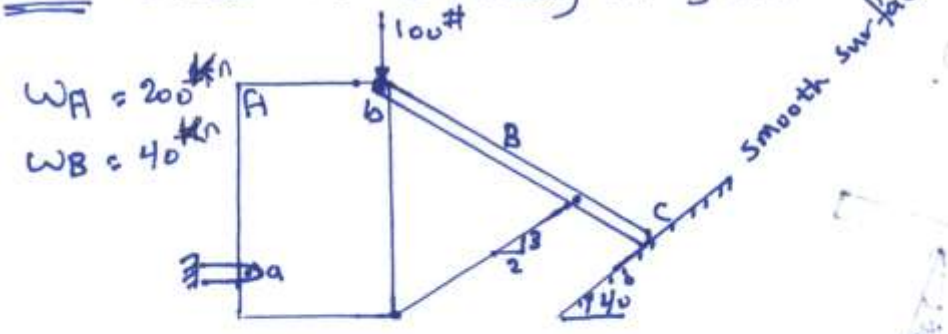
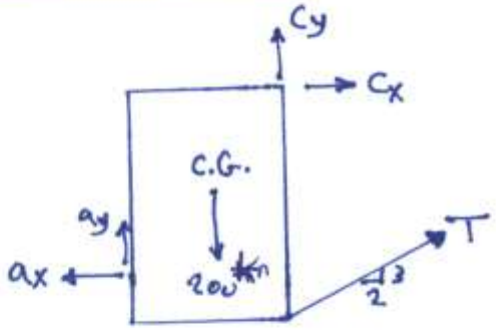
Q: Draw a free-body diagram.

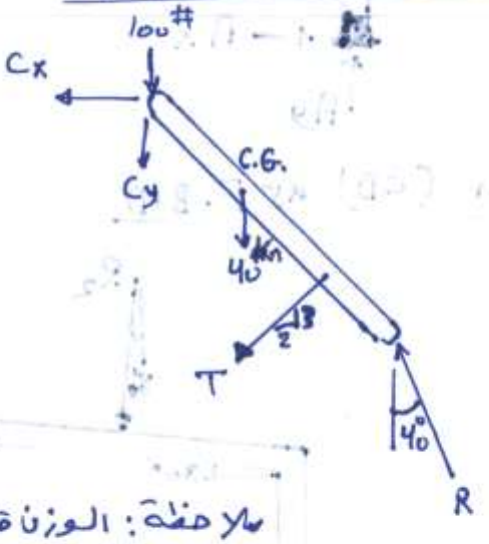


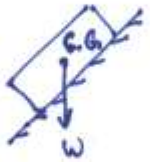
sol.

body (A) as F.B.D



member (B) as F.B.D

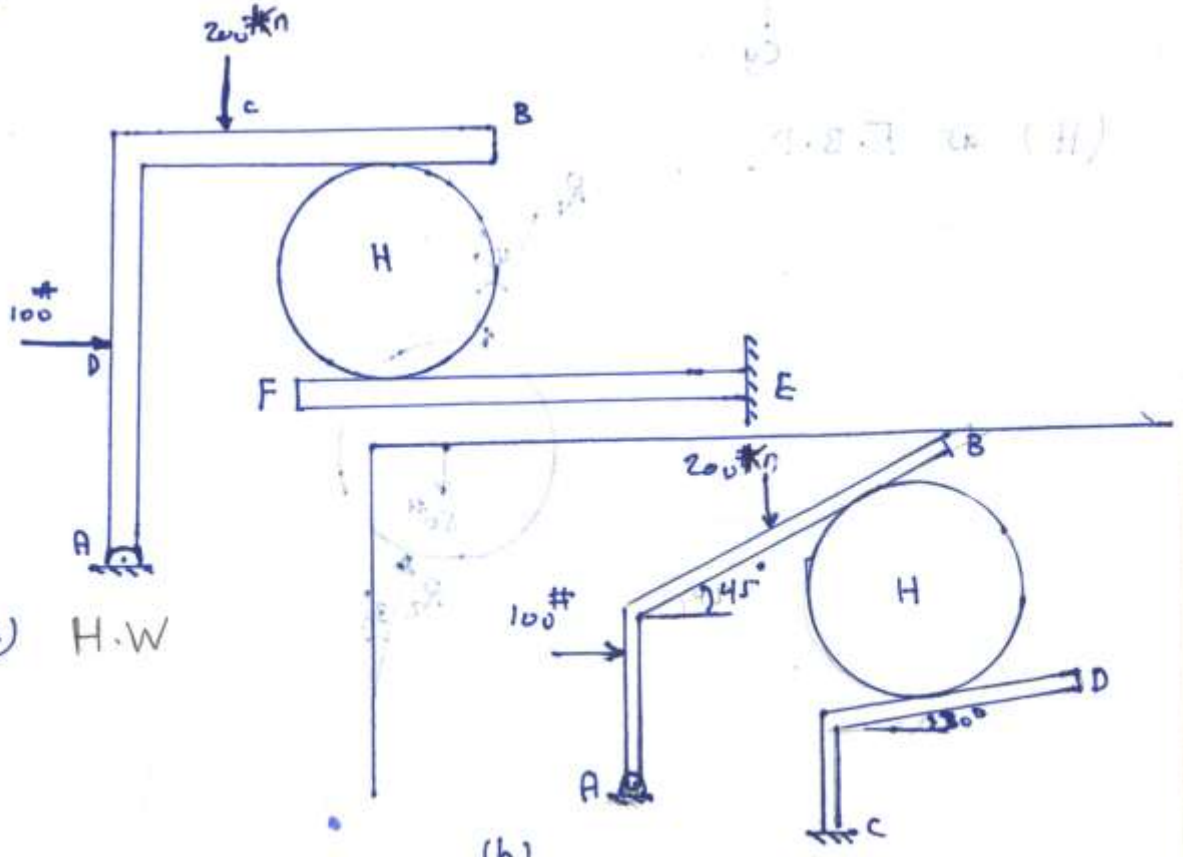




ملاحظة: الوزن قوة شاقولية نحو الاسفل

Q: Draw a free-body diagram.

$W_H = 50$ #n

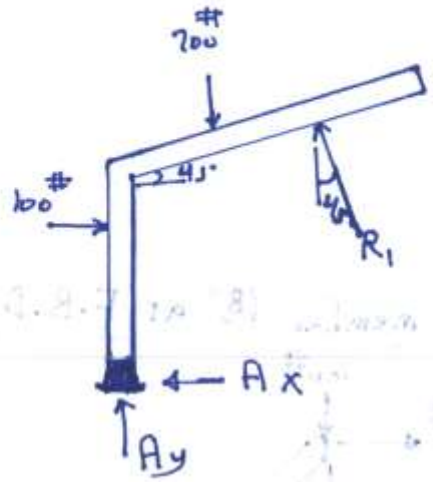


(a) H.W

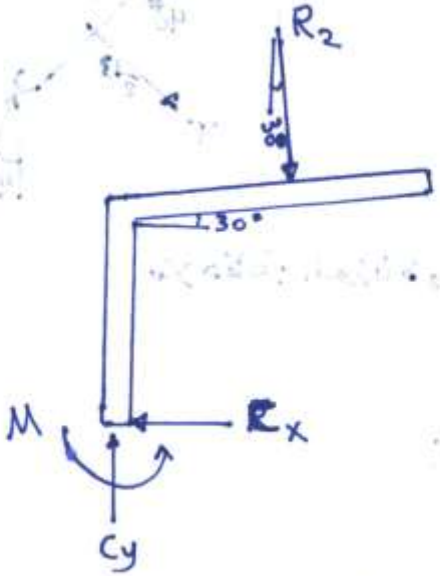
(b)

sol. (b)

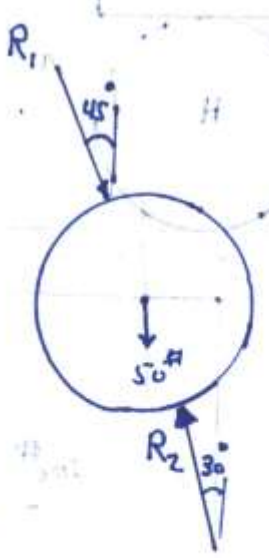
member (AB) as F.B.D



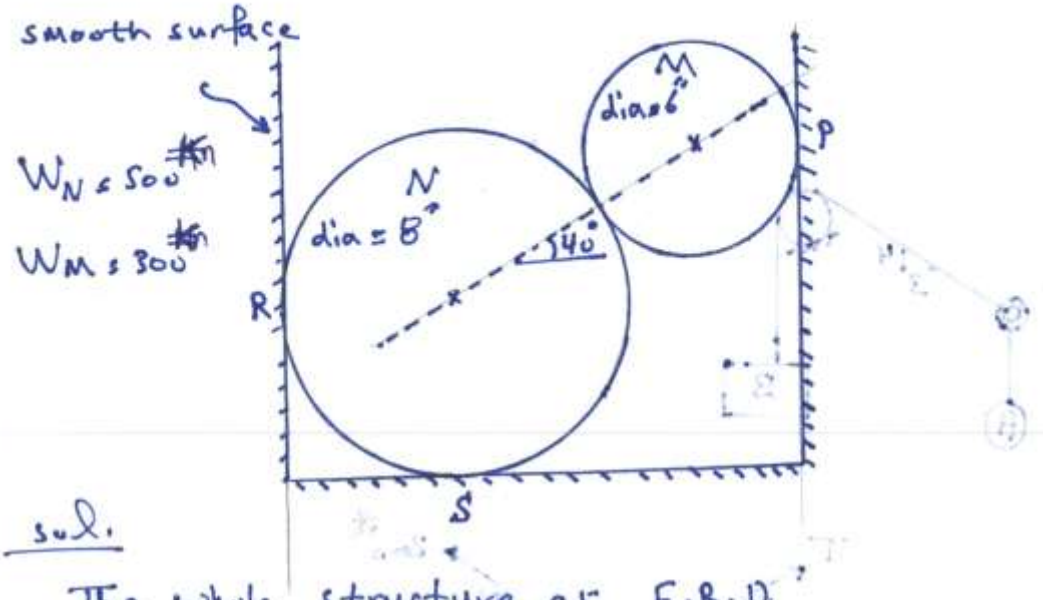
member (CD) as F.B.D



(H) as F.B.D

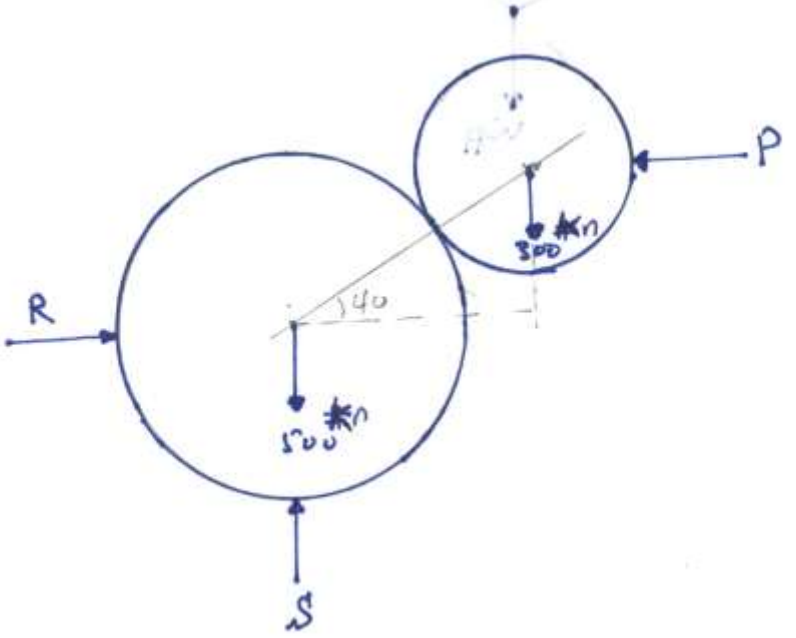


Q: Find Reactions at R and S.



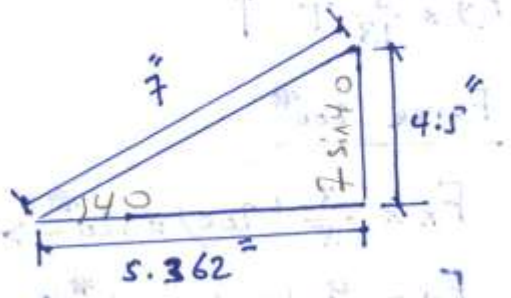
sol.

The whole structure as F.B.D



$\Sigma F_y = 0$

$S = 800$ #



$7 \cos 40 = 5.362$

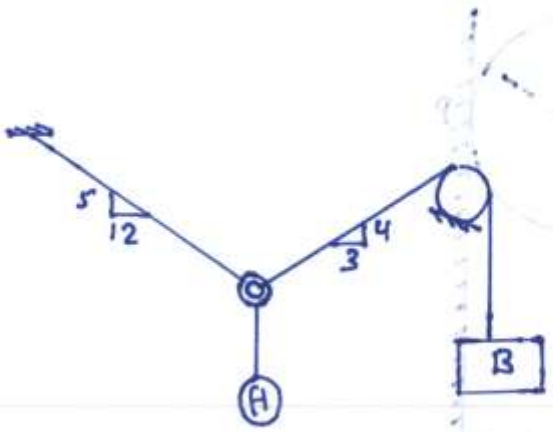
$\Sigma M_N \overset{+}{\circlearrowleft} = 0$

$P(4.5) - 300(5.362) = 0 \Rightarrow P = 357.46$ #$\leftarrow$

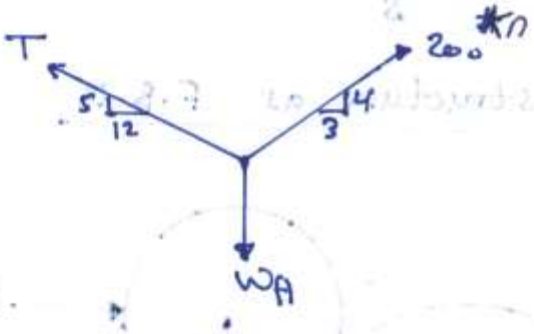
$\Sigma F_x = 0$

$R = 357.46$ #$\rightarrow$

Q: If body B weighs 200 kn. Find W_A.



Sol.



