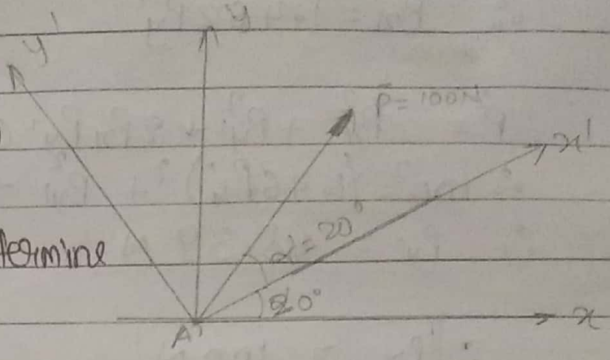
Q:1 If the force exerted on point A is 100N in the direction shown in figure. Determine force component acting along



a) x & y axes b.) x' & y' axes

c.) x & y' axes d.) determine angle α, knowing the component of forces along x axes is 80N while resolving x and y' axes

a.) $\theta_x = 40^\circ$

$\therefore P_x = P\cos\theta_x$

$= 100\cos 40^\circ$

$= \boxed{76.604N}$

$P_y = P\sin\theta_x$

$= 100\sin 40^\circ$

$= \boxed{64.28N}$

b.) $\theta_{x'} = \alpha - 20^\circ$

$\therefore P_{x'} = P\cos\alpha$

$= 100\cos 20^\circ$

$= \boxed{93.969}$

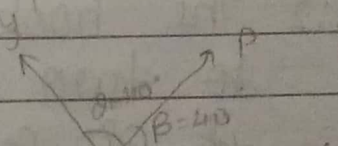
$P_{y'} = P\sin\alpha$

$= 100\sin 20^\circ$

$= \boxed{34.20}$

c.) angle between P_x and $P_{y'}$ $(\theta) = 110^\circ$

angle between P_x and P $(\beta) = 40^\circ$



$\therefore \tan\beta = \dfrac{P_{y'}\sin\theta}{P_x + P_{y'}\cos\theta}$

$\therefore \tan 40^\circ = \dfrac{P_{y'}(\sin 110^\circ)}{P_x + P_{y'}\cos 110^\circ}$

$\therefore P_x = 1.462 P_y'$

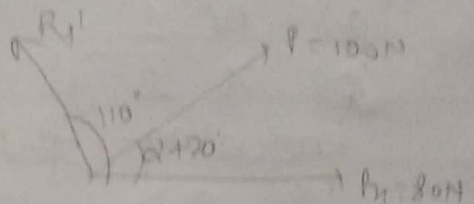
$P^2 = P_x^2 + P_{y'}^2 + 2P_x P_{y'} \cos\theta$

$\therefore 100^2 = (1.462P_{y'})^2 + P_{y'}^2 + 2(1.462P_{y'})P_{y'} \cos 110^\circ$

$\therefore \boxed{P_{y'} = 68.39\ N}$

$\therefore \boxed{P_x = 100\ N}$

d.) $\theta = 110^\circ$



$P^2 = P_x^2 + P_{y'}^2 + 2P_x P_{y'} \cos\theta$

$\therefore 100^2 = 80^2 + P_{y'}^2 + 2(80)P_{y'} \cos(110^\circ)$

$\therefore P_{y'} = 93.31\ N$

$\therefore \tan(20+\alpha) = \dfrac{P_{y'} \sin\theta}{P_x + P_{y'} \cos\theta}$

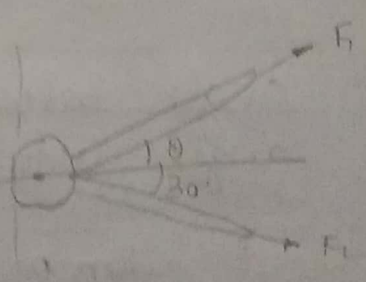
$= \dfrac{93.31 \sin 110^\circ}{80 + 93.31 \cos 110^\circ}$

$\tan(\alpha+20^\circ) = 1.8233$

$\therefore \alpha + 20^\circ = 61.2570$

$\therefore \boxed{\alpha = 41.2570^\circ}$

Q:2 The hook shown is subjected to two forces F_1 and F_2. if it is required that resultant forces have magnitude of 250N horizontal, determine



a.) magnitude of F_1 and F_2 provided $\theta = 50^\circ$

b.) magnitude of F_1 and F_2. F_1 is minimum

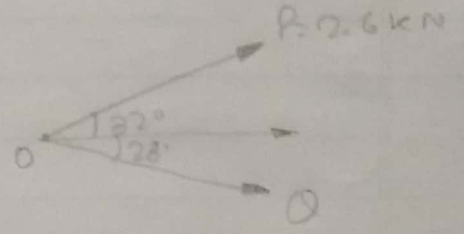
Q:3 a car is pulled by means of two ropes as shown in figure. The tension of one rope is P=2.6 KN. if the resultant of two force applied at O is directed along x-axis of car. Find the tension in other rope and magnitude of resultant

$\Sigma F_y = 0$

$\therefore P \sin 32° = Q \sin 28°$

$\therefore \frac{(2.6 \text{ KN}) \sin 32°}{\sin 28°} = Q$

$\therefore \boxed{Q = 2.934 \text{ KN}}$



$\Sigma F_x = P \cos 32° + Q \cos 28°$

$= 2.6 \cos 32° + 2.934 \cos 28°$

$= \boxed{4.795 \text{ KN}}$

Q:4. The striker of carrom board lying on board is being pulled by four players as shown in figure. The players are sitting exactly center of four sides. Find the resultant of force in magnitude and direction

