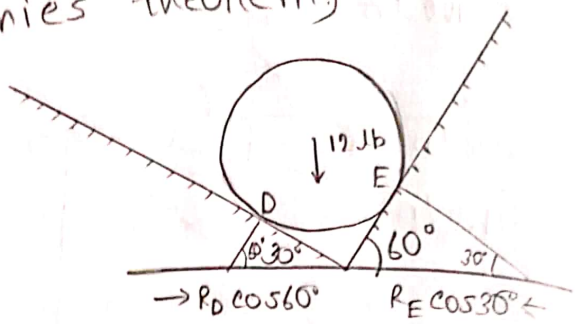
Problems on Engineering Mechanics

(Stable Circle) **Problem 1**

From the figure, (Use lamies theorem)



$\Sigma F_x = 0$

$\Rightarrow R_D \cos 60° - R_E \cos 30° = 0$

$\Rightarrow \frac{R_D}{2} - \frac{\sqrt{3} R_E}{2} = 0$

$\Rightarrow R_D = \sqrt{3} R_E$

$\Sigma F_y = 0$

$\Rightarrow R_D \sin 60° + R_E \sin 30° - 12 = 0.$

$\Rightarrow \frac{\sqrt{3} R_D}{2} + \frac{R_E}{2} - 12 = 0 \Rightarrow 3 R_E + R_E - 24 = 0.$

$\Rightarrow R_E = 6$ lb.

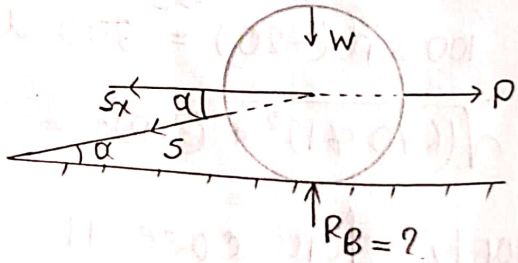
and $R_D = \sqrt{3} \times 6 = 10.39$ lb.

(S.C) **Problem 2**

$\Sigma F_x = 0$

$\Rightarrow P - S_x = 0$

$\Rightarrow P - S \cos\alpha = 0 \Rightarrow S = \frac{P}{\cos\alpha}$

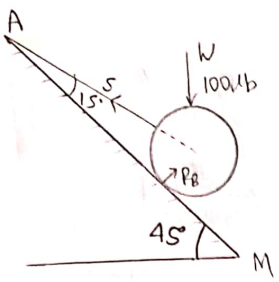


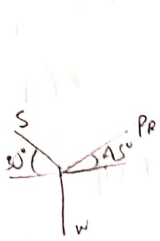
And, $\Sigma F_y = 0$

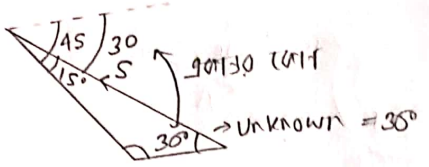
$\Rightarrow -(W + S \sin\alpha) + R_B = 0.$

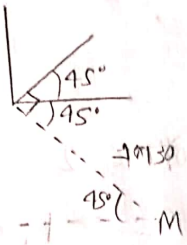
$\Rightarrow R_B = \frac{P}{\cos\alpha} \cdot \sin\alpha + W = P \tan\alpha + W.$

Problem 5 (S.C) Lamy's theorem









$\Sigma F_x = 0.$

$\Rightarrow R_B \cos 45° - T\cos 30° = 0.$ ——— (i)

$\Rightarrow R_B = T \cdot \frac{\cos 30°}{\cos 45°}$

And, $\Sigma F_y = 0$

$\Rightarrow R_B \sin 45° + T \sin 30° - 1000 = 0.$ ——— (ii)

$\Rightarrow T \cdot \frac{\cos 30°}{\cos 45°} \cdot \sin 45° + T \sin 30° - 1000 = 0$

$\Rightarrow T = 732.05$ lb

$\therefore R_B = 732.05 \times \frac{\cos 30°}{\cos 45°} = 896.57$ lb

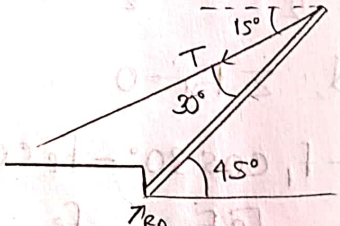
Problem 6 (Fishing Pole)

$\Sigma x = 0$

$\Rightarrow R_A \cos 45 - T\cos 15 = 0$ ——— (i)

$\Rightarrow \frac{\sqrt{2} \cdot R_A}{2} - T \cdot 965 = 0$

$\Rightarrow R_A = 1.37T$



$\Sigma Y = 0$

$\Rightarrow R_A \sin 45 - T \sin 15 - 20 = 0$ ——— (ii)

$\Rightarrow T = 14.14$ lb.

and, $R_A = 1.37 \times 14.14 = 19.37$ lb.

$\sin\theta = \frac{2}{4}$

$\Rightarrow \theta = \sin^{-1}\left(\frac{1}{2}\right) = 3$

$\Sigma F_y = 0$

$\Rightarrow R_A \sin 30° - 500$

$\Sigma F_x = 0$

$\Rightarrow R_A \cos 30° - T =$

Problem 8 $\Sigma F_x = 0$

$R_x - T = 0 \Rightarrow R_x - T$, $\Sigma F_y = 0$

$R_y - 500 = 0$, $R_y = 500$

$\Sigma M_A = 0$.

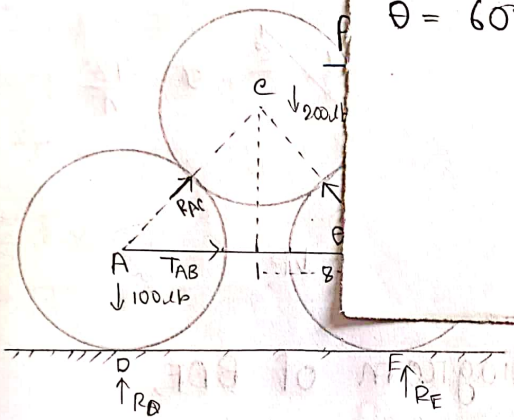
$\Rightarrow -T \times 6 + 500 \cdot 2\sqrt{3} = 0$

$\Rightarrow T = 288.7\ lb$

$R = \sqrt{R_x^2 + R_y^2} = 577.35\ lb.$

$\tan\theta = \frac{R_y \sin\alpha}{R_x + R_y \cos\alpha}$ -

$\theta = 60°$



A, B, C

$\Sigma F_x = 0$

$\Rightarrow R_{AC} \cos 48.18° - R_{BC} \cos 48.18° = 0$

$\Rightarrow R_{AC} = R_{BC}$

$\Sigma F_y = 0$

$\Rightarrow R_{AC} \sin 48.18° + R_{BC} \sin 48.18° - 200 = 0$

$\Rightarrow R_{AC} = \frac{200}{2 \sin 48.18°} = 134.18°$

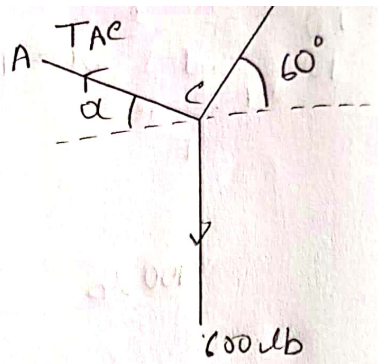
Again, consider body diagram of A

$\Sigma F_x = 0$

$\Rightarrow T_{AB} - R_{AC} \cos 48.18° = 0$

$\Rightarrow T_{AB} = 134.18 \times \cos 48.18° = 89.47.\ lb$

Consider the free body diagram of the system.



Using Lamie's theorem,

$$\frac{T_{AC}}{\sin(90°+60°)} = \frac{T_{BC}}{\sin(90°+\alpha)} = \frac{600}{\sin(180°-\alpha-60°)}$$

$$\Rightarrow \frac{T_{AC}}{\cos 60°} = \frac{T_{BC}}{\cos\alpha} = \frac{600}{\sin(120-\alpha)}$$

$$\therefore T_{AC} = \frac{600 \times \cos 60°}{\sin(120-\alpha)}, \text{ and,}$$

$$T_{BC} = \frac{600 \times \cos\alpha}{\sin(120-\alpha)}$$

a) T_{AC} will be minimum, when $\sin(120°-\alpha) = 1$

$$\Rightarrow \sin(120°-\alpha) = \sin 90°$$

$$\Rightarrow \alpha = 30° \quad \text{(Ans)}$$

b) $$T_{AC} = \frac{600 \times \cos 60°}{\sin(120°-30°)} = 300 \text{ lb}$$

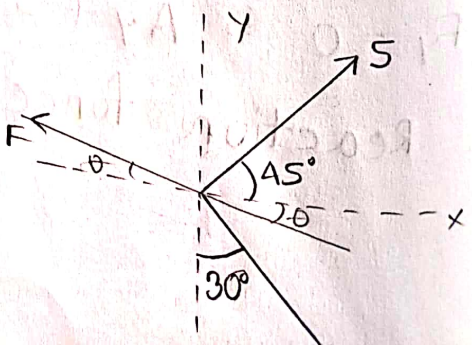
$$T_{BC} = \frac{600 \times \cos 30°}{\sin(120°-30°)} = 519.6 \text{ lb.} \quad \text{(Ans)}$$

Problem 14 (Bow)

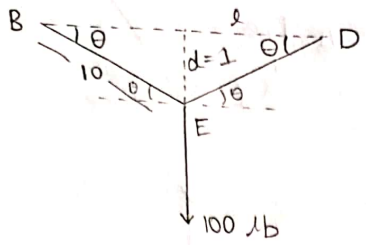
$\Sigma F_y = 0$

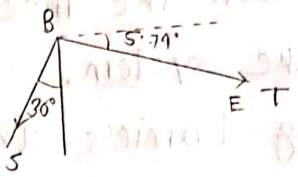
$\Rightarrow F\sin\theta + 5\sin 45 - 5\cos 30 = 0.$

$\Rightarrow F\sin\theta = .795 \quad \text{(i)}$



Problem 11 (Rope tension)





Consider the free body diagram of BED,

From, ΔBED, $\theta = \sin^{-1}\left(\frac{1}{10}\right) = 5{\cdot}74°$

$\Sigma F_y = 0$

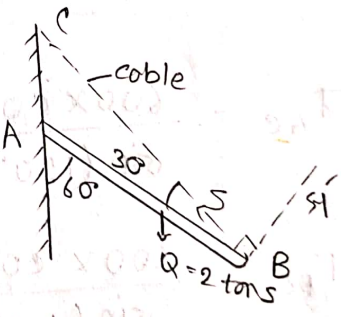
$\Rightarrow T\sin 5{\cdot}74° + T\sin 5{\cdot}74° - 100 = 0$

$\Rightarrow T = 500$ lb.

$\Sigma F_x = 0$ [as $\angle FBA \neq \angle ABQ$, $S \neq T$]

$\Rightarrow T\cos 5{\cdot}74° - S\sin 30° = 0 \Rightarrow S = 994{\cdot}99$ lb.

Problem 12 (fishing Pole)



$\Sigma M_A = 0.$

$\Rightarrow S_y' \times L - Q \times \frac{L}{2}\sin\theta = 0$

$\Rightarrow S_y' = 2 \cdot \frac{1}{2} \cdot \sin 60° = {\cdot}866$

$\Rightarrow S = \frac{{\cdot}866}{\sin 30°} = 1{\cdot}73$ lb.