Force T:

$r = \sqrt{12^2+5^2} = 13$

$F_x = \frac{12}{13} T \leftarrow$

$F_y = \frac{5}{13} T \uparrow$

Force 200 kn

$F_x = \frac{3}{5}(200) = 120\ kn \rightarrow$

$F_y = \frac{4}{5}(200) = 160\ kn \uparrow$

Force W_A:

$F_y = W_A \downarrow$

$\pm\rightarrow \sum F_x = 0$

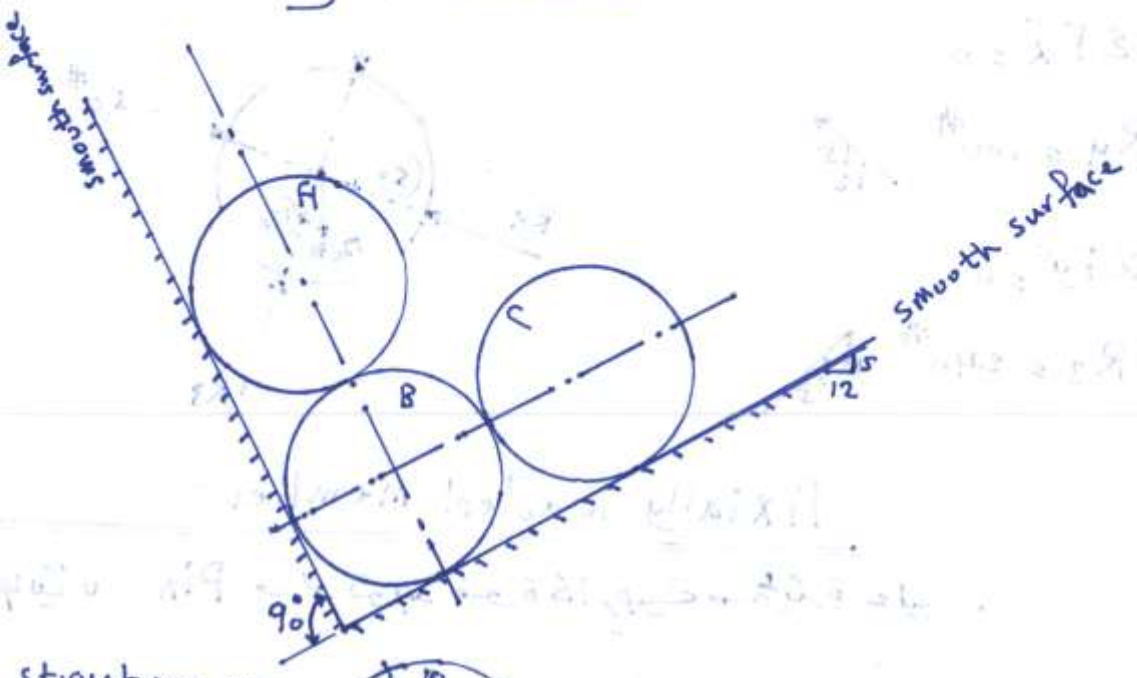
$-\frac{12}{13} T + 120 = 0 \Rightarrow T = 130\ kn$

$+\uparrow \sum F_y = 0$

$\frac{5}{13} T + 160 - W_A = 0 \Rightarrow W_A = 160 + \frac{5}{13}(130)$

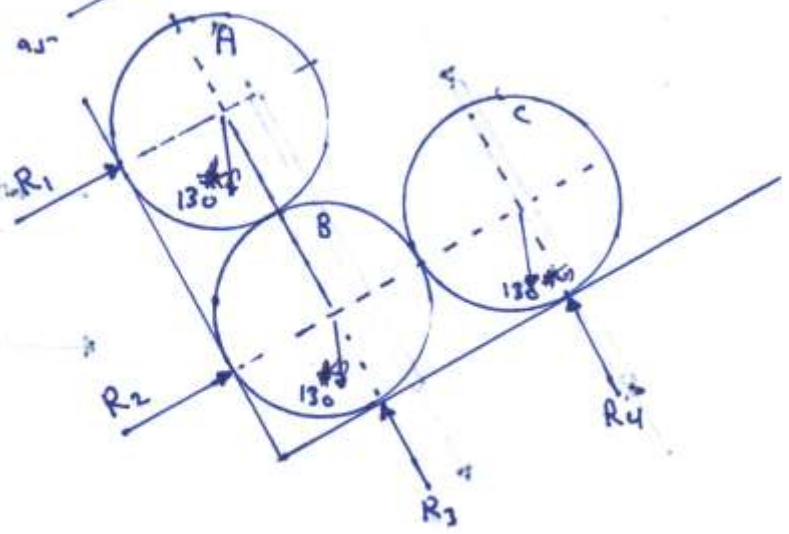
$W_A = 210\ kn \downarrow$

Q: Three empty 130 kN, 3' diameter drums are shown. Find all unknown forces acting on drum B.

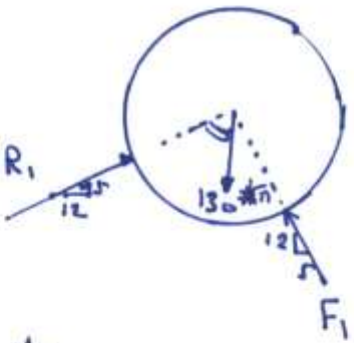


Sol.

The whole structure as F.B.D



Drum (A) as F.B.D



Force 130 kN:

$F_x = 130\left(\frac{5}{13}\right) = 50$ kN ← (5, 12)

$F_y = 130\left(\frac{12}{13}\right) = 120$ kN ↓ (12, 5)

$\Sigma F_x = 0$

$R_1 = 50$ kN

$\Sigma F_y = 0$

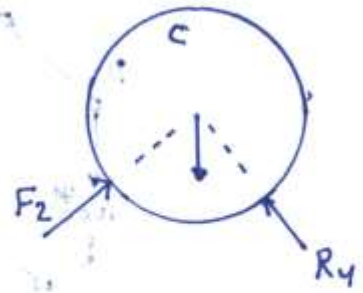
$F_1 = 120$ kN

Drum (C) as F.B.D

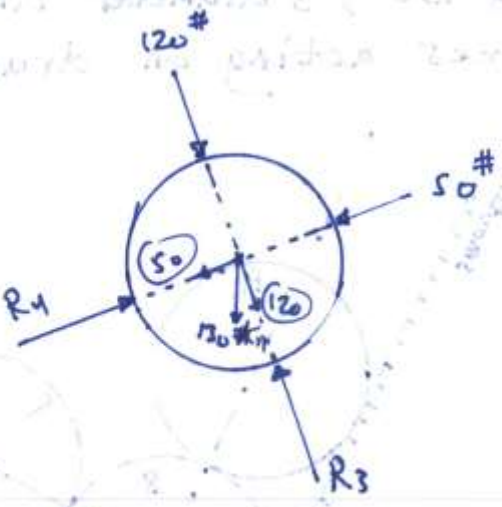
من التناظر

$R_4 = 120$ kN

$F_2 = 50$ kN



Drum B as F.B.D



$\Sigma F_x = 0$

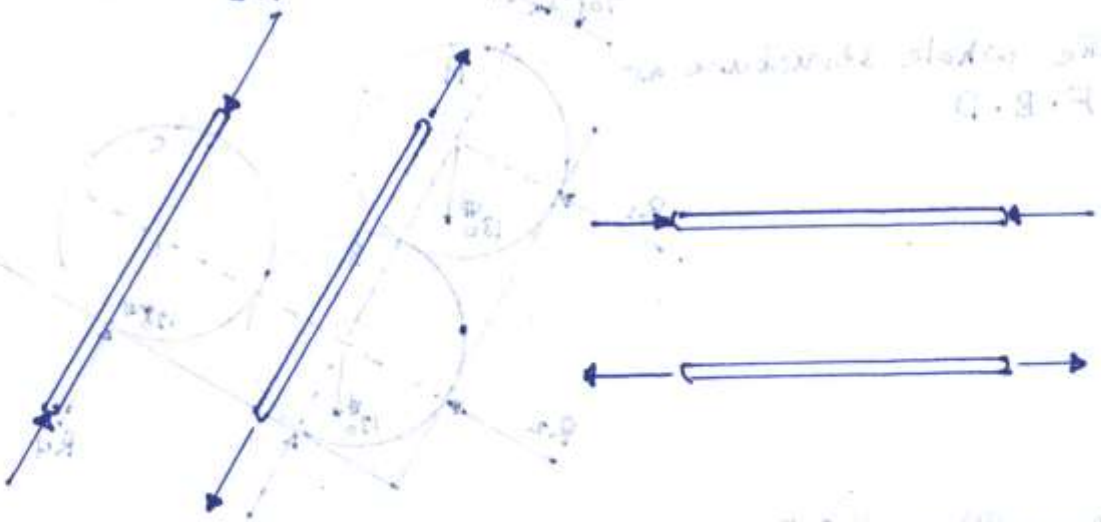
$R_4 = 100$ #in (5 : 12)

$\Sigma F_y = 0$

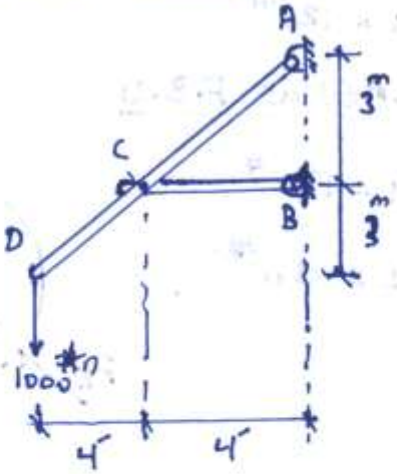
$R_3 = 240$ #in (12 : 5)

Axially loaded member

هو عضو ثنائي Pin ـ لا توجد قوة خارجية مؤثرة عليه.



Q: Find the reactions at A.

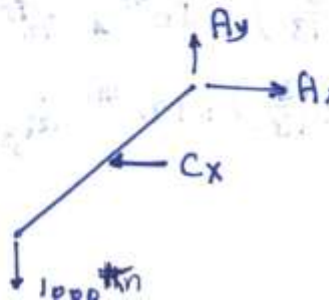


sol.

member (AD) as F.B.D

$\Sigma M_A = 0$ ↻

$C_x(3) - 1000(8) = 0 \Rightarrow C_x = 2666.7$ #in ←



$\Sigma F_x = 0$

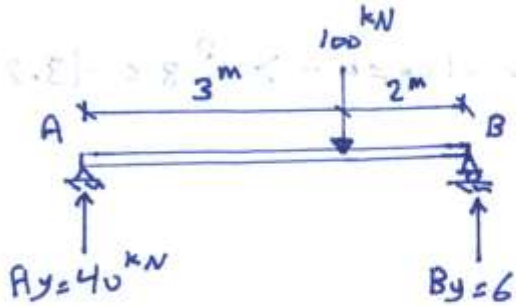
$A_x = 2666.7$ #in →

$\Sigma F_y = 0$

$A_y = 1000$ #in ↑

ملاحظة: اذا توازن جسم تحت تاثير ثلاث قوى فقط فانه يجب ان تلتقي هذه القوى الثلاث في نقطة واحدة (او تكون متوازية جميعاً).

Ex:



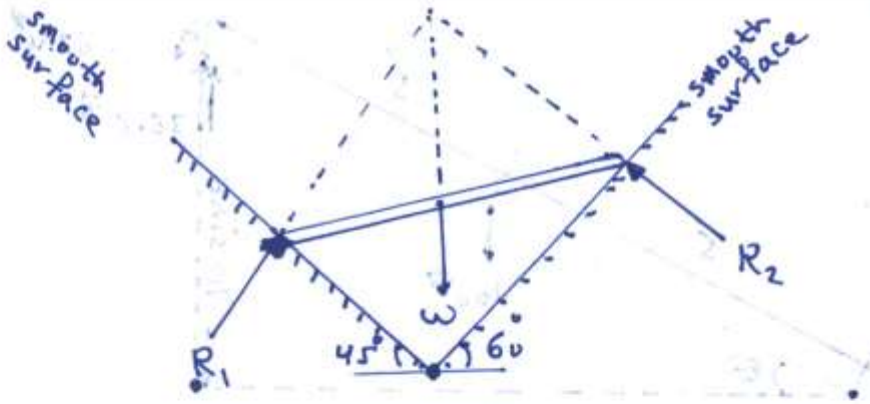
$+\circlearrowleft \Sigma M_A = 0$

$-By(5) + 100(3) = 0$

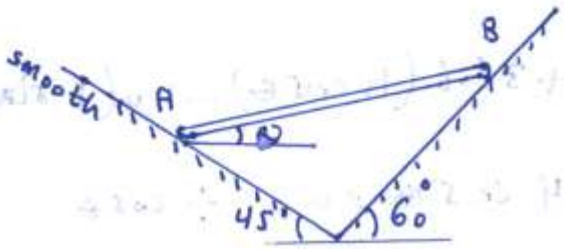
$\therefore By = 60\ kN \uparrow$

$+\uparrow \Sigma F_y = 0$

$Ay + 60 - 100 = 0 \Rightarrow Ay = 40\ kN \uparrow$

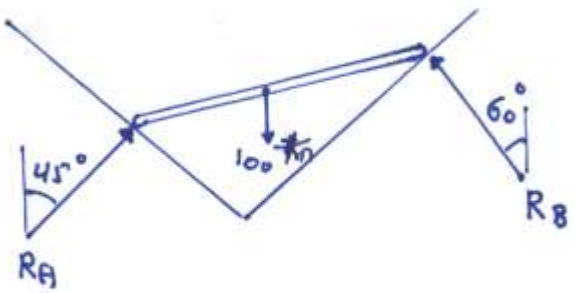


Q: The uniform bar AB is 10' long and weighs 100 kN. Find the angle θ at which the bar will be in equilibrium.



sol.