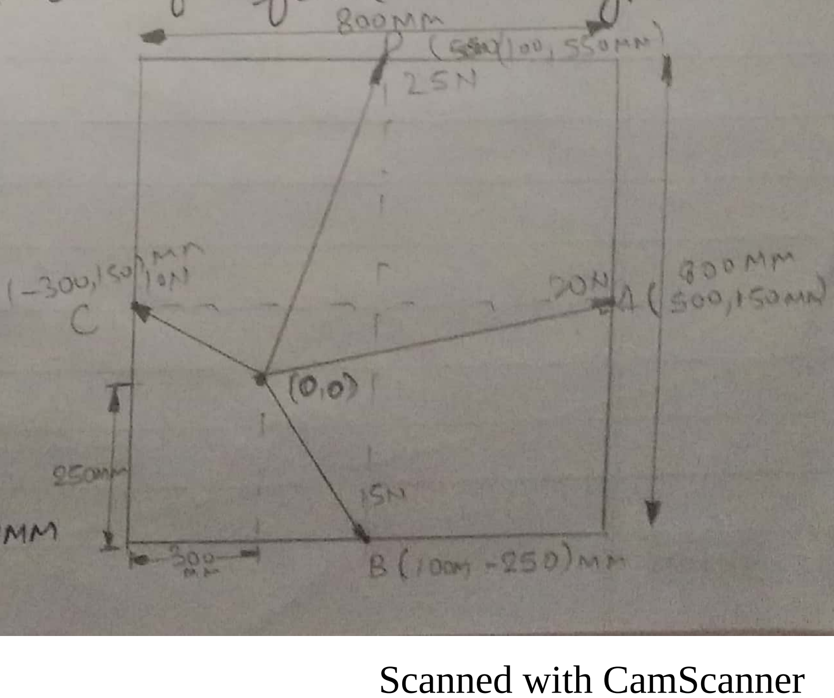
Let the striker be origin (0,0)

$\therefore$ points A, B, C, D become

A(500,150) MM

B(100,-250) MM

C(-300,150) MM D(100,550) MM



a.) $\vec{r_A} = (500\hat{i} + 150\hat{j})$ MM

$\hat{r_A} = \dfrac{10\hat{i} + 3\hat{j}}{\sqrt{109}}$

$\vec{F_A} = 20\dfrac{(10\hat{i}+3\hat{j})}{\sqrt{109}}$ N

$= 19.16\hat{i} + 5.75\hat{j}$ N

c.) $\vec{r_c} = -300\hat{i} + 150\hat{j}$ MM

$\hat{r_c} = \left(\dfrac{-2\hat{i}+\hat{j}}{\sqrt{5}}\right)$

$\vec{F_c} = \left(\dfrac{-2\hat{i}+\hat{j}}{\sqrt{5}}\right)(10)$ N

$= -8.94\hat{i} + 4.472\hat{j}$ N

b) $\vec{r_B} = 100\hat{i} - 250\hat{j}$ MM

$\hat{r_B} = \left(\dfrac{2\hat{i} - 5\hat{j}}{\sqrt{29}}\right)$ ~~MM~~

$\vec{F_B} = \dfrac{15(2\hat{i} - 5\hat{j})}{\sqrt{29}}$ N

$= 5.57\hat{i} - 13.93\hat{j}$ N

d.) $\hat{r_d} = \left(\dfrac{2\hat{i}+11\hat{j}}{\sqrt{125}}\right)$

$\therefore \vec{F_d} = 25\left(\dfrac{2\hat{i}+11\hat{j}}{\sqrt{125}}\right)$

$\vec{F_d} = 4.472\hat{i} + 24.596\hat{j}$

$\Sigma F = 20.262\hat{i} + 20.888\hat{j}$

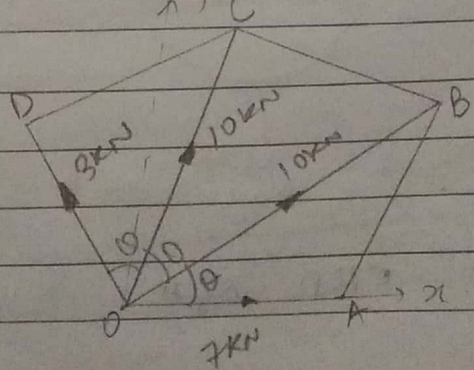
$\therefore \tan\theta = \dfrac{20.888}{20.262}$

$\therefore \boxed{\theta = 45.87^\circ}$

$|R| = \sqrt{20.262^2 + 20.888^2}$

$= \boxed{29.09\text{ N}}$

Q5 forces 7KN, 10KN, 10KN and 3KN respectively act at one of the angular points taken in order. Find resultant respectively



The ~~sum of~~ interior angle between sides of regular pentagon is 108°

$\therefore 3\theta = 108^\circ$

$\therefore \quad \theta = 36°$

Let O be origin and x and y axes as shown

$\therefore \quad F_1 = 7 kN\,\hat{i}$

$F_2 = 10(\cos 36°\,\hat{i} + \sin 36°\,\hat{j})\,kN$

$= (8.09\,\hat{i} + 5.878\,\hat{j})\,kN$

$F_3 = 10(\cos 72°\,\hat{i} + \cancel{\cos 7}\,\sin 72°\,\hat{j})\,kN$

$= (3.09\,\hat{i} + 9.510\,\hat{j})\,kN$

$F_4 = 3(\cos 108°\,\hat{i} + \sin 108°\,\hat{j})\,kN$

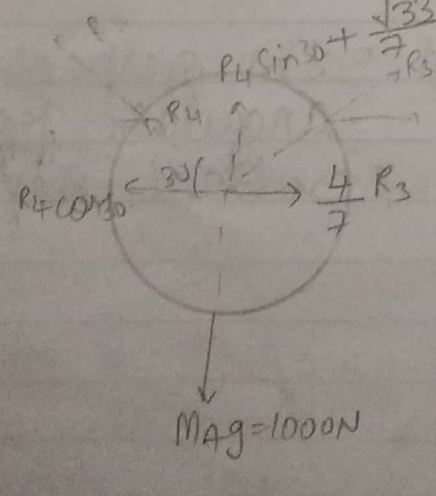
$= -0.927\,\hat{i} + 2.853\,\hat{j}$

$\vec{R_{eq}} = \Sigma F = 17.253\,\hat{i} + 18.241\,\hat{j}$

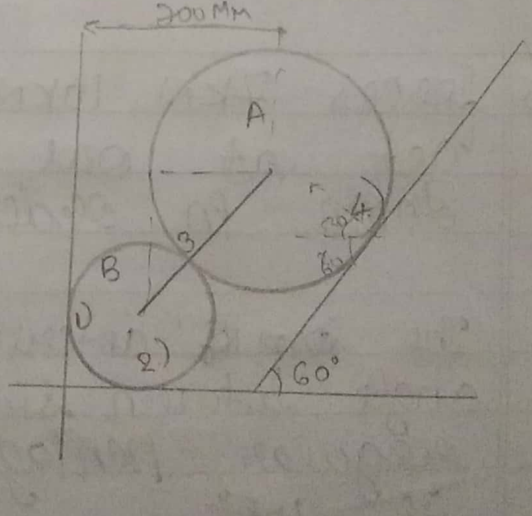
$\therefore \quad |\vec{R_{eq}}| = 25.107 N$

$\theta = \tan^{-1}\left(\frac{18.241}{17.253}\right) = 46.59°$

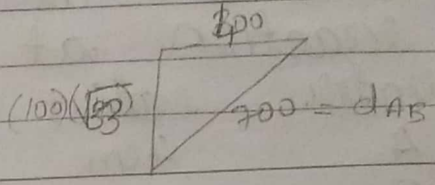
Q:6 two spheres A and B of weight 1000 N and 750 N respectively, are kept as shown in figure. determine reaction at all contact points 1, 2, 3, 4. Radius of A = 400 MM and B = 300 MM.



