{c}{\sin\gamma}$$

NO.
DATE / /
SUN. MON. TUES. WED. THUR. FRI. SAT.

*②

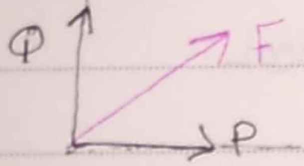


① * $\vec{P} + \underbrace{\vec{Q} + \vec{S}}_{\downarrow}$

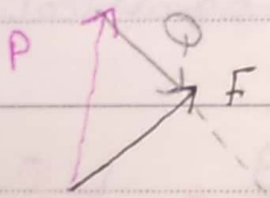
$\underbrace{P + R_1}_{R}$

*Concurrent forces → Point of application يتطبقوا على نفس ال

$\sqrt{3}$ vector | force components — تحليل القوة لمركبات



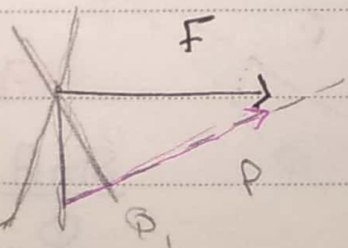
إذا بعرف F وبعرف واحدة من المركبات بنطلع المركبة الثانية



إذا بعرف واحد من المركبات direction و F

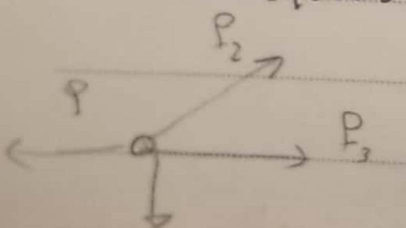
*minimum

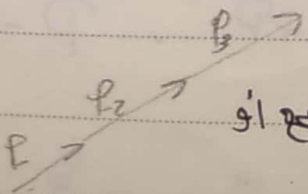
$Q \perp P$



لانهائيات ← Q_3 Q_2 Q_1

Concurren forces

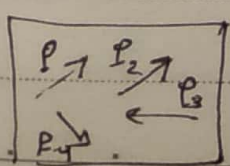




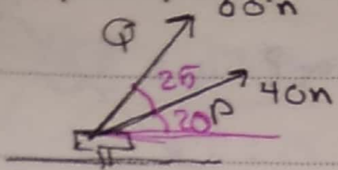
→ Collinear force

نفس ال Line of action يجمع أو يطرح.

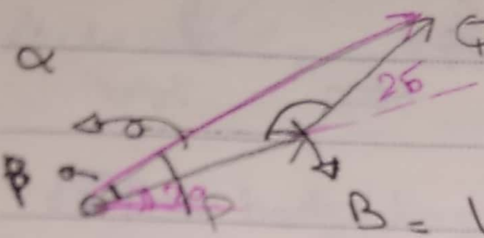
Coplanar forces ←



example :-



determine the $\underline{R}$



$R^2 = P^2 + Q^2 - 2PQ \cos B$

$R = \boxed{}$

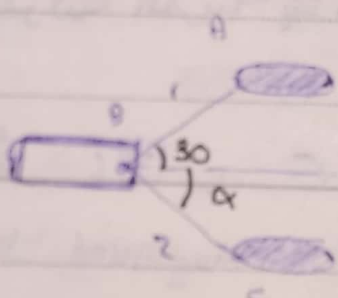
$B = 180 - 25 = 155$

$\alpha = 20 + \beta$

$\frac{60}{\sin \beta} = \frac{R}{\sin 155} = \beta = \boxed{}$

L3:-

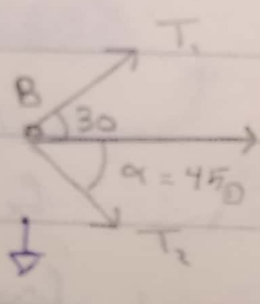
example :-



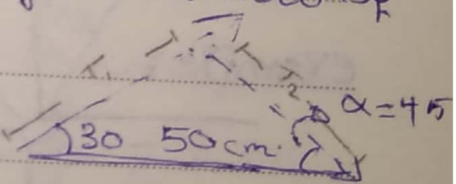
$R = 5000 \, lbf$

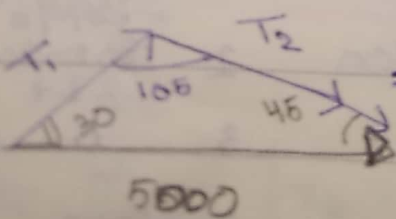
1) T_1, T_2? : $\alpha = 45°$

2) α? : T_2 minamom



5000 graphicly → 1 cm = 1000 lbf





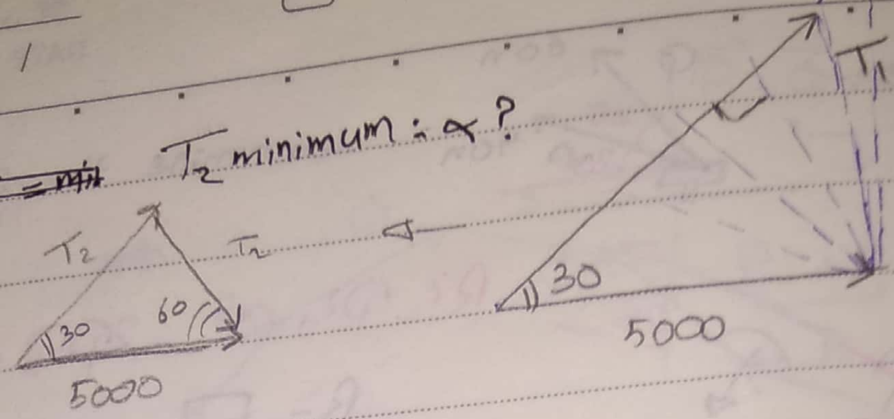
$\Rightarrow R^2 = T_1^2 + T_2^2 - 2T_1 T_2 \cos B$

$\frac{5000}{\sin 105} = \frac{T_1}{\sin 45} = \frac{T_2}{\sin 30} \Rightarrow T_1 = 3660.2 \, lb$

$\Rightarrow T_2 = 2588.1 \, lb$

NO.
DATE / /

2) ~~T_2 ? α = min~~ T_2 minimum : α ?

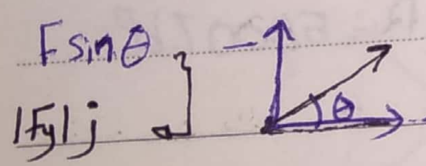


$T_1 = 5000 \cos 30$

$T_2 = 5000 \cos 60$

ch3 Rectangle component of force:

* بيحلل كل قوة لـ X com و Y com وبناخذ محصلة مجموعهم
ـــ بالتحليل : الحركة القريبة بناخذ cos والبعيدة بناخذ sin



$\rightarrow \boxed{x}\, i \quad |F_x|\, i$

magnitued للـ

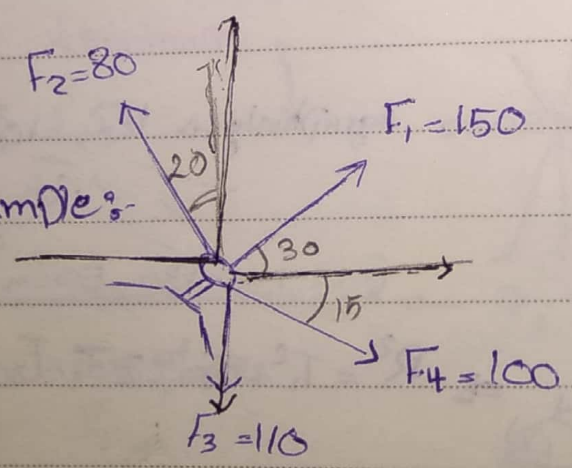
$* F = F_x \bar{i} + F_y \bar{j}$

$F_R = (\Sigma f_x)\bar{i} + (\Sigma f_y)\bar{j}$

$R = \sqrt{R_y^2 + R_x^2}$

$\theta = \tan^{-1} \frac{R_y}{R_x}$

example:-



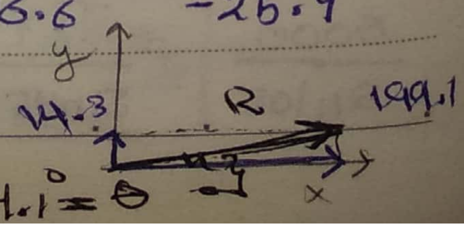
	f_x	f_y
1	$f_1 \cos 30$ (N) 129.9	$f_1 \sin 30$ (N) 75
2	$-80 \sin 20$ -27.4	$80 \cos 20$ 75.2
3	0	-110
4	$f \cos 15$ 96.6	$-f \sin 15$ -25.9

$R = 199.1\,\bar{i} + 14.3\,\bar{j}$

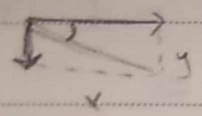
$R = \sqrt{(199.1)^2 + (14.3)^2}$ } للربع الأول

$= 199.6\,N$, $\theta = \tan^{-1} \frac{14.3}{199.1}$

$4.1^\circ = \theta$



equilibrim of aparticle

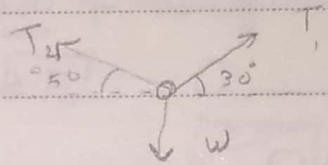


$\Sigma F = 0$

بناخد مثلث قائم الزاويه

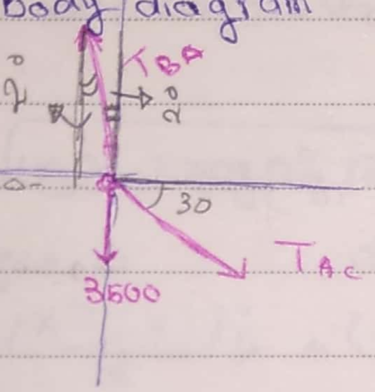
$\Sigma F_x = 0 \qquad \Sigma F_y = 0$

free body diagram



S.P

equilibrram



T_{AC} , T_{BC} ?

$\Sigma F_x = 0 \qquad \Sigma F_y = 0$

$T_{AC}x - T_{AB}x = 0$

$T_{AC}\cos 30 = T_{AB}\sin 2$

$0.86\,T_{AC} = 0.034\,T_{AB}$

$T_{AB} = 25.6\,T_{AC}$

$0 = T_{BA}\cos 2 - 35000 - T_{AC}\sin 30$

$25.7\,T_{AC}\cos 2 - 3500 - T_{AC}\sin 30$

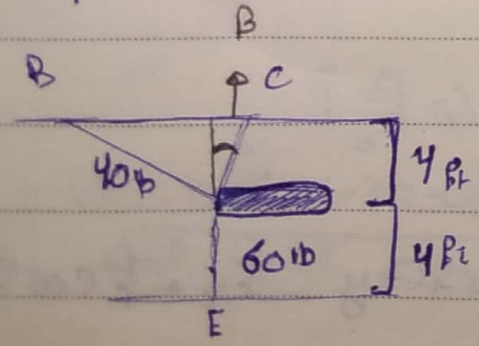
$T_{AC} = 141.18\text{ lb}$

$T_{AB} = 3570\text{ lb.}$

3500 = T_{AB} مع T_{AC} *الفروق متقاربه

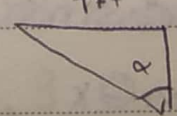
التأكد من الحل (Solution check.)