The whole structure as F.B.D



$+\rightarrow \Sigma F_x = 0$

$R_A \sin 45 - R_B \sin 60 = 0$

$\boxed{R_A = 1.2247\, R_B}$ —①

$\uparrow\uparrow \Sigma F_y = 0$:

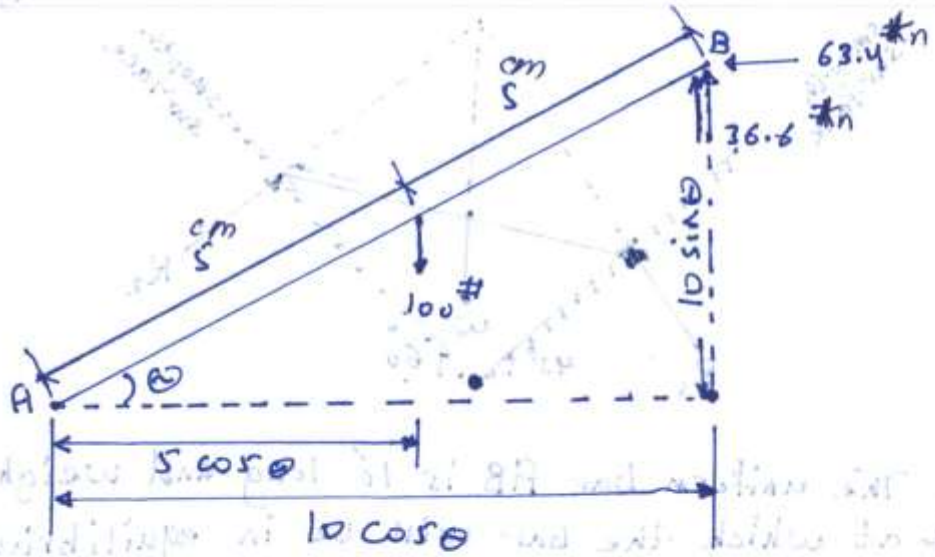
$R_A \cos 45 + R_B \cos 60 - 100 = 0$

$(1.2247 R_B)\cos 45 + R_B \cos 60 - 100 = 0 \rightarrow R_B = 73.2$ #n

R_B

$F_x = 73.2 \sin 60 = 63.4$ #n

$F_y = 73.2 \cos 60 = 36.6$ #n



$\Sigma M_A = 0$

$-63.4(10\sin\theta) + 36.6(10\cos\theta) + 100(5\cos\theta) = 0$

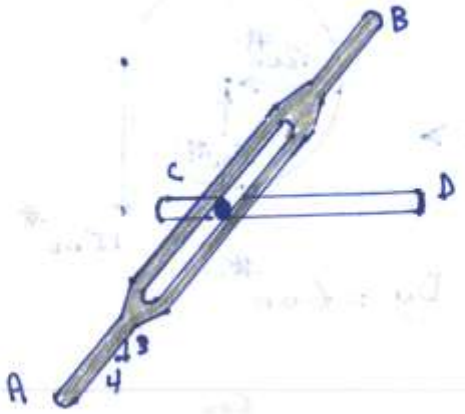
$634\sin\theta - 134\cos\theta = 0 \quad \div \cos\theta$

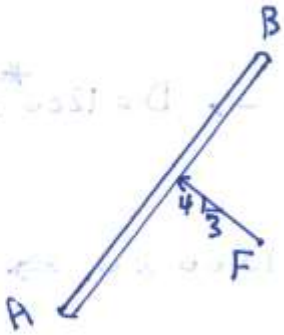
$634\tan\theta - 134 = 0$

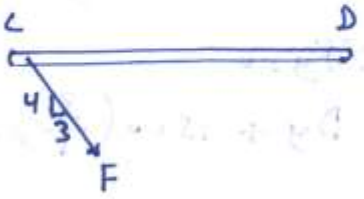
$\therefore \tan\theta = \frac{134}{634} \rightarrow \theta = 11.93^\circ$

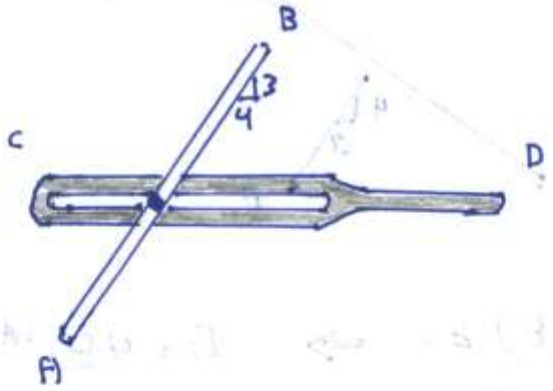
Slot with roller :

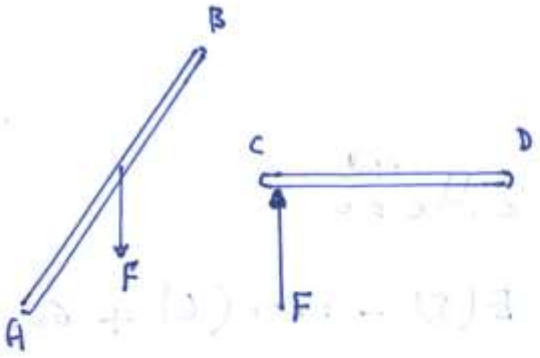
رد فعل واحد يكون عمودي على اتجاه الحركة



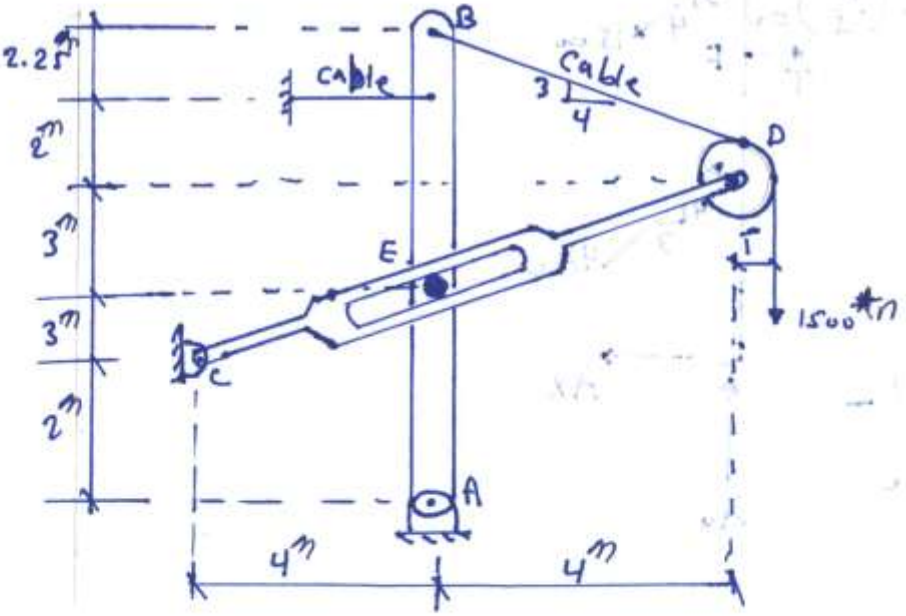






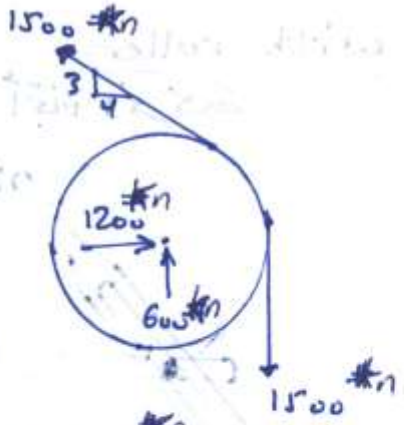


Q: Find the reactions at A.



sol.

Pulley (D) as F.B.D



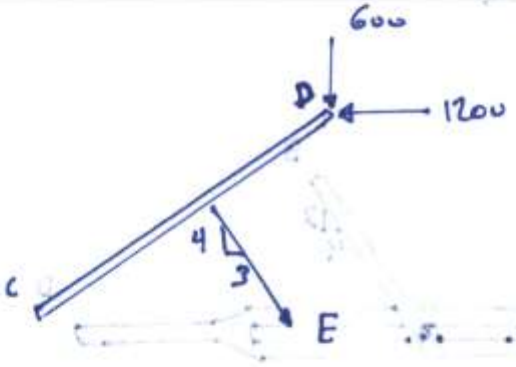
$\pm \rightarrow \Sigma F_x = 0$

$D_x - 1500\left(\frac{4}{5}\right) = 0 \rightarrow D = 1200\ lb \rightarrow$

$+\uparrow \Sigma F_y = 0$

$D_y + 1500\left(\frac{3}{5}\right) - 1500 = 0 \Rightarrow D_y = 600\ lb$

member (DC) as F.B.D



$\overset{+}{\circlearrowleft} \Sigma M_C = 0$

$E(5) - 1200(6) + 600(8) = 0 \Rightarrow E = 480\ lb$ (4–3)

member (AB) as F.B.D

$+\uparrow \Sigma F_y = 0$

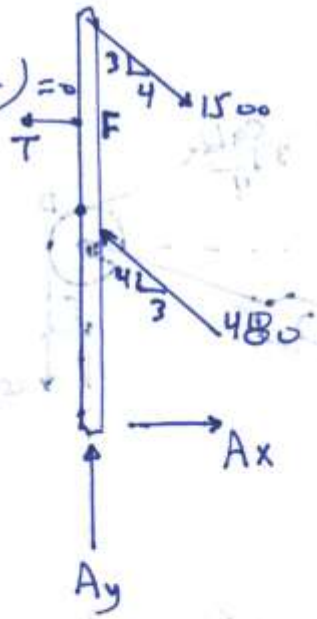
$A_y + 480\left(\frac{4}{5}\right) - 1500\left(\frac{3}{5}\right) = 0$

$A_y = 516\ lb \uparrow$

$\overset{+}{\circlearrowleft} \Sigma M_F = 0$

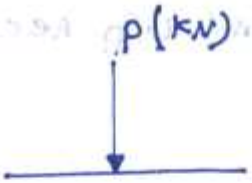
$-A_x(10) + 480\left(\frac{3}{5}\right)(5) + 1500\left(\frac{4}{5}\right)(2.25) = 0$

$\therefore A_x = 414\ lb \rightarrow$

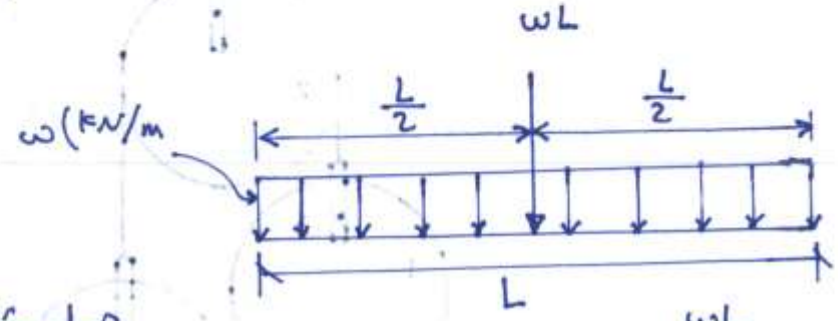


الاحمال

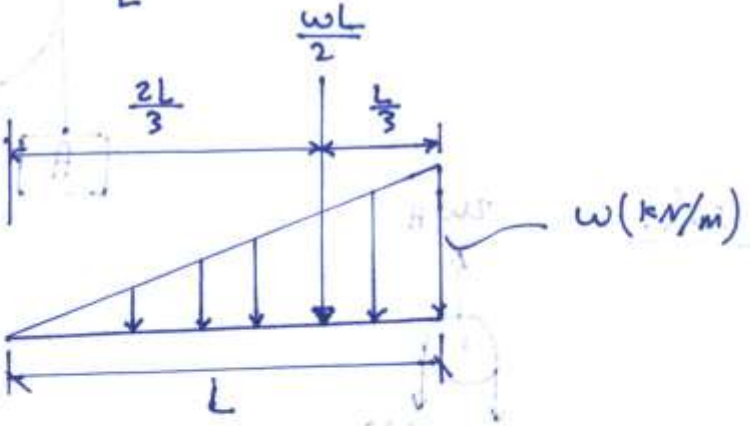
حمل مركز
Concentrated load



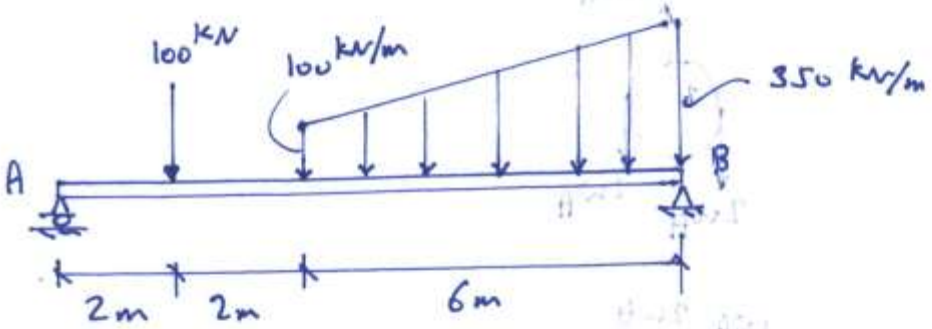
حمل موزع بانتظام
uniformly distributed load



حمل مثلثي
triangular load



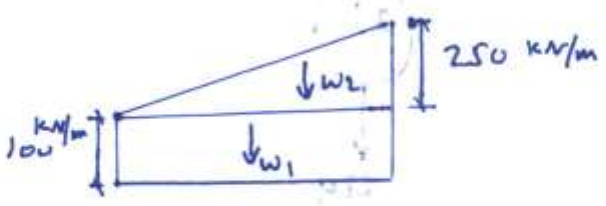
Q: Find the reactions on the beam at A and B.

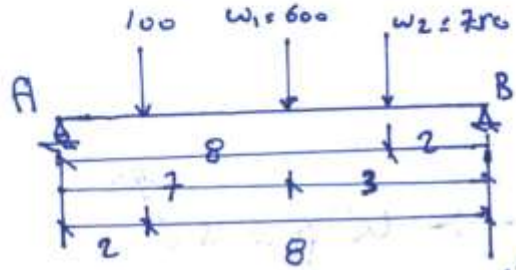


sol.

$w_1 = 100(6) = 600\ KN$

$w_2 = \frac{250(6)}{2} = 750\ KN$





$\Sigma M_A = 0$

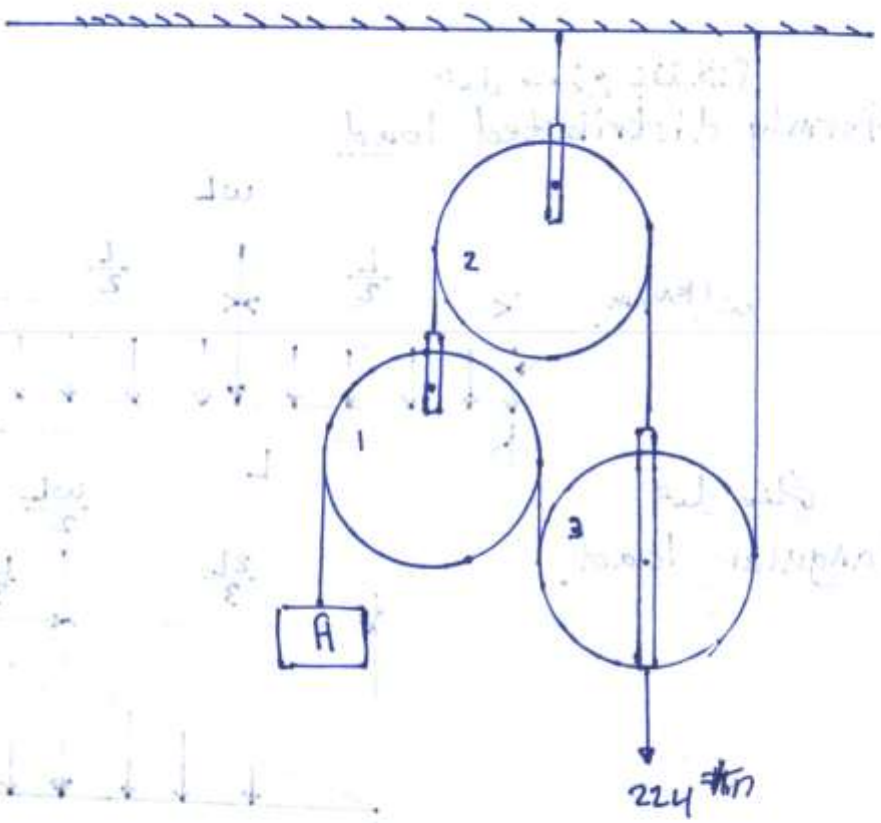
$-B_y(10) + 100(2) + 600(7) + 750(8) = 0$

$\therefore B_y = 1040\ KN \uparrow$

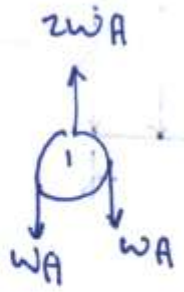
$+\uparrow \Sigma F_y = 0 \quad A_y + 1040 - 100 - 600 - 750 = 0 \rightarrow A_y = 410\ KN \uparrow$

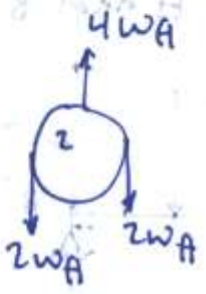
$\Sigma F_x = 0 \quad A_x = 0$

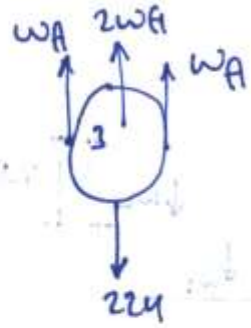
Q: Find W_A necessary to maintain the system in equilibrium.