Now,

$\Sigma F_x = 0 \Rightarrow A_x - S\sin 30° = 0 \Rightarrow A_x = {\cdot}867.$

$\Sigma F_y = 0 \Rightarrow A_y + S\cos 30° - 2 = 0 \Rightarrow A_y = {\cdot}5$

$\therefore$ Reaction force at A, $R_A = \sqrt{A_x^2 + A_y^2} = 1{\cdot}0008$ lb.

$\Sigma F_y = 0$

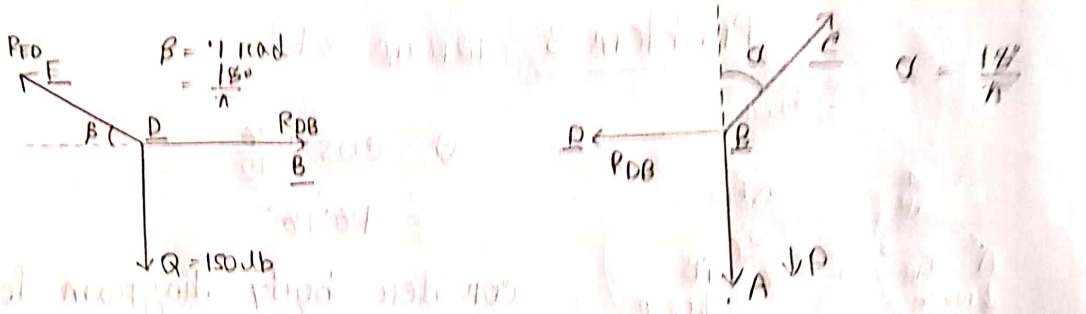
$\Rightarrow -100 - R_{AC} \sin 18°18' + R_D = 0.$

$\Rightarrow R_D = 100 + 134.18 \sin 18°18°$

$\therefore R_D = 200$ lb.

Since A and B identical $R_D = R_E = 200$ lb.

Problem 9 (Rope tension Force relation)



Consider the free body diagram of BDE,

$\Sigma F_y = 0$

$\Rightarrow R_{ED} \sin \frac{18}{\pi} - Q = 0 \Rightarrow R_{ED} = 1502.5$ lb.

$\Sigma F_x = 0.$

$\Rightarrow R_{DB} - R_{ED} \cos \frac{18}{\pi} = 0 \Rightarrow R_{DB} = 1495$ lb.

Consider the free body diagram of DBC,

$R_{BC} \sin \frac{18°}{\pi} - R_{DB} = 0.$ $[\Sigma F_x = 0]$

$\Rightarrow R_{BC} = 14974.95$ lb.

$\Sigma F_y = 0$

$\Rightarrow R_{BC} \cos \frac{18°}{\pi} - P = 0$

$\Rightarrow P = 14900$ lb. = Vertical pull at A.

(Ans)

$\Sigma F_x = 0.$

$\Rightarrow F\cos 45° + 5\sin 30° - F\cos\theta = 0.$

$\Rightarrow F\cos\theta = 6.04$ _____ (ii)

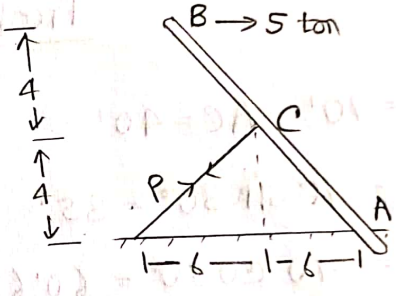
From (i) ÷ (ii), we get,

$\tan\theta = \frac{.795}{6.04} \Rightarrow \theta = 7.5°$ (with x-axis). (Ans).

From equation (i),

$F = 6.09$ lb. (Ans).

Problem 17 (Stable bar)



$\Sigma M_A = 0$

$\Rightarrow (5 \times 6) - T_{PC} \times \sqrt{6^2+4^2} = 0.$

$\Rightarrow T_{PC} = 5.54$ ton.

Now,

$\Sigma F_x = 0 \Rightarrow A_x - T_{PC}\cos 56.3 + 5 = 0$

$\Rightarrow A_x = -1.923$ ton.

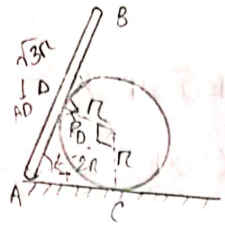
$\Sigma F_y = 0 \Rightarrow T_{PC}\sin 56.3 - A_y = 0 \Rightarrow A_y = 5.54\sin 56.3$

$= 4.61$ ton

Reaction at A, $R_A = \sqrt{(A_x)^2 + (A_y)^2} = \sqrt{(4.62)^2 + (1.92)^2}$

$= 5$ tons.

Problem 18 (S.C) - (S.B)



$\theta = \sin^{-1}\frac{r}{2r} = 30°$

$AD = \sqrt{(2r)^2 - r^2} = \sqrt{3}.r$

$\Sigma M_A = 0 \Rightarrow R_D \times \sqrt{3}r - 1.5r\cos 60° \times Q = 0$

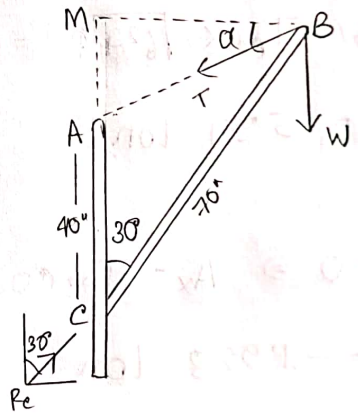
$\Rightarrow R_D = \frac{\sqrt{3}}{4}Q.$

$\Sigma F_x = 0.$

$T\sin 60° - R_D \cos 30° = 0.$

$\therefore T = R_D = .433\,Q.$ (Ans)

Problem 19 (crane)



$BC = 70', \; AC = 40'$

$BM = 70\sin 30° = 35'$

$CM = 70\cos 30° = 60.62'$

$AM = (60.62' - 40') = 20.62'$

$\therefore \tan\alpha = \frac{AM}{BM} = \frac{20.62}{35}$

$\alpha = 30.50°$

$\Sigma F_x = 0 \Rightarrow R_c \sin 30° - T\cos 30.50° = 0.$

$\Rightarrow R_c = 1.72\,T$

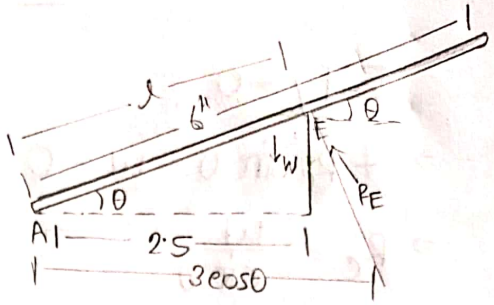
$\Sigma F_y = 0 \Rightarrow R_c\cos 30° - T\sin 30.50° = W$

$\Rightarrow 1.72\,T\cos 30° - T\sin 30.50° = 2.$

$\Rightarrow T = 2.03$ kg (Ans)

So, $R_c = 1.72 \times 2.03 = 3.5$ kg (Ans).

Problem 20



$\frac{2.5}{l} = \cos\theta \Rightarrow l = \frac{2.5}{\cos\theta}$.

$\Sigma F_y = 0$

$\Rightarrow R_E \cos\theta - W = 0$

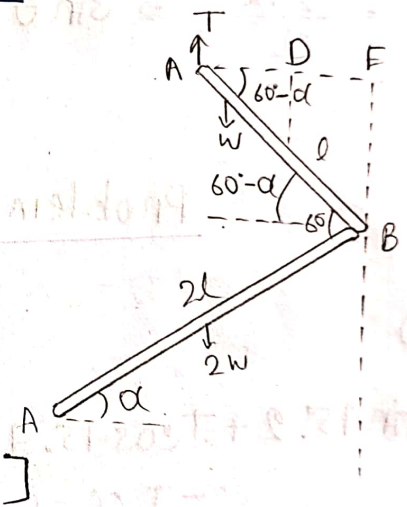
$\Rightarrow R_E = \frac{W}{\cos\theta}$

$\Sigma M_A \Rightarrow W.3\cos\theta - R_E.l = 0. \Rightarrow W.3\cos\theta - \frac{W}{\cos\theta}.\frac{2.5}{\cos\theta} = 0$

$\Rightarrow 3\cos^3\theta - 2.5 = 0 \Rightarrow \cos\theta = \sqrt[3]{\frac{2.5}{3}} \Rightarrow \theta = \cos^{-1}(941)$

$\Rightarrow \theta = 19.77°$ (Ans).

Problem 21 (Centroid)



$AE = l\cos(60-\alpha)$

$AD = \frac{l}{2}\cos(60-\alpha$

$\Sigma M_A = 0$

$\Rightarrow W \times AD - 2W[l\cos\alpha - AE] = 0$

$\Rightarrow \frac{l}{2}\cos(60-\alpha) - 2[l\cos\alpha - l\cos(60-\alpha)]$

$\Rightarrow \cos(60-\alpha) - 4\cos\alpha + 4\cos(60-\alpha) = 0.$

$\Rightarrow 5[\cos 60\cos\alpha + \sin 60.\sin\alpha] - 4\cos\alpha = 0.$

$\Rightarrow 5\left[\frac{1}{2}\cos\alpha + \frac{\sqrt{3}}{2}\sin\alpha\right] - 4\cos\alpha = 0.$

$\Rightarrow \frac{5\sqrt{3}}{2}\sin\alpha - (4 - \frac{5}{2})\cos\alpha = 0.$

$\Rightarrow \frac{5\sqrt{3}}{2}\sin\alpha = \frac{3}{2}\cos\alpha.$

$\Rightarrow \tan\alpha = \frac{\sqrt{3}}{5}$

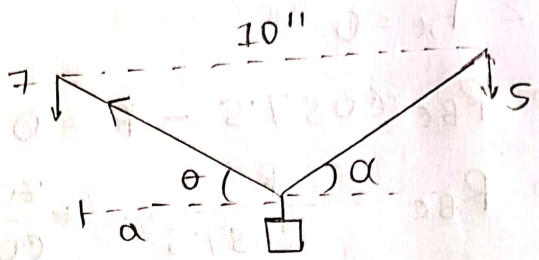
$\Rightarrow \alpha = 19.11°$ (Ans)

$\Sigma F_x = 0 \Rightarrow A_x = 0.$

So, Reaction at $A = \sqrt{A_x^2 + A_y^2} = \sqrt{0^2 + (\frac{P}{3})^2}$

$= \frac{P}{3}$. (Ans).

Problem 26



Consider the FBD.

$\Sigma F_x = 0$

$\Rightarrow 5\cos\alpha - 7\cos\theta = 0.$

$\Rightarrow 7\cos\theta = 5\cos\alpha$ —— (i).

$\Sigma F_y = 0$

$\Rightarrow 5\sin\alpha + 7\sin\theta - 10 = 0.$

$\Rightarrow 7\sin\theta = 10 - 5\sin\alpha$ —— (ii).

Squaring and adding eqn (i) and (ii),

$7^2(\sin^2\theta + \cos^2\theta) = 5^2\cos^2\alpha + (100 - 100\sin\alpha + 25\sin^2\alpha)$

$\Rightarrow 25\cos^2\alpha + 25\sin^2\alpha - 100\sin\alpha = 49 - 100$

$\Rightarrow 25 - 100\sin\alpha = -51$

$\Rightarrow \sin\alpha = .76 \Rightarrow \alpha = 49.46°$ (ans)

From eqn (i), $\cos\theta = 62.34°$.

