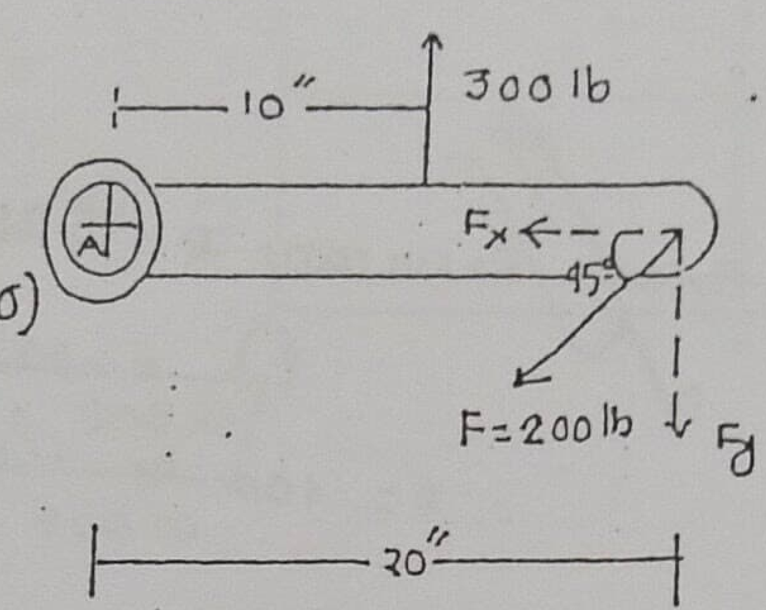
Chapter III

MOMENTS AND PARALLEL COPLANER FORCES

Ex28. $\circlearrowleft \Sigma M_A$

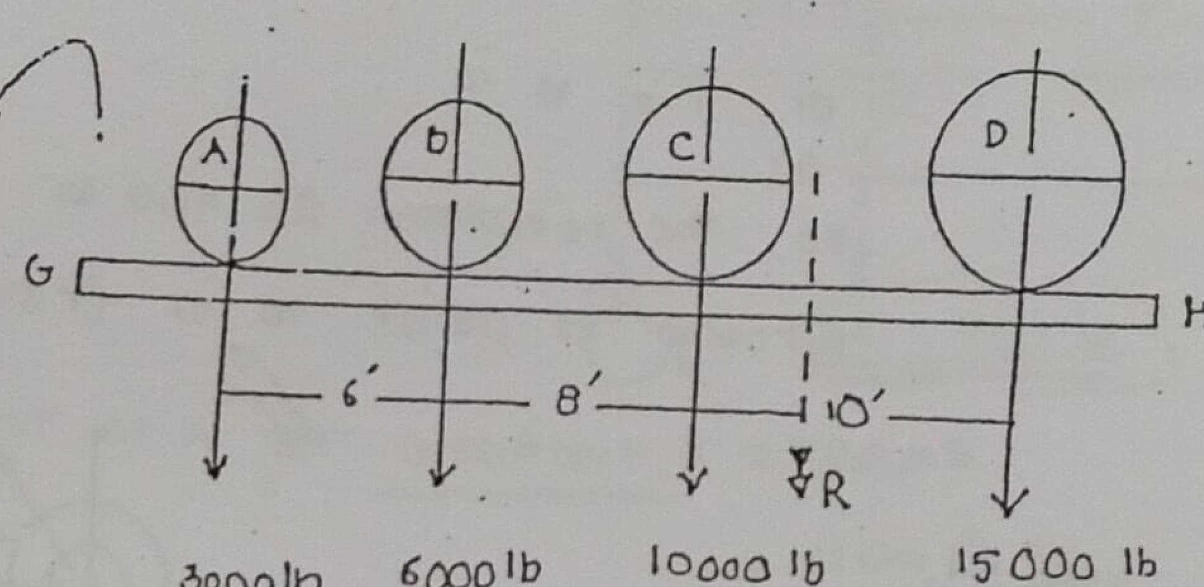
$= (-300 \times 10) + (F \cos 45^\circ \times 0) + (F \sin 45^\circ \times 20)$

$= -171.57$ in-lb



So, $\Sigma M_A = 171.57$ in-lb, anti clockwise. Ans:

Ex30.



Resultant, $R = \downarrow \Sigma F_y$

$= (3000 + 6000 + 10000 + 15000)$ lb

$= 34,000$ lb

$\circlearrowleft \Sigma M_A = (3000 \times 0) + (6000 \times 6) + (10000 \times 14) + (15000 \times 24)$

$= 536000$ in-lb ... (i)

We know, $\circlearrowleft \Sigma M_A = R \times r$ ... (ii)

From (i) and (ii) we get,

$R \times r = 5,36,000$

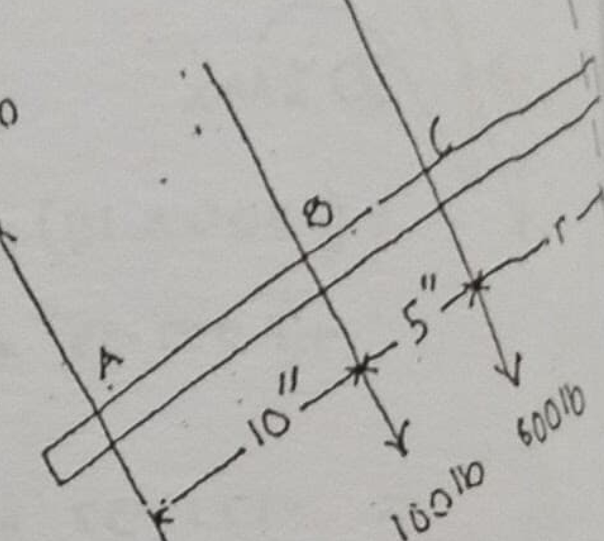
or, $r = 536000 / 34000 = 15.76$ ft

So, the resultant $R = 34.000$ lb acts vertically downward through a point 15.76 ft from A. Ans:

Ex 31. Resultant $R = +\uparrow \Sigma F_y$

$= -300 + 100 + 600$

$\therefore R = 400$ lb . . . (i)



$\circlearrowright + \Sigma M_C = (600 \times 0) - (100 \times 5) + (300 \times 15)$

$= 4000$ in - lb . . . (ii)

We know,

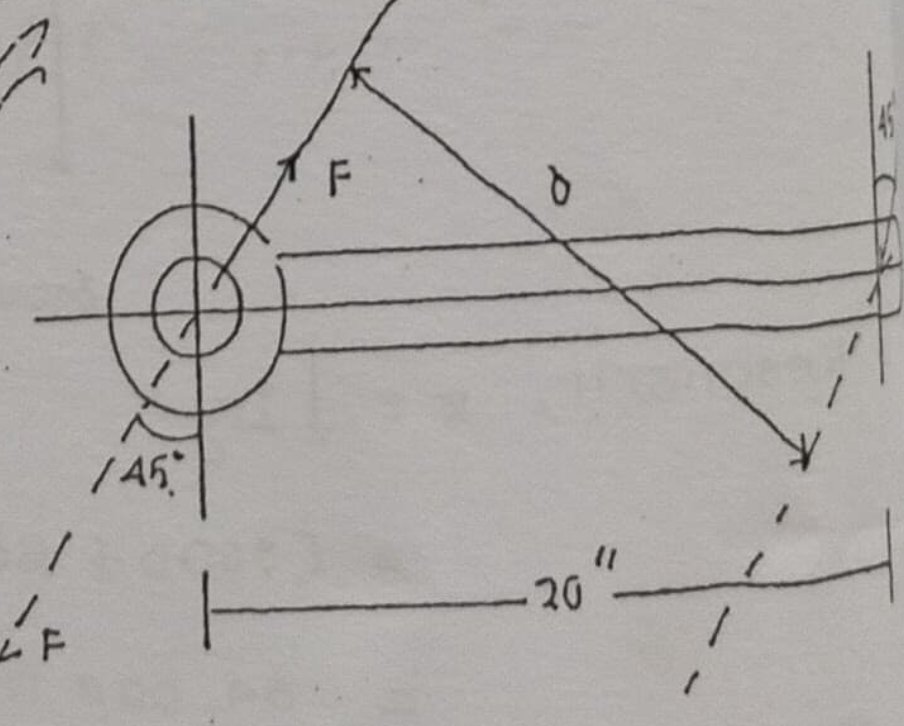
$\circlearrowright + \Sigma M_C = Rr$

or, $400r = 4000$

or, $r = 10$ in .

So, the resultant $R = 400$ lb acts vertically down[ward] through a point 10 in from C. Ans:

Ex 34.



Force through axis = Same in magnitude and sense of F

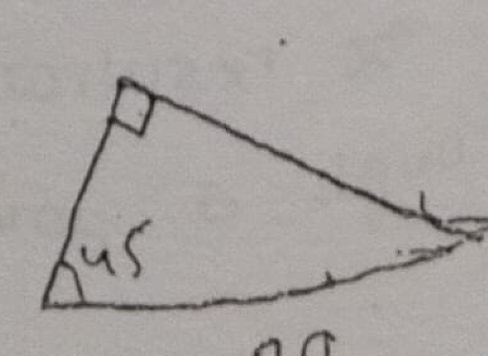
$= 300$ lb

Couple $= F \times d$

$= 300 \times 20 \sin 45°$

$= 4242.64$ in-lb

Ans:



166.

$\circlearrowright + \Sigma M_C = 0$

or, $F_2 \times 4 - F_1 \times 5 = 0$

or, $F_2 = 5/4 \, F_1$ . . . (i)

Again, $F_1 + F_2 = 900$

or, $F_1 + 5/4 \, F_1 = 900$

or, $F_1 = 400$ lb

From (i) $F_2 = 5/4 \times$

167.

Moment at A for re[...]

$\circlearrowright + \Sigma M_A = F_2 \times 10$ . .

From (i) and (ii),

$F_2 \times 10 = 2100$

or, $F_2 = 210$ lb

Again, $+\uparrow \Sigma F_y = -70[...]$

or, $F_2 - F_1 = -[...]$

or, $F_1 = F_2 + [...]$

$= 210[...]$

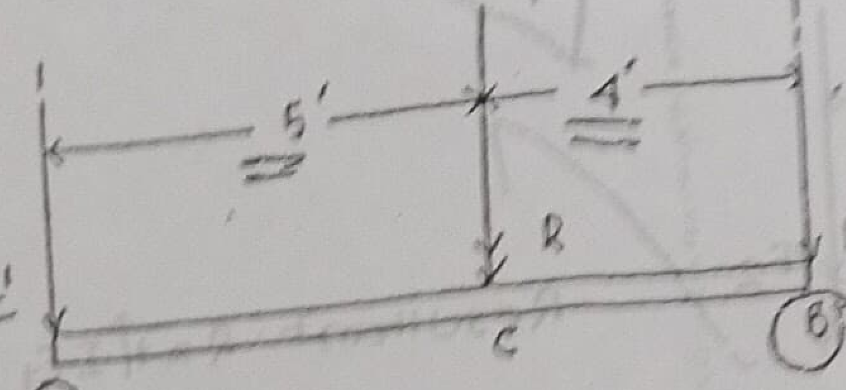
$\therefore F_1 = 910$ lb a[...]

166.

$\circlearrowleft \Sigma M_C = 0$

or, $F_2 \times 4 - F_1 \times 5 = 0$

or, $F_2 = 5/4\ F_1$ ... (i)



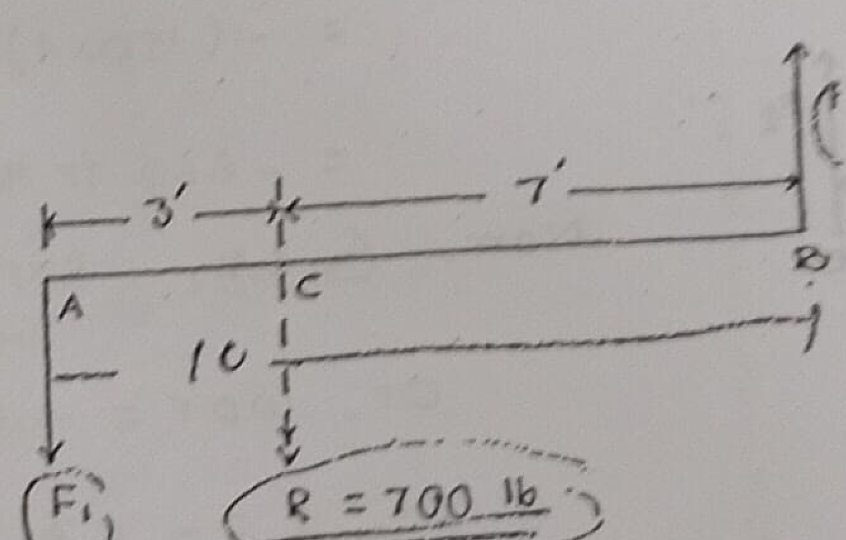
Again, $F_1 + F_2 = 900$ lb

or, $F_1 + 5/4\ F_1 = 900$ lb

or, $F_1 = 400$ lb ... (ii)

From (i) $F_2 = 5/4 \times 400 = 500$ lb Ans.

167.



Moment at A for resultant $R = 700 \times 3$

$= 2100$ ft lb ... (i)

$\circlearrowleft \Sigma M_A = F_2 \times 10$ ... (ii)

From (i) and (ii),

$F_2 \times 10 = 2100$

or, $F_2 = 210$ lb

Again, $+\uparrow \Sigma F_y = -700$

or, $F_2 - F_1 = -700$

or, $F_1 = F_2 + 700$

$= 210 + 700 = 910$ lb

$\circlearrowleft \Sigma M_C = -F_1 \times 3 - F_2 \times 7 = 0$

$\Rightarrow 3F_1 + 7F_2 = 0$

$F_1 + F_2 = 700$

$7F_1 - 7F_2 = 4900$

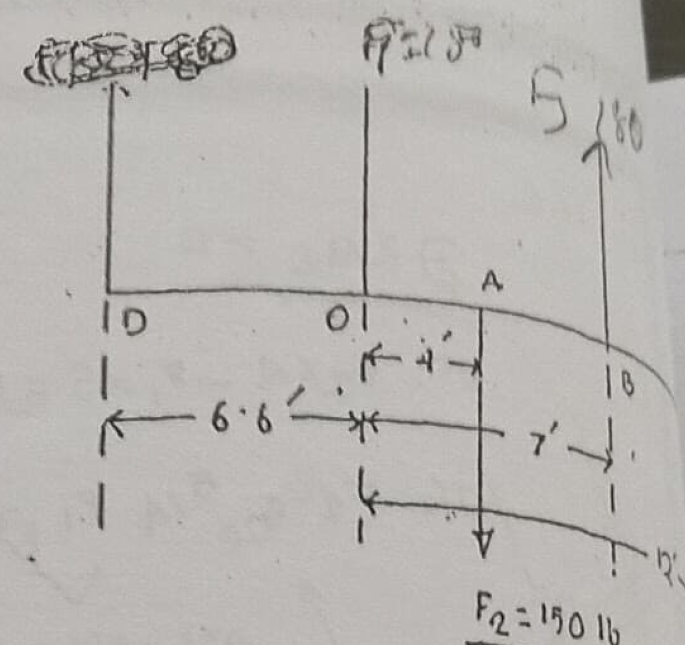
$10F_2 = 4900$

$\Rightarrow F_2 = 490$

$\therefore F_1 = 910$ lb and $F_2 = 210$ lb Ans.