Sol.



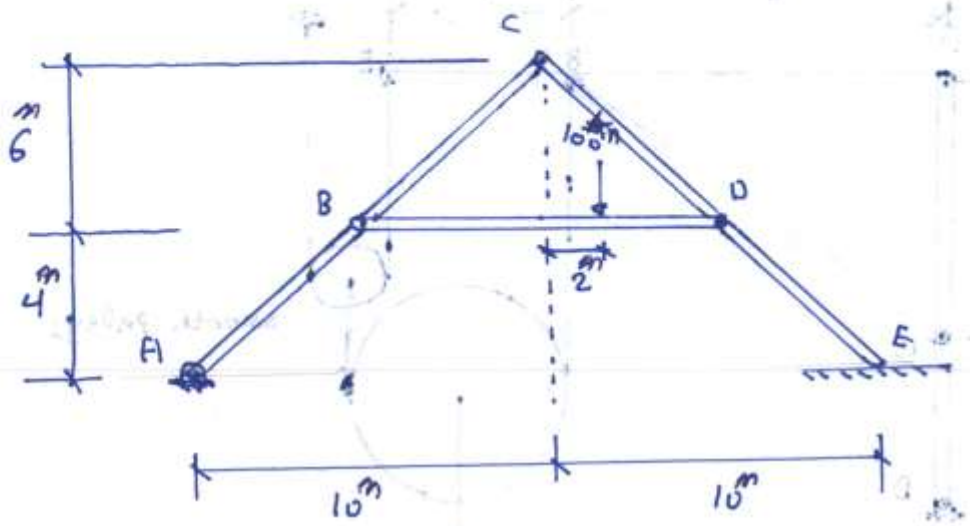




$\therefore +\uparrow \Sigma F_y = 0$

$$W_A + 2W_A + W_A - 224 = 0 \rightarrow W_A = 56 \text{ kN}$$

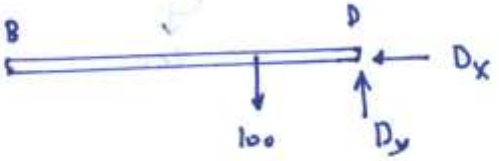
Q: Find the horizontal and vertical components of the pin reaction at D on member BD.



sol.

member (BD) as F.B.D

$\Sigma M_B \overset{+}{\circlearrowleft} = 0$



$-D_y(12) + 100(8) = 0$

$D_y = 66.67$ kN ↑

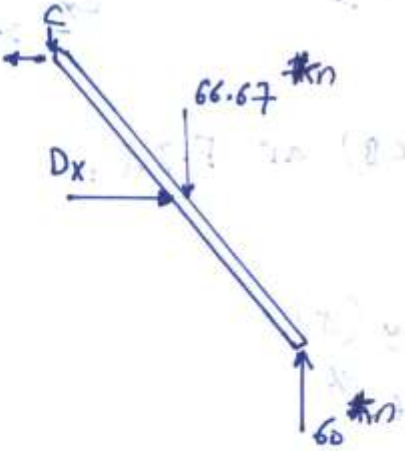
The whole structure as F.B.D

$\Sigma M_A \overset{+}{\circlearrowleft} = 0$

$-E_y(20) + 100(12) = 0 \Rightarrow E_y = 60$ kN ↑

member (CE) as F.B.D

$\Sigma M_C \overset{+}{\circlearrowleft} = 0$



$-D_x(6) + 60(10) + 66.67(6) = 0$

$D_x = -33.33$

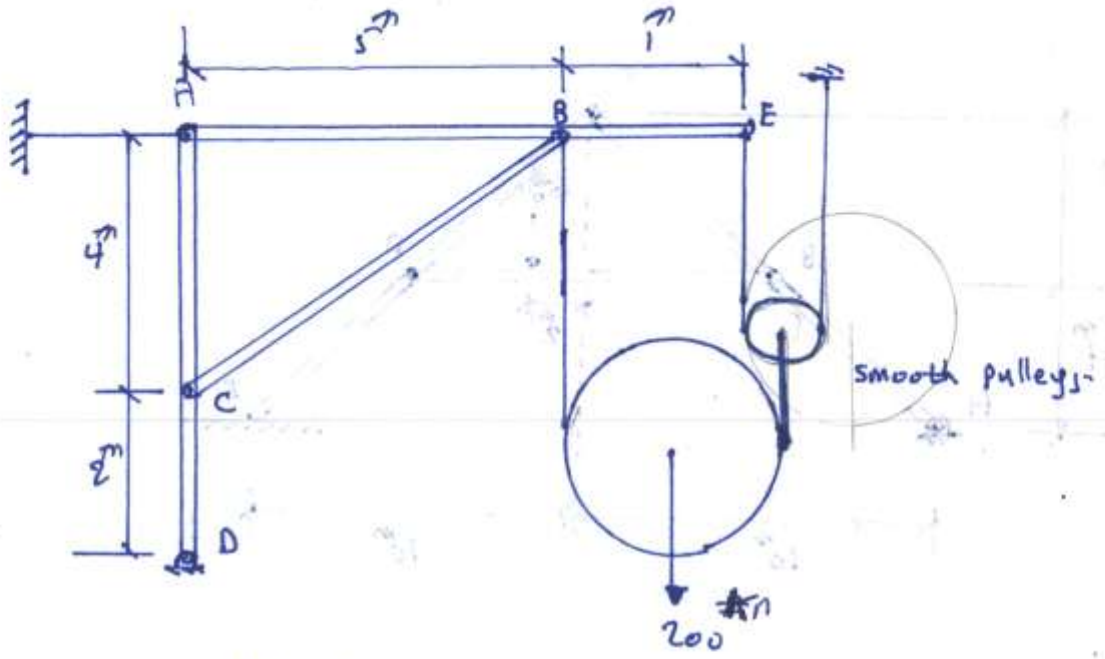
$\therefore D_x = 33.33$ kN ←

$\therefore$ in member DB

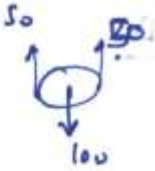
$D_x = 33.33$ kN →

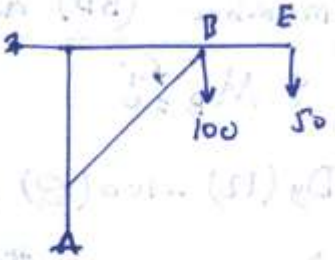
$D_y = 66.67$ kN ↑

Q: Find C_x and C_y on member ACD.



Sol



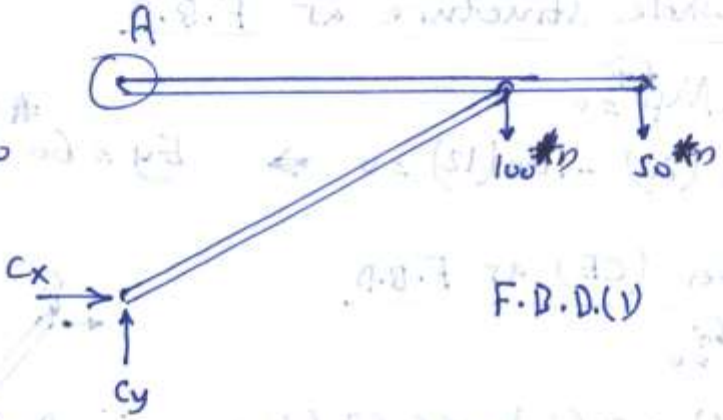


From F.B.D.(1)

$\Sigma M_A = 0$ (+)

$-C_x(4) + 100(5) + 50(6) = 0$

$C_x = 200$ kN →



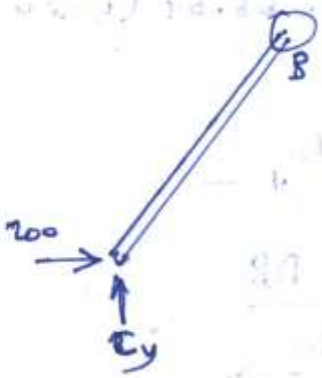
F.B.D.(1)

member (CB) as F.B.D.

$\Sigma M_B = 0$

$-200(4) + C_y(5) = 0$

$\rightarrow C_y = 160$ kN



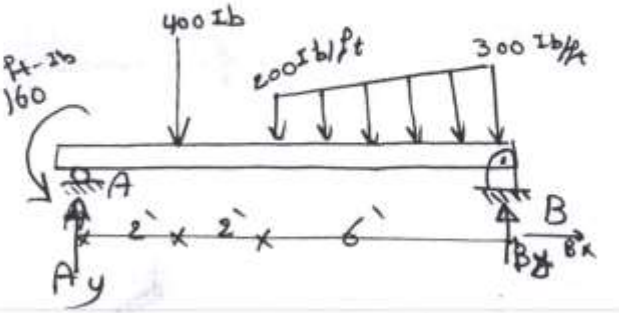
∴ In member ACD

$C_x = 200$ kN ←

$C_y = 160$ kN ↓

4-27 Det. Reaction at A & B

Sol.



$\Sigma F_x = 0 \rightarrow$ **Bx = 0**

$\Sigma M_A = 0$ +)

$$-B_y * 10 + 200 * 6 * (7) + \frac{100 * 6}{2} * (8) + 400(2) - 160 = 0$$

By = 1144 lb ↑

$\Sigma F_y = 0$

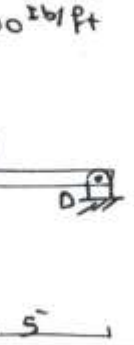
$$1144 + \frac{300 + 200}{2} * 6 - 400 + A_y = 0$$

Ay = 756 lb ↑

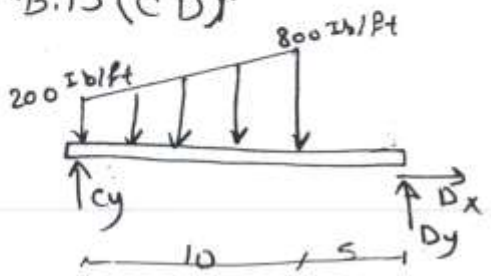
4-29 Det. R_A, R_B & R_D

16

Sol:



F.B.D (CD)



$\Sigma F_x = 0$ → $D_x = 0$

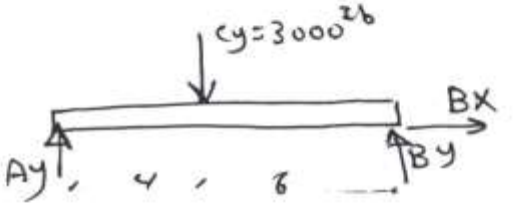
$\Sigma M_C = 0$ ↻

$-D_y * 15 + 200(10)(5) + \frac{600(10)}{2} * \frac{10}{3} = 0$ → $D_y = 2000$ lb ↑

$\Sigma M_D = 0$ ↻

$C_y(15) - 200*10*10 - \frac{600*10}{2} * (5 + \frac{10}{3}) = 0$ → $C_y = 3000$ lb ↑

F.B.D. AB



$\Sigma F_x = 0$ → $B_X = 0$

$\Sigma M_A = 0$ ↻

$-B_y * 10 + (3000) * 4 = 0$ → $B_y = 1200$ lb ↑

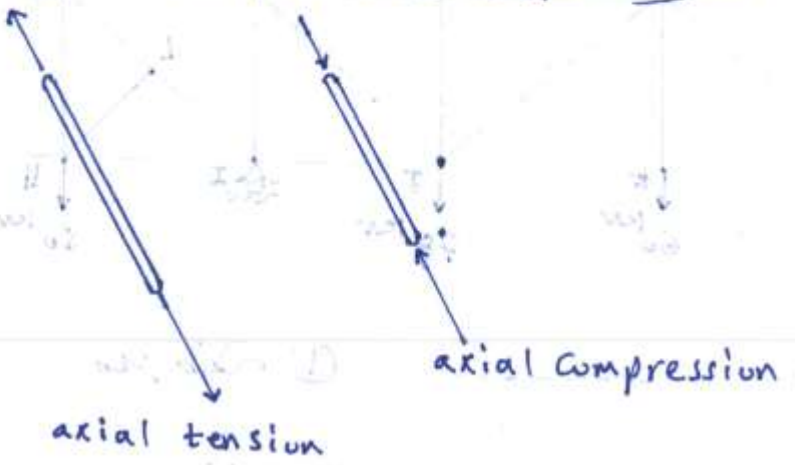
$\Sigma F_y = 0$

$1200 - 3000 + A_y = 0$

$A_y = 1800$ lb ↑

Truss

ال Truss هو axial member



هنالك طريقتان لحساب القوة في ال (Truss):

الطريقة الاولى: Joint Method

ويمكن فيها استخدام المعادلتين

$\Sigma F_x = 0$

$\Sigma F_y = 0$

الطريقة الثانية: section method

ويمكن فيها استخدام المعادلات

$\Sigma F_x = 0$

$\Sigma F_y = 0$

$\Sigma M = 0$

ملاحظات:

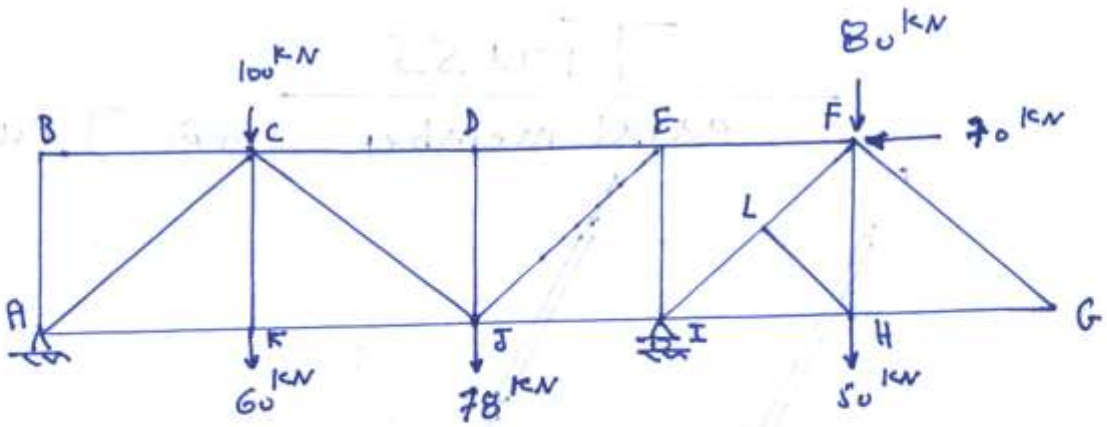
① اذا التقى ثلاث اضلاع في (joint) اثنان منهم على استقامة واحدة ولا توجد قوة خارجية على ذلك الـ joint .