F.B.D. of A



R_3 is acting along A and B



$\therefore \vec{r}_{AB} = \cancel{(300\hat{i} + \ldots)}$

$\hat{r}_{BA} = \left(\dfrac{4\hat{i} + \sqrt{33}\,\hat{j}}{7}\right)$

$\therefore \vec{R_3} = \dfrac{4R_3}{7}\hat{i} + \dfrac{\sqrt{33}}{7}R_3\hat{j}$

$\Sigma F_x = 0$

$\therefore R_4 \cos 30^\circ = \dfrac{4}{7}R_3$

$\therefore R_4 = \dfrac{8}{7\sqrt{3}}R_3$

$\Sigma F_y = 0$

$\therefore R_4 \sin 30^\circ + \dfrac{\sqrt{33}}{7}R_3 = 1000$

$\therefore \left(\dfrac{4}{7\sqrt{3}} + \dfrac{\sqrt{33}}{7}\right)R_3 = 1000$

$\therefore \boxed{R_3 = 869.137\text{ N}}$

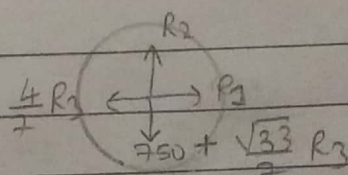
$\boxed{R_4 = 573.481\text{ N}}$

→ for B,

$\Sigma F_x = 0$

$R_1 = \dfrac{4}{7}R_3 = \dfrac{4}{7} \times 869.137$

$\boxed{R_1 = 496.65\text{ N}}$



F.B.D of B

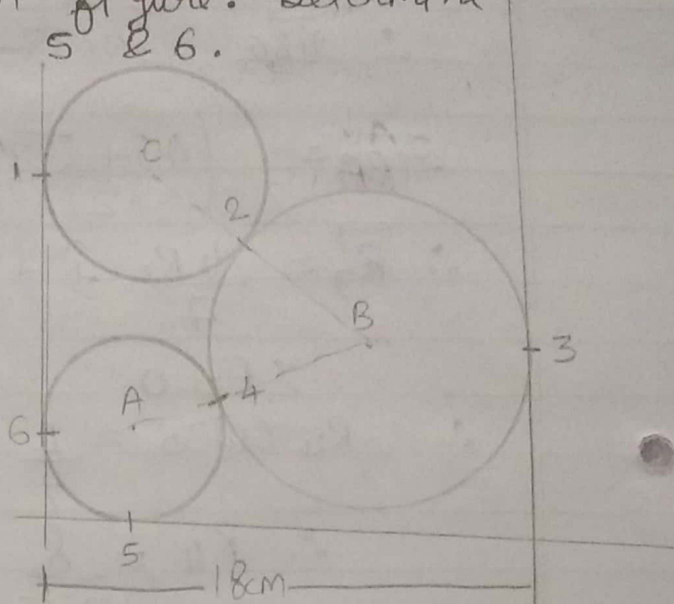
$\Sigma F_y = 0$

$\therefore R_2 = 750 + \dfrac{\sqrt{33}}{7}R_3 = 750 + 713.258$

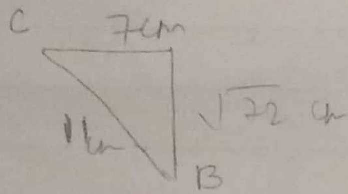
$\boxed{R_2 = 1463.268\text{ N}}$

Q:7. Three cylinders are piled up in a rectangular channel as shown in figure. Determine reaction at point 5 & 6.

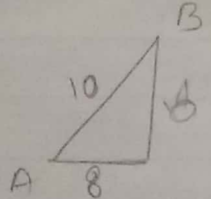
cylinder	radius	mass
A	4 cm	15kg
B	6cm	40kg
C	5 cm	20 kg



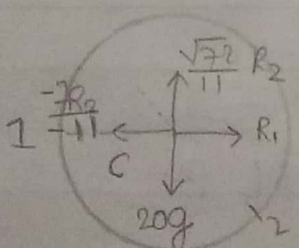
distance BC = 11 cm
distance AB = 10 cm



$$\hat{r}_{CB} = \left(\frac{7\hat{i} - \sqrt{72}\hat{j}}{11}\right)$$



$$\hat{r}_{BC} = \frac{-8\hat{i} - 6\hat{j}}{10}$$



$\Sigma F_y = 0$

$$\therefore \frac{\sqrt{72}}{11} R_2 = 20g = 20 \times 9.81$$

$$\therefore R_2 = \frac{11 \times 20 \times 9.81}{\sqrt{72}}$$

$$= 254.346 \text{ N}$$

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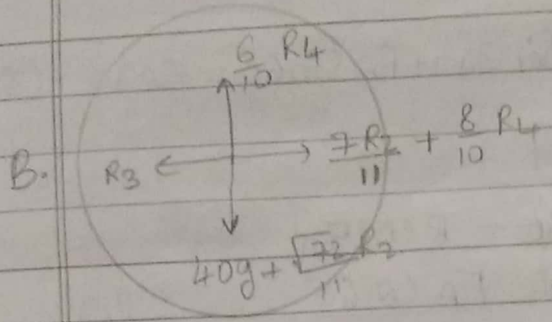
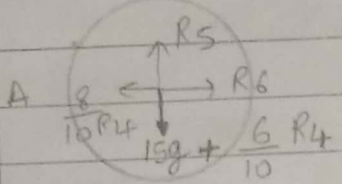