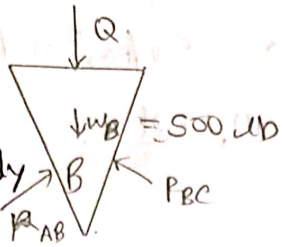
From ΔBCE, $\frac{h}{a} = \tan\theta \Rightarrow h = a\tan\theta = 1.91a$.

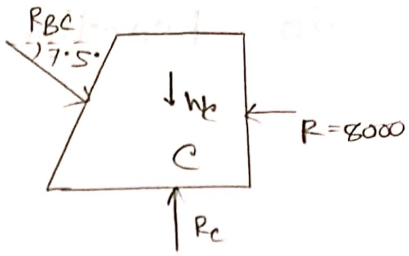
From ΔCDE, $\frac{h}{10-a} = \tan\alpha \Rightarrow h = (10-a)\tan\theta$

$= (10-a) \times 1.17.$

So, $1.91a = (10-a) \times 1.17.$

$\Rightarrow a = 3.8"$ (ans).





consider the free body diagram of body C,

$\Sigma F_x = 0$

$\Rightarrow R_{BC} \cos 7.5 - R = 0$

$\Rightarrow R_{BC} = \frac{R}{\cos 7.5} = \frac{8000}{\cos 7.5} = 8069.031$ lb.

consider the free body diagram of body B,

$\Sigma F_x = 0$

$\Rightarrow R_{AB} \cos 7.5 - R_{BC} \cos 7.5 = 0$

$\Rightarrow R_{AB} = R_{BC} = 8069$ lb.

$\Sigma F_y = 0.$

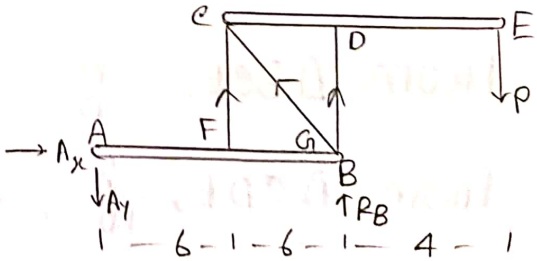
$\Rightarrow R_{AB} \sin 7.5 + R_{BC} \sin 7.5 - W_B - Q = 0.$

$\Rightarrow Q = 2R_{AB} \sin 7.5 - W_B$

$= 1606.43$ l. (Ans)

Problem 24

consider the free body diagram of the frame,



$\Sigma M_A = 0 \Rightarrow (P \times 16) - (R_B \times 12) = 0.$

$\Rightarrow R_B = \frac{4P}{3}.$

$\Sigma F_y = 0 \Rightarrow -P + R_B + A_y = 0 \Rightarrow A_y = P - R_B = P - \frac{4P}{3} = \frac{P}{3}$

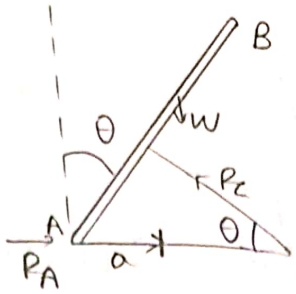
Problem 22

$\Sigma F_y = 0$

$\Rightarrow + R_c \sin\theta - W = 0$

$\Rightarrow R_c = \frac{W}{\sin\theta}$.

$AC = \frac{a}{\sin\theta}$



$\Sigma M_A = 0$.

$\Rightarrow W \times \frac{1}{2}\sin\theta - R_c \times AC = 0$.

$\Rightarrow \frac{WL}{2}\sin\theta = R_c \frac{a}{\sin\theta}$.

$\Rightarrow \frac{WL}{2a}\sin^2\theta = R_c = \frac{W}{\sin\theta}$

$\Rightarrow \frac{WL}{2a}\sin^3\theta = W$

$\Rightarrow \sin^3\theta = \frac{2a}{L} \Rightarrow \sin\theta = \sqrt[3]{\frac{2a}{L}} \Rightarrow \theta = \sin^{-1}\left(\sqrt[3]{\frac{2a}{L}}\right)$. (Ans)

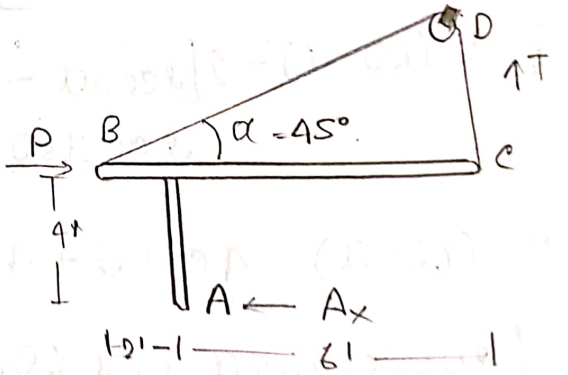
Problem 23

$\Sigma M_A = 0$

$\Rightarrow 4P + T\sin45°.2 + T\cos45°.4 - T.6 = 0$.

$\Rightarrow 1.757T = 4P = 4\times200$

$\Rightarrow T = 455.22$ lb (Ans).



A_x যত দিকে ধরলেও হবে যার সাধারণত ডান দিকে থাকে।

$\Sigma F_x = 0$

$P + T\cos45° - A_x = 0$.

$\Rightarrow A_x = 521.9$ lb

$\Sigma F_y = 0$.

$\Rightarrow P + T\sin45° - A_y = 0$

$\Rightarrow A_y = 777.11$ lb.

Using Lamies theorem, we get,

$$\frac{F}{\sin(90+56.81)} = \frac{R}{\sin(90^\circ+\theta)} = \frac{W}{\sin(180^\circ-\theta-\theta_2)}$$

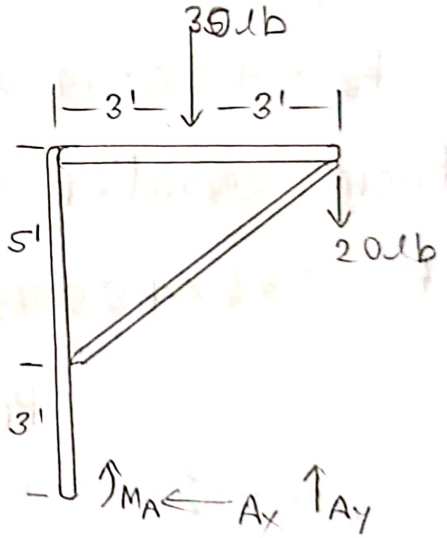
$$\Rightarrow \frac{F}{\cos(56.81^\circ)} = \frac{R}{\cos\theta} = \frac{W}{\sin(\theta+56.81)}$$

For the value of least force $F\sin(\theta+56.81^\circ)$ will be maximum, if, $\sin(\theta+56.81)=1$

$\theta = 33.19^\circ$ (Ans)

$$F = \frac{1000\times\cos 56.81^\circ}{\sin(33.19^\circ+56.81^\circ)} = 547.42 \text{ lb.} \quad \text{(Ans)}$$

Problem 33



$\Sigma F_x = 0$

$\Rightarrow A_x = 0$

$\Sigma F_y = 0 \Rightarrow A_y - 30 - 20 = 0.$

$\Rightarrow A_y = 50.$

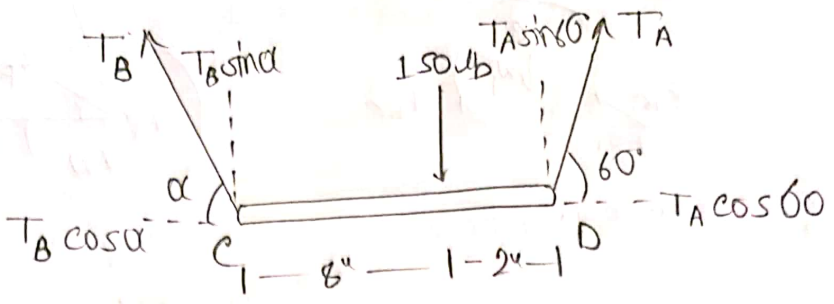
$\Sigma M_A = 0.$

$\Rightarrow -M_A + (30\times3) + (20\times6) = 0.$

$\Rightarrow M_A = 210 \text{ lb-ft}$ ↺ (Ans)

Reaction at A $= \sqrt{A_x^2 + A_y^2} = A_y = 50 \text{ lb}$ (Ans)

Problem 2



From the free body diagram,

$\Sigma M_e = 0 \Rightarrow F \times 8 - T_A \sin 60° \times 10 = 0.$

$\Rightarrow T_A = 138.56$ lb. So, $W_A = 138.56$ lb.

$\Sigma F_y = 0.$

$\Rightarrow T_B \sin\alpha + T_A \sin 60° - F = 0 \Rightarrow T_B \sin\alpha = 30°$ _____ (i)

$\Sigma F_x = 0$

$\Rightarrow T_A \cos 60° - T_B \cos\alpha = 0$

$\Rightarrow T_B \cos\alpha = 69.25$ _____ (ii).

Squaring and adding equation (i) and (ii),

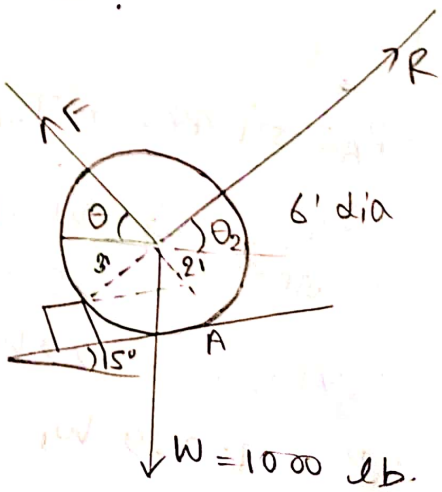
$T_B^2 = 30^2 + (69.25)^2 = 5039.72.$

$\Rightarrow T_B = 75.5$ lb. So, $W_B = 75.5$ lb.

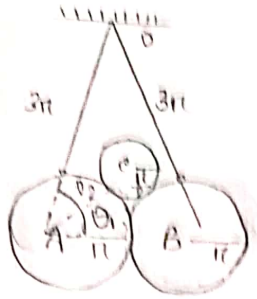
Problem 32

Consider the free body diagram of the wheel,

$\theta_1 = \sin^{-1}\frac{2}{3} = 41.81°$ $\quad \theta_2 = 41.81° + 15° = 56.81°$



Problem 2.6



For B and C

$\Sigma F_x = 0$

$\Rightarrow R_{AC}\cos 46.2 - R_{BC}\cos 46.2 = 0$

$\Rightarrow R_{AC} = R_{BC}$

$\theta_1 = \cos^{-1}(1/\text{[illegible]}) = 46.2$

$\theta_2 = \cos^{-1}(1/\text{[illegible]}) = 75.9$

$\Sigma F_y = 0$ $[R_{AB} = 0]$

$\Rightarrow R_{AC}\sin 46.2 + R_{BC}\sin 46.2 - W_1 = 0$

$\Rightarrow W_1 = 2R_{AC}\sin 46.2 \Rightarrow R_{AC} = \frac{W_1}{2\times\sin 46.2}$

For free body diagram of A

$\Sigma F_x = 0 \Rightarrow R_{AC}\cos 46.2 - T_{OA}\cos 75.9 = 0$

$\Rightarrow \frac{W_1 \times \cos 46.2}{2\times\sin 46.2} - T_{OA}\cos 75.9 = 0$

$\Rightarrow T_{OA} = \frac{W_1 \times \cos 46.2}{2\times\sin 46.2\times\cos 75.9}$

$\Sigma F_y = 0$

$\Rightarrow -R_{AC}\sin 46.2 + T_{OA}\sin 75.9 - W = 0$

$\Rightarrow -\frac{W_1}{2\times\sin 46.2} + \frac{W_1\times\cos 46.2\times\sin 75.9}{2\times\sin 46.2\times\cos 75.9} - W = 0$

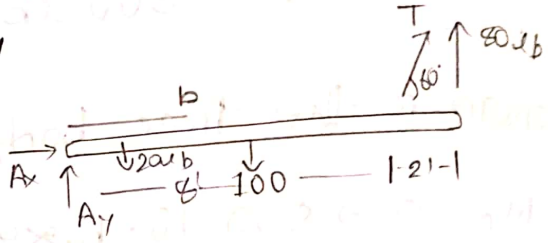
$\Rightarrow -.67W_1 + 1.929W_1 - W = 0$

$\therefore R_B = \sqrt{B_x^2 + B_y^2} = \sqrt{(625)^2 + (625)^2} = 883.88$ lb

$R_C = \sqrt{C_x^2 + C_y^2} = \sqrt{(625)^2 + (125)^2} = 637.38$ lb.

Problem 37

Consider the free body diagram of beam,



$\Sigma F_x = 0$

$\Rightarrow T\cos 60° - A_x = 0$

$\Rightarrow A_x = 40$ lb.

$\Sigma M_A = 0$

$\Rightarrow 20b \times \frac{b}{2} + 100 \times 5 - 80 \times 8 \sin 60° - 80 \times 10 = 0$

$\Rightarrow 10b^2 = 559.26$

$\Rightarrow b = 7.24$ ft. (Ans)

$\Sigma F_y = 0.$

$\Rightarrow A_y - 20b - 100 + 80 \sin 60° + 80 = 0.$

$\Rightarrow A_y = 135.57$ lb.

$\therefore$ Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2}$

$= \sqrt{(40)^2 + (135.57)^2}$

$= 141.35$ lb

(Ans).

Consider the free body diagram of the frame,

$\Sigma M_A = 0 \Rightarrow 500 \times 10 - D_x \times 14 = 0$

$\Rightarrow D_x = 357.14$ lb.

$\Sigma F_x = 0 \Rightarrow A_x - D_x = 0 \Rightarrow A_x = D_x = 357.14$ lb.

$\Sigma F_y = 0 \Rightarrow A_y = 500$ lb.

Consider the free body diagram of CF

$\Sigma M_C = 0 \Rightarrow 500 - 10 - E_y \times 6 = 0$

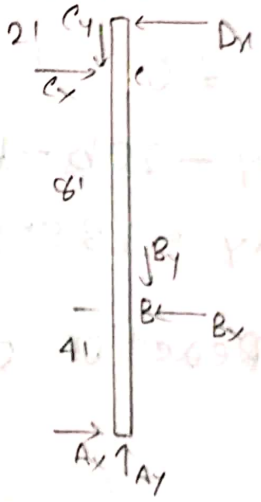
$\Rightarrow E_y = 625$ lb.

$\Sigma F_y = 0 \Rightarrow C_y + E_y - 500 = 0.$

$\Rightarrow C_y = 500 - 625 = -125$ lb. $\therefore C_y = 125$ lb (↓).

$\Sigma F_x = 0$

$\Rightarrow C_x - E_x = 0 \Rightarrow C_x = E_x$



Consider the free body diagram of AD,

$\Sigma M_B = 0$

$\Rightarrow -A_x \times 4 + C_x \times 6 - D_x \times 10 = 0$

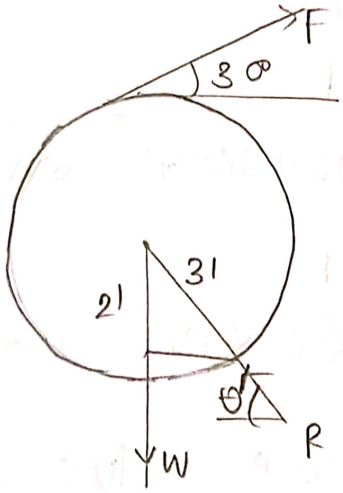
$\Rightarrow -357.14 \times 4 + C_y \times 6 - 357.14 \times 10 = 0$

$\Rightarrow C_x = 625$ lb.

$\Sigma F_x = 0 \Rightarrow A_x + C_x - B_x - D_x = 0 \Rightarrow B_x = 625$ lb

$\Sigma F_y = 0 \Rightarrow A_y - B_y + C_y = 0 \Rightarrow 500 - B_y + 125 = 0 \Rightarrow B_y = 625$ lb

Problem 34



Consider the free body digram of the wheel,

$\Sigma F_x = 0$

$\Rightarrow F\cos 30° - R_B \cos 41.81° = 0.$

$\Rightarrow F = .86\, R_B$ ——— (i)

$\theta = \sin^{-1}\frac{2}{3}$

$= 41.81°$

since the wheel is moving, $R_C = 0$ (Ans)

$\Sigma F_Y = 0.$

$\Rightarrow F\sin 30° + R_B \sin 41.81° - W = 0.$

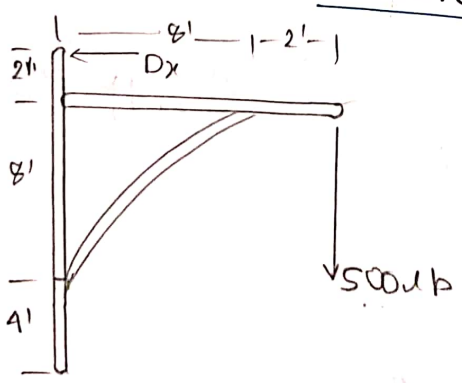
$\Rightarrow .86 R_B \times \sin 30° + R_B \sin 41.81 = 500$

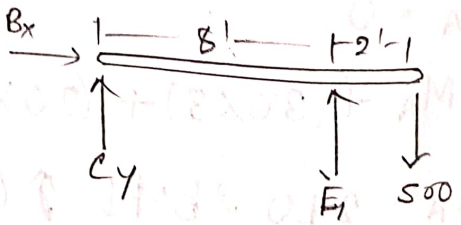
$\Rightarrow R_B = 455.79$ lb (Ans).

From equation (i)

$F = .86 \times 455.79 = 391.98$ lb (Ans).

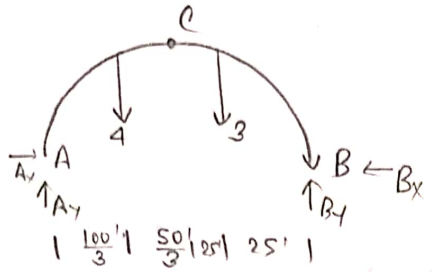
Problem 36

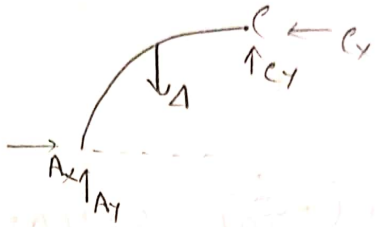




Problem 50

Arch : It is a vertical curved structure than spans an elevated space.





Consider the free body diagram of structure.

$\Sigma M_A = 0 \Rightarrow 4 \times \frac{100}{3} + 3 \times 75 - B_y \times 100 = 0.$

$\Rightarrow B_y = 3.58$ tons.

$\Sigma F_x = 0 \Rightarrow A_x - B_x = 0 \Rightarrow A_x = B_x$ _____ (i).

$\Sigma F_y = 0 \Rightarrow A_y + B_y - 3 - 4 \Rightarrow A_y = 3.42$ tons.

Reaction at A $= \sqrt{A_x^2 + A_y^2} = 4.01$ tons (ans).

consider the free body of AC,

$\Sigma M_C = 0$

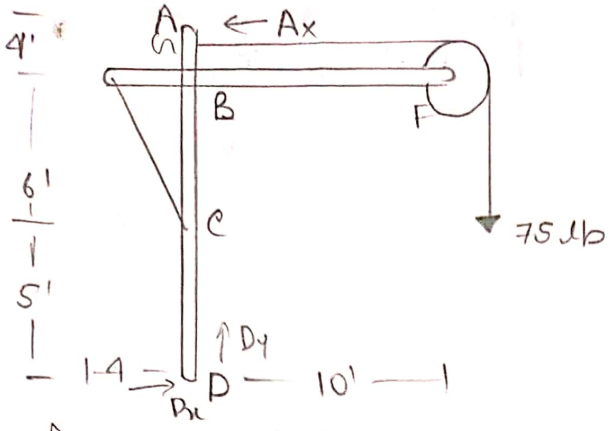
$\Rightarrow A_y \times 50 - A_x \times 50 - 4 \times \frac{50}{3} = 0$

$\Rightarrow A_x = 2.067$ tons.

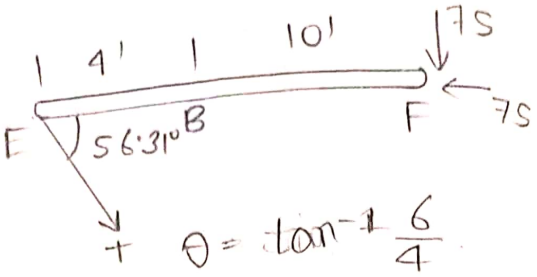
From equation (i), $A_x = B_x = 2.067$ tons.

Reaction at B $= \sqrt{B_x^2 + B_y^2} = 4.14$ tons (Ans)

Problem 46



free body of frame



free body of EF

Consider the free body diagram of the frame,

$\Sigma M_B = 0$

$\Rightarrow 75 \times 12 - A_x \times 15 = 0 \Rightarrow A_x = 60$ lb.

$\Sigma F_x = 0 \Rightarrow D_x - A_x = 0 \Rightarrow D_x = A_x = 60$ lb.

$\Sigma F_y = 0 \Rightarrow D_y - 75 = 0 \Rightarrow D_y = 75$ lb.

Consider the free body diagram of EF,

$\Sigma M_B = 0.$

$\Rightarrow 75 \times 10 - T \sin 56.31° \times 4 = 0.$

$\Rightarrow T = 225.35$ lb.

$\Sigma F_x = 0.$

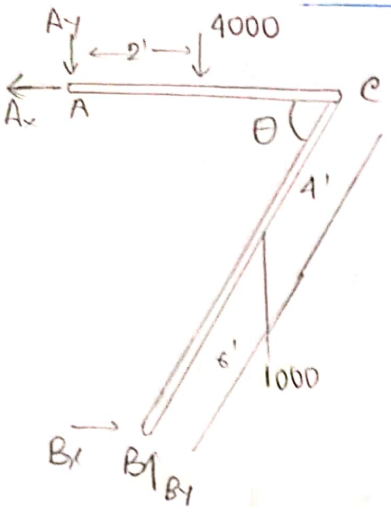
$\Rightarrow B_x + T \cos 56.31° - 75 = 0 \Rightarrow B_x = 50$ lb

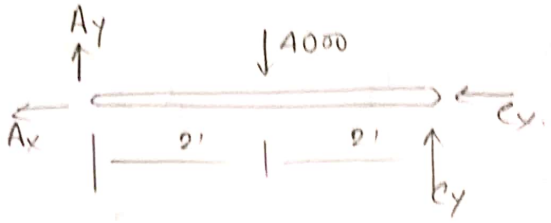
$\Sigma F_y = 0$

$\Rightarrow B_y - T \sin 56.31° - 75 = 0 \Rightarrow B_y = 262.5$ lb.

Ans

Problem 42





Consider the free body diagram of the frame.

$\Sigma M_B = 0$

$\Rightarrow 1000 \times 6 \cos 66.42° + 4 \times 2 \times 1000 - A_x \times 10 \sin 66.42° = 0$

$\Rightarrow A_x = 1134.77$ lb

$\Sigma F_x = 0 \Rightarrow A_x = B_x = 1134.77$ lb.

$\Sigma F_y = 0 \Rightarrow A_y + B_y - 4000 - 1000 = 0 \Rightarrow A_y + B_y = 5000$ ____(i)

Consider the free body diagram of frame member AC.

$\Sigma M_C = 0.$

$\Rightarrow A_y \times 4 - 4000 \times 2 \Rightarrow A_y = 2000$ lb

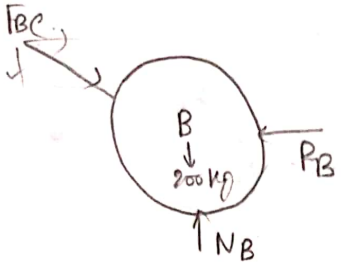
From (i), $B_y = 3000$ (Ans).

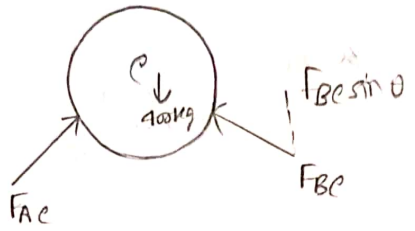
$\Sigma F_y = 0 \Rightarrow A_y + C_y - 4000 = 0 \Rightarrow C_y = 2000$ lb.

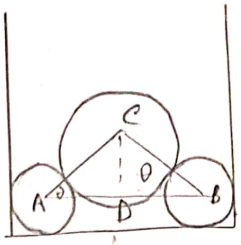
$\Sigma F_x = 0 \Rightarrow -A_x - C_x = 0 \Rightarrow C_x = -1134.77$

$\therefore C_x = 1134.77 (\rightarrow)$ (Ans).

Problem 68







From ΔABC, $\cos\theta = \frac{AD}{AC} \Rightarrow \theta = \cos^{-1}\frac{.35}{.45} = 38.94°$

consider the free body diagram of C,

$\Sigma F_x = 0 \Rightarrow F_{AC}\cos 38.94° - F_{BC}\cos 38.94° = 0.$

$\Rightarrow F_{AC} = F_{BC}$ _____(i)

$\Sigma F_y = 0 \Rightarrow F_{AC}\sin 38.94° + F_{BC}\sin 38.94° - 400 = 0.$

$\Rightarrow 2F_{AC}\sin 38.94° = 400 \Rightarrow F_{AC} = 318.21$ kg

$\therefore F_{AC} = F_{BC} = 318.21$ kg

consider the free body diagram of B,

$\Sigma F_x = 0 \Rightarrow F_{BC}\cos 38.94° - R_B = 0 \Rightarrow R_B = 247.51$ kg

$\Sigma F_y = 0 \Rightarrow N_B - 200 - F_{BC}\sin 38.94° = 0.$

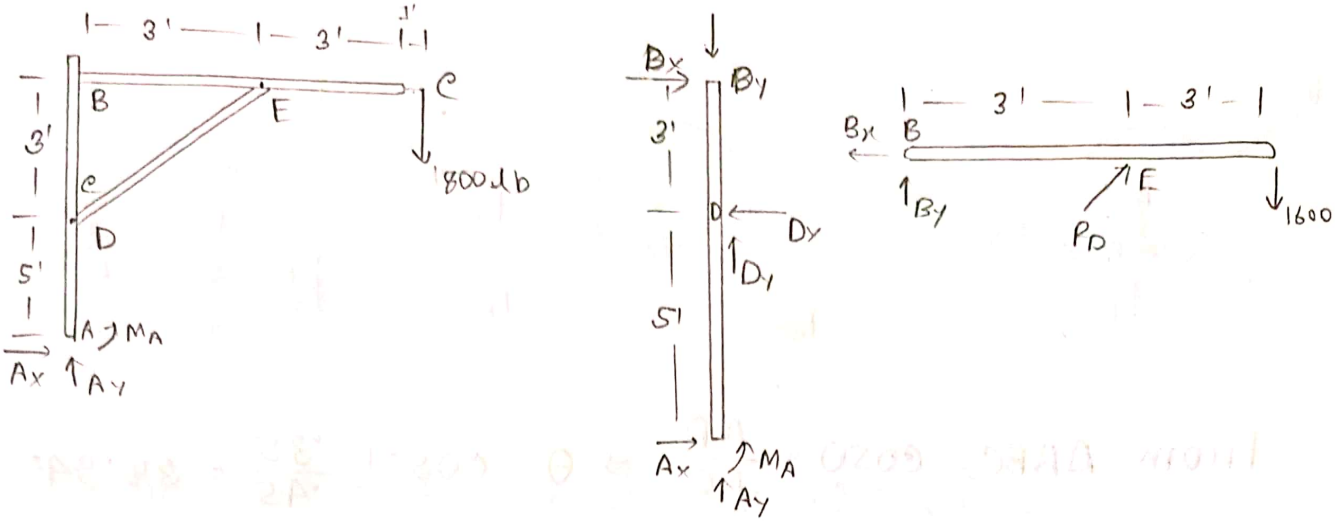
$\Rightarrow N_B = 400$ kg

since the cylinder A and B are identical,

$R_A = R_B = 247.51$ kg

$N_A = N_B = 400$ kg (Ans)

Problem 54



Consider the free body diagram of the frame.

$\Sigma F_x = 0 \Rightarrow A_x = 0$

$\Sigma F_y = 0 \Rightarrow A_y = 1600$ lb.

$\Sigma M_A = 0 \Rightarrow -M_A + 1600 \times 7 = 0 \Rightarrow M_A = 11200$ lb·ft.

Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2} = 1600$ lb.

Consider the free body diagram of AB.

$\Sigma M_B = 0 \Rightarrow A_x \times 8 - D_x \times 3 + M_A = 0.$

$\Rightarrow D_x = \frac{M_A}{3} = 3200$ lb./3733 lb.

$\Sigma F_y = 0 \Rightarrow A_y + D_y - B_y = 0.$

$\Rightarrow B_y - D_y = 1600$ lb. ——— (i)

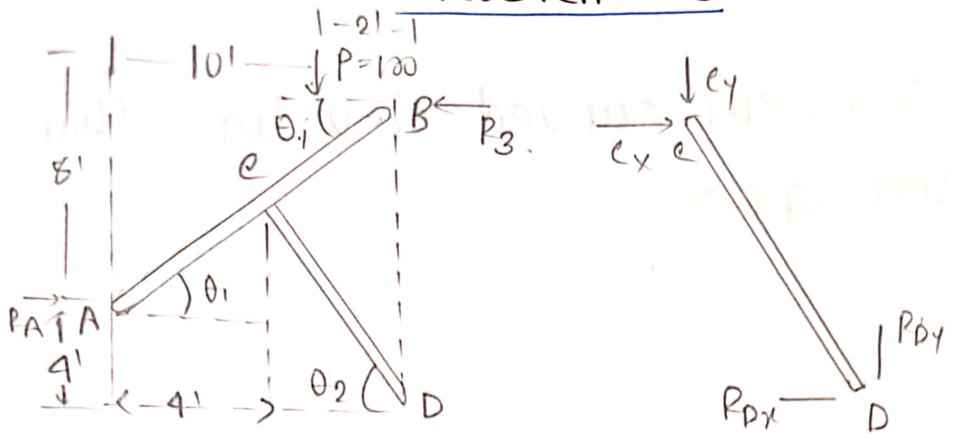
Consider the free body diagram BC,

$\Sigma M_E = 0. \Rightarrow 1600 \times 3 + B_y \times 3 = 0.$

$\Rightarrow B_y = -1600$

From eq (1). $D_y = 3200 \downarrow$ (Ans).

Problem 03



$\theta_1 = \tan^{-1}\left(\frac{6}{12}\right) = 33.69°$

$\theta_2 = \tan^{-1}\left(\frac{6.67}{8}\right) = 39.82°$

$CE = 4 \times \tan 33.69$
$= 2.67$

Consider the free body diagram of the frame

$\Sigma M_C = 0$ [Pin at C]

$\Rightarrow$ ~~$R_A \times$~~ $100 \times 6 - R_A \times 2.67 - R_B \times 5.33 = 0.$

$\Rightarrow 2.67 R_A - 1.533 R_B = 600$ ——— (i)

$\Sigma M_D = 0.$ [Base]

$\Rightarrow R_A \times 4 - 100 \times 2 - R_B \times 12 = 0.$

$\Rightarrow 4R_A - 12R_B = 200 \Rightarrow R_A - 3R_B = 50$ ——— (ii)

From equation (i) and (ii),

$R_A = 154.9$ lb and $R_B = 34.97$ lb. (Ans)

$\Sigma F_y = 0 \Rightarrow R_{DY} - 100 = 0 \Rightarrow R_{DY} = 100$ lb.

$\Sigma F_x = 0 \Rightarrow P_A - P_B - R_{DX} = 0 \Rightarrow R_{DX} = 119.93$ lb.

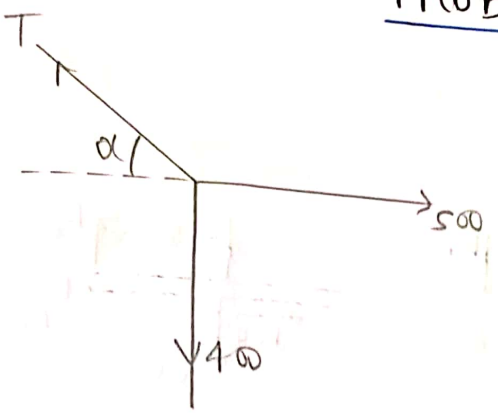
Consider the free body diagram of C.D.

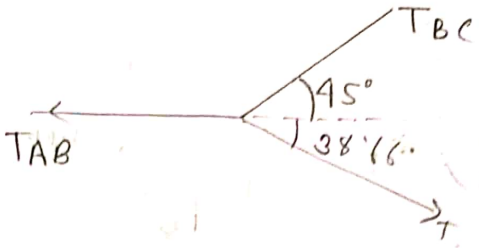
$\Sigma F_x = 0 \Rightarrow C_x - R_{DX} = 0 \Rightarrow C_x = R_{DX} = 119.93$ lb.

$\Sigma F_y = 0 \Rightarrow R_{DY} - C_y = 0 \Rightarrow C_y = R_{DY} = 100$ lb.

(Ans)

Problem 69





consider the free body diagram of BDE,

$\Sigma F_x = 0$

$\Rightarrow 500 - T\cos\alpha = 0.$

$\Rightarrow T\cos\alpha = 500$ _____(i)

$\Sigma F_y = 0. \Rightarrow T\sin\alpha - 400 = 0.$

$\Rightarrow T\sin\alpha = 400$ _____(ii).

$(i)^2 + (ii)^2 \Rightarrow T^2(\cos^2\alpha + \sin^2\alpha) = 500^2 + 400^2.$

$\Rightarrow T = 640.31$ lb.

dividing equation (ii) by (i),

$\tan\alpha = \frac{400}{500} \Rightarrow \alpha = 38.66°.$

From equation (i), $T = \frac{500}{\cos 38.66°} = 640.31$ kg

Consider the free body diagram of DBC,

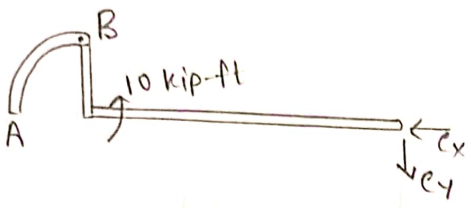
$\Sigma F_y = 0.$

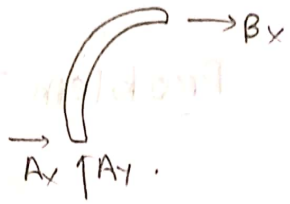
$\Rightarrow T_{BC}\sin 45° - T\sin 38.66° = 0.$

$\Rightarrow T_{BC} = \frac{640.31\sin 38.66°}{\sin 45°} = 565.69$ lb (Ans)

Problem 73

kip is a US customary unit of force. It equals 1000 pounds-force. It symbols kip, or less frequently klb.





Consider the free body diagram of the frame.

$\Sigma M_A = 0 \Rightarrow -C_y \times 6 - 10 = 0 \Rightarrow C_y = -1.67$ kip.

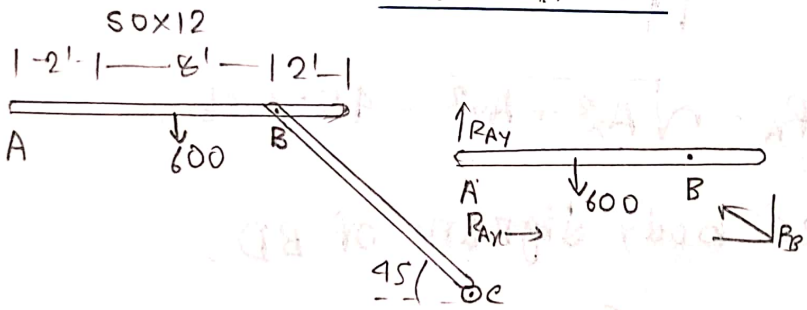
$\Sigma F_x = 0 \Rightarrow A_x - C_x = 0 \Rightarrow A_x = C_x$.

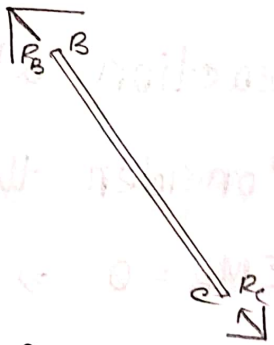
$\Sigma F_y = 0 \Rightarrow A_y + C_y = 0 \Rightarrow A_y = -C_y = 1.67$ kip.

Consider the free body diagram of the frame,

$\Sigma M_B = 0 \Rightarrow A_y \times 2 - A_x \times 2 \Rightarrow A_x = 1.67$ kip.

Problem 74





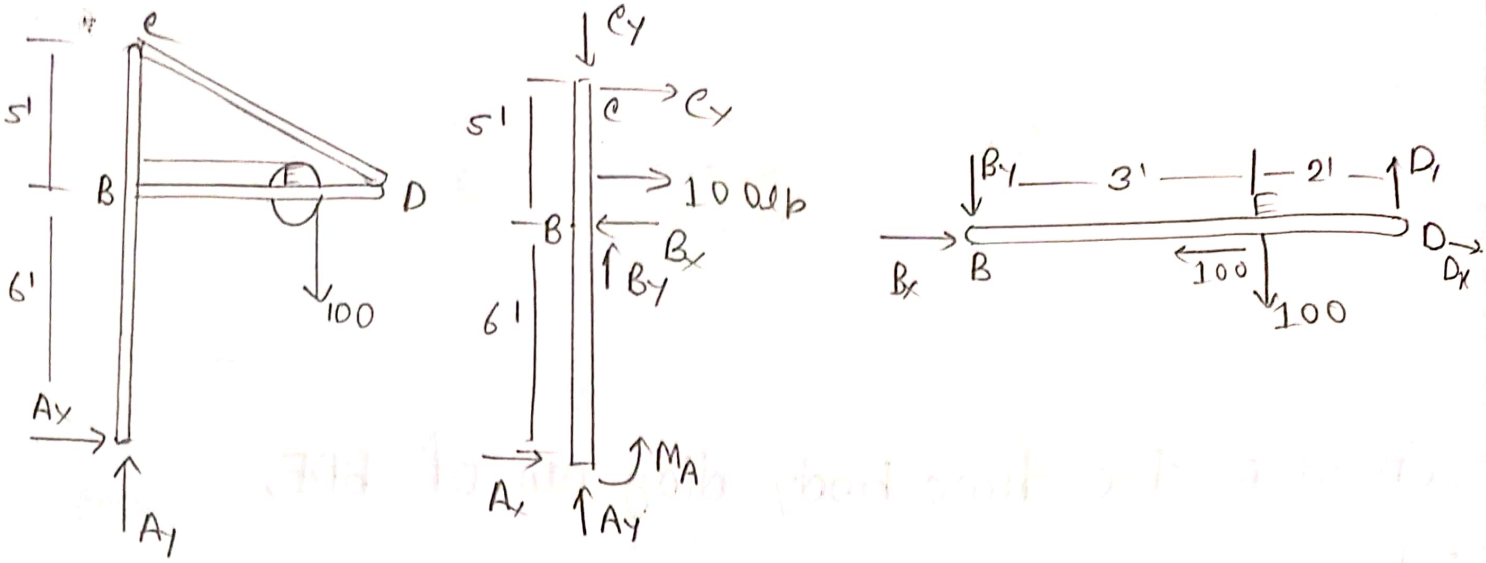
Consider the free body diagram of AB.

$\Sigma M_A = 0 \Rightarrow 600 \times 4 - R_B \sin 45° \times 8 = 0$.

$\Rightarrow R_B = 424.26$ lb.

$\Sigma F_x = 0 \Rightarrow R_{AX} - R_B \cos 45° \Rightarrow R_{AX} = 300$

$\Sigma F_y = 0 \Rightarrow R_{AY} + R_B \sin 45° - 600 = 0 \Rightarrow R_{AY} = 300$ lb.



Consider the free body diagram of the frame,

$\Sigma F_x = 0 \Rightarrow A_x = 0$

$\Sigma F_y = 0 \Rightarrow A_y - 100 = 0$

$\Sigma M_A = 0 \Rightarrow -M_A + 100 \times 4 = 0 \Rightarrow M_A = 400$ lb.

Consider the free body diagram of AC,

$\Sigma M_B = 0 \Rightarrow C_x \times 5 - A_x \times 6 - M_A + 100 \times 1 = 0.$

$\Rightarrow C_x = 60$ lb (Ans)

$\Sigma F_x = 0 \Rightarrow C_x - B_x + A_x = 0 \Rightarrow C_x = B_x = 60$ lb.

$\Sigma F_y = 0 \Rightarrow A_y + B_y - C_y = 0 \Rightarrow C_y = A_y + B_y = 100 + B_y$ —(i)

Consider the free body diagram of BD.

$\Sigma M_D = 0. \Rightarrow -B_y \times 5 - 2 \times 100 = 0.$

$\Rightarrow B_y = -40 \therefore B_y = 40 \uparrow$ (Ans)

From (i) $\Rightarrow C_y = 100 - 40 = 60$ lb (Ans)

Consider the free body diagram of cylinder

$\Sigma F_x = 0 \Rightarrow R_2 \cos 30^\circ - R_1 \cos 30^\circ = 0$

$\Rightarrow R_1 = R_2$

$\Sigma F_y = 0 \Rightarrow R_2 \sin 30^\circ + R_1 \sin 30^\circ - 100 = 0.$

$\Rightarrow 2R_1 \sin 30^\circ = 100$

$\Rightarrow R_1 = 100 \text{ lb.} = R_2.$

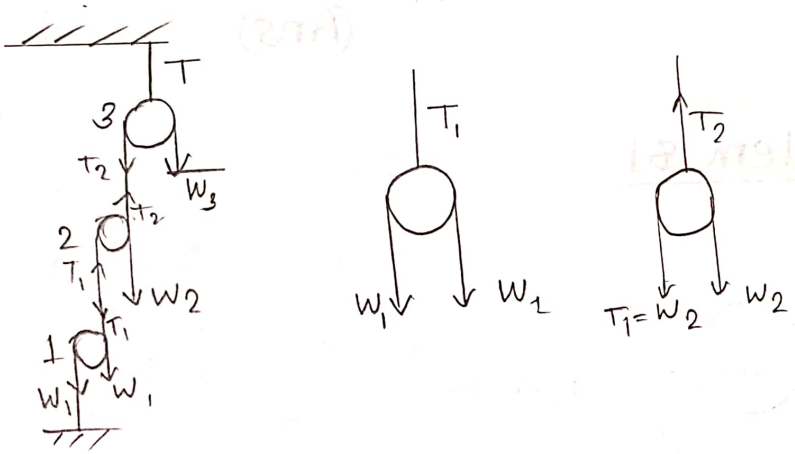
Consider the free body diagram of BD,

$\Sigma M_C = 0$

$\Rightarrow T \sin 60^\circ \times 6 - R_2 \times 3.5 - R_B \sin 30^\circ \times 4 = 0.$

$\Rightarrow T = 86.6 \text{ lb.}$

Problem 88



Free body for 1,

$\Sigma F_y = 0.$

$\Rightarrow T_1 - W_1 - W_1 = 0$

$\Rightarrow T_1 = 2W_1 = 20 \text{ lb} = W_2$

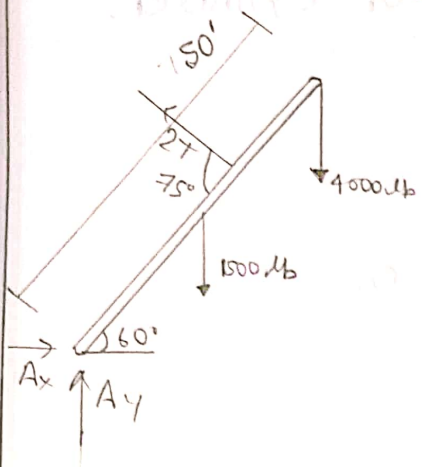
Free body for 2,

$\Sigma F_y = 0$

$\Rightarrow W_2 + W_2 - T_2 = 0 \quad [T_1 = W_2].$

$\Rightarrow 2W_2 = T_2 = 2 \times 20 = 40 \text{ lb}$

Problem 77



Consider the free body diagram of boom,

$\Sigma M_A = 0$

$\Rightarrow 1500 \times 25\cos 60° + 4000 \times 50\cos 60° - 2T\cos 75 \times 35 = 0.$

$\Rightarrow T =$

(Ans).

$\Sigma F_x = 0 \Rightarrow A_x - 2T\cos 15° = 0.$

$\Rightarrow A_x$

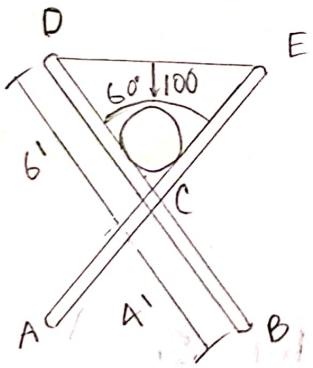
$\Sigma F_y = 0 \Rightarrow A_y - 1500 - 4000 + 2T\sin 15° = 0.$

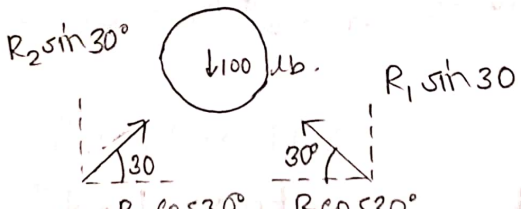
$\Rightarrow A_y.$

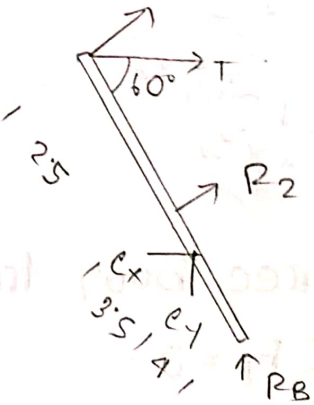
Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2} =$

(Ans).