$F_1 = 1190$

169



Resultant $R = +\uparrow \Sigma F_y$

$= (180 - 150 + 180 - 110)$ lb

$= 100$ lb

$\therefore R = 100$ lb $(\uparrow)$ . . . (i)

$\circlearrowleft \Sigma M_O = (F_1 \times 0) - (F_2 \times 4) + (F_3 \times 7) - (F_4 \times 12)$

$= -(150 \times 4) + (180 \times 7) - (110 \times 12)$

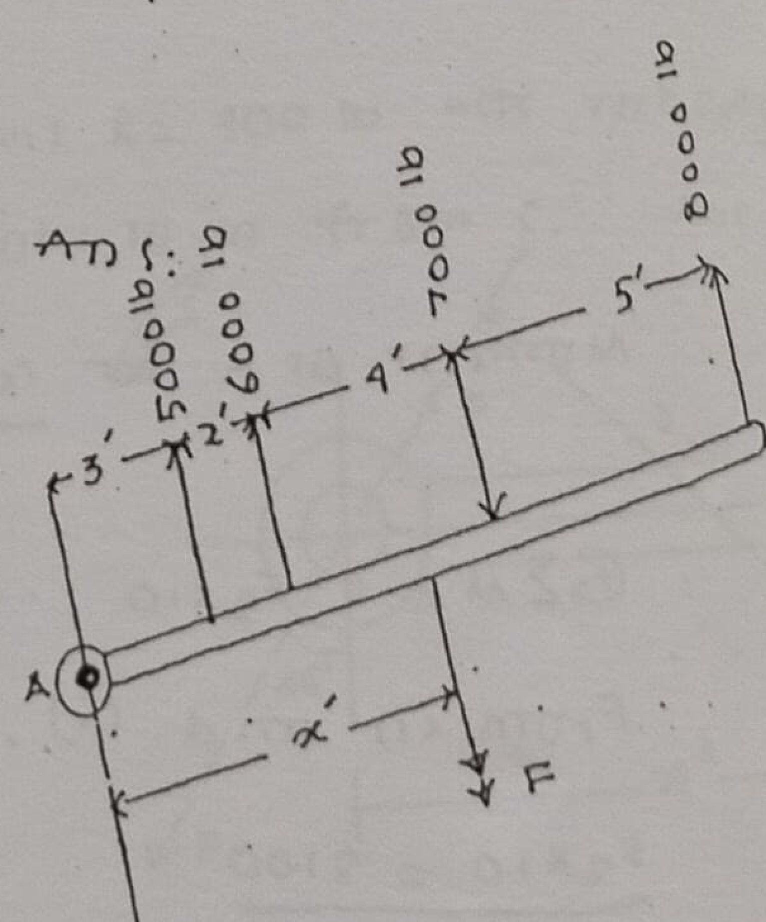
$= -660$ ft lb

Now, $\circlearrowleft \Sigma M_O = R \times r$

or, $100r = -660$

or, $r = -6.6$ ft Ans:

171.



$+\uparrow \Sigma F_y = 0$

or, $(5000 + 6000 - 7000 + 8000 - F) = 0$

or, $F = 12000$ lb

Now, $\circlearrowright \Sigma M_A = 0$

or, $(-5000 \times 3) - (6000 \times 5) + (7000 \times 9) - (8000 \times 14) + (F \times x) = 0$

or, $12000x = 94000$

$\therefore x = 7.83$ ft

Ans.

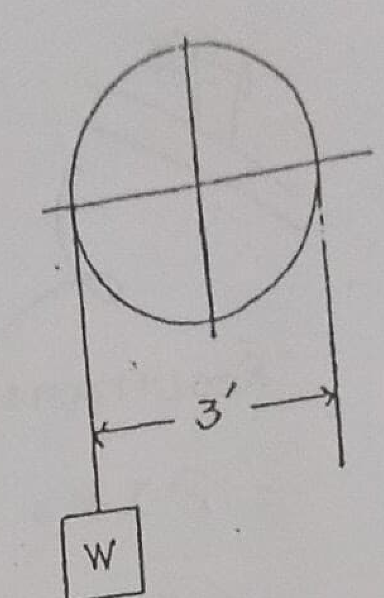
(173)

$\circlearrowright \Sigma M$ - - -

Given, $W = 500$ lb

Force = same in magnitude and opposite sense of given force.

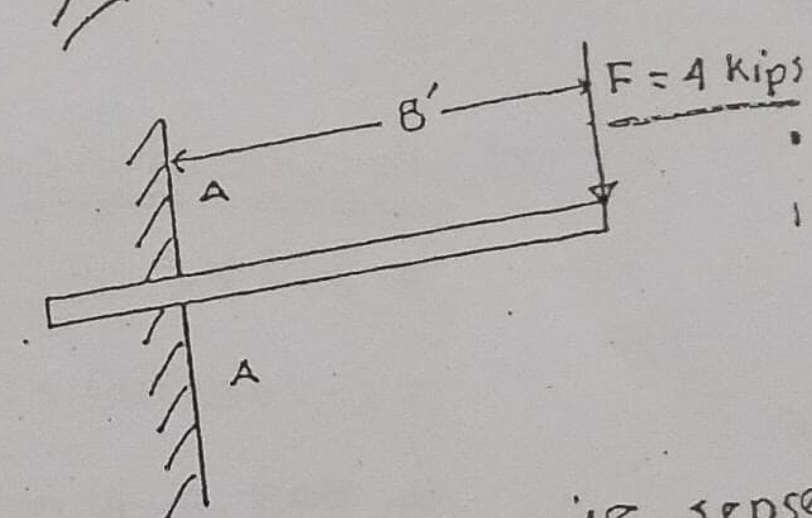
$= 500$ lb $(+\uparrow)$



on the disk ↓ Thrown

Couple $= 500 \times \frac{3}{2} = 750$ ft lb Ans:

174.

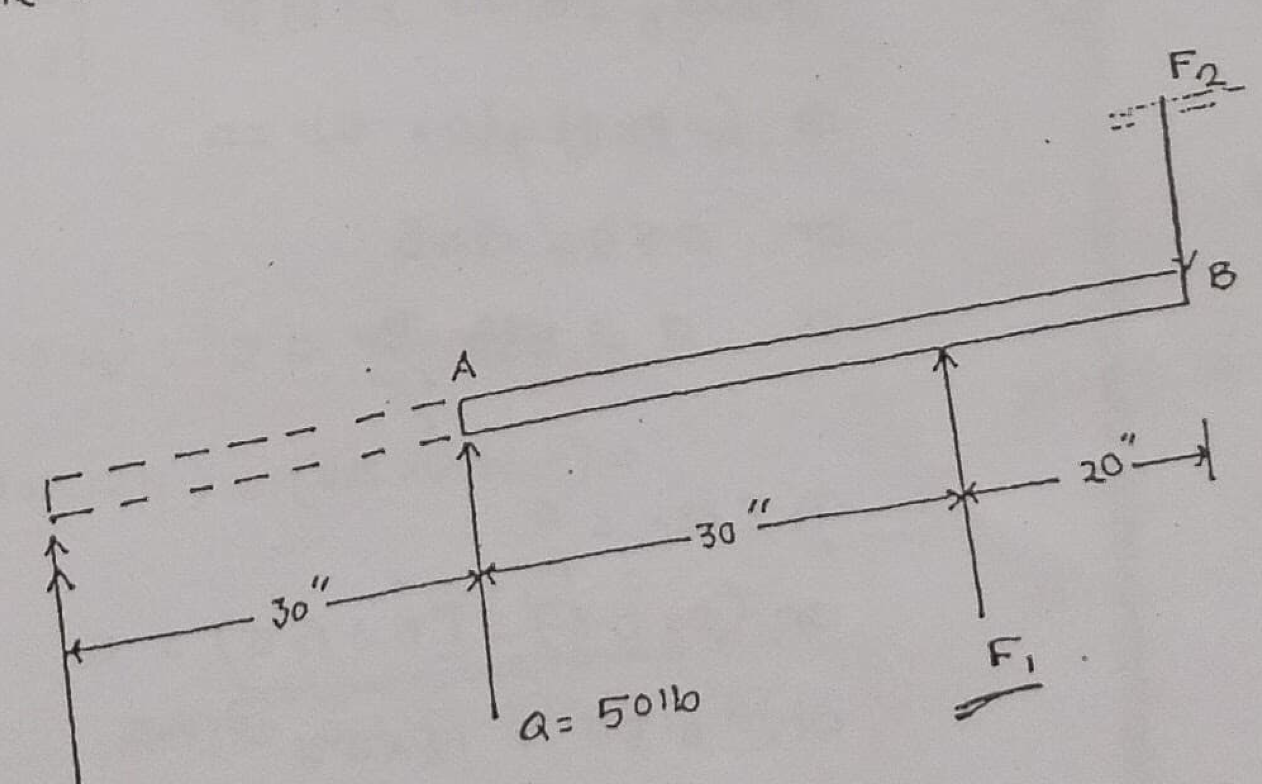


Force = same in magnitude and opposite sense of given force.

$= 4$ Kips $(\uparrow +)$

Couple $= 4 \times 8 = 32$ ft Kips C Ans.

176.



Couple = F×d

$\Rightarrow 1500 = F \times 20$

$C(F_1, F_2) = 1500$ in lb

$\therefore F_1 = F_2 = (1500/20) = 75$ lb

Resultant $R = +\uparrow \Sigma F_y = 50 + 75 - 75 =$ (50 lb)

Now taking moment at A, $\circlearrowright \Sigma M_A =$

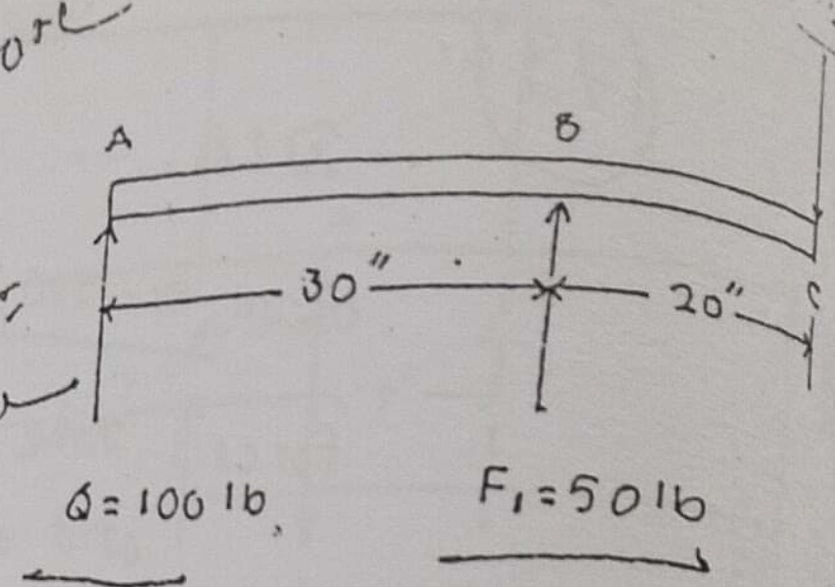
or, $50r = (-75 \times 30) + (75 \times 50)$

or, $r = -30$ in.

$\therefore$ Resultant $R = 50$ lb, acts -30 in from

178

2 force & distance ... Resultant = couple



Resultant = Couple

$= \Sigma M_A$

$= (-50 \times 30) + (150 \times 50)$

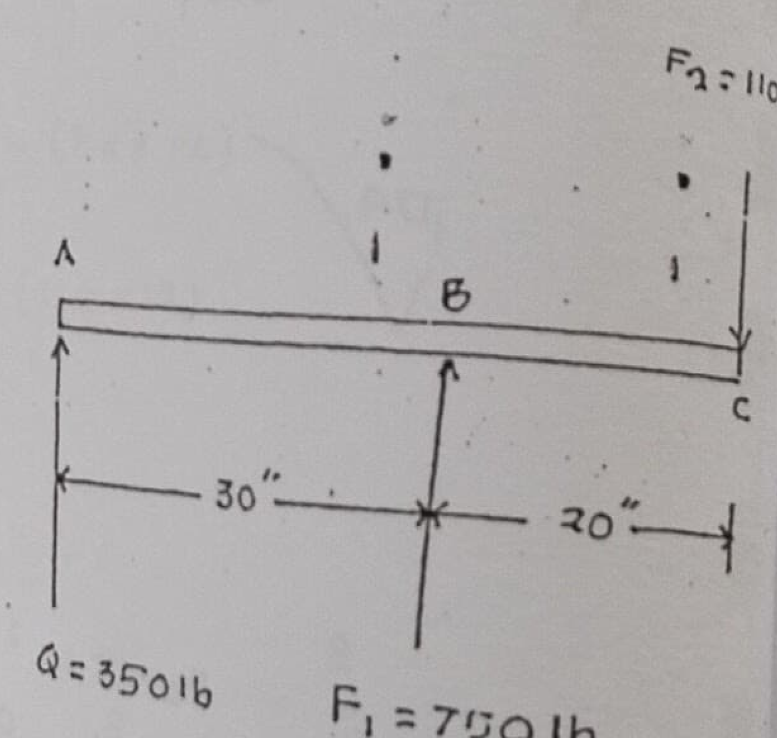
$= 6000$ in lb c. Ans.

179. Resultant = Couple

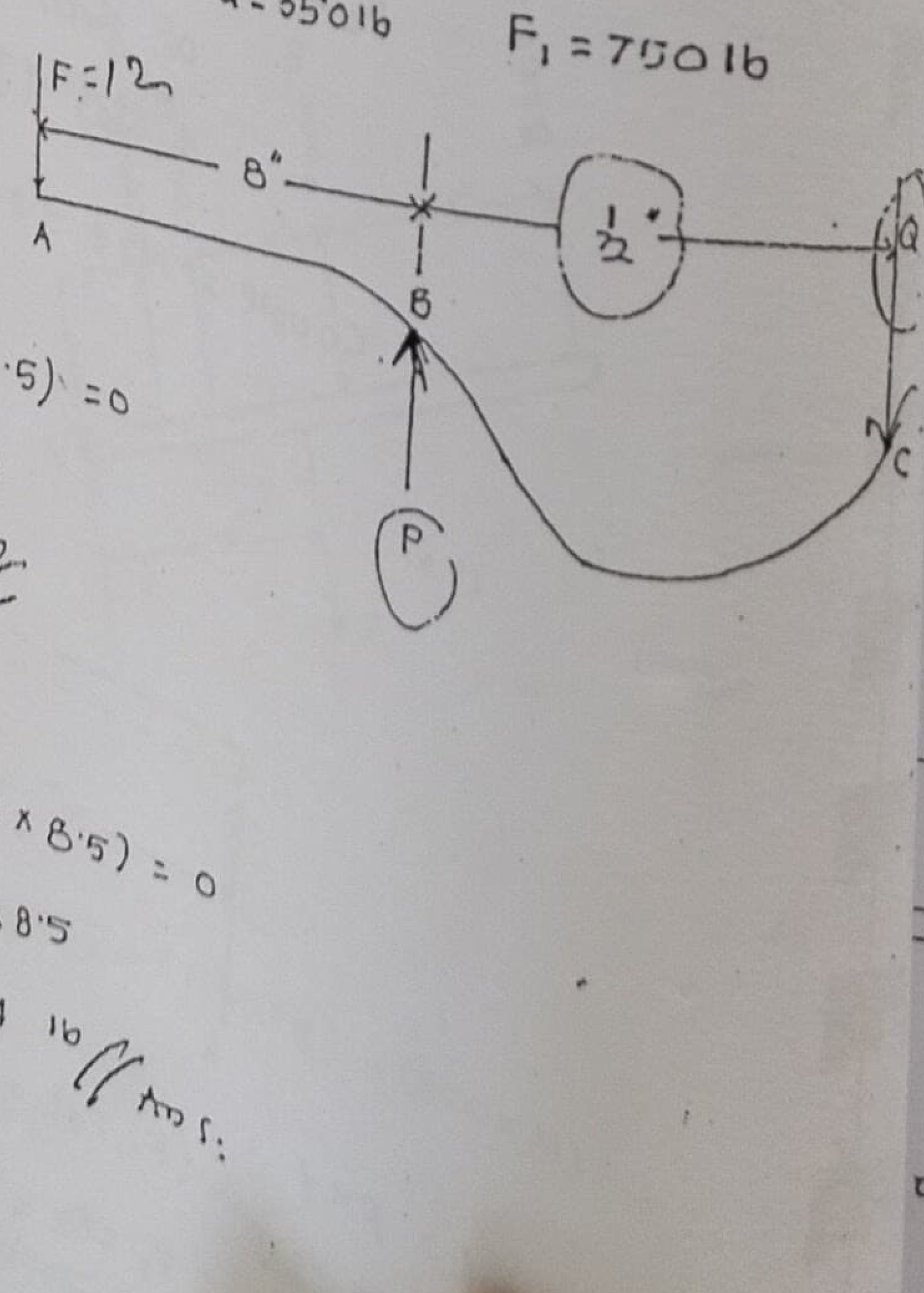
$= \Sigma M_A$

$= (-750 \times 30) + (1100 \times 50)$

$= 325$ in lb c. Ans.