$\Sigma F_y = 0$

$\therefore \frac{6}{10} R_4 = 40g + \frac{\sqrt{72}}{11} R_2$

$\therefore 0.6 R_4 = 588.6$

$\therefore R_4 = 981\ N$



$\Sigma F_y = 0$

$R_5 = 15g + \frac{6}{10} R_4$

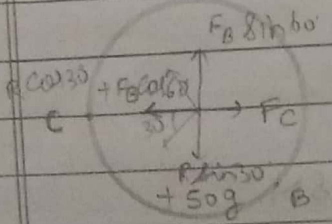
$\boxed{R_5 = 735.75\ N}$

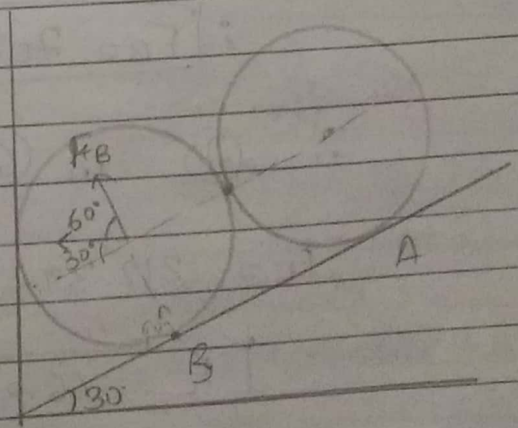
$\Sigma F_x = 0$

$\therefore \frac{8}{10} R_4 = R_6$

$\therefore \boxed{R_6 = 784.80\ N}$

8. Two identical rollers each of mass 50 kg are supported by an inclined plane and a vertical wall as shown in figure. Assuming smooth surfaces. find reaction at A, B and C.



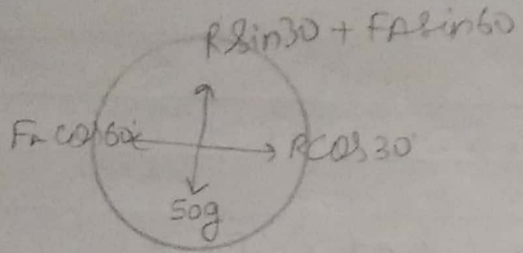


$\therefore \Sigma F_x = 0$

$\therefore F_C = R\cos 30° + F_B \cos 60°$ — (1)

$\Sigma F_y = 0$

$\therefore F_B \sin 60 = R \sin 30 + 50g$ — (2)



$\Sigma F_y = 0$

$\therefore R \sin 30 + F_A \sin 60 = 50g$ — (3)

$\Sigma F_x = 0$

$\therefore F_A \cos 60 = R \cos 30$

$\therefore R = \dfrac{F_A \cos 60}{\cos 30}$ — (4)

(4) in (3)

$F_A\left[\dfrac{\cos 60}{\cos 30} \cdot \sin 30 + \sin 60\right] = 50g$

$F_A(1.1547) = 50 \times 9.81$

$\boxed{R_A = F_A = 424.785N}$

$R = \dfrac{424.785 \times 1}{\sqrt{3}} = 245.25N$ — (5)

(5) in (1) and (2)

$\therefore F_C = 212.39 + \dfrac{F_B}{2}$ — (6)

$\dfrac{\sqrt{3}}{2} F_B = 613.125N$

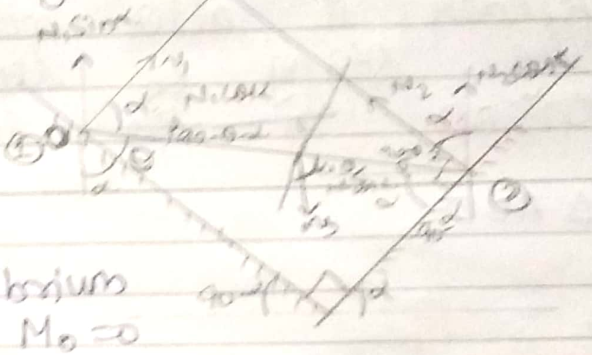
$\therefore \boxed{F_B = 707.975N}$ — (7)

$\therefore$ (7) in (6)

$F_C = 212.39 + \dfrac{707.975}{2} = 566.38N$

$\boxed{F_C = 566.38N}$

Q.9. A uniform rod AB remains in equillibrium in a vertical plane resting on smooth inclined planes AC and BC, which are at right angles. If the plane is at BC is at angle α, find θ



Let the normal at surface ① be N_1 and ② be N_2

→ The rod is in equillibrium

$\therefore \Sigma F_y = 0$ & $\Sigma F_x = 0$ $M_0 = 0$

$\therefore N_1 \sin\alpha + N_2 \cos\alpha = mg$ — ①

$\Sigma F_x = 0$

$\therefore N_1 \cos\alpha = N_2 \sin\alpha$ — ②

$M_0 = 0$

$\therefore 0 = -mg \frac{l}{2} \sin(\alpha+\theta) + N_2 l \sin\theta$

$\therefore mg = \dfrac{2 N_2 \sin\theta}{\sin(\alpha+\theta)}$ — ③

③ and ② in ①

$\therefore \dfrac{N_2 \sin^2\alpha}{\cos\alpha} + N_2 \cos\alpha = \dfrac{2 N_2 \sin\theta}{\sin(\alpha+\theta)}$

$\therefore N_2(\sin^2\alpha + \cos^2\alpha) = \dfrac{2 \sin\theta \cos\alpha \, N_2}{\sin(\alpha+\theta)}$

$\therefore \sin(\alpha+\theta) = 2 \sin\theta \cos\alpha$

$= \sin(\theta+\alpha) + \sin(\theta-\alpha)$

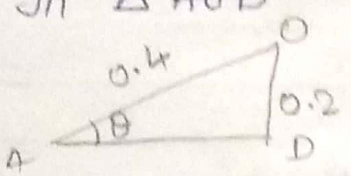
$\therefore \sin(\theta-\alpha) = 0$

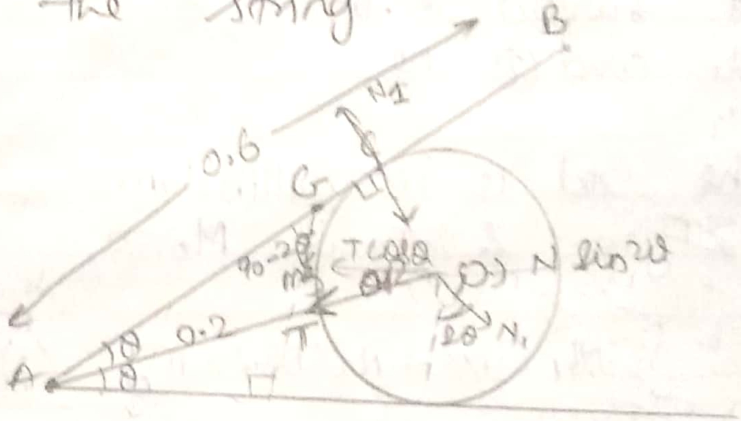
$\therefore \boxed{\theta = \alpha}$

vision

(10.) The figure shown below shows a smooth cylinder of radius 0.2m supporting a rod AB 0.6m long weighing 100N. The end of the rod A is hinged to a horizontal surface AD. The cylinder is also attached to the hinge by string of length 0.2m find the tension in the string.

In $\triangle AOD$





$\sin\theta = \dfrac{0.2}{0.4}$

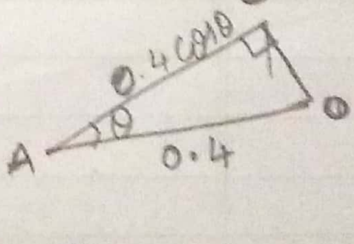
$\therefore \boxed{\theta = 30^\circ}$

cylinder is in equillibrium

$\therefore \Sigma F_x = 0$

$\therefore T\cos\theta = N_1 \sin 2\theta$ — (1)

moment about rod is zero



$\therefore (0.3) mg \cos 2\theta = N_1 (0.4\cos\theta)$

$\therefore N_1 = \dfrac{mg\cos 2\theta (0.3)}{0.4\cos\theta}$

$\therefore T\cos\theta = \dfrac{mg\cos 2\theta}{0.4\cos\theta} \sin 2\theta (0.3)$

$\therefore T = \dfrac{(100)\times 3 \times \cos 60 \times \sin 60}{4\times \cos 30 \times \cos 30} = \boxed{43.30\,N}$

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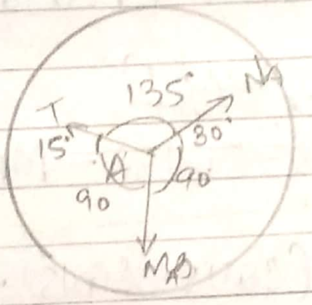
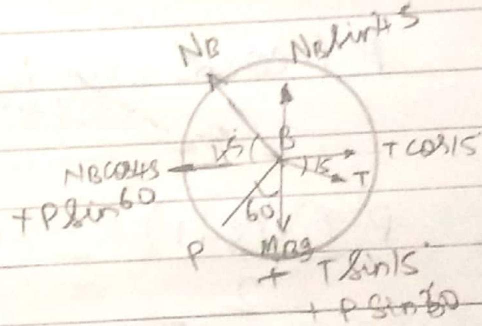
Q:11 cylinder A weighing 4000 N and cylinder B weighing 2000 N, rest on a smooth inclines as shown in figure they are connected by a bar of negligible weight hinged to geometric centres of the cylinder of smooth pins find the force P to be applied as shown such that it will hold the system in given position.



F.B.D. Of A



F.B.D. Of A

→ from Lammis theorom on F.B.D. of A

$$\frac{T}{\sin(120)} = \frac{M_A g}{\sin 135°}$$

$$\therefore T = \frac{\sin 120}{\sin 135} M_A g = \frac{\sin 120 (4000)}{\sin 135}$$

$$= 4898.98 \text{ N}$$

vision

→ FROM F.B.D. of B.

$\Sigma F_x = 0$

$\therefore \; T\cos 15 = N_B \cos 45 + P\sin 60$

$\therefore \; N_B \cos 45 = N_B \sin 45 = T\cos 15 - P\sin 60$

$\Sigma F_y = 0$

$N_B \sin 45 = M_B g + T\sin 15 + P\cos 60$

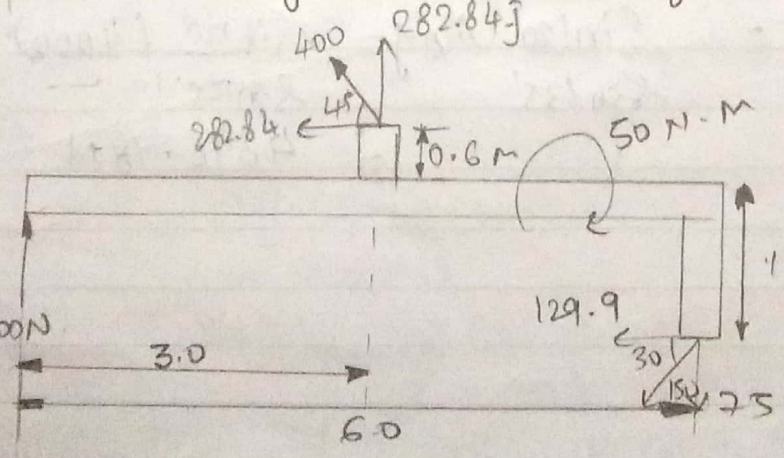
$\therefore \; T\cos 15 - P\sin 60 = M_B g + T\sin 15 + P\cos 60$

$\therefore \; P(\cos 60 + \sin 60) = T(\cos 15 - \sin 15) - M_B g$

$\therefore \; P\dfrac{(\sqrt{3}+1)}{2} = (4898.98)(\cos 15 - \sin 15) - 2000$

$\therefore \; \boxed{P = 1071.8\,N}$

12. A bracket is subjected to three forces and a couple as shown in figure. Determine the magnitude, direction and line of action of resultant



$\vec{F}_{eq} = 200\hat{j} + (-282.84\hat{i} + 282.84\hat{j}) + (-129.9\hat{i} - 75\hat{j})$

$= +407.84\hat{j} - 412.74\hat{i}$ N

$\boxed{|F_{eq}| = 580.24 \text{ N}}$

$\alpha = \tan^{-1}\left(\cancel{-412.74}\ \dfrac{407.84}{-412.74}\right)$

$\boxed{\alpha = 44.66^\circ}$

$M_{eq} = (3\hat{i} + 0.6\hat{j}) \times (-282.84\hat{i} + 282.84\hat{j}) - 50 + (6\hat{i} - \hat{j}) \times (-129.9\hat{i} - 75\hat{j})$