S.P

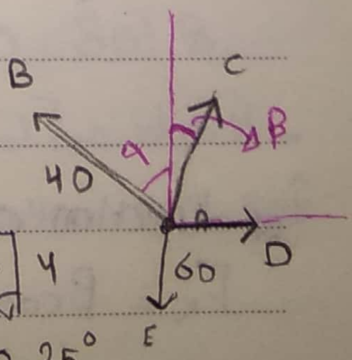


F? T_{AC} ?

$\alpha =$

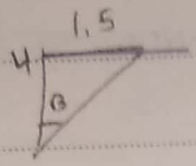


$\tan^{-1}\frac{7}{4} = 60.25°$



NO.

DATE / /

$B = $  $= \tan^{-1} \frac{1.5}{4} = 20.5$

ق3 $\Sigma F_x = 0$

$-40 \sin 40.25 + T_{AC} \sin 20.55 + D = 0$

$D = \boxed{19.6}$ lb

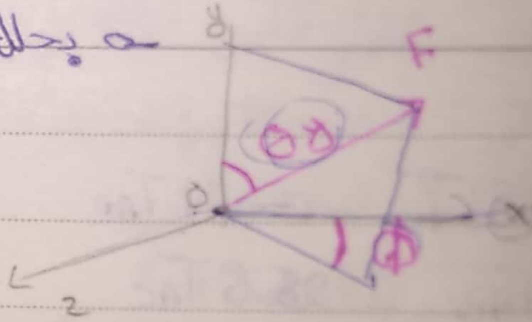
ق3 $\Sigma F_y = 0$

$40 \cos 60.25 + T_{AC} \cos 20.55 - 60 = 0$

$T_{AC} = \boxed{43.18}$ lb ← نوجد معوض

*** Rectangular component of a force in space.**

Plan XZ على , y_x على القوة بحلل ه



$F_y = F\cos\theta_y$

$F_{xz} = F\sin\theta_y$

$F_x = F_{xz}\cos\phi$, $F_z = F_{xz}\sin\phi$

$F\sin\theta_y$ لـ

$F = F_x \bar{i} + F_y \bar{j} + F_z \bar{k}$

*** direction cosins**

$F_x = F\cos\theta_x$, $F_y = F\cos\theta_y$, $F_z = F\cos\theta_z$

SUN. MON. TUES. WED. THUR. FRI. SAT.

NO.

DATE / /

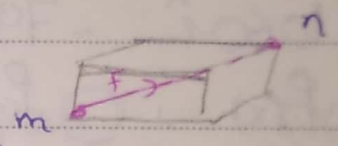
$\bar F = F_x \bar i + F_y \bar j + F_z \bar k$

$= F \bar\lambda$, $\bar\lambda = \cos\theta_x \bar i + \cos\theta_y \bar j + \cos\theta_z \bar k$

magnitued $\bar d$

magnitued $\lambda = 1 \to \cos^2\theta_x + \cos^2\theta_y + \cos^2\theta_z = 1$

$\bar d = d_x \bar i + d_y \bar j + d_z \bar k$



$|d| = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2}$

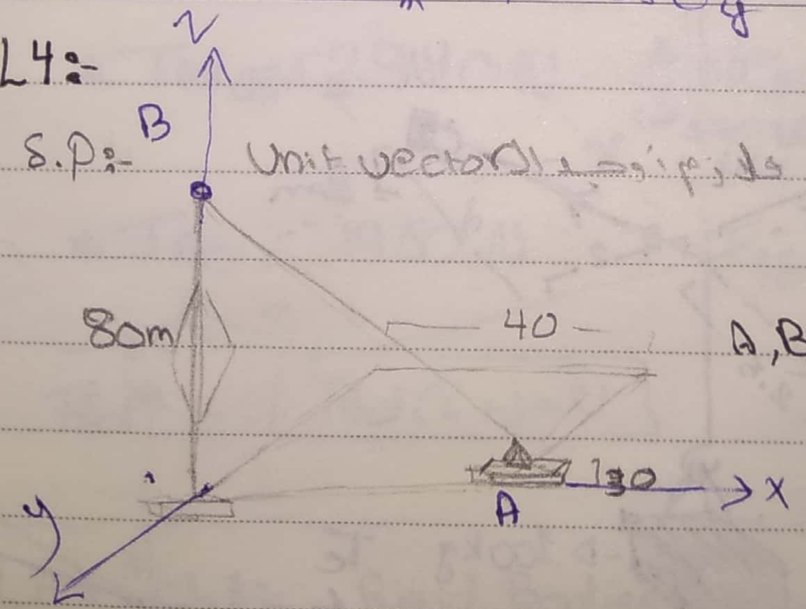
$$\hat\lambda = \frac{(x_2-x_1)}{d} i + \frac{(y_2-y_1)}{d} j + \frac{(z_2-z_1)}{d} k$$

$\cos\theta_x + \cos\theta_y + \cos\theta_z$

L4:-

S.P:-

- لا يوجد مع direction فلازم أوجد الـ Unit vector



. لازم نطلع احداثيات A,B

(40,-30,0) A

(0,0,80) B.

. الاتجاه من B لـ A عشان يشد

$\vec d = (40-0)\hat i + (-30-0)\hat j + (0-80)\hat k \to 40\hat i - 30\hat j - 80\hat k$

$|d| = \sqrt{40^2 + 30^2 + 80^2} = 94.3$

$\hat{\lambda} = \frac{40}{94.3}\hat{i} - 0.318\hat{j} - 0.848\hat{k}$

0.424

$* T = 2500 * \hat{\lambda} \rightarrow 2500 \times (0.424\hat{j} - 0.318\hat{j} - 0.848$

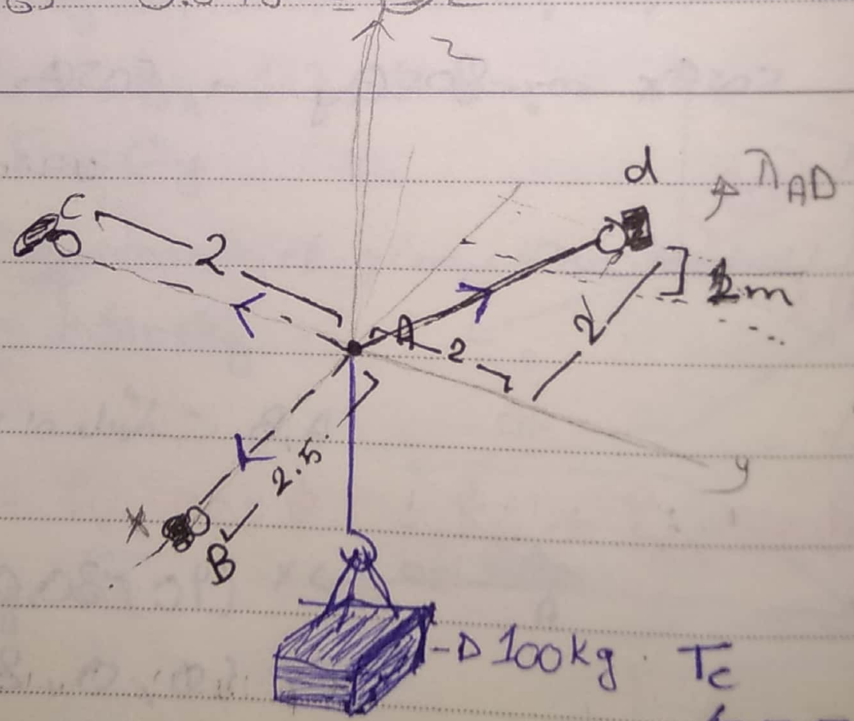
$\Rightarrow 1060\hat{i} - 795\hat{j} - 2120\hat{k}$

$F_{(x)}$	$F_{(y)}$	$F_{(z)}$
1060 N	−795 N	−2120 N

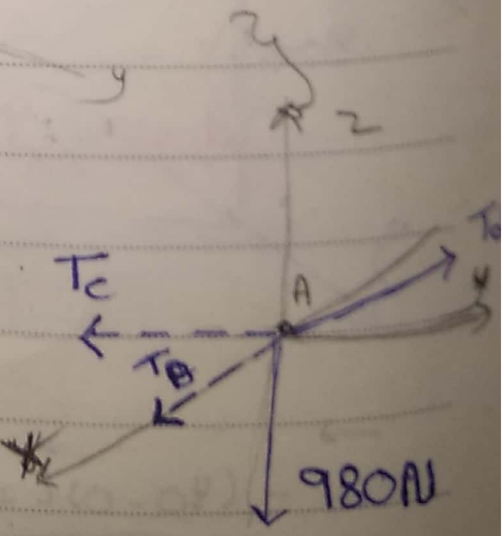
$\Rightarrow \cos^{-1} 0.424 \rightarrow \theta_x$, $\cos^{-1} 0.318 = \theta_y$

$\cos^{-1} -0.848 = \theta_z$

S.P:-



T AB, AC, AD ?



$* \; d_{Ad} = (-2i + 2\hat{j} + 1\hat{k})$

$\bar{\lambda}_{Ad} = -\frac{2}{3}i + \frac{2}{3}\hat{i} + \frac{1}{3}\hat{k}$

$T_{Ad} = T_{Ad}\left(-\frac{2}{3}\hat{i} + \frac{2}{3}\hat{i} + \frac{1}{3}\right)\hat{k}$

$\vec{T}_{AC} = -T_{AC}\,j$, $T_{AB} = T_{AB}\,i$, $\vec{W} = 980\,\hat{k}$

. هيك بكون كتبنا (T) كفكتور.