183 Given, F = 12 lb



$\Sigma M_B = 0$

or, $(-F \times 8) + (Q \times .5) = 0$

or, $0.5Q = 12 \times 8$

or, $Q = 192$ lb

$\Sigma M_C = 0$

or, $(P \times 0.5) - (F \times 8.5) = 0$

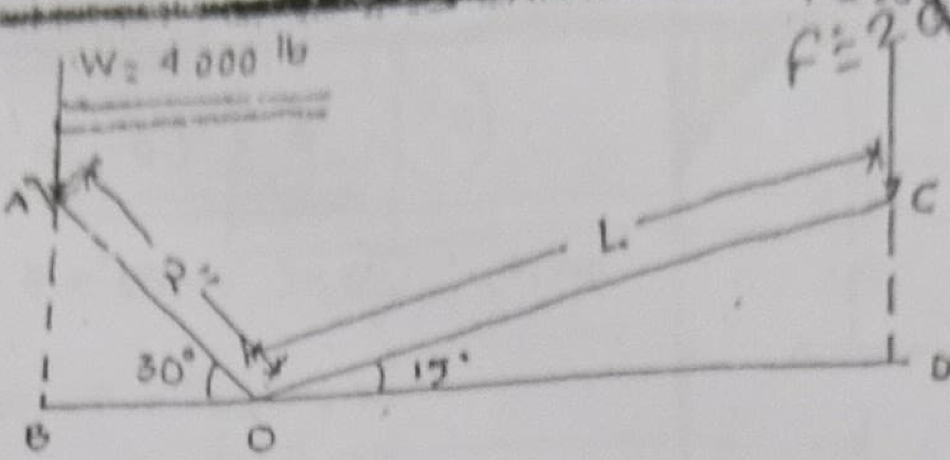
or, $0.5P = 12 \times 8.5$

or, $P = 204$ lb Ans.

1 kips = 1000 lb

2 ton = 4000 lb

184.



$\Sigma M_O = 0$

or, $(-4000 \times BO) + (200 \times OD) = 0$

or, $(-4000 \times 2\cos 30^\circ) + (200 \times L \cos 15^\circ) = 0$

or, $193.19\,L = 6928.20$

or, $L = 35.86$ in

so, $L = 35.86$ in Ans:

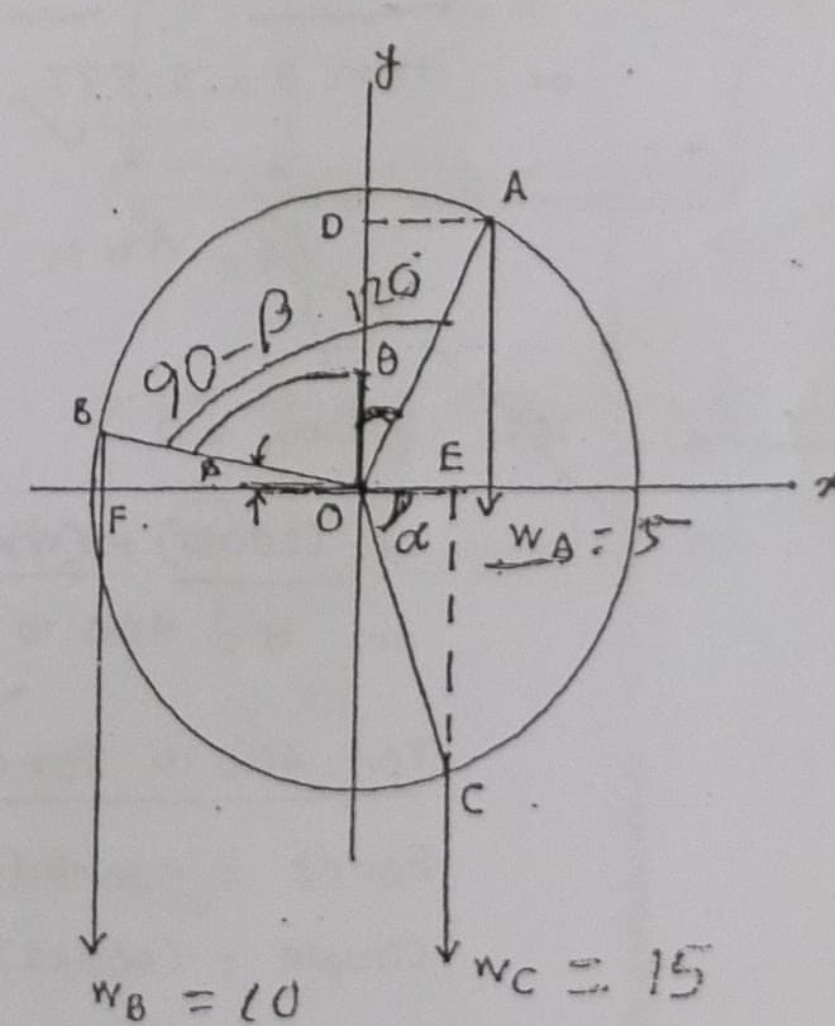
185. Given,

$W_A = 5$ lb

$W_B = 10$ lb

$W_C = 15$ lb

radious = 2'



Now,

$\Sigma M_O = 0$

or, $(W_A \times AD) + (W_C \times OE) - (W_B \times OF) = 0$

or, $(W_A \times 2\sin\theta) + (W_C \times 2\cos\alpha) - (W_B \times 2\cos\beta) = 0$

or, $10\sin\theta + 30\cos\alpha - 20\cos\beta = 0$

or, $5\sin\theta + 15\cos\alpha - 10\cos\beta = 0$ . . . (i)

Now, $\angle BOD = (90^\circ - \beta) = (120^\circ - \theta)$

$\therefore \beta = (\theta - 30^\circ)$ . . . (ii)

and, $\angle BOC = 90^\circ + \beta + (90^\circ - \alpha) = 120^\circ$

or, $120^\circ = 90^\circ + (\theta - 30^\circ) + (90^\circ - \alpha)$

or, $\alpha = (\theta + 30^\circ)$ . . . (iii)

From eqn (i) we get,

$5 \sin\theta + 15 \cos(\theta + 30^\circ) - 10 \cos(\theta - 30^\circ) = 0$

or, $5 \sin\theta + 15 (\cos\theta \cos 30^\circ - \sin\theta \sin 30^\circ)$
$- 10 (\cos\theta \cos 30^\circ + \sin\theta \sin 30^\circ) = 0$

or, $(13 \cos\theta - 8.66 \cos\theta) = 7.5 \sin\theta + 5 \sin\theta - 5 \sin\theta$

or, $4.33 \cos\theta = 7.5 \sin\theta$

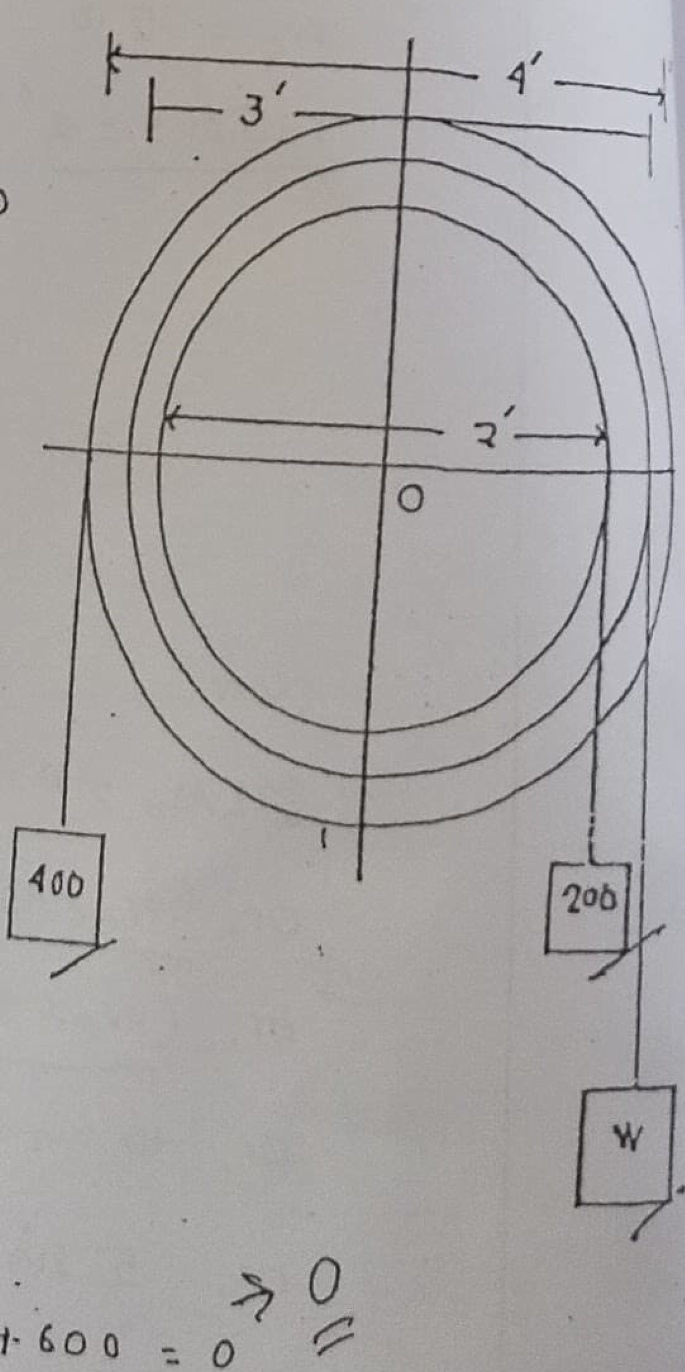
or, $\tan\theta = 0.577$

$\therefore \theta = 30^\circ$ Ans:

187. $\circlearrowright \Sigma M_O = 0$

or, $(200 \times 1) + (W \times 1.5) - (400 \times 2) = 0$

or, $W = 400$ lb



For 400 lb force.

Force = 400 lb (↓+)

Couple = $(400 \times 2) = 800$ ft lb C.

For 200 lb force.

Force = 200 lb (↓+)

Couple = $(200 \times 1) = 200$ ft lb C

For W,

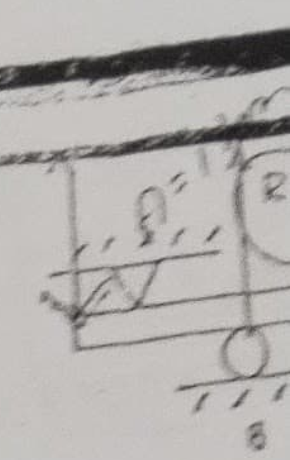
Force = 400 lb (↓+)

Couple = $(400 \times 1.5) = 600$ ft lb C

Resultant Couple ($\circlearrowright$) = $-800 + 200 + 600 = 0$

Resultant Force $= 400 + 200 + 400 = 1000$ lb (↓+) Ans:

188.



$\circlearrowright \Sigma M_B = 0$

or, $100 \times (6 - x) - (2000 \times x) = 0$

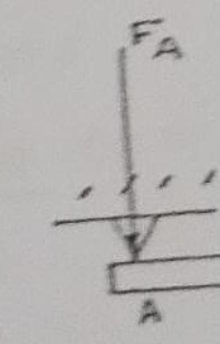
or, $x = 3.42$ in.

$+\uparrow \Sigma F_y = 0$

or, $R_B - 2000 - 100 = 0$

or, $R_B = 2100$ lb Ans:

189. $\circlearrowright \Sigma M_A = 0$



or, $(100 \times 6) - (1800 \times x) = 0$

or, $x = 0.33''$

Bending moment at B

$= 100 \times (6 - 0.33)$ $(6 - 3.42)$

$=$ ~~566.67~~ ft lb Ans:

190. $\circlearrowright \Sigma M_A = 0$

or, $(15 \times 6) - (1800 \times x) = 0$

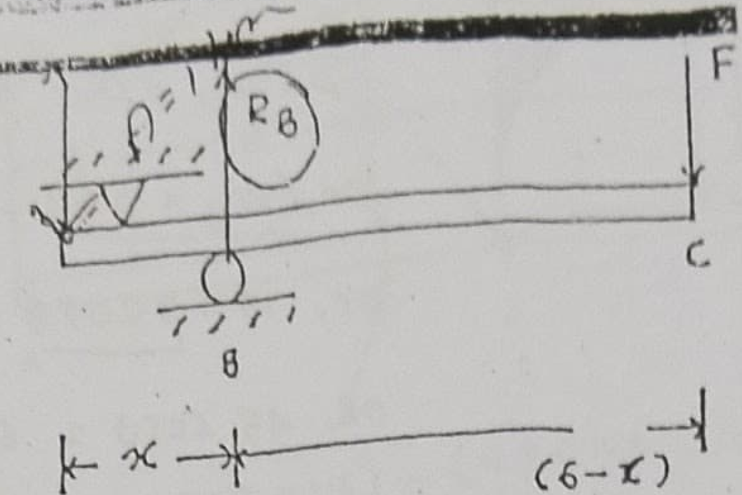
or, $x = 0.05'$

Bending moment at B

$= 15 \times (6 - 0.05)$

$= 89.25$ ft lb Ans:

188.



$\circlearrowright \Sigma M_B = 0$

or, $100 \times (6-x) - (2000 \times x) = 0$

or, $x = 3.42$ in.

$+\uparrow \Sigma F_y = 0$

or, $R_B - 2000 - 100 = 0$

or, $R_B = 2100$ lb Ans:

189. $\circlearrowright \Sigma M_A = 0$

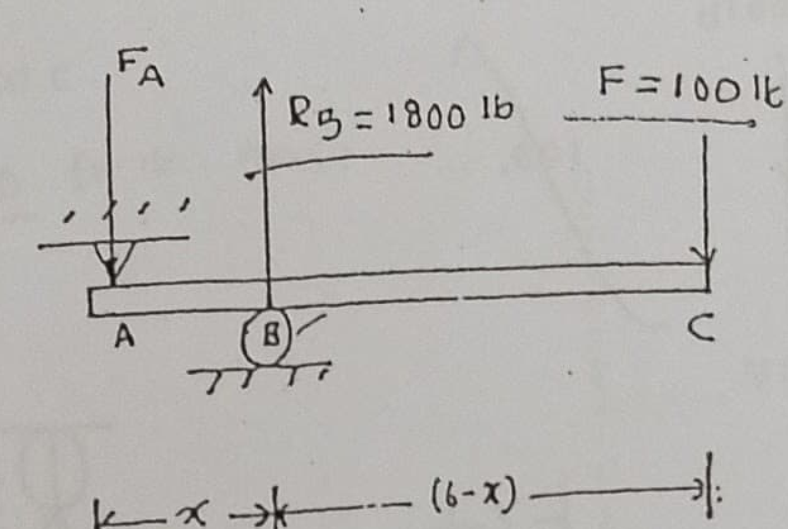
or, $(100 \times 6) - (1800 \times x) = 0$

or, $x = 0.33''$

Bending moment at B

$= 100 \times (6 - 0.33)$

$= 566.67$ ft lb Ans:



190. $\circlearrowright \Sigma M_A = 0$

or, $(15 \times 6) - (1800 \times x) = 0$

or, $x = 0.05'$

Bending moment at B

$= 15 \times (6 - 0.05)$

$= 89.25$ ft lb Ans:

F = 100 lb

191.