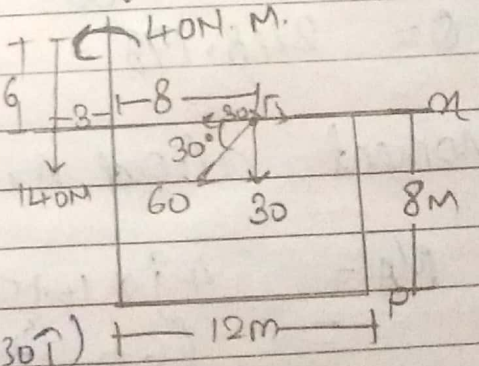
$= 388.324\hat{k}$

$x\hat{i} \times (-412.74\hat{i} + 407.84\hat{j}) = 388.324\hat{k}$

$x(407.84)\hat{k} = 388.324\hat{k}$

$\therefore \boxed{x = 0.952 \text{ M}}$

13. Replace the force and couple moment system by an equivalent force and couple moment during acting at point P.



$F_{eq} = -140\hat{j} - 30\sqrt{3}\hat{i} - 30\hat{j}$

$= -51.96\hat{i} - 170\hat{j}$ N

$M_P = (-4\hat{i} + 8\hat{j}) \times (-30\sqrt{3}\hat{i} - 30\hat{j}) + (-15\hat{i} \cancel{+} 8\hat{j}) \times 140\hat{j} + 40$

$= (120 + 240\sqrt{3} + 2100 + 40)\hat{k}$

$= 2675.7$ N.M.

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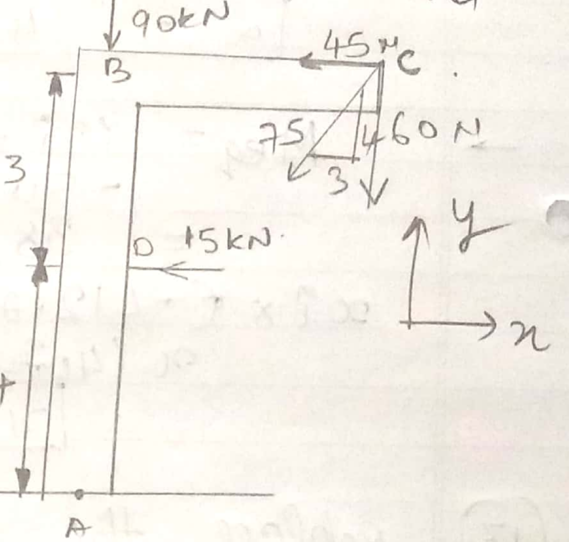
(14) The frame shown in figure is subjected to three coplanar forces replace this loading by an equivalent single resultant force and specify where the line of action of the resultant intersect members AB and AC.



$F_1 = -15\ kN\ (\hat{i})$
$F_2 = -90\hat{j}\ kN$
$F_3 = (-45\hat{i} - 60\hat{j})\ kN$

$R_{eq} = F_1 + F_2 + F_3$
$= (-60\hat{i} - 150\hat{j})\ kN$

$R_{eq} = 161.6\ kN$

$\theta = \tan^{-1}\left(\frac{-150}{-60}\right) = 68.198^\circ$ (with $-x$-axes)

$\theta = 248.198^\circ$ (with $+x$-axes)

Moment about A,

$M_A = 4\hat{j} \times (-15\hat{i}) + (2\hat{i} + 7\hat{j}) \times (-45\hat{i} - 60\hat{j})$
$= (60 + 195)\hat{k}$
$= 255\hat{k}$

$M_A = y\hat{j}\ (-60\hat{i} - 150\hat{j}) = 255\hat{k}$
$\Rightarrow 60y\hat{k} = 255\hat{k}$
$\Rightarrow y = 4.25\ m$

Moment about B,

$M_B = (-3\hat{j}) \times (-15\hat{i}) + (2\hat{i}) \times (-45\hat{i} - 60\hat{j})$
$x\hat{i} \times (-60\hat{i} - 150\hat{j}) =$ $-165\hat{k}$

$-150x = -165$

$\boxed{x = 1.1\ M}$

(15) Determine the tension in cables BC and BD and the reaction at ball and socket joint A for the mass shown in figure force at B $F = -10\hat{j}$ k.N.

$F_B = -10\hat{j}$ k.N

A (0,0,0) B (0,0,6) C (6,0,0) D (-3,6,0)

$\vec{BA} = -6\hat{k}$ $\vec{BD} = (-3\hat{i} + 6\hat{j} - 6\hat{k})$

$\vec{BC} = (6\hat{i} - 6\hat{k})$

→ the system is in equillibrium

$\therefore \Sigma F = 0$

$\therefore 0 = -10\hat{j} + (-A_z\hat{k}) + T_{BC}\left(\frac{\hat{i} - \hat{k}}{\sqrt{2}}\right) + T_{BD}\left(\frac{-\hat{i} + 2\hat{j} - 2\hat{k}}{3}\right)$

→ $\therefore T_{BD} \times \frac{2}{3} = 10$ [comparing $\hat{j}$ component]

$\therefore T_{BD} = 15$

→ $\frac{T_{BC}}{\sqrt{2}} - \frac{T_{BD}}{3} = 0$ [comparing $\hat{i}$ component]

$\therefore T_{BC} = 7.1$ KN

→ $-A_z - \frac{T_{BC}}{\sqrt{2}} - \frac{2}{3} T_{BD} = 0$ (Comparing $\hat{k}$ component

$\therefore A_z = 15$ KN

$A_x = 0$ $A_y = 0$

(16) A 120 kg sign board of uniform density measures 1.5 x 2.4 m and is supported by a ball and socket at A and by two cables as shown. Determine tension in each cable and reaction at A.