∴ القوة في الضلع الثالث = 0

② اذا التقى ضلعان في (joint) ليسا على استقامة واحدة ولا توجد قوة خارجية على ذلك الـ (joint).

∴ القوة في كلا الضلعين = 0

Ex:



$F_{LH} = 0$ ------ (1) قضيب

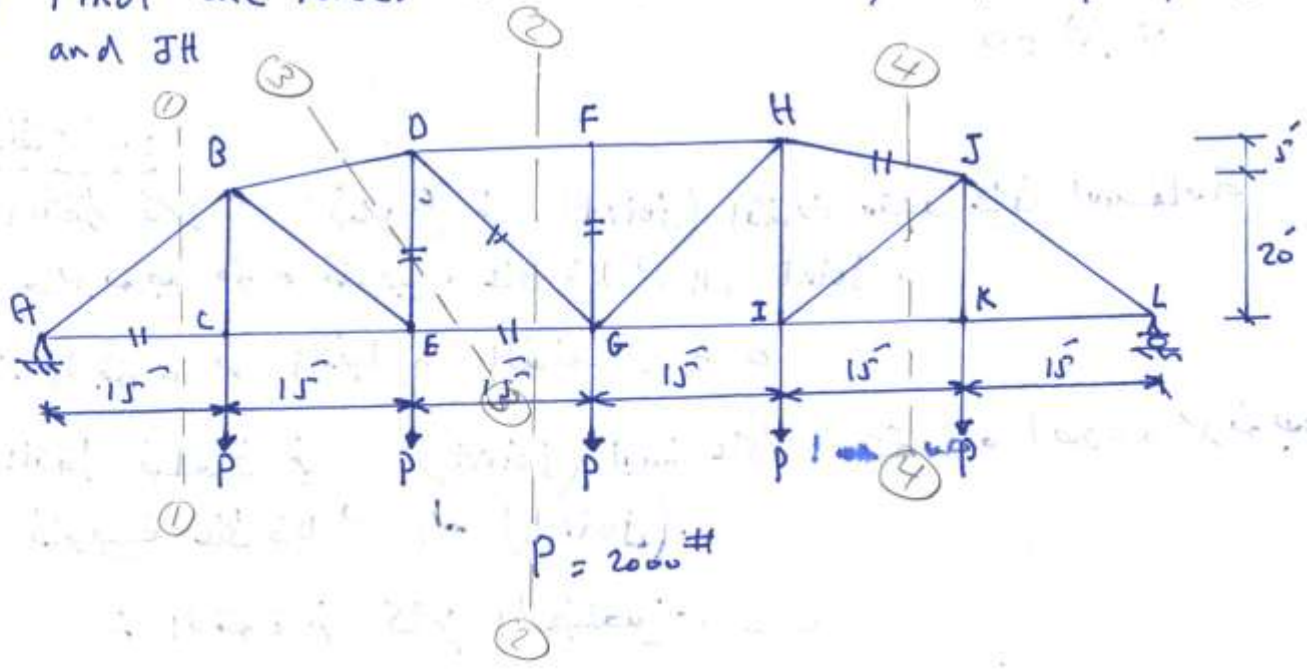
$F_{DJ} = 0$ ------ (1) قضيب

$F_{BA} = 0$ ------ } (2) قضيب
$F_{BC} = 0$ ------ }

$F_{GF} = 0$ ------ } (2) قضيب
$F_{GH} = 0$ ------ }

$F_{CK} \neq 0$ ------ (1) قضيب

Q: Find the forces in members AC, EG, DG, DE, FG and JH



$\Sigma M_A = 0 \circlearrowleft +$

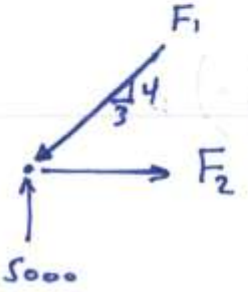
$-R_L(90) + 2000(75 + 60 + 45 + 30 + 15) = 0$

$\therefore R_L = 5000^{\#} \uparrow$

$+\uparrow \Sigma F_y = 0$

$R_A + 5000 - 2000 * 5 = 0 \rightarrow R_A = 5000^{\#} \uparrow$

Joint A :



$+\uparrow \Sigma F_y = 0$

$5000 - F_1\left(\frac{4}{5}\right) = 0 \rightarrow F_1 = 6250^{\#}$ (compression)

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

$F_2 - 6250\left(\frac{3}{5}\right) = 0 \rightarrow F_2 = 3750^{\#}$ (Tension)

$\therefore$ Force in member AC $= 3750^{\#}$ (T)

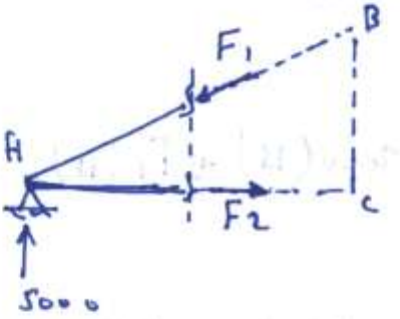
اكل بطريقة اخرى

sec. 1-1 (left part)

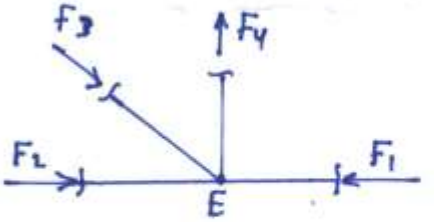
$\Sigma M_B \circlearrowleft + = 0$

$5000(15) - F_2(20) = 0$

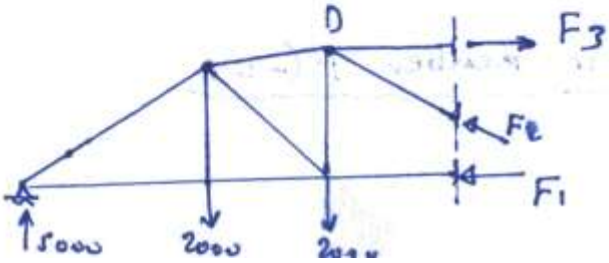
$F_2 = 3750^{\#}$ (T)



Joint E



sec 2-2 (left part)



$\Sigma M_D \overset{+}{\circlearrowleft} = 0$

$5000(30) - 2000(15) + F_1(25) = 0 \rightarrow F_1 = -4800$

$\therefore F_1 = 4800^{\#}$ (T)

$\therefore$ Force in member EG $= 4800^{\#}$ (T)

$+\uparrow \Sigma F_y = 0$

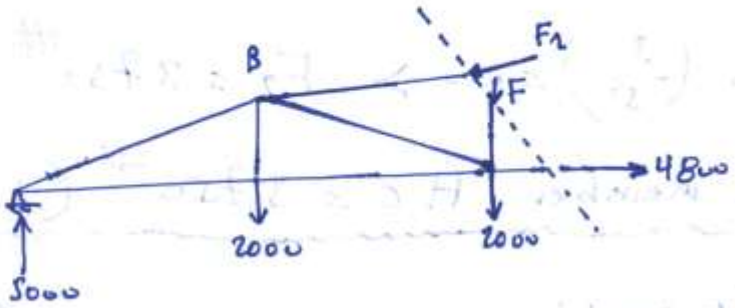
$5000 - 2000 - 2000 + F_2\left(\frac{4}{5}\right) = 0$

$\rightarrow F_2 = -1250$

$\therefore F_2 = 1250^{\#}$ (T)

$\therefore$ Force in member DG $= 1250^{\#}$ (T)

sec 3-3 (left part)



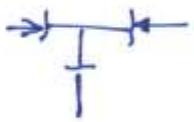
$\Sigma M_B \overset{+}{\circlearrowleft} = 0$

$5000(15) + 2000(15) + F_1(15) - 4800(20) = 0$

$F_1 = -600$

$\therefore$ Force in member DE $= 600^{\#}$ (T)

Joint F

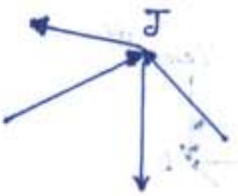


$\Sigma F_y = 0$

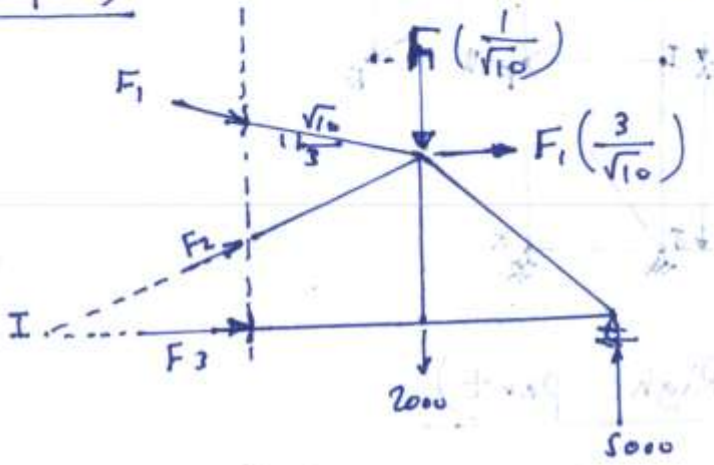
$FG = 0$

$\therefore$ Force in member FG $= 0$

Joint J



Sec 4-4 (right part)



$\circlearrowleft +$

$\Sigma M_I = 0$:

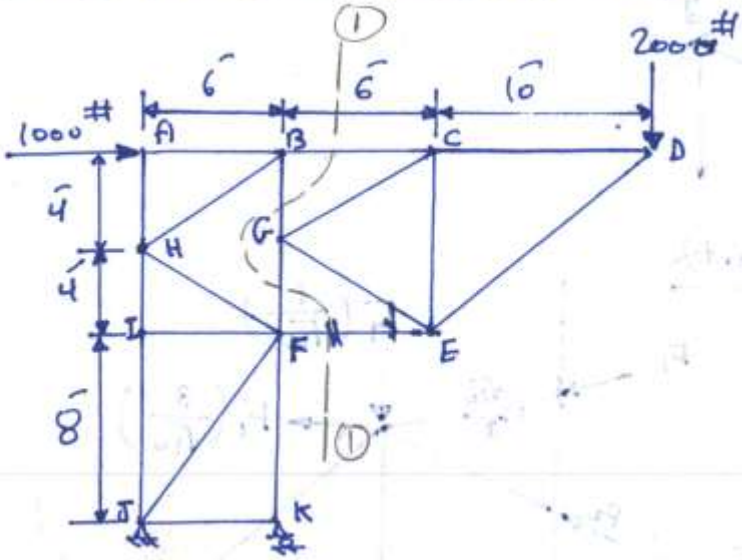
$2000(15) - 5000(30) + F_1\left(\frac{3}{\sqrt{10}}\right)(20) + F_1\left(\frac{1}{\sqrt{10}}\right)(15) = 0$

$\therefore F_1 = 5059.64$ #

$\therefore$ Force in member JH = 5059.64 # (C)

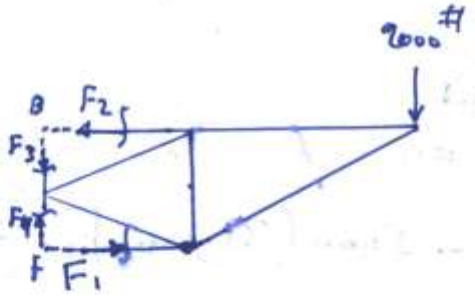
(7)

Q: Find the force in member EF.



sol.

sec 1-1 (Right part)



$\circlearrowleft +$

$\Sigma M_B = 0$

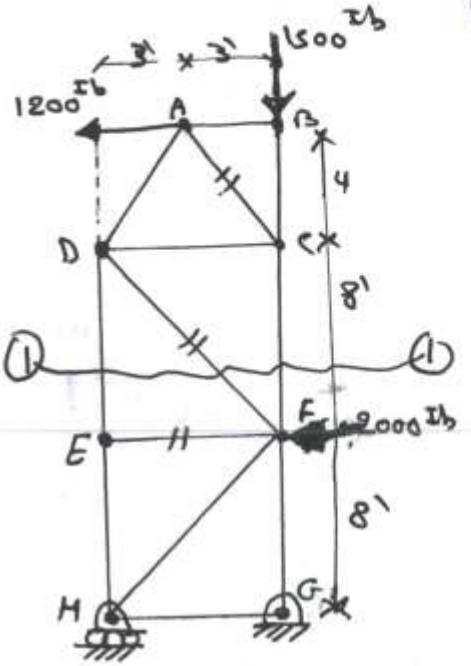
$-F_1(8) + 2000(16) = 0$

$F_1 = 4000$ #

$\therefore$ Force in member EF = 4000 # (C)

4-67

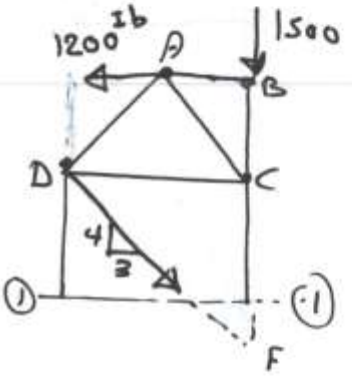
Det. EF, DF & Ac



Sol:

Joint E → $EF = 0$

sec. (1)-(1)

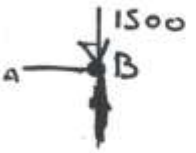


$\Sigma F_x = 0 \xrightarrow{+}$

$\frac{3}{5} DF = 1200$

$DF = 2000\ lb\ T$

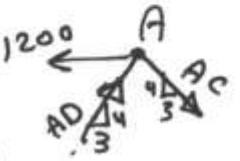
Joint B



$\pm \Sigma F_x = 0$

$\therefore BA = 0$

Joint A



$+\uparrow \Sigma F_y = 0$ $\quad AD \frac{4}{5} - AC \frac{4}{5} = 0$

$\therefore AD = AC$

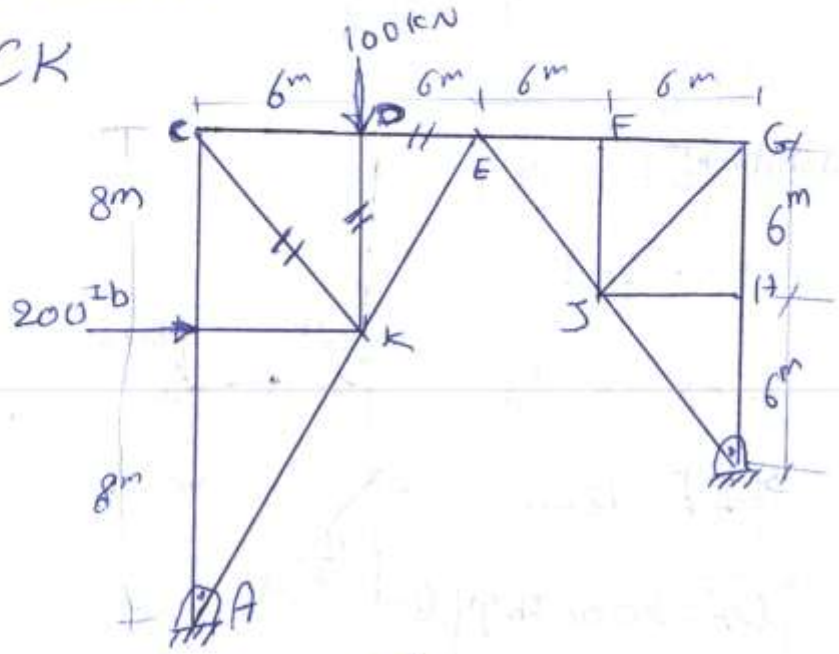
$\Sigma F_x = 0 \xrightarrow{+}$

$AC \frac{3}{5} + \overset{AC}{AD} \frac{3}{5} - 1200 = 0$

$2 \frac{3}{5} AC = 1200$

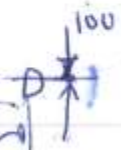
$AC = 1000\ lb\ T$

4-71 Det. the forces in members DE, DK & CK



Sol.

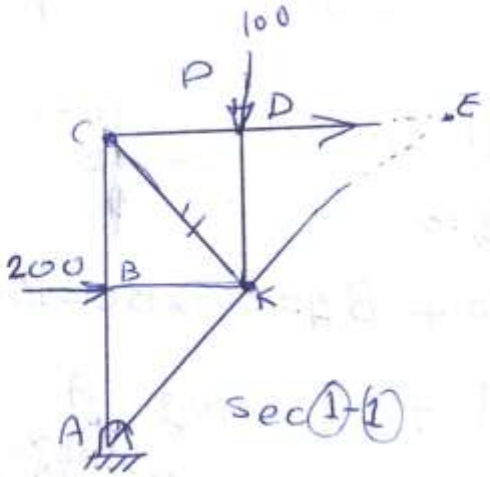
Joint D



$DK = 100\ KN\ C$

Sec (1-1)

$\pm \Sigma M_A = 0$



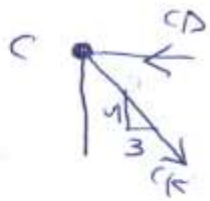
$DE \times 16 + 100 \times 6 + 200 \times 8 = 0$

$DE = 137.5\ KN\ C$

Joint D

$DC = 137.5\ KN\ C$

Joint C



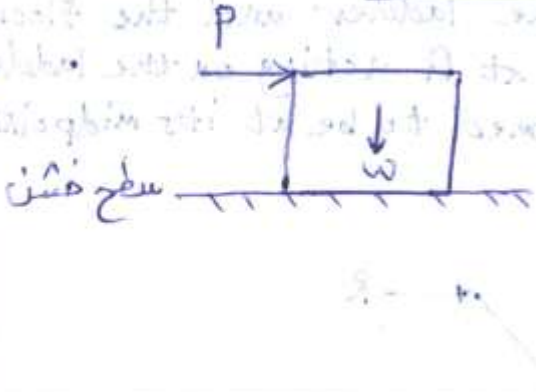
$\Sigma F_x = 0$

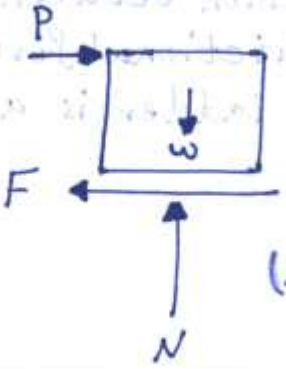
$CK \times \frac{3}{5} - 137.5 = 0$

$CK = 229.167\ KN\ T$

Friction

تعريف الاحتكاك



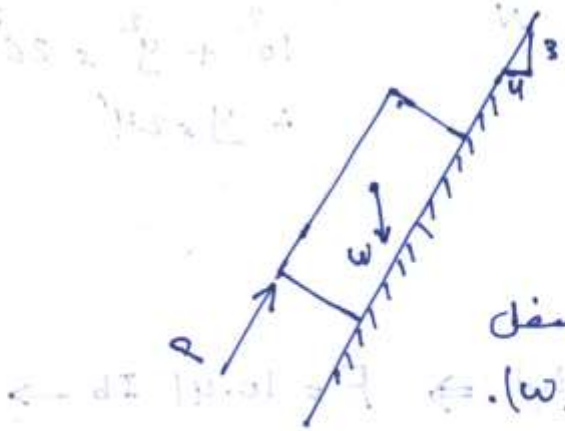


سوف تتولد قوتان احدهما موازية للسطح ويرمز لها بالحرف (F) والاخرى عمودية على السطح ويرمز لها بالحرف (N)

F → Frictional force
N → Normal force

دائماً (F) هي عكس اتجاه الحركة.

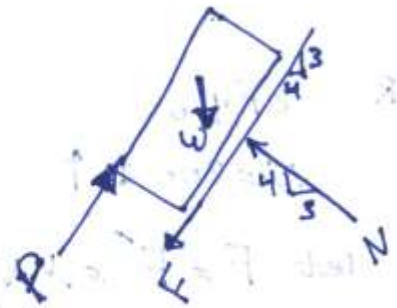
هنالك احتمالان للحركة



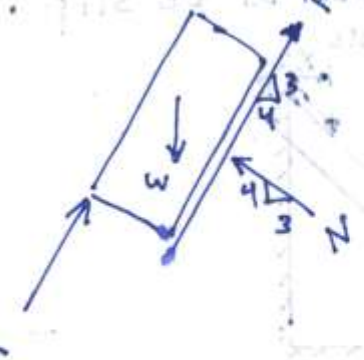
الاحتمال الاول: هو ان الجسم يصعد الى الاعلى نتيجة القوة (P)

الاحتمال الثاني: هو نزول الجسم الى الاسفل نتيجة تأثير وزنه (W).

الاحتمال الاول



الاحتمال الثاني



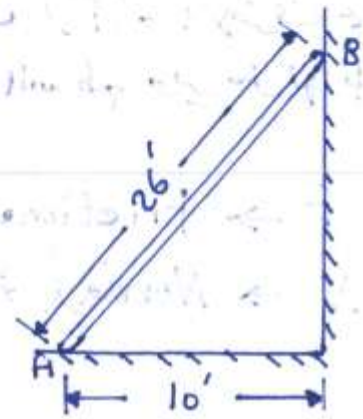
اكبر قيمة لقوة الاحتكاك μN والتي يرمز لها بـ F^-

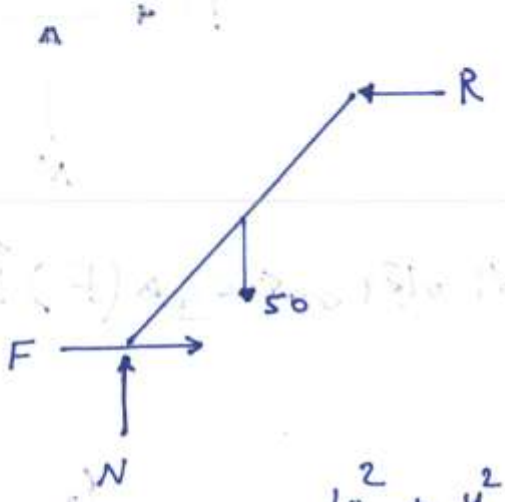
$\therefore F^- = \mu N.$

حيث ان μ معامل الاحتكاك

يجب ان تكون $F^- > F$

EX(1) A 26 ft ladder weighs 50 lb and is placed against a smooth vertical wall with its lower end 10 ft from the wall. The coefficient of friction between the ladder and the floor is 0.3. Determine the frictional force at A acting on the ladder. The mass center of the ladder is assumed to be at its midpoint.





$10^2 + y^2 = 26^2$

$\therefore y = 24'$

$+\uparrow \Sigma F_y = 0$

$N - 50 = 0$

$N = 50$ lb ↑

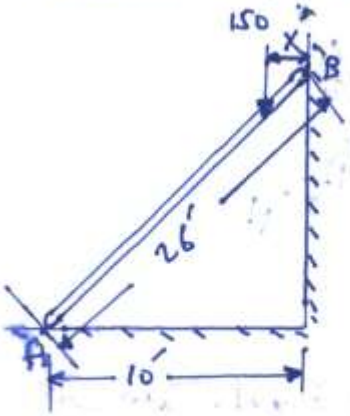
$\Sigma M_B = 0$ (+↻)

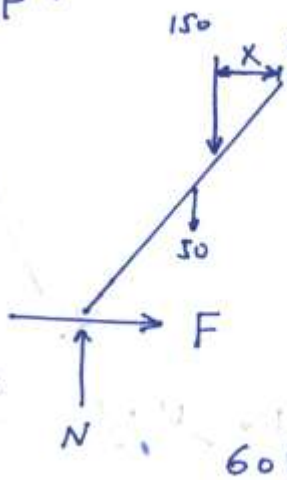
$-F(24) + 50(5) + 50(10) = 0 \Rightarrow F = 10.41$ lb →

$F' = \mu N = 0.3(50) = 15$ lb > 10.41

∴ O.K

EX(2): A 150 lb man starts to climb the ladder in EX(1). Determine the distance X from the man to the wall when the ladder starts to slip.





$+\uparrow \Sigma F_y = 0$

$N - 50 - 150 = 0$

$N = 200$ lb ↑

let $F = F' = \mu N$

$= 0.3(200) = 60$ lb

$\Sigma M_B = 0$ (+↺)

$60(24) + 50(5) + 150(X) - 200(10) = 0$

$\Rightarrow X = 2.067$ ft

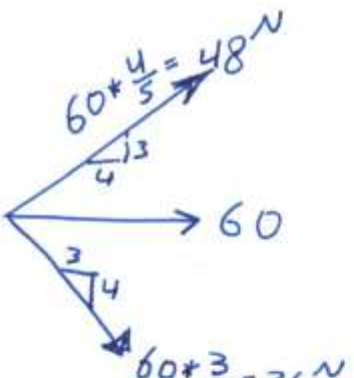
Q Body A weighs 200 N. The coefficient of friction between body A & the inclined plane is 0.4. Determine the frictional force on the block

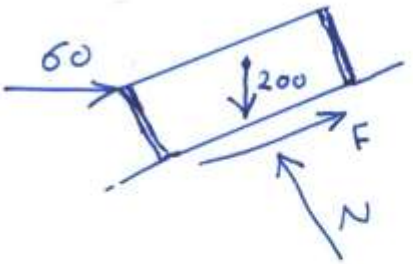
Sol:

Force 60 N

$F_{x'} = 48\ N \nearrow$

$F_{y'} = 36\ N \searrow$

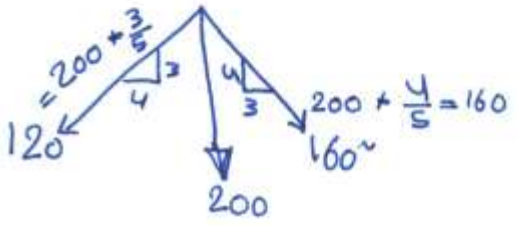




Force 200 N

$F_{x'} = 120\ N \swarrow$

$F_{y'} = 160\ N \searrow$



$+\nearrow \Sigma F_{x'} = 0 \rightsquigarrow F + 48 - 120 = 0 \rightsquigarrow F = 72\ N$ (3, 4)

$+\nwarrow F_{y'} = 0 \rightsquigarrow N - 160 - 36 = 0 \rightsquigarrow N = 196\ N$ (4, 3)

$F' = \mu . N = 0.4 * 196 = 78.4\ N > F = 72\ N$ O.K.

Q The homogeneous bar AB weighs 140 N, bodies C & D weigh 200 N & 300 N respectively. The coefficients of friction are 0.4 between the bar & body C, 0.3 between C & D & 0.2 between D & the horizontal plane, Determine the force P that will cause C to have impending motion. (35)

Sol.

