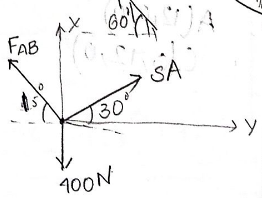
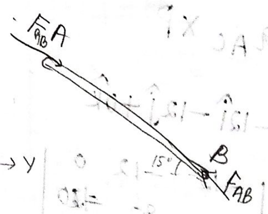
06/01/2022

EQUILIBRIUM OF FORCES:

An isolated view of a body which shows only external forces exerted on the body is called a free body diagram.

2D → concurrent
→ 3





$\Sigma F_x = 0.$

$-F_{AB}\cos 15^\circ + SA\cos 30^\circ = 0$

$\Sigma F_y = 0$

$F_{AB}\sin 15^\circ + SA\sin 30^\circ - 400 = 0.$

$-F_{AB}(0.96) + SA(0.86) = 0$ — (1)

$F_{AB}(0.25) + SA(0.5) = 400$ — (2)

$-F_{AB}(0.24) + SA(0.215) = 0.$

$F_{AB}(0.24) + SA(0.48) = 400.$

$SA(0.695) = 400.$

$SA = 575.5N.$

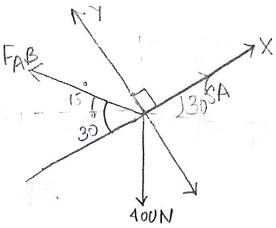
$F_{AB} = \frac{400 - 287.75}{0.25} = 449N$

II nd method:

$\Sigma F_y = 0$

$\frac{F_{AB}}{\sqrt{2}} - \frac{400 \times \sqrt{3}}{2} = 0$

$\boxed{F_{AB} \simeq 449N}$



$\Sigma F_x = 0$

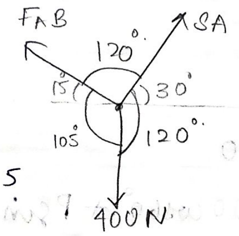
$-F_A\cos 45^\circ + SA - 400\sin 30^\circ = 0$

$\boxed{SA = 575.5N}$

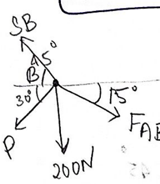
III rd method:

Lami's Theorem:

$\frac{F_{AB}}{\sin 120^\circ} = \frac{400}{\sin 135^\circ} = \frac{SA}{\sin 105}$



$\boxed{\begin{array}{l} F_{AB} \simeq 449N \\ SA = 575.5N \end{array}}$



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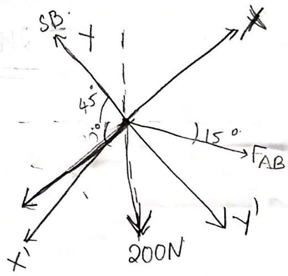


$\Sigma F_x = 0$

~~$-P\cos 15^\circ$~~

~~$-P\ SB\cos 75^\circ + 449\cos 15^\circ = 0$~~

$-P\cos 15^\circ - 200\sin 45^\circ + 490\sin 30^\circ = 0$

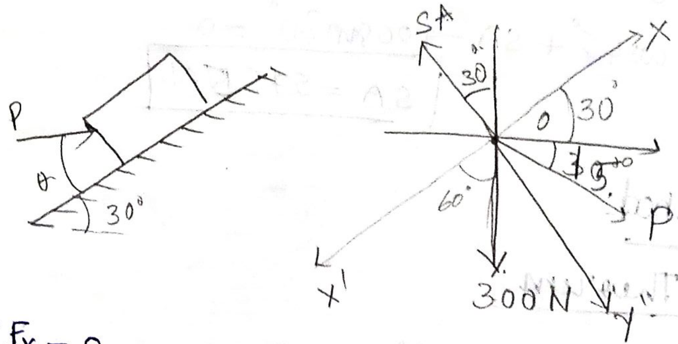
$P = 107.3N$

$\Sigma F_y = 0$

$SB - P\sin 15^\circ - 200\cos 45^\circ - 490\cos 30^\circ = 0$

$SB = \underline{538.00N}$

*



$\Sigma F_x = 0$

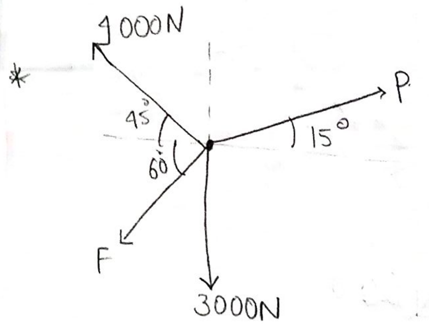
$-300\cos 60^\circ + P\sin 45^\circ = 0$

$P\sin 45^\circ = 150$

$P = 150 \times 1.41$

$= \underline{211.5N}$

*



$\Sigma F_x = 0$

$P\cos 15^\circ - 4000\cos 45^\circ - F\cos 60^\circ = 0$

$P(0.96) - 2836.87 - \frac{F}{2} = 0$

$P(0.96) - 0.5F = 2836.87$

$\Sigma F_y = 0$

$P\sin 15^\circ + 4000\sin 45^\circ - F\sin 60^\circ - 3000 = 0$

$P(0.25) + 2836.87 - 0.865F = 3000$

$0.25P - 0.865F = 163.13$

$0.24P - 0.125F = 709.2$

$\underline{-\ 0.24P \mp 0.8304F = 156.6}$

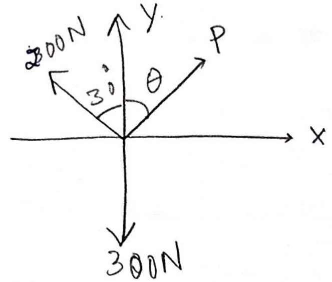
$0.7054F = 552.6$

$F = 783.3N$

$P = \frac{163.13 + 677.5}{0.25}$

$P = \underline{3362.52N}$

*



$\Sigma F_x = -200\cos 60^\circ + P\cos\theta = 0$

$P\cos\theta = 126.7$

$\Sigma F_y = P\sin\theta + 200\sin 60^\circ - 300 = 0$

$P\sin\theta = 173 - 259.5$

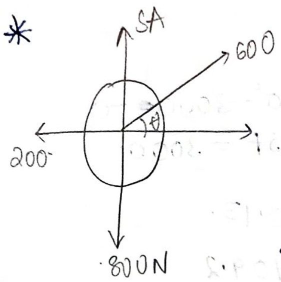
$\tan\theta = 0.27$

$\theta = \underline{15.1^\circ}$

$P = \frac{150}{0.96}$

$= \underline{156.25N}$

*



$600\cos\theta - 200 = 0$

$\cos\theta = 1/3$

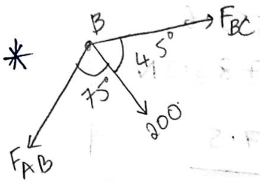
$\boxed{\theta = 70.52^\circ}$

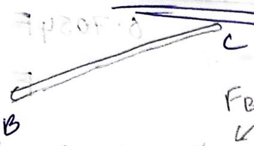
$SA + 600\sin\theta - 800 = 0$

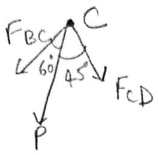
$SA = 800 - 600\sin\theta$

$SA = 234.34N$

*



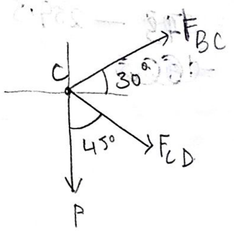




$$\frac{F_{BC}}{\sin 75^\circ} = \frac{200}{\sin 240^\circ}$$

$$F_{BC} = \frac{200 \times 0.96}{-0.86}$$

$$= -223.1N$$

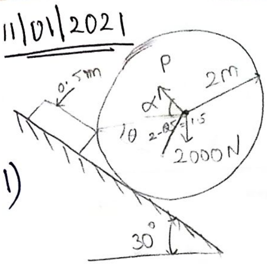


$$\frac{P}{\sin 75^\circ} = \frac{223.1}{\sin 45^\circ}$$

$P = 304.6N$

11/01/2021

1)

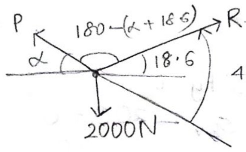


$\sin\theta = \frac{1.5}{2}$

$= \frac{3}{4}$

$\sin\theta = 0.75$

$\theta = 48.6^\circ$



48.6°

$$\frac{2000}{\sin(161.4-\alpha)} = \frac{P}{\sin(108.6)}$$

$$= \frac{R}{\sin(90+\alpha)}$$

P is min

$$\frac{2000}{\sin(180-\alpha-18.6)} = \frac{P}{\sin(108.6)}$$

↓

max ~~180~~ $161.4 - \alpha = 90$

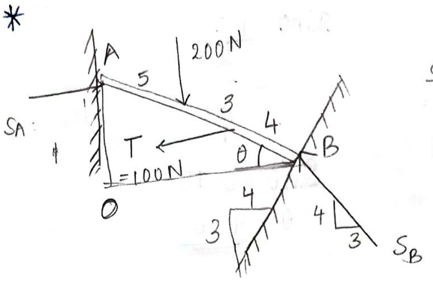
$\alpha = 71.4^\circ$

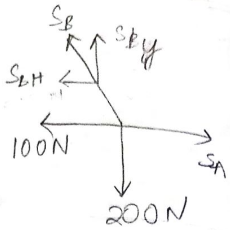
$$\frac{2000}{1} = \frac{P}{0.94}$$

$\boxed{P = 1880N}$

$R = 2000 \times 0.318 = \cancel{636N}$ $637.9N$

*





$\Sigma F_x = 0$

$S_A - 100 - S_{BH} = 0$

$S_A - 100 - S_B\left(\frac{3}{5}\right) = 0$

$\boxed{5S_A - 3S_B = 500}$

$\Sigma F_y = 0$

$S_{BV} - 200 = 0$

$S_B = \frac{\cancel{200}^{50} \times 5}{\cancel{4}}$

$\boxed{S_B = 250N}$

$5S_A = 500 + 750$

$S_A = 100 + 150$

$\boxed{S_A = 250N}$

$\Sigma M_B = 0$

$OA = 12\sin\theta$

$\Sigma M_B = 0$

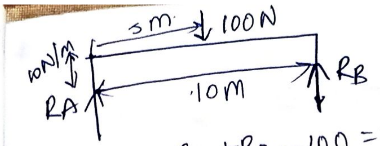
$250 \times 12\sin\theta - 200 \times 7\cos\theta - 4\sin\theta \times 100 = 0$

$(3000 - 400)\sin\theta = 1400\cos\theta$

$\frac{26}{14} = \cot\theta$

$\tan\theta = 0.53$

$\boxed{\theta = 28.3^\circ}$



$\Sigma M_A = 0 / \Sigma F_y = 0$

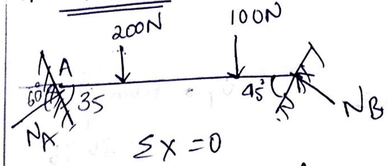
$100 \times 5 - R_B \times 10 = 0$

$R_B = 50N$

$R_A + R_B - 100 = 0$

$R_A = 50N$

* 13/01/2022



did in sheet

$\Sigma X = 0$

$N_A \cos 60^\circ - N_B \cos 45^\circ = 0$

$\Sigma Y = 0$

$N_A \sin 60^\circ - 200 - 100 + N_B \sin 45^\circ = 0$

~~$N_A = 4.93$~~

$\frac{N_A}{2} = \frac{N_B}{\sqrt{2}}$

$\frac{\sqrt{2}N_B \cdot \sqrt{3}}{2} - \frac{N_B}{\sqrt{2}} = 300$

$N_B\left(\frac{\sqrt{6}}{2} - \frac{1}{\sqrt{2}}\right) = 300$

$N_B = \frac{300 \times 2\sqrt{2}}{\sqrt{12} - 2} = \cancel{\frac{846}{1.46}}$

$= \cancel{164.8N}$ $= \cancel{580N}$

$= \cancel{230.7N}$

$N_B = 164.8N$

$N_A = 2\cancel{2}0.7N$

$\Sigma M_B = 0$

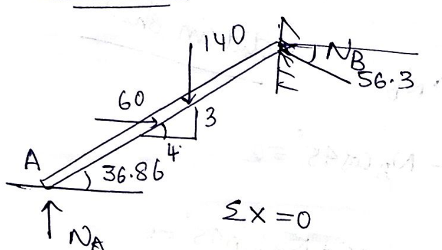
$220.7 \times \frac{\sqrt{3}}{2} \times 12 - 1800 - 100r = 0$