A (0,0,0) B (2.4,0,0) C (0, 0.9, 0.6)
D (0, 1.2, -2.4) G (1.2, 0.75, 0)

→ The system is in equillibrium,

$\therefore \Sigma F = 0$

$$\therefore 0 = (-120g)\hat{j} + (A_x\hat{i} + A_y\hat{j} + A_z\hat{k}) +$$

$$T_{EC}\left(-\frac{6}{7}\hat{i} + \frac{3}{7}\hat{j} + \frac{2}{7}\hat{k}\right) + T_{BD}\left(-\frac{2}{3}\hat{i} + \frac{1}{3}\hat{j} - \frac{2}{3}\hat{k}\right) \quad -(1)$$

→ Moment about A is zero

$$\therefore M_A = (1.2\hat{i} + 0.75\hat{j}) \times (-120g\hat{j}) + T_{EC}(1.8\hat{i}) \times \left(\frac{3}{7}\hat{j} + \frac{2}{7}\hat{k}\right)$$

$$+ T_{BD}(2.4\hat{i})\left(\frac{1}{3}\hat{j} - \frac{2}{3}\hat{k}\right) = 0$$

$$\therefore 144g\hat{k} = T_{EC}(0.771\hat{k} - 0.5142\hat{j}) + T_{BD}(0.8\hat{k} + 1.6\hat{j})$$

$$\therefore 1.6T_{BD} = 0.5142T_{EC}$$

$$\therefore \boxed{T_{BD} = 0.32\,T_{EC}}$$

$$\therefore 144g = 0.771T_{EC} + 0.8T_{BD}$$

$$\therefore \boxed{T_{EC} = 1374\text{ N}} \qquad \therefore \boxed{T_{BD} = 440.15\text{N}}$$

from equation ①

$\rightarrow$ $A_x - \frac{6}{7} T_{EC} - \frac{2}{3} T_{BD} = 0$ $\rightarrow$ $-120g + A_y + \frac{3}{7} T_{EC} + \frac{T_{BD}}{3} = 0$

$\therefore \boxed{A_x = 1428\ N}$ $\boxed{A_y = 440.5N}$

$\rightarrow$ $A_z + \frac{2}{7} T_{EC} - \frac{2}{3} T_{BD} = 0$

$\therefore \boxed{A_z = -104N}$

(17) A pipe ACDE is supported by ball and socket at A and E by wire DF. Determine the tension in the wire 640 N of load is applied at B as shown

$A(240\hat{k})$ $E(480\hat{i} + 160\hat{j})$

$D(480\hat{i} + 160\hat{j} + 240\hat{k})$

$B(240\hat{k} + 200\hat{i})$

$F(490\hat{j})$

$\lambda_{AB} = \overleftrightarrow{AB} = 480\hat{i} + 160\hat{j} - 240\hat{k}$

$= 80(6\hat{i} + 2\hat{j} - 3\hat{k})$

$\overrightarrow{AD} = 480\hat{i} + 160\hat{j}$ $\overrightarrow{AB} = 200\hat{i}$

$\hat{DF} = -48\hat{i} + 33\hat{j} - 24\hat{k}$

$\rightarrow$ Moment about axis AE is zero

$\therefore 0 = \lambda_{AB} \cdot (r_{AB} \times (-640\hat{j})) + \lambda_{AB} \cdot (r_{AD} \times \vec{T})$

$$0 = \lambda_{AE} \cdot \left[\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 200 & 0 & 0 \\ 0 & -640 & 0 \end{vmatrix} + \frac{160T}{63} \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 1 & 0 \\ -48 & 33 & -24 \end{vmatrix} \right]$$

$\therefore 0 = \lambda_{AE} \cdot [\hat{i}(-60.95T) + 182.86T\hat{j} + 373T\hat{k} - 640 \times 200\hat{k}]$

$\therefore 0 = (6\hat{i} + 2\hat{j} - 3\hat{k}) \cdot [-60.95T\hat{i} + 182.86T\hat{j} + 373T - 640 \times 200\hat{k}]$

$\therefore 0 = -1119.97T + 3 \times 640 \times 200$

$\therefore \boxed{T = 343N}$

(18) A 100 kg uniform rectangular plate is supported in position shown by triangles A and B and by cable CDE that passes over a frictionless hook at C. Assuming that tension is same in both cable determine (a.) tension in cable (b.) reaction at A and B. Assuming that B does not exceed any axial thrust

$\therefore B_x = 0$

$C(690, 0, 450)$ $A(90, 0, 0)$ $D(0, 675, 0)$

$G(480, 225, 0)$ $E(960, 675, 0)$

$\vec{CD} = -690\hat{i} + 675\hat{j} - 450\hat{k}$

$\hat{CD} = (-690\hat{i} + 675\hat{j} - 450\hat{k}) \div 1065$

$T_1 = T(-0.648\hat{i} + 0.634\hat{j} - 0.423\hat{k})$

$\vec{CE} = 270\hat{i} + 675\hat{j} - 450\hat{k}$

$T_2 = T\,(0.316\hat{i} + 0.789\hat{j} - 0.526\hat{k})$

$\therefore T_{eq} = T_1 + T_2 = T(-0.332\hat{i} + 1.423\hat{j} - 0.949\hat{k})$

moment about A is zero.

$\therefore \; 0 = (780\hat{i}) \times (B_y\hat{j} + B_z\hat{k}) + 150T(4\hat{i} + 3\hat{k}) \times$
$(-0.332\hat{i} + 1.423\hat{j} - 0.949\hat{k})$
$- (390\hat{i} + 225\hat{k}) \times (100g\,\hat{j})$

$\Sigma M_x = 0$

$\therefore \; 0 = \hat{i}(-3 \times 1.423 \times 150T + 22500g)$

$\therefore \; T = \dfrac{22500g}{3 \times 1.423 \times 150} = \boxed{845.0\,N}$

$\Sigma M_y = 0$

$0 = \hat{j}(-780B_z + (150T)(4)(0.949) - (150T)(3)(0.33$

$B_z = \dfrac{144900}{780} = 185.49\,N$

$\Sigma M_z = 0$

$0 = \hat{k}(780B_y + (150T)(4)(1.423) - 390 \times 100g)$

or $B_y = 113\,N$

$\Sigma F = 0$

$\therefore \; 100g\,\hat{j} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k}) + T(-0.332\hat{i}$
$+ 1.423\hat{j} - 0.949\hat{k}) + (B_y\hat{j} + B_z\hat{k})$