$\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma F_z = 0$

* $-\frac{2}{3} T_{Ad} + T_{AB} = 0 \rightarrow (1)$ (x)
* $\frac{2}{3} T_{Ad} - T_{AC} = 0 \rightarrow (2)$ (y)
* $\frac{1}{3} T_{Ad} - 980 = 0 \rightarrow (3)$

* $T_{Ad} = 2940\,N$ عوّض ↑ الله يعوض عليك ♥ هيك الحل كامل لأنه طالب (R)
* $T_{AC} = 1960\,N$, $T_{AB} = 1960\,N$

بعوض

$\vec{T}_{Ad} = \boxed{T_{Ad}(i + j + \hat{k})}$

L5:- Ch3:- Rigid Bodies "equivelent system of force"

*deformable body

* إذا ما كان باتزان

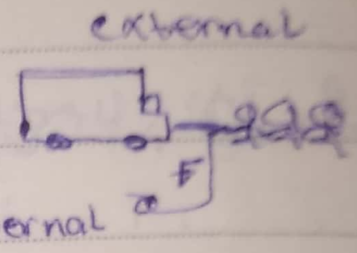
*Rigid body
- Rotation → moment
- Translation

حركة أو دوران

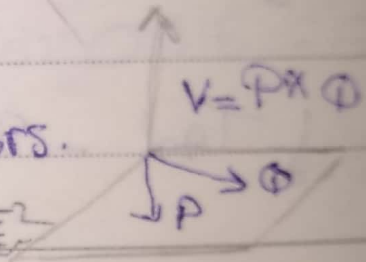
* تحويل القوى على ال rigid body لقوة واحدة و moment

External and internal forces

section cut لما يتبقى الأجزاء



* بقدر أحرك ال Force على نفس ال Line of action
وبيعطيني نفس التأثير
مش دائماً صحيح إذا بتعامل مع قوى داخلية.



* vector product of two vectors.

~~مثال عمودي على المستوى الي يحتوي المتجهين~~

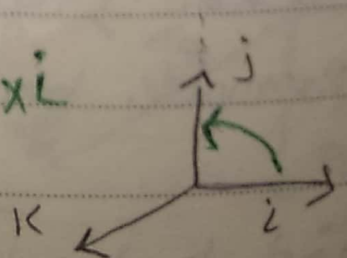
يلزمني line of action و magnitued لـ (P, Q)

$|V| = PQ\sin\theta$, direction قاعدة اليد اليمنى

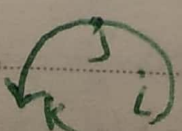
خواصها:-

- $Q \times P \neq (P \times Q) \rightarrow -(P \times Q)$ نفس ال magnitud باتجاه مختلف
- $P(Q_1 + Q_2) = P \times Q_1 + P \times Q_2$
- $(P \times Q) \times S \neq P \times (Q \times S)$

$K = j \times i$



Rectanguler component



$i \times i = 0$

$\hookrightarrow P \times Q$

$$\begin{array}{c|ccc|} & i & j & k \\ P & P_x & P_y & P_z \\ Q & Q_x & Q_y & Q_z \end{array}$$

نلغي صف i وعمود .

$\Rightarrow \vec{V} = i(P_y Q_z - P_z Q_y) - j(P_x Q_z - P_z Q_x)$
$+ k(P_x Q_y - P_y Q_x)$.

Moment of a force about a point

معاكس لعقارب الساعة + قوة مطبقة بعيد عن المحور الأصلي ، L_o

$M_o = \vec{r} \times \vec{F}$ → magnitude, direction ↺

$r F \sin\theta \rightarrow Fd$

L_o المسافة العمودية بين القوى ونقطة التأثير.

$\vec{r} \times (F_1 + F_2 + \dots) = \vec{r} \times \vec{F_1} + \vec{r} \times \vec{F_2} + \dots$

خصائص :-

The moment of the group of forces about a point equal the moment of the resultant about the point.

$$\begin{vmatrix} i & j & k \\ x & y & z \\ F_x & F_y & F_z \end{vmatrix} = (yF_z - zF_y)i - (xF_y - yF_x)j + (yF_z - zF_y)$$

3d

2d → F (i j), r (i j)

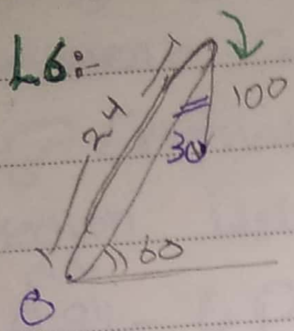
M → k [+ عكس , − مع]

NO.

DATE / /

SUN. MON. TUES. WED. THUR. FRI. SAT.

L6:

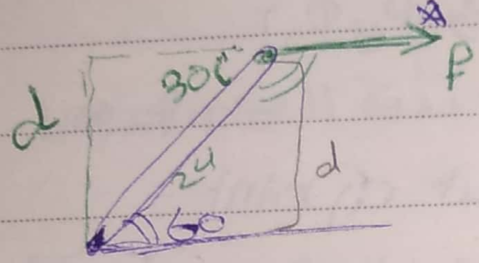


d = 24

* $M_o = r_o \times F = 24 \times 100 \times \sin 30$ لـ

$= 1200$ lb in

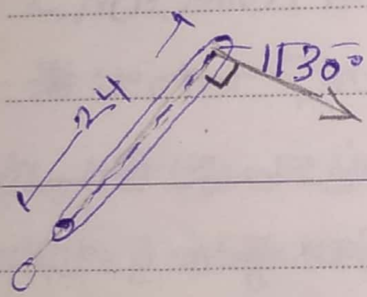
* Moment قوة أفقية بتعطي نفس الـ



$M = Fd \rightarrow 1200 = F \times 24 \cos$

$F = 57.7$ lb d لـ

* Smalest force to produce same M



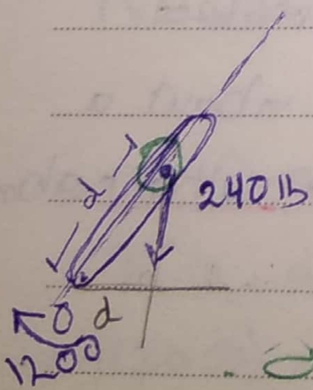
$M = F \times d$

Min لـ F, Max لـ d

direction $\rightarrow \theta = 3^\circ$ ⊥ OA

$1200 = F \times 24 \rightarrow F = 50$ lb

* Location of vertical force 240 lb

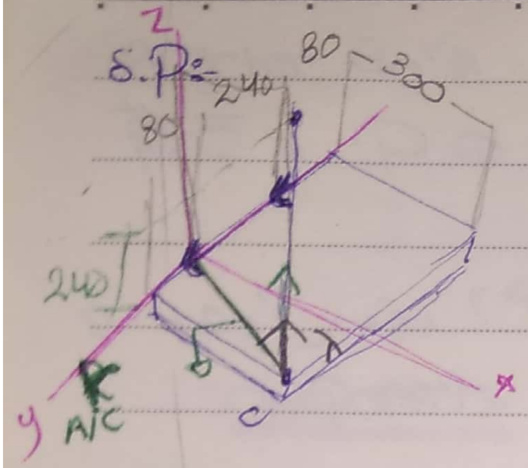


$M = F \times d$ $1200 = 240 \times d$

$d = 5$

مجهول المطلوب ← $d = OB \cos 60$

$OB = \frac{5}{\cos 60} = 10$ in



$$\mathcal{M} = \vec{r}_{C/A} \times \vec{F}$$

$A = (0,0,0)$, $C = (300, 80, 0)$

$\Rightarrow \vec{r}_{A/C} = 300i + 80j$

$\vec{F}$ حل لا باتجاه القوة

$$\vec{F} = 200\,\bar{\lambda} \;,\; \bar{\lambda} = \frac{d_{c/d}}{|d_{c/d}|}$$

$D = (0, -240, 240)$

$\vec{d}_{cd} = -300i - 320j + 240k$

$|d_{c/d}| = 500$ mm

$\lambda = -0.6i - 0.64j + 0.48k$

$\vec{F} \Rightarrow 200(\bar{\lambda}) = -120i - 128\hat{j} + 96\hat{k}$

$$\Rightarrow \mathcal{M} = \vec{r}_{A/C} \times \vec{F} = \begin{vmatrix} i & j & k \\ 300 & 80 & 0 \\ -120 & -128 & 96 \end{vmatrix}$$

$i\,(\cancel{80\times 96}\;7680)$

$-j\,(28800)$

$+k\,(-28800)$

$$\vec{\mathcal{M}} = 7680\,\hat{i} + 28800\,\hat{j} - 28800\,\hat{k}$$

$|M| = 141447$ Nmm

NO.
DATE / /
SUN. MON. TUES. WED. THUR. FRI. SAT.

$\theta_x = \cos^{-1} \frac{7680}{41497} =$

$\theta_y = \cos^{-1} \frac{22800}{41447}$

$\theta_z = \frac{-28800}{41447}$

47:- Scalar product of two vectors

* $P \cdot Q = PQ\cos\theta$ لـ بيستخدم غالبا "ليستخرج زاوية

$\bar{P} \cdot \bar{Q} = \bar{Q} \cdot \bar{P}$, $P(Q_1 + Q_2) = Q_1 P + Q_2 P$

$(\bar{P} \cdot \bar{Q}) \cdot \bar{S} \rightarrow$ غير معرفة

↳ Scalar quantity

$\bar{i} \cdot \bar{i} = 1$ و $\bar{j} \cdot \bar{j} = 1$ و $\bar{K} \cdot \bar{k} = 1$

$0 = k \cdot j$ أو $i \cdot J = 0$ أو لكن

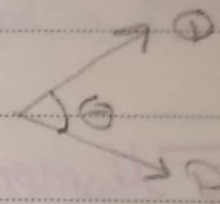
$\bar{P} \cdot \bar{Q} = P_x Q_x + P_y Q_y + P_z Q_z$

$\bar{P} \cdot \bar{P} = P^2 \rightarrow PP\cos 0 = P^2$

SUN. MON. TUES. WED. THUR. FRI. SAT. NO. DATE / /

2 vector الزاوية unknown.

$\bar{P} \cdot \bar{Q} = P Q \cos\theta = P_x Q_x + P_y Q_y + P_z Q_z$



باستخدام (P.Q) بعطيني اوجد اي
يا حول اي axis. components.
3d

3 Mixed Triple Product of 3 vector.
لو ايجاد ال M حول axis معين
$\bar{S} \cdot (\bar{P} \times \bar{Q})$ = scalar result.

خصائصها :-

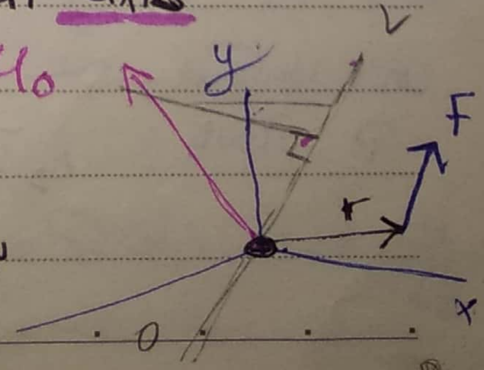
$\bar{S} \cdot (\bar{P} \times \bar{Q}) = \bar{P} \cdot (\bar{S} \times \bar{Q}) = \bar{Q} \cdot (\bar{P} \times \bar{S}) = (-)$

ايجاد قيمة ال Mixed triple :-

$$\begin{vmatrix} S_x & S_y & S_z \\ P_x & P_y & P_z \\ Q_x & Q_y & Q_z \end{vmatrix}$$

Moment of a force about a given axis

بوجد M_O يعني ال M لل $\vec{F}$ حول نقطة O
بعدين $\bar{M}_O$ بوجده حول
ال axis بحسب النقاط ويلي لقيت النقطة ol
ع يعطيني نفس ال M حول ال axis



NO. DATE / /

SUN. MON. TUES. WED. THUR. FRI. SAT.