$\cancel{100r = 2990}$

$\cancel{r = 29.9}$

$r = \underline{5.97\ m}$

* FBD of the bar



$\theta_1 = \tan^{-1}\frac{3}{4} = 36.86$

$\theta_2 = \tan^{-1}\left(\frac{3}{2}\right) = 56.3$

$\Sigma X = 0$

$60 - N_B \cos(56.3) = 0$ $\quad N_B = \frac{60}{0.554} = 108.3N$

$\Sigma Y = 0$

$N_A - 140 + N_B \sin(56.3) = 0$

$N_A = 140 - 108.3 \times 0.83 = \underline{50N}$

$\cos(36.86) = \frac{x}{10}$

$\sin(36.86) = \frac{y}{10-x}$

$\Sigma M_B^{\text{all forces}} = 0$

$N_A \cos(36.86) \times 10 - 60\left(\frac{y}{\cancel{10-x}}\right)(\cancel{10-x}) - 140 \times \frac{x}{10} \times 5 = 0$

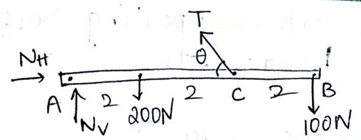
$50 \times \frac{x}{\cancel{10}} \times \cancel{10} - 60y - 70x = 0$

$20x + 60y = 0$

$x + 3y = 0$

$\underline{x = 3.31}$

*



$\theta = \tan^{-1}\left(\frac{8}{4}\right)$

$= \tan^{-1} 2$

$= 63.43^\circ$

3-5-13

$\Sigma F_x = 0$

$N_H - T\cos(63.43) = 0$

$\Sigma F_y = 0$

$N_V - 200 + T\sin(63.43) - 100 = 0$

$N_V + T\sin(63.43) = 300$

$\Sigma M_A = 0$

$200(2) - T\sin 63.43\,(4) + 600 = 0$

$T\sin 63.43 = \frac{1000}{4} = 250$

$T = \frac{250}{0.894} = 280N$

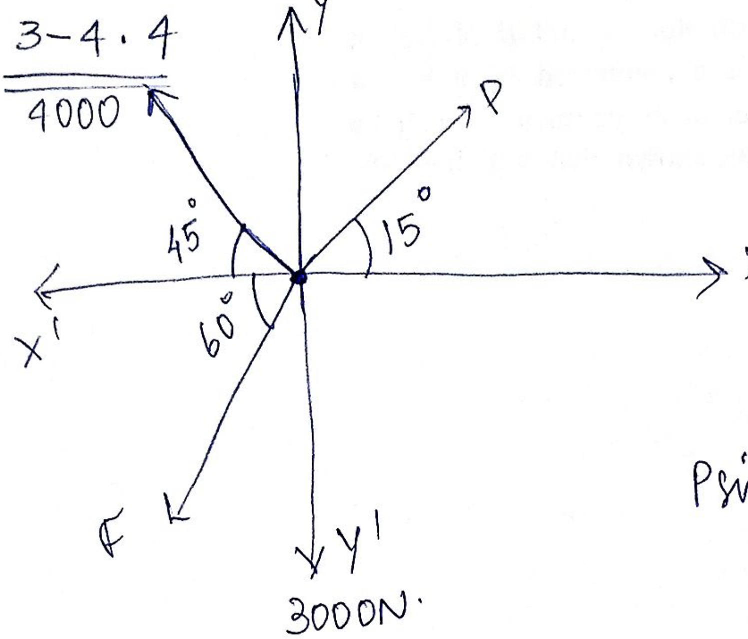
$N_H = T\cos(63.43)$

$= 280 \times 0.447 = \underline{125.16\ N}$

$N_V = 300 - 280 \times 0.894$

$= \underline{50\ N}$

3-4.4



$\Sigma F_x = 0$

$P\cos 15^\circ - 4000\cos 45^\circ - F\cos 60^\circ = 0$

$0.97P - 2828.8 - 0.5F = 0$

$\boxed{0.97P - 0.5F = 2828.8}$

$P\sin 15^\circ + 4000\cos 45^\circ - 3000 - F\sin 60^\circ = 0$

$0.25P + 2828.8 - 3000 - 0.866F = 0.$

$\boxed{0.26P - 0.866F = -171.2}$

$0.840P - 0.433F = 2449.74$

$\underline{0.13P - 0.433F = -85.6}$

$- \quad + \quad +$

$0.71P = 2535.34$

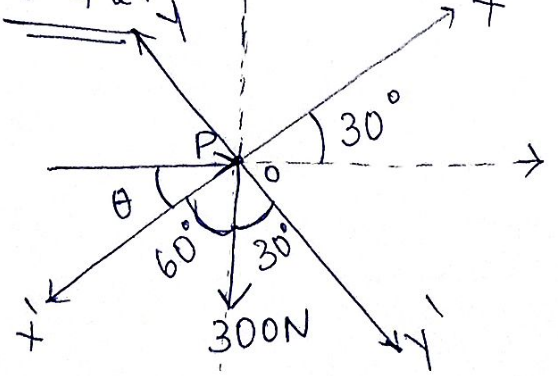
$\boxed{P = 3570.9N}$

$F = \frac{0.97P - 2828.8}{0.5}$

$= \frac{0.26P + 171.2}{0.866}$

$\boxed{F = 1269.7N}$

3-4.2:



$\Sigma F_x = 0.$

$+P\cos\theta - 300\cos 60^\circ = 0$

$P\cos\theta = 150$

$\Sigma F_y = 0: -P\sin\theta - 300\sin 60^\circ = 0$

take ~~θ = √3~~

~~$P\sin\theta = -150\sqrt{3}$~~

$\theta = 45^\circ$

~~$P = -150\sqrt{6}$~~

$P = 150 \times \sqrt{2}$

$= 212.1N$

3.4.2 A 300-N box is held at rest on a smooth incline by a force P making an angle θ with the incline as shown in Fig. P.3-4.2. If $\theta = 45°$, determine the value of P.

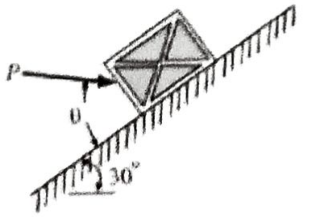


Figure P-3-4.2

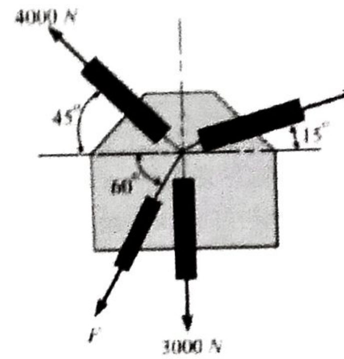
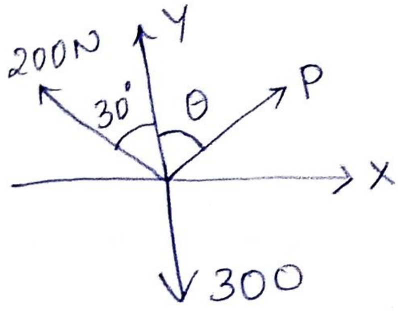


Figure P.3-4.4

3-4.5 The 300 N sphere in Fig. P-3-4.5 is supported by the pull P and a 200 N weight passing over a frictionless pulley. If $\alpha = 30°$, compute the values of P and θ.



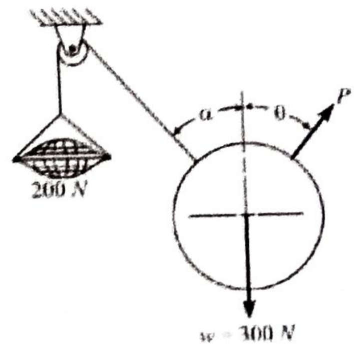


Figure P-3-4.5

$P \sin\theta - 200 \cos 60° = 0$

$\boxed{P \sin\theta = 100\ \text{N}}$

$-300 + P\cos\theta + 200 \sin 60° = 0$

$\boxed{P\cos\theta = -100\sqrt{3} + 300}$

$\cancel{\tan\theta = \frac{1}{\sqrt{3}}}$

$P\cos\theta = 127\text{N}$

$\tan\theta = \frac{100}{127}$

$= 0.78$

$\theta = 37.95°$

$P = \frac{100}{0.614}$

$= 162.8\text{N}$

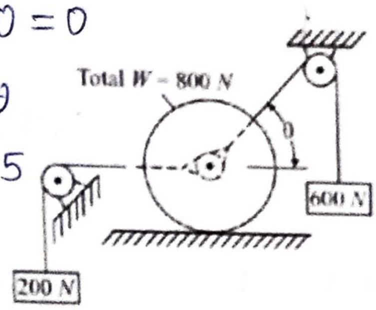
3-4.7 Cords are looped around a small spacer separating two cylinders each weighing 400 N and pass, as shown in Fig. P-3-4.7, over frictionless pulleys to weights of 200 N and 600 N. Determine the angle and the normal reaction S between the cylinders and the smooth horizontal surface.

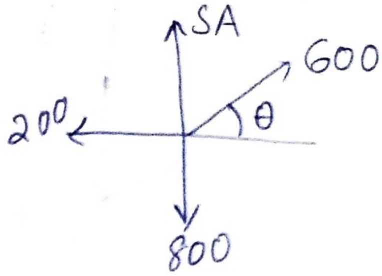
$$SA + 600\sin\theta - 800 = 0$$

$$SA = 800 - 600\sin\theta$$

$$= 800 - 565.65$$

$$= \underline{234.35\,N}$$

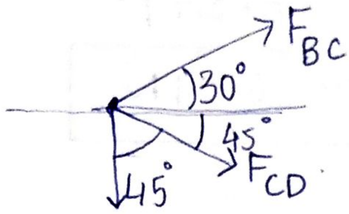




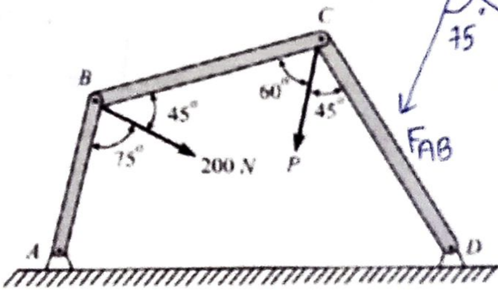
$$600\cos\theta - 200 = 0$$

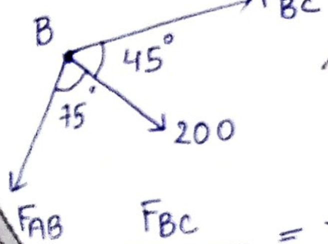
$$\cos\theta = 1/3 \quad \boxed{\theta = 70.52^\circ}$$

3-4.9 Three bars, pinned together at B and C and supported by hinges at A and D as shown in Fig. P-3-4.9 form a four-link mechanism. Determine the value of P that will prevent motion.