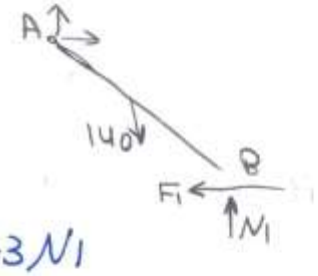
$F_1 = \dot{F_1} = 0.4 N_1$

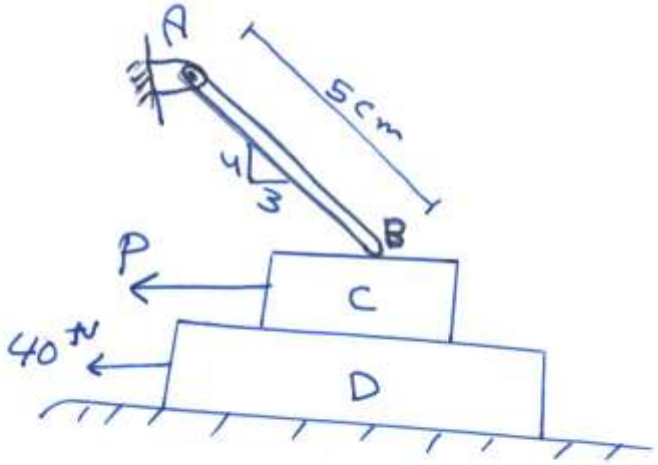
$\circlearrowleft \Sigma M_A = 0$

$140(1.5) + 0.4N_1(4) - 3N_1$

$N_1 = 150\ N \uparrow$

$F_1 = 60\ N \leftarrow$



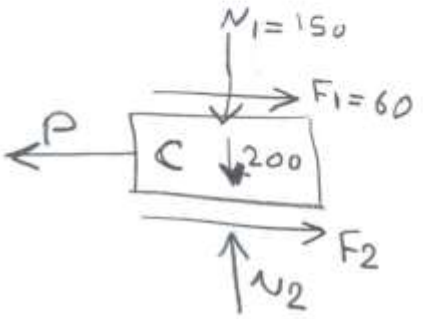


احتمال اول الصندوق C يتحرك وحده

$+\uparrow \Sigma F_y = 0$

$N_2 - 200 - 150 = 0 \rightarrow N_2 = 350\ N \uparrow$

$F_2 = \dot{F_2} = 0.3(350) = 105\ N \rightarrow$



$\overset{+}{\rightarrow} \Sigma F_x = 0 \rightarrow 60 + 105 - P = 0 \rightarrow P = 165\ N$ احتمال اول

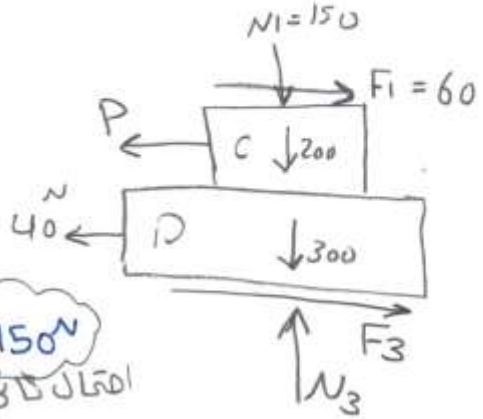
احتمال 2 الصندوقان C & D يتحركان معاً

$+\uparrow \Sigma F_y = 0$

$N_3 - 300 - 200 - 150 \rightarrow N_3 = 650\ N \uparrow$

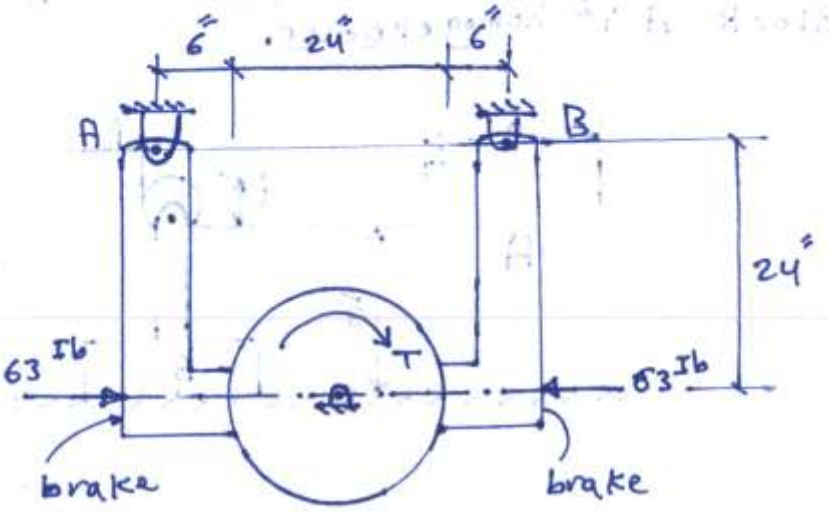
$F_3 = \dot{F_3} = 0.2(650) = 130\ N \rightarrow$

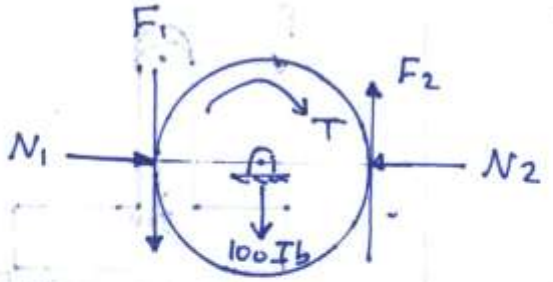
$\overset{+}{\rightarrow} \Sigma F_x = 0 \quad -P + 60 + 130 - 40 = 0 \rightarrow P = 150\ N$ احتمال ثاني

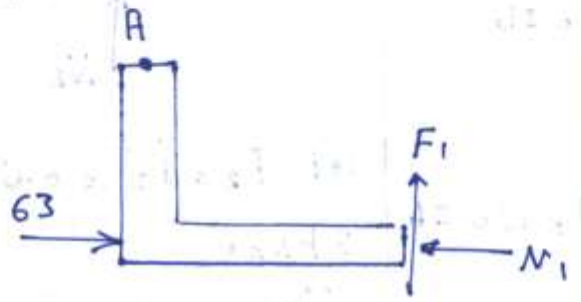


Select $P = 150\ N$

5-12 Q: The homogeneous cylinder weighs 100 lb. Determine the torque T required for motion to impend. The coefficient of friction between the drum and brakes is 0.5. Neglect the weight of the brakes.







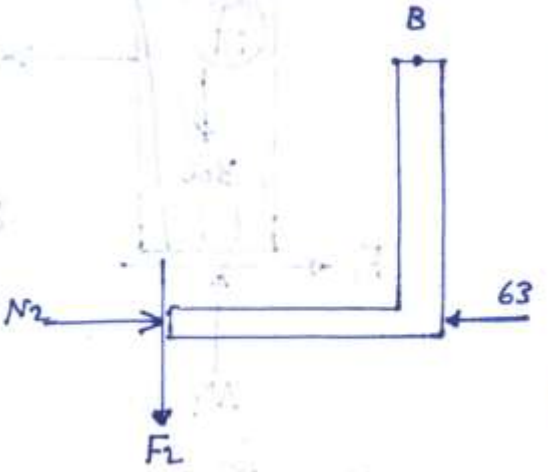
let $F_1 = F_1' = \mu N_1 = 0.5 N_1$

$\Sigma M_A = 0$

$-63(24) - 0.5N_1(6) + 24N_1 = 0$

$\Rightarrow N_1 = 72$ lb ←

$\therefore F_1 = 36$ lb ↑



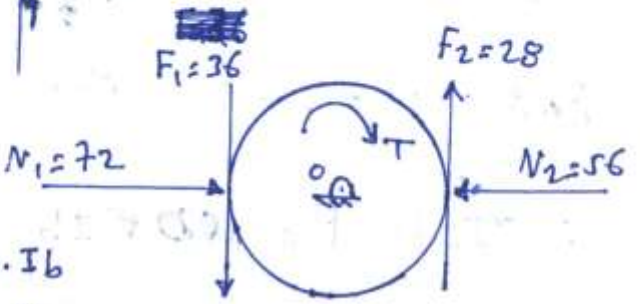
let $F_2 = F_2' = 0.5N_2$

$\Sigma M_B = 0$

$-0.5N_2(6) - 24(N_2) + 63(24) = 0$

$\Rightarrow N_2 = 56$ lb →

$F_2 = 28$ lb ↓



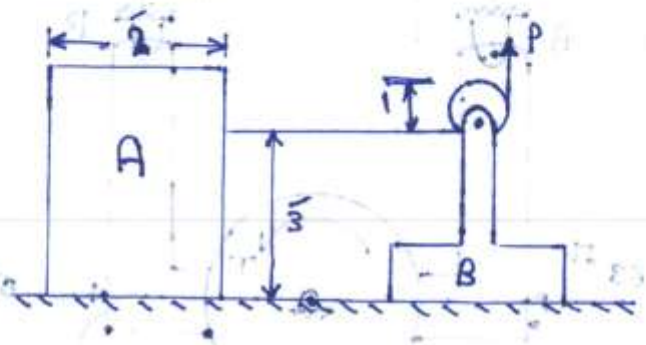
$\Sigma M_O = 0$

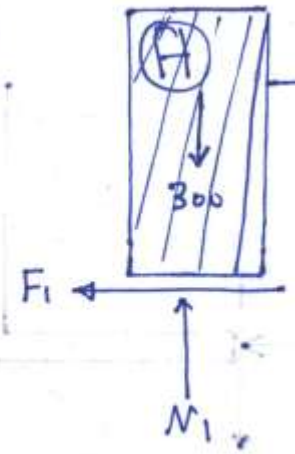
$T = 36(12) + 28(12) = 768$ in.lb

$= 64$ ft.lb

Q: Both block A and block B weigh 300 Ib. The coefficients of friction between A and B and the floor are 0.4 and 0.6, respectively. The pulley is frictionless. Determine the maximum value of P for which the system is in equilibrium. Block A is homogeneous.

(37)





$\Sigma F_y = 0$

$N_1 = 300$ Ib

let $F_1 = F_1' = \mu N_1 = 0.4\,(300) = 120$ Ib

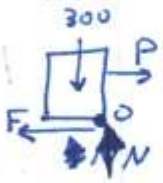
$\Sigma F_x = 0$

$P = 120$ Ib →

الانقلاب

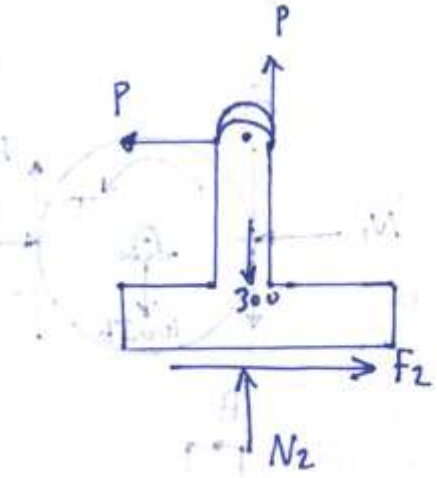
$\Sigma F_y = 0 \rightarrow N = 300^N$

$\Sigma M_{@O} = 0$



$P*3 - 300*1 = 0 \rightarrow P = 100$

∴ USE $P = 100$ Ib



let $F_2 = F_2' = 0.6 N_2$

$\Sigma F_x = 0$

$P = 0.6 N_2$ — ①

$\Sigma F_y = 0$

$300 = P + N_2$ — ②

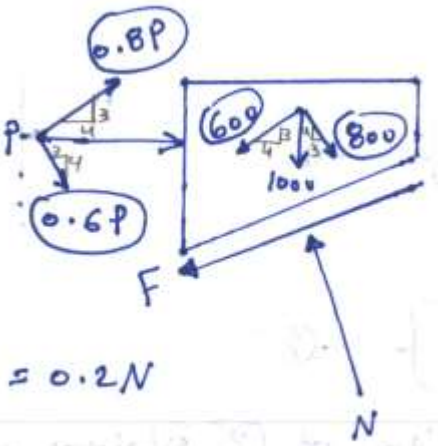
نعوض ① في ②

$300 = 0.6 N_2 + N_2$

$\therefore N_2 = 187.5$ Ib

$\therefore P = 112.5$ Ib

الاحتمال الاول صعود الكتلة A نحو الاعلى (الحركة الى اليمين)



let $F = F_{max} = \mu N = 0.2N$

$\uparrow \Sigma F_y = 0$

$$N = 800 + 0.6P \quad \text{---} (1)$$

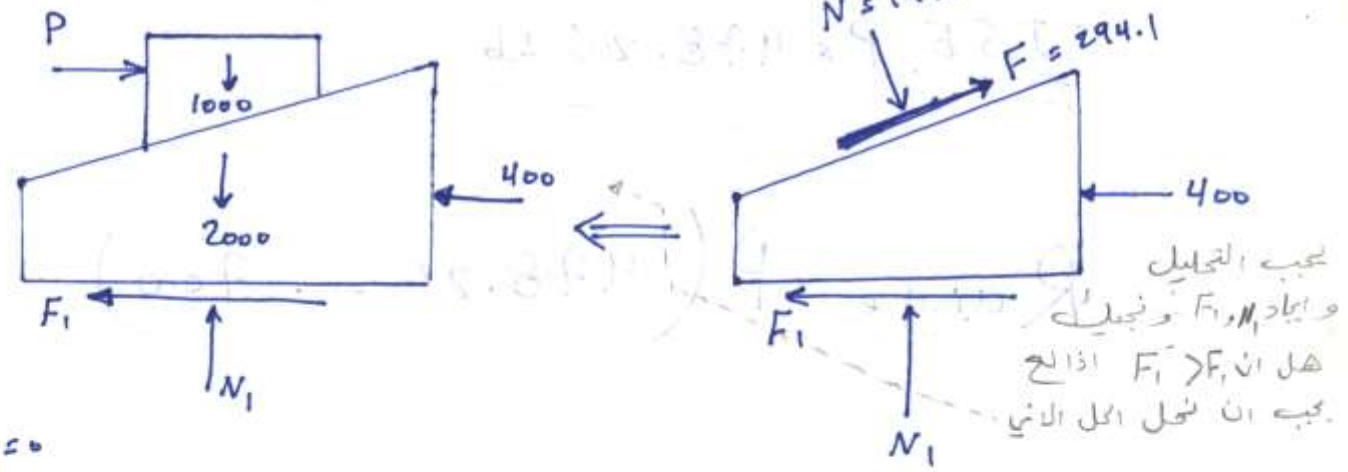
$\swarrow \Sigma F_x = 0 \quad F + 600 = 0.8P$

$$0.2N + 600 = 0.8P \quad \text{---} (2)$$

نعوض (1) في (2)

$$0.2(800 + 0.6P) + 600 - 0.8P = 0 \Rightarrow \boxed{P = 1117.6 \text{ lb}}$$

$\therefore N = 1470.5 \text{ lb}$ (4, 3) $\quad F = 294.1 \text{ lb}$ (4, 3)



يجب التحليل وايجاد F_1, N_1 ونجيب هل ان $F_1 < F_1^{max}$ اذا لا يجب ان نحل الحل الاتي

$\Sigma F_y = 0$

$N_1 = 3000 \text{ lb}$

let $F_1 = F_1^{max} = \mu N_1 = 0.1(3000) = 300 \text{ lb}$

$\Sigma F_x = 0$

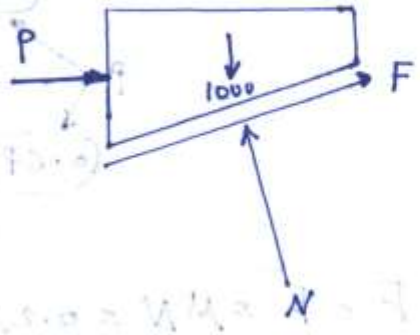
$P = 400 + 300 = \boxed{700 \text{ lb} \rightarrow = P}$

USE $P = 700$

الاحتمال الثاني نزول الجسم A نحو الاسفل (الحركة الى اليسار)

$\rightarrow \Sigma F_x = 0$

$0.2N + 0.8P = 600$ ——— ①



$\uparrow \Sigma F_y = 0$

$N = 800 + 0.6P$ ——— ②

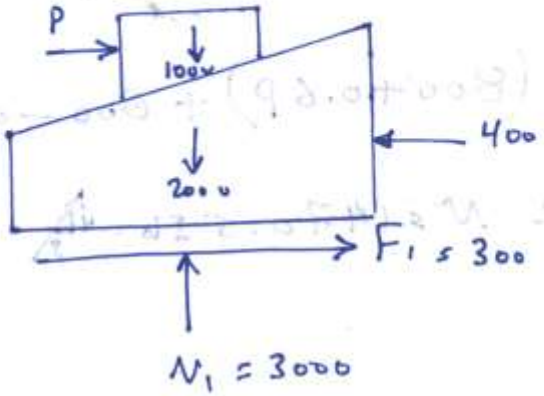
تعوض معادلة ② بمعادلة ①

$0.2(800 + 0.6P) + 0.8P = 600 \rightarrow P = 478.26\ lb$

$\Sigma F_x = 0$

$P = 400 - 300$

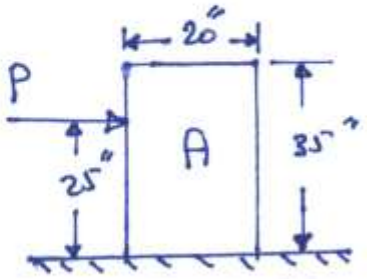
$\therefore P = 100\ lb$

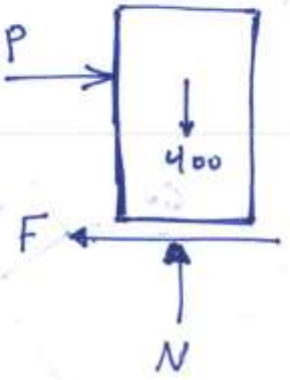


USE $P = 478.26\ lb$

$\therefore$ Range P (478.26 — 700).