$\therefore A_x - 0.332T = 0$

$\therefore A_x = 0.332T$

$\boxed{A_x = 114.54\,N}$

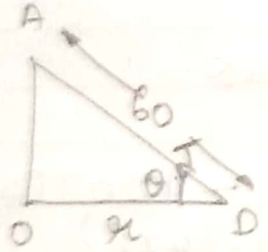
$100g = A_y + 1.423T + B_y$

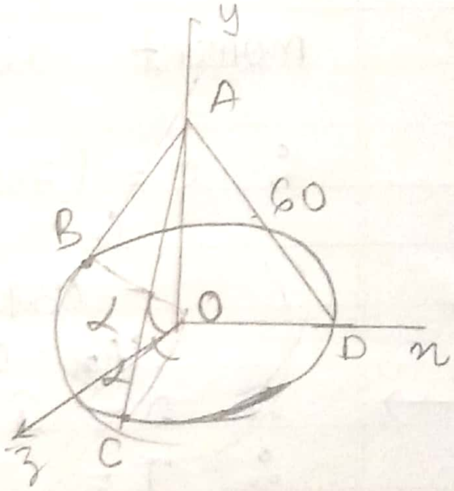
$\therefore \boxed{A_y = 377\,N}$

$A_z - 0.949T + B_z = 0$

$\boxed{A_z = 141.5\,N}$

(19) A 50 N circular plate of 18 cm radius is supported (as shown) by three wires each of 60 cm length. Determine the tension in each wire knowing $\alpha = 30^\circ$



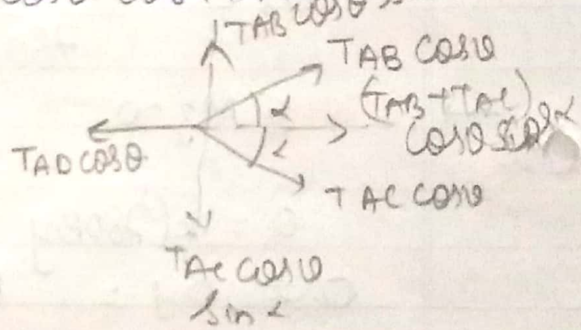


$$\cos\theta = \frac{x}{l} = \frac{18}{60}$$

$$\therefore \theta = \cos^{-1}\left(\frac{3}{10}\right)$$

$$\therefore \vec{T}_{AD} = T_{AD}\cos\theta\,(-\hat{i}) + T_{AD}\sin\theta\,(\hat{j})$$

$$\vec{T}_{AB} = T_{AB}\sin\theta\,(\hat{j}) + T_{AB}\cos\theta\cos\alpha\,(\hat{i}) + T_{AB}\cos\theta\sin\alpha\,(\hat{j})$$



$$\vec{T}_{AC} = T_{AC}\sin\theta\,(\hat{j}) + T_{AC}\cos\theta\cos\alpha\,(\hat{i}) - T_{AB}\cos\theta\sin\alpha\,(\hat{j})$$

$\Sigma F_z = 0$

$$\therefore T_{AB}\cos\theta\sin\alpha = T_{AC}\cos\theta\sin\alpha$$

$$\therefore \boxed{T_{AB} = T_{AC}}$$

$\Sigma F_x = 0 \quad \therefore \quad T_{AD}\cos\theta = (T_{AB} + T_{AC})\cos\theta\cos\alpha$

$$T_{AD} = 2T_{AB}\cos\alpha$$
$$= 2T_{AB}\cos 30$$
$$= \sqrt{3}\,T_{AB}$$

$\Sigma F_y = 0$

$T_{AB} \sin\theta + T_{AC} \sin\theta + T_{AD} \sin\theta = mg$

$\therefore \left(2T_{AB} + \sqrt{3}\, T_{AB}\right) \dfrac{3\sqrt{91}}{10} = 50$

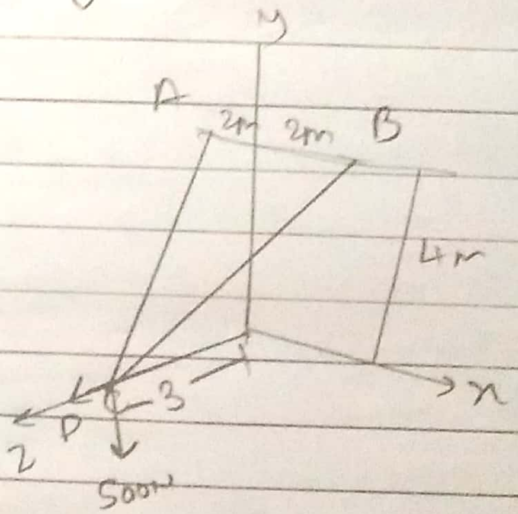
$\therefore T_{AB} = \dfrac{500}{\sqrt{91}\,(2+\sqrt{3})}$

$T_{AB} = 14.04\ N$

$\therefore T_{AB} = T_{AC} = 14.04 N$

$\therefore T_{AD} = \sqrt{3}\, T_{AB} = 24.32 N$

Q A load of 500 N is to be held in equillibrium by means of two string CA and CB and by a force P (along z axis) as shown in figure. Determine tension in string and magnitude P.



$A(-2,4,0)$ $B(2,4,0)$
$C(0,0,3)$

$\vec{CA} = (2,-4,3)$
$\vec{CB} = (-2,-4,3)$

$\vec{T}_{CA} = T_{CA} \dfrac{(2\hat{i} - 4\hat{j} + 3\hat{k})}{\sqrt{29}}$

$\vec{T}_{CB} = T_{CB} \dfrac{(-2\hat{i} - 4\hat{j} + 3\hat{k})}{\sqrt{29}}$

$\vec{P} = P(\hat{k})$

$\Sigma F = 0$

$\therefore 500\hat{j} = P\hat{k} + T_{CA} \left(\dfrac{+2\hat{i} - 4\hat{j} + 3\hat{k}}{\sqrt{29}}\right)$

$+ T_{CB} \dfrac{(-2\hat{i} - 4\hat{j} + 3\hat{k})}{\sqrt{29}}$

$500\hat{j} = P(\hat{k}) + \dfrac{(T_{CA} + T_{CB})}{\sqrt{29}}(-4\hat{j} + 3\hat{k})$

$\left(\dfrac{T_{CA} + T_{CB}}{\sqrt{29}}\right)(4) = 500\hat{j}$

$T_{CA} + T_{CB} = 673.14\ N$

$\therefore\ P = \dfrac{3}{\sqrt{29}}(T_{CA} + T_{CB}) = 375N$

$\boxed{T_{CA} = T_{CB} = 336.75}$ ($\because$ both are symmetric)