1) * $M_o = \vec{r} \times \vec{F}$

2) * $M_{OL} = \bar{\lambda} \cdot \bar{M}_o = \bar{\lambda} (\bar{r} \times \bar{F})$

3) Moment of F about coordinate axes.

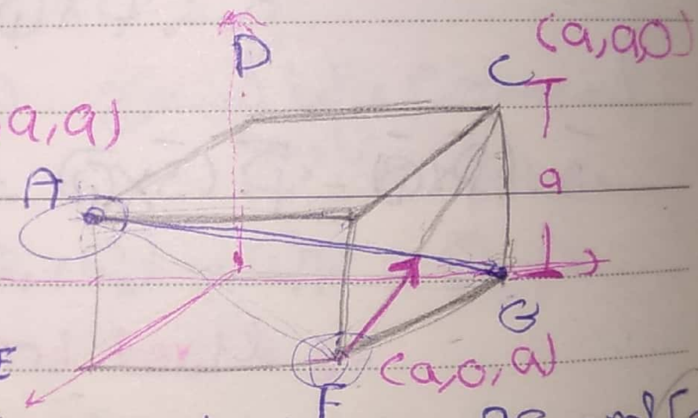
$$M_x = yF_z - zF_y$$
$$M_y = zF_x - xF_z$$
$$M_z = xF_y - yF_x$$

Example:-

a) about A (M)

b) about AB

c) about AG



d) perpendecular distance between AG and FC

$\bar{P}$ d

a: $M_A = \bar{r}_{AF} \times \bar{P}$

* $\bar{P} = P \times \bar{\lambda}$ → $\bar{\lambda} = \frac{FC}{|FC|} = \frac{0i + aj - ak}{\sqrt{a^2 + a^2}} = \frac{aj - ak}{\sqrt{2}\, a}$

unit vector لـ P باتجاه

→ $\bar{P} = \frac{P}{\sqrt{2}} j - \frac{P}{\sqrt{2}} k$

SUN. MON. TUES. WED. THUR. FRI. SAT.

NO.

DATE / /

$r_{AF} = a\hat{i} - a\hat{j} - 0\hat{k}$

$$\Rightarrow \bar{r} \times \vec{P} \quad \begin{vmatrix} i & j & k \\ a & -a & 0 \\ 0 & \frac{P}{\sqrt{2}} & -\frac{P}{\sqrt{2}} \end{vmatrix} = \frac{aP}{\sqrt{2}}(i + j + k)$$

b) لازم نوجد unit vector باتجاه AB الموازي لل x axis.

$$i \cdot M_A = M_{AB} = i \cdot \left(\frac{aP}{\sqrt{2}}(i + j + k)\right) = \frac{aP}{\sqrt{2}}$$

ملاحظة لو أخذنا ال reference point مثلا "B" رح يطلع نفس M_{AB}.

c) بنطلع unit vector باتجاه AG

$$\bar{\beta} \cdot M_A = M_{AG}$$

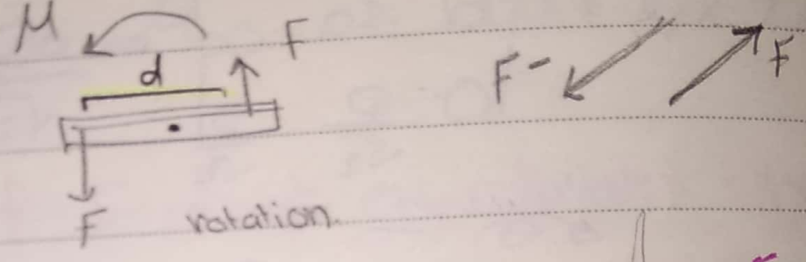
$$\Rightarrow \frac{d\,GA}{|GA|} = \frac{1}{\sqrt{3}}(i - j - k)$$

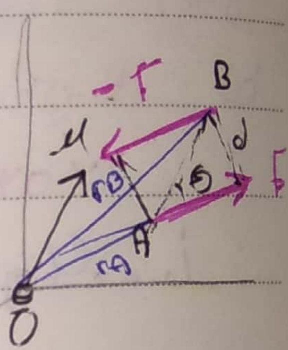
$$\frac{1}{\sqrt{3}}(i - j - k) \cdot \left(\frac{aP}{\sqrt{2}}(i + j + k)\right) = \frac{-aP}{\sqrt{6}}$$

d) $\vec{F} \times \vec{d} = M_{\text{حول } F_C} = \frac{-aP}{\sqrt{6}} = Pd \Rightarrow d = \frac{a}{\sqrt{6}}$

Moment of a couple

قوتين متساويات في المقدار ومتعاكسات في الاتجاه وبينهم مسافة





$$M = \bar{r}_A \times \bar{F} + r_B \times (-\bar{F})$$
$$= (r_A - r_B) \times \bar{F}$$
$$= r F \sin\theta = F d$$

العامود d

Ps: Moment vector لا يعتمد على ال origin

couple forces (لهم نفس M)

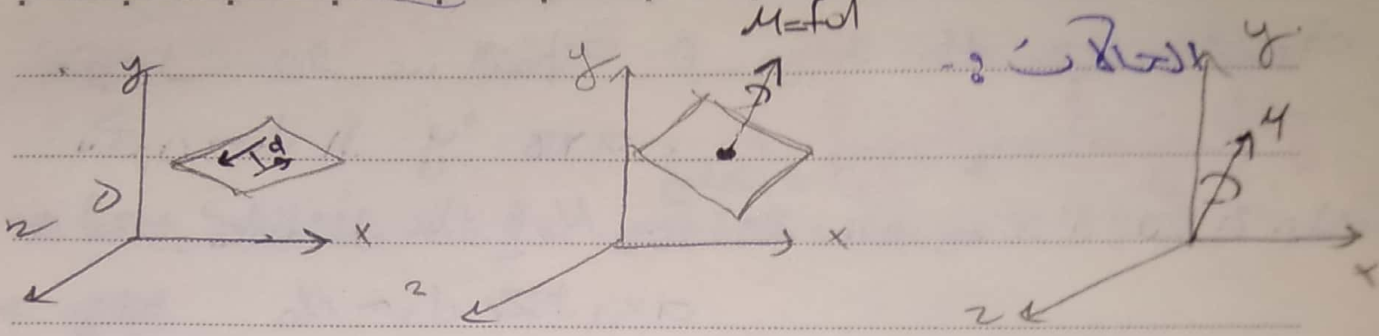
اذا كان

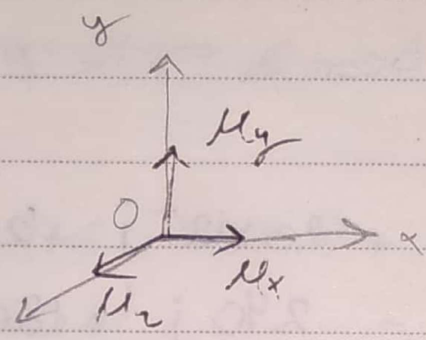
in the same plane ولازم يكونوا $F_1 d_1 = F_2 d_2$
ويعطوني نفس ال rotation

اذا عنا مجموعة من ال couple forces متساويات مختلفة
$M_1 = \bar{r} \times \bar{F}_1$ in plan P_1
$M_2 = \bar{r} \times \bar{F}_2$ in plan P_2
نفس احتاج جملة وأوجد ال R لكل ال M
$$M = \bar{r} \times \bar{R} = \bar{r} \cdot (F_1 + F_2)$$

SUN. MON. TUES. WED. THUR. FRI. SAT.

NO.
DATE / /





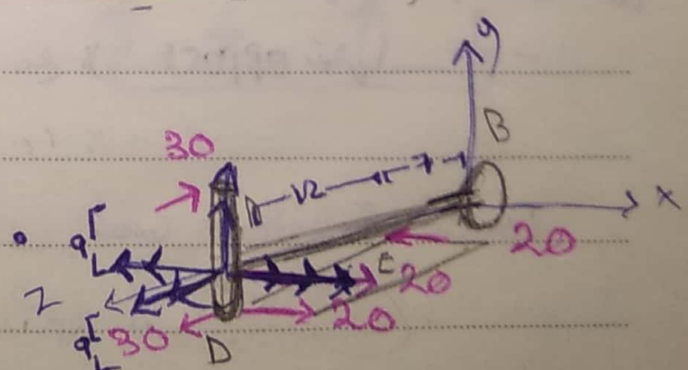
L8:-

The Moment ـ لا بنقل قوة أو حركها لازم انقل ال effect تبعها معها
بحيث M_0 بنفس اتجاه أثر القوة
← بنقل القوة على Point of intrests . بنقل كل ال F القوة على الجسم لنقطة واحدة .

$\vec{M}_{o1} = \vec{r}' \times \vec{F}$ → free vector

← بقدر أحركه لأي مكان على الجسم

SP:-



• أولاً عنا قوتين بال zy فال M_0 عليهن حول ال x- axis
• القوتين 20 مش موجودات بنفس المستوى فال M_0 رح يكون عمودي على ال plan

NO.

DATE / /

SUN. MON. TUES. WED. THUR. FRI. SAT.