EX (3) The solid homogeneous 400 lb block A rests on a horizontal plane. The coefficient of friction between the block and the plane is 0.34. Determine the force P, applied as shown, which will cause motion of A to impend.





$\downarrow \Sigma F_y = 0$

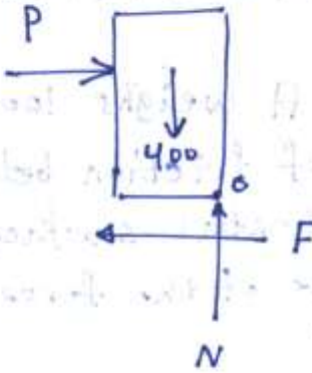
$N = 400$ lb $\uparrow$

let $F = F' = \mu N = 0.34(400) = 136$ lb $\leftarrow$

$\Sigma F_x = 0$

$P = 136$ lb $\rightarrow$

عندما يبدأ motion to impend يجب تجيل الانقلاب



$\Sigma M_O = 0$

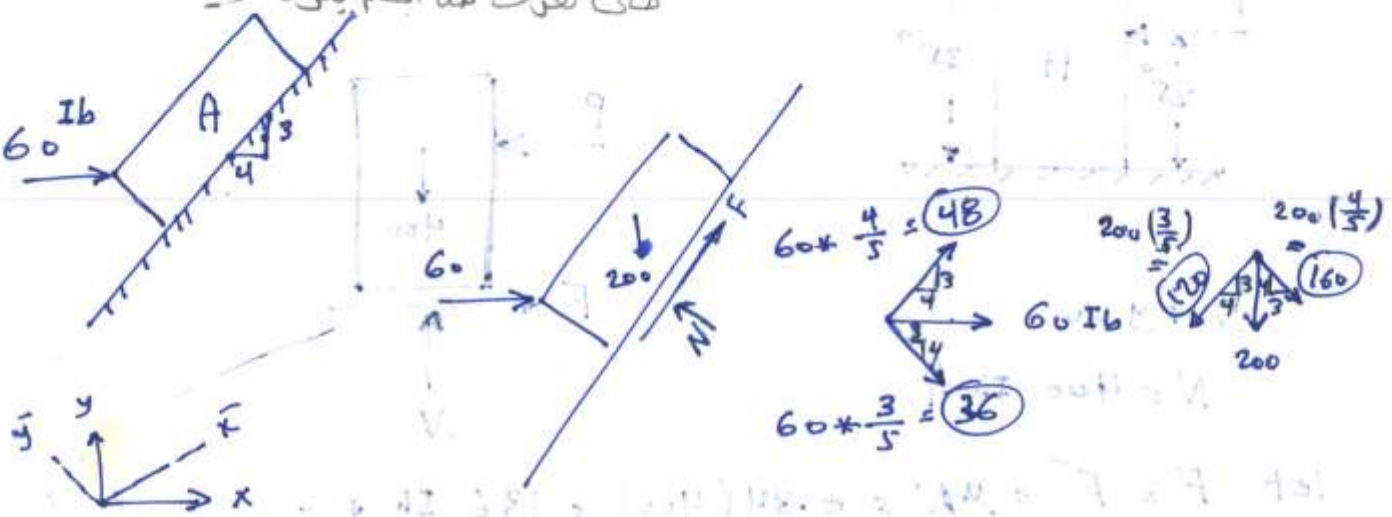
$P(25) = 400\ (10)$

$P = 160$ lb $\rightarrow$

نقطار الامل

USE $P = 136$ lb $\rightarrow$

Q: Body A weighs 200 Ib. The coefficient of friction between body A and the inclined plane is 0.4. Determine the frictional force on the block.



$+\nearrow \Sigma F_x = 0$

$F + 48 - 120 = 0$

$F = 120 - 48 = 72$ Ib (3/4)

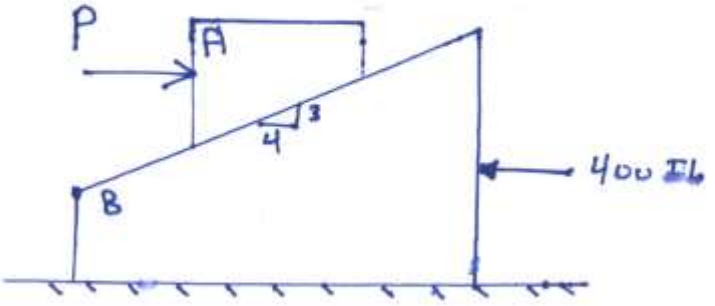
$+\uparrow \Sigma F_y = 0$

$N - 160 - 36 = 0$

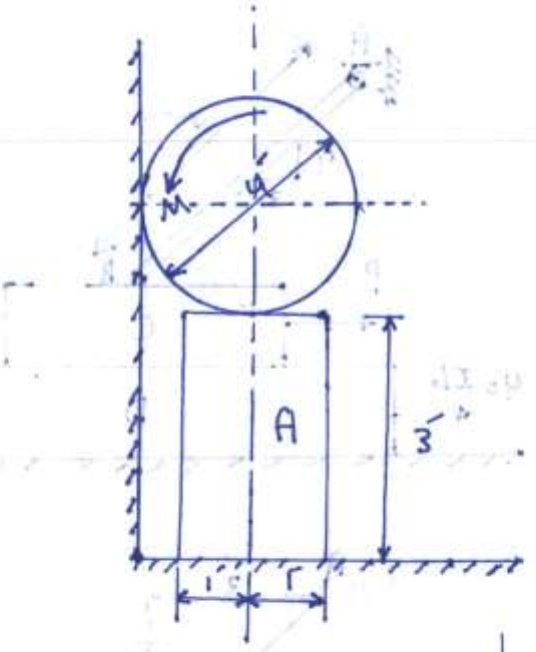
$N = 160 + 36 = 196$ Ib (4/3)

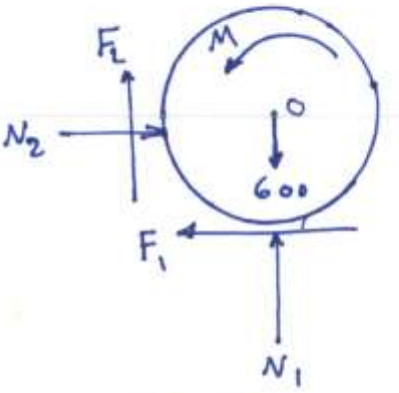
$F = \mu N = 0.4\,(196) = 78.4\ \# > 72$ O.K

Q: Block A weighs 1000 Ib and block B weighs 2000 Ib. The coefficient of friction between A and B is 0.2, and between B and the horizontal surface the coefficient is 0.1. Determine the maximum value of the force P for which body A will be in equilibrium.



Q: A homogeneous cylinder weighing 600 lb is resting on the 300 lb block A. The coefficient of friction for the cylinder at each contact surface is 0.3, and between the block A and the horizontal plane the coefficient is 0.2. Determine the minimum moment M necessary to rotate the cylinder counterclockwise.





let $F_1 = F_1' = 0.3N_1$

let $F_2 = F_2' = 0.3N_2$

$\xrightarrow{+}\ \Sigma F_x = 0 \Rightarrow N_2 - F_1 = 0 \Rightarrow N_2 = F_1$

$$\boxed{N_2 = 0.3N_1}$$

$\Sigma F_y = 0$

$$N_1 + 0.3N_2 = 600$$

$$N_1 + 0.3(0.3N_1) = 600$$

$$\Rightarrow N_1 = 550.46 \text{ lb}$$

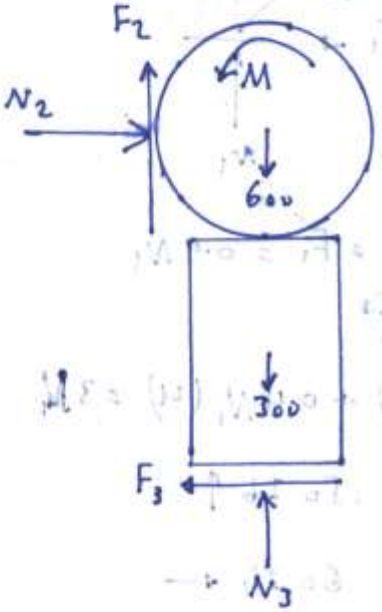
$$\therefore F_1 = 165.13 \text{ lb}$$

$$\therefore N_2 = 165.13 \text{ lb}$$

$$F_2 = 49.54 \text{ lb}$$

$\Sigma M_O = 0$

$$M = (165.13 + 49.54)(2) = 429.34 \text{ ft.lb}$$



let $F_3 = F_3' = 0.2N_3$

let $F_2 = F_2' = 0.3N_2$

$\Sigma F_x = 0$

$$\boxed{N_2 = 0.2N_3}$$

$\Sigma F_y = 0 \quad N_3 + 0.3N_2 = 900$

$0.2N_3 + 0.3 + N_3 = 900 \Rightarrow N_3 = 849.05$ lb

$F_3 = 169.81$ — $M = 169.81 - F_2 = 50.94$

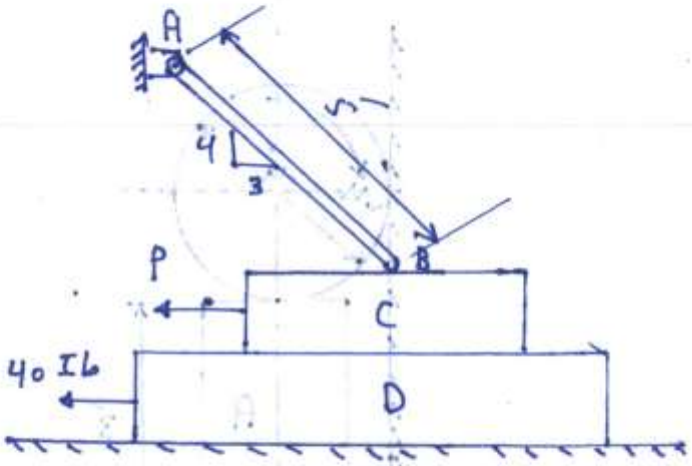
$\Sigma M_O = 0$

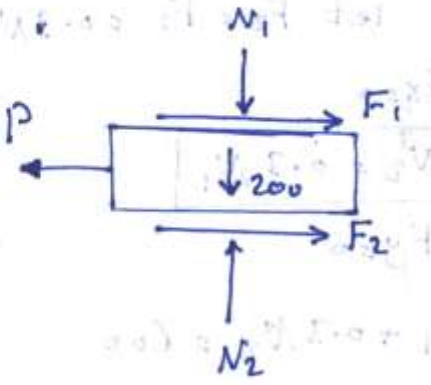
$M = 50.94(2) + 169.81(5)$

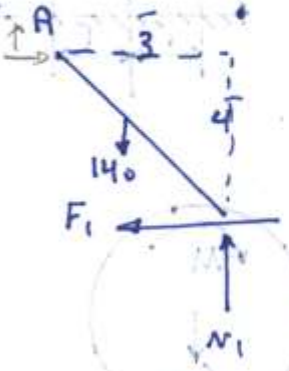
$= 950.93$ ft. lb

USE $M = 429.34$

5-31 **Q:** The homogeneous bar AB weighs 140 lb; bodies C and D weigh 200 lb and 300 lb, respectively. The coefficients of friction are 0.4 between the bar and body C, 0.3 between C and D, and 0.2 between D and the horizontal plane. Determine the force P that will cause C to have impending motion.







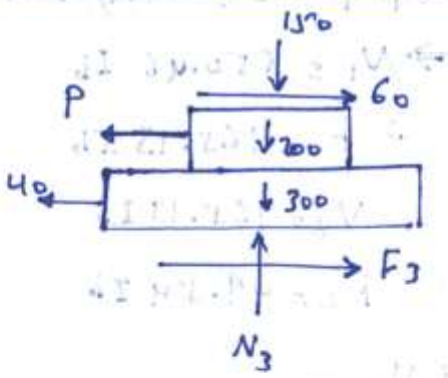
let $F_1 = F_1' = 0.4 N_1$

$\Sigma M_A = 0$ ↻

$140(1.5) + 0.4 N_1 (4) = 3 N_1$

$\therefore N_1 = 150$ lb ↑

$\therefore F_1' = 60$ lb ←



$\Sigma F_y = 0$

$N_3 = 650$ lb

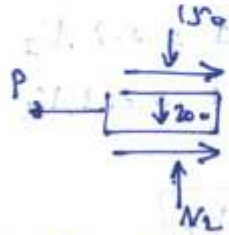
let $F_3 = F_3' = 0.2(650) = 130$ lb

$\Sigma F_x = 0$

$P = 130 + 60 - 40$

$P = 150$ lb

∴ USE $P = 150$ lb



$\Sigma F_y = 0$ ✗

i.e. $N_2 = 350$ lb

let $F_2 = F_2' = 0.3(350) = 105$ lb

$\therefore \Sigma F_x = 0$

$P = 165$ lb