$\circlearrowleft \Sigma M_O = 0$

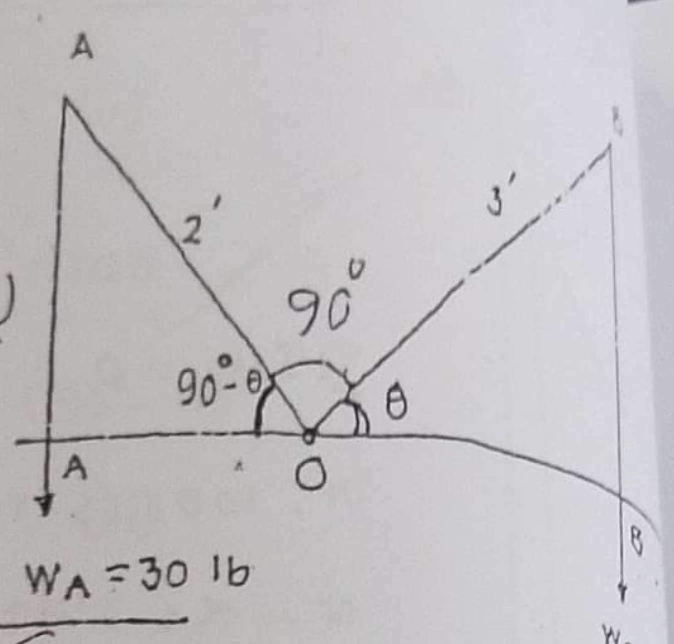
or, $(W_B \times OB) - (W_A \times OA) = 0$

or, $15 \times 3\cos\theta = 30 \times 2\cos(90^\circ - \theta)$

or, $45\cos\theta = 60\sin\theta$

or, $\tan\theta = \frac{3}{4}$

$\therefore \theta = \tan^{-1}(3/4) = 36.87^\circ$



2 values of θ

Again, $\tan\theta = \tan(180^\circ + \theta)$

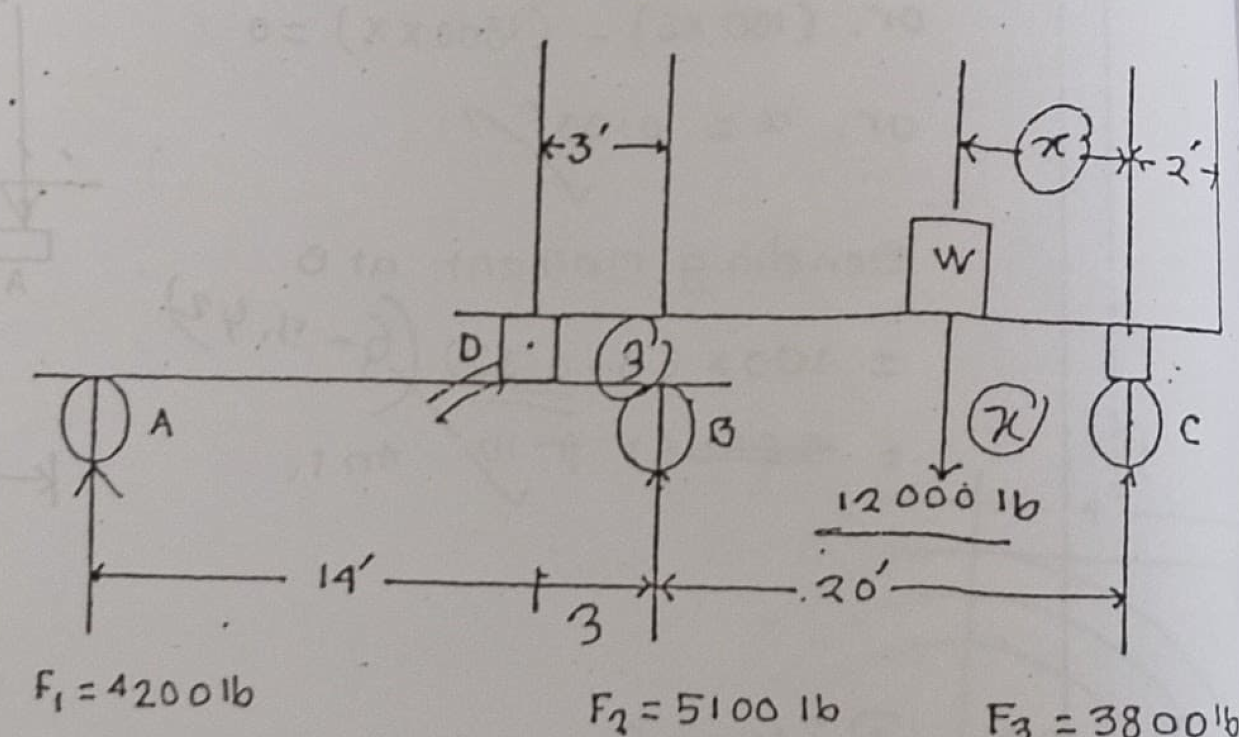
$= \tan(180^\circ + 36.87^\circ)$

$= \tan 216.87^\circ$

$\therefore \theta = 36.87^\circ$ and 216.87° Ans:

F = 100 lb

193.



Limiting axle load 5 tons = 10000 lb.

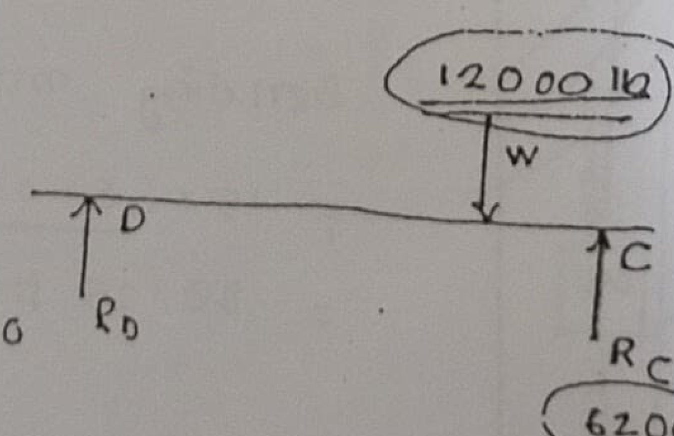
$\therefore$ Extra load on C = 10000 − 3800 = 6200 lb

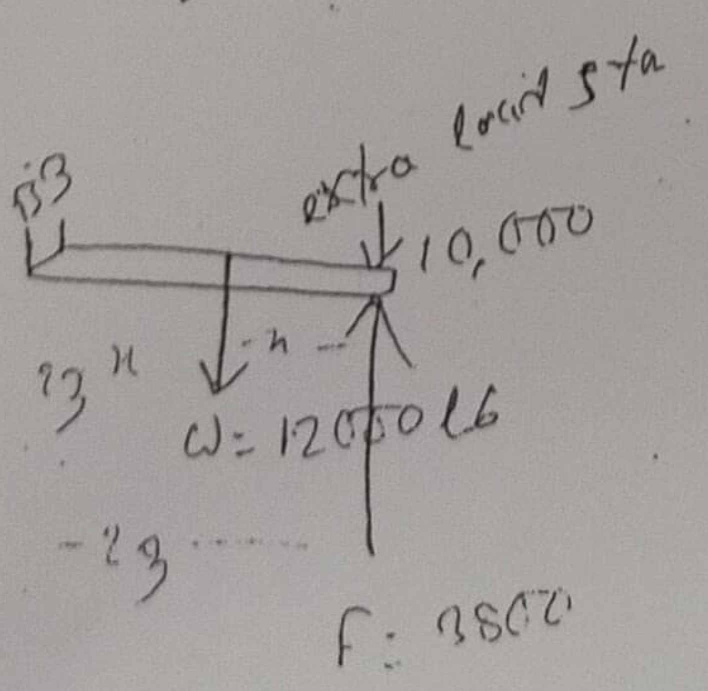
$\circlearrowleft \Sigma M_D = 0$

or, $12000 \times (23 - x) - (6200 \times 23) = 0$

or, $276000 - 12000x - 142600 = 0$

or, $x = 11.12'$





$F_1\ F_2\ F_3$

R → 5 ton

198.

a. $\circlearrowleft \Sigma M_B = 0$

or, $(W \times 22) - (10000 \times 20) +$

or, $W = (132000 / 22)$

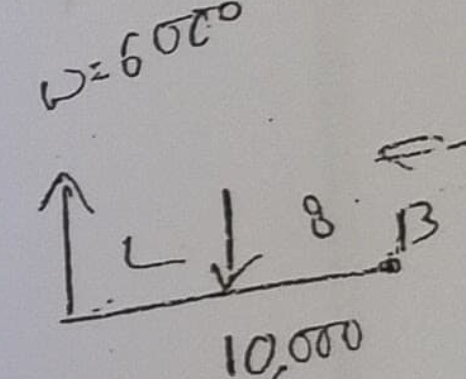
or, $W = 6000$ lb

Now, $\uparrow \Sigma F_y = 0$

or, $6000 - 10000 +$

or, $R_B = 0$

W = 6000



b. Bending moment a

$= 2000 \times 10 = 20,000$

$= 10,000 \times 8\ (200)$

$- 6000 \times 10$

$= 20,000$

a = 0 lb

a. Total uniform

$= 200 \times 20 = 4000$

weight of beam

$\circlearrowleft \Sigma M_A = 0$

or, $(4000 \times 7) +$

or, $R_2 = (2265$

$\therefore R_2 = 11325$

$\circlearrowleft \Sigma M_B = 0$

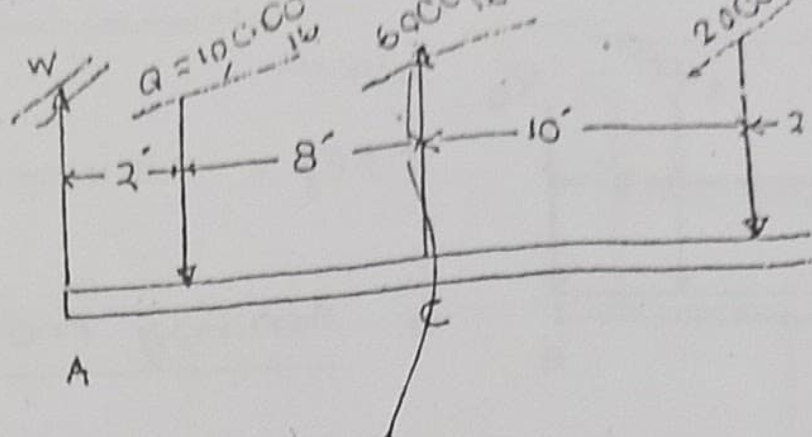
or, $(7000 \times 6$

or, $R_1 = (23$

$\therefore R_1 = 11$

b.

$(200 \times 17)\ \frac{17}{2}$



a. $\circlearrowright \Sigma M_B = 0$

or, $(W \times 22) - (10000 \times 20) + (6000 \times 12) - (2000 \times 2) = 0$

or, $W = (132000 / 22)$

or, $W = 6000$ lb

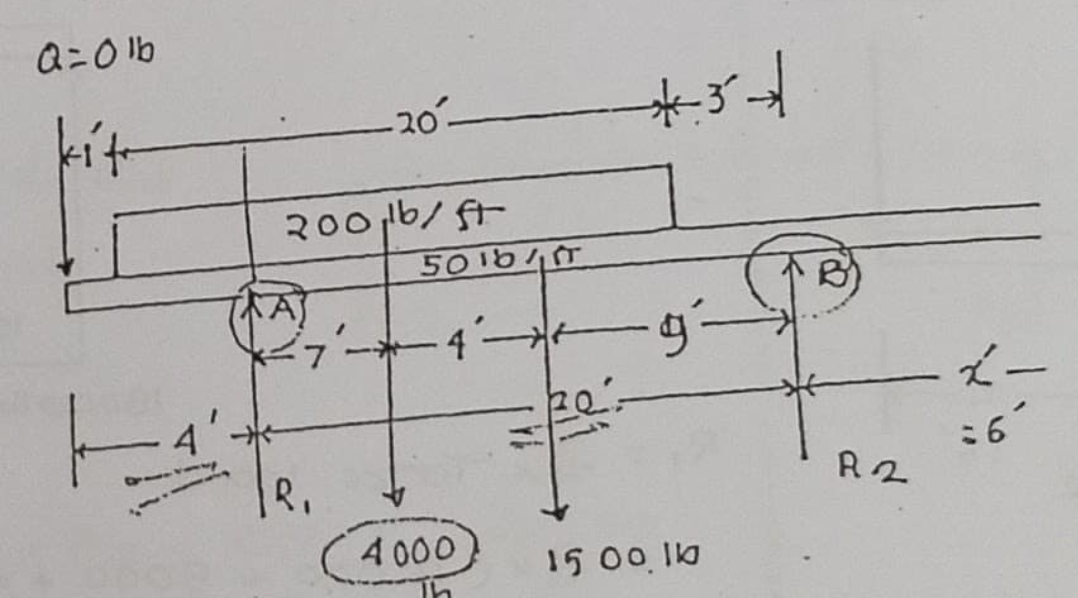
Now, $+\uparrow \Sigma F_y = 0$

or, $6000 - 10000 + 6000 - 2000 - R_B = 0$

or, $R_B = 0$

b. Bending moment at C

$= 2000 \times 10 = 20{,}000$ ft lb Ans:



a. Total uniform load

$= 200 \times 20 = 4000$ lb

Weight of beam $= 50 \times 30 = 1500$ lb

$\circlearrowright \Sigma M_A = 0$

or, $(4000 \times 7) + (1500 \times 11) - (R_2 \times 20) + (7000 \times 26) = 0$

or, $R_2 = (226500 / 20)$

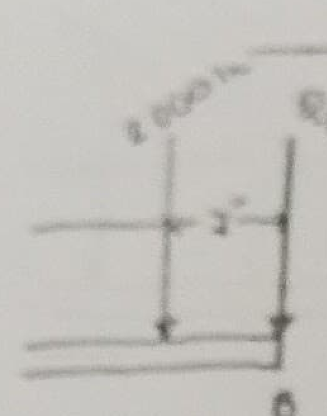
$\therefore R_2 = 11325$ lb

$\circlearrowright \Sigma M_B = 0$

or, $(7000 \times 6) - (1500 \times 9) - (4000 \times 13) + (R_1 \times 20) = 0$

or, $R_1 = (23500 / 20)$

$\therefore R_1 = 1175$ lb



$\uparrow \Sigma F_y = 0 + 1175 - 4000 - 1500 + 11325 - 7000 = 0$

b. <u>Bending moment:</u>

Bending moment at R_1

$= (50 \times 4)\frac{4}{2} + (200 \times 3)\frac{3}{2}$

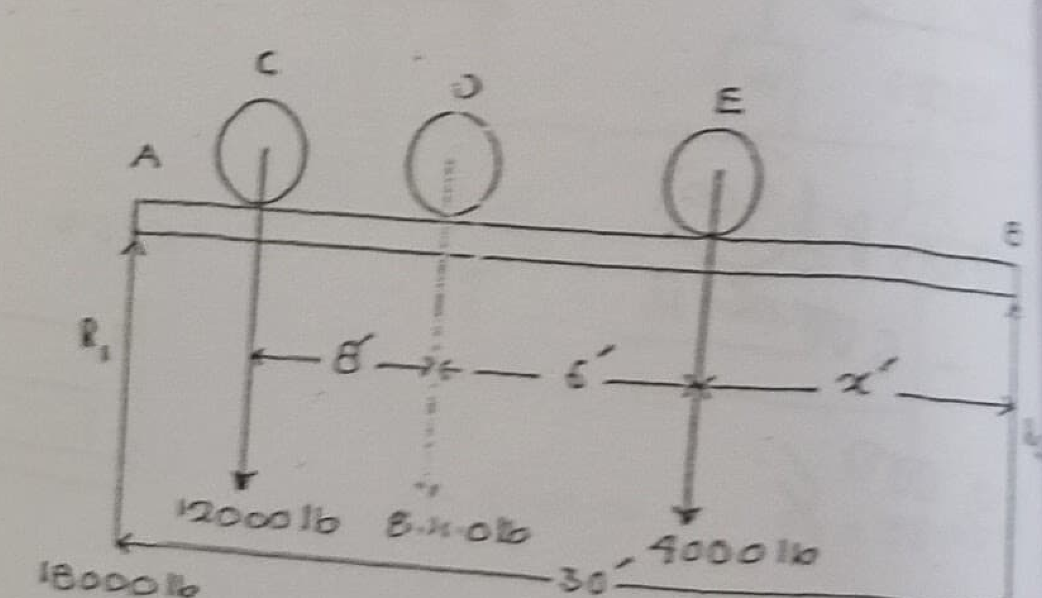
$= 1300$ ft lb   Ans:

Check:

$(200 \times 17)\frac{17}{2} + (50 \times 26)\frac{26}{2} - (11325 \times 20) + (7000 \times 26)$

$= 1300$ ft lb

Ans:



$R_1 = \frac{3}{4} \times$ Total load

$= \frac{3}{4} \times (12000 + 8000 + 4000)$

$= 18000$ lb

$\uparrow \Sigma M_B = 0$ ~~∴ $\Sigma M_C = 0$ will be used~~.

or, $(R_1 \times 30) - [12000 \times (14 + x)] - 8000 \times (6 + x) - 4000x = 0$

or, $x = (324000 / 24000)$

∴ $x = 13.5$ ft

So, distance $x = 13.5$ ft. Ans:

Now, $\uparrow \Sigma M_C = 0$

or, $(R_D \times 23) - (12000 \times 11.12) = 0$

or, $R_D = \frac{(12000 \times 11.12)}{23}$

∴ $R_D = 5800$ lb

$\uparrow \Sigma M_A = 0$

or, $(5800 \times 11) - (R_B \times 14) = 0$

or, $R_B = (5800 \times 11) / 14$

∴ $R_B = 4557.14$ lb

∴ Load on B $= F_2 + R_B = (5100$

$= 965$

$\uparrow \Sigma M_B = 0$

or, $(R_A \times 14) - (5800 \times 3) = 0$

or, $R_A = (5800 \times 3) / 14$

∴ $R_A = 1243.25$ lb

∴ Load on A $= F_1 + R_A = 420$

$= 544$

Therefore, $x = 11.12$ ft, load

is 5443.25 lb, 9658.5 lb

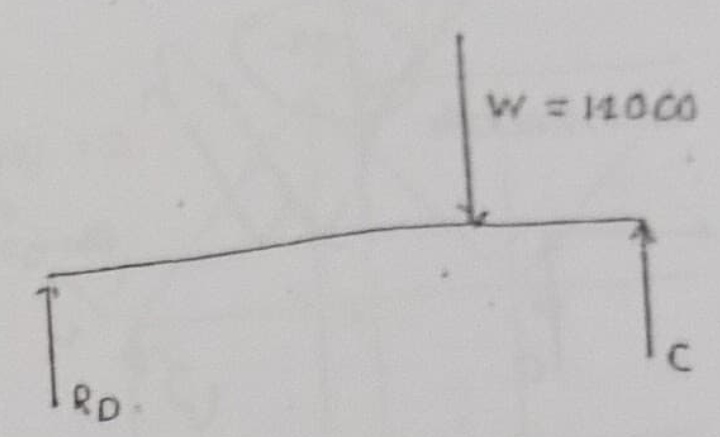
respectively.   Ans:

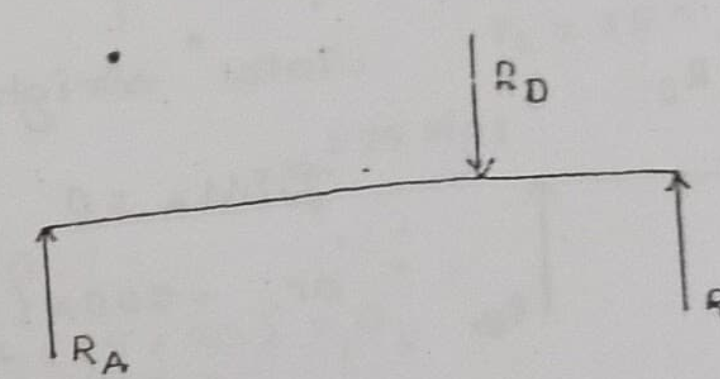
Now, $\circlearrowright \Sigma M_C = 0$

or, $(R_D \times 23) - (12000 \times 11.12) = 0$

or, $R_D = \dfrac{(12000 \times 11.12)}{23}$

$\therefore R_D = 5800$ lb





$\circlearrowright \Sigma M_A = 0$

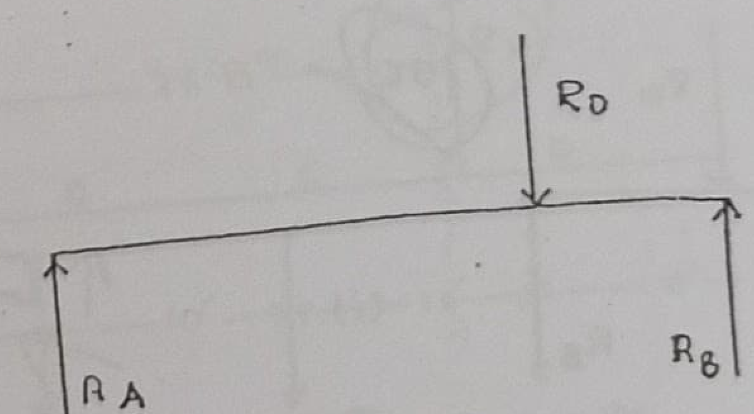
or, $(5800 \times 11) - (R_B \times 14) = 0$

or, $R_B = (5800 \times 11)/14$

$\therefore R_B = 4557.14$ lb

$\therefore$ Load on B $= F_2 + R_B = (5100 + 4557.14)$ lb

$= 9657$ lb.



$\circlearrowright \Sigma M_B = 0$

or, $(R_A \times 14) - (5800 \times 3) = 0$

or, $R_A = (5800 \times 3)/14$

$\therefore R_A = 1243.23$ lb

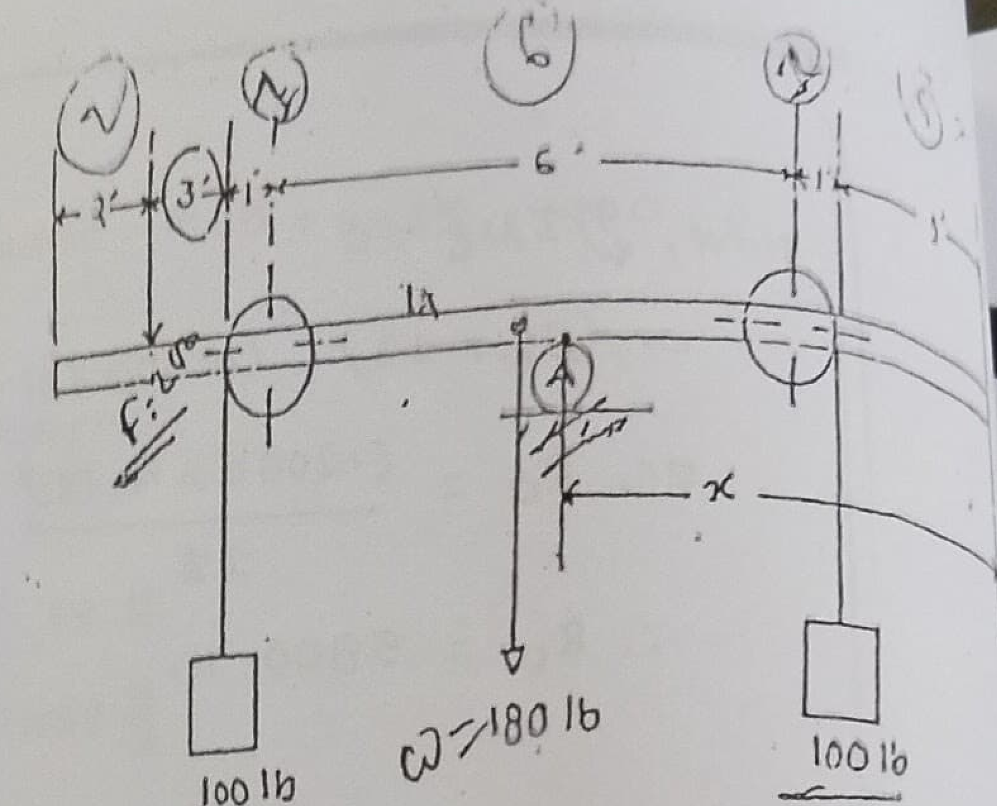
$\therefore$ Load on A $= F_1 + R_A = 4200 + 1243.23$

$= 5443.26$ lb

Therefore, $x = 11.12$ ft, load on A, B and C is 5443.23 lb, 9658.5 lb and 10,000 lb respectively.

Ans.

195.



Total weight of the beam = $18 \times 10 = 180$ lb.

$\circlearrowleft \Sigma M_A = 0$

or, $-200 \times (18 - x - 2) - 100 \times (18 - x - 5) - 180 \times (9 - x) + 100 \times (x - 5) = 0$

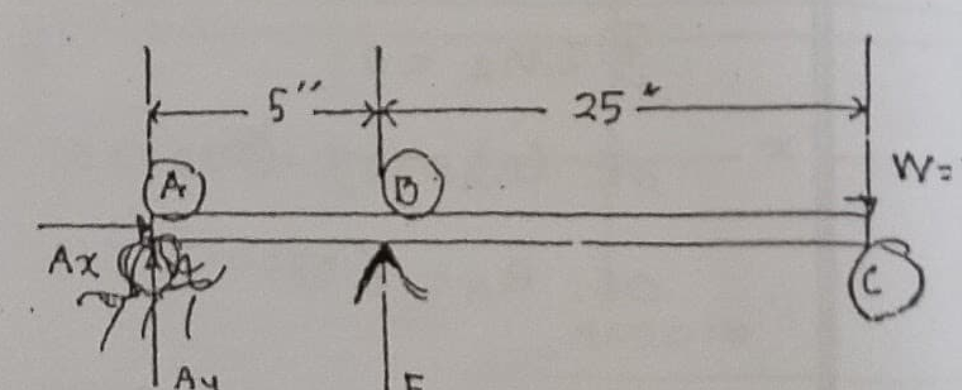
or, $100x - 500 + 180x - 1620 + 100x - 1300 + 200x - 3200 = 0$

or, $x = 11.41'$

Ans:

196.

(i)



$\circlearrowleft \Sigma M_A = 0$

or, $(W \times 30) - (F \times 5) = 0$

or, $F = (210 \times 30)/5$

$\therefore F = 1260$ lb

Pressure $P = \frac{F}{A}$ . . . (i)

Now, Area $A = \frac{\pi D^2}{4} = \frac{\pi 4^2}{4} = 12.57$ in^2

From (i),

$P = \frac{1260}{12.57} = 100.23$ psi. Ans:

(ii) Now, $+\uparrow \Sigma F_y = 0$

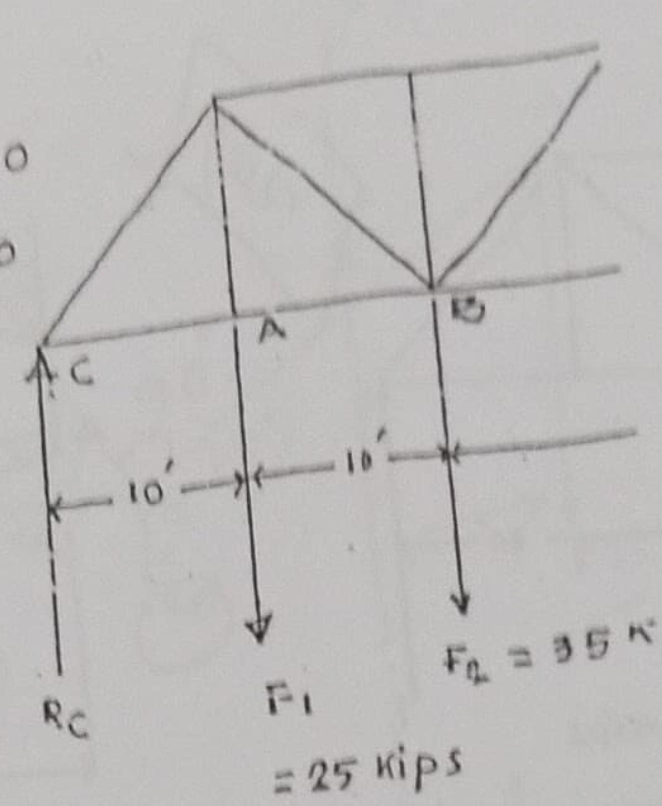
or, $A_y + 1260 - 210 = 0$

or, $A_y = -1050$ lb. $\therefore A_y = 1050$ lb $(\downarrow +)$

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

$\therefore$ Force at pin A = $A_y = 1050$ lb $(\downarrow +)$ Ans:

205.



$\circlearrowright \Sigma M_C = 0$

or, $(F_1 \times 10) + (F_2 \times 20) - (R_D \times 40) = 0$

or, $(25 \times 10) + (35 \times 20) - (R_D \times 40) = 0$

or, $R_D = 23.75$ kips.

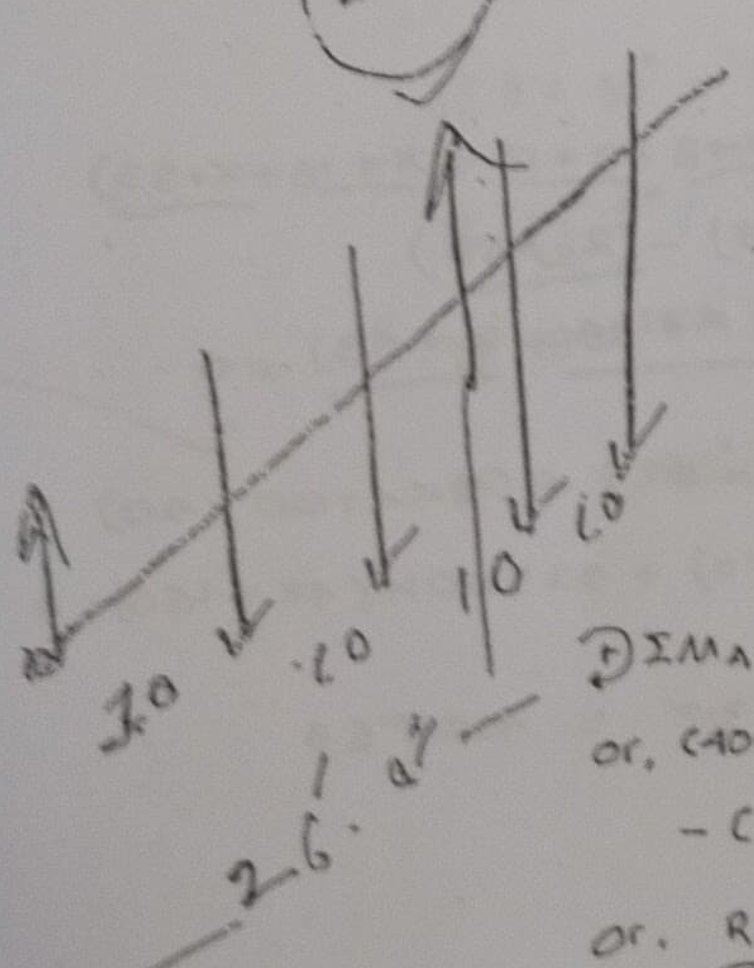
$\circlearrowright \Sigma M_D = 0$

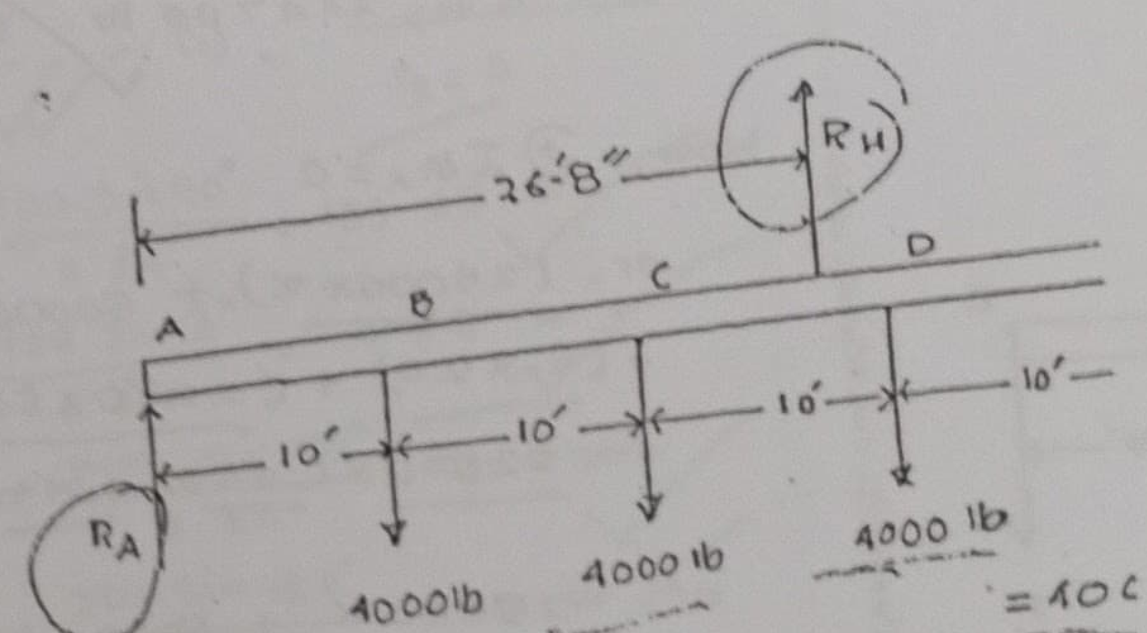
or, $(R_C \times 40) - (F_1 \times 30) - (F_2 \times 20) = 0$

or, $(R_C \times 40) - (25 \times 30) - (35 \times 20) = 0$

or, $R_C = 36.25$ kips. Ans.

207.