* بحول 20 عند النقطة A . مع ال M_o تبعها عند النقطة بيكون حول ال $+y$ axis ،

* بصير عنا فرق بين M_o 20 الجديدة وال 20 الأصلية بعطوا M_o حول $+Z$ axis

* صار ال M عنا الو 3 comp. ← M_x, M_y, M_z

* $M_x = (30 \times 18) i + (20 \times 12) j + (20 \times 9) k$
$= (-540 i + 240 j + 180 k)$ lb in

3 System of forces to a force and couple.

لو مش شرط القوى تلتقي ببعض، مان بيطلع عنا Resultant force و Resultant Moment

{ " M_o free vector, " بحركه وين ما بدي عادي "
" F vector " لما بنقله بنقل معها ال M تبعها. }

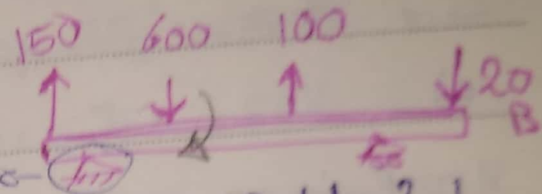
R R

في حالة ال F وال Moment عموديات على بعض بقدر أعوض وأحرك القوة عن النقطة وبنقل مع ال effect تبعها

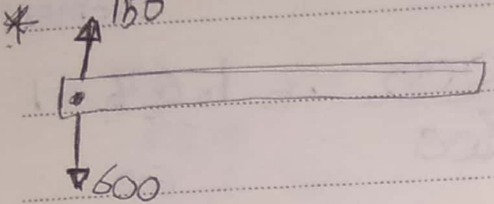
إذا كانت ال Forces كلها على نفس line of action او بنفس ال plane او كلهم موازيات

$M = r \times F \rightarrow r = \frac{M}{F}$ ← المسافة اللي لازم احرك القوة فيها

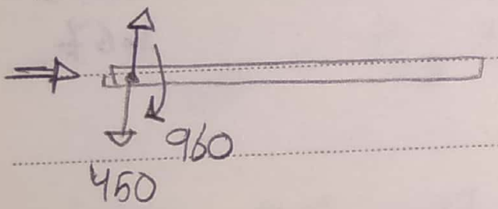
S.P :-



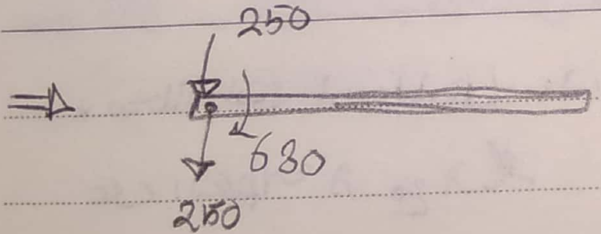
a) force and M_o at A



* $M_1 = 600 \times 1.6 = -960$ Nm
* $R_1 = -450$ N

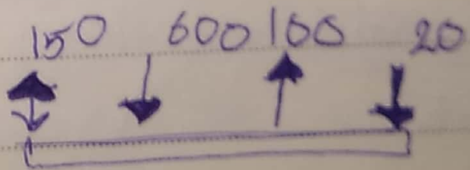


* $M_2 = 100 \times 2.8 = 280$ NM
$M_{R_1} = -680$ NM
$F_R = -350$ N



$M_3 = 250 \times 4.8 = -1200$
$M_P = -1880$ Nm
$F_R = -600$ N

b) F and M at B

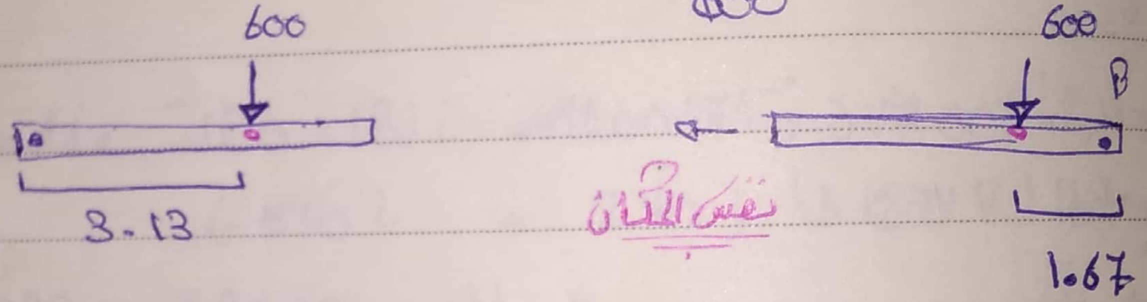


* $R_F = 600$
$M_1 = -200$ Nm
$M_3 = -720$ → $R = 600$ N , $M = 1000$ ccw
$M_2 - 1920$

c)

force most be to the ~~right~~ left to produce effect (Moment)

$$M = F \times d \rightarrow d = \frac{1000}{600} = 1.67$$



L9:-

S.P → الرسمة من السلايدات 3d

* بنحلل القوى لنحصل على ال vector form لها، بعدين بنشغلها على السطحة A مع ال M

$\cdot\ F_B = 700(\bar{\lambda})$

$\bar{\lambda} \rightarrow \dfrac{r_{B/E}}{|r_{B/E}|}$

$\dfrac{75i - 150j}{167.7}$

$\cdot\ B = (75, 100, 100)$

$\cdot\ E = (150, -50, 100)$

$\cdot\ C = (75, 100, 0)$

$= 700(0.44i - 0.89j)$ $\cdot\ D(100, 0, 0)$

$= (308i - 623j)\ N$ $\cdot\ A(0, 100, 50)$

$\cdot\ F_{cX} = 1000 \cos 45 = 707.1\ N$

$F_{cz} = 1000 \cos 45 = 707.1\ N$

$707.1 i + 707.1 j$

- $f_{Dx} = 600$ $\rightarrow r_{ab} = 75j + 50k$ mm
- $f_{Dy} = 1039.2$ $\rightarrow r_{ac} = 75j - 50k$ mm

$600i + 1039.2$ $\rightarrow r_{ad}$ $100j - 100i - 50k$

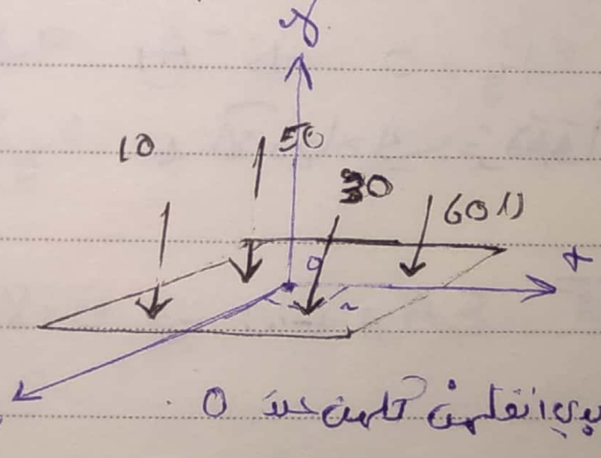
$$* M_{F_B/A} = r_{AB} \times F_B = \begin{array}{ccc} i & j & k \end{array} \begin{vmatrix} 75 & 50 & 0 \\ 3.8 & -60.38 & \end{vmatrix} = 30i - 45k \ N$$

$$* M_{F_C/A} = r_{AC} \times F_C = 17.68j \ Nm$$

$$* M_{F_D/A} = r_{AD} \times F_D = 163.9 \ k$$

$\rightarrow M_A = 30i + 17.68j + 118.9k$ Nmm

$\rightarrow R_A = 1615.1 \ i$



القوة 30 بينتقل معها 2 M, واحد حول
z, وواحد حول ال y.

لو بدي انقلهن كلهن عند 0
بحسب ال M فلازم نعرف المسافة لـ ح نحركها

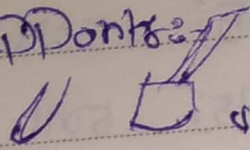
Ch4 :- equilibriam of rigid body.

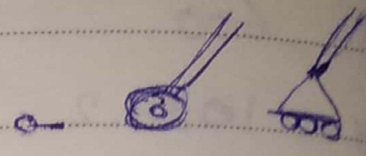
لا ماشي حركة, ولا دوران

$M_x = 0, M_y = 0, M_z = 0$

$\Rightarrow \Sigma f = 0$, $\Sigma M = 0$ $f_x = 0, f_y = 0, f_z = 0$

NO.
DATE / /

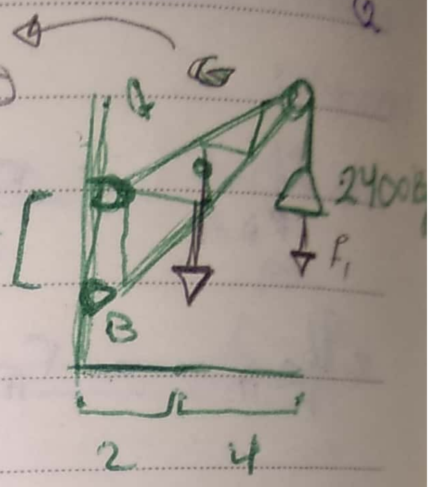
Supports: 

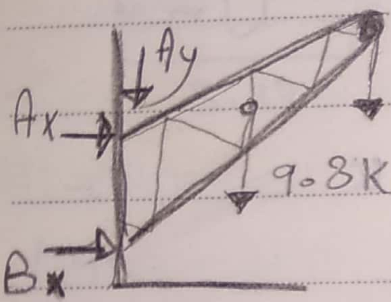
reaction عدد ←  ① ②

L10:

$\leftarrow 9.8 \times 1000$

* $P = 2400 \times 9.8$
$23520\ N \rightarrow 23.5\ KN$





* $\Sigma F_x = 0$, $\Sigma F_y = 0$

له مجهولين   مجهول واحد

$\Sigma M = 0$

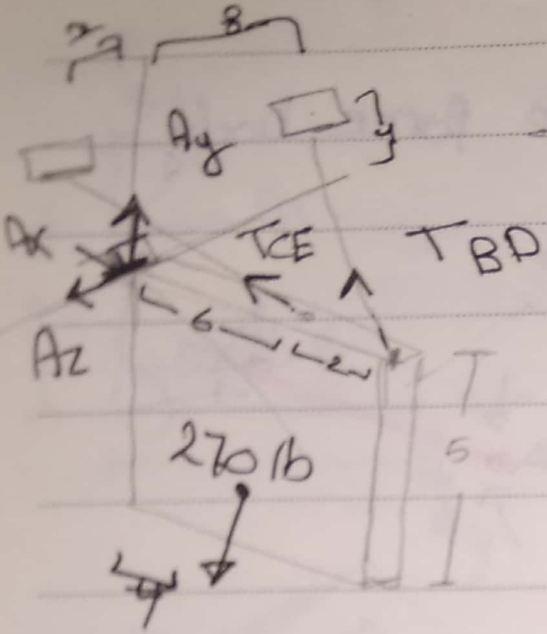
$\Sigma F_y = 0 \Rightarrow -A_y - 9.8 - 23.52 = 0$

× الاتجاه لي فرضناه ← $A_y = 33.32\ KN$

$\Sigma M_A = 0 \Rightarrow B_x \times 1.5 - 9.81 \times 2 - 23.52 \times 6$

$B_x = 107.1\ KN$

$\Sigma F_x = 0 \Rightarrow A_x + B_x = 0 \rightarrow A_x = -107.1$



$\Sigma F_x = 0 \quad \Sigma F_y = 0$

$\Sigma F_z = 0$

$\Sigma M_x = 0 \quad \Sigma M_y = 0$

$\Sigma M_z = 0$

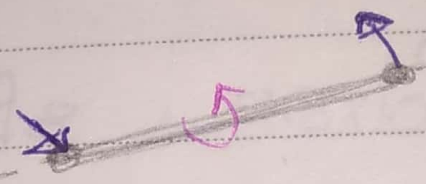
*reaction $\vec{A}$ $= A_x i + A_y j + A_z k$

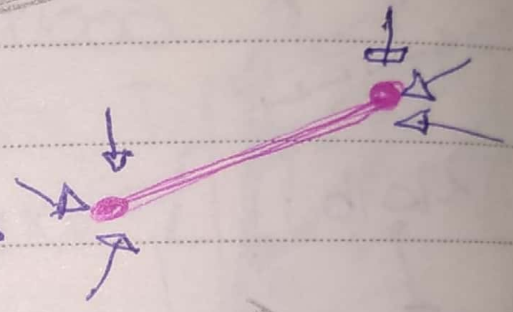
* $\vec{W} = -270 j$

$\rightarrow T_{CE} \rightarrow \lambda_{CE} = \dfrac{d_{CE}}{|CE|} =$

L11 :- Equilibriam of two force body

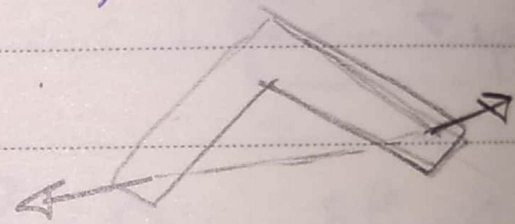
ع الأطراف ←





حتى ما يكون عنا حركة rotation

لازم الـ R يكونوا على نفس
LoA للـ member



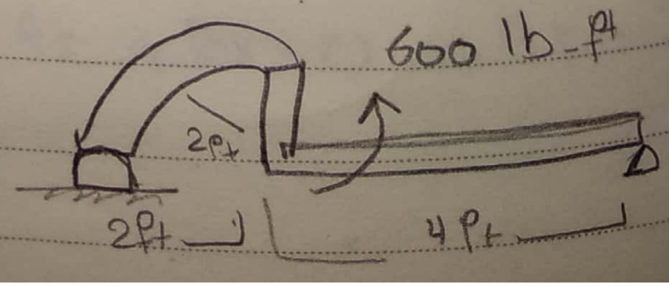
1. RF متساوية مقداراً ومتعاكسة
بالاتجاه

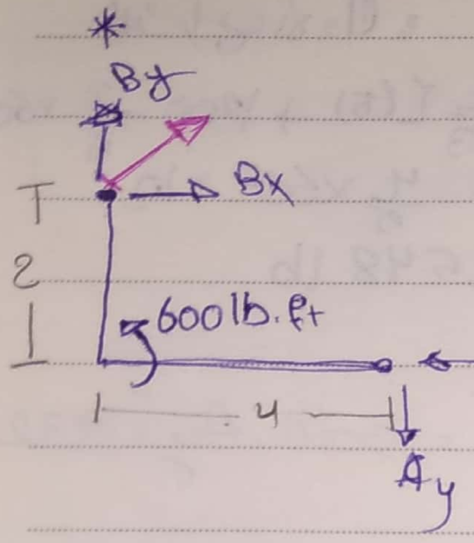
2. اتجاههما مع اتجاه الـ member
axis

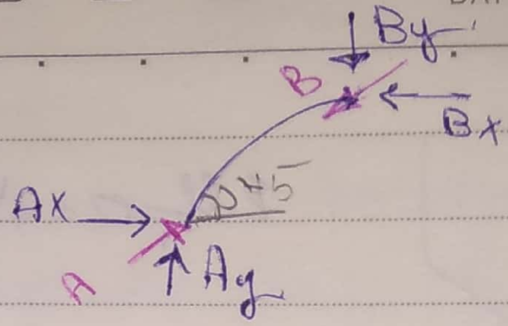
Equilibriam of a 3 force body :-

1) concurrent forces (بيمروا بنفس النقطة)
2) Parallel forces.

*Example :-







$B_y = 0.707 \rightarrow B_y = B\cos 45$

* $\Sigma M_c = 0 = 0.707B(4) - 0.707B(2) + 600$

$B = 141.4$ lb

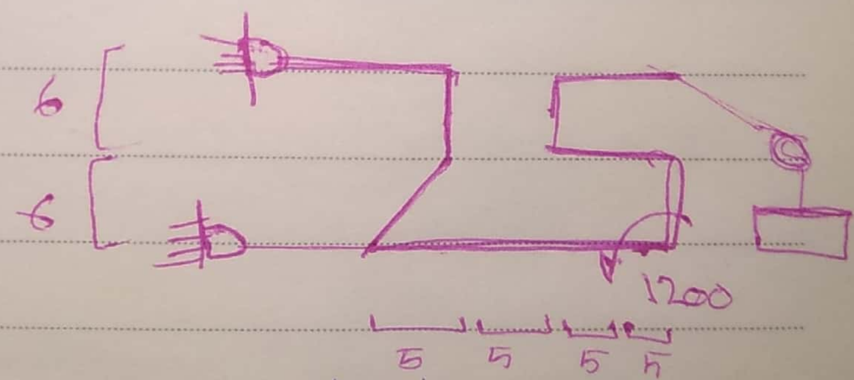
$\rightarrow B_x = 99.97$ lb , $B_y = 99.97$

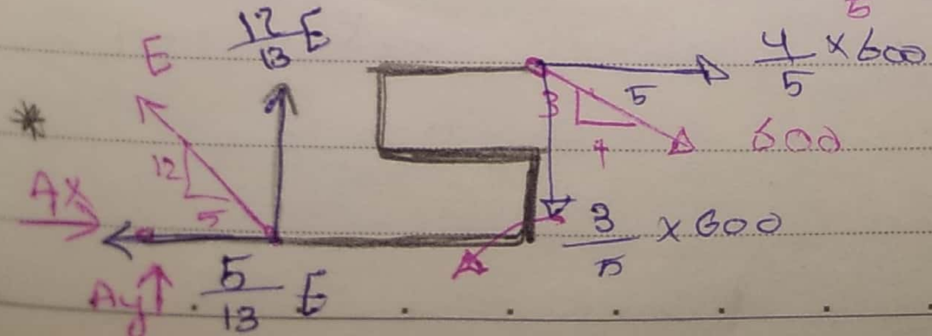
$\Sigma F_x = 99.97 - C_x = 0 \rightarrow C_x = 99.97$ lb

$\Sigma F_y = 99.97 - C_y = 0 \rightarrow C_y = 99.97$ lb

---

* Example

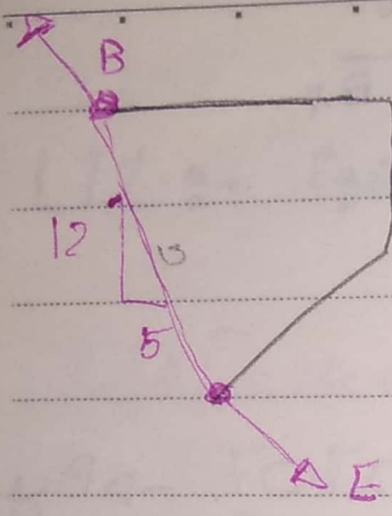




NO. ______

DATE / /

SUN. MON. TUES. WED. THUR. FRI. SAT.



السؤال الأول :

$$\Sigma M_A = 0 = +\frac{12}{13}E(5) + 1200 - \frac{3}{5}\times 600$$
$$- \frac{4}{5}\times 600 \times 12$$
$$E = 2548\ lb$$

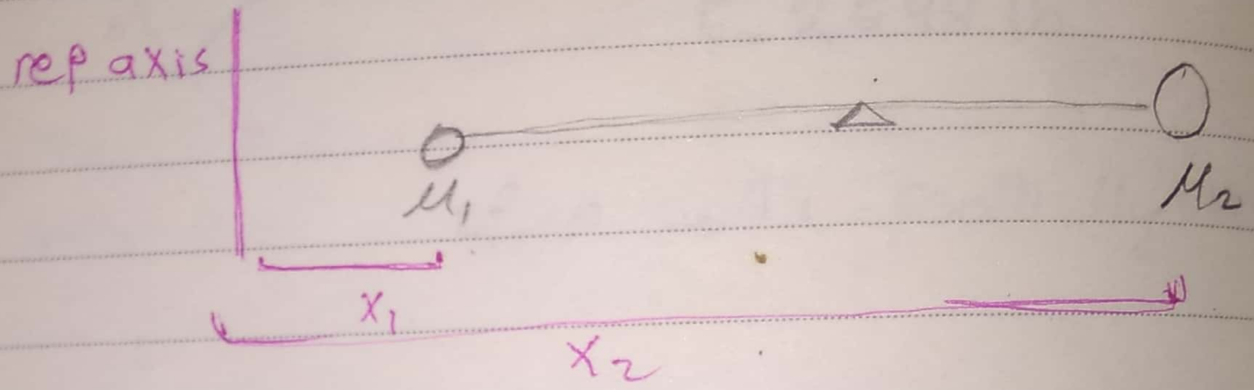
$\Sigma F_x = 0 \rightarrow A_x = 560\,lb,\ A_y = 1992\,lb$

NO.
DATE 3 / Aug /

SUN. MON. TUES. WED. THUR. FRI. SAT.

ch5:-

Distributed Forces centroied and center of gravity.



$$x_1 m_1 + x_2 m_2 = (m_1 + m_2)\bar{x}$$

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

* center of gravity

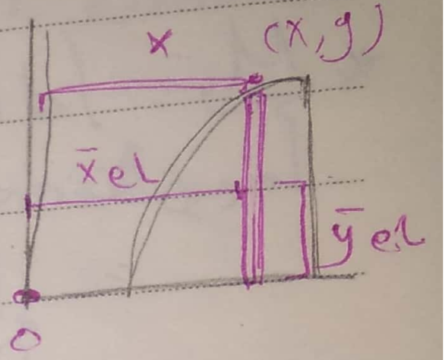
$$\bar{x} = \frac{\int dm\, x}{\int dm}$$

* center of gravity of a 2D Body

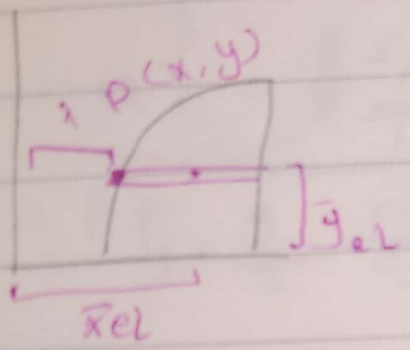
$\Sigma M_y = \bar{x}\, w = \Sigma x \Delta w \rightarrow \int dw$

$\Sigma M_x = \bar{y}\, w = \Sigma y \Delta w \rightarrow \int dw.$

$$\bar{X}A = \int \bar{x}_{el}\, dA = \int x(y\,dx)$$

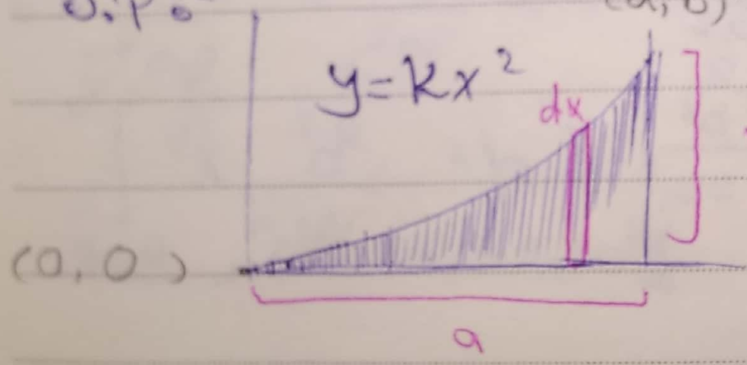


$$\bar{y}A = \int \bar{y}_{el}\, dA = \int \frac{y}{2}(y\,dx)$$



$$\bar{X}A = \int \bar{x}_{el}\, dA = \int \frac{a+x}{2}$$

S.P:- determine the centra



*بنلاقي k بدلالة a,b

$x = a,\ y = b$

$$y = \frac{b}{a^2}X^2 \leftarrow b = ka^2 \rightarrow k = \frac{b}{a^2}$$

→ vertecal strips $\rightarrow A = (\frac{b}{a}x^2)(dx)$

dM_y "First M of A about y" $= A * X$

$$\rightarrow A = \int_0^a \frac{b}{a^2}x^2\,dx = \frac{b}{a^2}\frac{x^3}{3}\Big]_0^a = \frac{ba}{3}$$

NO.
DATE / /
SAT.

$* M_y = \int_0^a dM_y = \int_0^a \left(\frac{b}{a^2} x^2\right) dx \cdot x /$

$= \int_a^b \frac{b}{a^2} x^3 dx = \frac{b}{a^2} \frac{x^4}{4} \Big]_0^a$

$= \frac{b a^2}{4}$

$*$ Location :- $\bar{x} = \frac{\frac{ba^2}{4}}{\frac{ba}{3}} = \frac{\Sigma M}{\Sigma A}$

$= \frac{3a}{4} \rightarrow \bar{x}$

$\bar{y}$:- $dM_x = dA \times \frac{y}{2}$

$\frac{b}{a^2} x^2 dx * \frac{b}{2a^2} x^2 = \frac{b^2}{2a^4} x^4 dx$

$\rightarrow M_x = \int_0^a \frac{b^2}{2a^4} x^4 dx \rightarrow \frac{b^2}{10a^4} x^5 \Big|_0^a$

$= \frac{b^2 a}{10}$

$\bar{y} = \frac{M_x}{A} = \frac{\frac{b^2 a}{10}}{\frac{ba}{3}} = \frac{3}{10} b$

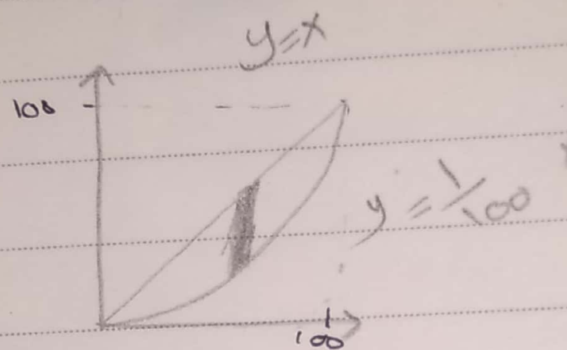
SUN. MON. TUES. WED. THUR. FRI. SAT. DATE / /

محمد الوزني

ch5 → center of mass

*center of area

← وين النقطة يلي بطابق عليها الجسم.



$A = \int dA$

$\bar{x} = \int \tilde{x} \, dA$

$\bar{y} = \int \tilde{y} \, dA$

← شريحة طولية

$\tilde{y} = \frac{y_1}{2} + \frac{y_2}{2}$

"بنحول كل y نقيمتها بال x"

$\tilde{x} = x \quad , \quad dA = (y_1 - y_2)\,dx$

← شريحة بالعرض

$\tilde{x} = \frac{x_1}{2} + \frac{x_2}{2}$

$\tilde{y} = y \quad , \quad dA = (x_1 - x_2)\,dy$

$* A = \int dA \quad , \quad \bar{x} = \frac{\int \tilde{x}\, dA}{A} \quad , \quad \bar{y} = \frac{\int \tilde{y}\, dA}{A}$

$*dA = y\,dx \quad , \quad dA = x\,dy$

بالطول بالعرض

$\tilde{x} = x , \tilde{y} = \frac{y}{2} \qquad \tilde{x} = \frac{x}{2} , \tilde{y} = y$

NO.

DATE / /

SUN. MON. TUES. WED. THUR. FRI. SAT.

wire :- $\bar{x} = \dfrac{\int x \, dL}{L}$, $\bar{y} = \dfrac{\int y \, dL}{L}$

$I_x = \Sigma \bar{x} A$, $I_{y_1} = \Sigma \bar{y} A$ (v) Q_x , Q_y

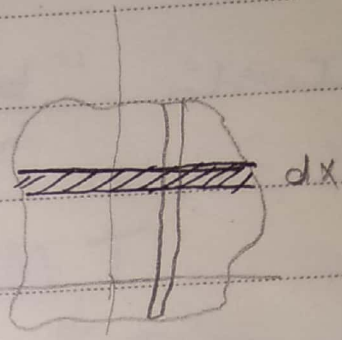
Ch6:-

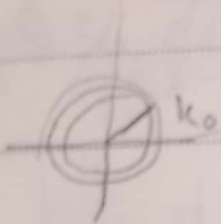
Radius of gyration of an area :-

$I_x = A(k_x)^2$

↳ radius of gyration

$I_y = k_y^2 A \rightarrow k_y = \sqrt{\frac{I_y}{A}}$





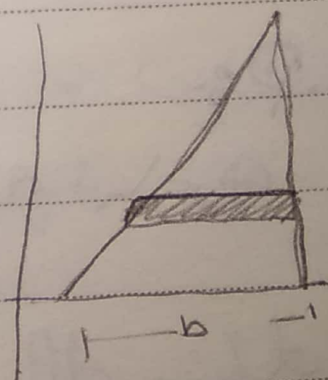
$I_y = k_y^2 A \rightarrow k_y = \sqrt{\frac{I_y}{A}}$

$J_o = k_o^2 A \rightarrow k_o = \sqrt{\frac{J_o}{A}}$

$* \; k_o^2 = k_x^2 + k_y^2$

S.P:-

determine the moment about the base.



بناخذ شريحة موازية لمحور الدوران

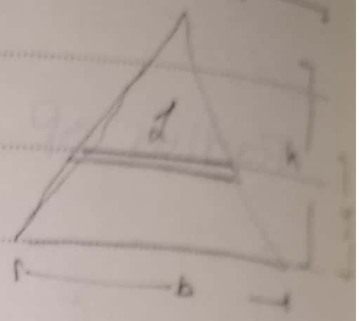
$dI_x = dA \times y^2 \rightarrow \int$

لازم نعرف حدود التكامل + المساحة للشريحة

NO.

DATE / /

SUN. MON. TUES. WED. THUR. FRI. SAT.



$$dI_x = dy \times L$$

"تشابه مثلثات" $\dfrac{b}{h} = \dfrac{L}{h-y}$

لمتباينات

$$L = b - \frac{b}{h} y$$

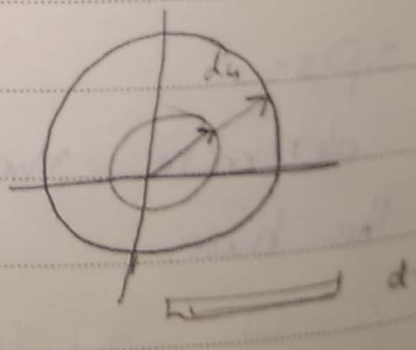
$$dI_x = y^2 dy \left(b - \frac{b}{h} y\right) \Rightarrow b y^2 - \frac{b}{h} y^3 dy$$

بالتكامل $I_x = \int_0^h b y^2 - \frac{b}{h} y^3 \, dy = \left. \frac{b}{3} y^3 - \frac{b}{4h} y^4 \right|_0^h$

$$= \frac{b h^3}{3} - \frac{b}{4} h^3 = \boxed{\frac{b h^3}{12}}$$

S.P3-

ناخذ شريحة دائرية لها عرض du

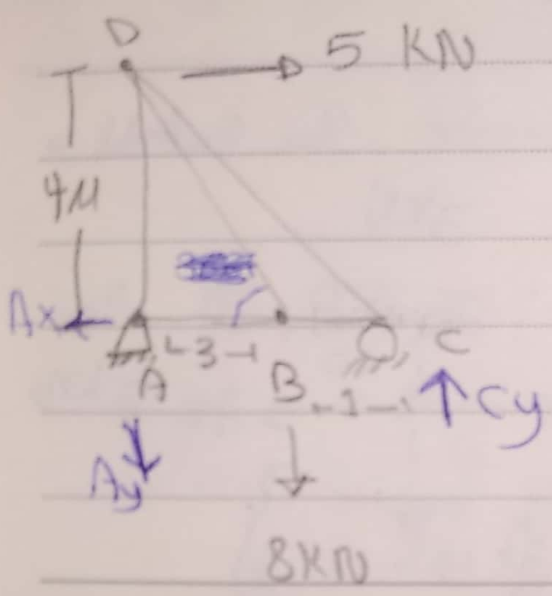


$$dI_o = dA \times u^2$$

$2\pi u$

Analysis of structrue

Trusses "Method of joints"



AB = 5KN T

BC = 11KN T

AD = 3KN T

CD = 15.58 KN C

BD = 10 KN T

1) find global equelibriam -

2) find the reaction of the supports.

$$\Sigma M_A = 0 = -5(4) - 8(3) + Cy(4)$$

$$20 + 24 = 4Cy$$

$$Cy = 11.$$

$$\Sigma F_y = 0 = 11 - 8 - Ay$$

$$Ay = 3KN$$

$$Ax = 5KN$$

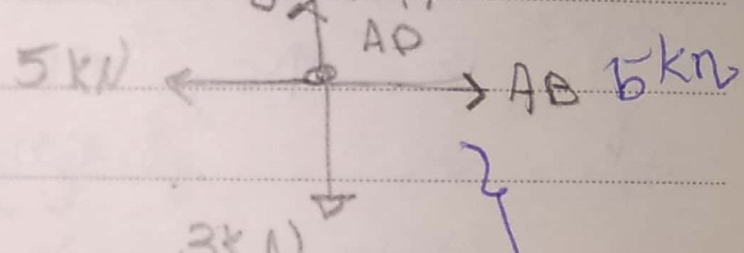
DATE / /

* select a joint
& نختار مفصل عليه أكثر شي 2unknown

* Draw FBD of joint

* solve
* Repeat

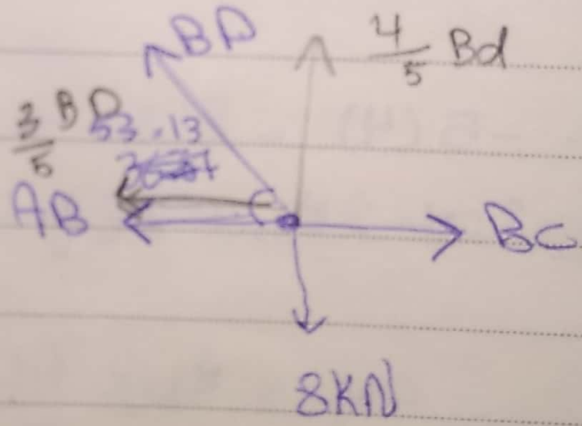
Joint A



$\Sigma F_x = 0$
$\Sigma F_y = 0$

away is always tension.

• Joint B



$\Sigma F_x = 0$
$\Sigma F_y = 0$

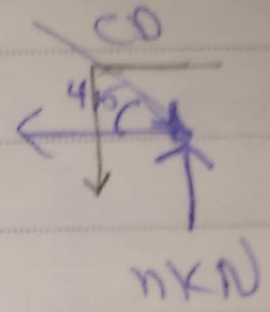
$BC - 5 - \frac{3}{5} BD = 0$ (1) $\quad BC = 11$ KN T

$\frac{4}{5} BD - 8 = 0 \longrightarrow$ (2) $BD = 10$ KN T

SUN. MON. TUES. WED. THUR. FRI. SAT.

NO.
DATE / /

• Joint C :-



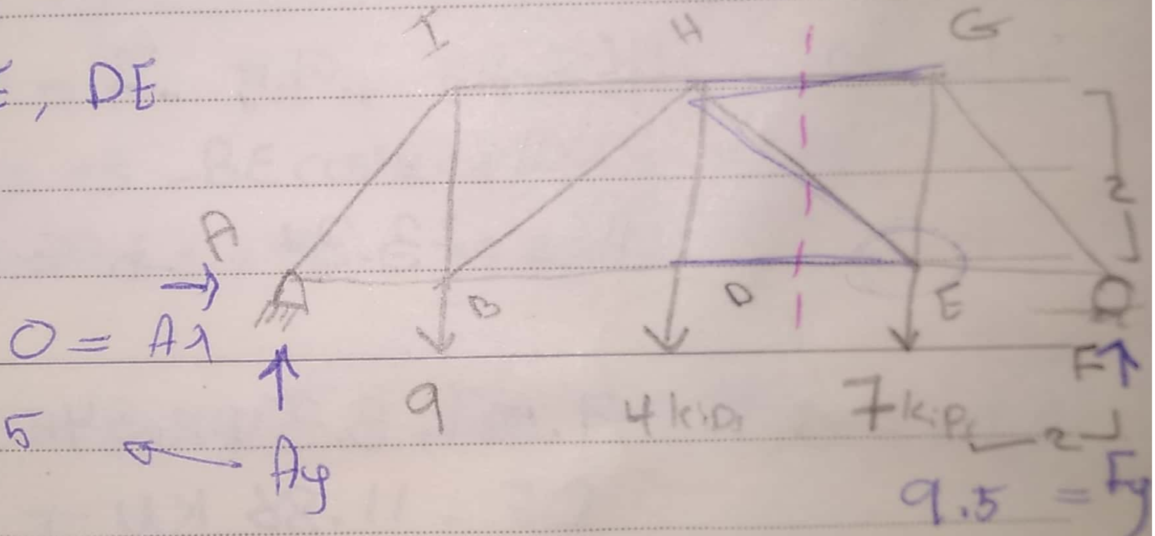
$\sum F_y = 11 - CD \sin 45 = 0$

$CD = 15.56 \text{ kN}$

---

* Method of sections

GH, HE, DE



• $\sum M_A = 0 = 8F_y - 7(6) - 4(4) - 9(2)$

$F_y = 9.5 \text{ kips}$

• $\sum F_y = 0, \ A_y = 10.5$

• اقطع الجزء المطلوب ← فقط Members 3

ما تقطع أكثر من 3

$\sum F_x = 0 \ , \ \sum F_y = 0 \ , \ \sum M = 0$

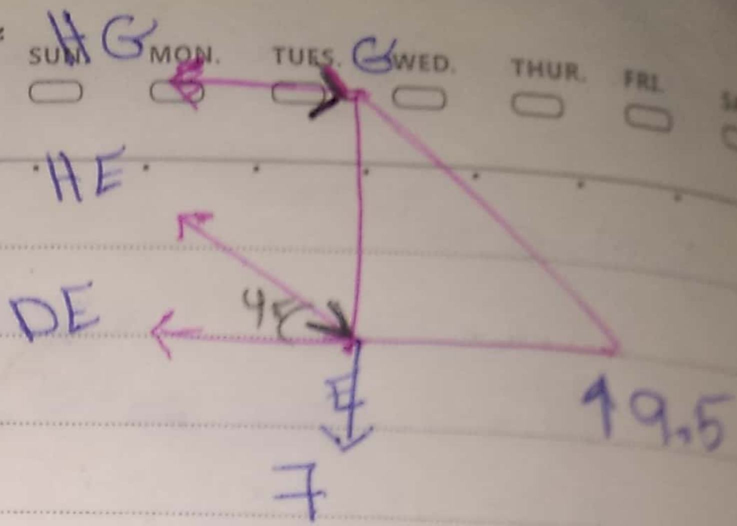
• وارسم الجانب الأسهل

NO.

DATE / /

$9.5 = HG$

3.34



$$\Sigma M_E = 0 = -HG(2) + 9.5(2) = 0$$

$$HG = -9.5 \Rightarrow 9.5\ C$$

$$\Sigma F_y = 0 = HE \sin 45 + 9.5 - 7 = 0$$

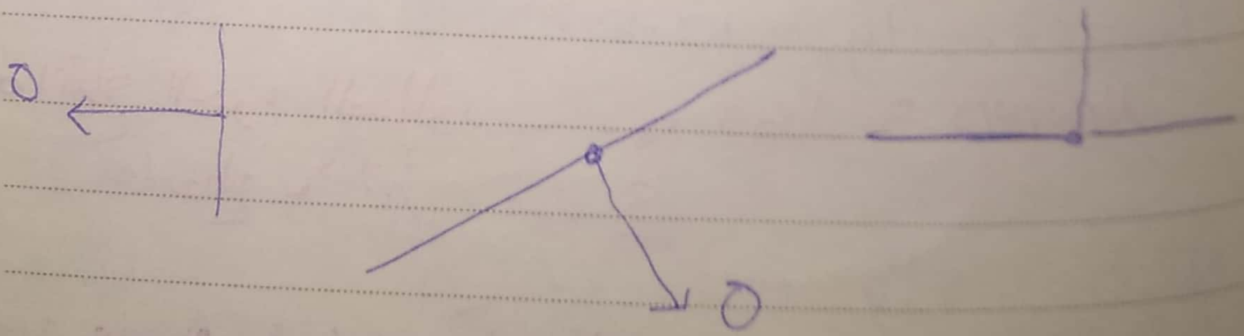
$$HE =$$

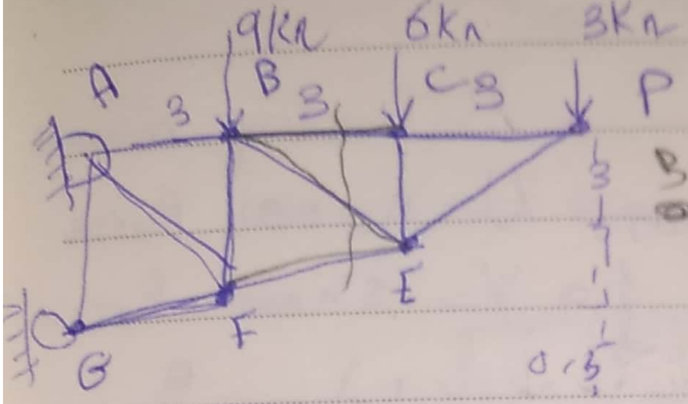
$$HE = -3.34 \Rightarrow 3.34\ C$$

$$\Sigma F_x = 0 = 9.5 + 3.34 \cos 45 - DE = 0$$

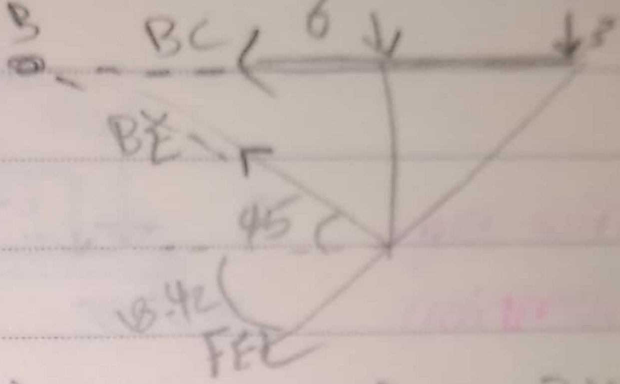
$$DE = 11.86\ kN\ T$$

Zero force members





BC , BE , FE ?



$$\sum M_E = 0 = BC(3) - 3(3) \rightarrow BC = 3\,kN\,T$$

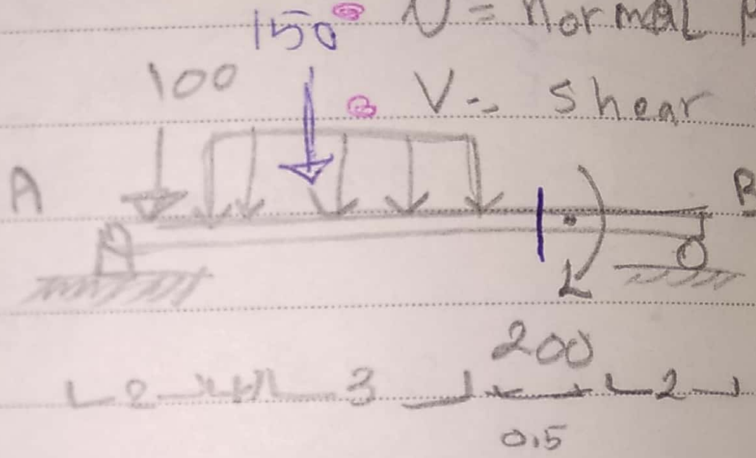
$$\sum F_x = -3 - BE\cos 45 - FE\cos 18.42 = 0$$

$$\sum F_y = BE\sin 45 - FE\sin 18.42 - 6 - 3$$

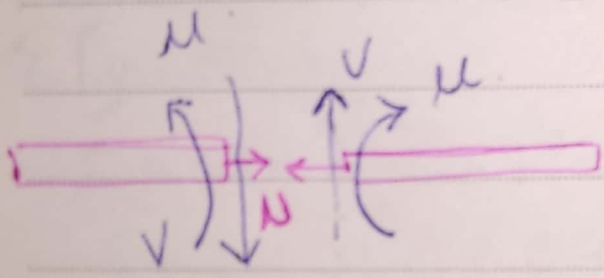
$BE = 8.49\,T \qquad FE = -9.49 = 9.49\,C$

Internal forces

- M = bending moment
- N = normal force
- V = shear force



- positive sign convention



$\Sigma M_A = 0 \rightarrow B_y =$