P = 304 N **Ans.**





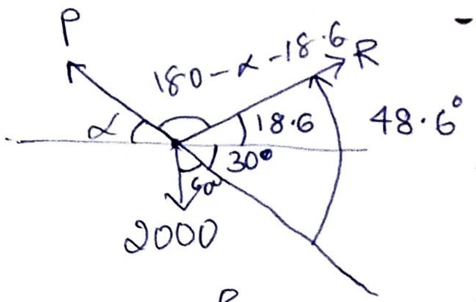
$$\frac{P}{\sin 75^\circ} = \frac{223.1}{\sin 45^\circ}$$

$$P = \underline{304.6N}$$

$$\frac{F_{BC}}{\sin 75^\circ} = \frac{200}{\sin(180-75-45)}$$

$$F_{BC} = -223.1N$$

3-4.10 Determine the amount and direction of the smallest force P required to start the wheel in Fig. P-3-4.10 over the block. What is the reaction at the block?



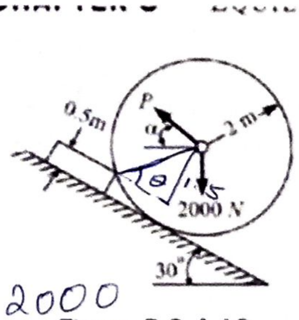


Figure P-3-4.10

$$\sin\theta = \frac{1.5}{2} = \frac{3}{4} = 48.6^\circ$$

$$R = \frac{2000 \times 0.318}{1}$$

$$= \underline{637.9N}$$

$$\frac{P}{\sin(108.6)} = \frac{R}{\sin(90+\alpha)} = \frac{2000}{\sin(161.4-\alpha)}$$

P = 1893 N at 71.3° with horizontal; R = 642 N **Ans.**

P is min

$$\underbrace{\frac{2000}{\sin(161.4-\alpha)}}_{\max = 1} \times \sin(108.6) = P = 2000 \times 0.94 \approx \underline{1895.53N}$$

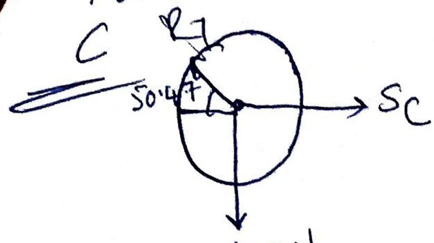
$$161.4 - \alpha = 90$$

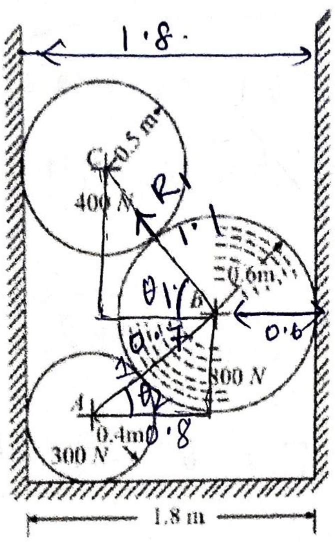
$$\alpha = \underline{71.4^\circ}$$

3-4.11 Three cylinders are piled in a rectangular ditch as shown in Fig. P-3-4.11. Neglecting friction, determine the reaction between cylinder A and the vertical wall.

$\sin^{-1}\left(\frac{0.7}{1.1}\right) = 50.47^\circ$

For C





$\sin^{-1}\left(\frac{0.8}{1.0}\right) = 36.8$

$-R_1 \cos 50.47 + S_C = 0.$

$S_C = 519 \times 0.636.$

$= 330.33\ N$

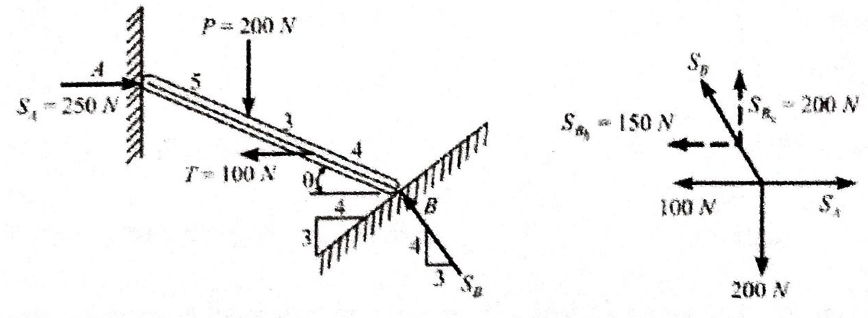
$\Sigma F_y = 0$

$R_1 \sin(50.47) - 400 = 0$

$R_1 = \frac{400}{0.771}$

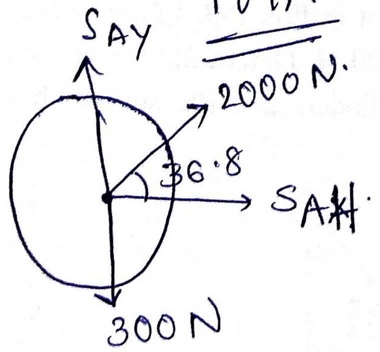
$\boxed{R_1 = 518.8\ N}$

3-5.3 A 12 m bar of negligible weight is acted upon by a vertical load $P = 200$ N and a horizontal load $T = 100$ N applied at the positions shown in Fig. 3-5.5(a). The ends of the bar are in contact with a smooth vertical wall and a smooth incline. Determine the equilibrium position of the bar as defined by the angle θ it makes with the horizontal.



(a) (b)

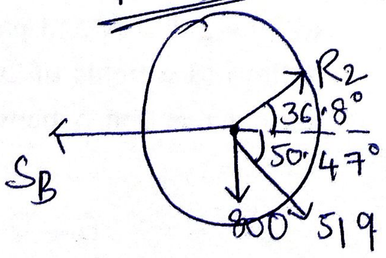
For A



$$S_{AH} + 2000 \sin 36.8 = 0$$

$$\underline{\underline{S_{AH} = 1198.04 N}}$$

For B



$$519 \cos 50.47° + R_2 36.8 - S_B = 0$$

$$R_2 \sin 36.8 - 800 - 519 \sin 50.47 = 0$$

$$R_2 = \frac{800 + 401.6}{0.599}$$

$$\boxed{R_2 = 2006.01 N}$$

3-5.5 Determine the forces P, F, and T required to keep the triangular frame ABC shown in Fig. P-3-5.5 in equilibrium

$\Sigma F_x = 0$

$5400 + F\frac{3}{\sqrt{13}} - P\left(\frac{3}{\sqrt{10}}\right) = 0$

$\Sigma F_y = 0$

$3600 - 1200 - \frac{P}{\sqrt{10}} - \frac{2F}{\sqrt{13}} = 0$

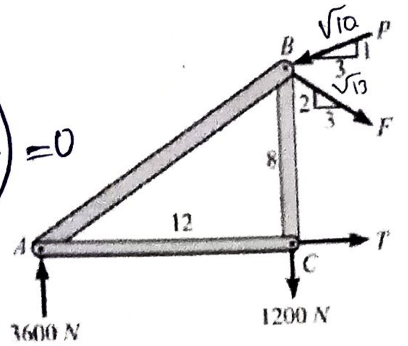


Figure P-3-5.5

$\Sigma M_B = 0$

$3600 \times 12 - T \times 8 = 0$

$T = \frac{\cancel{3600}^{1800} \times \cancel{12}^{3}}{\cancel{8}_{2}}$

$\boxed{T = 5400N}$

$P = 6330$ N; $F = 722$ N; $T = 5400$ N **Ans.**

3-5.6 The weight of the trapezoidal block is 7200 N acting shown in Fig. P-3-5.6. The ground reaction varies uniformly from an intensity of P_A N/m at A to P_B N/m at B. Determine P_A and P_B.

$\Sigma M_O = 0$

$7200 \times 5 - P_B \times 12 \times 6 - \frac{1}{2} \times (P_A - P_B) \times 12 \times 4 = 0$

$\Sigma F_y = 0$

$-7200 + P_B \times 12 + \frac{1}{2}(P_A - P_B) \times 12 = 0$

PA

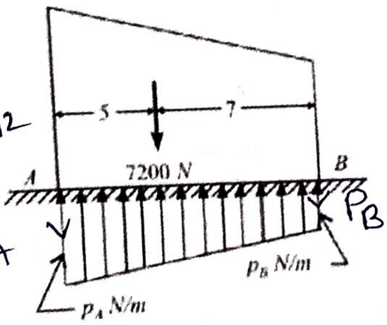
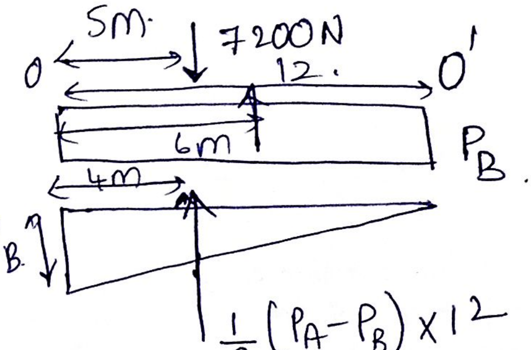


Figure P-3-5.6

P_B. $P_A - P_B$



$P_A = 900$ N/m; $P_B = 300$ N/m **Ans.**

3-5.7 A beam supports a load varying uniformly from an intensity of w N/m at the left end to p N/m at the right end. Find the values of w and p to cause the reactions shown in Fig. P-3-5.7.

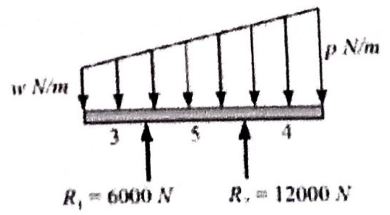


Figure P-3-5.7

$w = 1250$ N/m; $p = 1750$ N/m **Ans**

3-5.5

$$0.94P - 0.83F = 5400$$

$$0.322P + 0.55F = 2400$$

$$0.517P - 0.456\cancel{F} = 2970$$

$$0.267P + 0.4\cancel{56}F = 1992$$

$$0.784P = 4962$$

$$P = 6329.08N.$$

$$F = \frac{5950.02 - 5400}{0.83}$$

$$= 662.89N$$

3-5.8 As shown in Fig. P-3-5.8, the intensity of loading on a simply supported beam 10 m long is given by $y = 10x^3$ where y is in N/m and x is in m measured front A. Find the reactions at A and B.

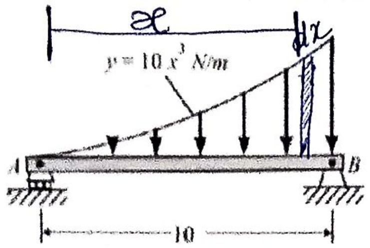


Figure P-3-5.8

$\Sigma F_y = 0$

$-\frac{200000}{4} + R_A + 20000 = 0$

$R_A = 5000$

$= \int_0^{10} (dx \times y) x$

$= \int_0^{10} x^4 . 10 dx$

$\frac{10}{5} (100000)$

$= 200000 - R_B \times 10 = 0$

$R_A = 5000$ N; $R_B = 20{,}000$ N

Ans $R_B = 20$ kN

3.5.12 A weight W rests on the bar AB as in Fig. P-3-5.12. The cable connecting W and B passes over frictionless pulleys. If bar AB has negligible weight, show that the reaction at A is $W(L - a)/(L + a)$.

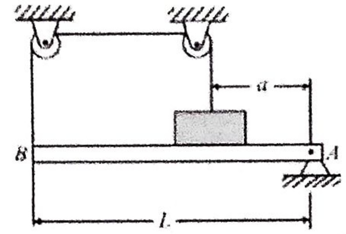


Figure P-3-5.12

3-5.13 A boom AB is supported in a horizontal position by a hinge A and a cable which runs from C over a small pulley at D as shown in Fig. P-3-5.13. Compute the tension T in the cable and the horizontal and vertical components of the reaction at A. Neglect the weight of the boom and the size of the pulley at D.

Did in C.W

Non-Concurrent force system:

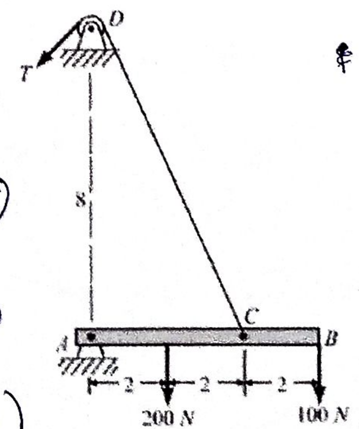
$\Sigma F_x = 0; \Sigma F_y = 0, \Sigma M = 0$

$N_H - T\cos 63.43 = 0$

$N_H = T(0.44)$ — (1)

$N_V + T(0.89) = 300$

$N_V = 300 - T(0.89)$



$\Sigma M = 0$

$200(2) + 100(6) - T(0.89)(4) = 0$

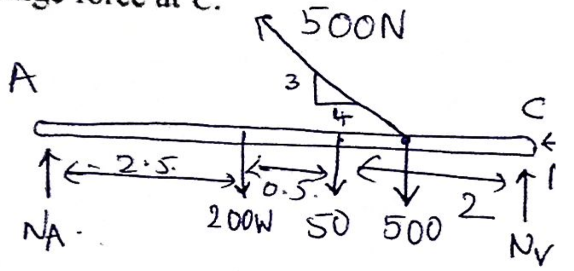
$T = 280.89$ N.

$N_H = 123.59$ N

$N_V = 300 - 280.89 \times 0.89$

$= 50.01$ N

3.5.15 A pulley of 1m radius, supporting a load of 500 N, is mounted at B on a horizontal beam as shown in Fig. P-3-5.15. If the beam weighs 200 N and the pulley weighs 50 N, find the hinge force at *C*.



$\Sigma F_y = 0$

$N_A - 200 - 50 - 500 + \cancel{500}^{100} \times \frac{3}{\cancel{5}} + N_V = 0$

$\boxed{N_A + N_V - 450 = 0}$

$\Sigma M_C = 0$

$N_A(5) - 200 \times (2.5) - 50 \times 2 - 500 \times 1 + \cancel{500}_{100} \times \frac{3}{\cancel{5}} = 0$

$5N_A - 500 - 100 - 500 + 300 = 0$

$5N_A = 800$

$\boxed{N_A = 160\ N}$

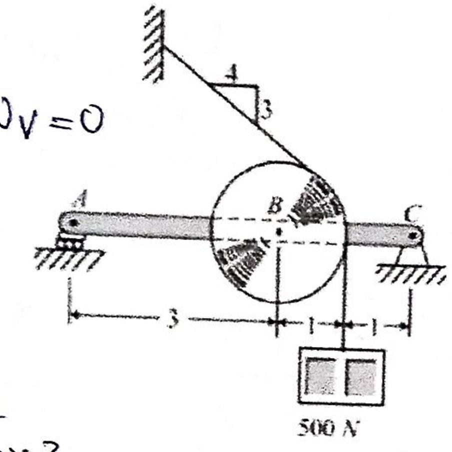


Figure P-3-5.15

$\Sigma F_x = 0$

$-N_H - 500\cos 36.86 = 0$

$N_H = -\cancel{500}^{100} \times \frac{4}{\cancel{5}}$

$\boxed{N_H = -400N}$

$N_V = 450 - 160$

$= 290\ N$ Ans

$N = \sqrt{(N_H)^2 + (N_V)^2}$

$= 472N$

C = 472 N up to the right at θ_x = 32°

3.5.19 A 12 m bar of negligible weight rests in a horizontal position on the smooth inclines in Fig. P-3-5.19. Compute the distance *x* at which load *T* = 100 N should be placed from point *B* to keep the bar horizontal.

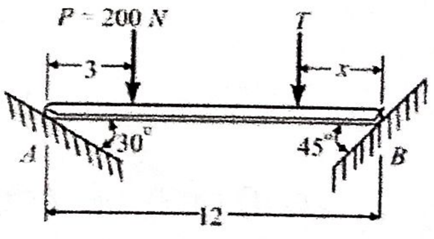
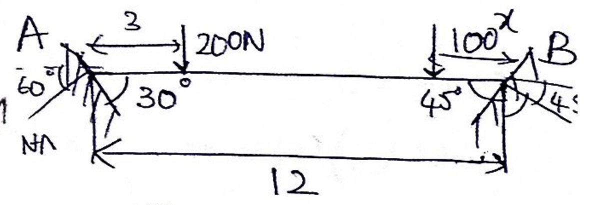


Figure P-3-5.19



$\Sigma M_B = 0$

$N_A \sin 60° \times 12 - 200 \times 9 - 100x = 0$

$100x = 219.78 \times \frac{\sqrt{3}}{2} \times 12 - 1800$

$\cancel{x = \frac{837.36}{100}}$

$100x = 481.316$

$\boxed{x = 4.82\ m}$

x = 4.83 m

Ans.

$\Sigma F_x = 0$

$N_A \cos 60° - N_B \cos 45° = 0$

$\frac{N_A}{2} = \frac{N_B}{\sqrt{2}}$

$\boxed{N_A = \sqrt{2} N_B}$

$\Sigma F_y = 0$

$N_A \sin 60° - 300 + N_B \sin 45° = 0$

$\frac{\sqrt{3} N_A}{2} + \frac{N_B}{\sqrt{2}} = 300$

$N_A\sqrt{3} + N_A = 600$

$N_A = \frac{600}{2.73}$

219.78N

$N_B = 155.87N$

3-5.21 Find the distance x (measured along *AB*) at which a horizontal force of 60 N should be applied to hold the uniform bar *AB* in the position shown in Fig. F-3-5.21. Bar *AB* is 10 m long and weighs 140 N. The incline and the floor are smooth.

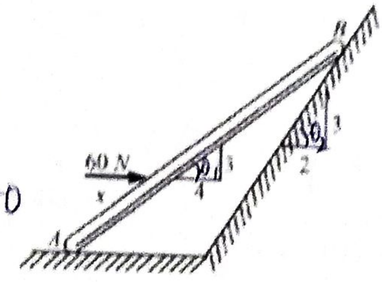
$\Sigma F_x = 0$

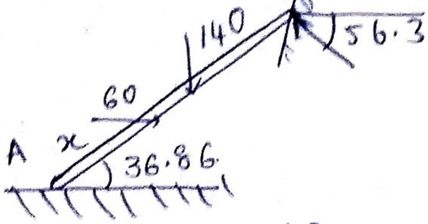
$60 - N_B \cos 56.3 = 0$

$N_B = 108.3N$

$N_A - 140 N_B \sin 56.3 = 0$

$N_A = 50N$





$\theta_1 = \tan^{-1}\frac{3}{4} = 36.36$

$\theta_2 = \tan^{-1}\left(\frac{3}{2}\right) = 56.3.$

Figure P-3-5.21

$x = 3.33$m **Ans.**

3-5.22 Bar AB of negligible weight is subjected to a vertical force of 600 N and a horizontal force of 300 N applied as shown in Fig. P-3-5.22. Find the angle θ at which equilibrium exists. Assume smooth inclined surfaces.

$\cancel{\Sigma F_x = 0}$

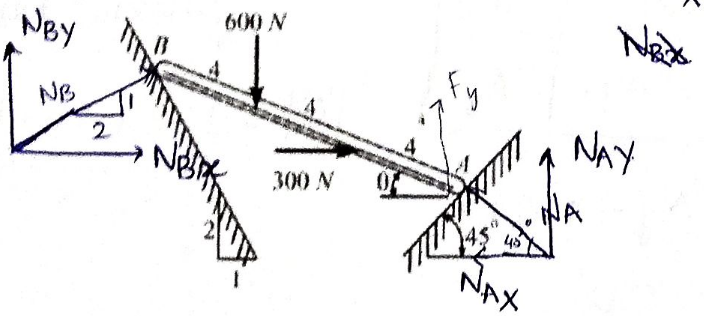


Figure P-3-5.22

$\theta = 45°$ **Ans.**

3-6.1 The vertical mast shown in Fig. 3-6.1 is mounted in a ball-and-socket joint at *A* and supported by two guy wires extending from *D* to anchorages at *B* and *C*. At the midpoint of the mast, a force *P* = 700 N acts parallel to the *Z* axis and a force F = 1400 N acts parallel to the *X* axis. Find the tensions in the guy wires and the reaction at A.

D(0,20,0) B(−10,5,6) C(−10,0,−8) A(0,0,0)

$\vec{B} = (-10\hat{i} - 15\hat{j} + 6\hat{k})$ Bm $\quad \vec{C} = (-10\hat{i} - 20\hat{j} - 8\hat{k})$ Cm

Combined P&F $\Rightarrow \vec{K} = 1400\hat{i} + 0\hat{j} + (-700\hat{k}) = 1400\hat{i} - 700\hat{k}$ $\quad$ E(0,10,0)

$\Sigma M_A = 0 \Rightarrow r_{AD} \times \vec{B} + r_{AD} \times \vec{C} + r_{AE} \times \vec{K} = 0$

$r_{\overline{AD}} = 20\hat{j} \qquad r_{AD} \times \vec{B} = (200\hat{k} + 0 + 120\hat{i})$ Bm

$r_{\overline{AE}} = 10\hat{j} \qquad r_{AD} \times \vec{C} = (200\hat{k} + 0 - 160\hat{i})$ Cm

3-5.22

$$\Sigma F_x = 0$$

$$N_B\left(\frac{2}{\sqrt{5}}\right) + 300 - \frac{N_A}{\sqrt{2}} = 0$$

$$\frac{2N_B}{\sqrt{5}} - \frac{N_A}{\sqrt{2}} = -300$$

$$\Sigma F_y = 0$$

$$N_B\left(\frac{1}{\sqrt{5}}\right) - 600 + \frac{N_A}{\sqrt{2}} = 0$$

$$\frac{N_B}{\sqrt{5}} = 600 - \frac{N_A}{\sqrt{2}}$$

$$1200 - \sqrt{2}\,N_A - \frac{N_A}{\sqrt{2}} = -300$$

$$1500 = N_A\left(\frac{2+1}{\sqrt{2}}\right)$$

$$500 \times \sqrt{2} = N_A$$

$$N_A = 705N$$

$$N_B = \sqrt{5}(100)$$

$$\boxed{N_B = 223.6N}$$

$$\cancel{\Sigma M_B = 0}$$

$$\cancel{600(4) - 300(8) + N_{Ay}(4) + N_{Ax}(4) = 0}$$

$$\cancel{600 \quad 1200 \cos\theta}$$

$$\Sigma M_B = 0$$

$$600(4)\cos\theta - 300 \times 8 \sin\theta - 705 \times \frac{1}{\sqrt{2}} \times 12\cos\theta + 705 \times \frac{1}{\sqrt{2}} \times 12 \sin\theta = 0$$

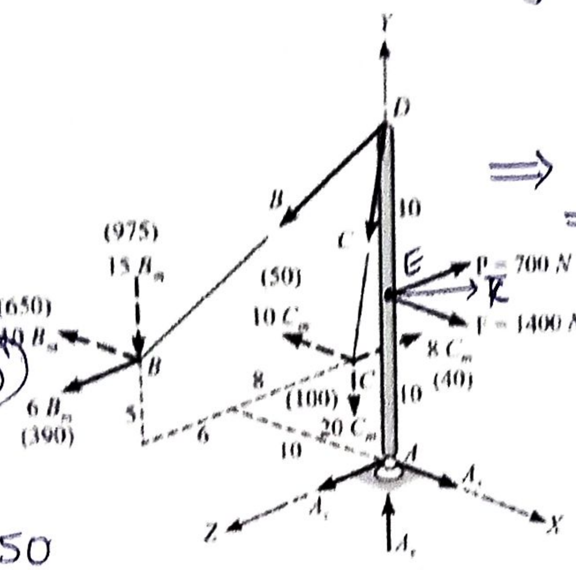
$$2400\cos\theta - 2400\sin\theta - 6000\cos\theta + 6000\sin\theta = 0$$

$$1800\sin\theta = 1800\cos\theta$$

$$\tan\theta = 1$$

$$\boxed{\theta = 45^\circ}$$

$r_{AE} = 10\hat{j}$ $\qquad$ $r_{AE} \times \vec{K} = -14000\hat{k} + 0 - 7000\hat{i}$



$\Rightarrow (200 Bm + 200 Cm - 14000)\hat{k} + (120Bm - 160Cm - 7000)\hat{i} = 0$

$\boxed{Cm = 70 - Bm}$

$2\cancel{00}Bm + 2\cancel{00}Cm = 140\cancel{0}\cancel{0}$

$12\cancel{0} Bm - 16\cancel{0}Cm = 70\cancel{0}\cancel{0}$

$Bm + Cm = 70$

$6Bm - 8Cm = 350$

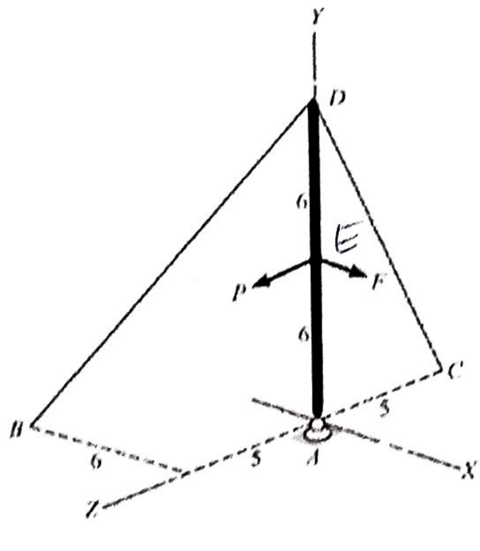
$3Bm - 4Cm = 175$

Figure 3-6.1

$3Bm - 280 + 4Bm = 175$ $\qquad$ $\boxed{7Bm = 455}$ $\qquad$ $Bm = 65\,N/m$ $\qquad$ $Cm = 5\,N/m$

3-6.14 A mast AD is supported in a ball-and-socket joint at A and by two guy wires BD and CD as shown in Fig. P-3-6.14. Find the magnitude of the force A if $\mathbf{F} = 600\,\hat{\mathbf{i}}$ N and $\mathbf{P}$ $400\,\hat{\mathbf{k}}$ N.

$A(0,0,0)$
$B(-6,0,5)$ $\qquad$ $E(0,6,0)$
$C(0,0,-5)$
$D(0,12,0)$



$\overline{BD} = (6\hat{i} + 12\hat{j} - 5\hat{k})\,Bm$

$\overline{CD} = (12\hat{j} + 5\hat{k})\,Cm$

$\vec{K} = 600\hat{i} - 400\hat{k}$

$\overline{AE} = 6\hat{j}$

$\overline{r_{AD}} = 12\hat{j}$

Figure P-3-6.14

Ans.

A = 1718 N

$\boxed{\Sigma M_A = 0}$

$\overline{r_{AD}} \times \overline{BD} = (-72\hat{k} - 60\hat{i})\,Bm$

$\overline{r_{AD}} \times \overline{CD} = 60\hat{i}\,Cm$

$\overline{r_{AE}} \times \overline{K} = -3600\hat{k} - 2400\hat{i}$

$-3600 - 72Bm = 0$ $\qquad$ $-2400 + 60Cm - 60Bm = 0$

$72Bm = 3600$ $\qquad$ $6\cancel{0}Cm = 240\cancel{0} + 300\cancel{0}$

$Bm = \frac{100}{2} = 50\,N/m$ $\qquad$ $Cm = 90\,N/m$

3-6.1

Force or tension across guy wires.

$DB \Rightarrow \vec{B} = 65(-10\hat{i} - 15\hat{j} + 6\hat{k})$

$|\vec{B}| = 65(\sqrt{100+225+36})$

$= \underline{1235 N}$

$DC \Rightarrow |\vec{C}| = \cancel{6}5(-10\hat{i} - 20\hat{j} - 8\hat{k})$.

$= 5\sqrt{100+400+64}$.

$= 5 \times 23.74 = \underline{\underline{117.85 N}}$

	$\hat{i}$	$\hat{j}$	$\hat{k}$
$\bar{B}$	-650	-975.	390
$\bar{C}$	-50	-100	-40.
$\bar{K}$	1400	0	-700.
$\bar{A}$	Ax	Ay	Az.

$\vec{A} = -700\hat{i} + 1075\hat{j} + 350\hat{k}$

$= \sqrt{(700)^2 + (1075)^2 + (350)^2}$

$= \sqrt{49 \times 10^4 + 1155625 + 122500}$.

$|\vec{A}| = \underline{\underline{1329.708 N}}$

$A_x = 700 \qquad A_y = +1075$

$A_z = 350$

25/01/2022 TRUSS: a framework; supporting roof, bridge etc.

STRUCTURAL ANALYSIS:

→ slender members : dimensions << length.

* Planar Truss: (Members ~~planar~~ + Loading) → Same plane

Otherwise spatial truss.

* longitudinal beams: Stringer.
* lateral beam : floor beam

wheels of wagon ⟶ slab ⟶ stringer ⟶ floor beams
Load transfer mechanism.

→ Self weight of truss is neglected.

* ~~Truss~~ → Force which is given by truss is far greater than its own weight.

→ Members are joined together by smooth pins.

• Bolting or welding the members to a common plate; is called gusset plate.

• All forces in diff directions are purely axial and have a point of concurrence.

• All the forces are applied at the joints.

Simple Truss: 3 members are pin connected at their ends they form a triangular truss; that will be rigid.

→ 2 more members are added and connecting these members to new point D.

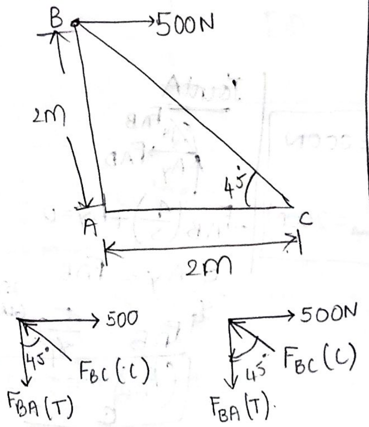
A simple truss is a planar truss which begins with a triangular element & can be expanded by adding 2 members and a joint.

ANALYSIS OF TRUSS

METHOD OF JOINTS

→ This method is based on the fact that if the entire truss is in equilibrium; then each of its joints is also in equilibrium.

→ Always start at a joint having atleast one known force & atmost 2 known forces.



01/02/2022

METHOD OF SECTIONS

→ If the truss is in equilibrium then any segment is also in equilibrium

→ If the forces within the members are to be determined; then an imaginary section which cut it into 2 parts & thereby expose each internal force as external to the FBD.

→ Method of sections can also be used to cut/section the members of an entire truss.

* In general; segment passes through not more than 3 members in which forces are unknown.

→ Member forces acting on one part are equal & opp. in direction.

→ on FBD of joint
: if force away from joint ⇒ TENSION.

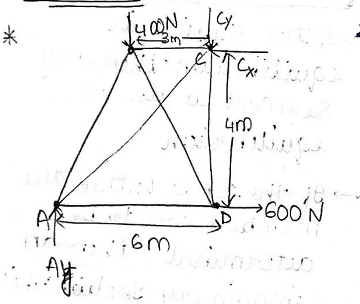
→ on FBD of joint
: if force towards joint ⇒ COMPRESSION.

the force in a particular truss member is one of the advantages using method of sections.

→ If solution of sense of a force yields -ve scalar; it indicates that the force's sense is opp. to that shown on FBD. (assumed)

29/01/2022

*



$\Sigma F_x = 0$

$600 - C_x = 0$

$\boxed{C_x = 600N}$

$\Sigma M_C = 0$

$A_y \times 6 - 600 \times 4 - 400 \times 3 = 0$

$A_y = \frac{2400 + 1200}{6}$

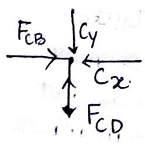
$\boxed{A_y = 600 N}$

$\Sigma F_y = 0$

$-C_y + A_y - 400 = 0$

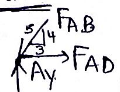
$\boxed{C_y = 200N}$

Joint C:



$$\boxed{\begin{aligned}(F_{CB})_{Compression} &= 600N \\ (F_{CD})_{compression} &= 200N\end{aligned}}$$

Joint A



$-F_{AB}\left(\frac{4}{5}\right) + A_y = 0$

$\frac{5}{4} A_y = F_{AB}$

$F_{AB} = \frac{5}{4} \times 600$

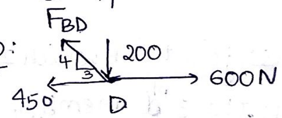
$\boxed{(F_{AB})_C = 750N}$

$\Sigma F_x = 0$

$F_{AD} - F_{AB}\left(\frac{3}{5}\right) = 0$

$(F_{AD})_T = F_{AB}\left(\frac{3}{5}\right) = 750 \times \frac{3}{5} = \boxed{450N = (F_{AD})_T}$

Joint D:



$\Sigma F_x = 0 \Rightarrow 600 - 450 - F_{BD}\left(\frac{3}{5}\right) = 0$

$\frac{5}{\cancel{3}} \times \cancel{150}^{50} = F_{DB}$

$\boxed{(F_{DB})_T = 250N}$

⇒

Member force	Sense	Magnitude
AB	C	750
BC	C	600
CD	C	200
DA	T	450
BD	T	250

* Zero Force Members:

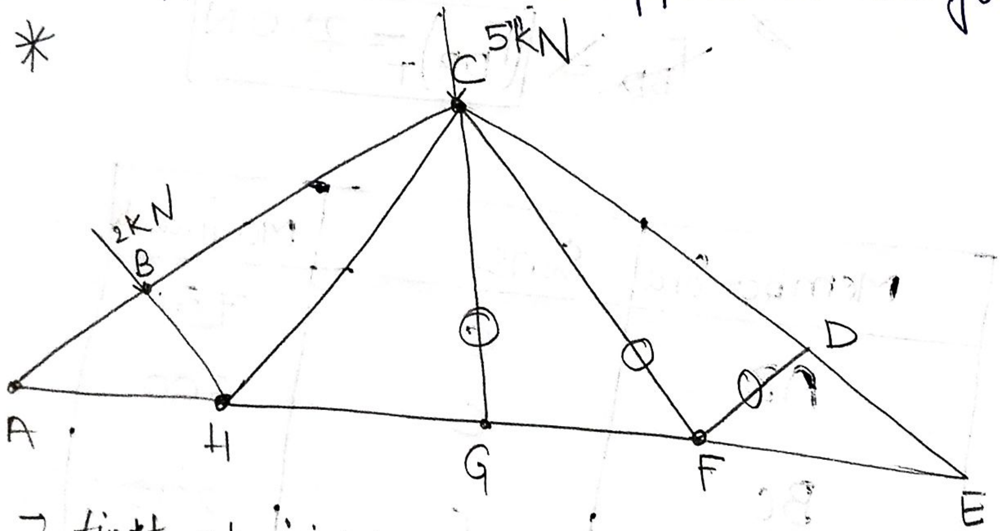
→ Members which support no loading.

→ These zero force members are used to increase the stability of the truss during construction & to provide added support if the loading is changed.

→ If only 2 members form a truss joint; and no external load or support reaction is applied to the joint, the 2 members must be zero force members.

→ If 3 members form a truss joint for which 2 of the members are collinear; the 3rd member is a zero force member provided no external load or support reaction is applied to the joint.

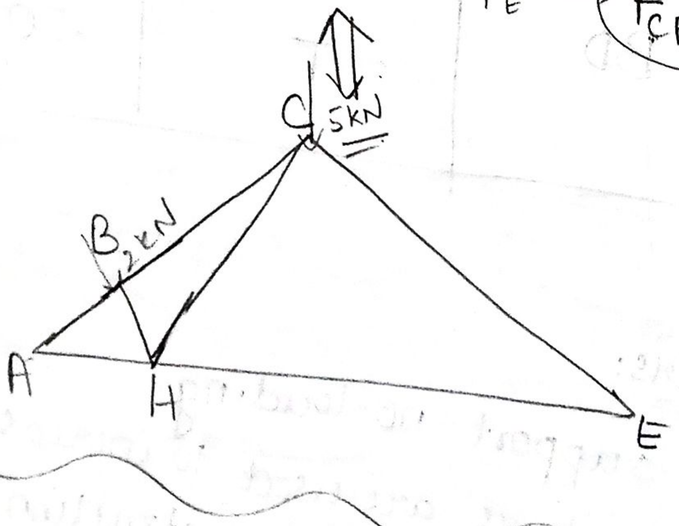
*



→ first at joint D → $F_{DF} = 0$

→ then at joint F → only 3 forces.

$F_{GF} = F_{FE} \Rightarrow F_{CF} = 0$



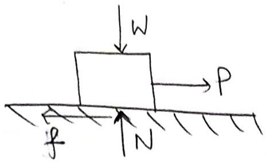
03/02/2022

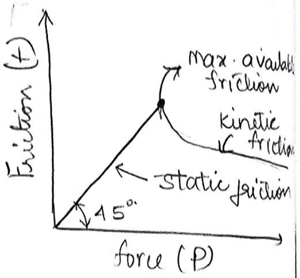
FRICTION

→ Contact resistance exerted by one body upon a second body when the second body moves or tends to move past the first body.

→ Friction is a retarding force always acting opposite to the motion or tendency to move.

*





→ for all situations when $P>0$; P is enough to cause motion.

$\boxed{P=F}$

Static friction: No motion

Kinetic friction: In motion

→ on verge of motion; $f = f_{max}$.

→ frictional resistance depends on amount of wedging action b/w hills and ~~valleys~~ vales.

$$f \propto R(\text{Normal reaction})$$

$$\boxed{f = \mu R}$$

$\mu \rightarrow$ coefficient of friction.

→ Frictional resistance decreases when the body is in motion, because in motion there is less chance for wedging action i.e. the hills and vales are not as free to mesh as when the block was at rest.

→ Forces along the direction of motion are smaller than when the contact surfaces are at rest.

→ Friction force is essentially independent of the apparent contact are.

* The true contact area is much smaller; occurring as it does at the peaks of the contact irregularities.
* High intensity of normal pressure at these peaks results in localized yielding.

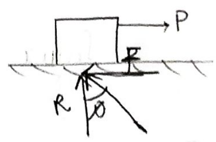
→ If the normal pressure is doubled; area of real contact must be doubled.

* ANGLE OF FRICTION:

The particular value of angle b/w resultant of R & f and normal reaction (R) is called angle of friction.

$$\tan\phi = \frac{f}{R}$$

$$\boxed{\tan\phi = \mu}$$



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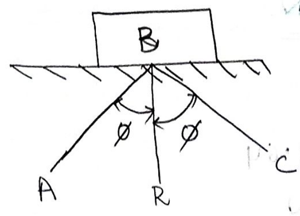
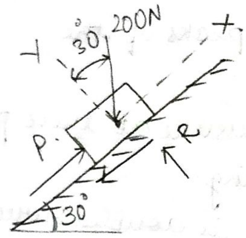


Problems involving non-coplanar forces it must be contained within the cone generated by revolving AB about normal BN; is called CONE OF FRICTION.

* friction is neglected; reactions are always normal to the surfaces in contact.
* Friction is tangential to the surfaces in contact.

Q:



(i) impend up the plane
(ii) down the plane
(iii) P = 80N
determine magnitude & direction of the friction force.

$\mu = 0.20$

(i) At impending motion $f = f_{max}$ $f_{max} = R \times \mu$

$\Sigma F_y = 0$

$-200 \cancel{\sin} \cos 60^\circ + R = 0$

$R = \cancel{2}00 \times \frac{\sqrt{3}}{\cancel{2}} = 173.2$

$f_{max} = 173.2 \times 0.2$

$= \underline{\underline{34.64\,N}}$

$\Sigma F_x = 0$

$-200 \cos 60^\circ - f + P = 0$

$P = +100 + 34.64$

$= \underline{\underline{134.64\,N}}$

(ii) $\Sigma F_y = 0$

$f_{max} = 34.64\,N$.

$-200 \cos 60^\circ + f + P = 0$

$P = 100 - f$

$= 100 - 34.64$

$= \underline{\underline{65.36\,N}}$

(iii) $P = 80\,N$. $P \rightarrow$ up the incline

$-200 \cos 60^\circ - f + P = 0$

$P - 100 = f$

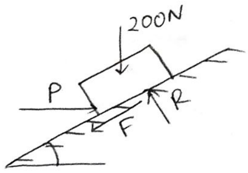
$f = -20\,N$

$\Rightarrow$ P is down the incline and f is up the incline

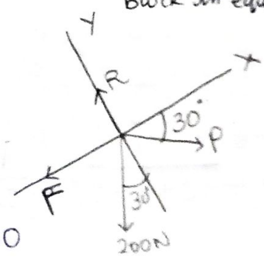
$f = 20\,N$ (up).

Q 5/02/2022

Q:



$\mu = 0.2$ Compute the magnitude of P due to which block in equilibri



$\Sigma F_y = 0$

$R - 200 \cos 30^\circ - P \sin 30^\circ = 0$

$R - \frac{P}{2} = 173.2\,N$

$\boxed{R = \frac{P}{2} + 173.2}$

$F = \mu R$

$\Sigma F_x = 0$

$P\cos 30^\circ - F - 200\sin 30^\circ = 0$

$\frac{\sqrt{3}P}{2} - 100 = F$

$= 0.2R$

0.866
1.732
2

$\frac{\sqrt{3}P}{2} - 100 = 0.2\left(\frac{P}{2} + 173.2\right)$

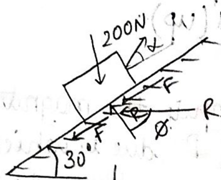
$0.866P - 100 = 0.1P + 34.64$

$0.766P = 134.64$

$P = 175.77\,N$

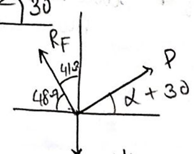
$P = 175.77N$

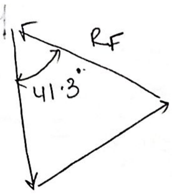
Q:



$\tan\phi = 0.2$

$\phi = 11.3^\circ$





$\frac{200}{\sin(180-48.7-\alpha-30)} = \frac{P}{\sin(90+48.7)}$

P should be min

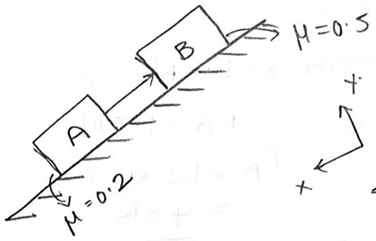
$\sin(180-48.7-\alpha-30) = \sin 90^\circ$

$\alpha = 11.3^\circ$

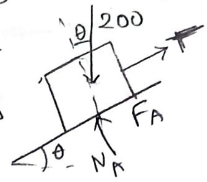
$P = 200 \times \sin(90+48.7)$

$= 132N$

Q:



FBD of Block A:



$\Sigma F_y = 0$

$N_A - 200\cos\theta = 0$

$N_A = 200\cos\theta$

$F_A = 0.2 \times 200 \times \cos\theta$

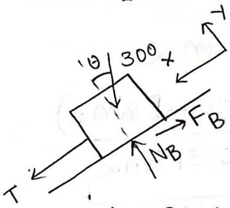
$\boxed{F_A = 40\cos\theta}$

$\Sigma F_x = 0$

$-T - F_A + 200\sin\theta = 0$

$T = 200\sin\theta - 40\cos\theta$ — (1)

FBD of Block B:



$N_B = 300\cos\theta$

$F_B = 150\cos\theta$

$\Sigma F_y = 0$

$N_B - 300\cos\theta = 0$

$\Sigma F_x = 0$

$T - F_B + 300\sin\theta = 0$

$T = 150\cos\theta - 300\sin\theta$

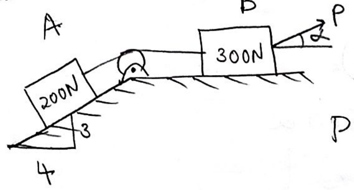
$500\sin\theta = 190\cos\theta$

$\tan\theta = \frac{19}{50} = \frac{3.8}{10}$

$= 0.38$

$\theta = 20.81^\circ$

Q:

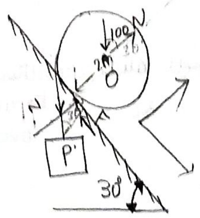


$\mu_A = \mu_B = 0.30$

P is min

08/02/2022

*



$\Sigma M_o = 0$ ↻+

$-(P \times 1) + F \times 1 = 0$

$\boxed{P = F}$

$\Sigma F_y = 0$

$-100\cos 30^\circ - P\cos 30^\circ = 0$ +N

$\boxed{\cancel{P = -100\,N - N}}$

$N = (100 + P)\cos 30^\circ$

$= 100 \times 1.732$

$\boxed{N = 173.2\,N}$

$\Sigma F_x = 0$

$P\sin 30^\circ + 100\sin 30^\circ - \cancel{F} = 0$

$\frac{P}{2} - P + 50 = 0$

$\boxed{P = 100\,N}$

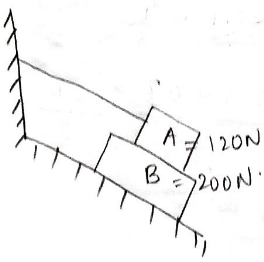
$\cancel{N = -200N}$

$\mu = \frac{100}{173.2}$

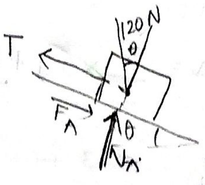
$= 0.577$

$\boxed{\tan\theta = \mu}$

*



FBD of A



$\mu = 0.25$

$\Sigma F_y = 0$

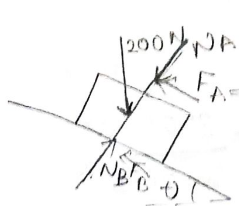
$N_A - 120\cos\theta = 0$

$N_A = 120\cos\theta$

$F_A = \mu N_A$

$= 0.25 \times 120\cos\theta = \underline{30\cos\theta}$

*



$\Sigma F_y = 0$

$-200\cos\theta - 120\cos\theta + N_B = 0$

$\boxed{N_B = 320\cos\theta}$

$F_B = 80\cos\theta$

$32 \times 25 = 160 + 64 = 800$

$\Sigma F_x = 0$

$-200\sin\theta - F_A - F_B = 0$

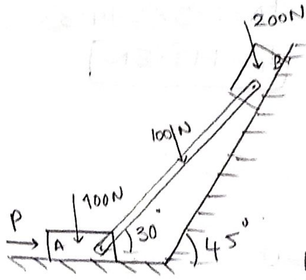
$-200\sin\theta = 110\cos\theta$

$\tan\theta = -\frac{11}{20}$

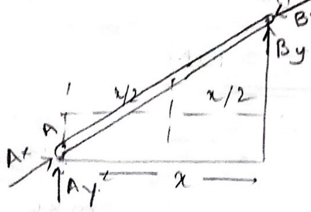
$= 0.55$

$\theta = 28.81^\circ$

*



Take components one vertical & another along the geometry.



$\Sigma M_A = 0$

$100 \times \frac{x}{2} - B_y \times x = 0$

$\boxed{B_y = 50N}$

$\Sigma F_y = 0$

$A_y - 100 + B_y = 0$

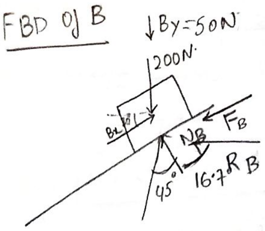
$\boxed{A_y = 50}$

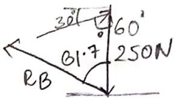
$\Sigma F_x = 0$

$A_x - B_x = 0$

$\boxed{A_x = B_x}$

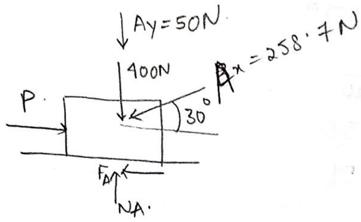
FBD of B





$$\frac{B_x}{\sin(61.7^\circ)} = \frac{250}{\sin 58.3}$$

$$\underline{B_x = 258.71\,N}$$



$\Sigma F_x = 0$

$P - \frac{258.7}{2} \times \sqrt{3} - F_A = 0$

$\underline{P = 398\,N}$

$\Sigma F_y = 0$

$-450 - 258.7 \sin 30 + N_A = 0$

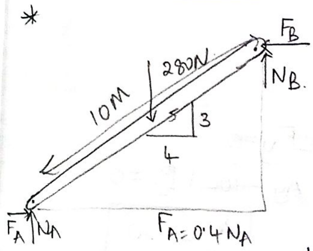
$N_A = 450 + \frac{258.7}{2}$

$= \underline{579.35\,N}$

$F_A = 0.3 \times 579.35$

$\boxed{F_A = 173.8\,N}$

*



$\Sigma M_B = 0$

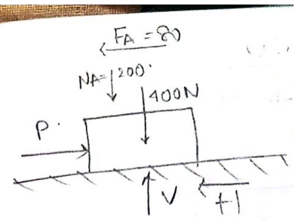
$280 \times \frac{4}{\cancel{5}} \times \cancel{5} + N_A \times \cancel{10} \times \frac{4}{\cancel{5}}$

$- 0.4\, N_A \times \frac{3}{\cancel{5}} \times \cancel{10} = 0$

$1120 + 8N_A - 2.4\, N_A = 0$

$N_A = \frac{1120}{5.6}$

$\boxed{N_A = 200\,N}$



$\Sigma F_x = 0$

$P - 80 - 240 = 0$

$\boxed{P = 320\,N}$

$\Sigma F_y = 0$

$-200 - 400 + V = 0$

$V = 600$

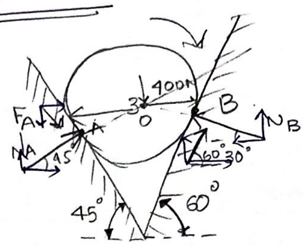
$\Sigma F_x = 0$

$H = 0.4 \times 600$

$= 240\,N$

10/02/2022

*



$\phi = 15^\circ$

$F_A = \tan\phi\, N_A$

$F_B = \tan\phi\, N_B$

$\Sigma F_x = 0$

$F_A \cos 45^\circ + N_A \cos 45^\circ - N_B \cos 30^\circ + F_B \cos 60^\circ = 0$

$0.189 N_A + 0.707 N_A - 0.866 N_B + 0.133 N_B = 0$

$0.896 N_A = 0.733 N_B$

$\boxed{N_A = 0.818 N_B}$

$\Sigma F_y = 0 \Rightarrow -F_A \sin 45 + N_A \sin 45^\circ + N_B \sin 30^\circ + \tan 15^\circ \sin 60 N_B = 400$

$\frac{-F_A}{\sqrt{2}} + \frac{N_A}{\sqrt{2}} + \frac{N_B}{2} + \frac{\sqrt{3} F_B}{2} - 400 = 0$

$-0.707 \times 0.26 N_A + 0.707 N_A + \frac{N_A}{1.636} + 0.866 \times 0.268 \frac{N_A}{0.818}$

$-0.183 N_A + 0.707 N_A + 0.611 N_A + 0.275 N_A - 400 = 0$

$= 400$

$1.41 N_A = 400$

$\boxed{N_A = 283.68 N}$

$N_B = \frac{283.68}{0.818}$

$\boxed{N_B = 346.6 N}$

$F_A = 73.7 N$

$F_B = 90.16 N$

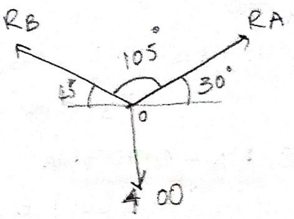
$R_A = 294.5$

$R_B = 358.63$

73.2

$M = 1.5(73.7 + 90.16)$

$= \underline{246 Nm}$



$\frac{400}{\sin 105} = \frac{R_A}{\sin 135} = \frac{R_B}{\sin 120}$

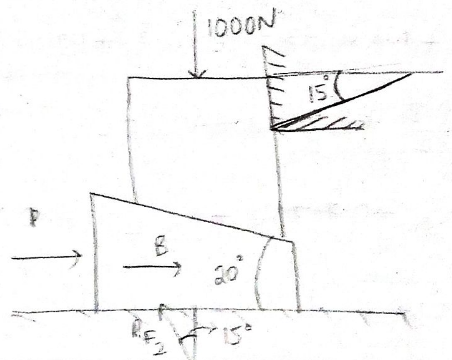
$R_A = 294.5$

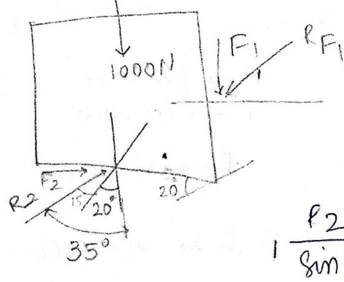
$R_B = 358.96$

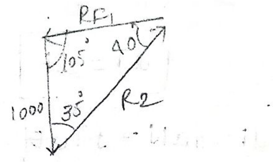
$N_A = 283.68 N$

$N_B = 346.6 N$

$M = 246$



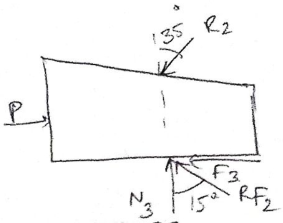


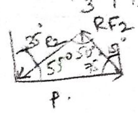


$\frac{F_2}{\sin 105°} = \frac{1000}{\sin 40} \Rightarrow$

$R_2 = \frac{965.925}{0.642}$

$= \underline{1504.55 N}$





$\frac{P}{\sin 50} = \frac{R_2}{\sin 75°}$

$P = \frac{1152.552}{0.965}$

$P = 1194.3 N$

12/02/2022

* BELT FRICTION:

→ The transmission of power by means of belt or rope drives, or the braking of large loads by means of band brakes, depends on frictional resistance developed b/w belt & the driving or resisting surface with which it is in contact.

→ If surface of pulley is smooth, torque will not be developed.

→ If surface is rough; however the tension in the belt will vary throughout the length of contact.

$$\boxed{dT = dF}$$

$F \rightarrow$ friction
$T \rightarrow$ Tension

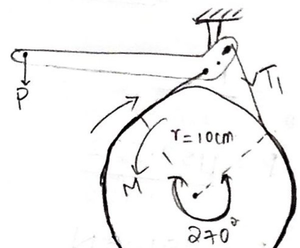
$$\boxed{dF = f\,dN = f\,T\,d\theta}$$

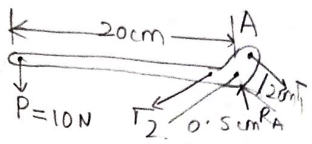
$f \rightarrow$ friction

$$\boxed{\frac{T_2}{T_1} = e^{f\beta}}$$

β is in radians.

*





$\Sigma M_A = 0 \Rightarrow 2T_1 - \frac{T_2}{2} - 200 = 0$

$T_2 = T_1\, e^{0.2(1.5\pi)}$

$= 2.56\,T_1$

$2T_1 - 1.28\,T_1 - 200 = 0$

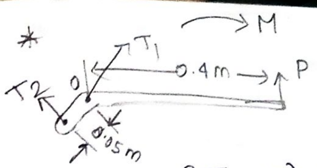
$0.72\,T_1 = 200.$

$$\boxed{T_1 = 277.7}$$

$T_2 = 2.56 \times 277.7$

$$\boxed{T_2 = 711\,N}$$

*



$\frac{T_2}{T_1} = \cancel{\theta}\, e^{0.3 \times 250 \times \frac{\pi}{180}}$

$T_2 = 3.7\,T_1$

$(T_2 - T_1)\,0.2 = 320\,Nm$

$(3.7T_1 - T_1) \times 0.2 = 320$

$2.7T_1 \times 0.2 = 320$

$T_1 = \frac{1600}{2.7}$

$= 592.5\,N$

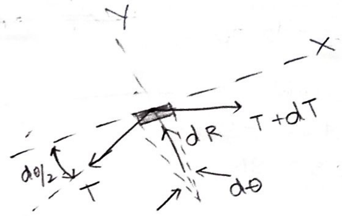
$T_2 = 2192.5$

$\Sigma M_O = 0$

$T_2 \times 0.05 = P \times 0.4$

$$\boxed{P = 274.06\,N}$$

*



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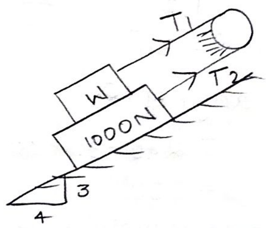
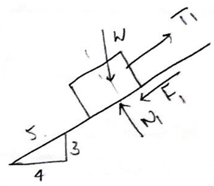


$\frac{T_2}{T_1} = e^{(0.2)(180 \times \frac{\pi}{180})}$

$$\boxed{T_2 = 1.84\,T_1}$$



$\Sigma F_y = 0$

$W\left(\frac{4}{5}\right) = N_1$

$F_1 = N_1 \times 0.2$

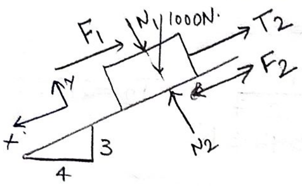
$$\boxed{F_1 = 0.16\,W}$$

$\Sigma F_x = 0$

$-W \times \frac{3}{5}^{0.6} - 0.16W + T_1 = 0$

$\boxed{T_1 = 0.76W}$

$T_2 = 1.42W$



$\Sigma F_y = 0$

$-N_1 + N_2 - 1000 \times \frac{4}{5} = 0$

$N_2 = 800 + 0.8W$

$F_2 = 0.2(800 + 0.8W)$

$= 160 + 0.16W$

$\Sigma F_x = 0$

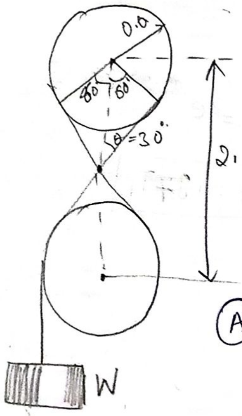
$-F_1 - F_2 + 1000 \times \frac{3}{5} - T_2 = 0$

$-0.16W - 160 - 0.16W$

$-1.42W + 600 = 0$

$W = 252.8N$

*



$\sin\theta = \frac{0.6}{1.2} = \frac{1}{2}$

$\theta = 30°$

Total angle

$= 240 + 30 + 30$

$= 300°$

(A) if impending motion is along P.

$\frac{P}{W} = e^{\frac{1}{\pi} \times 300 \times \frac{\pi}{180}}$

$P = 1000\, e^{300/180}$

$= 5294.49N$

(B) if impending motion is along W.

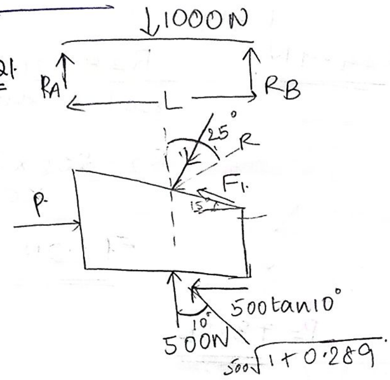
$\frac{W}{P} = e^{\frac{1}{\pi} \times 300 \times \frac{\pi}{180}}$

$P = \frac{W}{5.29}$

$= 189.03N$

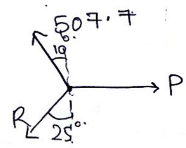
14/02/2022

*
5.5.21



$R_A = R_B = 500N$

$500\sqrt{1+0.289} = 507.7N$

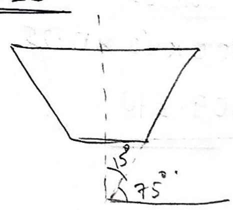


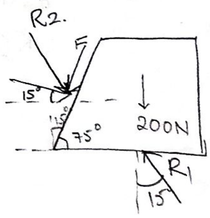
$\frac{P}{\sin 145°} = \frac{507.7}{\sin 115}$

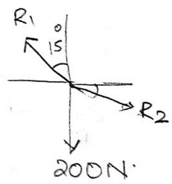
$P = \frac{291.2}{0.906}$

$\boxed{P = 321.4N}$

5-5.23







$$\frac{200}{\sin 135^\circ} = \frac{R_1}{\sin 60^\circ}$$

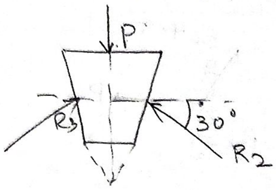
$$R_1 = \frac{200 \times \sqrt{3}/\cancel{2}\,\sqrt{2}}{\frac{1}{\cancel{\sqrt{2}}}}$$

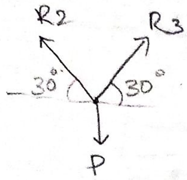
Geometry & Loading

$$= \frac{200 \times 1.732}{1.414}$$

Based on Symmetry

$$R_2 = R_3 = \cancel{244.9} = \underline{244.9\,N.}$$





$$\frac{R_2}{\sin 165} = \frac{200}{\sin 1\ldots}$$

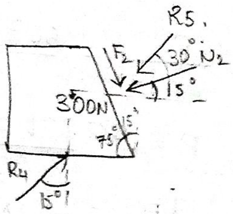
$$R_2 = 200 \times \sqrt{2} \times 0.2\ldots$$

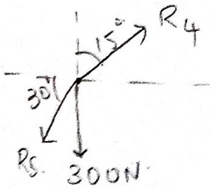
$$\underline{73.2\,N}$$

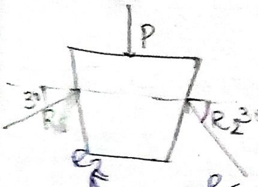
$R_2 = R_3 = 73.2\,N.$

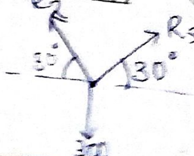
$\underline{P = 73.2\,N}$

~~5-2.22~~







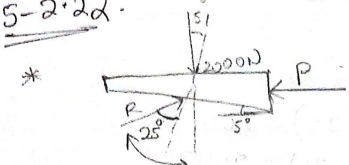


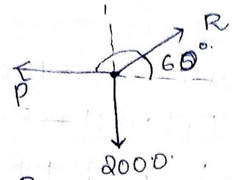
$$\frac{R_5}{\sin 165^\circ} = \frac{300}{\sin 135^\circ}$$

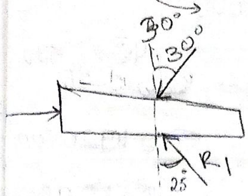
$$R_5 = 300 \times \sqrt{2} \times 0.25$$

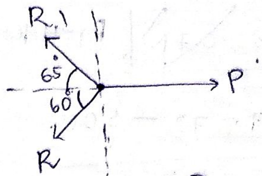
$$= \underline{109.8\,N}$$

5-2.22.









$$\frac{R}{\sin 90^\circ} = \frac{2000}{\sin 120^\circ}$$

$$R = \frac{2000 \times 2}{\sqrt{3}}$$

$$= \frac{4000}{1.732}$$

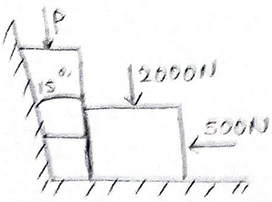
$$\boxed{R = 2309.46\,N}$$

$$\frac{P}{\sin 125} = \frac{2309.4}{\sin 115}$$

$$= \frac{1891.9}{0.906}$$

$$\boxed{P = 2088.18\,N}$$

5-5.24 $\phi = 15^\circ$



$\Sigma F_y = 0$

$-2000 + R_2 \cos 15^\circ = R_1 \sin\ldots$

$R_2 \cos 15^\circ - R_1 \sin 15^\circ = 2000$

$\boxed{R_2\,0.96 - 0.25 R_1 = 2000}$

$\Sigma F_x = 0$

$R_1 \cos 15^\circ - 500 - R_2 \sin 15^\circ = 0$

$R_1(0.96) - R_2(0.25) = 500$

$-R_1(0.25) + R_2(0.96) = 2000$

$R_1(0.92) - R_2(0.24) = 480$

$-R_1(0.0625) + R_2(\cancel{0.24}) = 500$

$0.8591 R_1 = 980$

$\cancel{\boxed{R_1 = 582.07 N}}$ $R_1 = 1140.73$

$R_2 = \frac{558.7872 - 500}{0.25}$

$\cancel{R_2 = 595.09\ N}$

$R_2 = 2380.3 N$ $\cancel{\boxed{R_2 = 235.14 N}}$

$N_2 - 2000 - R_1 \sin 15^\circ = 0$

$R_1 \cos 15^\circ - 500 - N_2 \tan 15^\circ = 0$

$N_2 = 2000 + 0.26 R_1$

$0.96 R_1 - 0.26 N_2 = 500$

$0.26 R_1 - N_2 = -2000$

$0.96 R_1 - 0.26 N_2 = 500$

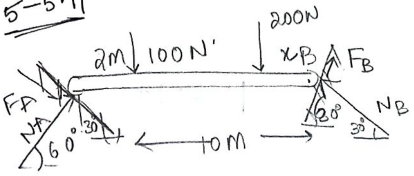
$0.0626 R_1 - 0.26 N_2 = -520$

$+ \qquad\qquad +$

$0.8974 R_1 = 1020$

$\boxed{R_1 = 1136.6 N}$

5-5.11



$\phi = 15^\circ$

$\tan 15^\circ = 0.27$

$\Sigma F_x = 0$

$F_A \cos 30^\circ + N_A \cos 60^\circ - N_B \cos 30^\circ + F_B \cos 60^\circ = 0$

$0.27 N_A \times \frac{\sqrt{3}}{2} + \frac{N_A}{2} - \frac{\sqrt{3}}{2} N_B + \frac{0.27 N_B}{2} = 0$

$0.233 N_A + 0.5 N_A + (0.135 - 0.866) N_B = 0$

$0.733 N_A = 0.731 N_B$

$\boxed{N_A = 0.997 N_B}$

$\boxed{N_A \simeq N_B}$

$\Sigma F_y = 0$

$-0.27 N_A \sin 30^\circ + N_A \sin 60^\circ - 300 + 0.27 N_B \sin 60^\circ + N_B \sin 30^\circ = 0$

$-0.135 N_A + 0.866 N_A + 0.233 N_B + 0.5 N_B = 300$

$1.464 N_A = 300$

$N_A = N_B = 204.9 N$

$F_A = F_B = 54.9 N$

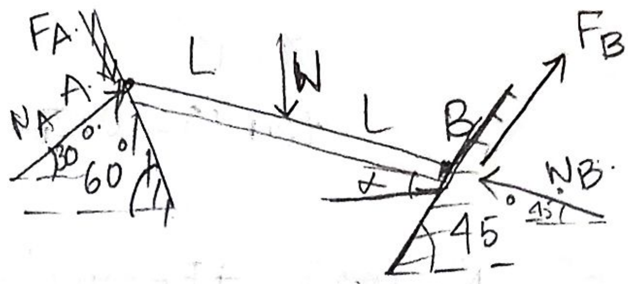
$\Sigma M_B = 0$

$-F_A \sin 30^\circ \times 10 + N_A \sin 60^\circ \times 10 - 100 \times 8 - 200 \times x = 0$

$-274.5 + 1774.4 - 800 = 200x$

$\boxed{x = 3.49}$

5.5.12



$\mu = 0.27$

$\Sigma F_x = 0$

$-N_B \cos 45° + N_A \cos 30° + F_A \cos 60° + F_B \cos 45$

$-N_B\, 0.707 + 0.866 N_A + 0.135 N_A + 0.19 N_B$

$1.001 N_A = 0.517 N_B$

$\boxed{N_A = 0.516 N_B}$

$\Sigma F_y = 0$

$N_A \sin 30° + N_B \sin 45° - F_A \sin 60° + F_B \cos 45°$

$- W = 0$

$W = 0.258 N_B + 0.707 N_B - 0.1206 N_B$

$+ 0.19 N_B$

$W = 1.0344 N_B$

$\boxed{N_B = W(0.966)}$

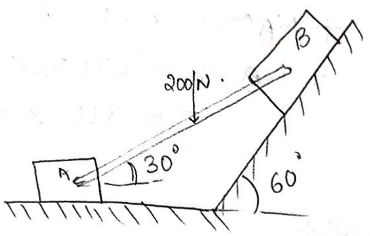
$\boxed{N_A = 0.498 W}$

$\boxed{F_B = 0.26 W}$

$\boxed{F_A = 0.134 W}$

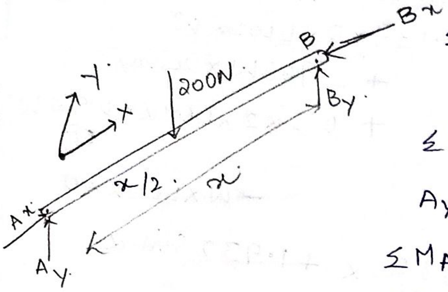
5-5.19

$\mu = 0.25$



$W_A = 400N$

$W_B = 300N$



$\Sigma F_x = 0$

$B_x = A_x$

$\Sigma F_y = 0$

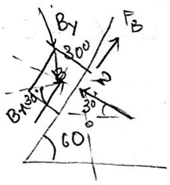
$A_y + B_y = 200$

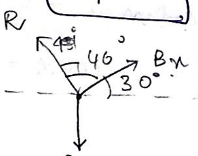
$\Sigma M_A = 0$

$-200 \times \frac{x}{2} + -B_y x = 0$

$\boxed{B_y = 100}$

$\boxed{A_y = 100}$





$\mu = 0.25$

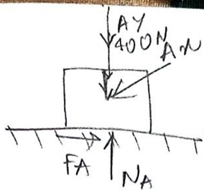
$\phi = \tan^{-1}(0.25)$

$= 14°$

$$\frac{300}{\sin 106} = \frac{B_x}{\sin 134}$$

$$B_x = \frac{215.8}{0.96}$$

$\boxed{A_x = 224.7 = B_x}$



$\boxed{\mu = 0.389}$

$\Sigma F_y = 0$

$N_A - A_y - 400 = 0$

$N_A = 500N$

5-1

$\Sigma F_x = 0$

$F_A - A_x \cos 30° = 0$

$F_A = 224.7 \times$

$F_A = 194.5$