$\circlearrowright \Sigma M_A = 0$

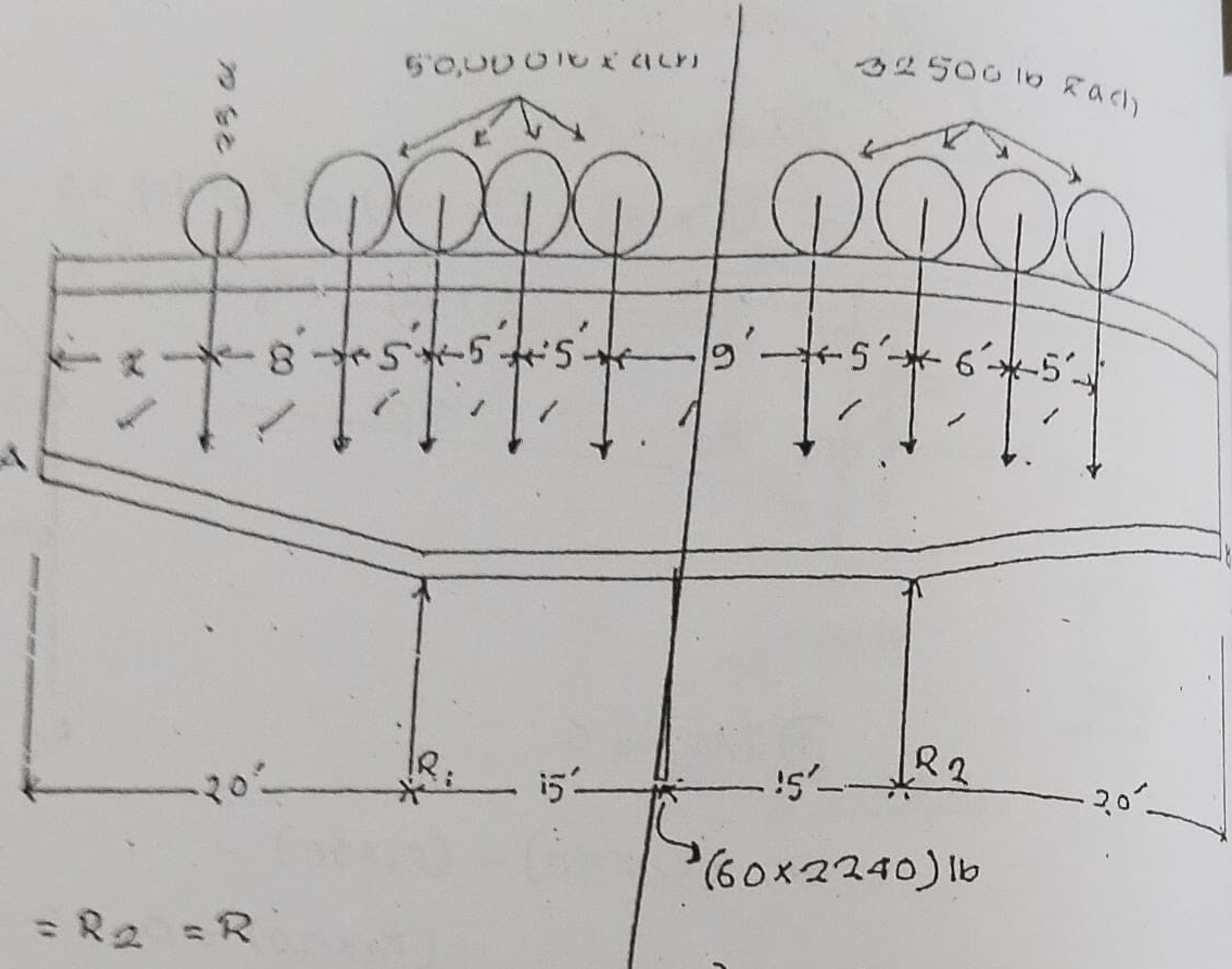
or, $(4000 \times 10) + (4000 \times 20) + (4000 \times 30) + (4000 \times 40) - (R_H \times 26.67) = 0$

or, $R_H = 14998.13$ lb

$\circlearrowright \Sigma M_H = 0$

or, $(R_A \times 26.67) - (4000 \times 16.67) - (4000 \times 6.67) + [4000 \times (40 - 10 - 26.67)] + [4000 \times (40 - 26.67)]$

or, $R_A = 1001.87$ lb   Ans:



Let, $R_1 = R_2 = R$

$\therefore \uparrow \Sigma F_y = 0$

or, $R_1 + R_2 - 25000 - (4\times50000) - (4\times32500) - (60\times2240) = 0$

or, $2R = 489400$

or, $R = 244700$ lb

Now, $\Sigma M_A = 0$

or, $(25000\times x) + 50000\times(x+8 + x+13 + x+18 + x+23) - (R_1\times20) + (2240\times60\times35) - (R_2\times50) + 32500\times(x+32 + x+37 + x+43 + x+48) = 0$

or, $25000x + 50000\times(4x+62) - (244700\times20) + 4704000 - (244700\times50) + 32500\times(4x+160) = 0$

or, $25E3x + 200E3x + 130E3x = 4125E3$

or, $355E3x = 4125E3$

or, $x = 11.62'$

So, the value of $x = 11.62'$ Ans:

210. $\Sigma M_B = 0$

or, $(F\times26\cos30^\circ) - (R_C\times18\cos60^\circ) = 0$

or, $R_C = 250.18$ lb (↓+

$\uparrow \Sigma F_y = 0$

or, $R_B - 250.18 - 100 = 0$

or, $R_B = 350.18$ lb

212. $\Sigma M_O = 0$

or, $(W\times AB) - (T_1\times OC) =$

or, $(100\times7\sin\theta) - (T_1\times3$

or, $T_1 = \frac{700\sin\theta}{3.82}$

If $\theta = 90^\circ$, $T_1 = \frac{700\sin}{3.82}$

If $\theta = 3^\circ$; $T_1 = \frac{700\sin}{3.82}$

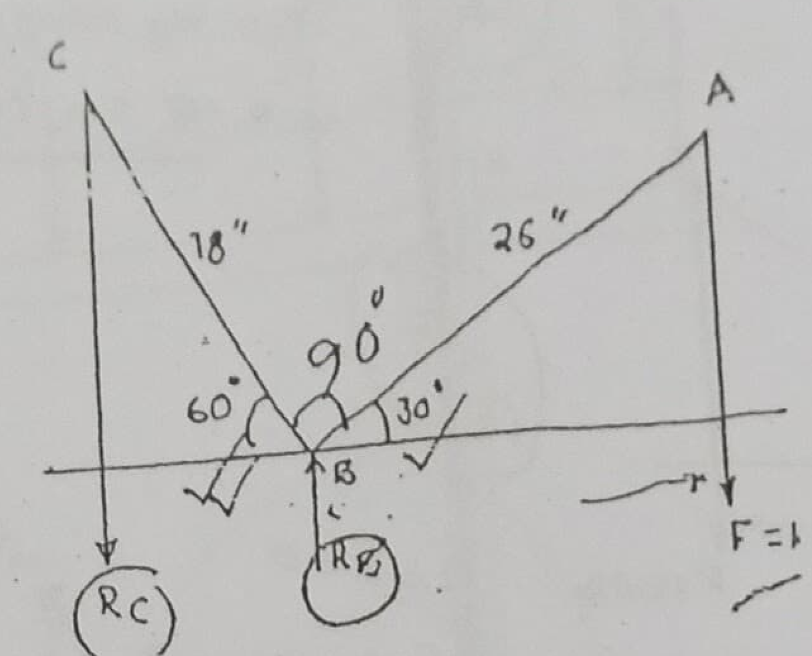
If $\theta = 150^\circ$; $T_1 = \frac{700}{3}$

If $\theta = 180^\circ$; $T_1 = \frac{700\,s}{3}$

210. $\circlearrowleft + \Sigma M_B = 0$

or, $(F \times 26 \cos 30^\circ) - (R_C \times 18 \cos 60^\circ) = 0$

or, $R_C = 250 \cdot 18$ lb $(\downarrow +)$



$+\uparrow \Sigma F_y = 0$

or, $R_B - 250 \cdot 18 - 100 = 0$

or, $R_B = 350 \cdot 18$ lb

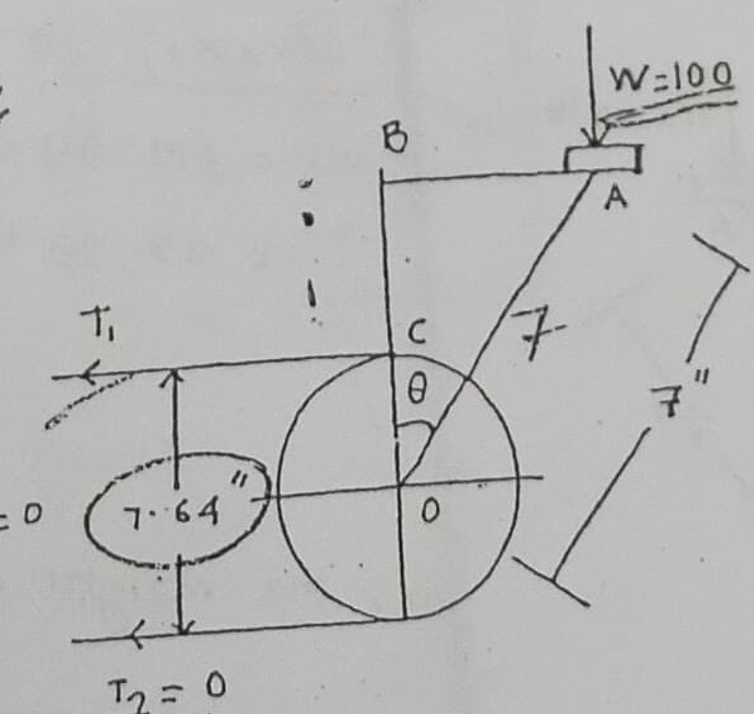
Ans:

212. $\circlearrowleft + \Sigma M_O = 0$

or, $(W \times AB) - (T_1 \times OC) = 0$

or, $(100 \times 7 \sin\theta) - (T_1 \times 3 \cdot 82) = 0$

or, $T_1 = \dfrac{700 \sin\theta}{3 \cdot 82}$ ... (i)



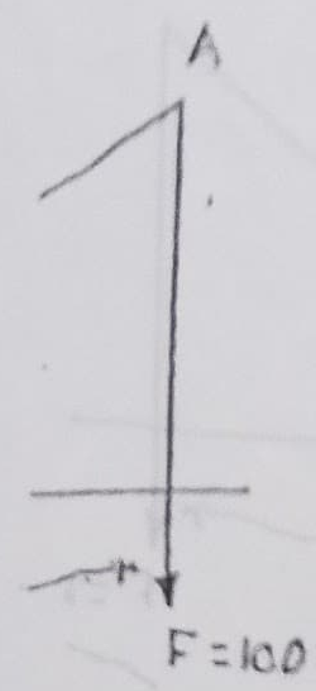
If $\theta = 90^\circ$, $T_1 = \dfrac{700 \sin 90^\circ}{3 \cdot 82} = 183 \cdot 25$ lb

If $\theta = 3^\circ$; $T_1 = \dfrac{700 \sin 3^\circ}{3 \cdot 82} = 9 \cdot 59$ lb

If $\theta = 150^\circ$; $T_1 = \dfrac{700 \sin 150^\circ}{3 \cdot 82} = 91 \cdot 62$ lb

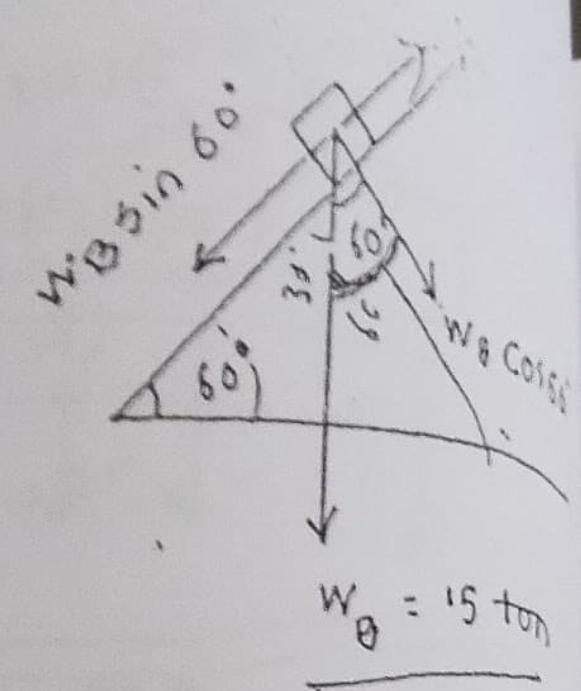
If $\theta = 180^\circ$; $T_1 = \dfrac{700 \sin 180^\circ}{3 \cdot 82} = 0$ lb

Ans:



$T = W_B \sin 60^\circ$

$= 15 \sin 60^\circ = 12.99$ tons



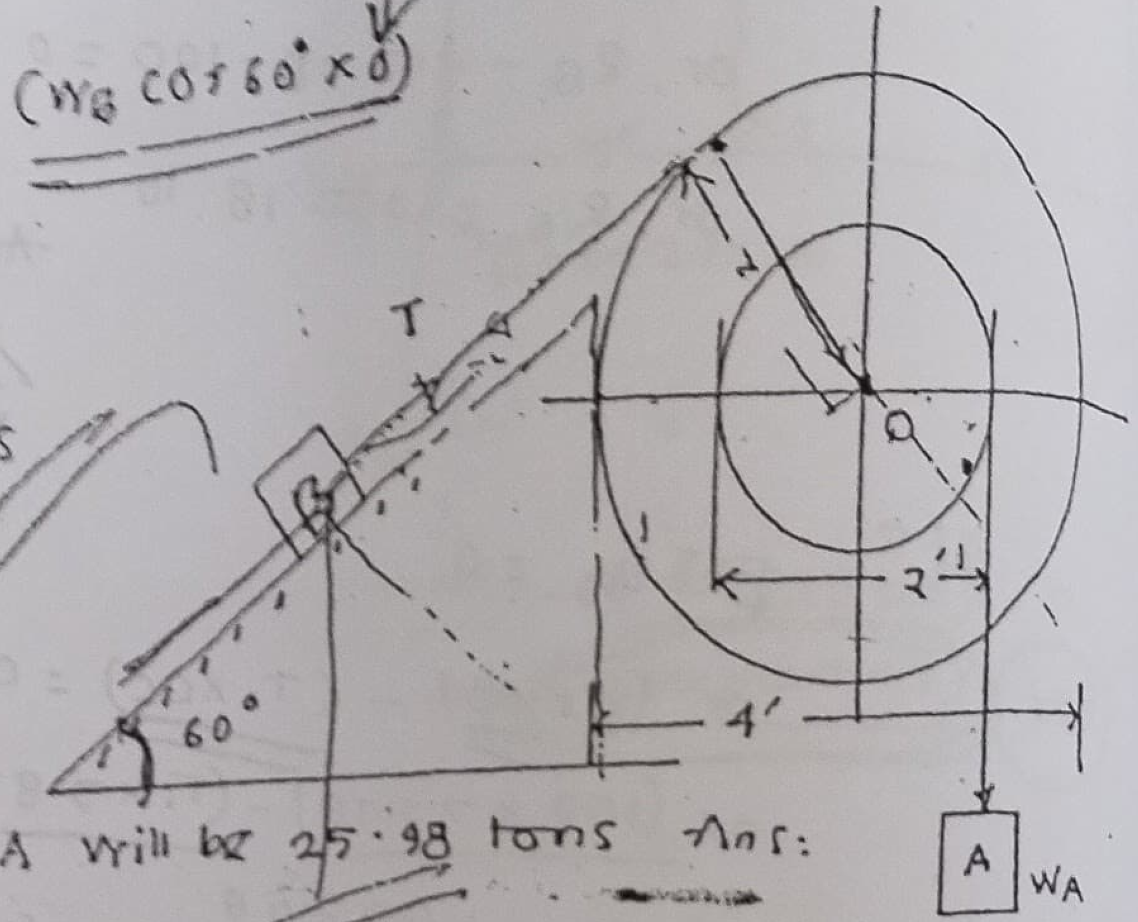
$\Sigma M_o = 0$

$(-W_B \sin 60^\circ \times 2) + (W_B \cos 60^\circ \times 0)$

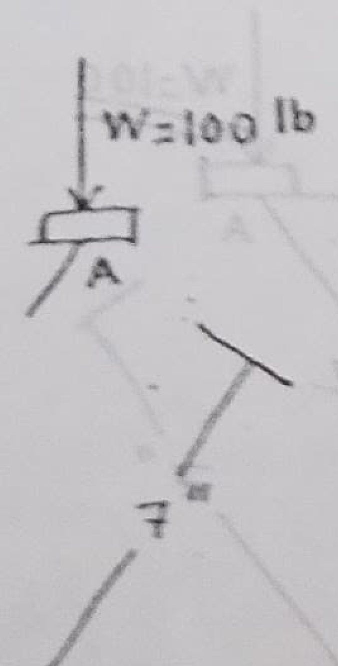
$+ (W_A \times 1) = 0$

$W_A = (12.99 \times 2)$

$= 25.98$ tons



So, the weight of A will be 25.98 tons Ans:



215. $\circlearrowleft + \Sigma M_G = 0$

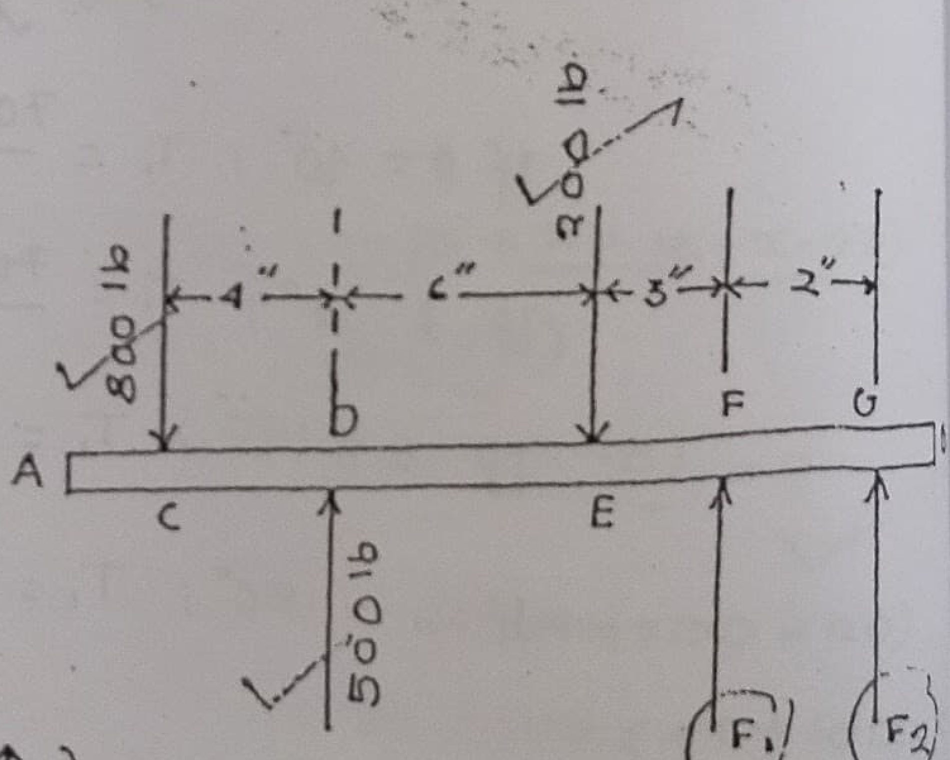
or, $(-800 \times 15) + (500 \times 11)$

$-(200 \times 5) + (F_1 \times 2) = 0$

or, $2F_1 = 7500$

or, $F_1 = 3750$ lb

$\therefore F_1 = 3750$ lb $(\uparrow +)$



$\circlearrowleft + \Sigma M_F = 0$

or, $(-800 \times 13) + (500 \times 9) - (200 \times 3) - (F_2 \times 2) = 0$

or, $2F_2 = -6500$

or, $F_2 = 3250$ lb $(\downarrow +)$

Bending moment at C $= \circlearrowleft + \Sigma M_c = (-500 \times 4) + (200 \times 10)$

$-(3750 \times 13) + (3250 \times 15)$

Bending moment at E $= \circlearrowleft + \Sigma M_E$ to the left

$= (500 \times 6) - (800 \times 10) = -5000$ in

216.