Problem 81







Consider the free body diagram of the frame,

$\Sigma M_A = 0 \Rightarrow 100 \times 4\cos 60° - R_B \times 2 \times 4\cos 60° = 0$

$\Rightarrow R_B = 50$ lb.

$\Sigma F_y = 0 \Rightarrow R_A + R_B - 100 = 0 \Rightarrow R_A = 50$ lb.

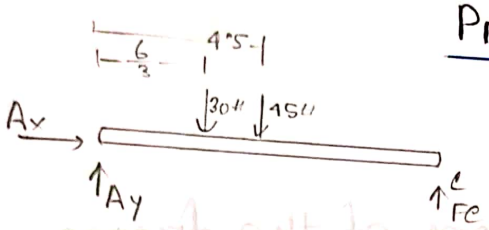
$\therefore R_{AB} = \sqrt{300^2 + 300^2} = 424.26$ lb.

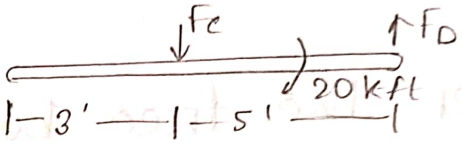
Consider the free body diagram of BC

$\Sigma F_x = 0 \Rightarrow R_B \cos 45° - R_C \cos 45° = 0$

$\Rightarrow R_B = R_C = 424.26$ lb (Ans).

Problem 75



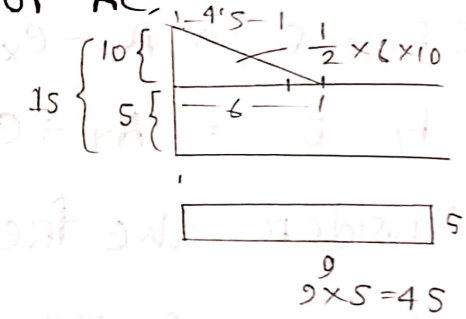


Consider the free body diagram of AC,

$\Sigma M_A = 0.$

$\Rightarrow \frac{6}{3} \times (\frac{1}{2} \times 10 \times 6) + 45 \times 4.5 - F_C \times 9 = 0.$

$\Rightarrow F_C = 29.16$ lb. (Ans).



$\Sigma F_y = 0$

$\Rightarrow A_y - 30 - 45 + F_C = 0$

$\Rightarrow A_y = 45.8$ lb

$\Sigma F_x = 0$

$A_x = 0.$

Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2} = 45.8$ lb.

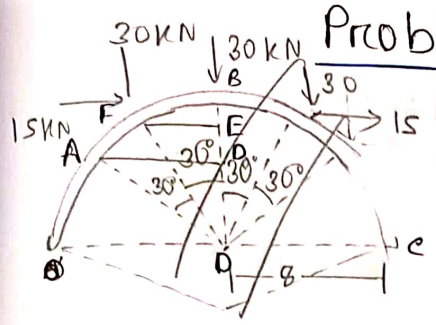
Consider the free body digram of BD,

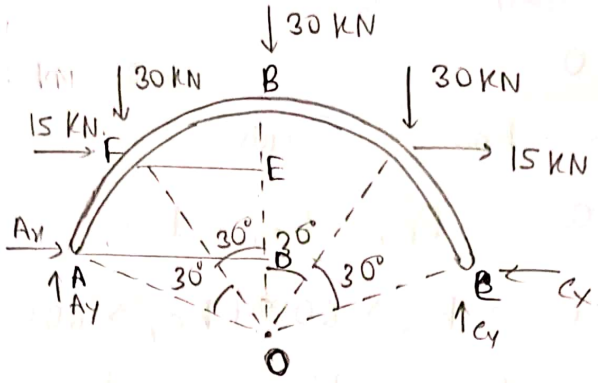
$\Sigma M_B = 0 \Rightarrow F_C \times 3 + 20 - F_D \times 8 = 0$

$\Rightarrow F_D = 13.44$ lb.

(Ans)

Problem 114





From figure,

$AD = 8 \sin 60°$

$= 6.93$

$OD = 8\cos 60°$ $\quad OE = 8\cos 30°$ $\quad EF = 8\sin 30°$

$= 4$ $\quad = 6.93\ m$ $\quad = 4$

$BE = (8 - 6.93)$ $\quad DE = 6.93 - 4$

$= 1.07$ $\quad = 2.93.$

Free body of frame,

$\Sigma M_A = 0.$

$\Rightarrow 15 \times 2.93 + 30 \times (6.93 - 4) + 30 \times 6.93 + 30 \times (6.93 + 4) + 15 \times 2.93 - C_y \times 2 \times 6.93 = 0.$

$\Rightarrow 13.86\ C_y = 711.6$

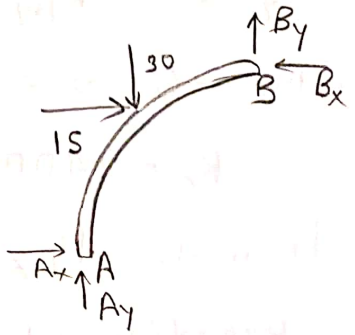
$\Rightarrow C_y = 51.34\ kN.$

$\Sigma F_y = 0. \Rightarrow A_y + C_y - 30 - 30 - 30 = 0.$

$\Rightarrow A_y = 38.66\ kN.$

$\Sigma F_x = 0. \Rightarrow A_x + 15 + 15 - C_x = 0 \Rightarrow A_x - C_x + 30 = 0. \quad \text{---(i)}$

free body of AB



$\Sigma M_B = 0.$

$\Rightarrow A_y \times 6.93 - A_x \times 4 - 15 \times 1.07 - 30 \times 4 = 0.$

$\Rightarrow A_x = 32.97\ kN.$

From (i), $C_x = 2.97\ kN.$

$A_x = 211.11$ lb.

$\Sigma F_x = 0 \Rightarrow C_x - A_x = 0 \Rightarrow C_x = A_x = 211.11$ lb.

$\Sigma F_y = 0 \Rightarrow C_y - A_y - 400 = 0 \Rightarrow C_y - A_y = 400$ —— (i).

$\Sigma M_B = 0.$

$\Rightarrow A_x \times 6 - A_y \times 18 = 0 \Rightarrow A_y = 70.37.$

From equation (i),

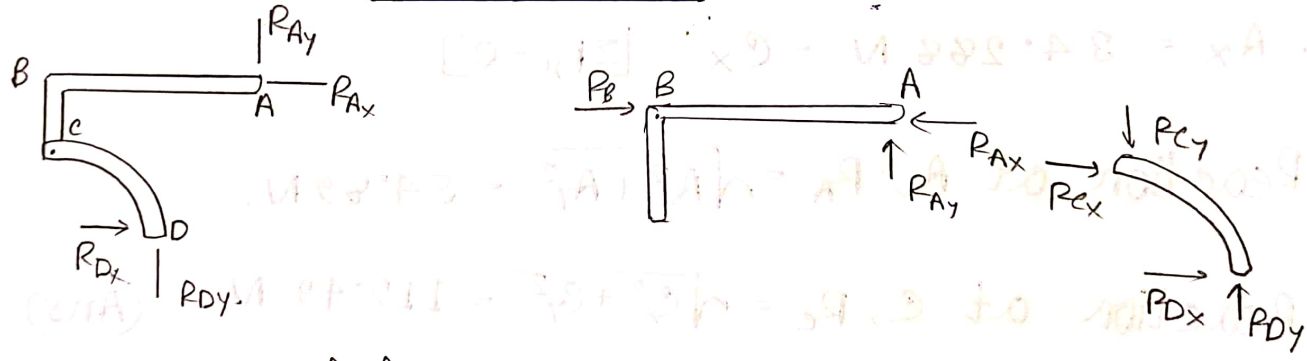
$C_y = 400 + 70.37 = 470.37$ lb.

Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2} = 222.53$ lb.

Reaction at C, $R_C = \sqrt{C_x^2 + C_y^2} = 515.573$ lb.

(Ans).

Problem 109.



Free body of frame,

$\Sigma F_x = 0 \Rightarrow R_{Ax} - R_{Dx} = 0 \Rightarrow R_{Ax} = R_{Dx}$ —— (i)

$\Sigma F_y = 0 \Rightarrow R_{Dy} + A_{Ay} - 300 \Rightarrow R_{Ay} = R_{Dy} + 300$ —— (ii)

Free body of AB,

$\Sigma M_B = 0 \Rightarrow 300 \times 600 - R_{Ay} \times 1200 = 0.$

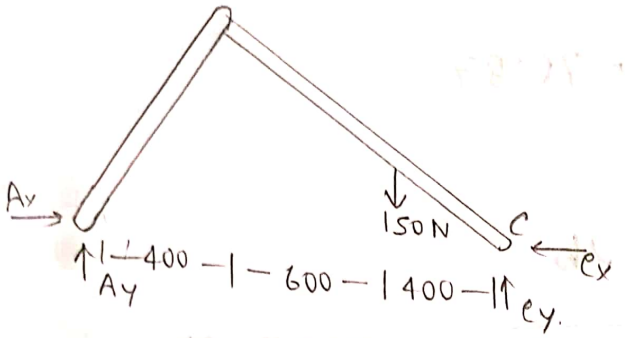
$\therefore R_{Ay} = 150N = R_{Dy}$

Free body for 3

$T_2 = W_3 = 40$ lb.

$\Sigma F_y = 0 \Rightarrow T - W_3 - T_2 = 0 \Rightarrow T = T_2 + W_3 = 40 + 40 = 80$ lb

Problem 107



$\Sigma M_B = 0 \Rightarrow A_y \times 400 - A_x \cdot 500 = 0 \Rightarrow A_x = 0.8\, A_y.$

$\Sigma M_A = 0 \Rightarrow 150 \times 1000 - C_y \times 1400 = 0 \Rightarrow C_y = 107.14\,N.$

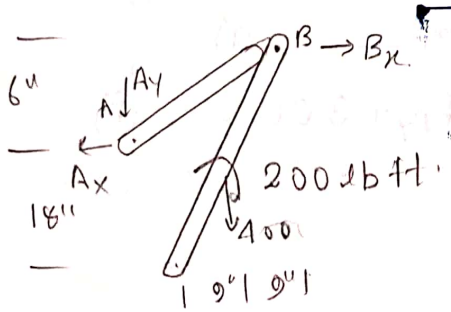
$\Sigma F_y = 0 \Rightarrow A_y + C_y - 150 = 0 \Rightarrow A_y = 42.86\,N.$

$\therefore A_x = 34.288\,N = C_x \quad [\Sigma F_x = 0].$

Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2} = 54.89\,N.$

Reaction at C, $R_C = \sqrt{C_x^2 + C_y^2} = 112.49\,N.$ (Ans).

Problem 108



Consider FBD of frame

$\Sigma M_C = 0 \Rightarrow 4000 \times 9 - A_x \cdot 18 + 200 = 0$

$\Sigma F_x = 0 \Rightarrow A_x + 15 - B_x = 0. \Rightarrow B_x = 47.97\ KN.$

$\Sigma F_y = 0 \Rightarrow A_y - 30 - B_y = 0 \Rightarrow B_y = 5.66\ KN.$

Reaction at A, $R_A = \sqrt{A_x^2 + A_y^2} = 50.81\ KN$

" " B, $R_B = \sqrt{B_x^2 + B_y^2} = 48.75\ KN.$

" " C, $R_C = \sqrt{C_x^2 + C_y^2} = 37.43\ KN.$

for 131, 119

Free body of CD,

$\Sigma F_x = 0$.

$\Rightarrow R_{ex} = -R_{Dx}$ _____(iii).

$\Sigma F_y = 0. \Rightarrow R_{Dy} = R_{ey} = 150.$

$\Sigma M_D = 0 \Rightarrow R_{ex} \times 600 + R_{ey} \times 600 = 0.$

$\Rightarrow R_{ex} = -R_{ey} = -150.$

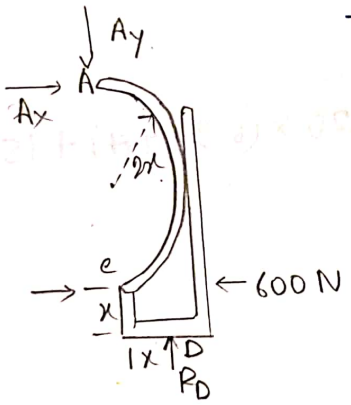
$\therefore$ Reaction at A, $R_A = \sqrt{R_{Ax}^2 + R_{Ay}^2} = \sqrt{150^2 + (-150)^2}$

$= 212.13$ N.

" " C, $R_c = \sqrt{R_{ex}^2 + R_{ey}^2} = 212.13$ N.

(Ans)

Problem 112.



Free body of frame,

$\Sigma F_x = 0 \Rightarrow R_{Ax} - R_e = 0 \Rightarrow R_{Ax} = R_e$ _____(i)

$\Sigma F_y = 0 \Rightarrow -R_{Ay} + 600 = 0 \Rightarrow R_{Ay} = 600$

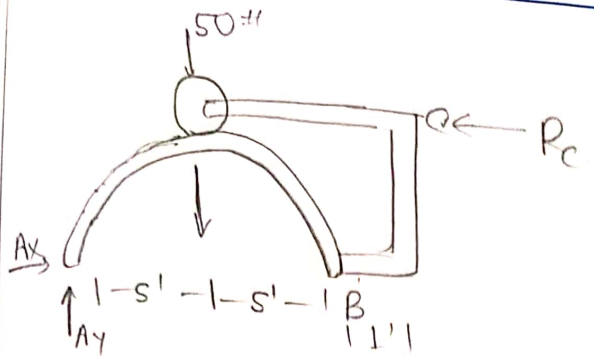
$\Sigma M_e = 0 \Rightarrow -R_{Ay} \cdot 4x + R_e \cdot x = 0. \Rightarrow -600 \cdot 4x + R_e \cdot x$

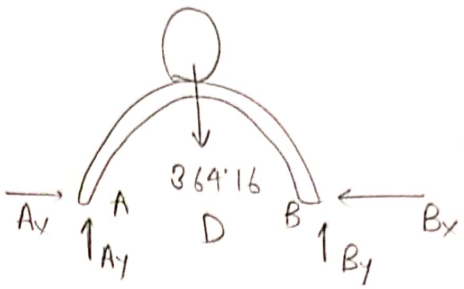
$\therefore R_e = 2400$ N.

From (i) $R_{Ax} = 2400$ N.

$\therefore$ Reaction at A, $R_A = \sqrt{600^2 + 2400^2} = 2473.8$ N.

Problem 148





free body of frame.

weight of arc AB $= \frac{1}{2} \times 2\pi r \times 20 = 314.16$ lb.

$\Sigma M_A = 0 \Rightarrow (314.16 + 50) \times 5 - R_c \times 6 = 0.$

$\Rightarrow R_c = 303.5$ lb.

$\Sigma F_y = 0 \Rightarrow A_y - 50 - 314.16 = 0.$

$\Rightarrow A_y = 364.16$ lb.

$\Sigma F_x = 0 \Rightarrow A_x - R_c = 0 \Rightarrow A_x = R_c = 303.5$ lb.

free body of AB,

$\Sigma M_A = 0 \Rightarrow 364.16 \times 5 - B_y \times 10 = 0.$

$\Rightarrow B_y = 122.08$ lb

$\Sigma F_x = 0 \Rightarrow A_x - B_x = 0. \Rightarrow A_x = B_x = 303.5$ lb. (Ans)

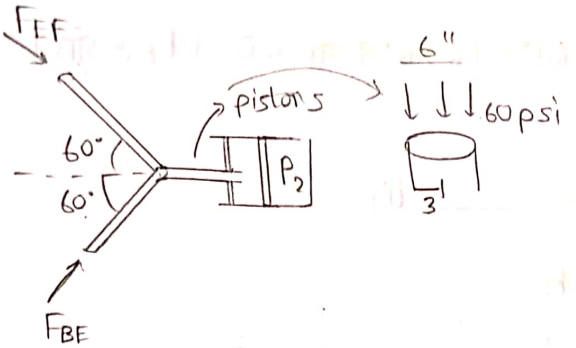
Problem 150

∴ Force transmitted at C, $F_C = (5015i + 2500j)$ lb.

or, $F_C = \sqrt{C_x^2 + C_y^2}$

$= 5603.59$ lb (Ans).

Problem 159



here,

$P_2 = \pi(3)^2 \times 60 = 1696.4$ lb

From this free body diagram,

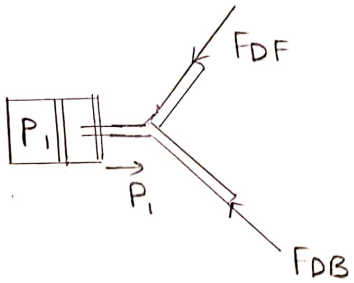
$\Sigma F_y = 0 \Rightarrow F_{EF} \sin 60° - F_{BE} \sin 60° = 0.$

$\Rightarrow F_{EF} = F_{BE}$

$\Sigma F_x = 0 \Rightarrow F_{EF} \cos 60° + F_{BE} \cos 60° - 1696.4 = 0.$

$\therefore F_{EF} = F_{BE} = 1696.4$ lb.

For other part of P_1



$P_1 = \pi(3)^2 \times 100 = 2827.44$

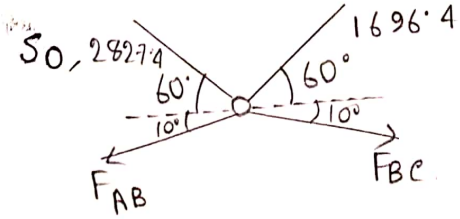
$\Sigma F_y = 0 \Rightarrow F_{DF} \sin 60° - F_{DB} \sin 60° = 0.$

$\Rightarrow F_{DF} = F_{DB}.$

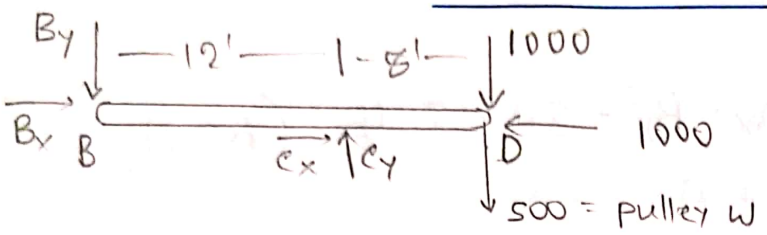
$\Sigma F_x = 0 \Rightarrow F_{DF} \cos 60° + F_{DB} \cos 60° - 2827.44 = 0.$

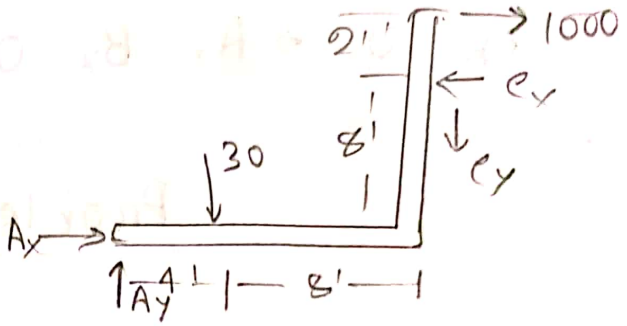
$\Rightarrow F_{DF} = 2827.44 = 0. = F_{DB}.$

So,



Problem 153





free body of BD,

$\Sigma M_B = 0 \Rightarrow 1500 \times 20 - C_y \times 12 = 0. \Rightarrow C_y = 2500$ lb

free body of AC,

$\Sigma M_A = 0 \Rightarrow 30 \times 4 + C_y \times 12 - C_x \times 8 + 1000 \times 10 = 0.$

$\Rightarrow C_x = 5015$ lb.

Free body of C,

$\Sigma F_y = 0 \Rightarrow P + 2W = 330 \Rightarrow P = 330 - 2W$

Free body of B,

$\Sigma F_y = 0 \Rightarrow P_1 = 2W$

Free body of A,

$\Sigma M_A = 0 \Rightarrow 3 \times P_1 - 8 \times P = 0.$

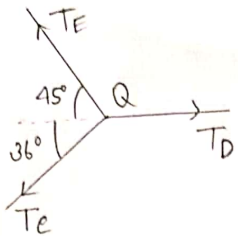
$\Rightarrow 6W - 8(330 - 2W) = 0.$

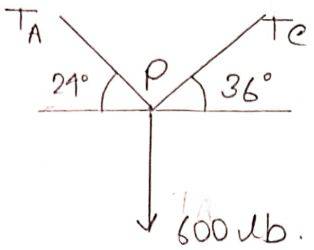
$\Rightarrow 6W - 2640 + 16W = 0 \Rightarrow W = 120 \text{ lb.}$ (Ans).

$= 5261.195 \text{ lb}$

(Ans).

Problem 174





Free body of P,

$\Sigma F_x = 0 \Rightarrow T_A \cos 24° - T_C \cos 36° = 0$

$\Rightarrow T_A = \dfrac{T_C \cos 36}{\cos 24}$

$\Sigma F_y = 0 \Rightarrow T_A \sin 24° + T_C \sin 36° = 6000$

$\Rightarrow \dfrac{T_C \cos 36}{\cos 24} \cdot \sin 24 + T_C \sin 36 = 6000$

$\Rightarrow T_C = 6329.229$ lb

Free body of Q,

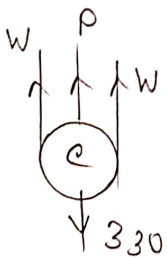
$\Sigma F_y = 0 \Rightarrow T_E \sin 45° - T_C \cos 36° = 0$

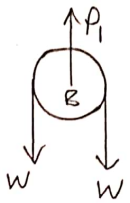
$\Rightarrow T_E = \dfrac{6329.229 \times \sin 36}{\sin 45} = 5261.195$ lb

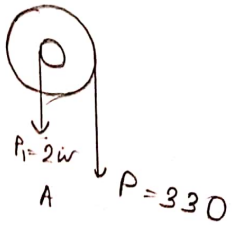
$\Sigma F_x = 0 \Rightarrow T_E \cos 45° + T_C \cos 36° = T_D$

$\Rightarrow T_D = 8840.68$ lb (Ans).

Problem 184







consider this free body,

$\Sigma F_x = 0$

$\Rightarrow F_{AB}\cos 10° + 2827.4\cos 60° - 1696.4\cos 60° - F_{BC}\cos 10° = 0$

$\Rightarrow F_{AB} - F_{BC} = -574.22$ lb. _____ (i).

$\Sigma F_y = 0.$

$\Rightarrow F_{AB}\sin 10° - 2827.48\sin 60° - 1696.4\sin 60° + F_{BC}\sin 10° = 0.$

$\Rightarrow F_{AB} + F_{BC} = 2256.28$ _____ (i).

$\therefore F_{AB} = 1099.53$ lb

$F_{BC} = 1567.75$ lb. (Ans).

Problem 167