$\circlearrowleft + \Sigma M_A = 0$

or, $(3500 \times 4) + (4000 \times 1$

$+ (5000 \times 18) - (R_{BC} \times$

or, $R_{BC} = (144000/$

$\therefore R_{BC} = 12000$ lb

Again,

$\circlearrowleft + \Sigma M_o = 0$

or, $(R_{BC} \times 2) - (W \times \frac{D}{2}$

or, $(12000 \times 2) - ($

or, $D = 12$

$\therefore D =$

217.

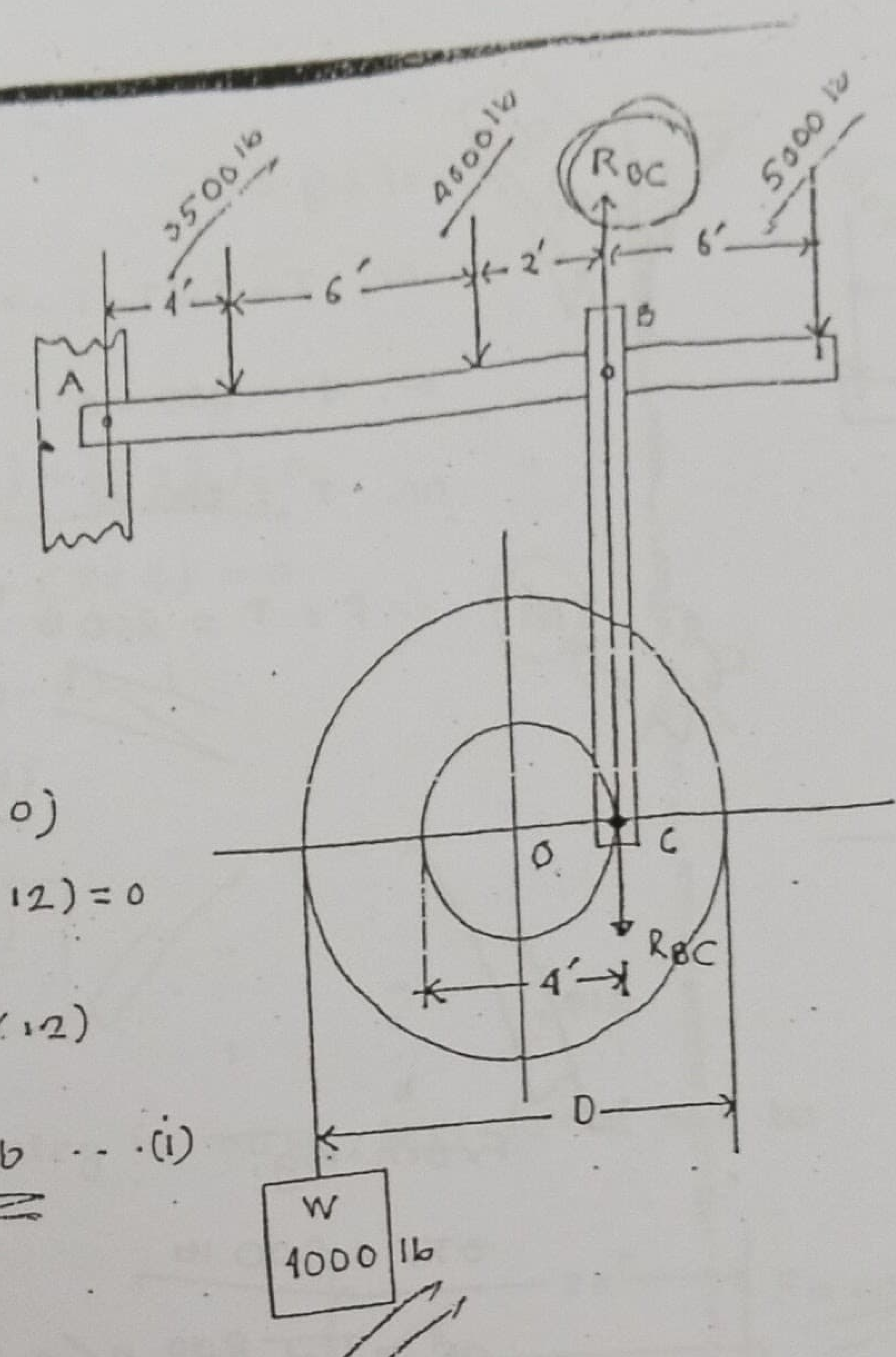
As per the figure,

$T_1 = \frac{W}{2} = \frac{800}{2} = 400$

$T_2 = \frac{T_1}{2} = \frac{400}{2} = 200$ lb

$T_3 = \frac{T_2}{2} = \frac{200}{2} = 100$

$\therefore F = T_3 = 100$ lb



$\circlearrowleft \Sigma M_A = 0$

or, $(3500 \times 4) + (4000 \times 10) + (5000 \times 18) - (R_{BC} \times 12) = 0$

or, $R_{BC} = (144000/12)$

$\therefore R_{BC} = 12000$ lb ... (i)

Again,

$\circlearrowleft \Sigma M_O = 0$

or, $(R_{BC} \times 2) - (W \times \frac{D}{2}) = 0$

or, $(12000 \times 2) - (1000 \times \frac{D}{2}) = 0$

or, $D = 12'$

$\therefore D = 12$ ft Ans:

21 7)

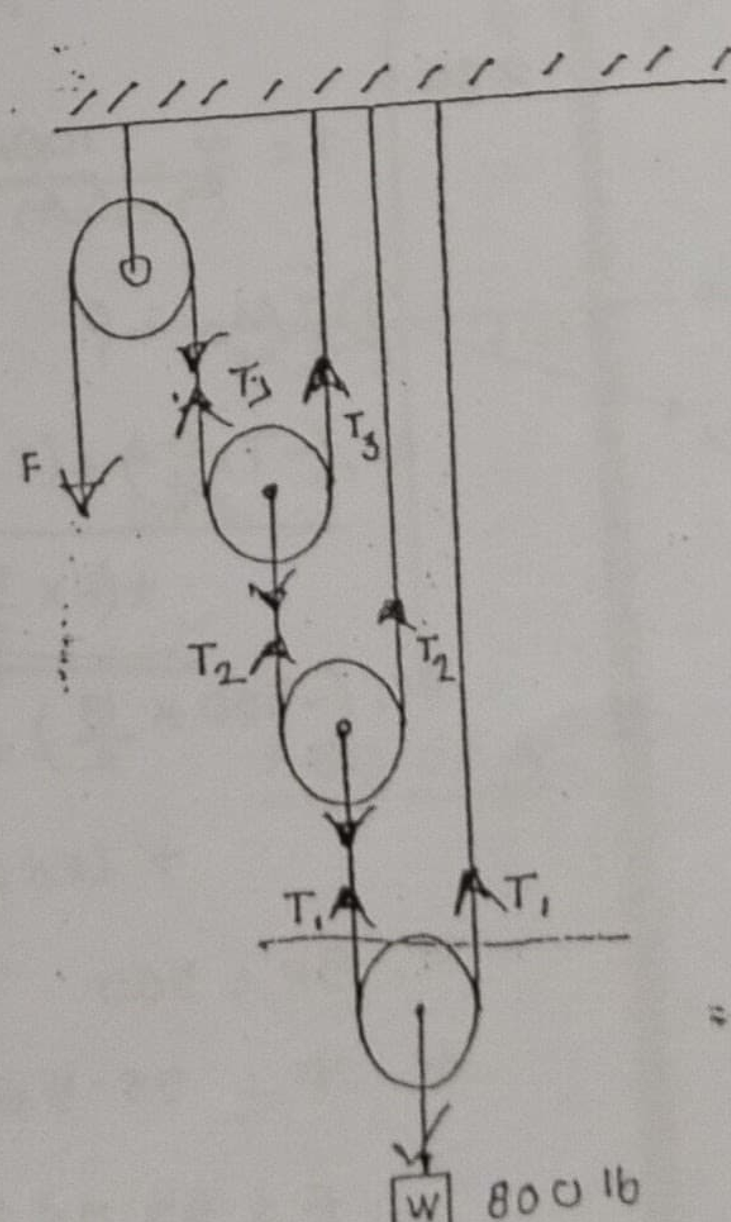
As per the figure,

$T_1 = \frac{W}{2} = \frac{800}{2} = 400$ lb

$T_2 = \frac{T_1}{2} = \frac{400}{2} = 200$ lb

$T_3 = \frac{T_2}{2} = \frac{200}{2} = 100$ lb

$\therefore F = T_3 = 100$ lb Ans:



218.

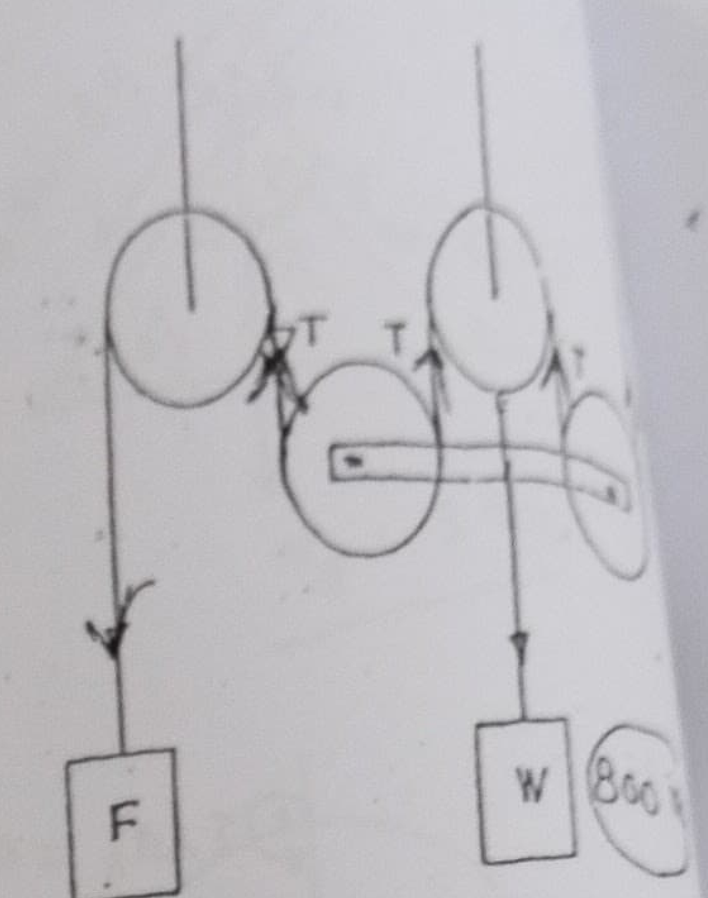
$+\uparrow \Sigma F_y = 0$

or, $T + T + T + T - W = 0$

or, $4T - 800 = 0$

or, $T = 200$ lb

$\therefore F = T = 200$ lb Ans:



219.

From Fig.

$3T_1 = 800$ lb

or, $T_1 = \frac{800}{3}$ lb ... (i)

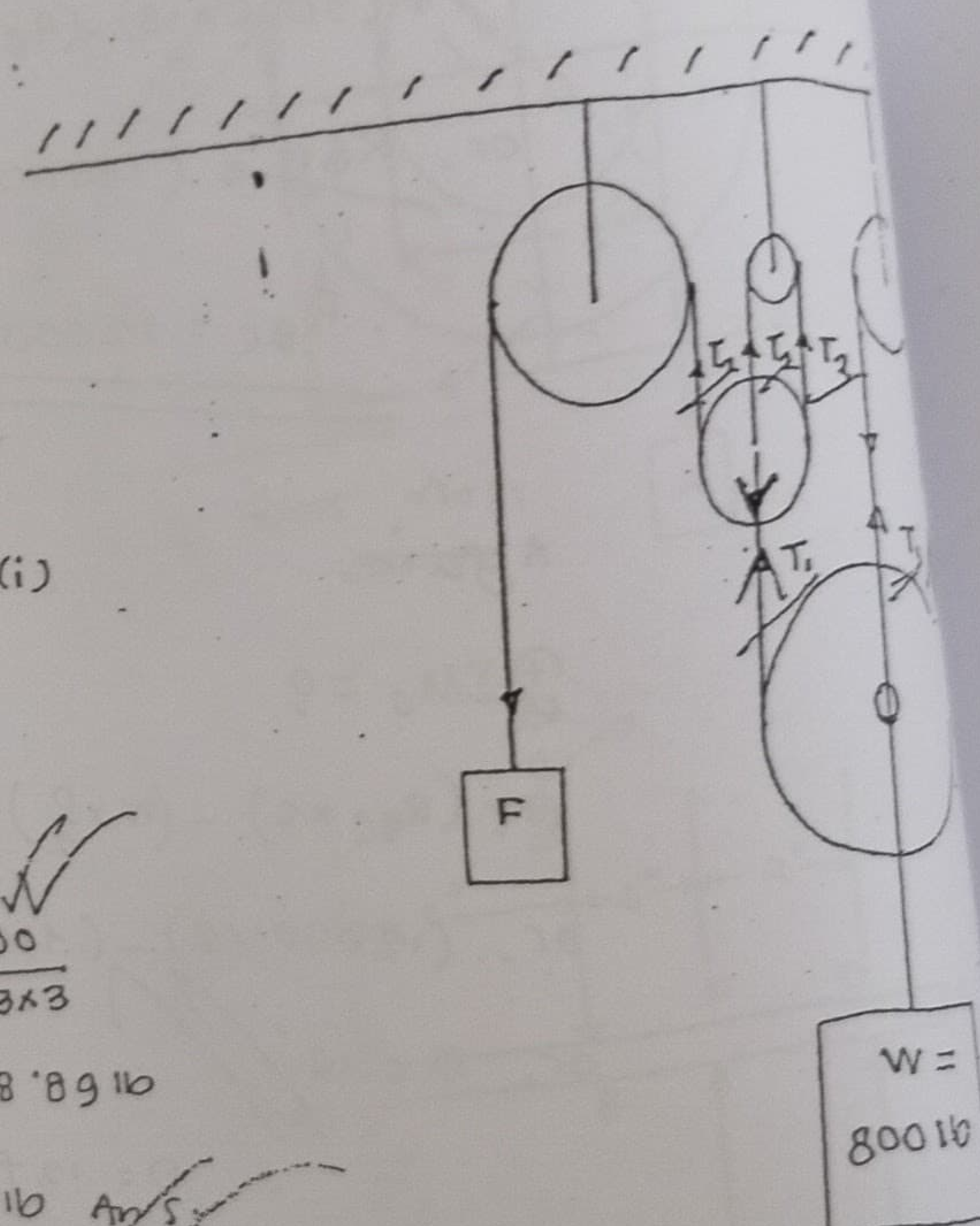
Again, $3T_2 = T_1$

or, $T_2 = \frac{T_1}{3}$

$= \frac{800}{3 \times 3}$

or, $T_2 = 88.89$ lb

$\therefore F = T_2 = 88.89$ lb Ans:



220.

$T = \frac{W}{2} = \frac{1000}{2} = 500$ lb

$\circlearrowright \Sigma M_O = 0$

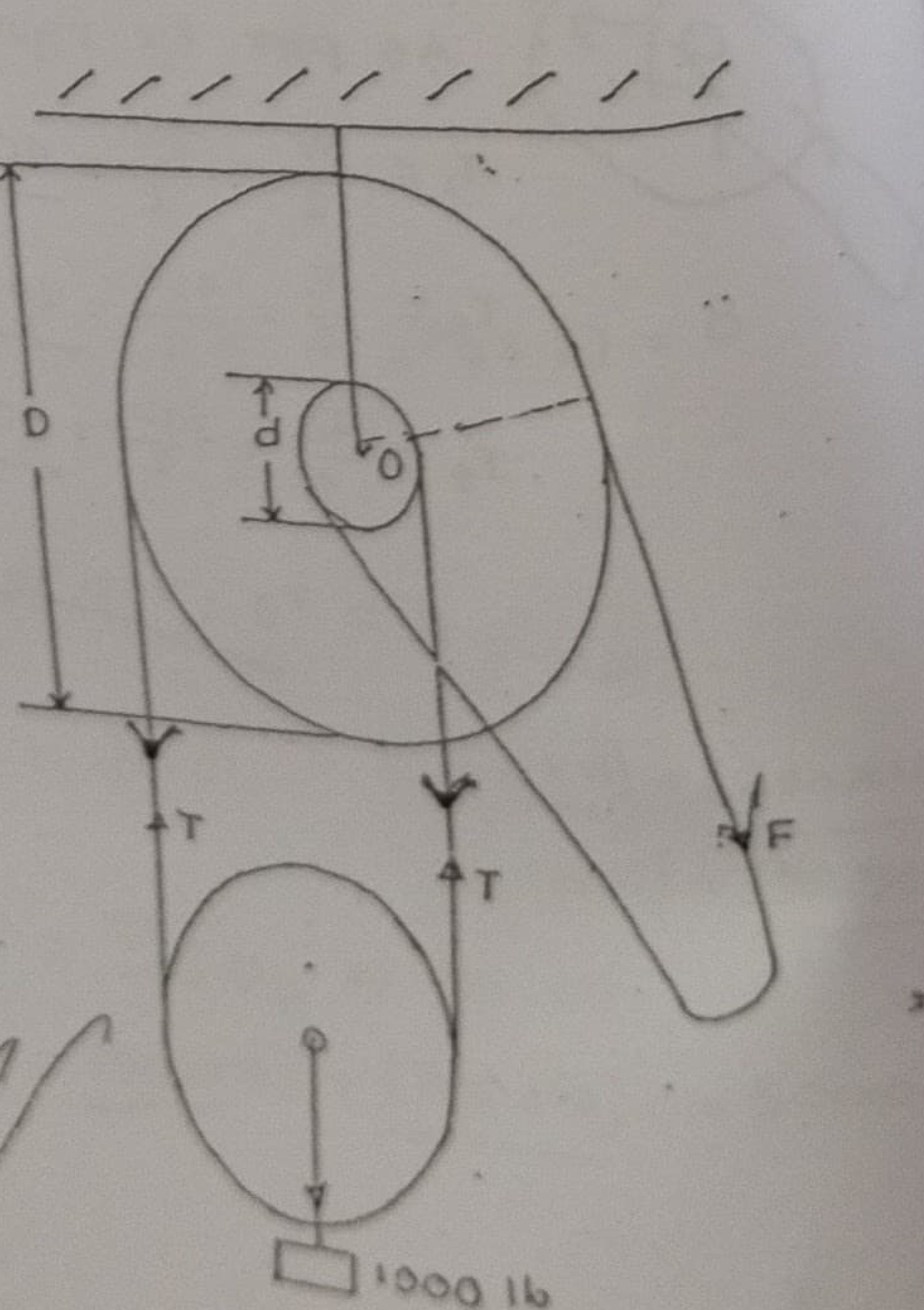
or, $\left(-T \times \frac{D}{2}\right) + \left(T \times \frac{d}{2}\right) + \left(F \times \frac{D}{2}\right) = 0$

or, $\left(-500 \times \frac{18}{2}\right) + \left(500 \times \frac{16}{2}\right) + \left(F \times \frac{18}{2}\right) = 0$

or, $9F = 500$

or, $F = 55.56$ lb

$\therefore F = 55.56$ lb Ans:



221. From previous

$T = \frac{W}{2}$ ... (i)

$\circlearrowright \Sigma M_O = 0$

or, $\left(-T \times \frac{D}{2}\right) + (T$

or, $(F \times D) - (T \times$

or, $F \times D = T$

or, $F = \frac{T(}{}$

$\therefore F = \frac{W(}{}$

If dia of in

required.

222.

$\circlearrowright \Sigma M_C = 0$

or, $(60 \times 20$

or, $R_n =$

From F

By apply

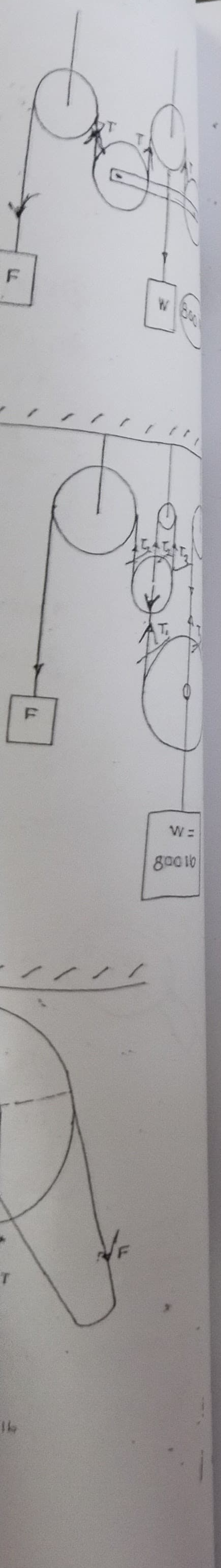
$\frac{100}{\sin(90° +}$

or, N_A

So, th

betwe

100 lb



221. From previous fig.

$T = \frac{W}{2}$ ... (i)

$\circlearrowright \Sigma M_O = 0$

or, $\left(-T \times \frac{D}{2}\right) + \left(T \times \frac{d}{2}\right) + \left(F \times \frac{D}{2}\right) = 0$

or, $(F \times D) - (T \times D) + (T \times d) = 0$

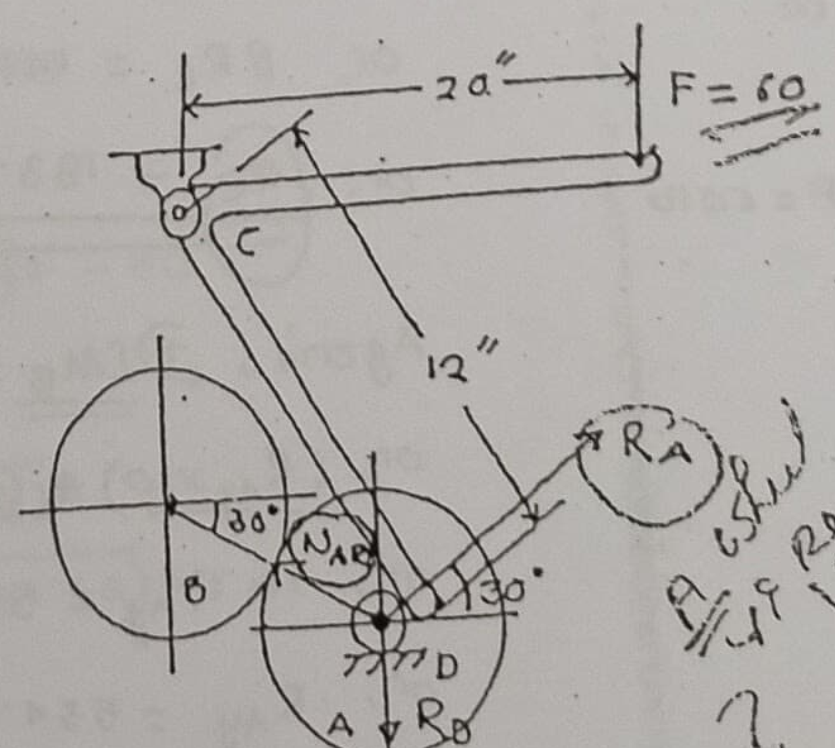
or, $F \times D = T \times (D - d)$

or, $F = \frac{T(D-d)}{D}$

$\therefore F = \frac{W(D-d)}{D}$

If dia of inner pulley is more, less force will be required.

222.



$\circlearrowright \Sigma M_C = 0$

or, $(60 \times 20) - (R_A \times 12) = 0$

or, $R_A = 100$ lb ... (i)

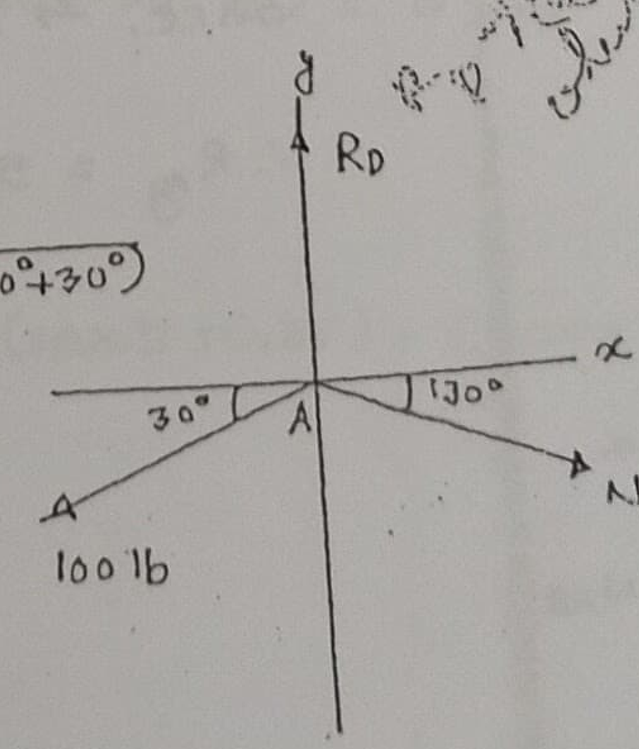
From FBD of A,

By applying Lami's theorem,

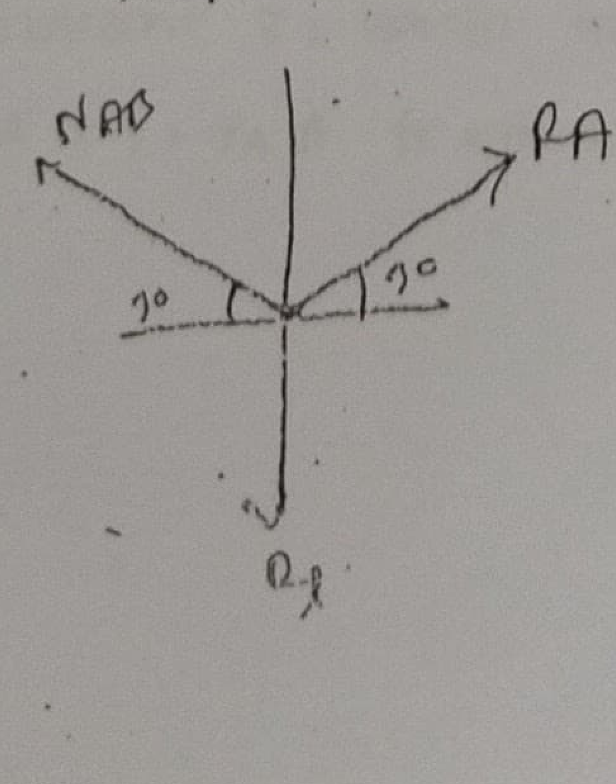
$$\frac{100}{\sin(90° + 30°)} = \frac{R_D}{\sin(180° - 60°)} = \frac{N_{AB}}{\sin(90° + 30°)}$$

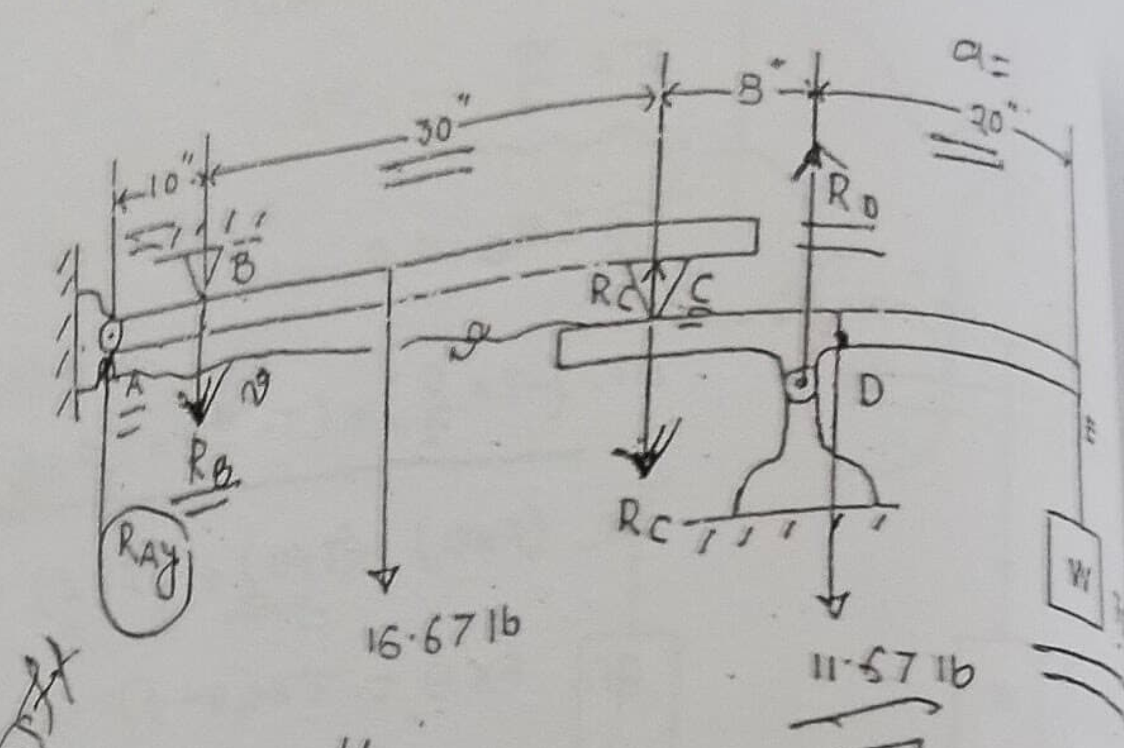
or, $N_{AB} = 100$ lb

So, the normal force between the wheels will be 100 lb. Ans.



FBD of A



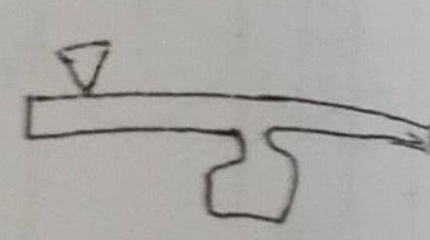


$$W_{AC} = \frac{5\times 40}{12} = 16\cdot 67 \text{ lb}$$

$$W_{CE} = \frac{5\times 28}{12} = 11\cdot 67 \text{ lb}$$

$\therefore \sum M_D = 0$

or, $(-R_C \times 8) + (11\cdot 67 \times 6) + (70 \times 20) = 0$



or, $8R_C = 1470$

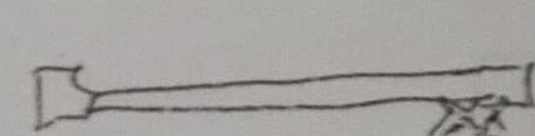
or, $R_C = 183\cdot 75$ lb . . . (i)

Again, $\sum M_B = 0$

or, $(R_{Ay} \times 10) + (16\cdot 67 \times 10) - (183\cdot 75 \times 30) = 0$

or, $10\, R_{Ay} = 5345\cdot 8$

or, $R_{Ay} = 534\cdot 58$ lb



Since, $\sum F_x = 0$; $\therefore R_{Ax} = 0$

$\therefore R_{Ay} = 534\cdot 58$ lb at 90° Ans: