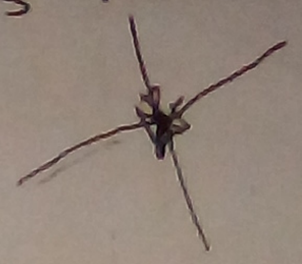
FREE BODY.

important rules:

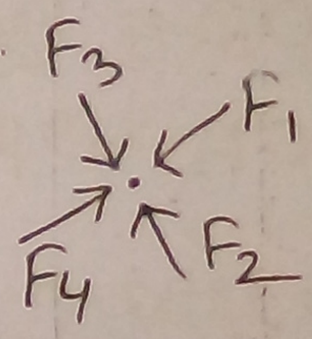
1) Free body diagram:

Inwhich diagram of a body shows us where many forces are acting at same point or different points is known as the free body diagram.



> concurrent forces:

Inwhich forces are acting at a same point are called the concurrent forces.



In the fig: we see F_1, F_2, F_3, F_4 are the concurrent forces.

> co-planner forces:

When many forces are applied at a same plane are known as the co-planner forces.

> Non-co-planner forces:

When many forces are applied at different plane are known as the non-co-planner forces.

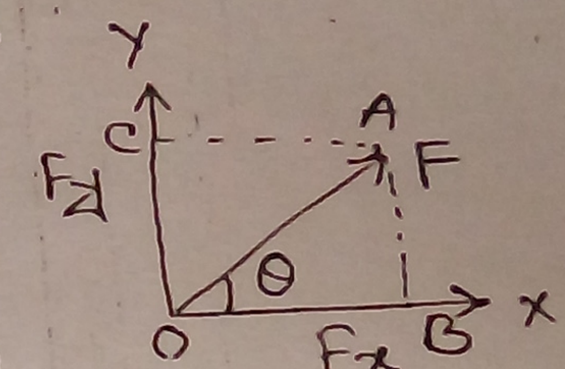
⇒ Statics ——————.

When a body is not moved after applying external forces then it is said to be statics.

⇒ Dynamics:

When a body is moved after applying external forces then it is said to be dynamics.

⇒ Regulation of force:



Here, $OB = Fx$.

$OC = Fy$.

$OA = F$ (resultan force).

∴ Resultan, force,

$$F = \sqrt{Fx^2 + Fy^2} \quad \text{——— (i)}.$$

∴ Direction, $\theta = \tan^{-1}.\left(\frac{Fy}{Fx}\right)$ ——— (ii).

⇒ Important law:

1. At statics condition,

$\sum Fx = 0$.

$\sum Fy = 0$.

$\sum M_p = 0$.

Moment:

The resultan of the multiple of force and the perpendicular distance which point it will be worked and the fixed point is called the moment of that point.

∴ Moment = force × perpendicular distance.

∴ $M = F \times d$ ——— ①

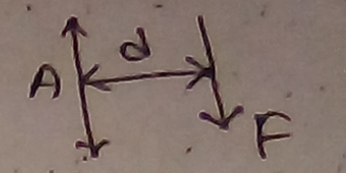
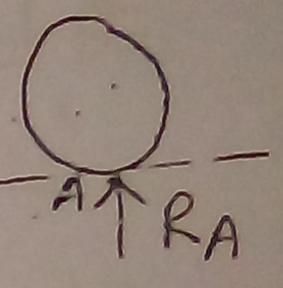


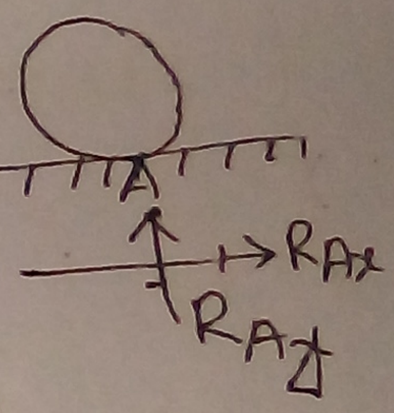
fig: 1.

⇒ Some surface and acting force:

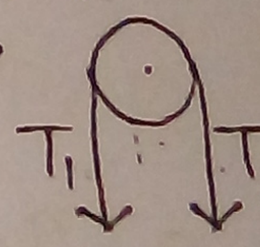
1. Smooth surface has only a perpendicular force.



2. Non smooth surface has two forces, horizontal and perpendicular both forces.

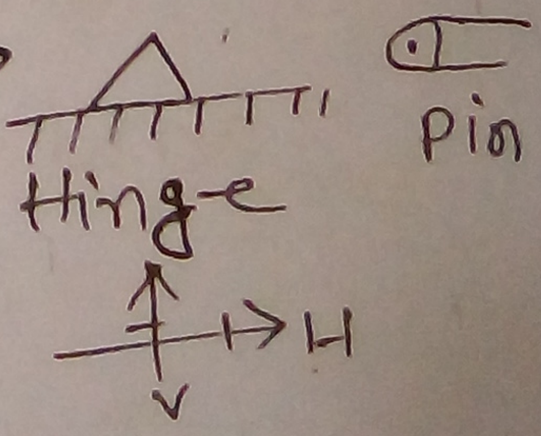


3. Frictionless pulley are when smooth, then the tensions are allways equal.
Like cables, Ropes, strings.

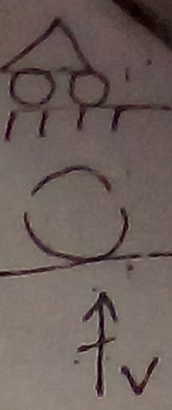


$T_1 = T_2$

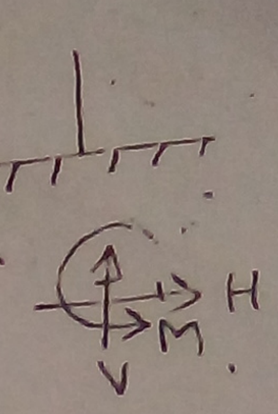
4. Hinge or pin support has two kinds of forces, horizontal and perpendicular forces.



5. Roller support has only a force which is perpendicular acting.

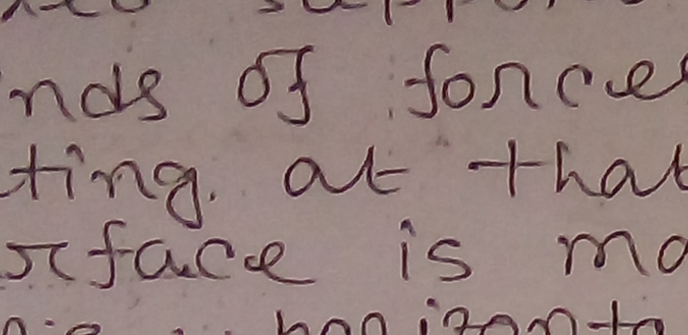


6. fixed support has three kinds of forces which are acting at that point where surface is made.
Here, horizontal, perpendicular and moment are the forces.



⇒ <u>Load distribution</u>:

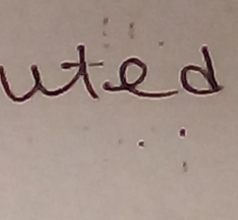
1. Uniformly load is distributed in - rectangular shape.



∴ Total load, = length x weight.
= L x W.

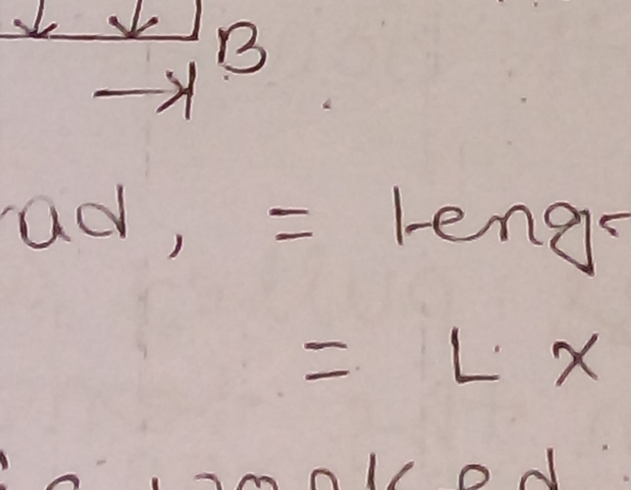
And it is worked as $\frac{L}{2}$ distance.

2. In triangular shape.



∴ T.L = $\frac{1}{2}$ x L x W.

and worked as distance.



Statement of LAMI'S theorem:

If three co-planner forces are acting at a point in different straight lines be in equilibrium then each is proportional to the angle of sine between the other two.

⇒ Proof of theorem:

Here, $\vec{P}, \vec{Q}, \vec{R}$ are the three co-planner forces acting on o point. And, we get they are acting in different straight line be in equilibrium. Now. we think, $R \wedge Q = \alpha$, $Q \wedge P = \gamma$, $P \wedge R = \beta$. Now, we get for the condition of equilibrium.

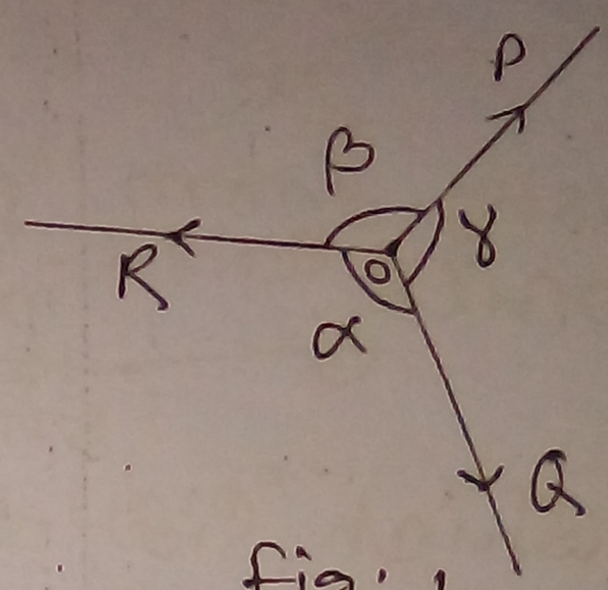


fig: 1

$$\vec{P} + \vec{Q} = -\vec{R}.$$

$$\Rightarrow \vec{P} + \vec{Q} + \vec{R} = 0. \quad \text{——— (1)}.$$

$$\Rightarrow \vec{P} \times \vec{P} + \vec{Q} \times \vec{P} + \vec{R} \times \vec{P} = 0.$$

$$\Rightarrow \hat{n}\, Q \cdot P \cdot \sin Q \wedge P = + P \cdot R \cdot \sin P \wedge R \cdot \hat{n}.$$

$$\Rightarrow Q \cdot \sin\gamma = R \cdot \sin\beta.$$

$$\therefore \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}. \quad \text{——— (11)}.$$

[$\because \vec{A} \times \vec{B} = \hat{n} A B \sin \angle AOB$ and $\vec{A} \times \vec{A} = \hat{n} A^2 \sin 0^\circ = 0$].

Again, from ①. $\vec{P}+\vec{Q}+\vec{R}=0$.

$\Rightarrow \vec{P}\times\vec{Q}+\vec{Q}\times\vec{Q}+\vec{R}\times\vec{Q}=0$.

$\Rightarrow \vec{P}\times\vec{Q}=\vec{Q}\times\vec{R}$.

$\Rightarrow \hat{n}\,PQ\sin P\wedge Q = \hat{n}\,Q\cdot R\sin Q\wedge R$.

$\Rightarrow -P\cdot\sin\gamma = -R\cdot\sin\alpha$.

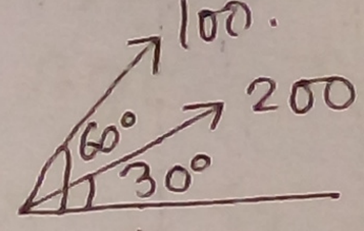
$\therefore \frac{P}{\sin\alpha}=\frac{R}{\sin\gamma}$. ——— (iii).

Now, from (ii) and (iii) no. equn. we may write,

$$\frac{P}{\sin\alpha}=\frac{Q}{\sin\beta}=\frac{R}{\sin\gamma} \quad \text{——— (iv)}.$$

which is the required equation to be proved the theorem. (proved).

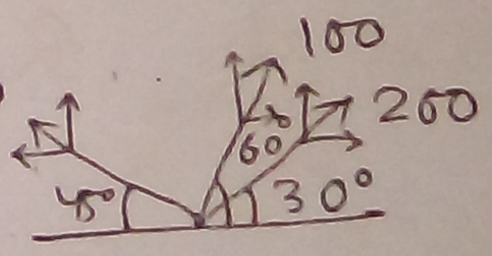
Resultan force:



$\therefore F=\sqrt{(200)^2+(100)^2+2\times100\times200\times\cos30^\circ}$.

$= 290.93$ unit. Ans:-

Determination of the rectangular components of each forces:



$\therefore (F_1)_x = 200\cos30^\circ = 173.21$.

$\therefore (F_1)_y = 200\sin30^\circ = 100$.

$\therefore (F_2)_x = 100\cos60^\circ = 50$.

$\therefore (F_2)_y = 100\sin60^\circ = 86.61$.

$\therefore (F_3)_x = -150\cos45^\circ = -106.06$.

$\Sigma fy = 150 \times \sin 41.40 = 100.00$

$\therefore Rx = \Sigma fx = 112.15.$

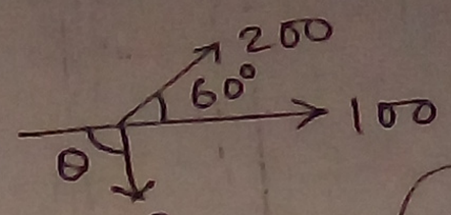
$\therefore Ry = \Sigma fy = 202.66.$

$\therefore R = \sqrt{Rx^2 + Ry^2}.$

$= 315.23$ unit.

$\therefore \theta = \tan^{-1}\left(\frac{Ry}{Rx}\right) = 68.19°.$

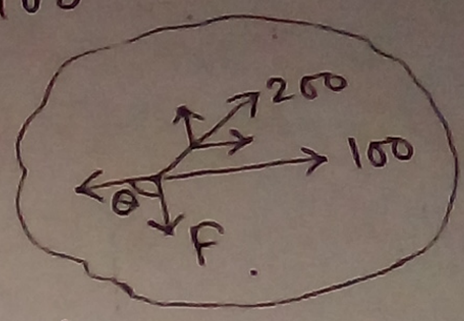
(2) Find out the F.



$\therefore \Sigma fx = 0.$

$\Rightarrow 100\cos 0° + 200\cos 60° - F\cos\theta = 0.$

$\therefore F\cos\theta = 200.$ ——— (i).



$\therefore \Sigma fy = 0 \Rightarrow 100\sin 0° + 200\sin 60° - F\sin\theta = 0.$

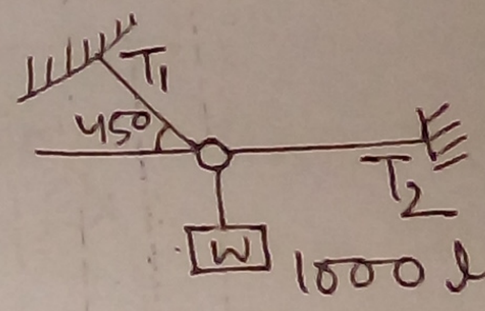
$\therefore F\sin\theta = 173.21$ ——— (ii).

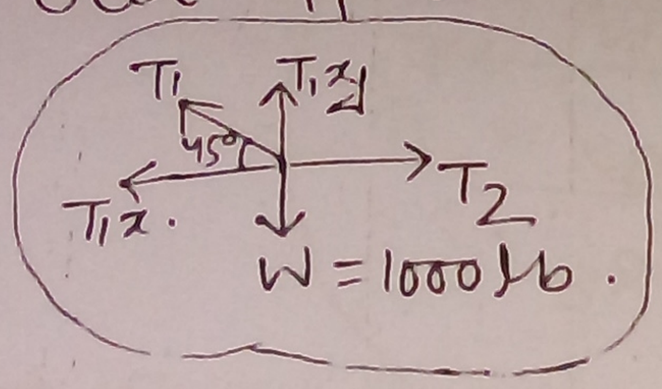
$\therefore \tan\theta = \frac{173.21}{200}. \quad \therefore \theta = 40.9°.$

$\therefore F = \frac{200}{\cos 40.9°} = 264.55$ unit.

Ans:-

(3) Find out T_1 and T_2:





By considering the f.b.d.

$\therefore \Sigma Fx = 0 \Rightarrow T_2 = T_1 x = T_1 \cos 45°.$ ——— (i).

$\therefore \Sigma Fy = 0 \Rightarrow T_1 y - W = 0 \Rightarrow T_1 \sin 45° = W = 1000$

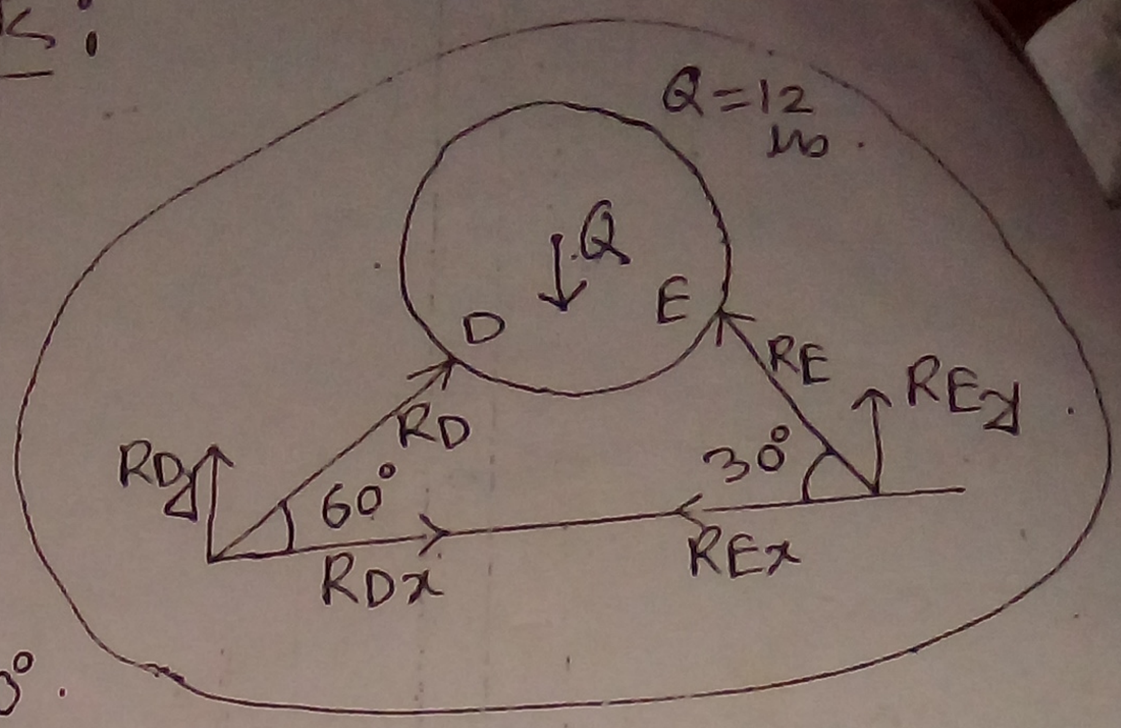
$\therefore T_1 = 1414.2$ lb Ans:-

From (i). $T_2 = 1414.21 \times \cos 45°$

$\therefore T_2 = 999.998$ lb. Ans:-

Problem of Book:

1.



By considering the F.b.d.

$\therefore \Sigma F_x = 0$.

$\Rightarrow R_{Dx} - R_{Ex} = 0$.

$\Rightarrow R_D \cos 60^\circ = R_E \cos 30^\circ$.

$\therefore R_D = R_E \tan 60^\circ$. ——①.

$\therefore \Sigma F_y = 0$. $\Rightarrow R_{Dy} + R_{Ey} - Q = 0$.

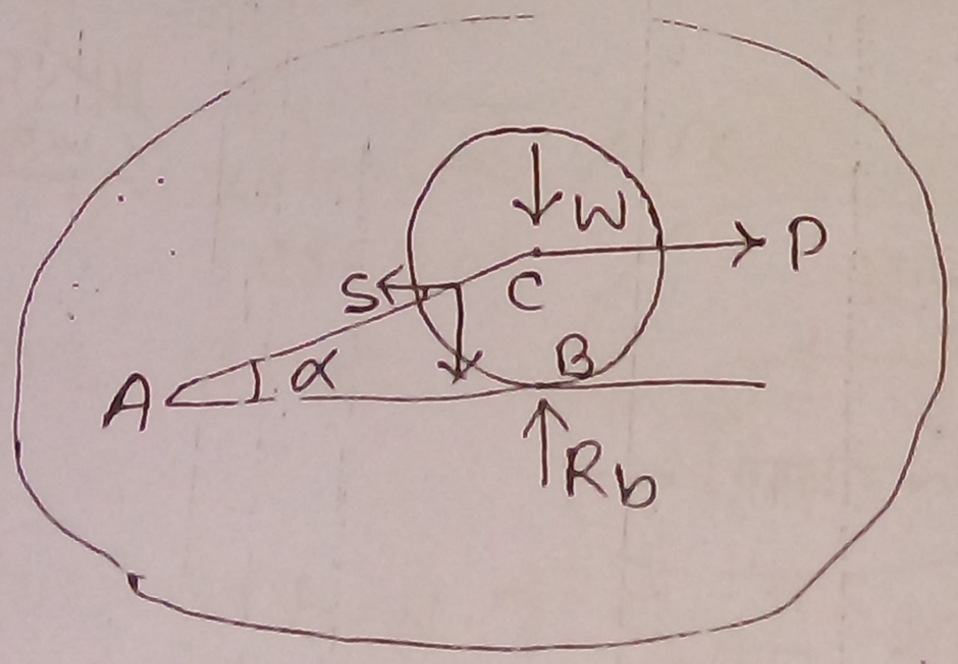
$\Rightarrow R_D \sin 60^\circ + R_E \sin 30^\circ = 12$.

$\Rightarrow R_E \tan 60^\circ \cdot \sin 60^\circ + R_E \sin 30^\circ = 12$.

$\therefore R_E = 6$ lb. Ans!→

Now, from ①, $R_D = 10.39$ lb. Ans!→.

2.



By considering the F.b.d.

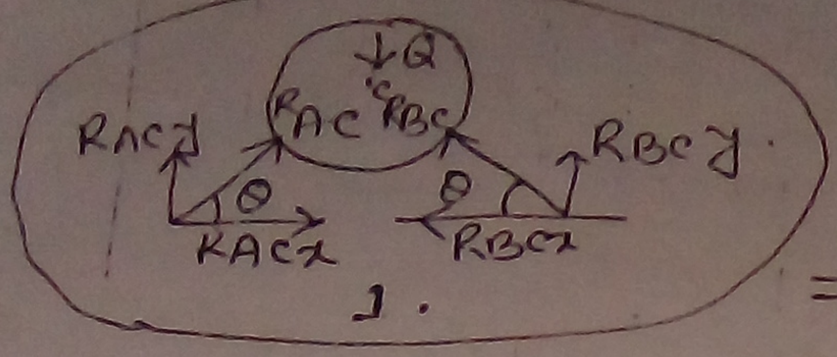
$\therefore \Sigma F_x = 0 \Rightarrow P - S\cos\alpha = 0$.

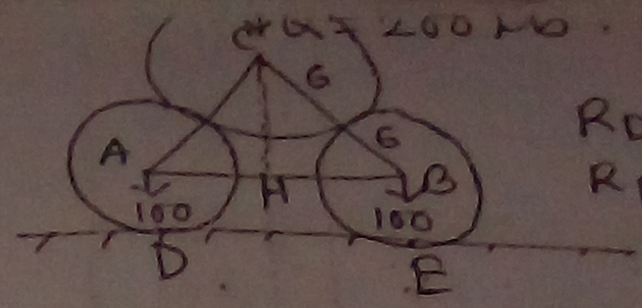
$\Rightarrow S = \frac{P}{\cos\alpha}$. Ans!→

$\therefore \Sigma F_y = 0 \Rightarrow W + S\sin\alpha - R_b = 0$.

$\therefore R_b = W + P\cdot\tan\alpha$. Ans!→

Now, we get.
after c circle
free. then.





From. F.b.d.1.

$\Sigma F_x = 0$

$\Rightarrow R_{ACx} - R_{BCx} = 0.$

$\Rightarrow R_{AC}\cos\theta = R_{BC}\cos\theta.$

$\therefore R_{AC} = R_{BC}$ ——— ①.

$\therefore \Sigma F_y = 0.$

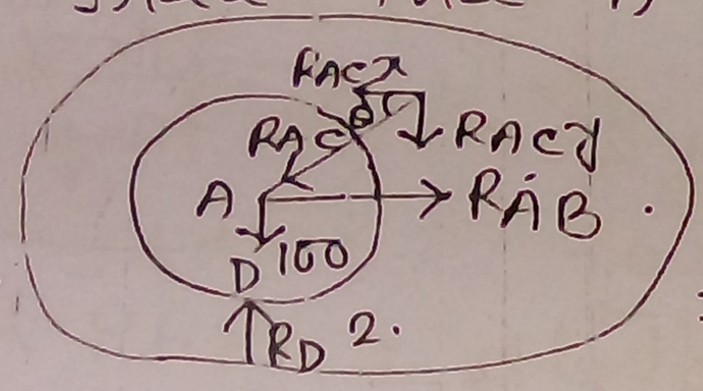
$\Rightarrow R_{ACy} + R_{BCy} - Q = 0.$

$\Rightarrow 2R_{AC}\sin\theta = Q = 200.$

$\therefore R_{AC} = \frac{100}{\sin\theta} = \frac{100}{4\sqrt{5}/12} = 134.16$ lb.

$\therefore R_{BC} = R_{AC} = 134.16$ lb.

Now, by free the A circle.



From. f.b.d.2.

$\therefore \Sigma F_x = 0.$

$\Rightarrow R_{ACx} - R_{AB} = 0.$

$\Rightarrow R_{AB} = R_{AC}\cos\theta.$

$\Rightarrow R_{AB} = 134.16 \times \frac{8}{12}.$

$\Rightarrow R_{AB} = 89.44$ lb.

$\therefore R_{AB} = S = 89.44$ lb.

—Ans:—

$\Sigma F_y = 0.$

$\Rightarrow R_{ACy} + 100 - R_D = 0.$

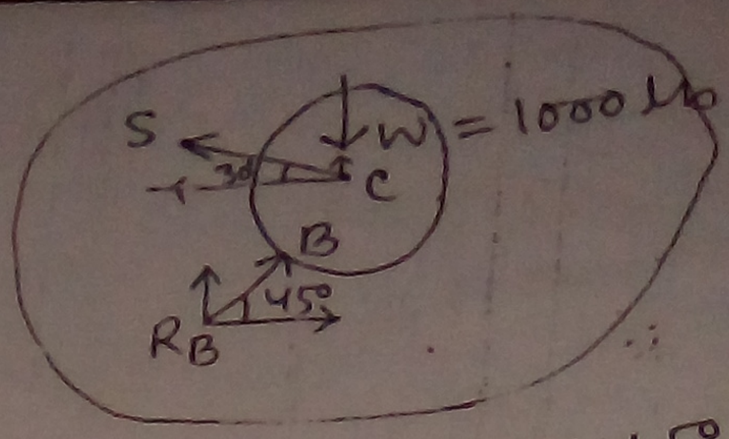
$\Rightarrow R_D = 134.16 \times \sin\theta + 100.$

$\therefore R_D = 134.16 \times \frac{4\sqrt{5}}{12} + 100 = 200$ lb. —Ans:—

From the Q. fig. by taking moment about D point, $\therefore \Sigma M_D = 0 \Rightarrow 100 \times 16 - R_E \times 16 + 200 \times 8 = 0.$

$\therefore R_E = 200$ lb. —Ans:—

5.



S = ?
R_B = ?

By considering the F.b.d. we get.

$\therefore \Sigma F_x = 0 \Rightarrow S\cos 30° - R_B \cos 45° = 0.$

$\therefore S = R_B \cdot \frac{\cos 45°}{\cos 30°}$ ——— (1).

$\therefore \Sigma F_y = 0 \Rightarrow S\sin 30° + R_B \sin 45° - 1000 = 0.$

$\Rightarrow R_B \cdot \cos 45° \cdot \tan 30° + R_B \sin 45° = 1000.$

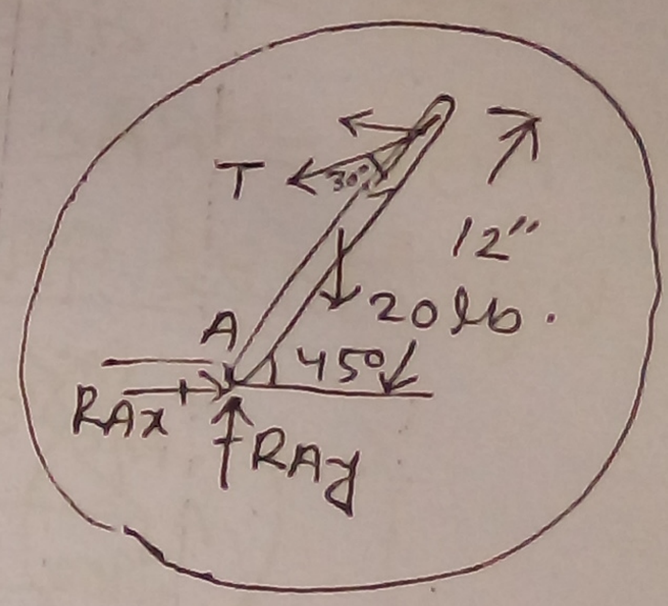
$\therefore R_B = 806.58$ lb. Ans.

Now. from (1). $S = 732.06$ lb. Ans.

6.

By considering the F.b.d.

$\Sigma M_A = 0.$



$\Rightarrow -T\sin 30° \times 12 + 20 \times 6\cos 45° = 0.$

$\therefore T = 14.14$ lb. $= 14.14$ lb.

$\therefore \Sigma F_x = 0 \Rightarrow R_{Ax} - T\cos 15° = 0.$

$\therefore R_{Ax} = 13.658$ lb.

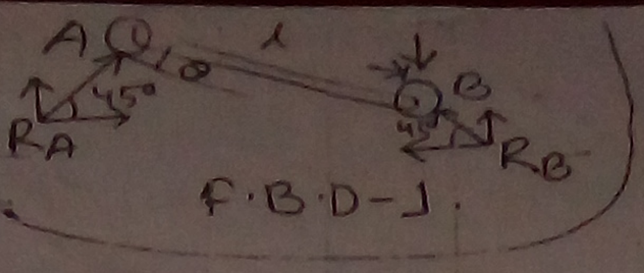
$\therefore \Sigma F_y = 0 \Rightarrow R_{Ay} - 20 - T\sin 15° = 0.$

$\therefore R_{Ay} = 23.659$ lb.

$\therefore R_A = \sqrt{R_{Ax}^2 + R_{Ay}^2}.$

$= 27.38$ lb. Ans.

g consider-
-ing the F·B·D



θ = ?

$\Sigma F_x = 0$

$\Rightarrow R_A \cos 45° - R_B \cos 45 = 0.$

$\therefore R_A = R_B.$ ——— ①

$\Sigma F_y = 0$

$\Rightarrow R_A \sin 45° + R_B \sin 45° - W - 2W = 0.$

$\Rightarrow 2R_A \sin 45° = 3W.$

$\Rightarrow R_A = \frac{3}{2} \cdot \frac{W}{\sin 45°}.$ $\quad \therefore R_B = \frac{3}{2} \cdot \frac{W}{\sin 45°}$

$\therefore \Sigma M_B = 0.$

$\Rightarrow R_A l \cos\theta - Wl \cos(45° - \theta) = 0.$

$\Rightarrow \frac{3}{2} \cdot \frac{W}{\frac{1}{\sqrt{2}}} \cdot l\cos\theta - Wl \cos(45° - \theta) = 0.$

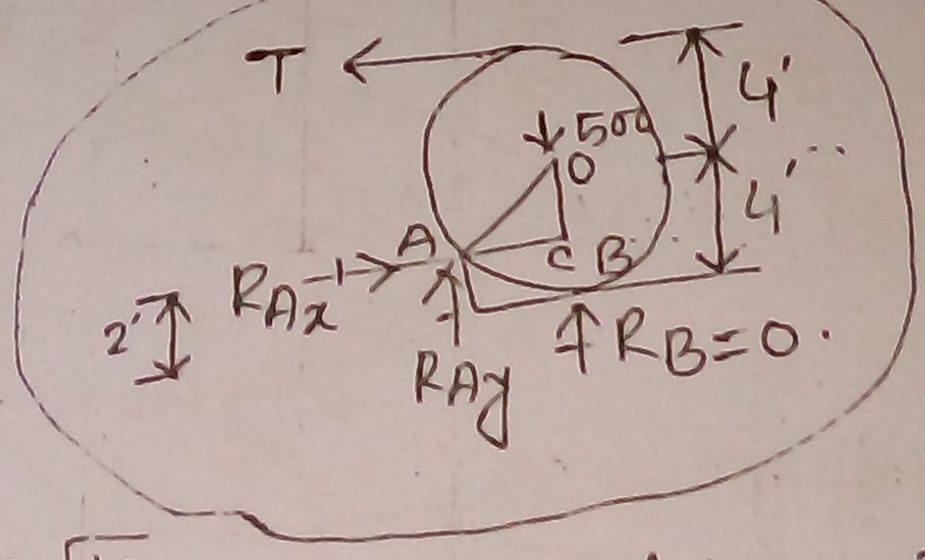
$\Rightarrow \frac{3}{\sqrt{2}} \cdot \cos\theta - \cos(45° - \theta) = 0.$

$\Rightarrow \frac{3}{\sqrt{2}} \cos\theta = \cos 45° \cos\theta + \sin 45° \cdot \sin\theta.$

$\Rightarrow \cos\theta \cdot \left(\frac{3}{\sqrt{2}} - \frac{1}{\sqrt{2}}\right) = \frac{1}{\sqrt{2}} \cdot \sin\theta.$

$\Rightarrow \sqrt{2} \cdot \sqrt{2} = \tan\theta.$ $\quad \therefore \theta = \tan^{-1}(2).$ ~~Ans~~

8.



$OC = 4 - 2 = 2.$

$AO = 4.$

$\therefore AC = \sqrt{4^2 - 2^2} = \sqrt{12}$

$\therefore d = \sqrt{12}.$

$\Sigma M_A = 0.$

$\Rightarrow 500 \times \sqrt{12} - R_B \times \sqrt{12} - T \times 6 = 0.$

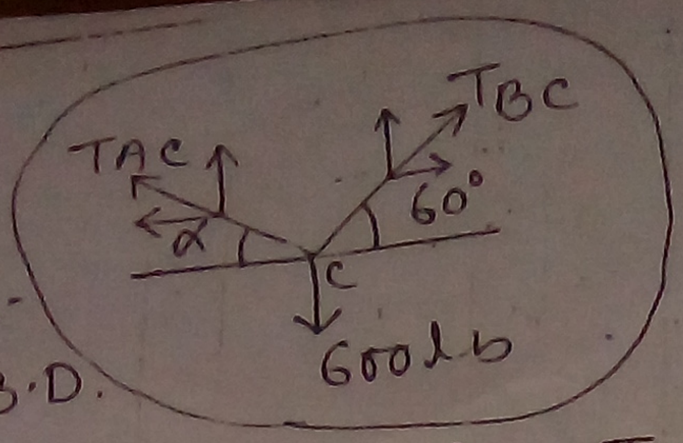
$\therefore T = \frac{500 \times \sqrt{12}}{6} = 288.68 \text{ lb}.$ ~~Ans~~

$\therefore \Sigma f_x = 0 \Rightarrow R_{Ax} - T = 0.$ $\quad \therefore R_{Ax} = T = 288.68 \text{ lb}.$

$\therefore \Sigma f_y = 0 \Rightarrow R_{Ay} - 500 = 0$ $\quad \therefore R_{Ay} = 500 \text{ lb}.$

$\therefore R_A = \sqrt{R_{Ax}^2 + R_{Ay}^2} = 577.36 \text{ lb}.$ ~~Ans~~

13.*



(a) By considering the F.B.D.

$\therefore \Sigma F_x = 0 \Rightarrow T_{BC}\cos 60° - T_{AC}\cos\alpha = 0$

$\therefore T_{BC} = \dfrac{T_{AC}\cos\alpha}{\cos 60°}$ ——— (i).

$\therefore \Sigma F_y = 0$.

$\Rightarrow T_{BC}\sin 60° + T_{AC}\sin\alpha - 600 = 0$.

$\Rightarrow T_{AC}\cos\alpha \cdot \tan 60° + T_{AC}\sin\alpha = 600$.

$\Rightarrow T_{AC} = \dfrac{600}{\sin\alpha + \cos\alpha \cdot \frac{\sin 60°}{\cos 60°}}$

$\Rightarrow T_{AC} = \dfrac{600 \times \cos 60°}{\sin(\alpha + 60°)}$ ——— (ii).

But, for the condition of max., $\alpha + 60° = 90°$

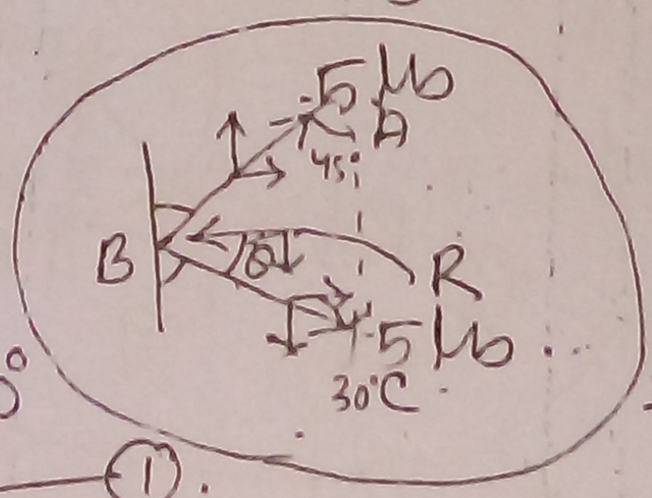
$\therefore \alpha = 30°$ Ans

(b) $\therefore$ From (ii), $T_{AC} = 600 \times \cos 60°$.

$\therefore T_{AC} = 300$ lb. Ans

And, from (i), $T_{BC} = 520$ lb. Ans

14.



$\Sigma F_x = 0$.

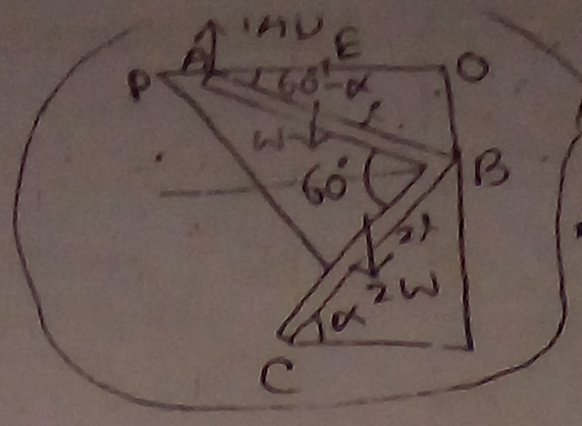
$\Rightarrow 5\cos 45° + 5\cos 60° - R\cos\theta = 0$ ——— (i).

$\therefore \Sigma F_y = 0$.

$\Rightarrow 5\sin 45° - 5\sin 60° + R\sin\theta = 0$ ——— (ii).

From (i), (ii) $\theta = \tan^{-1}\left(\dfrac{0.79}{6.04}\right) \simeq 7.46°$. Ans

From (i), $R = 6.1$ lb. Ans



$AE = \frac{l}{2}\cos(60°-\alpha)$.

$AP = \frac{2l}{2}\cos\alpha - l\cos(60°-\alpha)$.

$\Sigma M_A = 0$.

$\Rightarrow W \times \frac{l}{2}\cos(60°-\alpha) - 2W\left\{\frac{2l}{2}\cos\alpha - l\cos(60°-\alpha)\right\} = 0$.

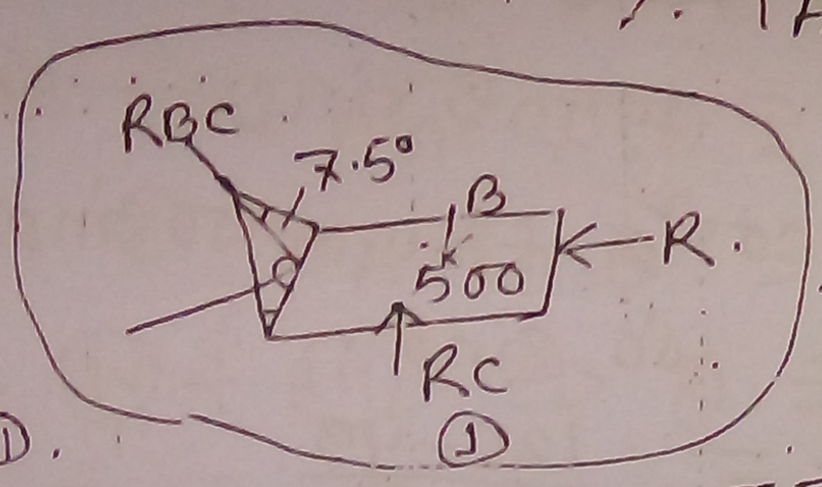
$\Rightarrow \frac{1}{2}\cos(60°-\alpha) = 2\cos\alpha - 2\cos(60°-\alpha)$.

$\therefore \alpha = 10.10°$. Ans:-

$\therefore \Sigma F_y = 0$. $\Rightarrow T_{AD} - W - 2W = 0$.

$\therefore T_{AD} = 3W$. Ans:-

25.

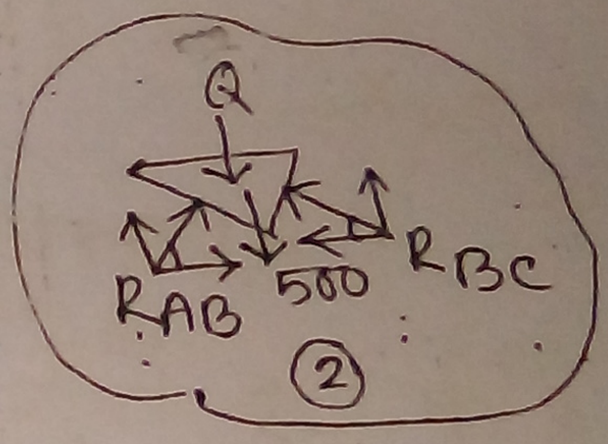


Given that. $W_A = 2000$ lb.
$W_B = 500$ lb.
$W_C = 5000$ lb.
$R = 8000$ lb.

for ①.

$\therefore \Sigma F_x = 0$. $\Rightarrow R_{BC}\cos 7.5° - 8000 = 0$.

$\therefore R_{BC} = 806.03$ lb.



for ②.

$\Sigma F_x = 0$.

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

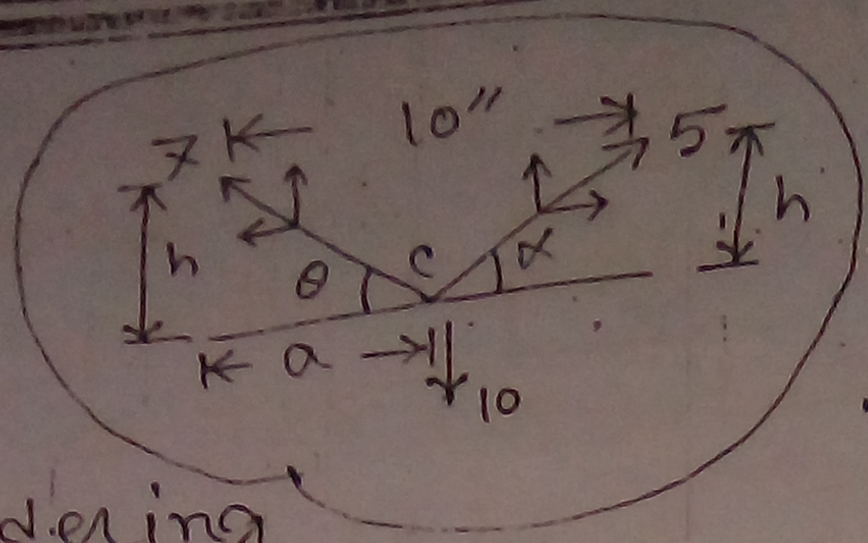
$\therefore R_{AB} = R_{BC} = 806.03$ lb.

$\therefore \Sigma F_y = 0$.

$\Rightarrow Q + 500 - R_{AB}\sin 7.5° - R_{BC}\sin 7.5° = 0$.

$\therefore Q = 710.5$ lb. Ans:-

*
26.



$\alpha = ?$
$a = ?$

By considering the F.b.d.

$\Sigma F_x = 0$.

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

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

$\therefore \cos\theta = \frac{5}{7}\cos\alpha$. —— (ii).

$\therefore \Sigma F_y = 0 \Rightarrow 5\sin\alpha + 7\sin\theta = 10$.

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

$\therefore$ (i)^2 + (ii)^2 $\Rightarrow 49.1 = 25\cos^2\alpha + 100 - 100\sin\alpha + 25\sin^2\alpha$

$\Rightarrow -49 + 125 = 100\sin\alpha$.

$\Rightarrow \sin\alpha = \frac{125-49}{100}$

$\therefore \alpha = 49.47°$. Ans;

$\therefore \tan\theta = \frac{h}{a}$. —— (iv) $\tan\alpha = \frac{h}{10-a}$. —— (v).

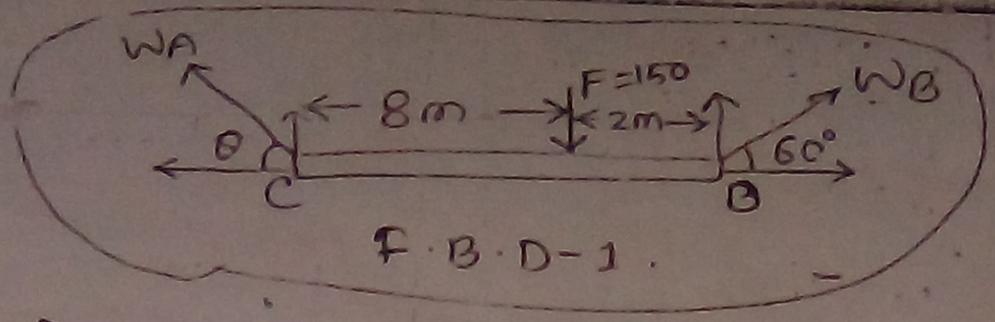
$\Rightarrow h = a\tan\theta$.

$\Rightarrow (10-a).\tan\alpha = \tan\theta \times a$. [$\theta$ from (ii)].

$\Rightarrow \left(\frac{10-a}{a}\right) = \frac{\tan\theta}{\tan\alpha} = \frac{\tan 62.35°}{\tan 49.47°} = 1.63$.

$\Rightarrow \frac{10}{a} = 1.63 + 1 = 2.63$.

$\therefore a = 3.81"$. Ans;



F.B.D-1.

$W_A = ?$
$W_B = ?$

$\therefore \Sigma F_x = 0 \Rightarrow W_B \cos 60° - W_A \cos\theta = 0.$

$\therefore W_A \cos\theta = W_B \cos 60° \quad \text{——} ①.$

$\therefore \Sigma F_y = 0 \Rightarrow W_A \sin\theta + W_B \sin 60° - 150 = 0.$

$\therefore W_A \sin\theta = 150 - W_B \sin 60°. \quad \text{——} ②.$

$\therefore \Sigma M_A = 0 \Rightarrow -W_B \sin 60° \times 10 + 150 \times 8 = 0.$

$\therefore W_B = \frac{150 \times 8}{10 \sin 60°} = 138.57 \text{ lb}.$

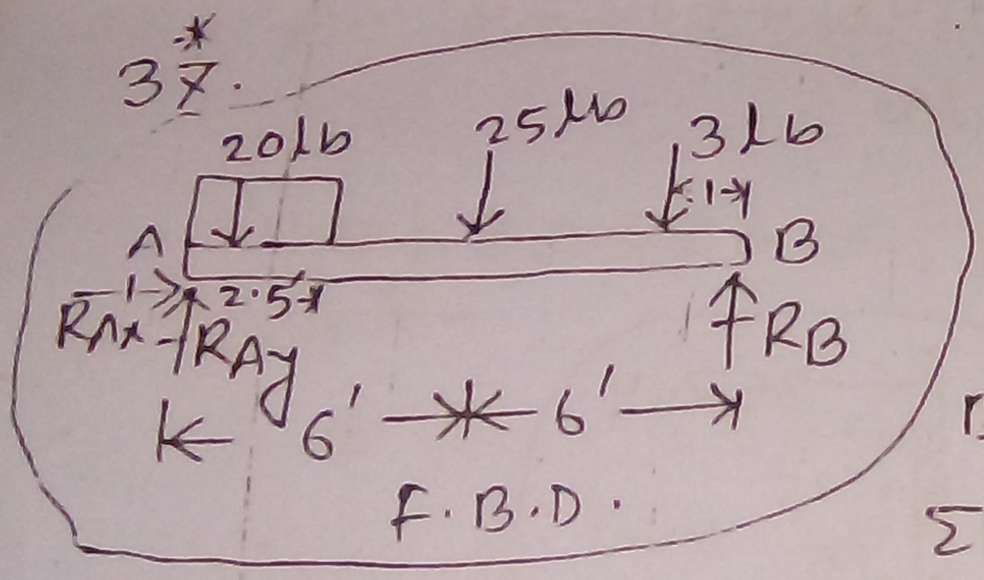
From ①, $W_A \cos\theta = 69.29 \text{ lb}. \quad \text{——} ③$ Ans:-

From ②, $W_A \sin\theta = 30.1 \text{ lb}. \quad \text{——} ④.$

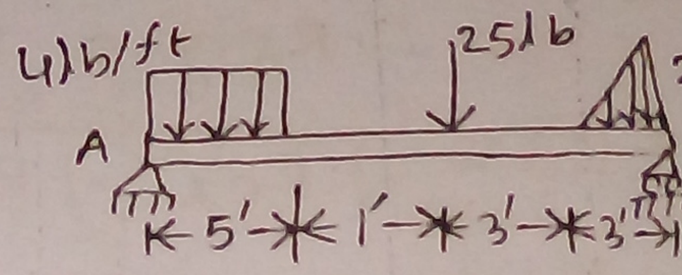
$\therefore ④ \div ③ \Rightarrow \theta = 23.41°.$

$\therefore$ From ①, $W_A = \frac{69.29}{\cos 23.41°} = 75.51 \text{ lb}.$ Ans:-

3*.



F.B.D.



∴ Reaction of A, B = ?

By considering F.B.D.

$\Sigma F_x = 0. \quad \therefore R_{Ax} = 0.$

$\Sigma M_A = 0 \Rightarrow 20 \times 2.5 + 25 \times 6 + 3 \times 11 - R_B \times 12 = 0.$

$\therefore R_B = 19.42 \text{ lb}.$ Ans:-

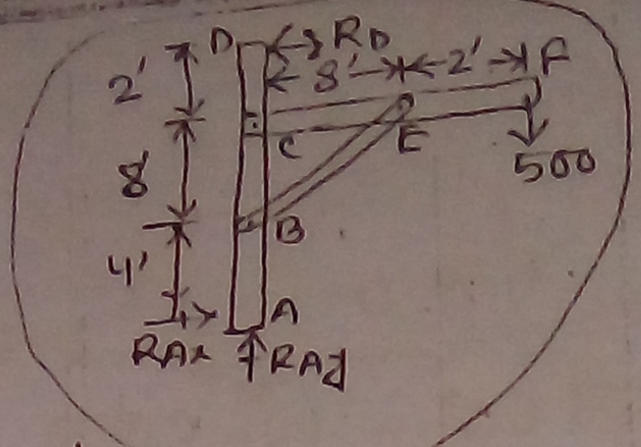
$\therefore \Sigma M_B = 0.$

$\Rightarrow -R_{Ay} \times 12 - 20 \times 9.5 - 25 \times 6 - 3 \times 1 = 0.$

$\therefore R_{Ay} = -28.59 \text{ lb}.$

$\therefore R_A = \sqrt{(R_{Ax})^2 + (R_{Ay})^2} = 28.59 \text{ lb}.$ Ans:-

38*



$\Sigma M_A = 0$.

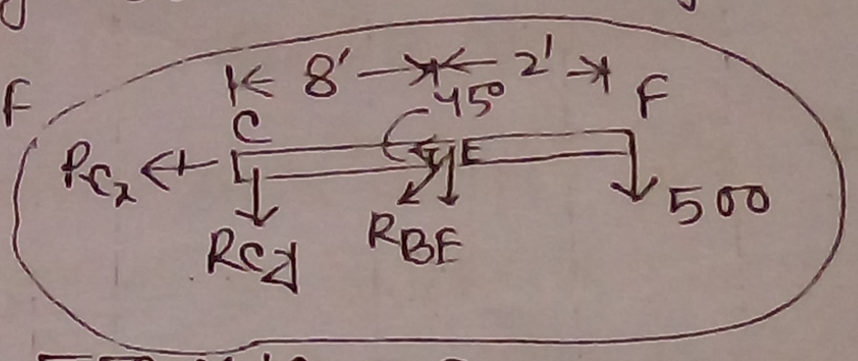
$\Rightarrow D - R_D \times 14 + 500 \times 10 = 0$.

$\therefore R_D = 357.14$ lb.

$\therefore \Sigma F_x = 0 \Rightarrow R_{Ax} - R_D = 0$. $\therefore R_{Ax} = R_D = 357.14$ lb.

$\therefore \Sigma F_y = 0 \Rightarrow R_{Ay} - 500 = 0$ $\therefore R_{Ay} = 500$ lb.

By free the CF



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

$\Sigma M_C = 0$.

$\Rightarrow R_{BE} \sin 45° \times 8 + 500 \times 10 = 0$.

$\therefore R_{BE} = -883.89$ lb.

$\Sigma F_x = 0 \Rightarrow R_{Cx} + R_{BE} \cos 45° = 0$.

$\therefore R_{Cx} = 625$ lb.

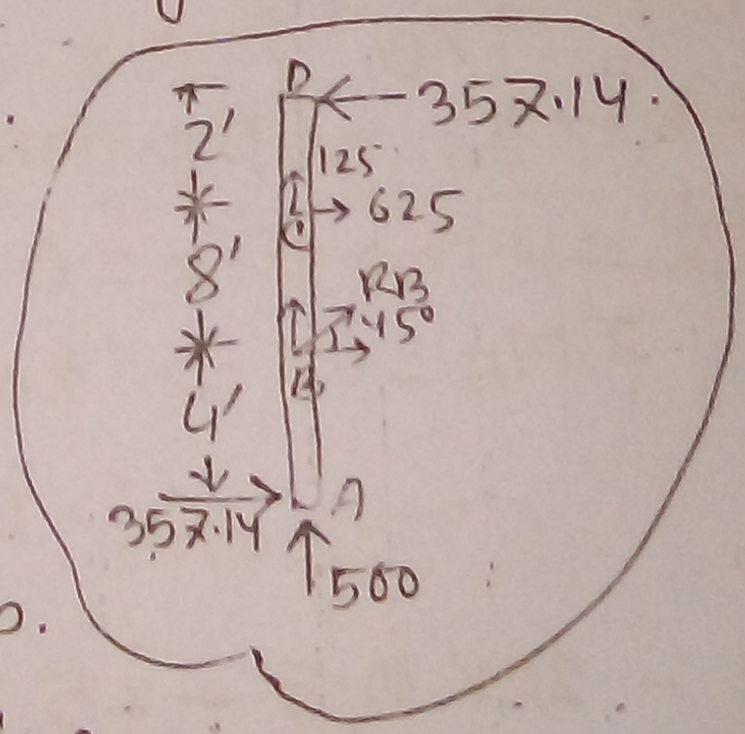
$\therefore \Sigma F_y = 0 \Rightarrow R_{Cy} + R_{BE} \sin 45° + 500 = 0$.

$\therefore R_{Cy} = 125$ lb.

$\therefore R_C = \sqrt{R_{Cx}^2 + R_{Cy}^2} = 637.38$ lb.

Ans:-

By free the AD.



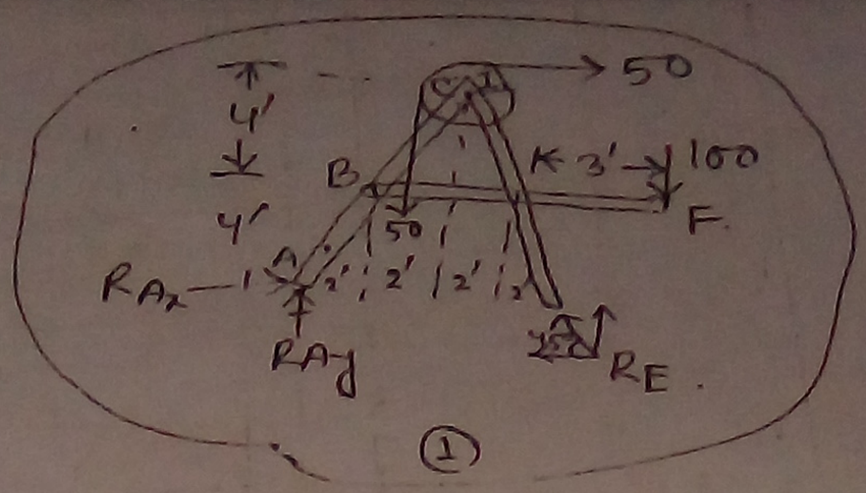
$\Sigma M_A = 0$.

$\Rightarrow R_B \cos 45° \times 4 + 625 \times 12 - 357.14 \times 14 = 0$.

$\therefore R_B = -883.89$ lb.

Ans:-

2.060.



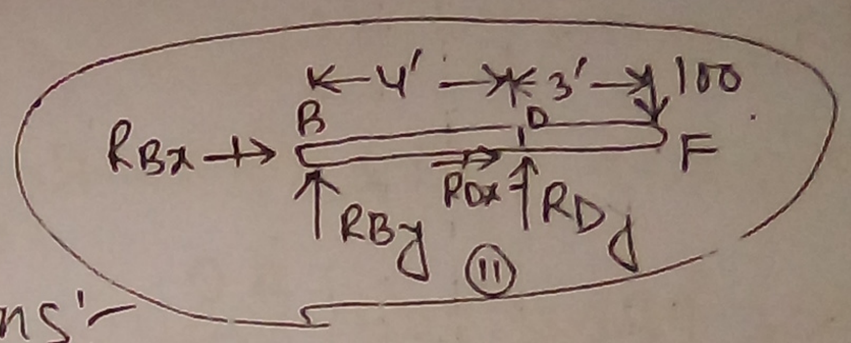
$\Sigma M_A = 0$.

$-R_E \sin 45° \times 8 + 50 \times (1.5 \times 2) + 50 \times 9 + 100 \times 9 = 0$.

$\therefore R_E = 265.17$ # Ans:-

$\Sigma F_x = 0 \Rightarrow R_{Ax} + 50 - R_E \cos 45° = 0$. $\therefore R_{Ax} = 137.5$ # Ans:-

$\Sigma F_y = 0 \Rightarrow R_{Ay} - 50 - 100 + R_E \sin 45° = 0$ $\therefore R_{Ay} = 37.5$ # Ans:-



From ⑪

$M_B = 0 \Rightarrow -R_{Dy} \times 4 + 100 \times 2 = 0$.

$\Rightarrow R_{Dy} = 175$ #. Ans:-

$F_y = 0 \Rightarrow R_{By} + R_{Dy} - 100 = 0$. $\therefore R_{By} = -75$ # Ans:-

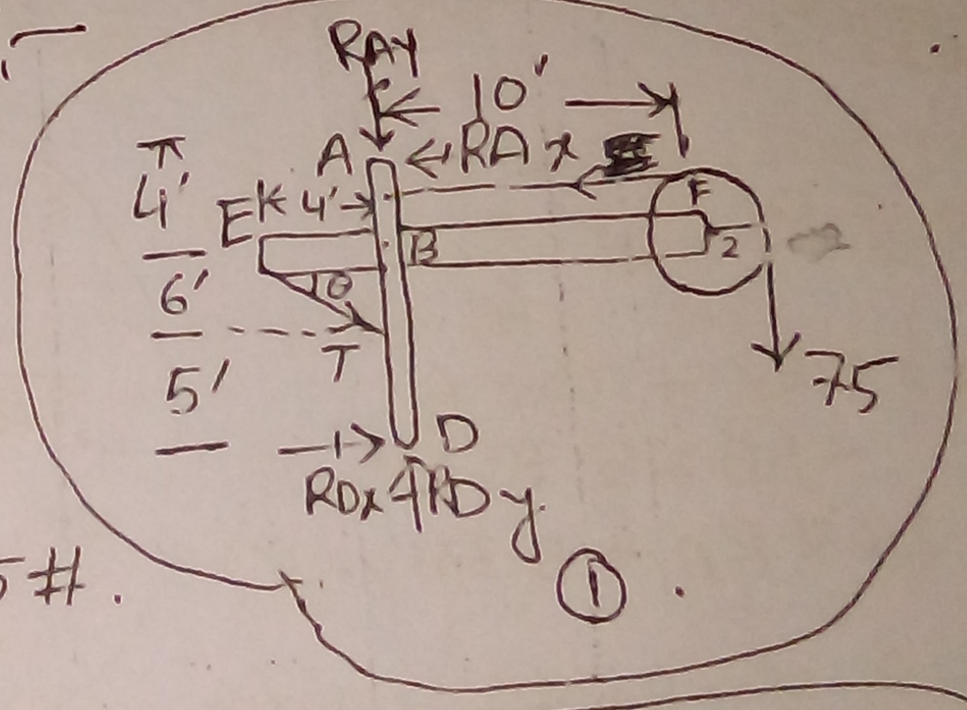
$\Sigma F_x = 0 \Rightarrow R_{Bx} + R_{Dx} = 0$. $\therefore R_{Bx} = -R_{Dx}$ —— ①.

From AC Bar, $\Sigma M_C = 0 \Rightarrow -R_{Ax} \times 8 - R_{Ay} \times 4 - R_{Bx} \times 4 + R_{By} \times 2 = 0$.

$\therefore R_{Bx} = 275$ # Ans:-

$\therefore R_{Bx} = R_{Dx} = -275$ # Ans:-

5. * 2.061.



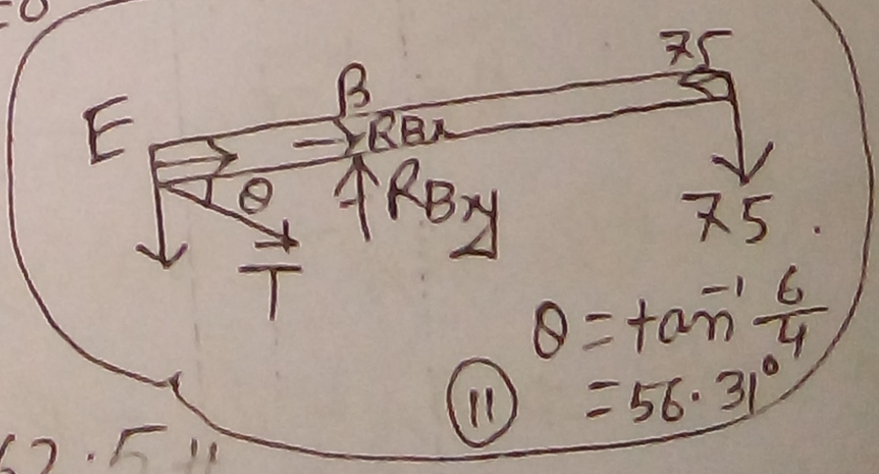
$M_D = 0 \Rightarrow -R_{Ax} \times 15 + 75 \times 12 = 0$.

$\therefore R_{Ax} = 60$ #

$\Sigma x = 0 \Rightarrow R_{Dx} - R_{Ax} = 0$.

$\therefore R_{Dx} = R_{Ax} = 60$ #.

$y = 0 \Rightarrow R_{Dy} - 75 = 0 \therefore R_{Dy} = 75$ #.



$\Sigma M_B = 0 \Rightarrow -T \sin 56.31° \times 4 + 75 \times 10 = 0$

$\therefore T = 225.35$ # Ans:-

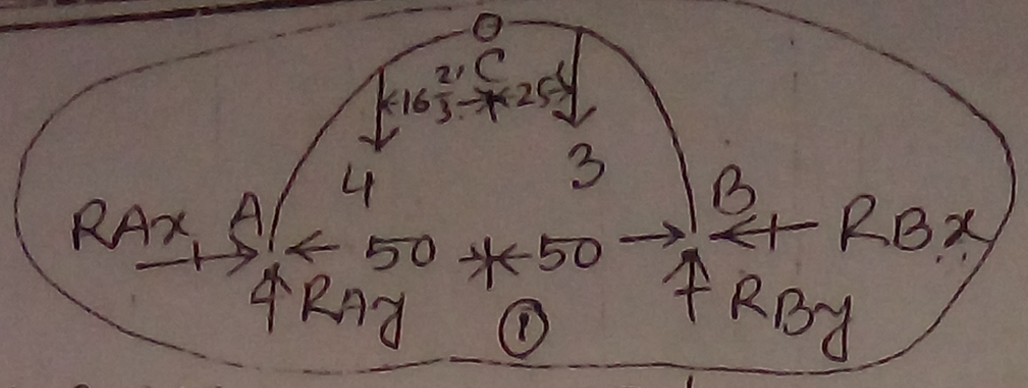
$x = 0 \Rightarrow T \cos 56.31° + R_{Bx} - 75 = 0$.

$\therefore R_{Bx} = 50$. # Ans:-

$\Sigma F_y = 0 \Rightarrow R_{By} = T \sin 56.31° + 75 = 262.5$ # Ans:-

*2000

50.



$\Sigma M_B = 0$.

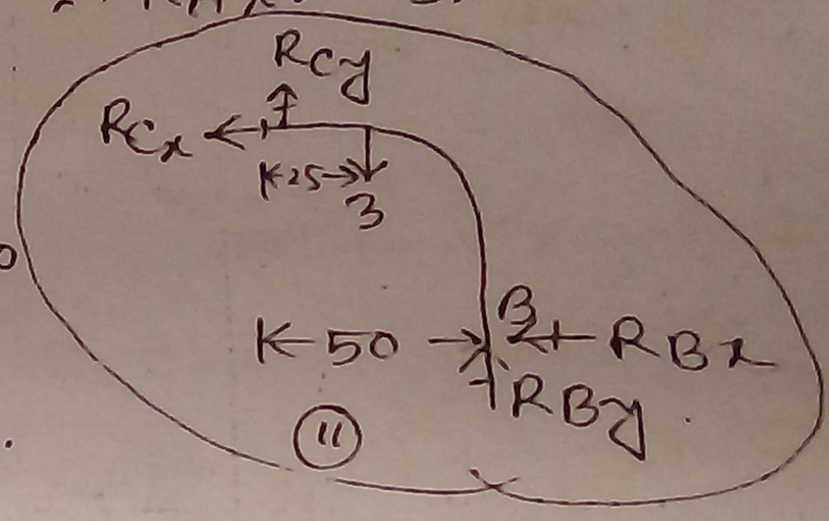
$\Rightarrow -R_{By} \times 100 + 3 \times 75 + 4 \times 33\frac{1}{3} = 0$.

$\therefore R_{By} = 3.58$ t. Ans!

$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_{By} - 4 - 3 = 0$.

$\therefore R_{Ay} = 7 - 3.58 = 3.42$ t. Ans!

$\Sigma F_x = 0 \Rightarrow R_{Ax} - R_{Bx} = 0 \quad \therefore R_{Ax} = R_{Bx}$. —①.



$\Sigma M_B = 0$.

$\Rightarrow -3 \times 25 - R_{cx} \times 50 - R_{cy} \times 50 = 0$.

$\therefore R_{cx} + R_{cy} = -\frac{75}{50}$. —⑪.

$\Sigma F_x = 0 \Rightarrow R_{Bx} + R_{cx} = 0 \quad \therefore R_{cx} = -R_{Bx}$.

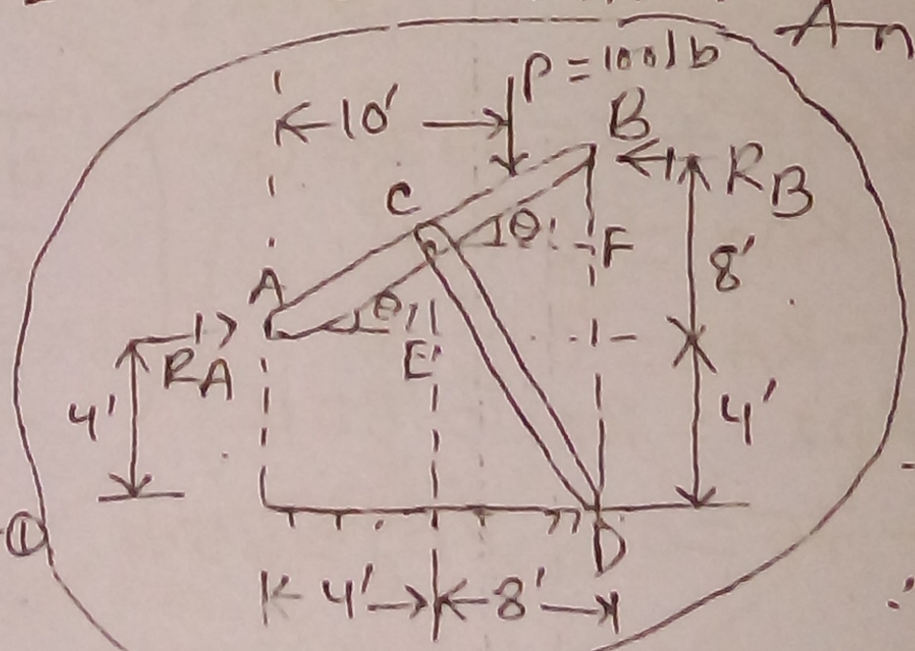
$\Sigma f_y = 0 \Rightarrow R_{cy} = -R_{By}$. $\therefore R_{cy} = -3.58$.

From ⑪ $-R_{Bx} = -\frac{75}{50} + 3.58 = 2.08$.

$\therefore R_{Bx} = 2.08$ t. $= R_{Ax}$. Ans!

*2007

53.



$\Sigma M_C = 0$.

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

$\therefore 2.67 R_A + 5.33 R_B = 600$ —①

$\theta_1 = \tan^{-1}\left(\frac{8}{12}\right) = 33.69°$.

$\therefore CE = 4 \tan 33$

$= 2.67$.

$\therefore BF = 8 - CE = 5$

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

$\therefore R_A + 3R_B = 50$ —⑪.

From ①, ⑪, $R_A = 154.9$ # Ans! $R_B = 34.97$ # Ans!

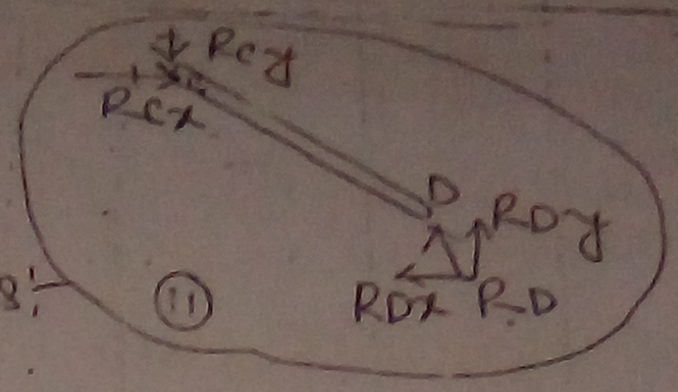
$\Sigma F_x = 0 \Rightarrow R_A - R_B - R_{Dx} = 0 \quad \therefore R_{Dx} = 119.93$ # Ans!

$\therefore \Sigma F_y = 0 \Rightarrow R_{Dy} - 100 = 0 \quad \therefore R_{Dy} = 100$ #. Ans!

$\Sigma F_x = 0$.

$\Rightarrow R_{Cx} - R_{Dx} = 0$.

$\therefore R_{Cx} = R_{Dx} = 119.93$ # Ans:-

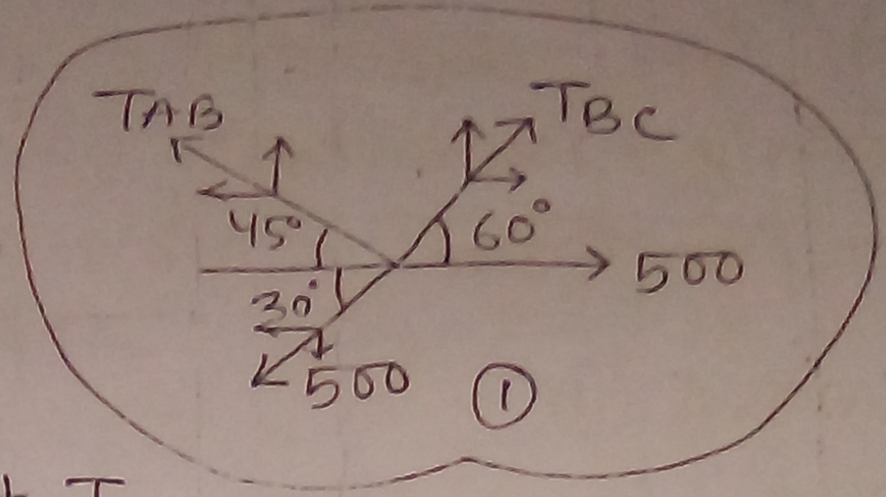


$\Sigma F_y = 0 \Rightarrow R_{Cy} - R_{Dy} = 0$.

$\therefore R_{Cy} = R_{Dy} = 100$. # Ans:-

67.*

By considering the F.B.D (1).



$T_{AB} = ?$

$T_{BC} = ?$

$\Sigma F_x = 0 \Rightarrow 500 + T_{BC}\cos 60° - T_{AB}\cos 45° - 500\cos 30° = 0$.

$\therefore 0.5\,T_{BC} - 0.708\,T_{AB} = 66.99$ — (1)

$\therefore \Sigma F_y = 0 \Rightarrow T_{AB}\sin 45° + T_{BC}\sin 60° - 500\sin 30° = 0$.

$\therefore 0.708\,T_{AB} + 0.867\,T_{BC} = 250$ — (11).

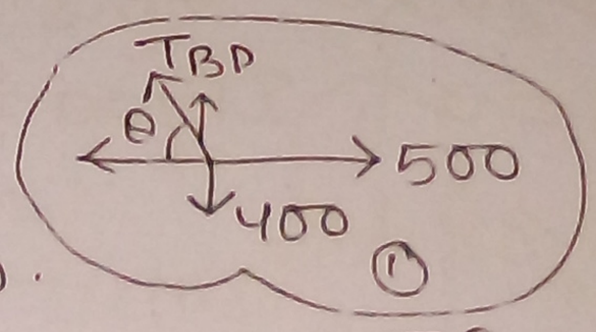
$\therefore$ From, (1) + (11) $\Rightarrow T_{BC} = 231.89$ lb. — Ans:-

From (1) $\Rightarrow T_{AB} = 69.15$ lb. — Ans:-

*2008

69. By considering F.B.D.

(1).



$\Sigma F_x = 0 \Rightarrow T_{BD}\cos\theta - 500 = 0$.

$\therefore T_{BD}\cos\theta = 500$ — (1)

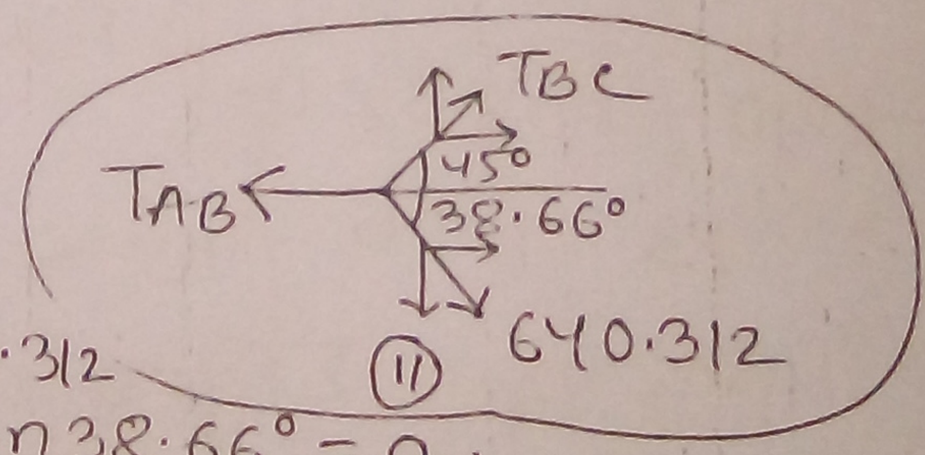
$\Sigma F_y = 0 \Rightarrow T_{BD}\sin\theta - 400 = 0$

$\therefore T_{BD}\sin\theta = 400$ — (11)

$\therefore$ (1)^2 + (11)^2 $\Rightarrow T_{BD} = \sqrt{500^2 + 400^2} = 640.312$ lb.

From (1). $\theta = 38.66°$.

From F.B.D - (11).



$\Sigma F_y = 0 \Rightarrow T_{BC}\sin 45° - 640.312 \times \sin 38.66° = 0$.

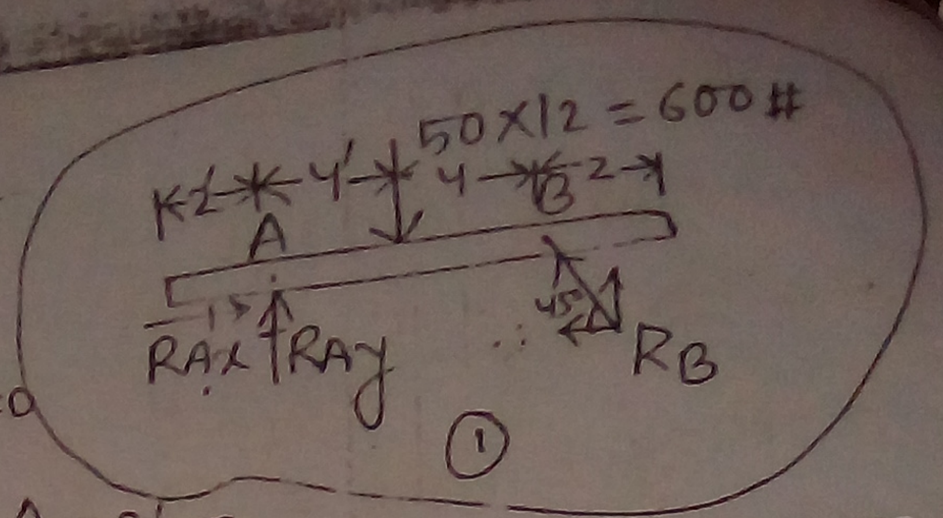
$\therefore T_{BC} = 565.67$ lb. Ans:-

$\therefore \Sigma F_x = 0 \Rightarrow -T_{AB} + T_{BC}\cos 45° + 640.312 \times \cos 38.66° = 0$.

$\therefore T_{AB} = 900.41$ lb. — Ans:-

*2004

Q4. By considering ①



$\Sigma M_A = 0$.

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

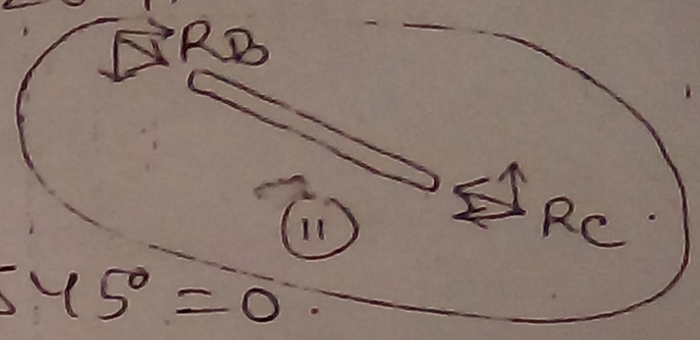
$\therefore R_B = 424.26$ # Ans!

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

$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_B \sin 45° - 600 = 0 \therefore R_{Ay} = 300$ #

$\therefore R_A = \sqrt{300^2 + 300^2} = 424.26$ # Ans!

By considering ⑪

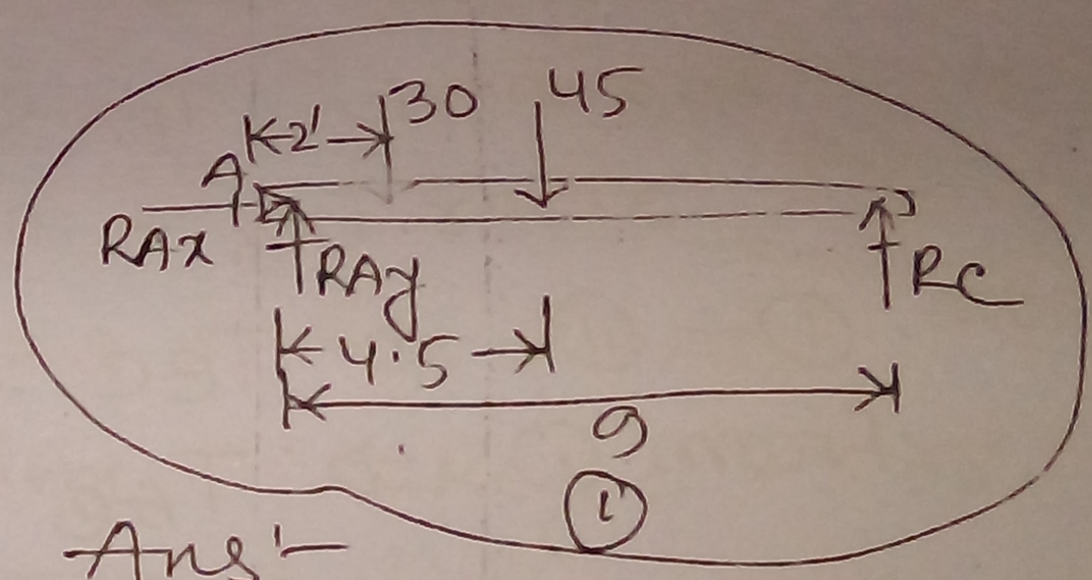


$\Sigma F_x = 0 \Rightarrow R_B \cos 45° - R_C \cos 45° = 0$.

$\therefore R_B = R_C = 424.26$ # Ans!

*2007, 2008+10=2011.

Q5. F.B.D → ①.



$\Sigma M_A = 0$.

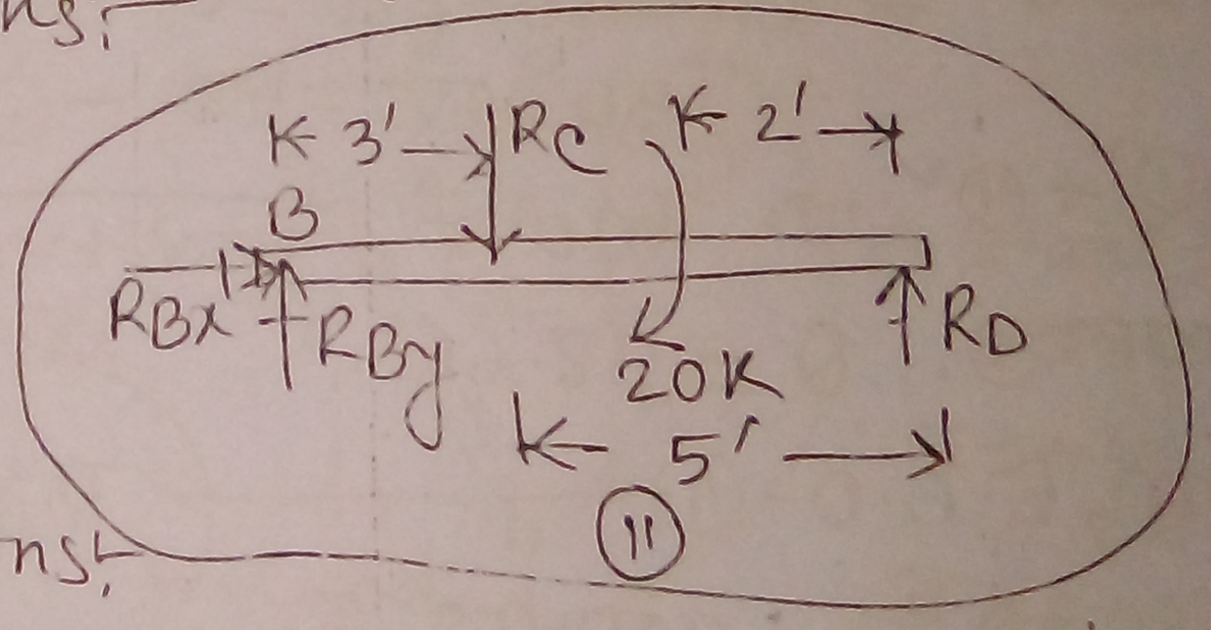
$\Rightarrow 30 \times 2 + 45 \times 4.5 - R_C \times 9 = 0$.

$\therefore R_C = 20.16$ lb. Ans!

$\Sigma F_x = 0 \Rightarrow R_{Ax} = 0$. $\Sigma F_y = 0 \Rightarrow R_{Ay} + R_C - 30 - 45 = 0$.

$\therefore R_A = 45.84$ lb. Ans! $\therefore R_{Ay} = 45.84$ lb.

F.B.D → ⑪.



$\Sigma M_B = 0$.

$\Rightarrow R_C \times 3 + 20 - R_D \times 8 = 0$.

$\therefore R_D = 13.43$ lb. Ans!

$\Sigma F_x = 0 \Rightarrow R_{Bx} = 0$. $\Sigma F_y = 0 \Rightarrow R_{By} - R_C + R_D = 0$.

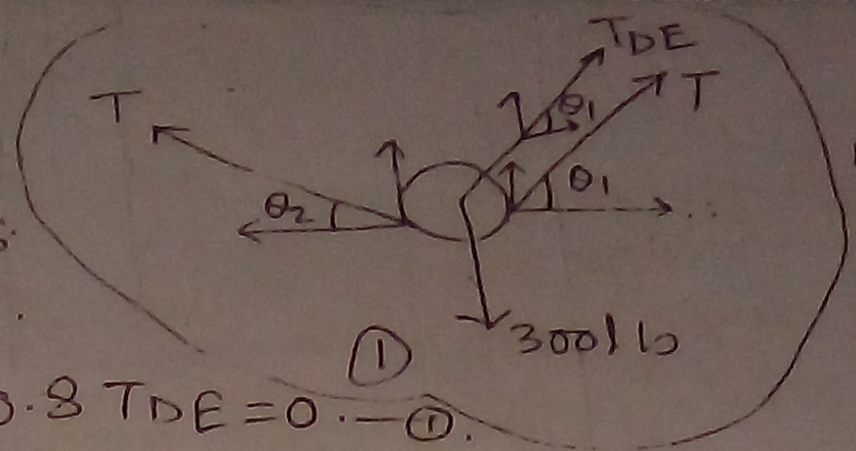
$\therefore R_{By} = 15.73$ lb.

$\therefore R_B = 15.73$ lb.

Ans!

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

6.



$\theta_1 = \tan^{-1}\left(\frac{3}{4}\right) = 36.87°$

$\theta_2 = \tan^{-1}\left(\frac{7}{8}\right) = 20.56°$

$\Sigma F_x = 0$.

$\Rightarrow T\cos 36.87° + T_{DE}\cos 36.87° - T\cos 20.56° = 0$.

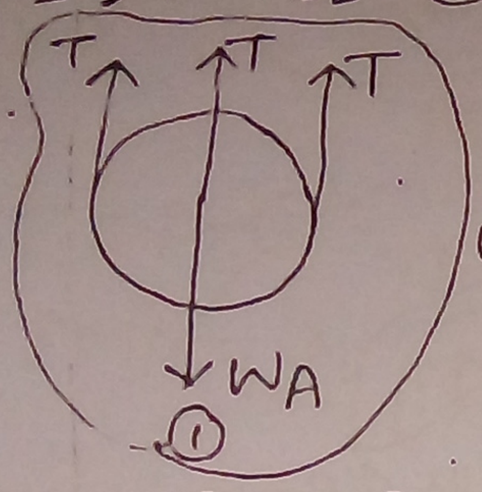
$\therefore 0.8T - 0.937T + 0.8T_{DE} = 0$ — ①.

$\Sigma F_y = 0 \Rightarrow -T\sin 36.87° + T_{DE}\sin 36.87° + T\sin 20.56° - 300 = 0$

$\Rightarrow T_{DE} = 48.5$ # Ans:-

From ① $T = 5.83T_{DE}$ — ⑪ and, $T = 285.16$ # Ans:-

87.

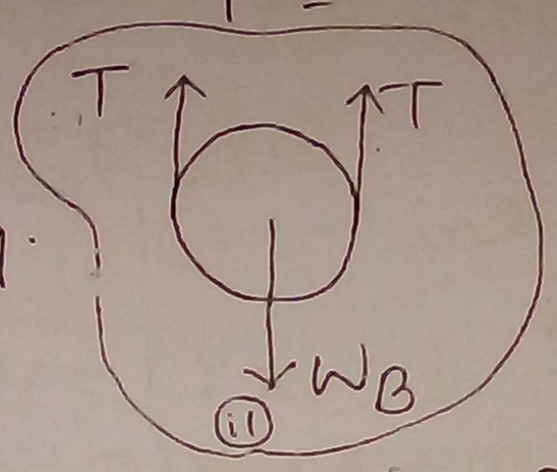


$W_A = 15$ kg.

F.B.D → ①. $\Sigma F_y = 0$.

$\Rightarrow T + T + T - W_A = 0$.

$\therefore T = \frac{W_A}{3} = \frac{15}{3} = 5$ kg.



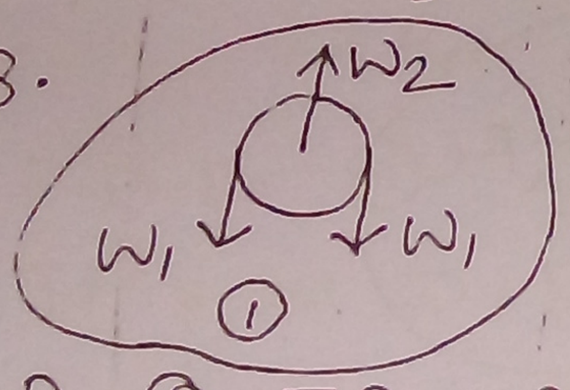
F.B.D — ⑪.

$\Sigma F_y = 0 \Rightarrow T + T - W_B = 0$.

$\Rightarrow W_B = 2T = 2 \times 5$

$\therefore W_B = 10$ kg. Ans:-

88.



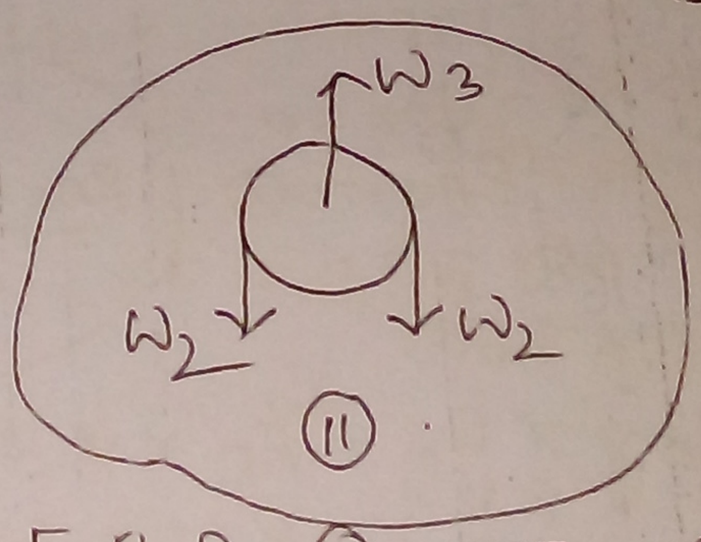
$W_1 = 10$ lb.

F.B.D — ①. $\Sigma F_y = 0$.

$\Rightarrow -W_1 - W_1 + W_2 = 0$.

$\Rightarrow W_2 = 2W_1 = 2 \times 10$.

$\therefore W_2 = 20$ lb. Ans:-



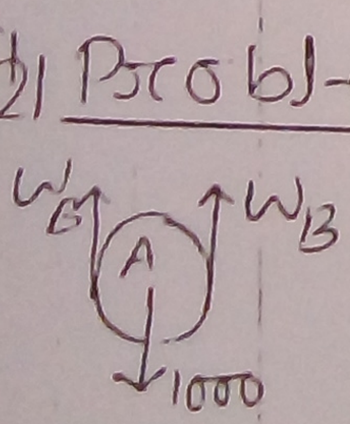
F.B.D — ⑪. $\Sigma F_y = 0$.

$\Rightarrow -W_2 - W_2 + W_3 = 0$.

$\Rightarrow W_3 = 2W_2 = 2 \times 20$.

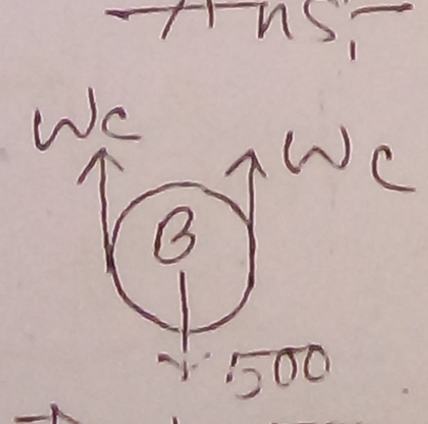
$\therefore W_3 = 40$ lb. Ans:-

21 Problem:



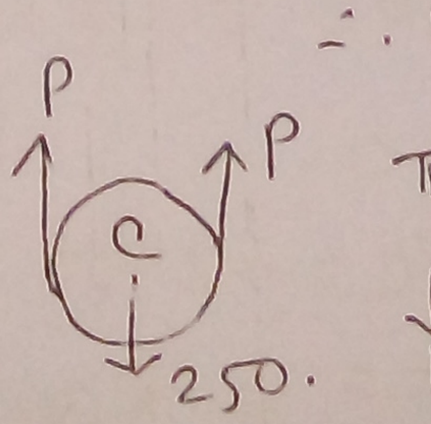
$F_y = 0$.

$\Rightarrow W_B = \frac{1000}{2} = 500$ lb.



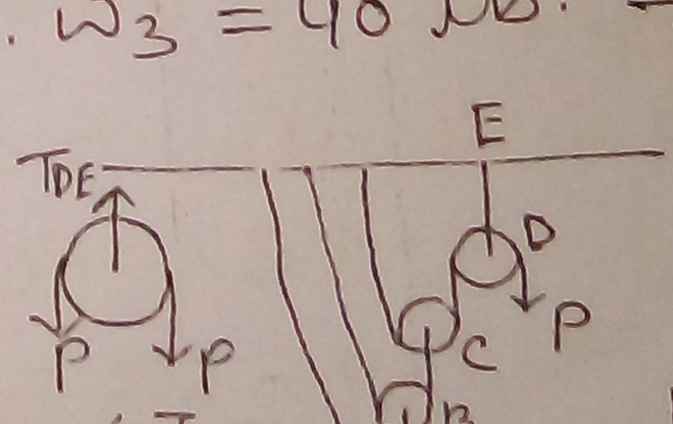
$\Rightarrow W_c = \frac{500}{2}$

$\therefore W_c = 250$.



$\therefore P = \frac{250}{2}$.

$\therefore P = 125$ lb $= 250$ lb Ans:-



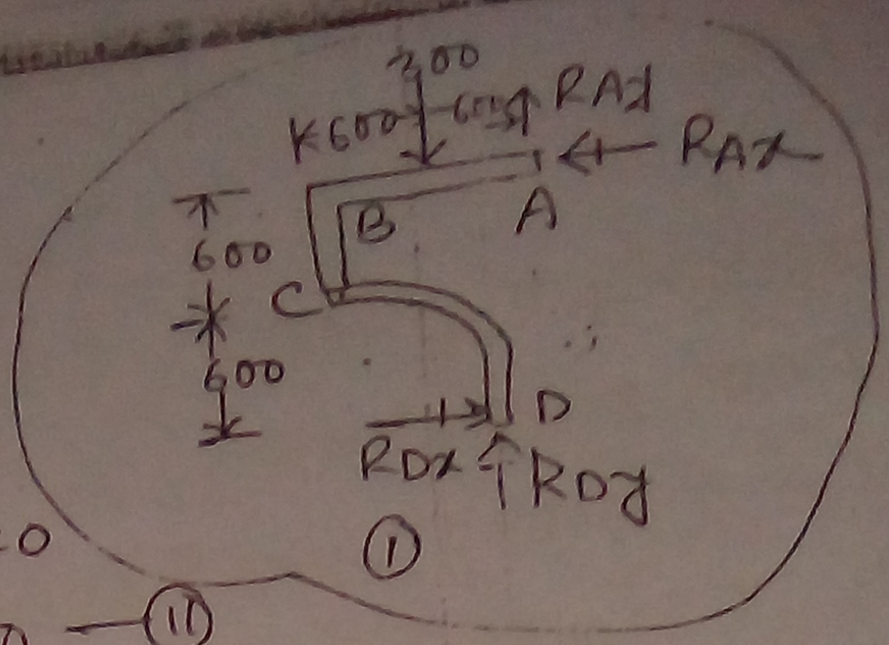
$\therefore T_{DE} = 2P$

Ans:-

P = ?

T_{DE} = ?

109. *2011



F.B.D — ①.

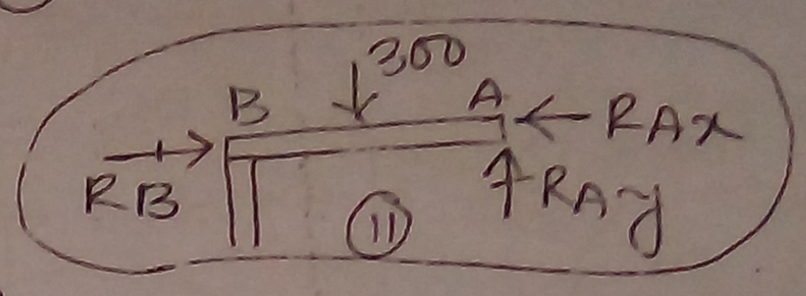
$\Sigma F_x = 0 \Rightarrow R_{Ax} - R_{Dx} = 0.$

$\therefore R_{Ax} = R_{Dx}$ — ①.

$\Sigma F_y = 0 \Rightarrow R_{Dy} + R_{Ay} - 300 = 0$

$\therefore R_{Ay} = -R_{Dy} + 300$ — ⑪

F.B.D — ⑪

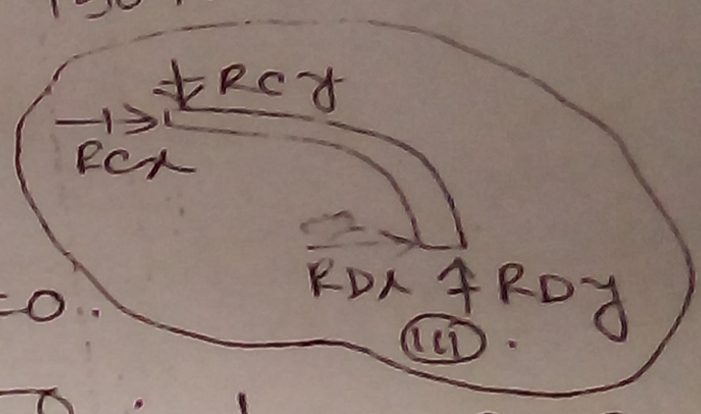


$\Sigma M_B = 0 \Rightarrow 300 \times 600 - R_{Ay} \times 1200 = 0.$

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

$\Sigma F_x = 0 \Rightarrow R_{Cx} = -R_{Dx}$ — ⑪.

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



$\Sigma M_D = 0 \Rightarrow -R_{Cx} \times 600 - R_{Cy} \times 600 = 0.$

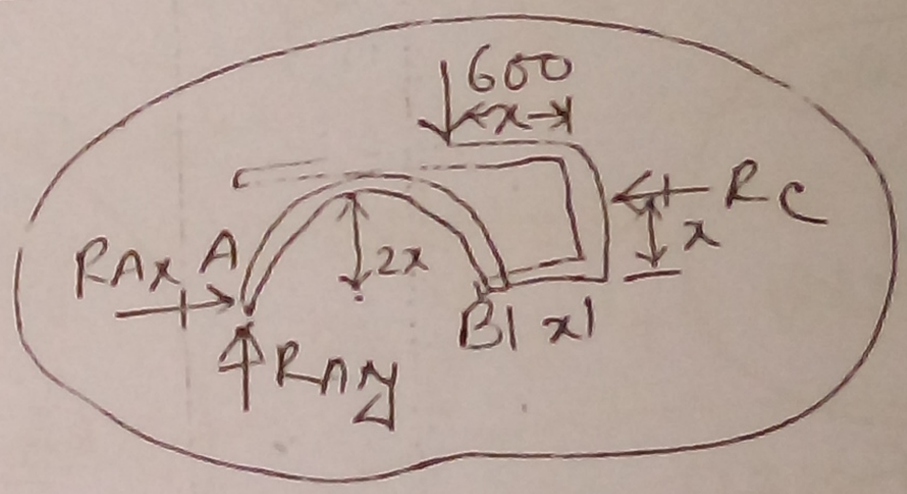
$\therefore R_{Cx} = -R_{Cy} = -150$. from ①. $R_{Ax} = 150.$

$\therefore R_A = 212.13.N.$ Ans:— $R_C = 212.13\ N.$ Ans:—

*2009

112. $\Sigma F_x = 0 \Rightarrow R_C - R_{Ax} = 0.$

$\therefore R_C = R_{Ax}$ — ①.



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

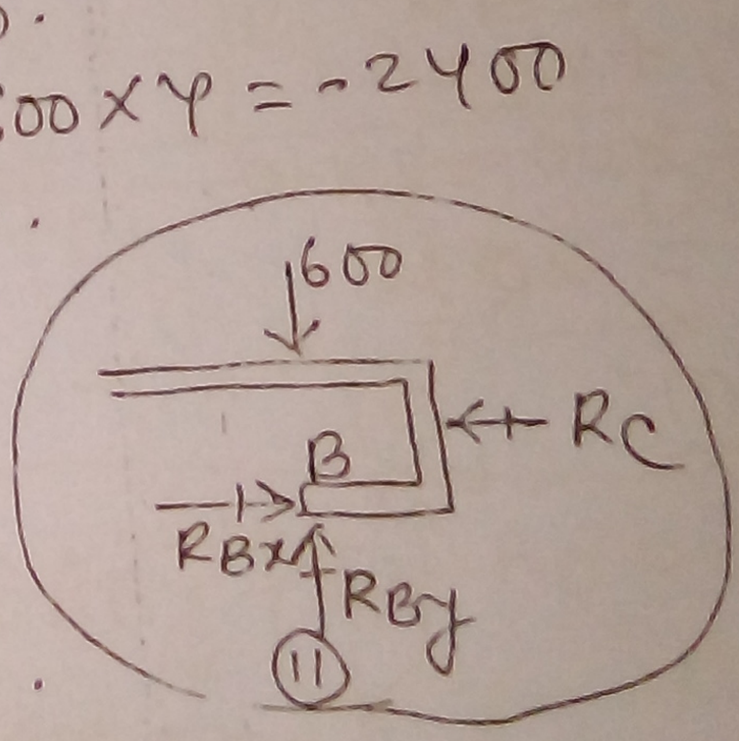
$\therefore R_{Ay} = 600.$

$\Sigma M_B = 0 \Rightarrow -R_{Ay} \times 4x - R_C \times x = 0.$

$\therefore R_C = -600 \times 4 = -2400$

$\therefore R_{Ax} = -2400.$

$\therefore R_A = 2473.87\ \#$ Ans:—



F.B.D — ⑪.

$\Sigma F_x = 0 \Rightarrow R_C - R_{Bx} = 0.$

$\therefore R_{Bx} = R_C = -2400.$

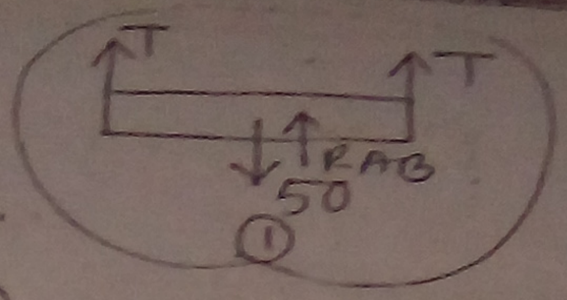
$\Sigma F_y = 0 \Rightarrow R_{By} - 600 = 0 \quad \therefore R_{By} = 600.$

$\therefore R_B = 2473.87\ \#$ Ans:—

2004

145.

F·B·D — ①

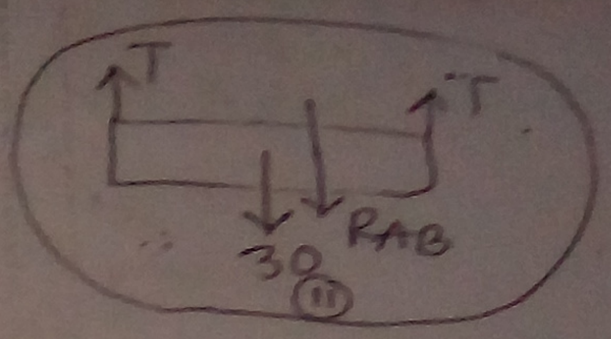


$\Sigma F_y = 0$.

$\Rightarrow T + T + R_{AB} - 50 = 0$.

$\Rightarrow 2T + R_{AB} = 50$ — ①.

F·B·D — ⑪



$\Rightarrow \Sigma F_y = 0 \Rightarrow -T - T + 30 + R_{AB} = 0$.

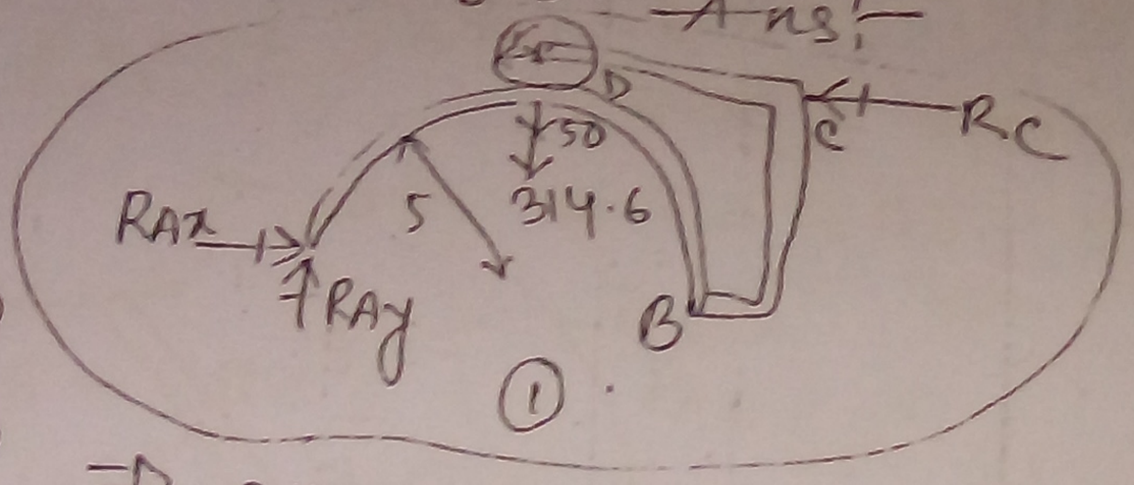
$\therefore -2T + R_{AB} = -30$ — ⑪.

① + ⑪ $\Rightarrow 2R_{AB} = 20$.

$\therefore R_{AB} = 10$ Kg. — Ans! —

$\therefore$ ① $T = 20$ Kg. — Ans! —

148.



F·B·D — ①

$\Sigma M_A = 0$

$\Rightarrow 314.6 \times 5 - R_C \times 6 + 50 \times 5 = 0$.

$\therefore R_C = 303.83$ Kg. — Ans! —

$W_{AB} = \pi \times 5 \times 20$.
$= 314.6$

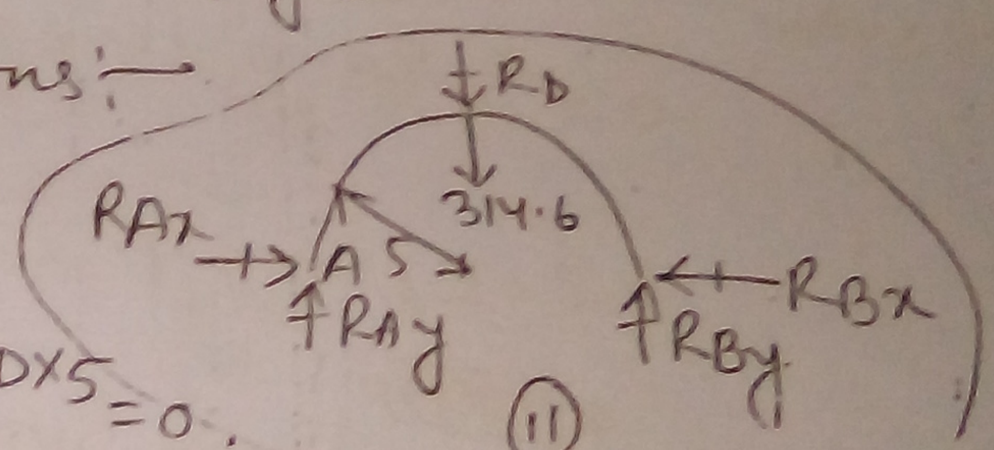
$\Sigma F_x = 0$.

$\Rightarrow R_{Ax} - R_C = 0 \Rightarrow R_{Ax} = R_C = 303.83$ Kg.

$\Sigma F_y = 0 \Rightarrow R_{Ay} - 50 - 314.6 = 0$. $\therefore R_{Ay} = 364.6$ Kg.

$\therefore R_A = 474.6$ Kg. — Ans! —

F·B·D — ⑪.



$\Sigma M_B = 0 \Rightarrow +R_{Ay} \times 10 - 314.6 \times 5 - R_D \times 5 = 0$.

$\therefore R_D = 121.66$.

$\Sigma F_x = 0 \Rightarrow R_{Bx} - R_{Ax} = 0 \therefore R_{Bx} = R_{Ax} = 303.83$ Kg.

$\therefore \Sigma F_y = 0 \Rightarrow R_{Ay} + R_{By} - 314.6 - R_D = 0$. — Ans!

$\therefore R_{By} = 364.6$ Kg. — Ans! —

* 2005

157. F·B·D – ①.

$\Sigma M_B = 0$.

$\Rightarrow -R_{cy} \times 12 + 1500 \times 20 = 0$.

$\therefore R_{cy} = 2500$.

F·B·D – ⑪.

$\Sigma M_A = 0$.

$\Rightarrow + R_{cx} \times 8 - (R_{cy} \times 12) + 1000 \times 10 + 30 \times 4 = 0$.

$\therefore R_{cx} = 5015$.

$\therefore R_c = 5603.59$. # Ans:-

* 2003

206.

F·B·D – ①.

$\Sigma M_A = 0$.

$\Rightarrow 4.5 \times 18 \sin 60° - R_B \times 10 \cos 60° = 0$.

$\therefore R_B = 14.03$ k. Ans:-

$\Sigma F_x = 0 \Rightarrow R_{Ax} - 4.5 = 0$

$\therefore R_{Ax} = 4.5$ k

$\Sigma F_y = 0 \Rightarrow R_{Ay} - R_B = 0$.

$\therefore R_{Ay} = R_B = 14.03$ k

$\therefore R_A = 14.73$ k. Ans:-

* 2006

207. F·B·D – ①.

By using Lami's theorem.

$$\frac{F}{\sin(90° + 51.81°)} = \frac{R}{\sin(90° + \theta)} = \frac{W}{\sin[180° - (\theta + 51.81°)]}$$

$\Rightarrow \frac{F}{\cos 51.81°} = \frac{R}{\cos\theta} = \frac{W}{\sin(\theta + 5}$

But, for least force, F, $\theta + 51.81° = 90° \therefore \theta = 38.19°$. Ans

$$\therefore F = \frac{\cos 51.81° \times 1000}{\sin(38.19° + 51.81°)} = 618.27 \text{ lb}.$$ Ans:-

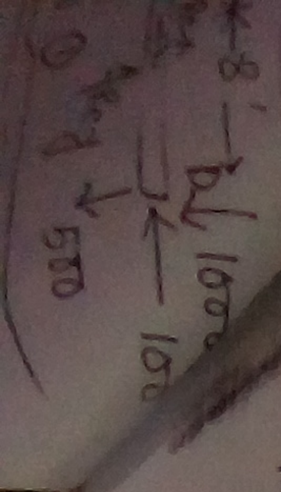
$\omega = 1000$ lb.

$\theta_1 = \sin^{-1}(2/3)$.

$= 41.81°$.

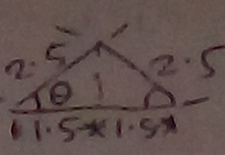
$\theta_2 = 41.81° + 10°$.

$= 51.81°$.

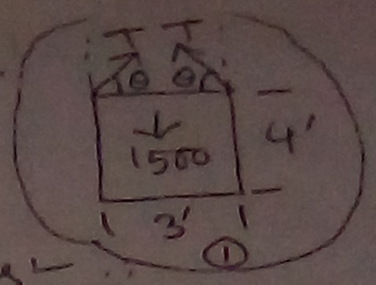


(604)

228. F.B.D — (I)



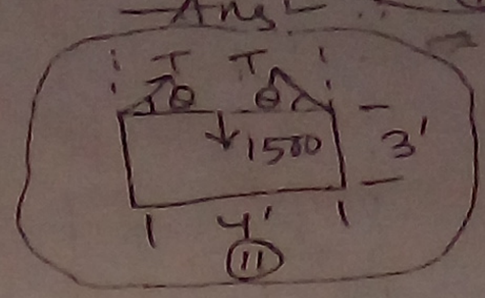
$\theta = \cos^{-1}\left(\frac{1.5}{2.5}\right) = 53.13°$



$\Sigma F_y = 0$.

$\Rightarrow 2T \sin 53.13° - 1500 = 0$. $\therefore T = 938$ lb. — Ans:—

F.B.D — (II)



$\Sigma F_y = 0$.

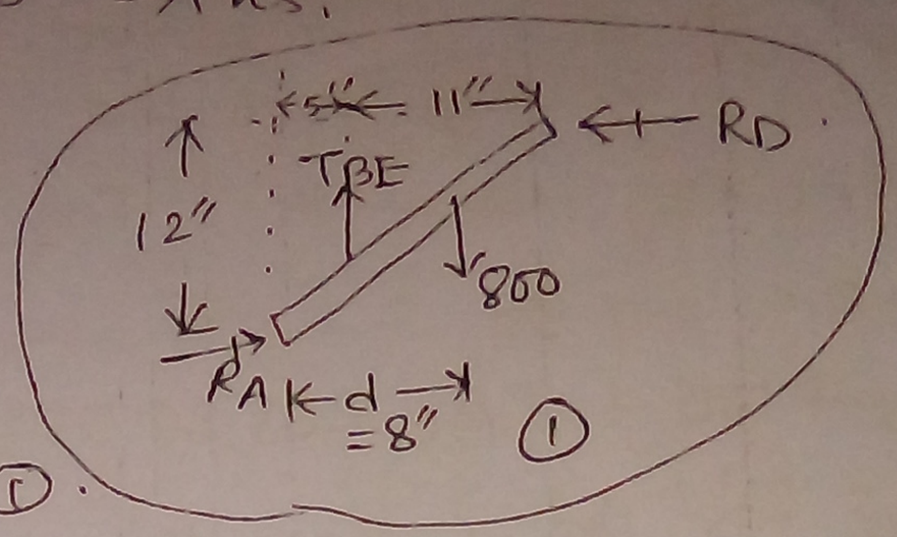
$\Rightarrow 2T \sin 36.87° - 1500 = 0$.

$\therefore T = 1250$ lb. — Ans:—

$\theta = \tan^{-1}\left(\frac{3}{4}\right) = 36.87°$.

238. considering

(a) F.B.D — (I).



$\therefore \Sigma M_A = 0$.

$\Rightarrow -T_{BE} \times 5 + 800 \times 8 - R_D \times 12 = 0$. — (I).

$\Sigma F_y = 0 \Rightarrow T_{BE} - 800 = 0$ $\therefore T_{BE} = 800$ #. — Ans:—

From (I), $R_D = 200$ #. — Ans:—

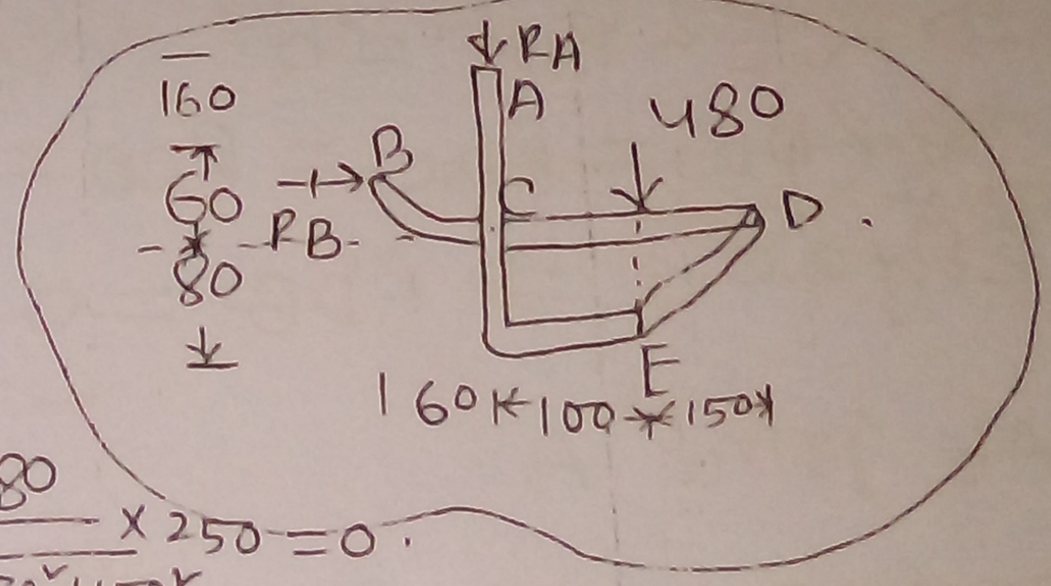
$\Sigma F_x = 0 \Rightarrow R_A - R_D = 0$. $\therefore R_A = R_D = 200$ #. — Ans:—

(b) When, $R_{A\max} = 500$ lb. $d = ?$

$\Sigma M_D = 0 \Rightarrow +500 \times 12 + 800 \times (16 - d) - T_{BE} \times 11 = 0$.

$\therefore d = 12.5$". — Ans:—

266. $\Sigma M_A = 0$.



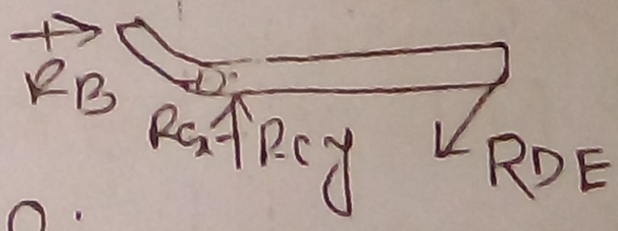
$\Rightarrow -R_B \times 160 + 480 \times 100 = 0$.

$\therefore R_B = 300$ N. — Ans:—

$\Sigma M_C = 0$

$\Rightarrow 300 \times 60 + 480 \times 100 + R_{DE} \times \frac{80}{\sqrt{80^2 + 150^2}} \times 250 = 0$.

$\therefore R_{DE} = -561$ N. — Ans:—

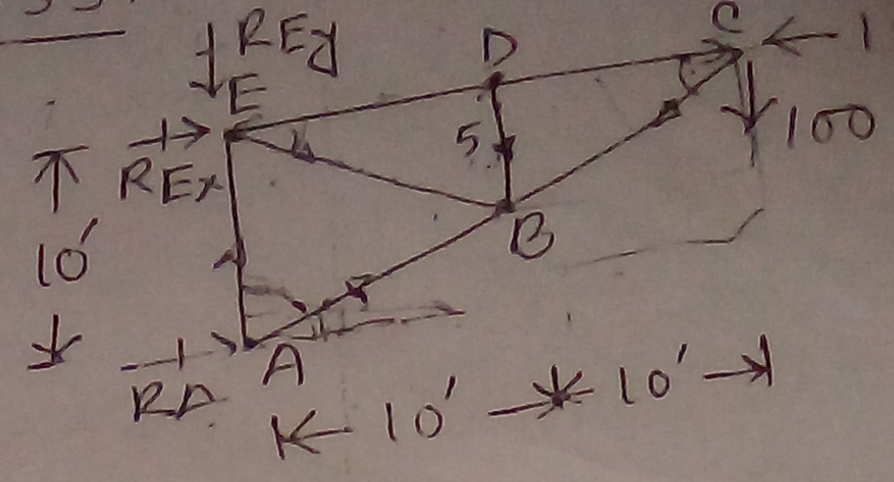


$\Sigma F_x = 0 \Rightarrow R_{Cx} + 300 - \frac{F_{DE} \times 150}{\sqrt{80^2 + 150^2}} = 0$.

$\therefore R_{Cx} = -495$ N. — Ans:—

$\Sigma F_y = 0 \Rightarrow F_{Cy} - 480 - F_{DE} \frac{80}{\sqrt{80^2 + 150^2}} = 0$ $\therefore R_{Cy} = 216$ N. — Ans:—

[2] TRUSS.



* 2003.
347.

$\Sigma M_E = 0$.

$\Rightarrow 100 \times 20 - R_A \times 10 = 0$.

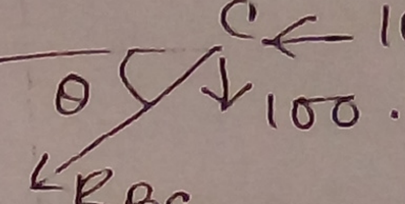
$\therefore R_A = 200$ lb.

$\Sigma F_x = 0$. $\Rightarrow R_A + R_{Ex} = 100$.

$\therefore R_{Ex} = 100$. lb.

$\therefore \Sigma F_y = 0 \Rightarrow R_{Ey} + 100 = 0 \quad \therefore R_{Ey} = -100$ lb.

At joint C. ⟶



$\theta = \tan^{-1}(\frac{5}{10})$

$= 26.57°$.

$\Sigma F_x = 0$.

$\Rightarrow R_{CD} + 100 + R_{BC} \cos 26.57° = 0$ —— ①.

$\Sigma F_y = 0 \Rightarrow 100 + R_{BC} \sin 26.57° = 0$.

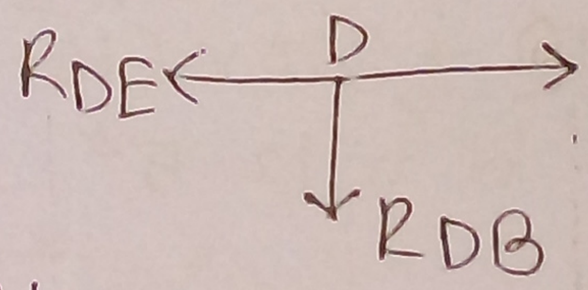
$\therefore R_{BC} = -223.6$ lb (C) ⑪.

$\therefore$ from ①. $R_{CD} = 100$ lb. (T).

—Ans!—

—Ans!—

At joint D.



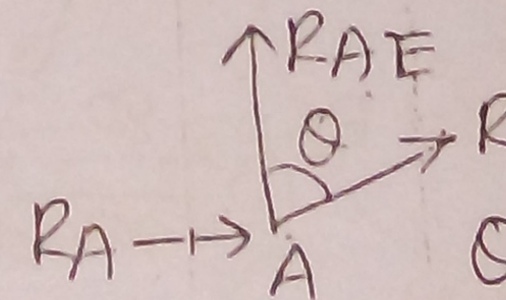
$\Sigma F_x = 0$.

$\Rightarrow R_{DE} - R_{DC} = 0$.

$\Rightarrow R_{DE} = R_{DC} = R_{CD} = 100$ lb (T) —Ans!—

$\Sigma F_y = 0$. $\Rightarrow R_{DB} = 0$. $\therefore R_{DB} = 0$. —Ans!—

At joint A.



$\theta = (90° - 25.57°)$.

$= 63.43°$ ↓

$\Sigma F_y = 0$.

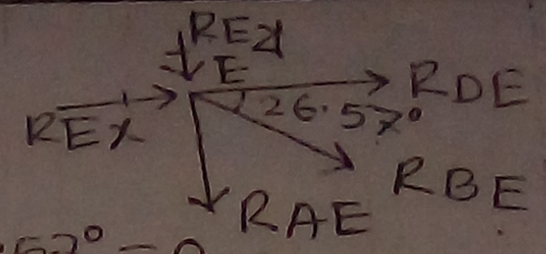
$\Rightarrow R_{AE} + R_{AB} \sin 63.43° = 0$. —— ⑪.

$\Sigma F_x = 0$. $\Rightarrow R_A + R_{AB} \cos 63.43° = 0$.

$\therefore R_{AB} = -223.6$ lb (C) —Ans!—

From ⑪. $R_{AE} = 100$ lb. (T). ↓ —Ans!—

At joint E.

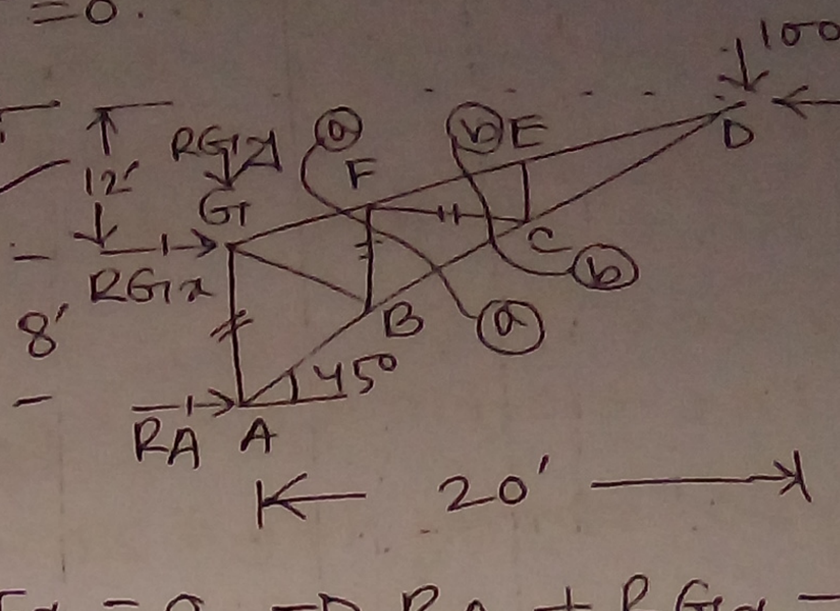


$\Sigma F_y = 0$.

$\Rightarrow R_{EY} + R_{AE} + R_{BE} \sin 26.57° = 0$.

$\therefore R_{BE} = 0$. —Ans!

*[1095]
348.



$\Sigma M_{G1} = 0$.

$\Rightarrow -R_A \times 8 + 100 \times 20 - 100 \times 12 = 0$.

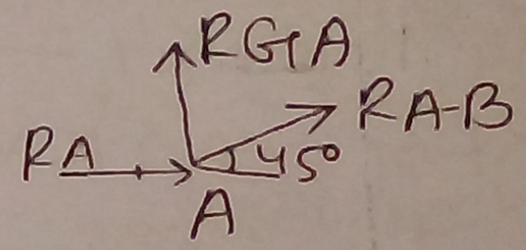
$\therefore R_A = 100$ lb.

$\Sigma F_x = 0 \Rightarrow R_A + R_{G1x} - 100 = 0$.

$\therefore R_{G1x} = 0$.

$\Sigma F_y = 0 \Rightarrow R_{G1y} + 100 = 0 \therefore R_{G1y} = -100$.

At joint A.



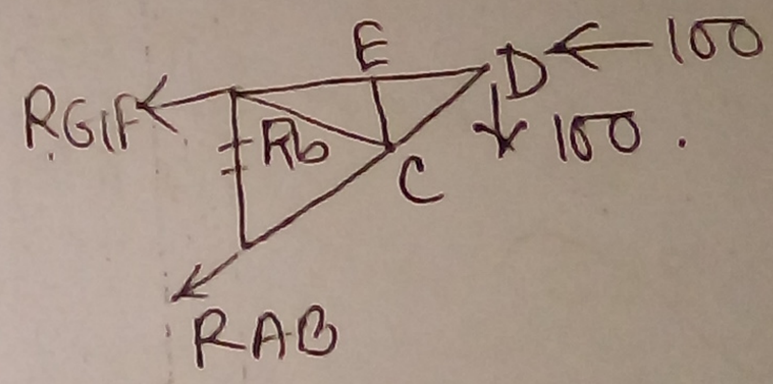
$\Sigma F_x = 0$.

$\Rightarrow R_A + R_{AB} \cos 45° = 0$.

$\therefore R_{AB} = -141.42$ lb.

$\Sigma F_y = 0 \Rightarrow R_{G1A} + R_{AB} \sin 45° = 0$. $\therefore R_{G1A} = 100$ lb. —Ans!

Rd considering the right portion of ⓐ-ⓐ.

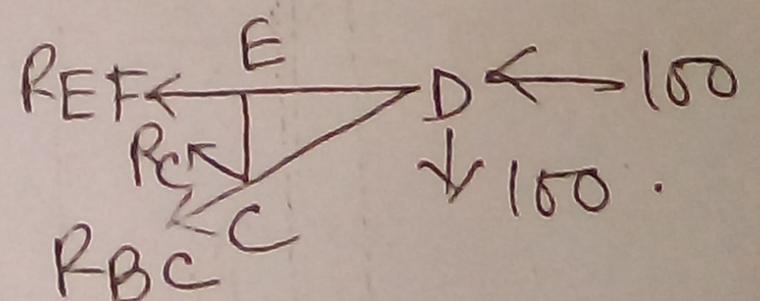


$\Sigma M_D = 0$.

$\therefore \Rightarrow R_b = 0$.

$\therefore R_b = 0$. —Ans!

From ⓑ-ⓑ sec. right portion.

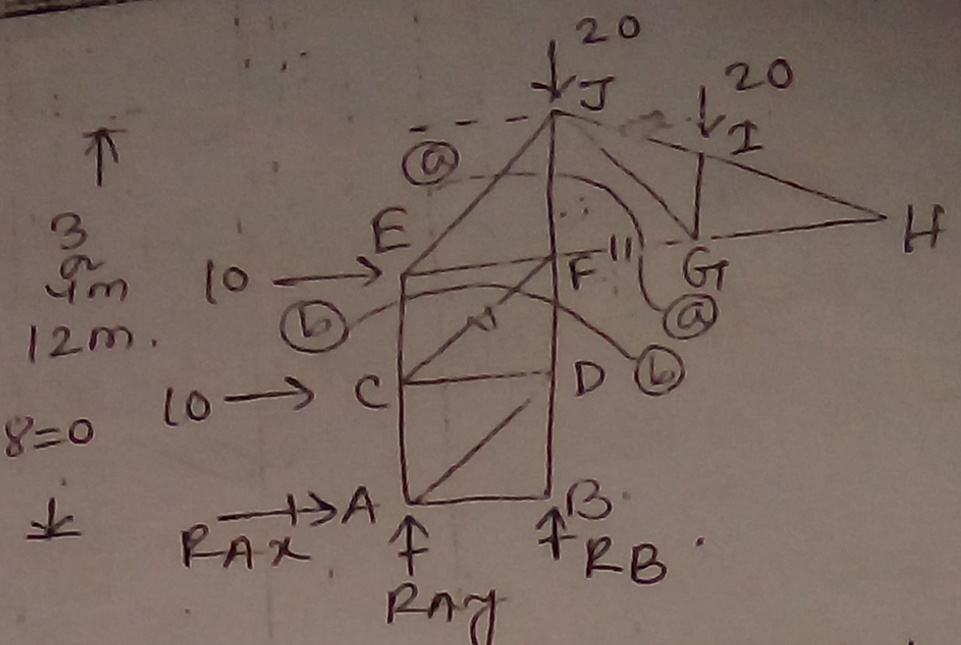


$\Sigma M_D = 0$.

$\Rightarrow R_c = 0$.

$\therefore R_c = 0$. —Ans!

* 2000
359.



$\Sigma M_A = 0$.

$\Rightarrow -R_B \times 4 + 10 \times 4 + 10 \times 8 + 20 \times 4 + 20 \times 8 = 0$

$\therefore R_B = 30\ KN$.

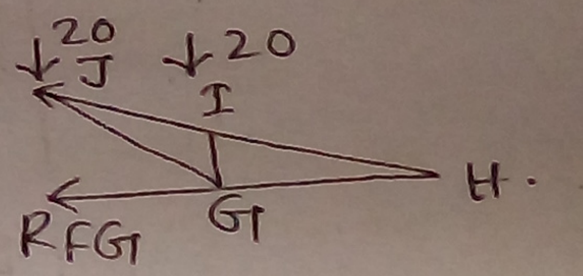
$\Sigma F_x = 0$.

$\Rightarrow R_{Ax} + 10 + 10 = 0$. $\therefore R_{Ax} = -20\ KN$.

$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_B - 20 - 20 = 0$.

$\therefore R_{Ay} = 10\ KN$.

R. portion of sec. ⓐ-ⓐ.

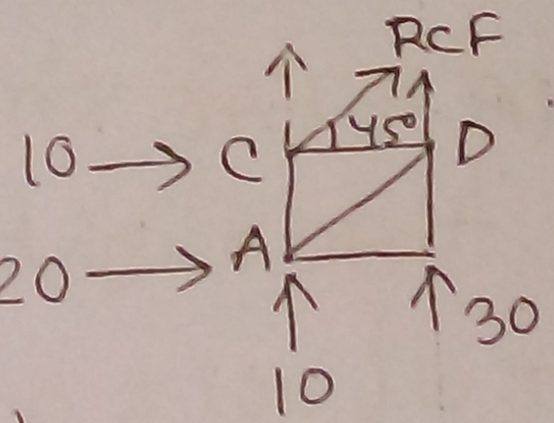


$\Sigma M_J = 0$.

$\Rightarrow + R_{FG} \times 4 + 20 \times 4 = 0$.

$\therefore R_{FG} = -20\ KN$. Ans:- (c)

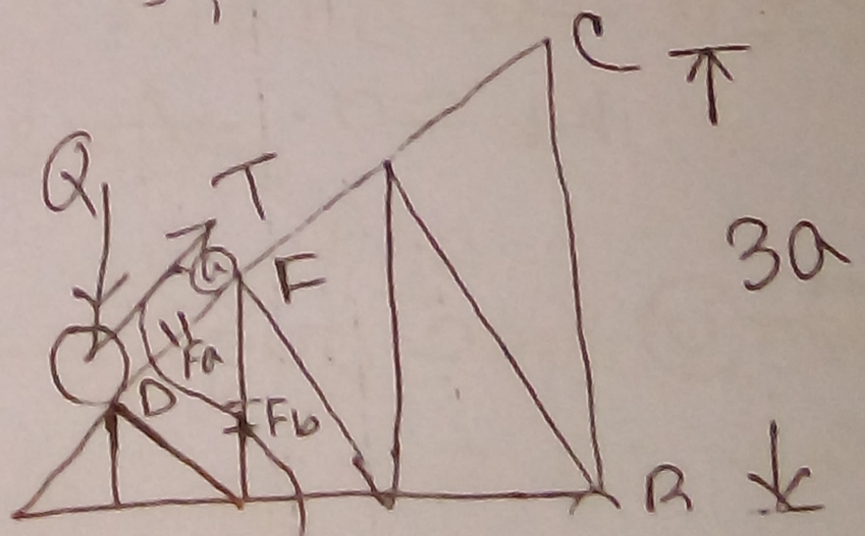
$\Sigma M_A = 0$.



$\Rightarrow -30 \times 4 + R_{CF} \cos 45° \times 4 + 10 \times 4 = 0$

$\therefore R_{CF} = 28.28\ KN$. Ans:-

363.



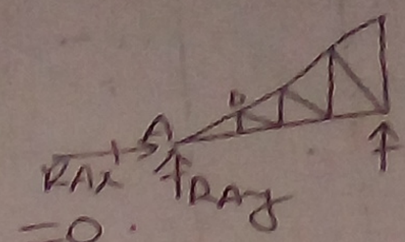
$\Sigma F_x = 0$.

$\Rightarrow Q \sin\theta - T = 0$.

$M_A = 0$.

$\Rightarrow 800 \times \frac{5}{4} a - R_B \times 4a = 0$.

$\therefore R_B = 250$ lb.



$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_B - 800\cos\theta = 0$.

$\therefore R_{Ay} = 300$ lb.

$\Sigma F_x = 0 \Rightarrow R_{Ax} - 800\sin\theta = 0$. $\Rightarrow R_{Ax} = 480$ kg.

Now, Right portion of section ⓐ-ⓐ.

$\Sigma M_F = 0 \Rightarrow -F_c \times \frac{3}{2} a + R_B \times 2a = 0$.

$\therefore F_c = 333.3$ lb. Ans.

$\Sigma M_A = 0 \Rightarrow F_b \times 2a - R_B \times 4a = 0$.

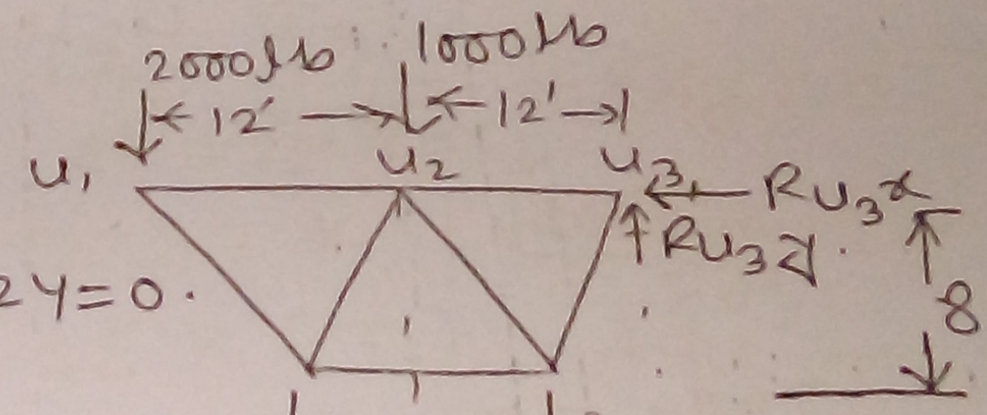
$\therefore F_b = 500$ lb. Ans.

$\Sigma M_G = 0 \Rightarrow -R_B \times 2a + F_a \sin\theta \times \frac{3}{2} a = 0$.

$\therefore F_a = 555.5$ lb. Ans.

* 2002

365.



$\Sigma M_{U_3} = 0$.

$\Rightarrow -R_{L_2} \times 6 + 1000 \times 12 + 2000 \times 24 = 0$.

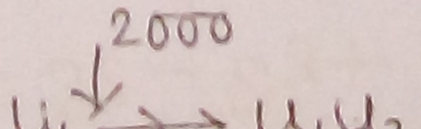
$\therefore R_{L_2} = 10,000$ lb.

$\Sigma F_y = 0 \Rightarrow R_{L_2} + R_{U_3 y} - 2000 - 1000 = 0$.

$\therefore R_{U_3 y} = -7000$ lb $\Rightarrow R_{U_3} = \frac{-7000}{8/10}$

$F_x = 0 \Rightarrow R_{U_3 x} = 0$. $\therefore R_{U_3} = -875$ lb.

$\pm$ joint U_4

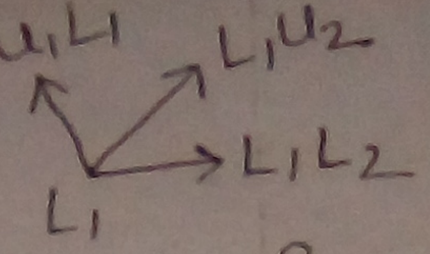


$\Sigma y = 0 \Rightarrow 2000 + U_1L_1 V = 0$.

$\Rightarrow U_1L_1 = -\frac{2000}{8/10} = -2500$ lb. Ans.

$\Sigma x = 0 \Rightarrow U_1L_1 h + U_1U_2 = 0$ $\therefore U_1U_2 = 1500$ lb. Ans.

At joint L_1



$\Sigma F_y = 0$.

$\Rightarrow U_1L_1 V + L_1U_2 V = 0$.

$\Rightarrow L_1U_2 \cdot \frac{8}{10} = -(-2500) \times \frac{8}{10}$ ∴

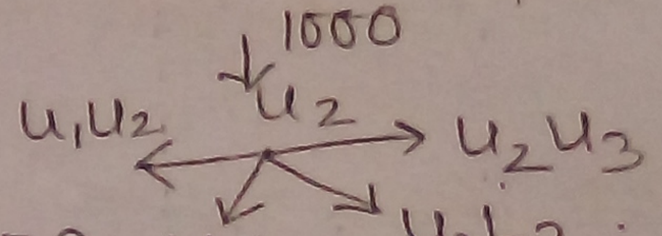
$\therefore L_1U_2 = 2500$ lb. Ans:-

$\Sigma F_x = 0 \Rightarrow U_1L_1 h - L_1L_2 - L_1U_2 h = 0$.

$\Rightarrow L_1L_2 = 2500 \times \frac{6}{10} - (-2500) \times \frac{6}{10}$ ∴

$\therefore L_1L_2 = 3000$ lb. Ans:-

At joint U_2.



$\Sigma F_y = 0$.

$\Rightarrow U_2L_1 V + U_2L_2 V + 1000 = 0$.

$\Rightarrow U_2L_2 = -\frac{1000}{8/10} - 2500$. $= -3750$ lb. Ans:-

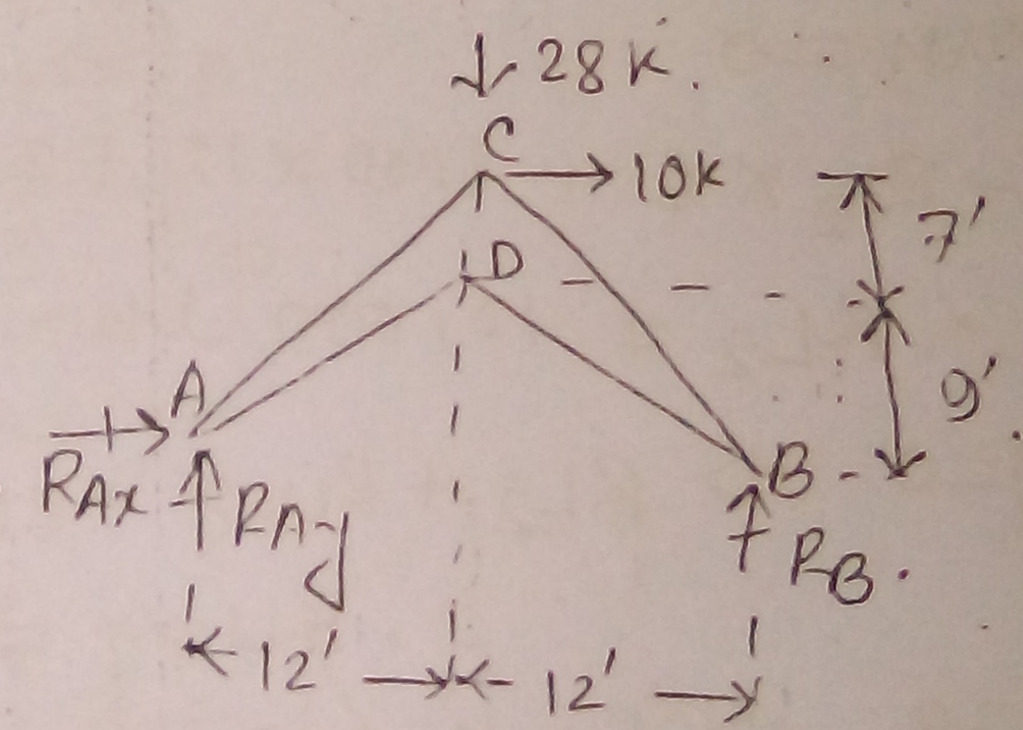
$\Sigma F_x = 0 \Rightarrow -U_1U_2 - U_2L_1 h + U_2U_3 + U_2L_2 h = 0$.

$\Rightarrow U_2U_3 = U_1U_2 + U_2L_1 h - U_2L_2 h$.

$\therefore U_2U_3 = 8750$ lb. Ans:-

* 2001

367.



$\Sigma M_A = 0$.

$\Rightarrow 28 \times 12 + 10 \times 16 - R_B \times 24 = 0$.

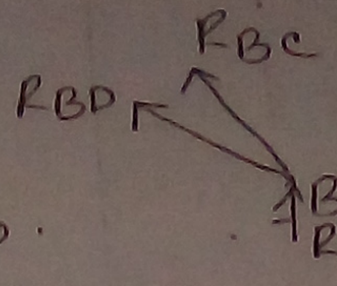
$\therefore R_B = 20.67$ K.

$\Sigma F_x = 0$. $\Rightarrow R_{Ax} + 10 = 0$. $\therefore R_{Ax} = -10$K.

$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_B - 28 = 0$.

$\therefore R_{Ay} = 7.33$ K.

At joint B.



$\Sigma F_x = 0$.

$\Rightarrow R_{BC} \cdot \frac{12}{\sqrt{12^2+16^2}} + R_{BD} \cdot \frac{12}{\sqrt{12^2+9^2}} = 0$.

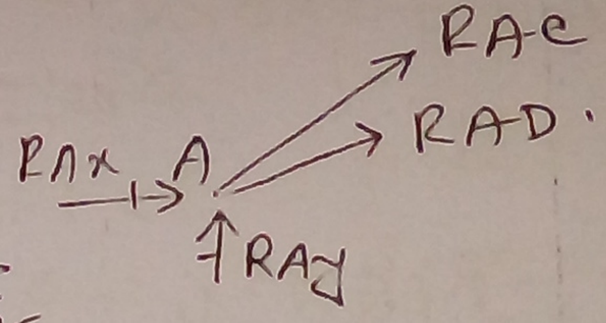
$\therefore -0.75 R_{BC} = R_{BD}$ ——— (I).

$\Sigma F_y = 0 \Rightarrow R_{BC} \cdot \frac{16}{\sqrt{12^2+16^2}} + R_{BD} \cdot \frac{9}{\sqrt{12^2+9^2}} + R_B = 0$.

$\therefore R_{BC} = -59.06\ K$. (C). —Ans;—

$\therefore R_{BD} = 44.29\ K$. (T). —Ans;—

At joint A.



$\Sigma F_x = 0$.

$\Rightarrow R_{AC} \cdot \frac{12}{\sqrt{12^2+16^2}} + R_{AD} \cdot \frac{12}{\sqrt{12^2+9^2}} + R_{Ax} = 0$.

$\therefore R_{AD} = \frac{1}{0.8}(10 - 0.6 R_{AC})$. ——— (II).

$\Sigma F_y = 0 \Rightarrow R_{AC} \cdot \frac{16}{\sqrt{12^2+16^2}} + R_{AD} \cdot \frac{9}{\sqrt{12^2+9^2}} + R_{Ay} = 0$.

$\therefore R_{AC} = -42.37\ K$ (C). —Ans;—

$\therefore$ From (II), $R_{AD} = 44.28\ K$ (T.). —Ans;—

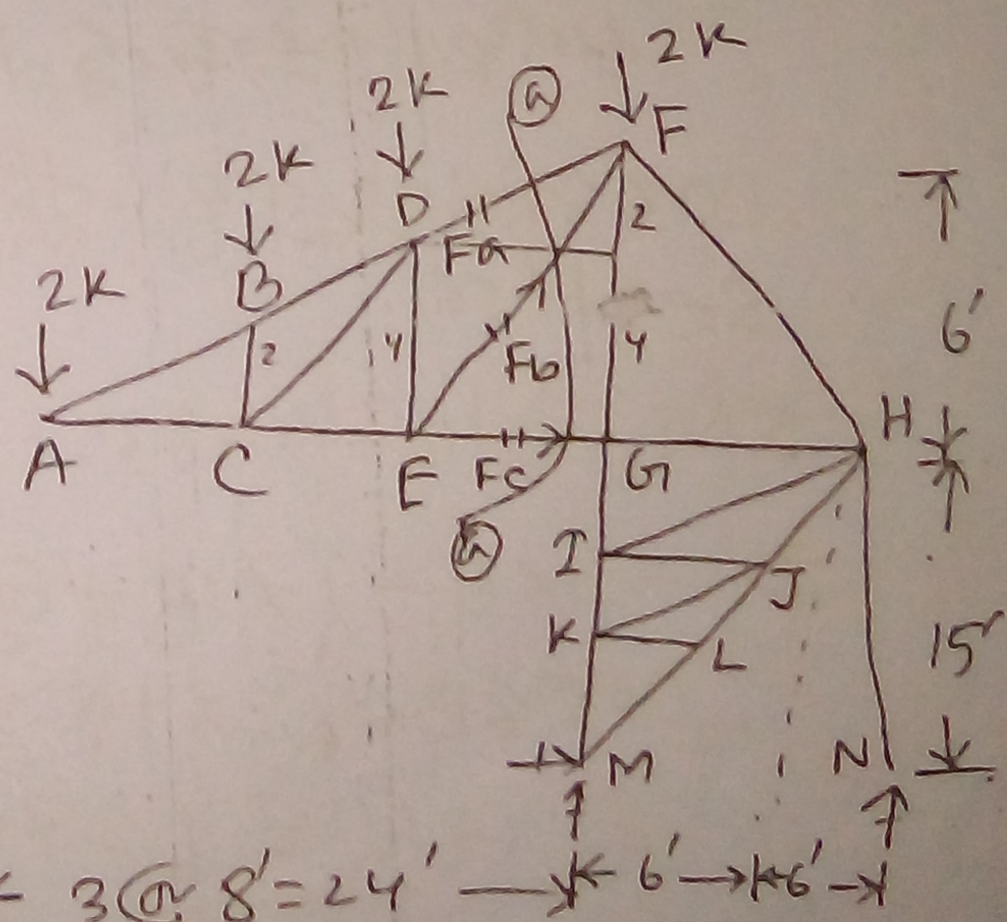
* 368. considering left sec. (A)-(A).

$\Sigma M_A = 0$.

$\Rightarrow 2 \times 8 + 2 \times 16 - F_b \times \frac{8}{10} \times 8 = 0$.

$\therefore F_b = 3.75k$. (T).

—Ans;—



$\Sigma M_F = 0$.

$\Rightarrow -2\times24 - 2\times16 - 2\times8 - F_C \times 6 = 0$.

$\therefore F_C = -16\,K$ (C.) Ans!

$\Sigma M_E = 0$.

$\Rightarrow -2\times16 - 2\times8 + F_A \cdot \frac{8}{\sqrt{68}} \times 4 = 0$.

$\therefore F_A = 12.37\,K$. (T.) Ans!

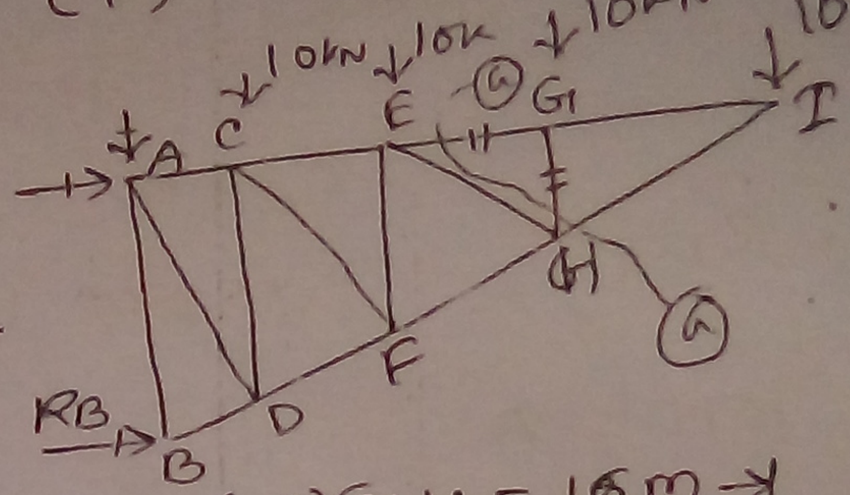
* 370. Right sec. Ⓐ–Ⓐ.

$\Sigma M_E = 0$.

$\Rightarrow 10\times4 + 10\times8 + R_{GH}\times4 = 0$.5

$\therefore R_{GH} = -50\,KN$.

Ans!



$\Sigma M_H = 0$.

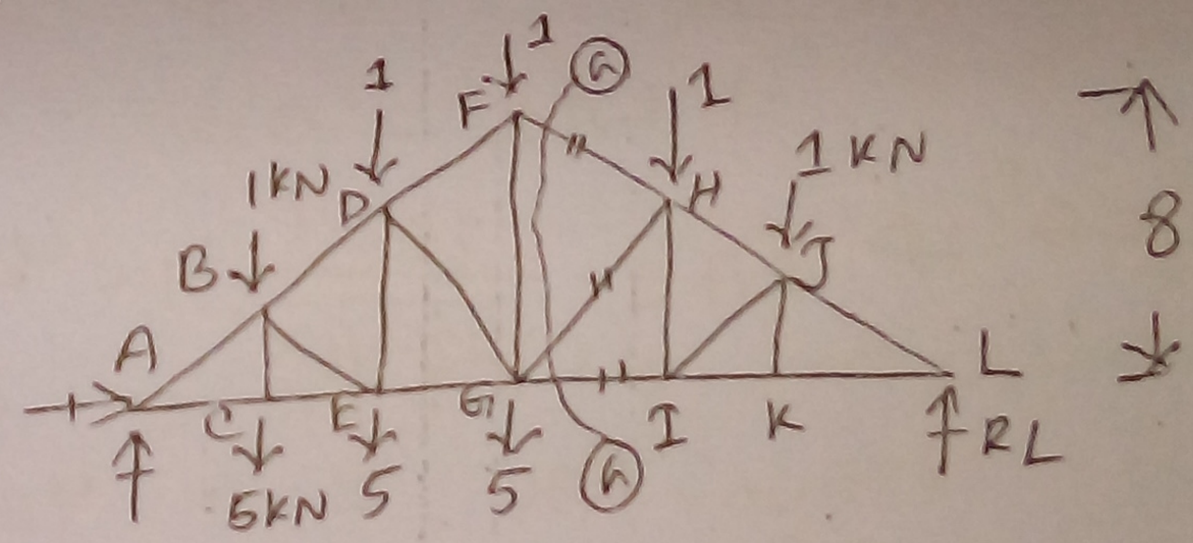
$\Rightarrow 10\times4 - R_{EG}\times\frac{5}{4} = 0$.

$\therefore R_{EG} = 16\,KN$.

Ans!

* 2004

378.

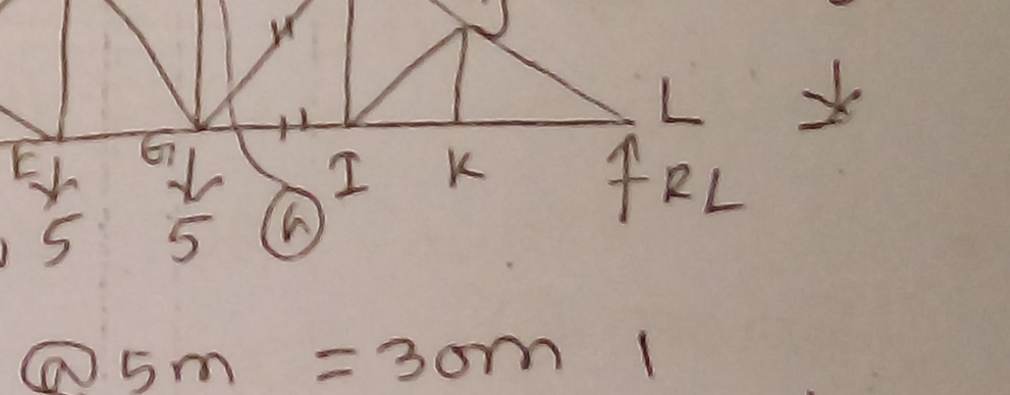


$\Sigma M_A = 0$.

$\Rightarrow 6\times5 + 6\times10 + 6\times15 + 1\times20 + 1\times25 - P_L\times30 = 0$.1

$\therefore R_L = 7.5\,KN$.

considering the Right portion of Ⓐ–Ⓐ section.



$\Sigma M_L = 0$.

$\Rightarrow -1\times5 - 1\times10 + G_H \cdot \cos 28.07^\circ \times 15 = 0$.

$\therefore G_H = 1.372\,KN$. Ans!

$\Sigma M_H = 0 \Rightarrow 1 \times 5 - RL \times 10 = 0$

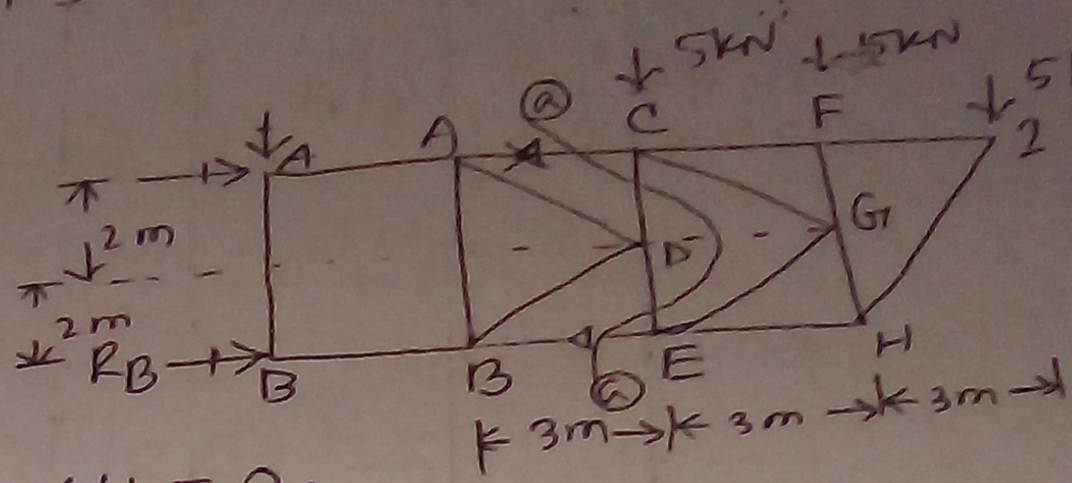
$\therefore GI = 13.13\ KN.\ (T.)$ — Ans!

$\Sigma F_y = 0 \Rightarrow FH \sin 28.07° - GH \cdot \sin 61.93° - 1 - 1 + RL = 0.$

$\therefore FH = -13.81\ KN\ (C).$ — Ans!

* 2003
353.

considering the right portion of section ⓐ–ⓐ.



$\Sigma M_C = 0.$

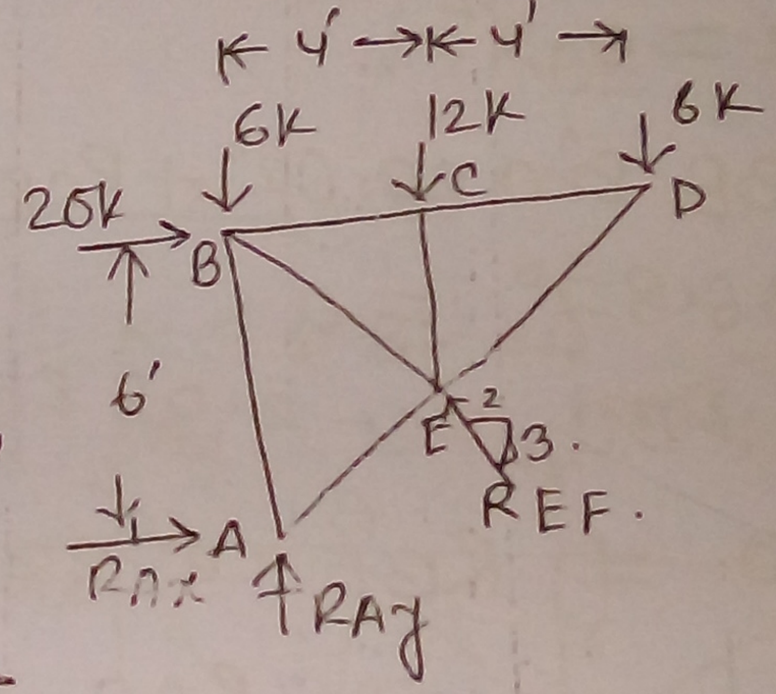
$\Rightarrow 5 \times 3 + 5 \times 6 + FBE \times 4 = 0.$

$\therefore FBE = -11.28\ KN.\ (C).$ — Ans!

$\Sigma F_x = 0. \Rightarrow FAC + FBE = 0.$

$\therefore FAC = -FBE = 11.28\ KN\ (T.)$ — Ans!

* 2006
395.



$\Sigma M_A = 0.$

$\Rightarrow +20 \times 6 + 12 \times 4 + 6 \times 8 - EF \cdot \frac{2}{\sqrt{2^2+3^2}} \times 3 - EF \cdot \frac{3}{\sqrt{2^2+3^2}} \times 4 = 0.$

$\therefore EF = 43.2\ K.$ — Ans!

$\therefore EF_x = 43.2 \times \frac{2}{\sqrt{2^2+3^2}} = 35.95\ K.$ — Ans!

$\therefore EF_y = 43.2 \times \frac{3}{\sqrt{2^2+3^2}} = 23.07\ K.$ — Ans!

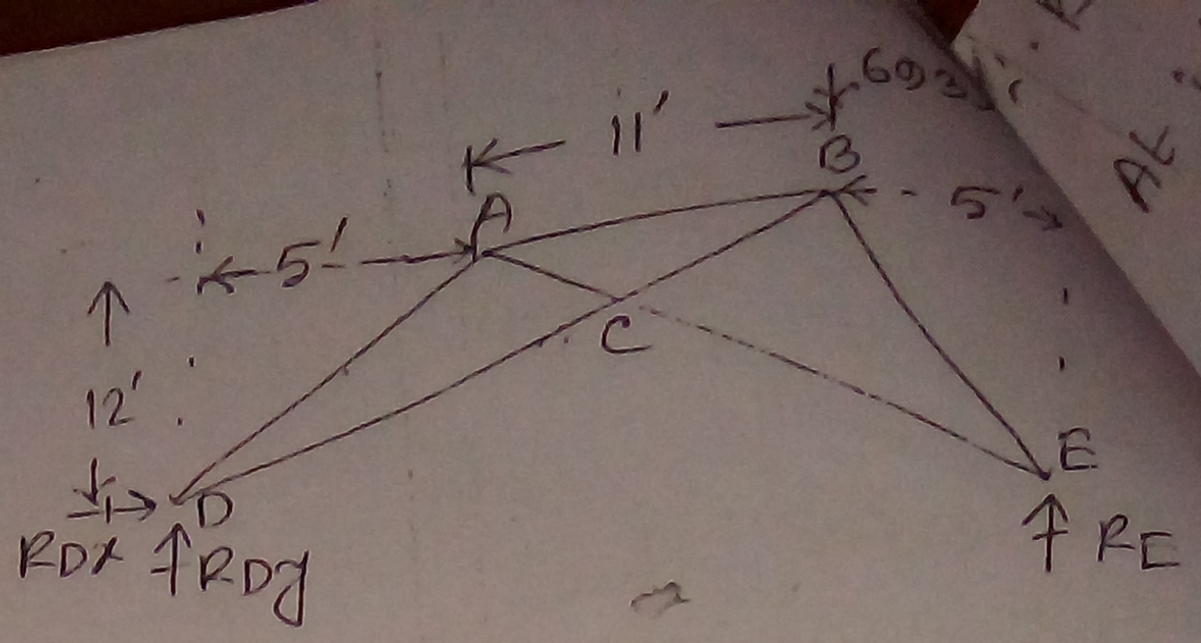
$\Sigma F_x = 0 \Rightarrow R_{Ax} + 20 - EF_x = 0 \quad \therefore R_{Ax} = 4\ K.$ — Ans!

$\therefore \Sigma F_y = 0 \Rightarrow R_{Ay} - 6 - 12 + EF_y - 6 = 0.$

$\therefore R_{Ay} = 11.86\ K\ (T).$ — Ans!

* (2006).

374.



$\Sigma M_D = 0$.

$\Rightarrow -RE \times 21 + 693 \times 16 = 0$.

$\therefore RE = 528$ lb.

$\Sigma Fx = 0 \Rightarrow RDx = 0$.

$\Sigma Fy = 0 \Rightarrow RDy + RE - 693 = 0$.

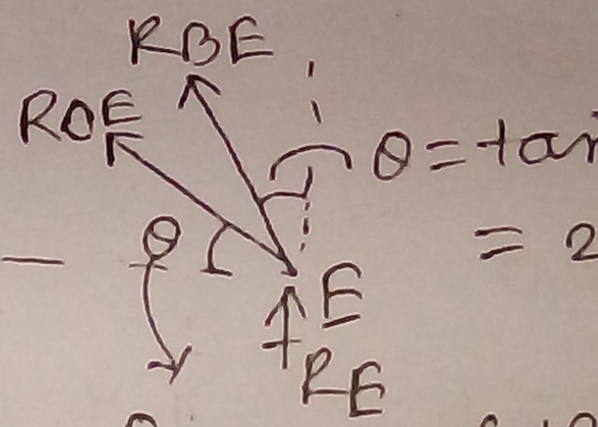
$\therefore RDy = 165$ lb.

At joint E.

$\Sigma Fx = 0$.

$\Rightarrow RBE \sin 22.62° + RCE \cos 36.87° = 0$.

$\therefore RBE = -2.08\, RCE$ ——— (1).



$\Sigma Fy = 0 \Rightarrow RBE \cos 22.62° + RCE \sin 36.87° - 1KE = 0$.

$\therefore RCE = 400$ lb. (T). Ans!

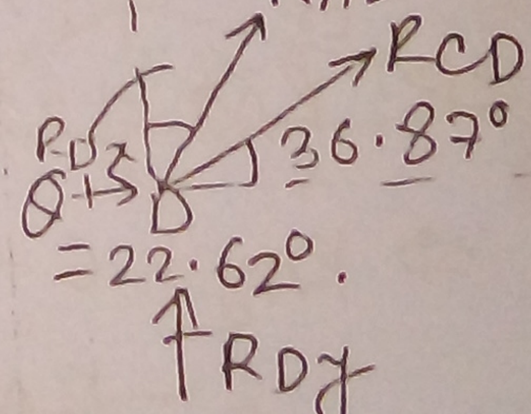
$\therefore RBE = -832$ lb (C). Ans!

At joint D.

$\Sigma Fx = 0$.

$\Rightarrow Pnx + RAD \sin 22.62° + RCD \cos 36.87° = 0$.

$\therefore RAD = -2.08\, RCD$.

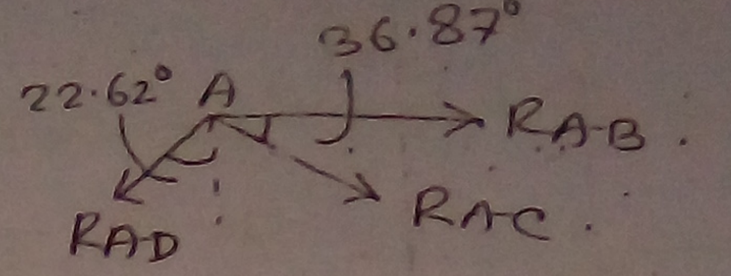


$\Sigma Fy = 0 \Rightarrow RDy + RAD \cos 22.62° + RCD \sin 36.87° = 0$.

$\therefore RCD = 125$ lb (T.). Ans!

$\therefore R_{AD} = -260\ lb\ (C)$. —Ans:—

At joint A.



$\Sigma F_x = 0$.

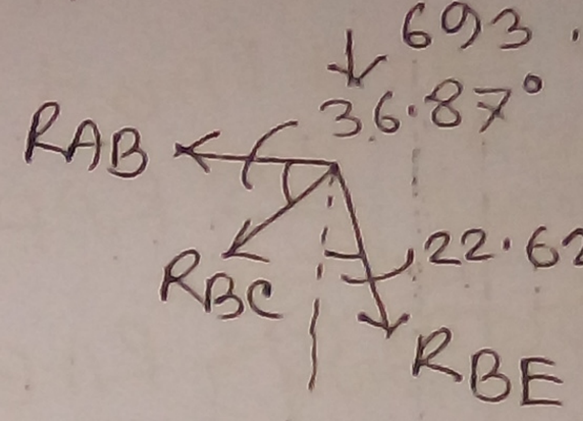
$\Rightarrow D - R_{AD} \sin 22.62° + R_{AB} + R_{AC} \cos 36.87° = 0$. —①

$\Sigma F_y = 0$. $\Rightarrow R_{AD} \cos 22.62° + R_{AC} \sin 36.87° = 0$.

$\therefore R_{AC} = -400\ lb$. (C). —Ans:—

$\therefore$ From ①, $R_{AB} = 420\ lb$ (T.). —Ans:—

At joint B.



$\Sigma F_y = 0$.

$\Rightarrow R_{BE} \cos 22.62° + R_{BC} \sin 36.87° = -693$.

$\therefore R_{BC} = -125\ lb$ (C). —Ans:—

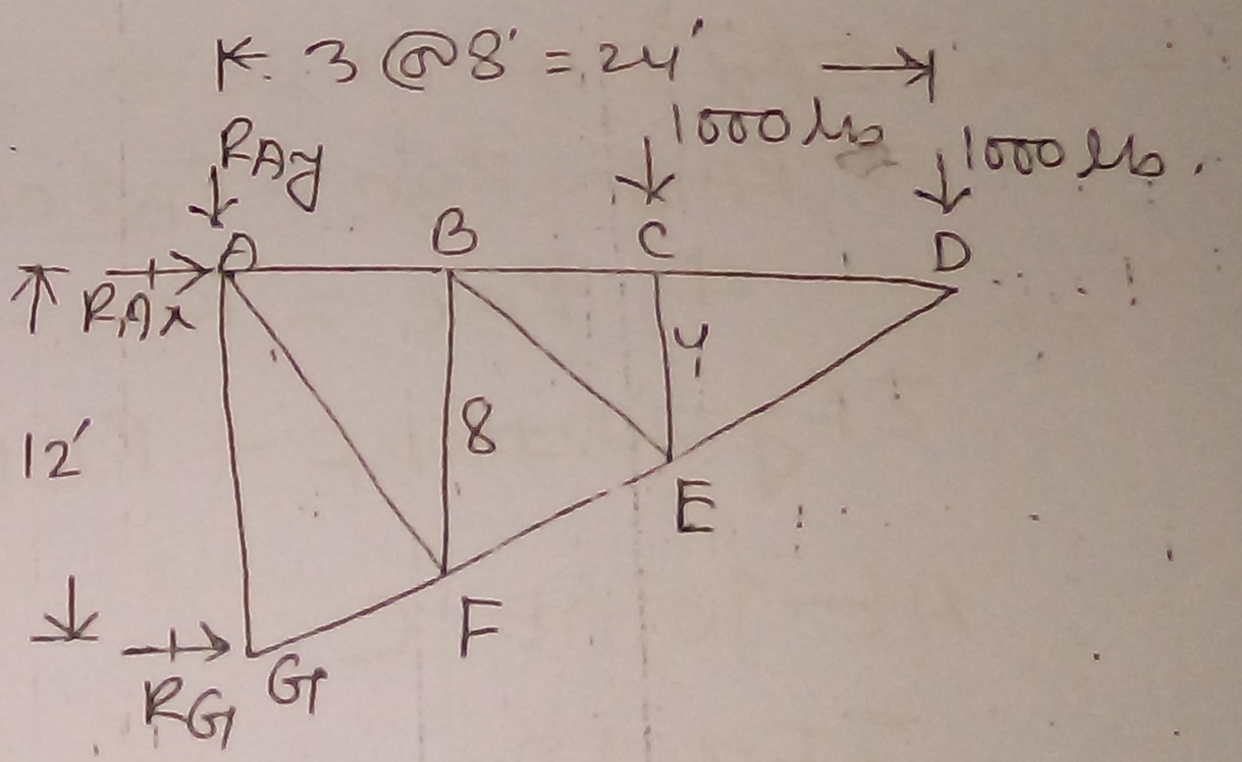
*2008.

388.

$\Sigma M_D = 0$.

$\Rightarrow 1000 \times 16 + 1000 \times 24 - R_G \times 12 = 0$.

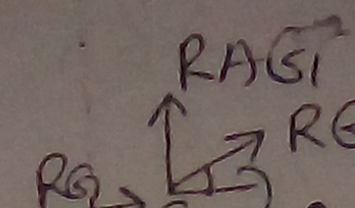
$\therefore R_G = 3.33\ K lb$.



$\Sigma F_x = 0 \Rightarrow R_{Ax} + R_G = 0$. $\therefore R_{Ax} = -R_G = -3.33\ K lb$.

$\Sigma F_y = 0 \Rightarrow R_{Ay} + 1000 + 1000 = 0$ $\therefore R_{Ay} = -2000\ lb = -2.00\ K lb$.

At joint G.



$\Sigma F_x = 0$.

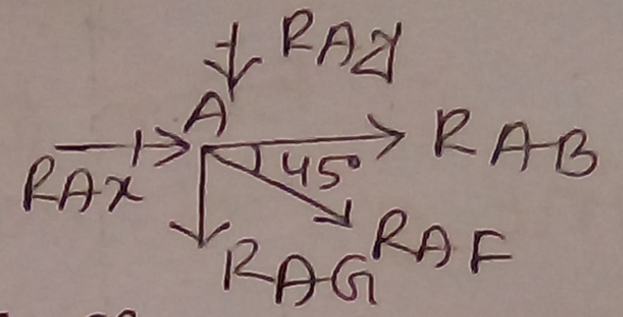
$\Rightarrow RG + RGF \cos 26.57° = 0$.

$\therefore RGF = -3.72$ kNb. Ans;-

$\Sigma F_y = 0$. $\Rightarrow RAG + RGF \sin 26.57° = 0$.

$\therefore RAG = 1.67$ kNb. Ans;-

At joint A.



$\Sigma F_x = 0$.

$\Rightarrow RAx + RAB + RAF \cos 45° = 0$ —①

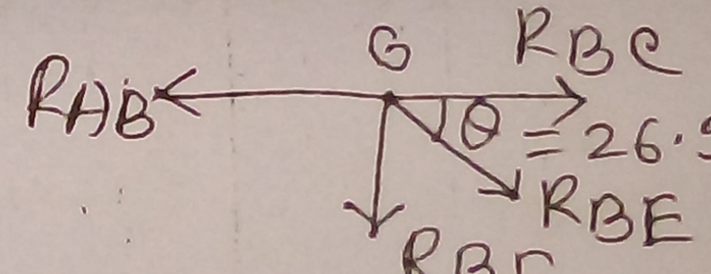
$\therefore RAF = 0.48$ kNb. Ans;-

From ①, $RAB = 3$ kNb. Ans;-

$\Sigma F_y = 0$.

$\Rightarrow RAJ + RAG + RAF \sin 45° = 0$

At joint B.



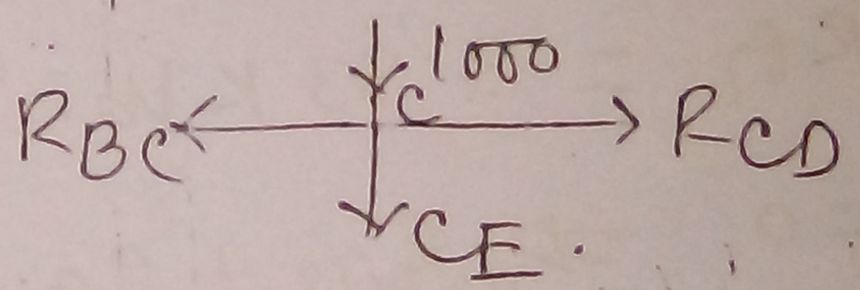
$\Sigma F_x = 0$.

$\Rightarrow RAB - RBC - RBE \cos 26.57° = 0$.

$\Rightarrow RBC = RAB - RBE \cos 26.57°$. —— ①.

$\Sigma F_y = 0 \Rightarrow RBF + RBE \sin 26.57° = 0$. —— ⑪.

At joint C.

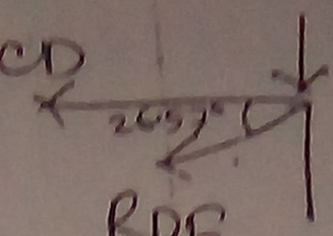


$\Rightarrow RBC - RCD = 0$. $\therefore RBC = RCD$.

$\therefore \Sigma F_y = 0 \Rightarrow RCE + 1000 = 0$.

$\therefore RCE = -1$ kNb. Ans;-

At D joint.



$\Sigma F_y = 0$.

$\Rightarrow 1000 + R_{DE} \sin 26.57° = 0$. $\therefore R_{DE} = -2.24$ Klb. —Ans:—

$\Sigma F_x = 0$. $\Rightarrow R_{CD} + R_{DE} \cos 26.57° = 0$.

From C joint. $\therefore R_{CD} = 2$ Klb. —Ans:—

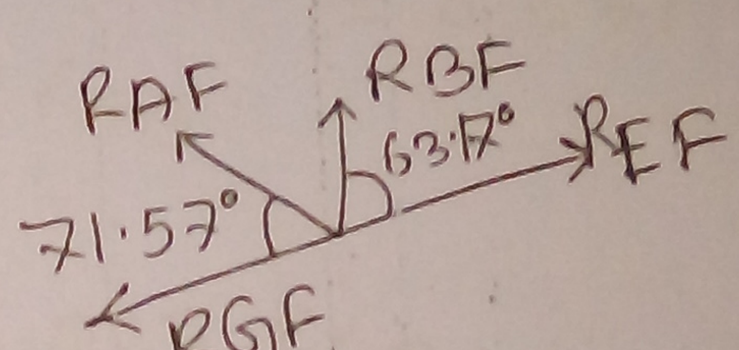
$\therefore R_{BC} = R_{CD} = 2$ Klb. —Ans:—

From B joint.

$R_{BE} = 1.42$ Klb. —Ans:—

$R_{BF} = -0.5$ Klb. —Ans:—

At joint. F



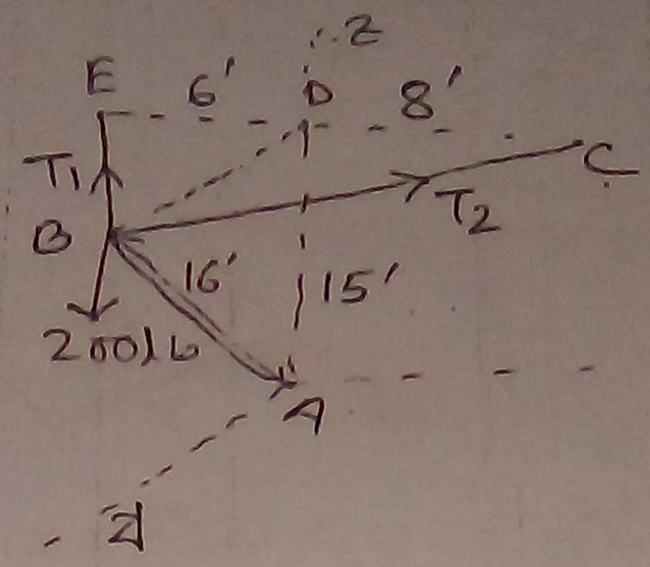
$\Sigma F_x = 0$.

$\Rightarrow R_{EF} + R_{GF} - R_{BF} \cos$

$63.17° - R_{AF} \cdot \cos 71.57° = 0$.

$\therefore R_{EF} = 3.34$ Klb. (T). —Ans:—

THREE DIMENSION.



$BD = \sqrt{16^2 - 15^2}$.
$= 5.57$.

$\therefore T_1 x = \frac{6\,T_1}{\sqrt{6^2+5.57^2}}$.
$= 0.733\,T_1$.

$\therefore T_1 y = \frac{5.57\,T_1}{\sqrt{6^2+5.57^2}}$.
$= 0.68\,T_1$.

$T_2 x = \frac{8\,T_2}{\sqrt{8^2+5.57^2}} = 0.82\,T_2$.

$T_2 y = \frac{5.57\,T_2}{\sqrt{8^2+5.57^2}}$.
$= 0.571\,T_2$.

$\therefore R_{ABy} = \frac{5.57\,R_{AB}}{\sqrt{15^2+5.57^2}} = 0.348\,R_{AB}$.

$\therefore R_{ABz} = \frac{15\,R_{AB}}{\sqrt{15^2+5.57^2}} = 0.937\,R_{AB}$.

$\therefore \Sigma F_x = 0$.

$\Rightarrow T_1 x - T_2 x = 0 \Rightarrow 0.733\,T_1 - 0.82\,T_2 = 0$.

$\therefore T_1 = \frac{0.82}{0.733}\,T_2$. —①.

$\Sigma F_z = 0$.

$\Rightarrow R_{ABz} = 200$. $\Rightarrow R_{AB} \times 0.937 = 200$.

$\therefore R_{AB} = 213.44$ lb.

$\Sigma F_y = 0$. $\Rightarrow T_1 y + T_2 y - R_{ABy} = 0$. —Ans:—

$\Rightarrow 0.68\,T_1 + 0.571\,T_2 - 0.348 \times 213.44 = 0$.

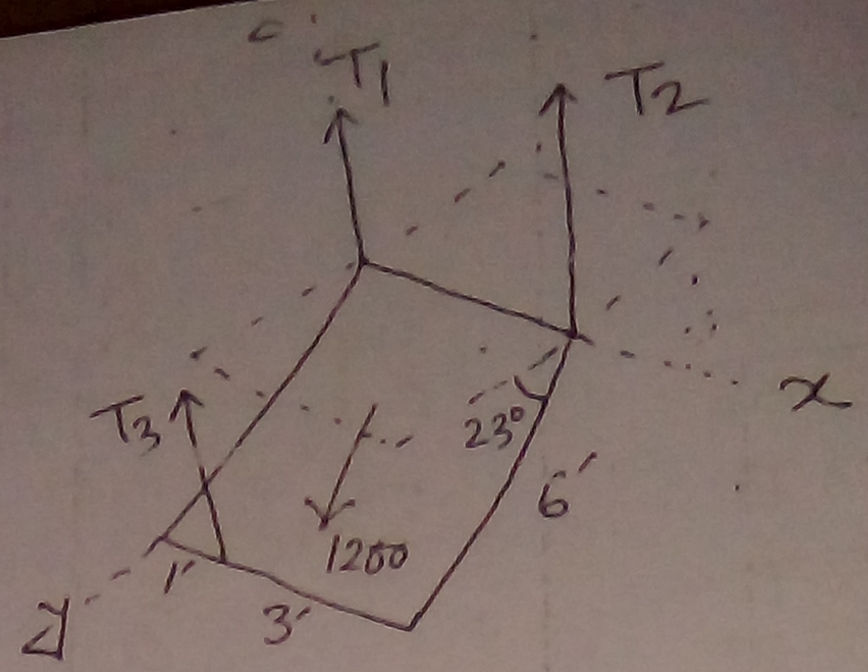
$\Rightarrow 0.68 \times \frac{0.82}{7.33}\,T_2 + 0.571\,T_2 = 0.348 \times 213.44$.

$\therefore T_2 = 62.55$ lb. —Ans:—

From ①. $T_1 = 55.85$ lb. —Ans:—

*(Wrong)

Z16.



$\Sigma F_{1x} = 0$

$\Rightarrow T_3 \times 6\cos 23° - 1200 \times 6\cos 23° = 0.$

$\therefore T_3 = \frac{1200 \times 3}{6} = 600$ lb. — Ans:—

$\Sigma M_y = 0 \Rightarrow T_3 \times 1 - 1200 \times 2 + T_2 \times 4 = 0.$

$\therefore T_2 = 450$ lb. Ans:—

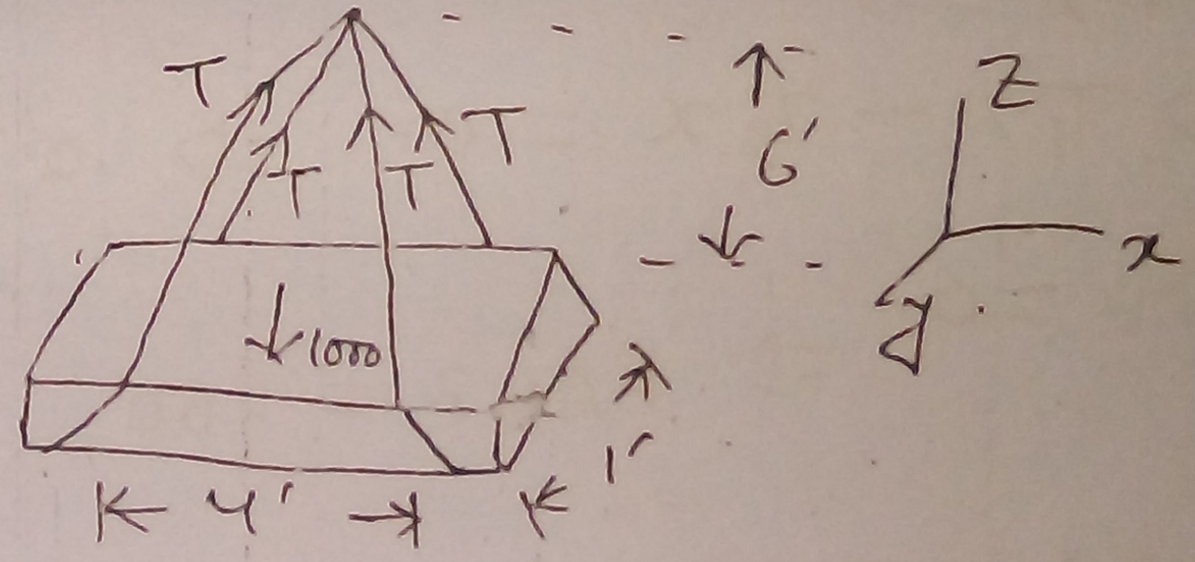
$\Sigma F_z = 0. \Rightarrow T_1 + T_2 + T_3 - 1200 = 0.$

$\therefore T_1 = 150$ lb. Ans:—

Z17.

$\therefore T_2 = \frac{6T.}{\sqrt{2^2 + 1.5^2 + 6^2}}.$

$= 0.946T.$



$\Sigma F_z = 0. \Rightarrow T_2 + T_2 + T_2 + T_2 - 1000 = 0.$

$\Rightarrow 4T_2 = 1000.$

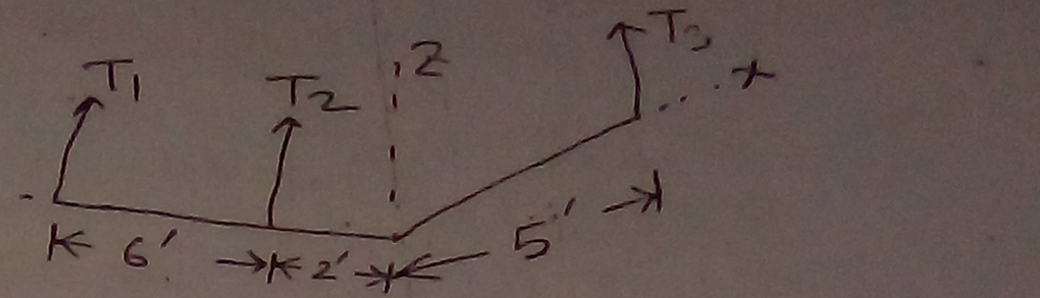
$\Rightarrow T = \frac{1000}{4 \times 0.946}.$

$\therefore T = 264.26$ lb.

Ans:—

18.

weight 40 lb per foot length.



ΣM_y axis. $=0$.

$\Rightarrow T_3 \times 5 - 200 \times 2.5 = 0$. $\therefore T_3 = 100$ lb. Ans:-

ΣM_x axis. $=0$.

$\Rightarrow T_1 \times 8 + T_2 \times 2 - 320 \times 4 = 0$.

$\Rightarrow 4T_1 + T_2 = 320 \times 2$. ——— (i).

$\Sigma F_z = 0 \Rightarrow T_1 + T_2 + T_3 - 320 - 200 = 0$.

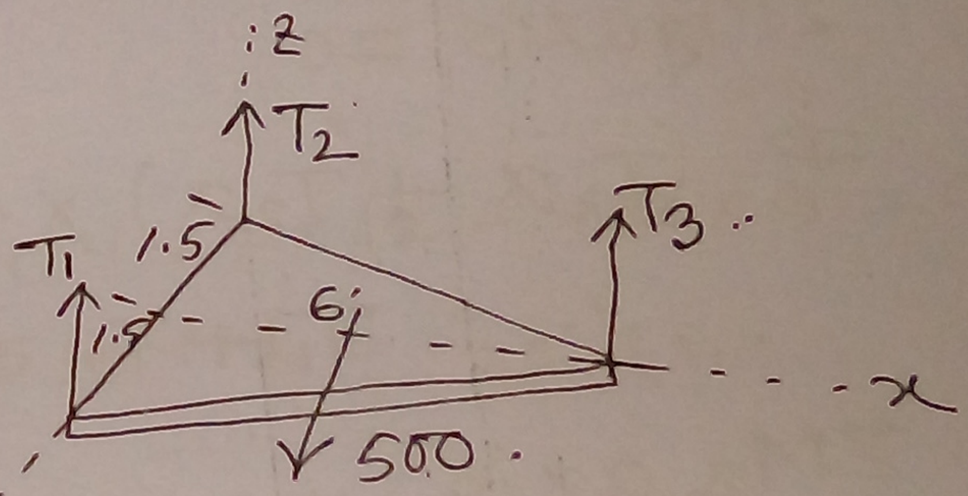
$\therefore T_1 + T_2 = 420$. ——— (ii).

From (i), (ii) solving, $T_1 = 73.33$ lb. Ans:-

$T_2 = 346.67$ lb. Ans:-

*2006.

X78.



ΣM_y axis $=0$.

$\Rightarrow T_3 \times 6 - 500 \times 2 = 0$.

$\therefore T_3 = 166.67$ lb. Ans:-

ΣM_x axis $=0$.

$\Rightarrow T_1 \times 1.5 - T_2 \times 1.5 = 0$.

$\therefore T_1 = T_2$. ——— (i).

$\Sigma F_z = 0 \Rightarrow T_1 + T_2 + T_3 - 500 = 0$.

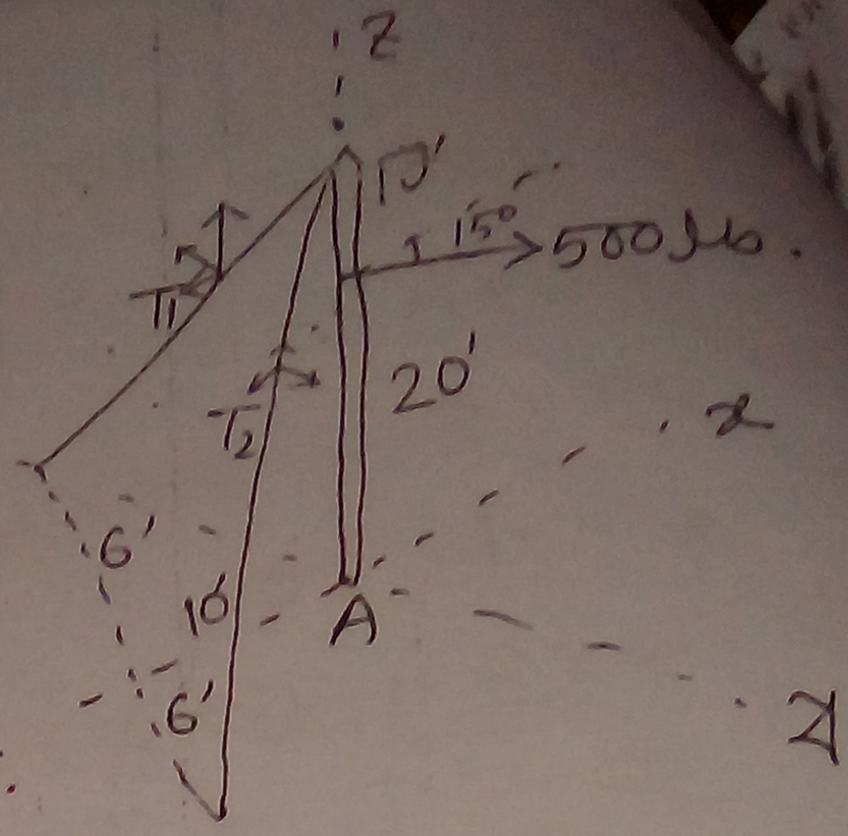
$\Rightarrow 2T_1 = 500 - 166.67$.

$\therefore T_1 = 166.67$ lb. Ans:-

From (i), $T_2 = 166.67$ lb. Ans:-

*2005

722.



First, we get the projection of T_1 and T_2.

$\therefore T_1 x = T_2 x$.

$= \frac{10\,T}{\sqrt{10^2+6^2+30^2}} = 0.31\,T.$

$\therefore T_2 y = T_1 y = \frac{6\,T.}{\sqrt{10^2+6^2+30^2}} = 0.186\,T.$

$\therefore T_1 z = T_2 z = \frac{30\,T}{\sqrt{10^2+6^2+30^2}} = 0.932\,T.$

ΣM_y axis $= 0$.

$\Rightarrow (T_1 x + T_2 x) \times 30 - 500 \cos 15° \times 20 = 0.$

$\therefore \quad T_1 + T_2 = 1038.62$ ——— (I).

ΣM_x axis. $= 0$.

$\Rightarrow (T_1 y - T_2 y) \times 30 - 500 \sin 15° \times 20 = 0.$

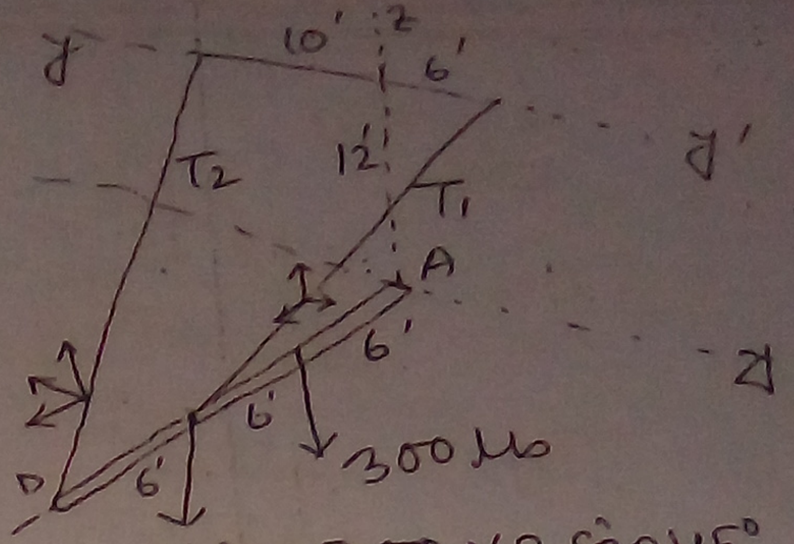
$\therefore T_1 - T_2 = 463.8$ ——— (II).

Now, solving (I), (II),

$T_1 = 751.21$ lb. —Ans!—

$T_2 = 287.41$ lb. —Ans!—

* 2004



$$T_1x = \frac{12\,T_1}{\sqrt{12^2+12^2+6^2}} = 0.67\,T_1$$

$$T_1y = \frac{6\,T_1}{\sqrt{12^2+6^2+12^2}} = 0.33\,T_1$$

$$T_1z = 0.67\,T_1$$

$$T_2x = \frac{18\,T_2}{\sqrt{18^2+10^2+12^2}} = 0.76\,T_2$$

$$T_2y = \frac{10\,T_2}{\sqrt{18^2+10^2+12^2}} = 0.42\,T_2$$

$$T_2z = \frac{12\,T_2}{\sqrt{18^2+10^2+12^2}} = 0.5\,T_2$$

W = 300 × 2 sin 45°.
= 424.27 lb.

WAD = 400 lb.

ΣM y-y' axis = 0.

$\Rightarrow R_{Ax} \times 12 - 300 \times 6 - 424.27 \times 12 - 400 \times 9 = 0$.

$\therefore R_{Ax} = 451.44$ lb. Ans:-

$\Sigma M_{(A)}$ z axis = 0.

$\Rightarrow T_1y \times 12 - T_2y \times 18 = 0$. $\therefore T_1 = 1.01\,T_2$. — ①.

$\Sigma F_x = 0 \Rightarrow T_1x + T_2x - R_{Ax} = 0$.

$\therefore T_2 = 428.62$ lb. Ans:-

$\therefore T_1 = 818.67$ lb. Ans:-

$\Sigma F_y = 0 \Rightarrow T_1y - T_2y - R_{Ay} = 0$.

$\therefore R_{Ay} = 90.15$ lb. Ans:-

$\Sigma F_z = 0 \Rightarrow R_{Az} + T_1z + T_2z - 424.27 - 400 - 300 = 0$.

$\therefore R_{Az} = 361.44$ lb. Ans:-

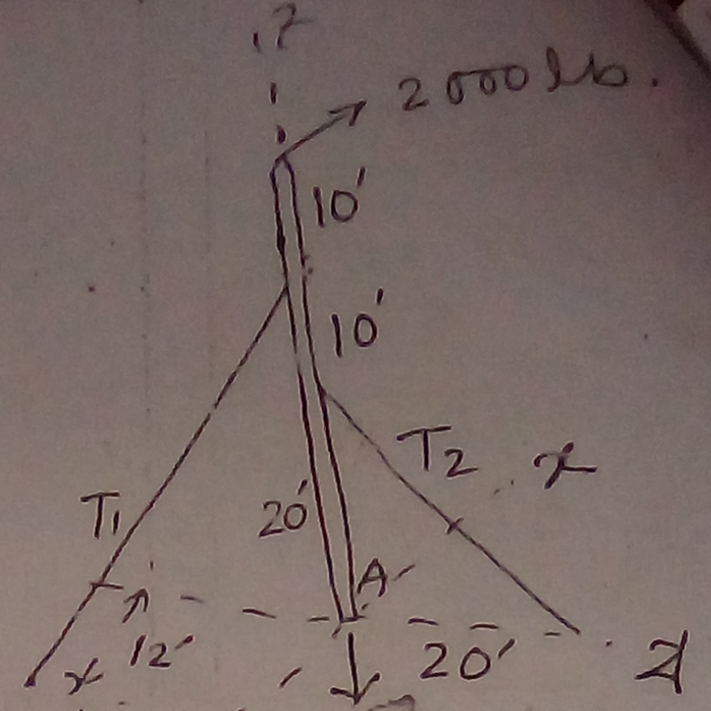
*(2000)

Z25.

$$T_1x = \frac{12\,T_1}{\sqrt{12^2+16^2+30^2}} = 0.33T_1$$

$$T_1y = \frac{16\,T_1}{\sqrt{12^2+16^2+30^2}} = 0.44T_1$$

$$T_1z = \frac{30\,T_1}{\sqrt{12^2+16^2+30^2}} = 0.83T_1$$



$$T_2y = \frac{20\,T_2}{\sqrt{20^2+20^2}} = 0.707T_2.$$

$$\therefore T_2z = 0.707\,T_2.$$

ΣM_x axis $= 0$.

$$\Rightarrow T_1y \times 30 - T_2y \times 20 = 0.$$

$$\therefore T_2 = 0.942\,T_2 \quad \text{---------- (1)}.$$

ΣM_y axis, $= 0$.

$$\Rightarrow T_1x \times 30 - 2000 \times 40 = 0.$$

$$\therefore T_1 = 8008.008 \text{ lb.} \quad \text{Ans!}$$

$$\therefore T_2 = 7543.543 \text{ lb.} \quad \text{Ans!}$$

$\Sigma F_x = 0 \Rightarrow T_1x - 2000 - RAx = 0.$

$$\therefore RAx = 666.66 \text{ lb.} \quad \text{Ans!}$$

$\Sigma F_y = 0 \Rightarrow T_1y - T_2y + RAy = 0.$

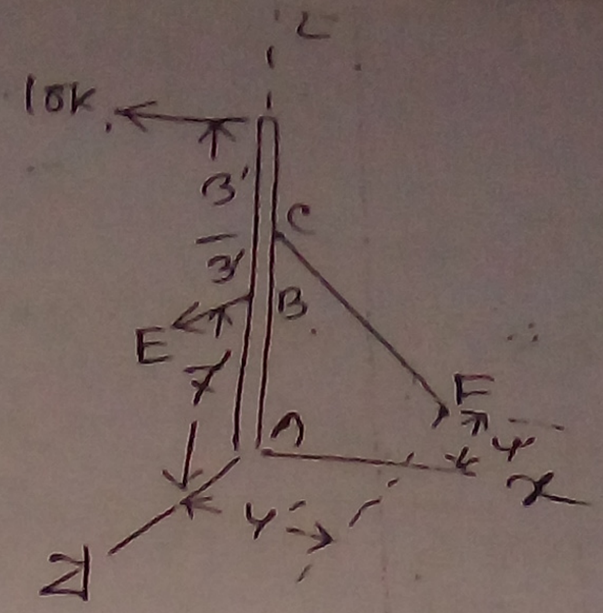
$$\therefore RAy = 1777.73 \text{ lb.} \quad \text{Ans!}$$

$\Sigma F_z = 0 \Rightarrow 1000 + T_1z + T_2z - RAz = 0.$

$$\therefore RAz = 12079.03 \text{ lb.} \quad \text{Ans!}$$

[2008]

Q1.



Now, we get the projection of the tension CF.

$$CF_x = \frac{4\,CF}{\sqrt{4^2+4^2+10^2}} = 0.348\,CF.$$

$$CF_y = 0.348\,CF.$$

$$CF_z = \frac{10\,CF}{\sqrt{4^2+4^2+10^2}} = 0.87\,CF.$$

$BE_y = BE.$

ΣM_y axis $= 0.$

$\Rightarrow CF_x \times 10 - 10 \times 13 = 0.$ $\therefore CF = 37.36$ lb.

—Ans!—

ΣM_x axis $= 0.$

$\Rightarrow CF_y \times 10 - BE_y \times 7 = 0.$

$\therefore BE = 18.57$ lb. —Ans!—

$\Sigma F_x = 0.$ $\Rightarrow -10 + CF_x - RA_x = 0.$

$\therefore RA_x = 3$ lb. —Ans!—

$\Sigma F_y = 0$ $\Rightarrow -BE_y + CF_y + RA_y = 0.$

$\therefore RA_y = 5.57$ lb. —Ans!—

$\Sigma F_z = 0$ $\Rightarrow RA_z - CF_z = 0.$

$\Rightarrow RA_z = CF_z = 0.87 \times 37.36$ lb.

$\therefore RA_z = 32.5$ lb. —Ans!—

733.

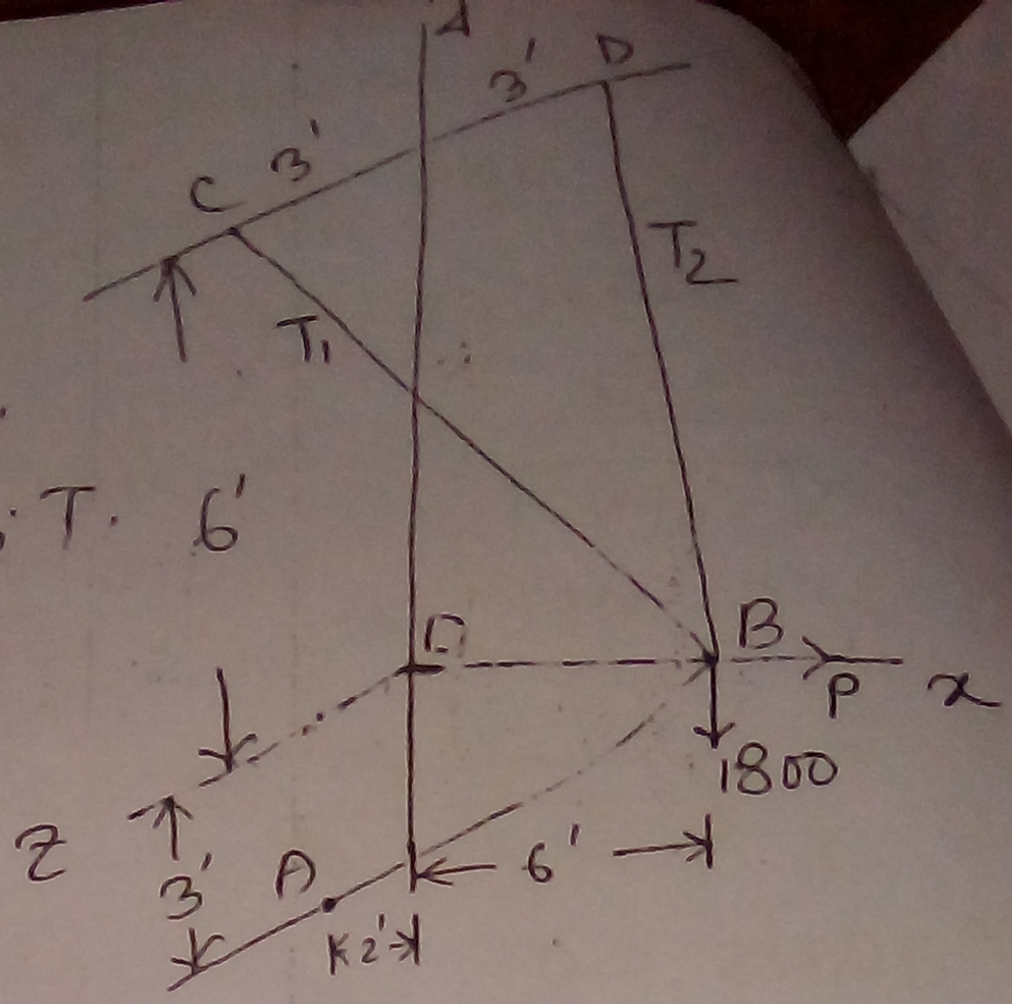
$T_1 = T_2 = T$.

so, the projection.

$$T_x = \frac{T \times 6}{\sqrt{6^2+6^2+3^2}} = \frac{2}{3} \cdot T \cdot \frac{6}{}$$

$$T_y = \frac{2}{3} \cdot T.$$

$$T_z = \frac{1}{3} \cdot T.$$



ΣM_A (z-axis) $= 0$.

$$\Rightarrow -(T_1 y + T_2 y) \times 6 - (T_1 x + T_2 x) \times 3 + P \times 3 + 1800 \times 6 = 0$$

$$\therefore 16T - 3P = 1800 \times 6. \quad \text{——— (i)}.$$

ΣM_A (y axis) $= 0$.

$$\Rightarrow -(T_1 x + T_2 x)\, 2 + (T_1 z - T_2 z) \times 3 + 2P = 0.$$

$$\therefore 2P - \frac{8}{3} \cdot T = 0 \quad \text{——— (ii)}.$$

From (i), (ii), $T = 900$ lb.

$P = 1200$ lb. Ans!→

$\Sigma F_x = 0 \Rightarrow T_1 x + T_2 x + P - R_{Ax} = 0$.

$\therefore R_{Ax} = 2400$ lb. Ans!→

$\Sigma F_y = 0 \Rightarrow T_1 y + T_2 y - 1800 + R_{Ay} = 0$.

$\therefore R_{Ay} = 600$ lb. Ans!→

$\therefore \Sigma F_z = 0 \Rightarrow R_{Az} = 0$. Ans!→

(2) At same elevation.

$$y = \frac{Wx^2}{2Q}. \quad \text{But, } x = \frac{L}{2}. \quad \therefore y = d.$$

then, $$Q = \frac{WL^2}{8d}. \quad \text{——— (I).}$$

(II) $$F_{max} = \sqrt{Q^2 + \left(\frac{WL}{2}\right)^2}. \quad \text{——— (II).}$$

(III) $$S_{max} = L + \frac{8d^2}{3L} - \frac{32d^4}{5L^3} \quad \text{——— (III).}$$

(IV) $$S = L + \frac{W^2L^3}{24Q^2} - \frac{W^4L^5}{640Q^4}. \quad \text{——— (IV).}$$

CABLES.

* 2007
1305. Here, given that, $L = 200$ ft.
$d = 200 \times 5\% = 10$ ft.
$F_{max} = 2040$ lb.
$\therefore W = ?$

We know, for the condition of same elevation.

$$Q = \frac{WL^2}{8d} = \frac{W \times (200)^2}{8 \times 10}.$$

$\therefore Q = 500W$. —— (1).

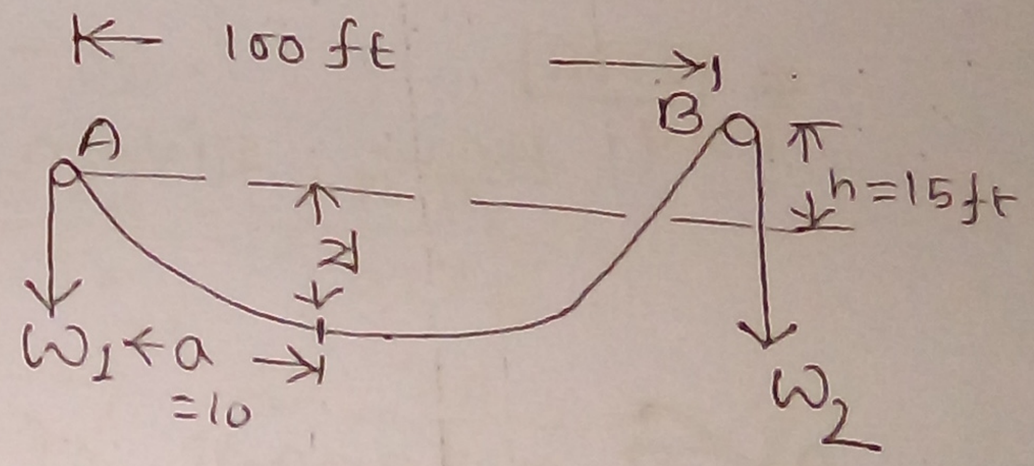
Again, $F_{max}^2 = Q^2 + \left(\frac{WL}{2}\right)^2$.

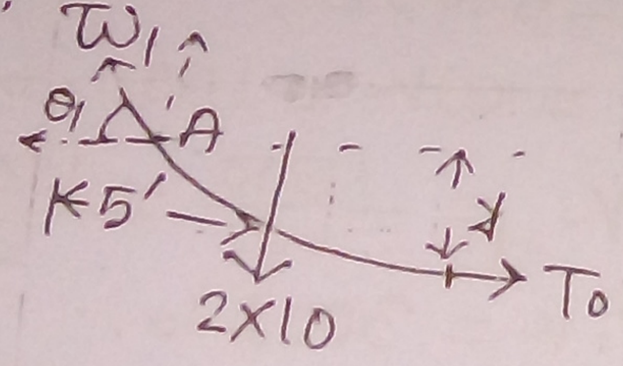
$\Rightarrow (2040)^2 = (500W)^2 + \left(\frac{W \times 200}{2}\right)^2$.

$\therefore W = 4$ lb/ft. —Ans:—

* 2003
1310.

At first we get, according to condition.



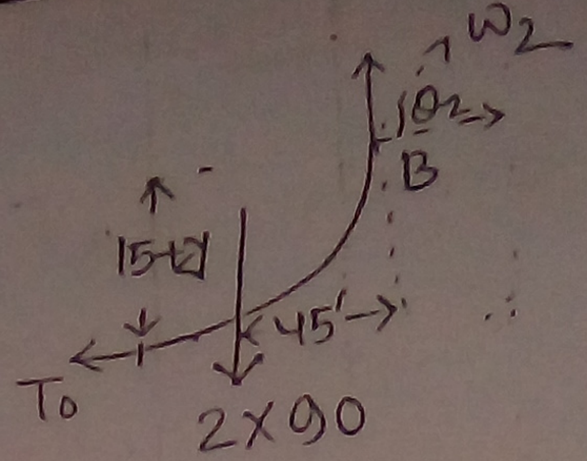


$M_A = 0 \Rightarrow 2 \times 10 \times 5 - T_0 \times y = 0$.

$\therefore T_0 = \frac{100}{y}$. —— (1).

$F_x = 0 \Rightarrow W_1 \cos\theta_1 - T_0 = 0$. $\therefore W_1 \cos\theta_1 = T_0$. —— (11).

$F_y = 0 \Rightarrow W_1 \sin\theta_1 - 2 \times 10 = 0$. $\therefore W_1 \sin\theta_1 = 20$ —— (111).



$\Sigma M_B = 0$.

$\Rightarrow 2\times90\times45 - T_0(15+y) = 0$.

$\Rightarrow 2\times90\times45 - \frac{100}{y}(15+y) = 0$. [From ①]

$\therefore y = 0.1875'$. $\therefore T_0 = 533.33$ lb.

$\Sigma F_x = 0 \Rightarrow W_2\cos\theta_2 - T_0 = 0$.

$\therefore W_2\cos\theta_2 = T_0 = 533.33$. —— (iv).

$\Sigma F_y = 0 \Rightarrow W_2\sin\theta_2 - 2\times90 = 0$.

$\therefore W_2\sin\theta_2 = 180$ —— (v).

Now, (v)^2 + (iv)^2 $\Rightarrow$ $W_2 = 562.89$ lb. —Ans'—

And, (ii)^2 + (iii)^2 $\Rightarrow$ $W_1 = 533.7$ lb. —Ans'—

* 2008.

1314. Here, given that, $w = 5$ lb/ft.

$L = 600$ ft.

$T_0 = wK = 1500$ lb

a) The length of the cable,

$\Rightarrow K = \frac{1500}{w} = \frac{1500}{5}$

$\therefore K = 300$ lb.

$s = 2K\sinh\left(\frac{x}{K}\right)$.

$x = \frac{L}{2} = \frac{600}{2} = 300$ ft.

$= 2\times300\sinh\left(\frac{300}{300}\right)$.

$\therefore s = 705.12$ ft. —Ans'—

we get. $y = k \cdot \cosh\left(\frac{x}{k}\right) = 300 \cosh\left(\frac{300}{300}\right)$

$= 462.92$ ft.

$\therefore$ sag. $d = y - k = (462.92 - 300)$ ft.

$\therefore d = 162.92$ ft. Ans:-

(c) Maximum tension, $T_{max} = w \times y$

$= 5 \times 462.92$ lb

$= 2314.62$ lb. Ans:-

*2005

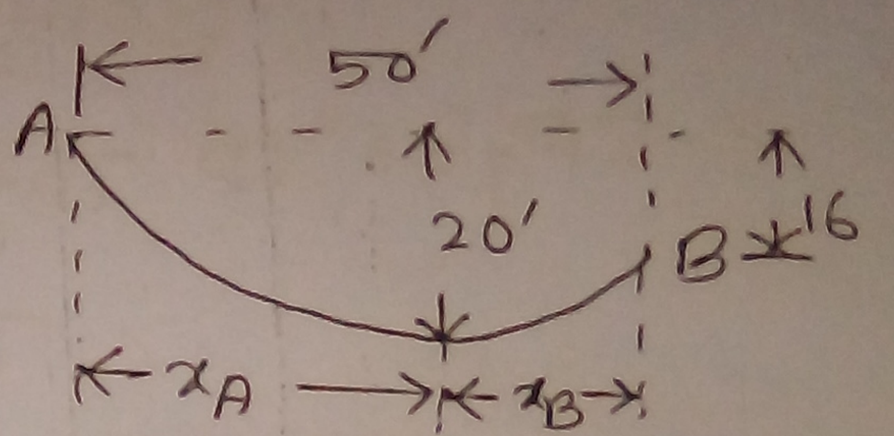
1389.

We know,

$$y = \frac{w x^2}{2Q} \quad \text{---(i)}$$

By using this equn. for the two points.

$$2g = \frac{w x_A^2}{2 \times T_0} \quad \text{---(ii)}$$



$w = 100$ lb/ft

and. $4 = \frac{w x_B^2}{2 \times T_0}$ ---(iii).

(ii) $\div$ (iii) $\rightarrow \frac{20}{4} = \frac{w x_A^2}{2 T_0} \times \frac{2 T_0}{w x_B^2}$.

$\Rightarrow 5 = \left(\frac{x_A}{x_B}\right)^2 \Rightarrow \frac{x_A}{x_B} = \sqrt{5}$.

$\Rightarrow \frac{x_A}{50 - x_A} = \sqrt{5}$. $\therefore x_A = 34.55'$.

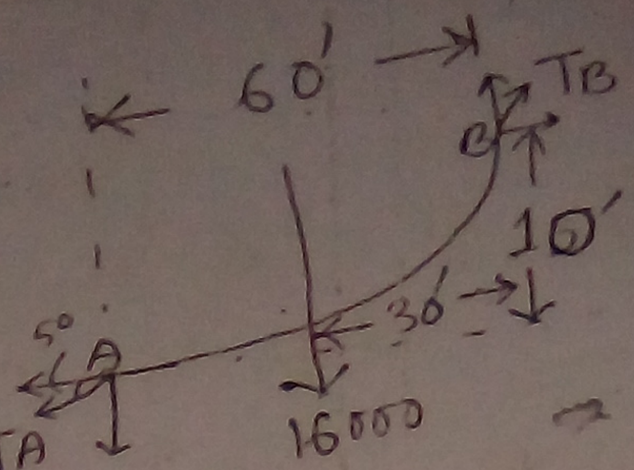
$\therefore x_B = 15.45'$.

$\therefore$ From (ii), $T_0 = 2,983.75$ lb. Ans:-

Maximum tension, $T = \sqrt{T_0^2 + (w x_A)^2}$.

$= 4565.90$ lb. Ans:-

* 2002
2007
1303.



$\Sigma M_B = 0$.

$\Rightarrow T_A \cos 5° \times 10 - T_A \sin 5° \times 60 - 16000 \times 30 = 0$.

$\therefore T_A = 101424.11$ lb.

$\therefore \Sigma F_x = 0 \Rightarrow T_{Bx} - T_A \cos 5° = 0$.

$\therefore T_{Bx} = 101038.16$ lb.

$\therefore \Sigma F_y = 0 \Rightarrow T_{By} - T_A \sin 5° - 16000 = 0$.

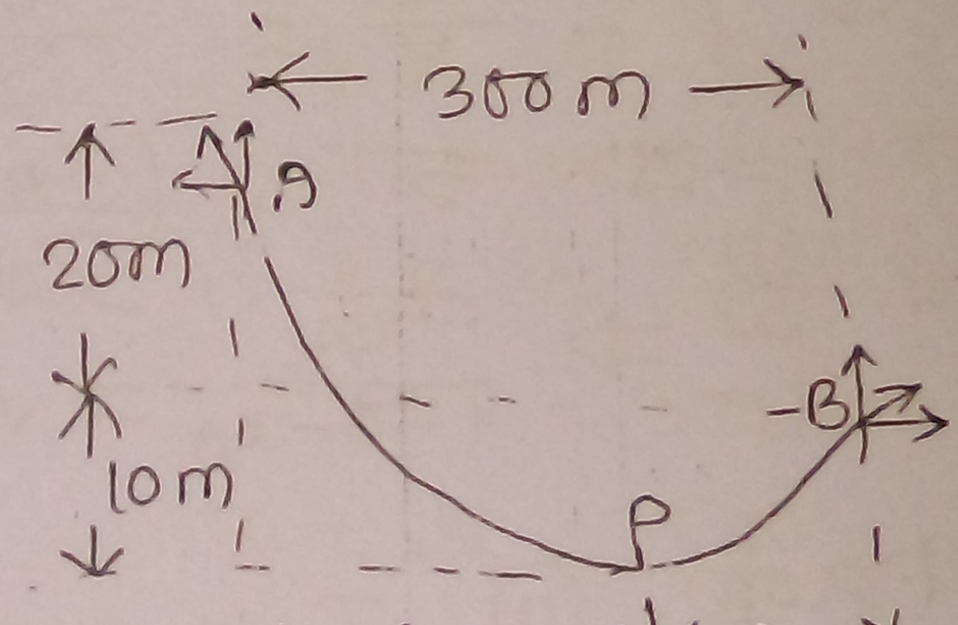
$\therefore T_{By} = 24833.60$ lb.

∴ Maximum tension.

$$T_B = \sqrt{T_{Bx}^2 + T_{By}^2}$$

$= 104046.72$ lb. Ans:→

* 2006.
1364.



We know,

$$y = \frac{wx^2}{2T_0} \quad \text{—①}.$$

So, for the two points, we get,

$w = 3$ kg/m.

$$30 = \frac{w \times a_2^2}{2 \times T_0} \quad \text{—(ii)}.$$

$$10 = \frac{w \times a_1^2}{2 T_0} \quad \text{—(iii)}$$

(II) ÷ (III) $\Rightarrow 3 = \frac{a_2^2}{a_1^2} = \frac{a_2^2}{(300-a_2)^2}$

$\Rightarrow \sqrt{3} = \frac{a_2}{300-a_2}$

$\therefore a_2 = 100.192$ m.

$\therefore a_1 = 199.8$ m.

$\therefore$ From (III). $T_o = 1808.41$ N.

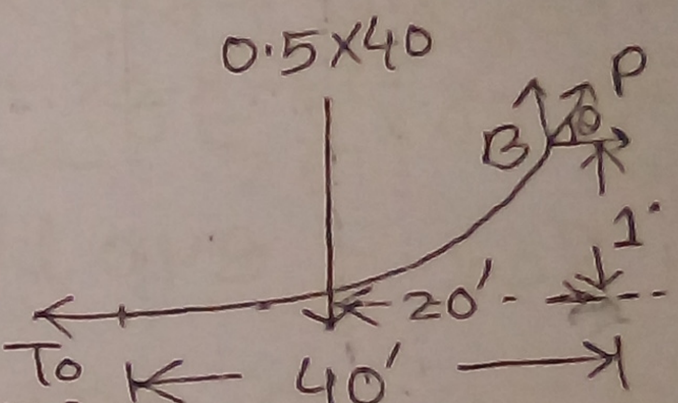
$\therefore$ Maximum tension, after putting the value of T_o, w, a_2 $\therefore T_{max} = \sqrt{T_o^2 + (wa_2)^2}$.

$= 1806.28$ N. —Ans:—

*2009

1324.

considering the left half of the cable.



$\therefore \frac{40}{80} = 0.5$ lb/ft.

$\Sigma M_B = 0 \Rightarrow T_o \times 1 - 0.5 \times 40 \times 20 = 0$

$\therefore T_o = 400$ lb.

$\Sigma F_x = 0 \Rightarrow P\cos\theta - T_o = 0 \therefore P\cos\theta = T_o = 400$ —(I).

$\Sigma F_y = 0 \Rightarrow P\sin\theta - 0.5 \times 40 = 0 \therefore P\sin\theta = 20$ —(II)

$\therefore$ (I)^2 + (II)^2 $\Rightarrow P = 400.5$ lb. —Ans:—

Now, (II) ÷ (I). $\Rightarrow \tan\theta = \frac{20}{400} \therefore \theta = 2.87°$.

—Ans:—

And, total length,

$S = L + \frac{8d^2}{3L} - \frac{32d^4}{5L^3}$.

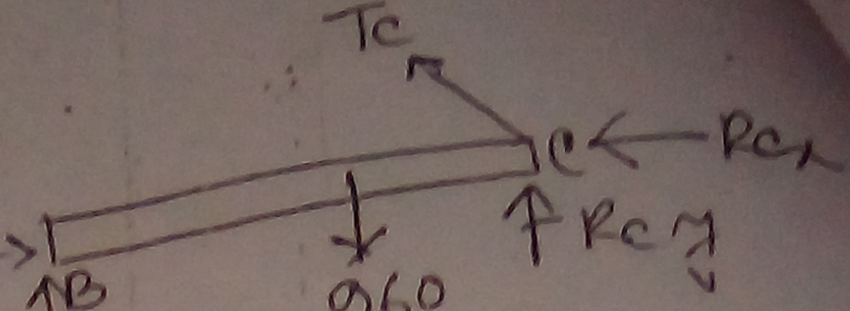
$L = 80'$.

$d = 1'$.

$\therefore S = 80.03$ ft. —Ans:—

*[2011]
1334.

At first, we get the F.B.d of BC.



$\Sigma M_C = 0$.

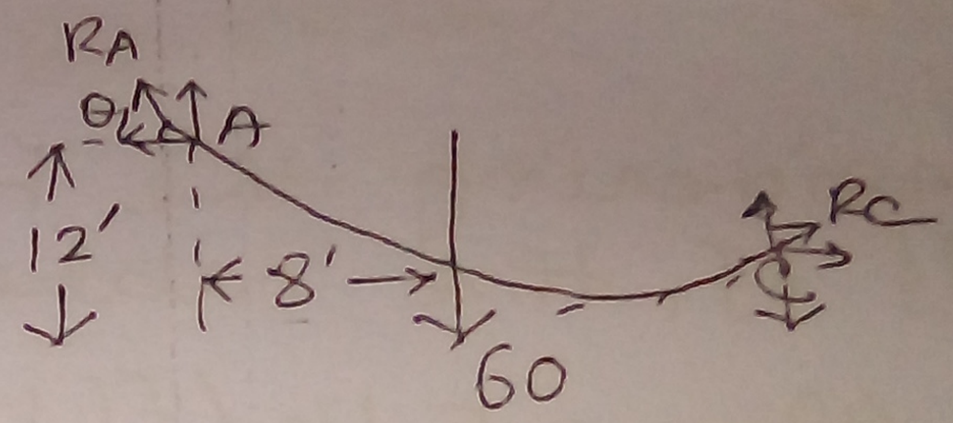
$\Rightarrow -R_{By} \times 16 + 960 \times 6 = 0$.

$\therefore R_{By} = 360$ lb.

$\Sigma F_y = 0 \Rightarrow R_{By} + R_{Cy} - 960 = 0$.

$\therefore R_{Cy} = 600$ lb.

Now, we get from the cable.



$\Sigma M_A = 0$.

$\Rightarrow -R_{Cx} \times 12 + R_{Cy} \times 16 + 60 \times 8 = 0$.

$\therefore R_{Cx} = 840$ lb.

$\Sigma F_x = 0 \Rightarrow R_{Cx} - R_{Ax} = 0 \Rightarrow R_{Cx} = R_{Ax}$.

$\therefore R_{Ax} = R_{Cx} = 840$ lb.

$\Sigma F_y = 0 \Rightarrow R_{Ay} + (-R_{Cy}) - 60 = 0$.

$\therefore R_{Ay} = 660$ lb.

$\therefore \theta_1 = \tan^{-1}\left(\frac{R_{Ay}}{R_{Ax}}\right) = \tan^{-1}\left(\frac{660}{840}\right) = 38.15°$.

$\therefore \theta_1 = 38.15°$. Ans!

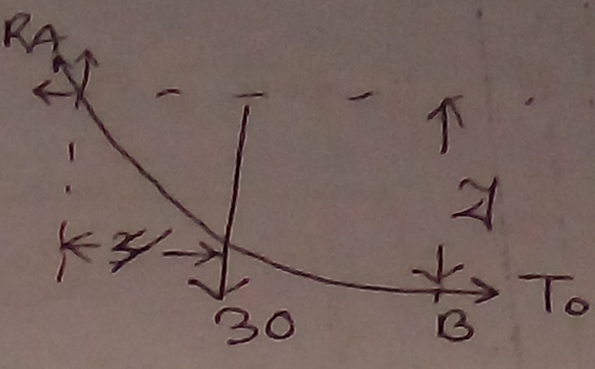
$\therefore \theta_2 = \tan^{-1}\left(\frac{R_{Cy}}{R_{Cx}}\right) = \tan^{-1}\left(\frac{600}{840}\right)$.

$\therefore \theta_2 = 35.54°$. Ans!

ron the half cable.

$\Sigma M_B = 0$.

$\Rightarrow -R_{Ax} \times y + R_{Ay} \times 8 - 30 \times 4 = 0$.

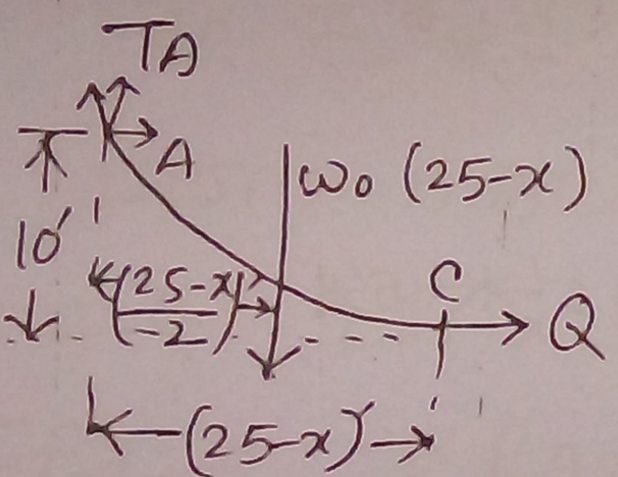


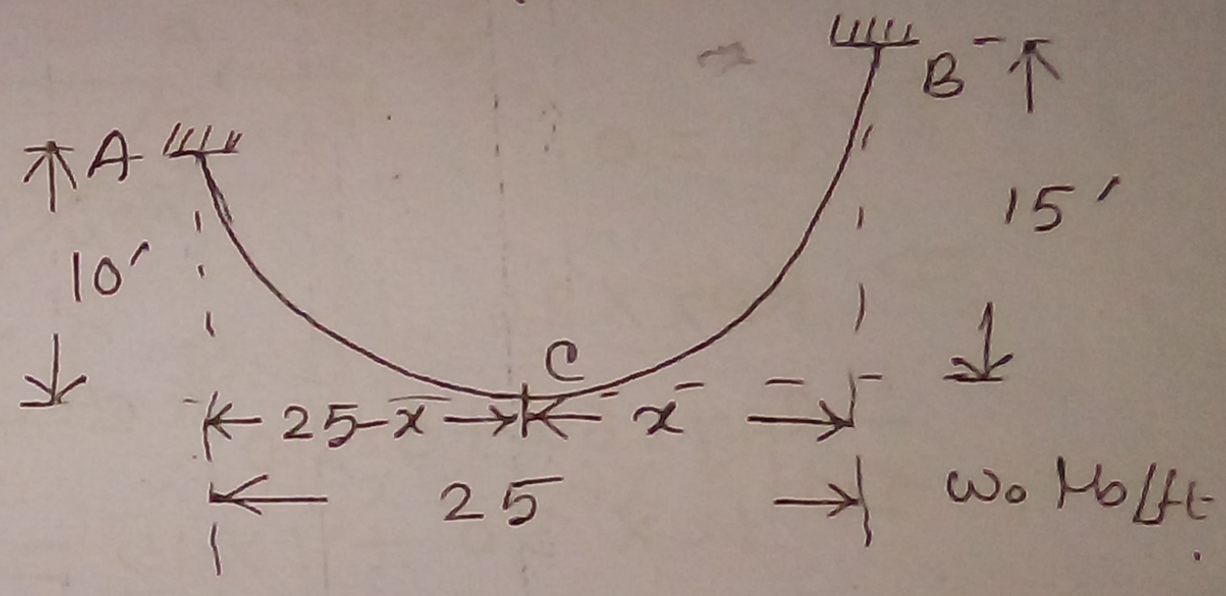
$\therefore y = 6.143$ ft.

$\therefore$ Sag. $h = y - 6 = (6.143 - 6)$ ft.

$\therefore h = 0.143$ ft. Ans:-

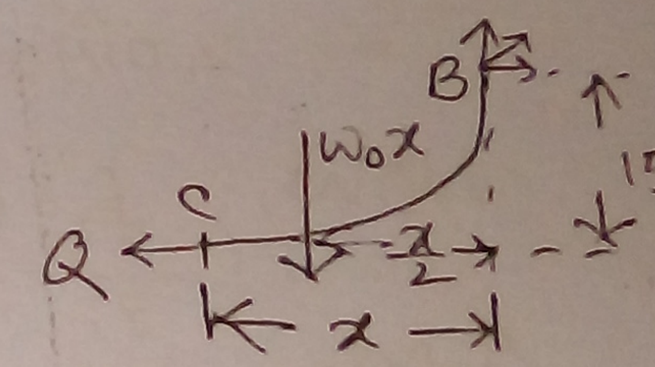
PROBLEM





$\therefore$ We know, $y = \frac{wx^2}{2Q}$ —— ①.

Now, we get, for the F.B.D of ①, ⑪,



$$10 = \frac{w_0 \cdot (25-x)^2}{2Q} \quad \text{—— ⑪}.$$

$$15 = \frac{w_0 x^2}{2Q} \quad \text{—— ⑪}.$$

$\therefore$ ⑪ $\div$ ⑪, $\frac{2Q}{2Q} = \frac{w_0 (25-x)^2}{w_0 x^2} \times \frac{15}{10}$.

$\therefore x = 13.76$ ft.

From ⑪, $Q = 3788$ lb. Ans:-

Now. $T_A = \sqrt{Q^2 + \{w_0(25-x)\}^2}$.

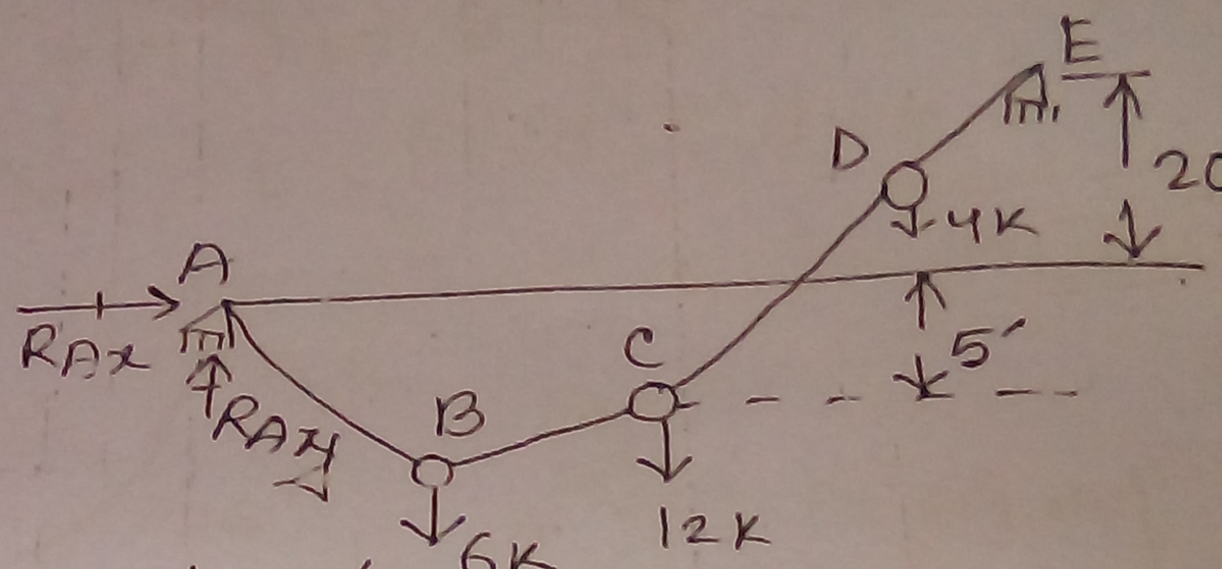
$\therefore T_A = 7733$ lb. -Ans'r.

$\therefore T_B = \sqrt{Q^2 + (w_0 x)^2}$.

$= 9084$ lb. -Ans'r

*

1323.

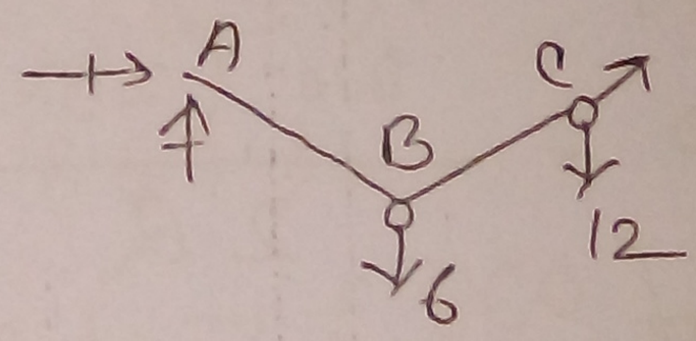


$\Sigma M_E = 0$.

$\Rightarrow R_{Ax} \times 20 - R_{Ay} \times 60 + 6 \times 40 + 12 \times 30 + 4 \times 15 = 0$.

$\sim 20 R_{Ax} - 60 R_{Ay} + 660 = 0$ —— (I).

Now. F.B.D of A, B, C.



$\Sigma M_C = 0$.

$\Rightarrow -R_{Ax} \times 5 - R_{Ay} \times 30 + 6 \times 10 = 0$.

$\therefore -5 R_{Ax} - 30 R_{Ay} + 60 = 0$. —— (II).

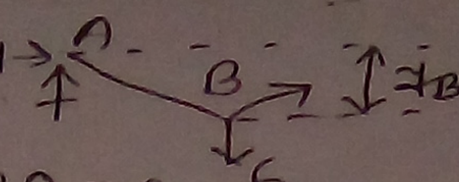
From, solving (I), (II),

$R_{Ax} = -18$ K.

$R_{Ay} = 5$ K.

...m. F.B.D. of AB.

$\Sigma M_B = 0$.



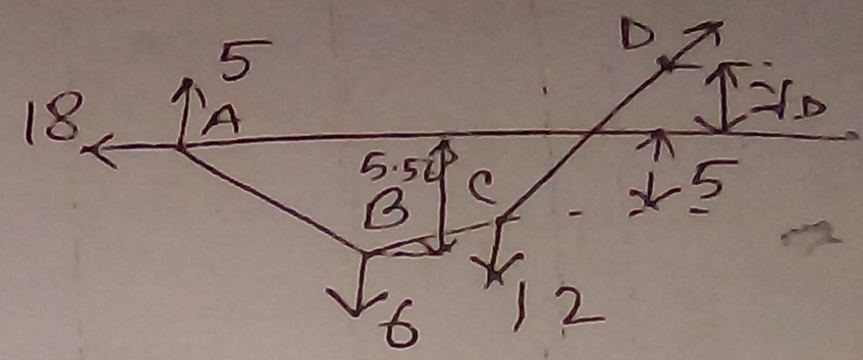
$\Rightarrow R_{Ax} \times Z_B - R_{Ay} \times 20 = 0$.

$\therefore Z_B = 5.56$ ft.

Now, from F.B.D of ABCD.

$M_D = 0$.

$\Rightarrow -18 \times Z_D - 5 \times 45 + 6 \times 25 + 12 \times 15 = 0$.



$\therefore Z_D = 5.83$ ft. Ans:-

Now, from ABCDE of F.B.D.

$\Sigma F_x = 0 \Rightarrow R_{Ax} - R_{Ex} = 0$. $\therefore R_{Ex} = R_{Ax} = 18$ K.

$\therefore \Sigma F_y = 0 \Rightarrow R_{Ay} + R_{Ey} - 6 - 12 - 4 = 0$.

at E. $\therefore R_{Ey} = 17$.

$\therefore \theta = \tan^{-1}.(R_{Ey}/R_{Ex}) = \tan^{-1}\left(\frac{17}{18}\right)$.

$\therefore \theta = 43.37°$. Ans:-

nd, $T_{max} = \sqrt{(R_{Ex})^2 + (R_{Ey})^2}$.

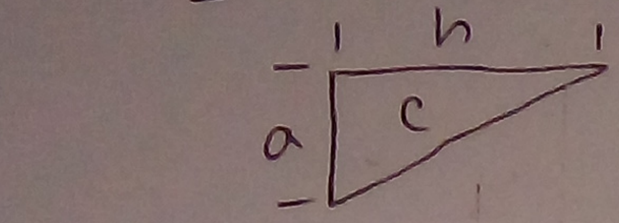
$\therefore T_{max} = \sqrt{18^2 + 17^2}$.

$= 24.76$ K

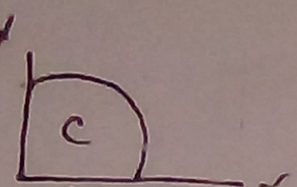
Ans:-

Some regular centroid of Bodies.

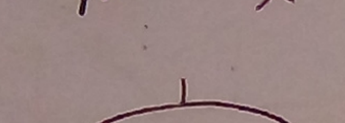
1. Triangle



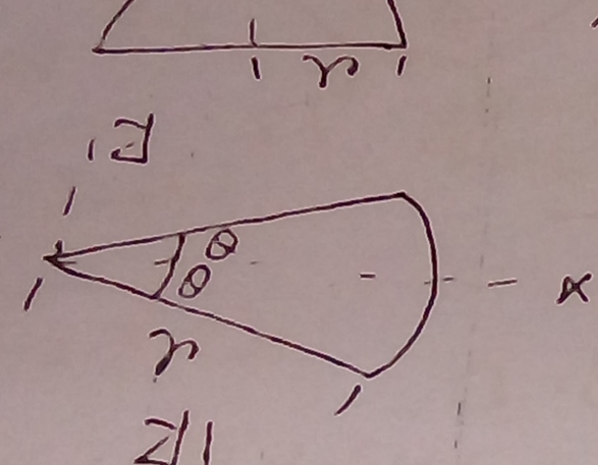
$\bar{x} = \frac{h}{3}$. $\bar{y} = \frac{a}{3}$. $A = \frac{ah}{2}$

2. 

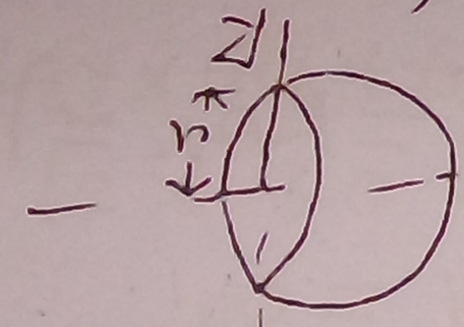
$\bar{x} = \bar{y} = \frac{4r}{3\pi}$ $A = \frac{\pi r^2}{4}$.

3. 

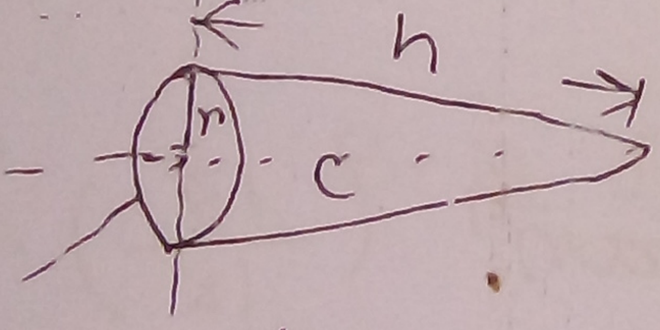
$\bar{x} = 0$. $\bar{y} = \frac{4r}{3\pi}$ $A = \frac{\pi r^2}{2}$.

4. 

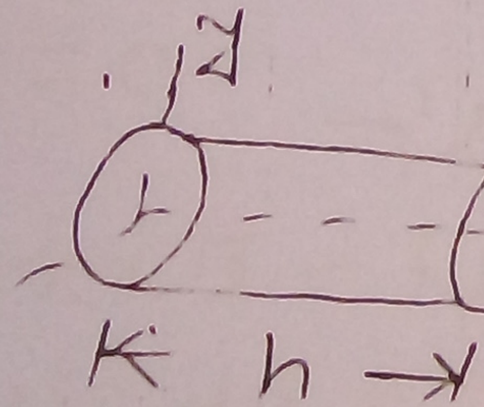
$\bar{x} = \frac{2r\sin\theta}{3\theta}$ $\bar{y} = 0$. $A = \frac{\pi r^2}{6}$.

5. 

$\bar{x} = \frac{3r}{8}$. $\bar{y} = \bar{z} = 0$. $V = \frac{2}{3}\pi r^3$.

6. 

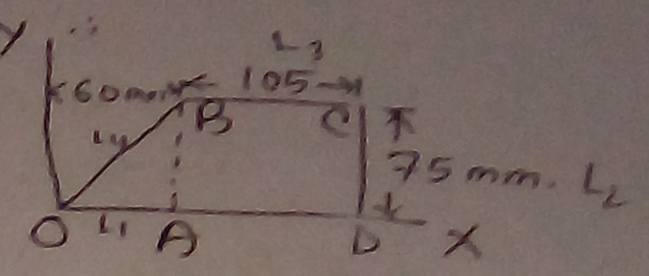
$\bar{x} = \frac{3h}{4}$. $\bar{y} = \bar{z} = 0$. $V = \frac{1}{3}\pi r^2 h$

7. 

$\bar{x} = \frac{h}{2}$. $\bar{y} = \bar{z} = 0$. $V = \pi r^2 h$.

CENTROID.

Problem: Centroid of the area.



Name of Area	$\bar{x}$ mm	$\bar{y}$ mm	A mm^2	$\bar{x}A$ mm^3	$\bar{y}A$ mm^3
1. OAB Triangle.	40	25	2250	90,000	56250.
2. ABCD rectangle	112·5	37·5	7875	885900	295300:
Σ			10125	975900	351600.

$$\therefore \bar{x} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{975900}{10125} = 96.30 \text{ mm.}$$

$$\therefore \bar{y} = \frac{\Sigma \bar{y}A}{\Sigma A} = \frac{351600}{10125} = 34.726 \text{ mm.}$$

} Ans:

Centroid of the shadded line.

Line mm	$\bar{x}$ mm	$\bar{y}$ mm	$\bar{x}L$ mm^2	$\bar{y}L$ mm^2.
165	82·5	0	13612	0.
75	165	37·5	12375	2812.
105	112·5	75	11812	7875.
96·05	30	37·5	2881	3602.
441·05			40680	14289.

$$\therefore \bar{x} = \frac{\Sigma \bar{x}L}{\Sigma L}.$$

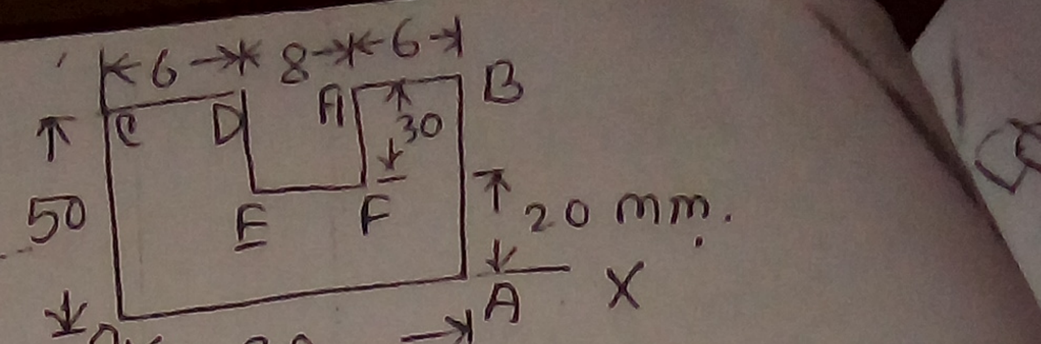
$$= 92.23 \text{ mm}$$

$$\therefore \bar{y} = \frac{\Sigma \bar{y}L}{\Sigma L}.$$

$$= 32.39 \text{ mm.}$$

Ans:

Problem: Centroid of the shadded area.

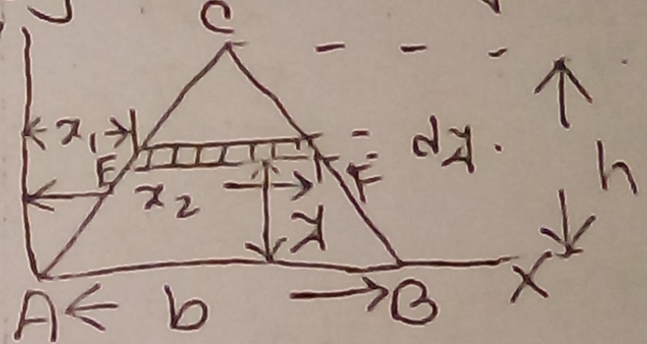


Name of area.	Area A mm^2	$\bar{x}$ mm	$\bar{y}$ mm	$\bar{x}A$ mm^3	$\bar{y}A$ mm^3.
1. OABC	1000	10	25	10,000	25,000
2. DEFH	-240	10	35	-2400.	-8400
Σ =	760			7600	16,600.

$\therefore \bar{x} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{7600}{760} = 10$ mm.

$\therefore \bar{y} = \frac{\Sigma \bar{y}A}{\Sigma A} = \frac{16,600}{760} = 21.85$ mm. } Ans:-

Problem: Centroid of Triangle.



$\therefore dA = (x_2 - x_1) \cdot d\bar{y}$.

$\therefore \bar{y}A = \int \bar{y} \cdot dA$.

$= \int \bar{y} \cdot (x_2 - x_1) \cdot d\bar{y}$ ——— (1).

From similar triangle $\triangle ABC$, $\triangle EFC$.

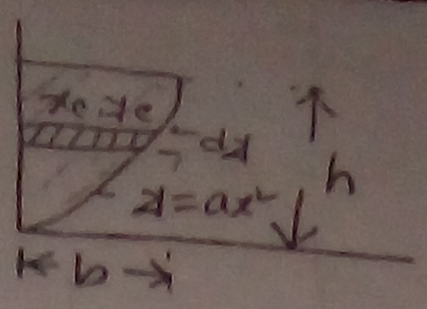
$\frac{x_2 - x_1}{b} = \frac{h - \bar{y}}{h}$. $\Rightarrow x_2 - x_1 = \frac{b}{h} \cdot (h - \bar{y})$.

$\Rightarrow \int \bar{y} \cdot (x_2 - x_1) \cdot d\bar{y} = \frac{b}{h} \int_0^h (h\bar{y} - \bar{y}^2) \cdot d\bar{y}$.

$\Rightarrow \bar{y}A = \frac{b}{h} \left[h\frac{\bar{y}^2}{2} - \frac{\bar{y}^3}{3} \right]_0^h = \frac{bh^2}{6}$.

$\therefore \bar{y} = \frac{bh^2}{6A} = \frac{bh^2}{6} / \frac{bh}{2} = \frac{h}{3}$. Ans:-

(b) Problem:



Given that.

$y = ax^2 \Rightarrow x = \sqrt{\frac{y}{a}}$ — ①

$\Rightarrow h = a \cdot b^2 \quad \therefore x_a = \sqrt{\frac{y}{x_a}} = \sqrt{\frac{y}{x_a}}$

$\therefore a = \frac{h}{b^2}$ —— ⑪.

$dA = x\,dy$

So, $x_c = \frac{\int x_c \cdot dA}{A} = \frac{\int \frac{x}{2} \cdot dA}{A} = \frac{1}{2}\int \frac{x \cdot x\,dy}{A}$

(i)- $= \frac{1}{2} \cdot \frac{\int x^2 \cdot dA}{\frac{2}{3} \cdot bh} = \frac{3}{4bh} \cdot \int \frac{y}{a} \cdot dy$.

$= \frac{3}{4bh} \cdot \frac{1}{a} \cdot \int_0^h y \cdot dy = \frac{3}{4} \cdot \frac{1}{bh} \times \frac{b^2}{h} \cdot [y^2/2]_0^h$.

$\therefore x_c = \frac{3b}{4h^2} \times \frac{h^2}{2} = \frac{3}{8} b$.

$\therefore y_c = \frac{\int y_c \cdot dA}{A} = \frac{\int y \cdot x \cdot dy}{2/3 \cdot bh} = \frac{\int y \cdot \sqrt{\frac{y}{a}} \cdot dy}{2/3 \cdot bh}$

$= \frac{3}{2} \cdot \frac{1}{bh} \cdot \int_0^h y \cdot b \cdot \sqrt{y/h} \cdot dy$.

$= \frac{3}{2} \cdot \frac{1}{h^{3/2}} \cdot \int_0^h y^{3/2} \cdot dy = \frac{3}{2h^{3/2}} \times \frac{2}{5} h^{5/2}$.

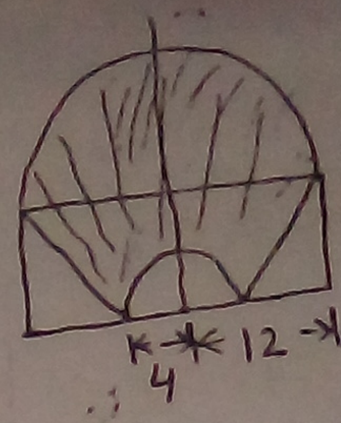
$\therefore y_c = \frac{3}{5} h$.

$\therefore (x_c, y_c) = \left(\frac{3}{8} b, \frac{3}{5} h\right)$.

Ans:

—

Q Books problem solved:



807. The area is symmetrical to y axis. so $\bar{x} = 0$.

And area = (A big semi circle + A rectangle - (two triangle + a small S.C).

Name of area	area A cm^2	$\bar{y}_{cm}$	$\bar{y}A$ cm^3.
(i) Big S.C.	$\frac{1}{2}\pi(12)^2$ $= 226.2$	$\frac{4\times12}{3\pi}+12$ $= 17.09$	3866.43
(ii) Rectangle.	24×12 $= 288$	$\frac{12}{2} = 6$	1728.
(iii) Two triangle	$-2\times\frac{1}{2}\cdot8\times12$ $= -96$ $= -(48+48)$	$2\cdot\frac{12}{3}$ $= 8 = (4+4)$	$-192-192$ $= -384$.
(iv) small S.C	$-\frac{1}{2}\pi\times(4)^2$ $= -25.13$	$\frac{4\times4}{3\pi}$ $= 1.7$	-42.66.
ΣA	$= 303.07$		$\Sigma\bar{y}A = 5167.77$.

$\therefore \bar{y} = \frac{\Sigma\bar{y}A}{\Sigma A} = \frac{5167.77}{303.07} = 13.16$ cm.

$\therefore \bar{x} = 0$. $\therefore \bar{y} = 13.16$ cm. Ans:-

819.
Total area
= Area

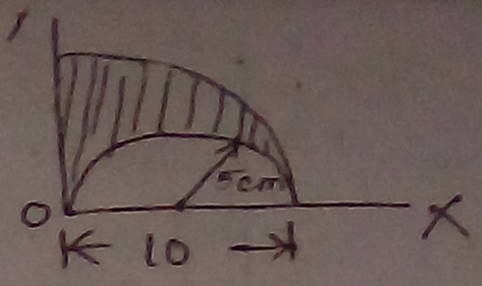
12cm.

ect.

819.

Total area.

= Area of quarter circle - Area of a semi circle.



Name of area.	Area. A cm	$\bar{x}$ cm	$\bar{y}$ cm	$\bar{x}A$ cm^3	$\bar{y}.A$ cm^3.
① q.c.	$\frac{1}{4}\pi \times (10)^2$ $=78.5$	$\frac{4\times10}{3\pi}$ $=4.24$	$\frac{4\times10}{3\pi}$ $=4.24$	333.3	333.3.
⑪ s.c	$-\frac{1}{2}\pi \times (5)^2$ $=-39.27$	$\frac{10}{2}$ $=5.$	$\frac{4\times5}{3\pi}$ $=2.12$	-196.35	-83.25

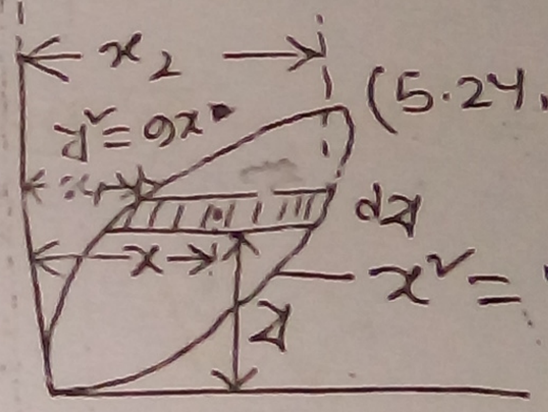
$\Sigma A = 39.27$ $\quad \Sigma\bar{x}A = 136.98$ $\quad \Sigma\bar{y}A = 250.06$

$$\therefore \bar{x} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{136.98}{39.27} = 3.43 \text{ cm.}$$

$$\therefore \bar{y} = \frac{\Sigma \bar{y}A}{\Sigma A} = \frac{250.06}{39.27} = 6.37 \text{ cm.}$$

} Ans:-

826. Let the differential area is parallel to x axis.



So, $dA = (x_2 - x_1) \cdot dy$ —①.

And, we get, $x^2 = 4y$. $\therefore x_2 = 2y^{\frac{1}{2}}$.

and, $y^2 = 9x$. $\therefore x_1 = \frac{y^2}{9}$.

$$\therefore dA = A = \int_0^{6.87} (x_2 - x_1) \cdot dy = \int_0^{6.87} \left(2 \cdot y^{\frac{1}{2}} - \frac{y^2}{9}\right) \cdot dy$$

$$= \left[\frac{2 \cdot y^{3/2}}{3/2} - \frac{y^3}{3\times9}\right]_0^{6.87}$$

$\therefore A = 12. \text{ in}^2.$

$$\therefore \int x\,dA = \int_0^{6.87} \left(x_1 + \frac{x_2 - x_1}{2}\right) \cdot dA$$

$$= \int_0^{6.87} \left(\frac{x_2 + x_1}{2}\right)(x_2 - x_1) \cdot dy$$

$$= \frac{1}{2} \int_0^{6.87} (x_2^2 - x_1^2) \cdot dy$$

$$= \frac{1}{2} \int_0^{6.87} (4y - y^4/81) \cdot dy$$

$$\therefore \int x\,dA = 28.3 \text{ in}^3.$$

$$\therefore \int y\,dA = \int_0^{6.87} y \cdot (x_2 - x_1) \cdot dy$$

$$= \int_0^{6.87} y\left(2y^{\frac{1}{2}} - \frac{y^2}{9}\right) \cdot dy$$

$$= \int_0^{6.87} \left(2 \cdot y^{3/2} - y^3/9\right) \cdot dy$$

$$\therefore \int y\,dA = 37.68 \text{ in}^3.$$

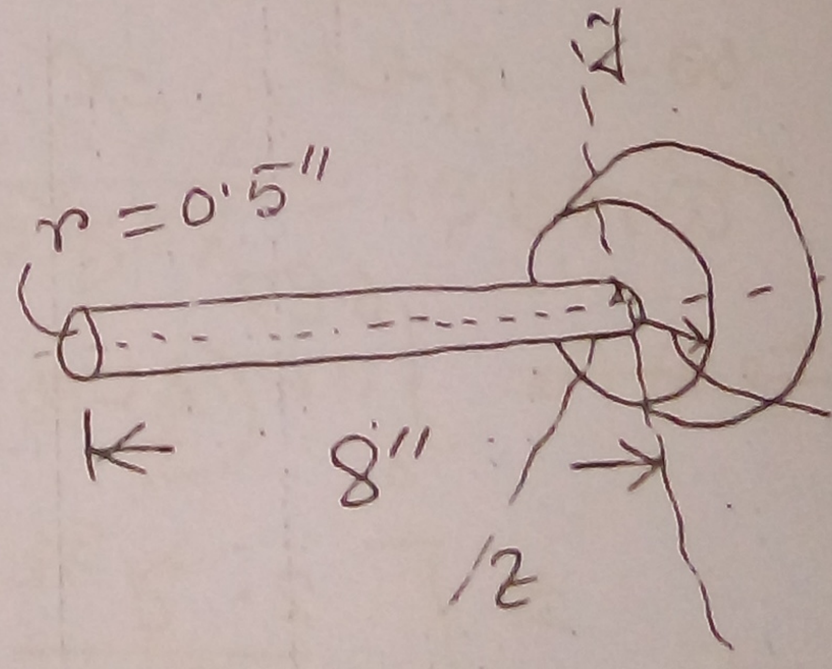
$$\therefore \bar{x} = \frac{\int x\,dA}{\int dA} = \frac{28.3}{12} = 2.36 \text{ in.}$$

$$\therefore \bar{y} = \frac{\int y\,dA}{\int dA} = \frac{37.68}{12} = 3.03 \text{ in}$$

} Ans

822.

The volume is symetrical to x axis. so $\bar{y} = 0$. $\bar{z} = 0$.



∴ The total volume = volume of hemisphere + volume of rod.

Name of vol.	volume V in^3	$\bar{x}$ in	$\bar{x}V$ in^4
① H.S	$\frac{1}{2}\times\frac{4}{3}\pi(2)^3$ $= 16.76$	$\frac{3\times2}{8}$ $=0.75$	12.57
⑪ Rod.	$\pi\times(0.5)^2\times8$ $= 6.28$	$-\frac{8}{2}=-4$	-25.13

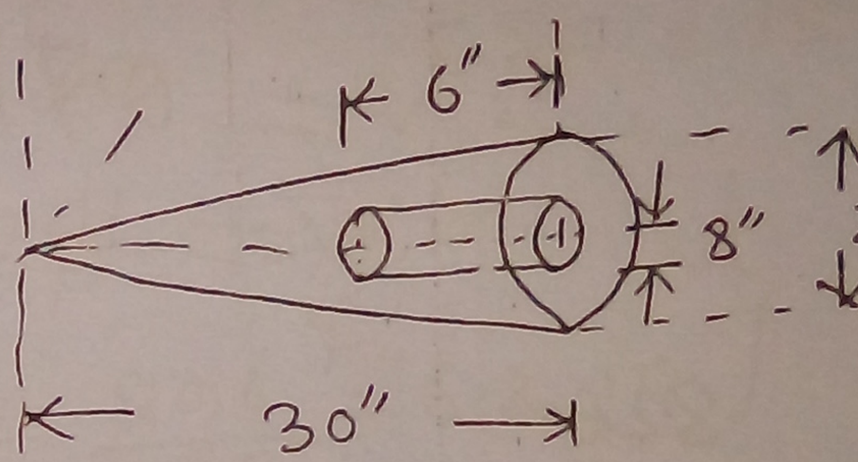
$\Sigma V = 23.04$ $\quad \Sigma\bar{x}V = -12.56$

$\therefore \bar{x} = \frac{\Sigma\bar{x}V}{\Sigma V} = \frac{-12.56}{23.04} = 0.545$ in. —Ans:—

$\bar{y} = 0. \quad \bar{z} = 0.$

823.

The volume is symetrical to x axis. so



$\bar{y} = 0. \quad \bar{z} = 0.$

The total volume = volume of cone − volume of cylinder.

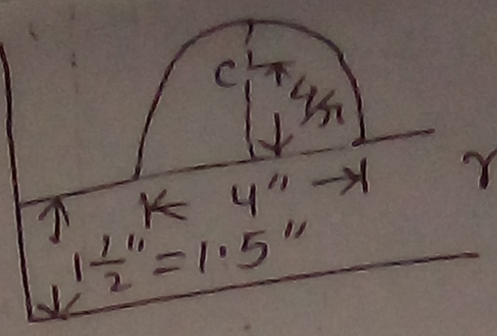
Name of volume	volume V in^3.	$\bar{x}$ in	$\bar{x}V$ in^4.
i) cone	$\frac{1}{3}\pi\times(10)^2\times30$ $= 3140.$	$\frac{3\times30}{4}$ $=22.5$	70650.
⑪ cylinder	$-\pi\times(\frac{8}{2})^2\times(30-24)$ $=-301.6$	$(24+\frac{6}{2})$ $=27$	-8143.2

$\Sigma V = 2840$ $\quad \Sigma\bar{x}V = 62542.8$

$\therefore \bar{x} = \frac{\Sigma\bar{x}V}{\Sigma V} = 22.02$ in.

$\bar{y} = 0 \quad \bar{z} = 0.$ —Ans:—

824.



(a) Given that,

$\theta = 270^\circ = \frac{3\pi}{2}$

$L = \pi r = 2\pi$.

$\therefore \bar{y} = (1.5 + \frac{4}{3\pi})$

$\therefore A = \theta \bar{y} L = \frac{3\pi}{2} \times (1.5 + \frac{4}{3\pi}) \times 2\pi$.

$\therefore A = 82.11 \text{ in}^2$. Ans:-

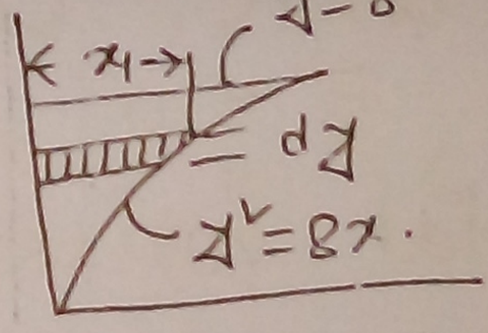
(b) $\theta = 360^\circ = 2\pi$. $\bar{y} = \frac{4r}{3\pi}$. $A = \frac{1}{2} \cdot \pi r^2$.

where the radius of the semi-circular bar is r.

$\therefore V = \theta \bar{y} A = 2\pi \times \frac{4r}{3\pi} \times \frac{1}{2} \cdot \pi r^2$.

$\therefore V = \frac{4}{3} \pi r^3$. -Ans:-

826.



$\therefore dA = x_1 \cdot dy = \frac{y^2}{8} \cdot dy$. $x_1 = y^2/8$

$\therefore A = \int_0^8 dA = \int_0^8 \frac{y^2}{8} \cdot dy = \frac{1}{8} \cdot [\frac{y^3}{3}]_0^8 = \frac{64}{3} \cdot \text{in}^2$.

$\therefore \int x\, dA = \int_0^8 \frac{x_1}{2} \cdot x_1\, dy = \frac{1}{2} \int_0^8 x_1^2 \cdot dy = \frac{1}{2} \int_0^8 \frac{y^4}{64}$.

$= \frac{1}{2} \cdot \frac{1}{64} [y^5/5]_0^8 = \frac{256}{5} \cdot \text{in}^3$.

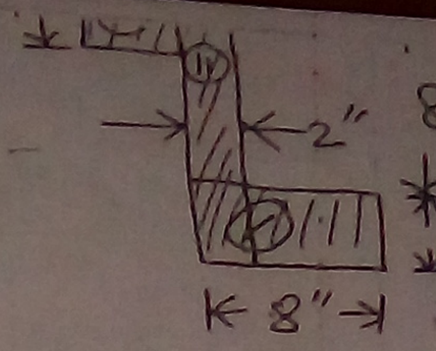
$\therefore \int y\, dA = \int_0^8 y \cdot x_1\, dy = \int_0^8 y \cdot y^2/8 \cdot dy$

$= \int_0^8 y^3/8 \cdot dy = \frac{1}{8} [y^3/3]_0^8 = 128 \text{ in}^3$.

$\therefore \bar{y} = \frac{\int y\, dA}{\int dA} = \frac{256 \times 3}{5 \times 64} = \frac{128 \times 3}{64} = 6 \text{ in}$ } Ans:-

836.

The total area is the sum of the three rectangle.



Name of area	Area A in^2	$\bar{x}$ in	$\bar{y}$ in	$\bar{x}A$ in^3	$\bar{y}A$ in^3
(I)	$6\times8=48$	4	3	192	144
(II)	$2\times8=16$	1	10	16	160
(III)	$4\times4=16$	-2	12	-32	192
	$\Sigma A = 80$			$\Sigma\bar{x}A = 176$	$\Sigma\bar{y}A = 496$

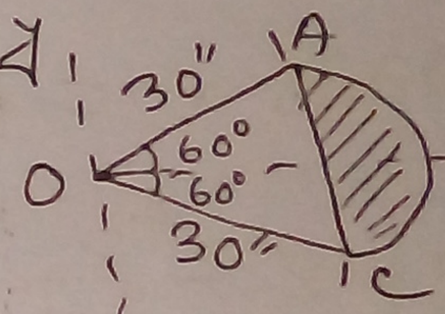
$$\therefore \bar{x} = \frac{\Sigma\bar{x}A}{\Sigma A} = \frac{176}{80} = 2.2 \text{ in.}$$

$$\therefore \bar{y} = \frac{\Sigma\bar{y}A}{\Sigma A} = \frac{496}{80} = 6.2 \text{ in.}$$

} Ans:-

837. It is symetrical to x axis.

$\therefore \bar{y} = 0$.

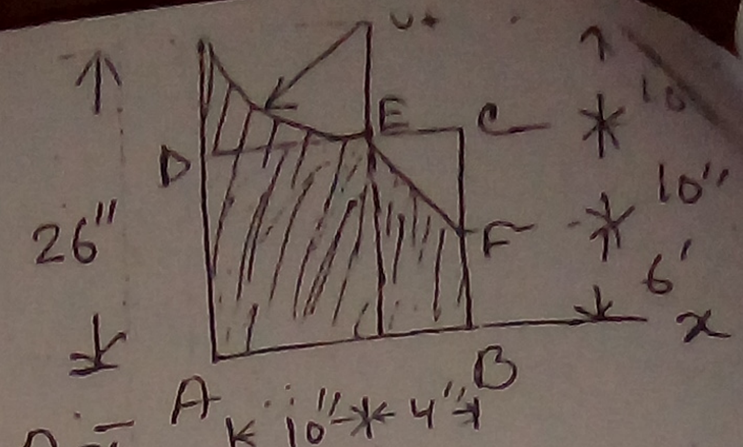


segments.	Area A in^2	$\bar{x}$ in	$\bar{x}A$ in^3
i) ΔABC area	$\frac{1}{3}\pi\times(30)^2=942.28$	$\frac{2r\sin\theta}{3\theta}$ $=16.54$	15588.5
(II) ΔAC arc.	$-\frac{1}{2}(2\times30\sin60^\circ\times2\times30\cos60^\circ)=-389.7$	$\frac{2}{3}30\cos60^\circ$ $=10$.	-3897.
	$\Sigma A = 552.78$		$\Sigma\bar{x}A = 11691.5$

$$\therefore \bar{x} = \frac{\Sigma\bar{x}A}{\Sigma A} = 21.15 \text{ in.}$$ Ans:-

—

840. Given that,
$\theta = 136°$.



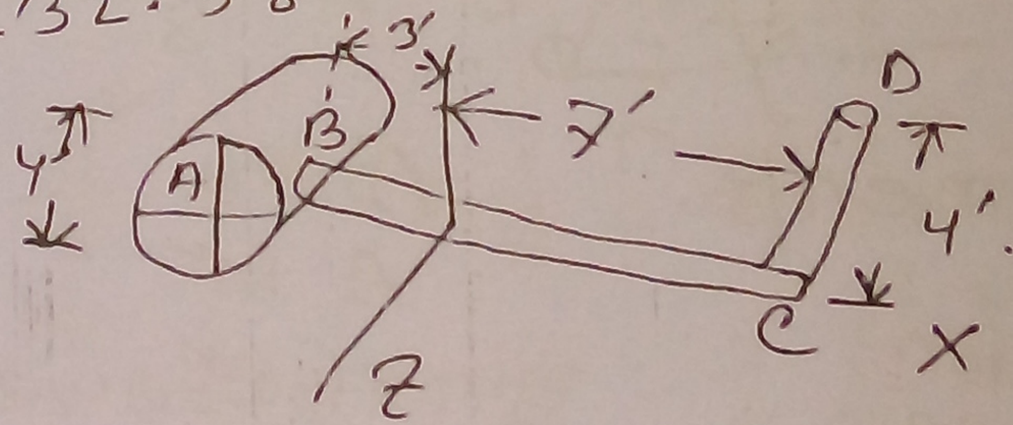
Seg.	A in^2	$\bar{x}$ in	$A\bar{x}$. in^3.
(I) ABCD	$14 \times 16 = 224$	$\frac{14}{2} = 7$.	1565.
(II) DEGH	$10 \times 10 = 100$	$\frac{10+0}{2} = 5$	500.
(III) $\triangle$ECF	$-10 \times 4 \times \frac{1}{2} = -\frac{40}{2} = -20$	$(10 + \frac{2 \times 4}{3}) = 12.67$.	-253.33.
(IV) HGE	$-\frac{1}{4}\pi \times 10^2 = -78.54$	$(10 + \frac{4 \times 10}{3\pi}) = 5.76$	-452.06.
	$\Sigma A = 225.46$		$\Sigma \bar{x} A = 1362.61$.

$\therefore \bar{x} = \frac{\Sigma \bar{x} A}{\Sigma A} = 6.04$ in.

$\therefore V = \theta \bar{x} A = 136 \times \frac{\pi}{180} \times 6.04 \times 225.46$ in^3. —Ans

$\therefore V = 3232.38$ in^3.

853.
Symetrical to xz plane. $\therefore \bar{z} = 0$.

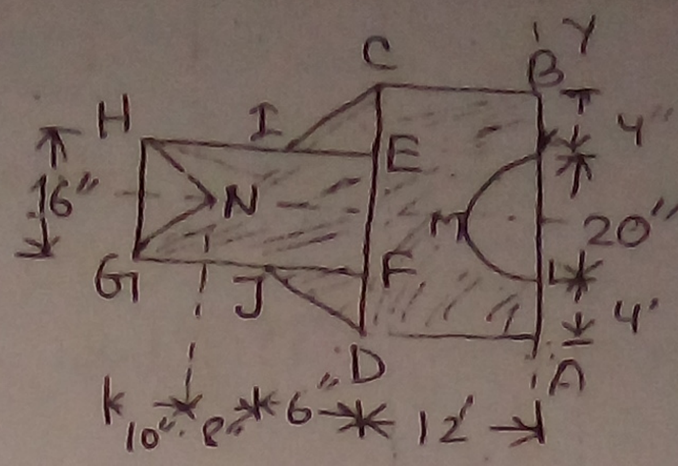


Seg.	w	$\bar{x}$	$\bar{y}$	$\bar{x}w$	$\bar{y}w$.
(I) A	322.0	-5	0	-1610	0
(II) BC	257.6	2	0	515.2	0
(III) CD	64.4	7	2	450.8	128.8.
	$\Sigma w = 644$			$\Sigma \bar{x}w = -644$.	$\Sigma \bar{y}w = 128.8$

$\therefore \bar{x} = \frac{\Sigma \bar{x}w}{\Sigma w} = -1'$. $\bar{y} = \frac{\Sigma \bar{y}w}{\Sigma w} = 0.2'$ Ans:-

540.

The area is symetri-cal to x axis. so, $\bar{y} = 0$.



segments	A. in^2	$\bar{x}$ in	$\bar{x}A$. in^3.
① ABCD	$12 \times 28 = 336$	$-\frac{12}{2} = -6$.	-2016.
② EFGH	$24 \times 16 = 384$	$-(12 + \frac{24}{2}) = -24$	-9216.
③ $\triangle EIC$ and $\triangle DFJ$.	$\frac{1}{2} \times 6 \times 6 = 18$	$-(12 + \frac{6}{3}) = -14$	$2 \times (-252)$.
④ $\triangle HNG$.	$-\frac{1}{2} \times 16 \times 10 = -80$.	$-(26 + \frac{2 \times 10}{3}) = -32.67$	2613.6.
⑤ KLM	$-\frac{1}{2} \times \pi \times 10^2 = -157$	$-\frac{4 \times 10}{3\pi} = -4.25$	666.33.

$\Sigma A = 510$.

$\Sigma \bar{x} A = -8456$.

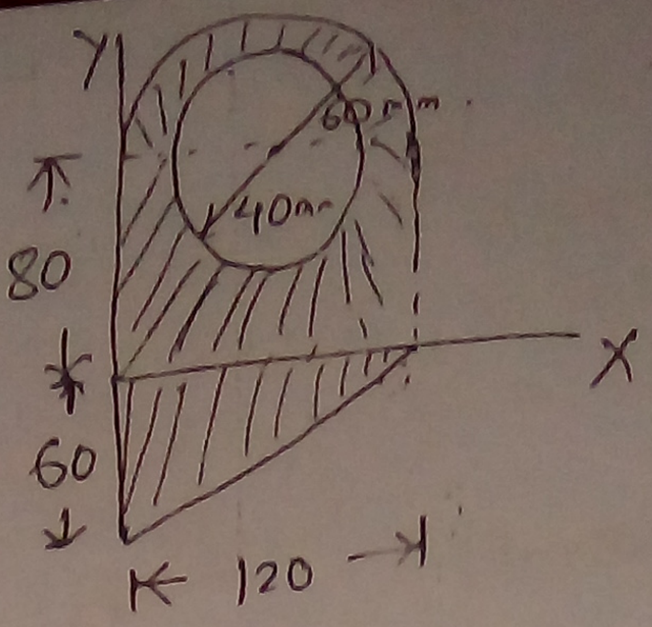
$\therefore \bar{x} = \frac{\Sigma \bar{x} A}{\Sigma A} = \frac{-8456}{510} = -16.3$ in.

$\therefore \bar{y} = 0$.

~~Ans~~

870.

Total area = Rectangle + Triangle + Semi-circle - circle.



Seg.	A mm^2	$\bar{x}$ mm	$\bar{y}$ mm	$\bar{x}A$ mm^3	$\bar{y}A$ mm^3
(I) Rectangle	120×80 = 9600	60	40	576000	384000
(II) Triangle	$\frac{1}{2}\times 120\times 60$ = 3600	120/3 = 40	$-60/3$ = -20	144000	-72000
(III) Semi circle	$\frac{1}{2}\times\pi\times(60)^2$ = 5655	60	$\left(80+\frac{4\times 60}{3\pi}\right)$ = 105.46	337300	596376.3
(IV) Circle	$-\pi\times(40)^2$ = -5027	60	80+0 = 80	-301620	-402160

$\Sigma A = 13828$ $\quad \Sigma \bar{x}A = 757680$. $\quad \Sigma \bar{y}A = 506216.3$

∴ The first moment of area,

$Q_x = 506216.3\ mm^3$.

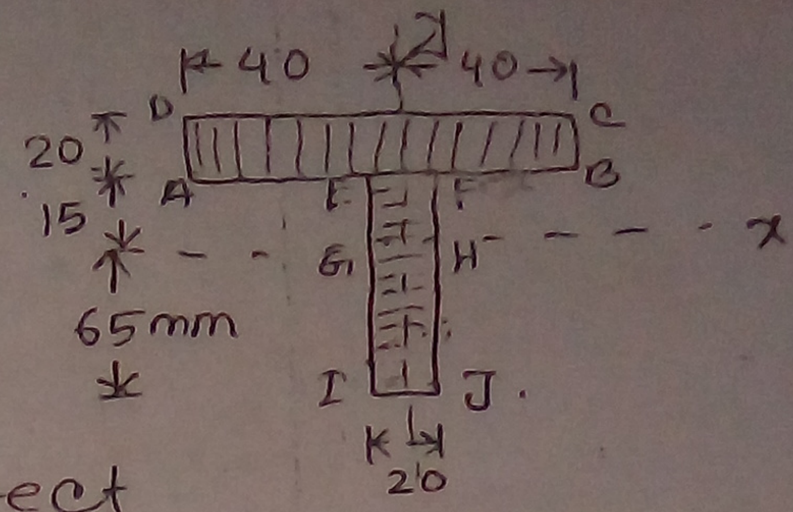
$Q_y = 757680\ mm^3$. Ans

$$\therefore \bar{x} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{757680}{13828} = 54.8\ mm$$

$$\therefore \bar{y} = \frac{\Sigma \bar{y}A}{\Sigma A} = \frac{506216.3}{13828} = 36.6\ mm$$

Ans

881.



The area is symetrical to $\bar{y}$ axis. so $\bar{x}=0$.

For the A_1 with respect x axis.

Seg.	A mm^2	$\bar{y}$ mm	$\bar{y}A$ mm^3.
① ABCD	$80\times20 = 1600$	$15+\frac{20}{2} = 25$	40,000
⑪ EFGH	$20\times15 = 300$	$15/2 = 7.5$	2250.
	$\Sigma A = 1900$		$\Sigma \bar{y}A = 42250$.

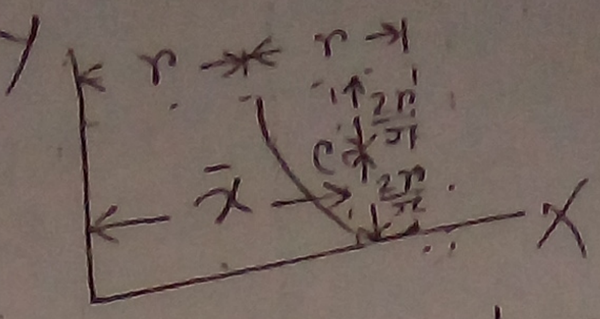
∴ First moment of inertia with respect to x axis for A_1. $Q_x = 42250\ mm^3$. Ans:-

Now. for A_2.

Seg.	A mm^2	$\bar{y}$ mm	$\bar{y}A$ mm^3.
i) (20×65) GHIJ	$20\times65 = 1300$	$-65/2 = -32.5$.	-42250.
	$\Sigma A = 1300$		$\Sigma \bar{y}A = -42250$.

∴ First moment of inertia with respect to x axis for A_2. $Q_x = -42250\ mm^3$. Ans:-

002.



Here,

$\bar{x} = 2r - \frac{2r}{\pi}$.

$= 2r\left(\frac{\pi-1}{\pi}\right)$.

$\theta = 2\pi$. $L = \frac{1}{4} \cdot 2\pi r$.

$= \frac{1}{2}\pi r$.

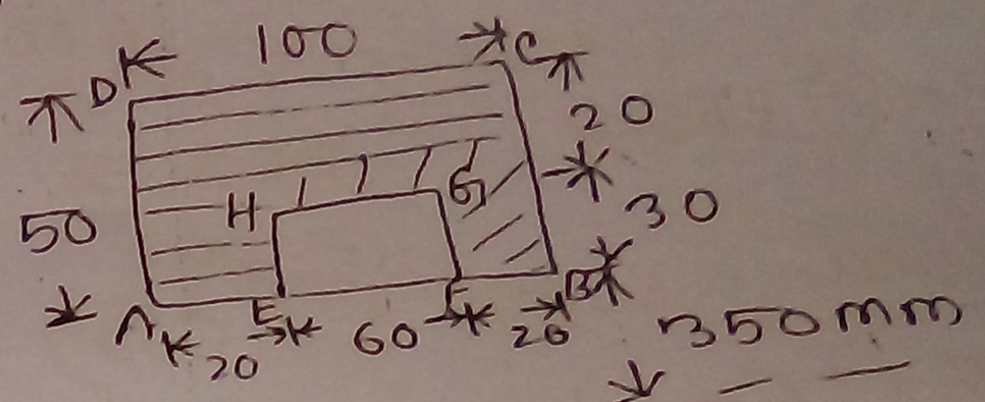
From Pappus - Guldinus theorem,

$A = \theta \bar{x} L = 2\pi \times 2r\left(\frac{\pi-1}{\pi}\right) \times \frac{1}{2}\pi r$.

$= 2\pi r^2(\pi-1)$. Ans:-

003. Given that.

$\rho = 7.85 \times 10^3 \text{ kg/m}^3$.



Sec	A mm^2	$\bar{y}$ mm	$\bar{y}A$ mm^3.
Rec i) ABCD	100 × 50 = 5000	350 + 50/2 = 375	1875000.
ii) EFGH	−60 × 30 = −1800	350 + 30/2 = 365	− 657000.
	$\Sigma A = 3200$		$\Sigma \bar{y}A = 1218.000$.

$\therefore \bar{y} = \frac{\Sigma \bar{y}A}{\Sigma A} = 380.625$ mm.

$\therefore v = \theta \bar{y} A = 2\pi \times 380.625 \times 3200 \text{ mm}^3$.

$= 7.65 \times 10^{-3} \text{ m}^3$.

$\therefore$ Mass, $M = \rho v = 7.85 \times 10^3 \times 7.65 \times 10^{-3}$

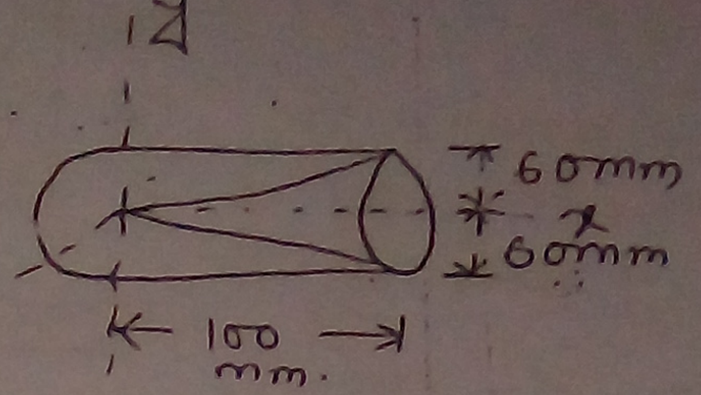
$= 60$ kg. -Ans:-

Again, weight, $W = M \times g = 60 \times 9.8$ N.

$\therefore W = 588$ N. -Ans:

Q11.

The volume is symetrical to x axis. $\therefore \bar{y} = \bar{z} = 0$.



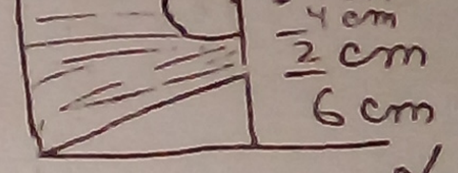
Seg.	V mm^3	$\bar{x}$ mm	$\bar{x}V$ mm^4.
i) cylinder	$\pi \times (60)^2 \times 100 = 1.13 \times 10^6$	$\frac{100}{2} = 50$.	56.55×10^6
ii) Hemisphere	$\frac{1}{2} \times \frac{4}{3} \pi \times (60)^3 = 0.46 \times 10^6$	$-\frac{3 \times 60}{8} = -22.5$	-10.18×10^6.
iii) cone	$-\frac{1}{3} \pi \times (60)^2 \times 100 = -0.38 \times 10^6$	$\frac{3 \times 100}{4} = 75$	-28.28×10^6.
	$\Sigma V = 1.206 \times 10^6$		$\Sigma \bar{x} V = 18.09 \times 10^6$.

$\therefore \bar{x} = \frac{\Sigma \bar{x} V}{\Sigma V} = 15$ mm.

$\therefore \bar{y} = 0 \quad \bar{z} = 0$

} Ans:-

Q22.

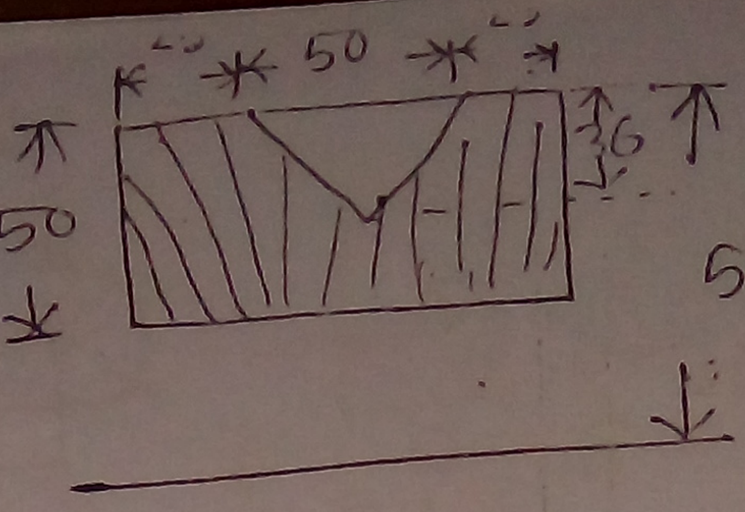


Seg.	A cm^2	$\bar{x}$ cm	$\bar{y}$ cm	$\bar{x}A$ cm^3	$\bar{y}A$ cm^3.
i) Rec. tangle	$9 \times 18 = 162$	4.5	9	720	1458
ii) Triangle	$-\frac{1}{2} \times 9 \times 6 = -27$	$\frac{2 \times 9}{3} = 6$	$\frac{6}{3} = 2$	-162	-54.
iii) Semicircle	$-\frac{1}{2} \pi \times (4)^2 = -25.13$	$9 - \frac{4 \times 4}{3\pi} = 8.4$		-183.5	-307.56.
	$\Sigma A = 109.87$	$\Sigma \bar{x} A = 383.5$			$\Sigma \bar{y} A = 1102.44$.

$\therefore \bar{x} = \frac{\Sigma \bar{x} A}{\Sigma A} = 3.49$ cm

$\therefore \bar{y} = \frac{\Sigma \bar{y} A}{\Sigma A} = 10.04$ cm

} Ans:-



Hi The area is symetrical to $\bar{y}$ axis.

$\therefore \bar{x} = 0$.

Seg.	A. mm^2	$\bar{y}$ mm	$\bar{y}A$. mm^3.
(i) Rectangle	$50 \times 100 = 5000$	$450 + \frac{50}{2} = 475$	2.38×10^6
(ii) Triangle	$-\frac{1}{2} \times 50 \times 36 = -900$	$\left(500 - \frac{36}{3}\right) = 488$	-0.439×10^6

$\Sigma A = 4100$ $\quad \Sigma \bar{y}A = 1.94 \times 10^6$.

$\therefore \bar{Y} = \frac{\Sigma \bar{y}A}{\Sigma A} = 472.15$ mm.

$\therefore V = \theta \bar{Y} A = 2\pi \times 472.15 \times 4100$

$= 1.217 \times 10^{-2}\ m^3$.

$\therefore M = \rho V = 7.83 \times 10^3 \times 1.217 \times 10^{-3}$ kg

$= 95.4$ kg.

$\therefore$ weight. $W = Mg$

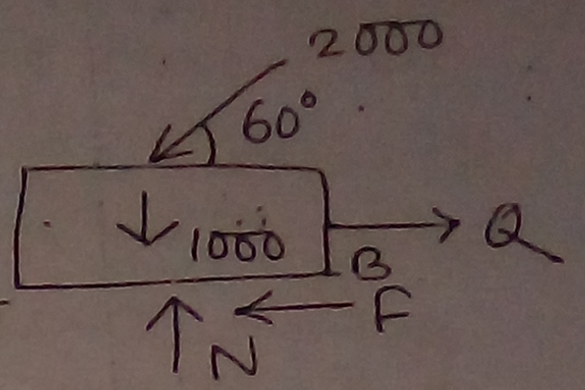
$= 95.4 \times 9.8$ N.

$= 936$ N.

$\rightarrow$ Ans:

FRICTION.

* 2000
402.



considering the freebody

a) $\Sigma F_y = 0 \Rightarrow N - 1000 - 2000 \sin 60° = 0.$

$\therefore N = 2732$ lb.

$\therefore F = fN = 0.25 \times 2732 = 683$ lb.

$\Sigma f_x = 0 \Rightarrow Q - F - 2000 \cos 60° = 0.$

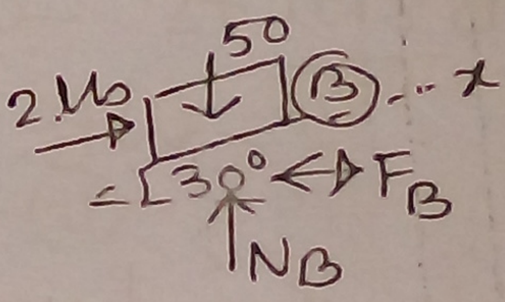
$\therefore Q = 1683$ lb. Ans:-

b) when, $Q = 0$. then, $F = -1000$ lb.

then, Q will impending motion toward the left. Ans:-

* 2003
412.

a) for the B block.



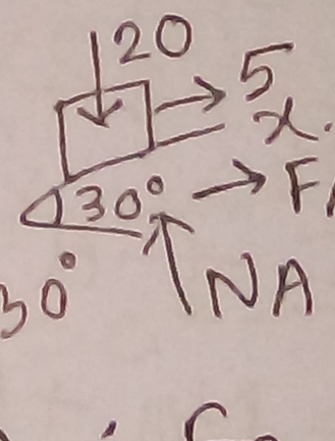
$\Sigma F_x = 0 \Rightarrow 2 + F_B - 50 \sin 30° = 0.$

$\therefore F_B = 23$ lb.

$\Sigma f_y = 0 \Rightarrow N_B - 50 \cos 30° = 0.$ $\therefore N_B = 43.3$ lb.

$\therefore f_B = F_B / N_B = 23 / 43.3 = 0.531.$ Ans:-

b) for A block.



$\Sigma F_y = 0 \Rightarrow N_A - 20\cos 30° = 0.$ ($20\cos 30°$ = $20\cos 60°$)

$\therefore N_A = 10$ lb. ($20\sin 30°$)

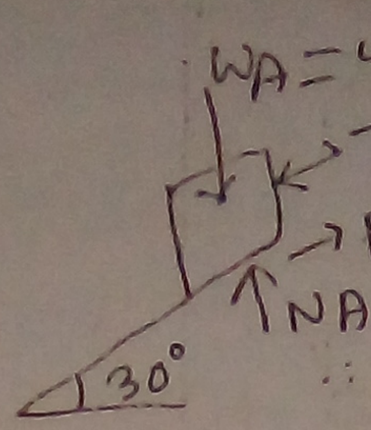
$\Sigma F_x = 0 \Rightarrow F_A + 5 - 20 \sin 60° = 0$ $\therefore F_A = 12.32$ lb.

$\therefore f_A = F_A / N_A = \frac{12.32}{10} = 1.23$. Ans:-

c).

$= 8.289$ (Am.)

a *2000
415. For A block.



$f_D = \frac{1}{3}$.

$\rightarrow +\Sigma F_x = 0$.

$\rightarrow + F_A - T + W_A \cos 60° = 0$.

$\Rightarrow F_A = T - 200$.

$\Rightarrow f_A N_A = T - 200 \quad \therefore N_A = 3T - 600$ — ①.

$\uparrow +\Sigma F_y = 0 \Rightarrow N_A - W_A \sin 60° = 0$.

$\Rightarrow N_A = 400 \sin 60° = 346.41$.

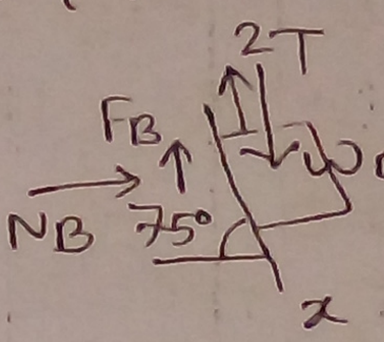
$\Rightarrow 3T - 600 = 346.41 \quad \therefore T = 315.5$ lb. Ans'r

b. For B block.

$\uparrow \Sigma F_y = 0$.

$\Rightarrow N_B - W_B \cos 75° = 0$.

$\therefore N_B = W_B \cos 75°$.



$f_B = \frac{1}{4}$.

$\rightarrow +\Sigma F_x = 0 \Rightarrow 2T + F_B - W_B \sin 75° = 0$.

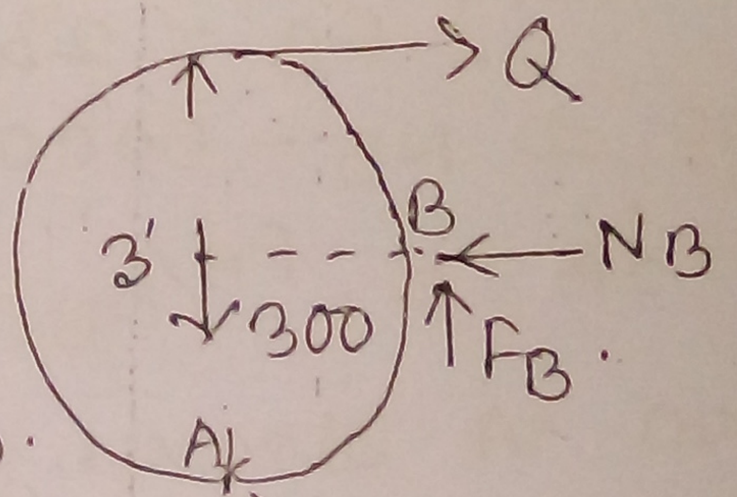
$\Rightarrow W_B \sin 75° - \frac{1}{4} \cdot N_B = 2 \times 315.49$

$\Rightarrow W_B \sin 75° - \frac{1}{4} \cdot W_B \cos 75° = 2 \times 315.5$.

$\therefore W_B = 701.11$ lb. Ans'r

ii) 2006
*410.

$f_A = f_B = \frac{1}{3}$.



$\Sigma M_A = 0$.

$\Rightarrow Q \times 3 - N_B \times 1.5 - F_B \times 1.5 = 0$

$\Rightarrow 3Q - N_B \times 1.5 - \frac{1}{3} N_B \times 1.5 = 0$.

$\therefore N_B = \frac{3}{2} \cdot Q$. — ①.

$\uparrow \Sigma F_y = 0 \Rightarrow N_A + F_B - 300 = 0$.

$\Rightarrow + F_A \times 3 + \frac{1}{3} \cdot N_B - 300 = 0$.

$\therefore F_A = \frac{1}{3} \cdot \left(300 - \frac{N_B}{3}\right)$. — ⑪

$\rightarrow \Sigma F_x = 0 \Rightarrow F_A + Q - N_B = 0$.

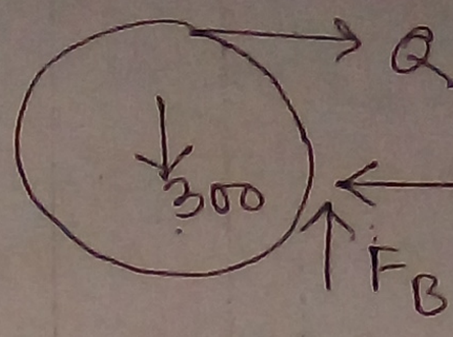
$\Rightarrow \frac{1}{3} \cdot \left(300 - \frac{1}{3} \cdot \frac{3}{2} Q\right) + Q - \frac{3}{2} Q = 0 \quad \therefore Q = 150$ lb. Ans'r (in spinning)

rolling.

$\Sigma F_y = 0 \Rightarrow F_B - 300 = 0$.

$\Rightarrow F_B = 300 \Rightarrow \frac{1}{3} \cdot N_B = 300$.

$\therefore N_B = 900$ lb.



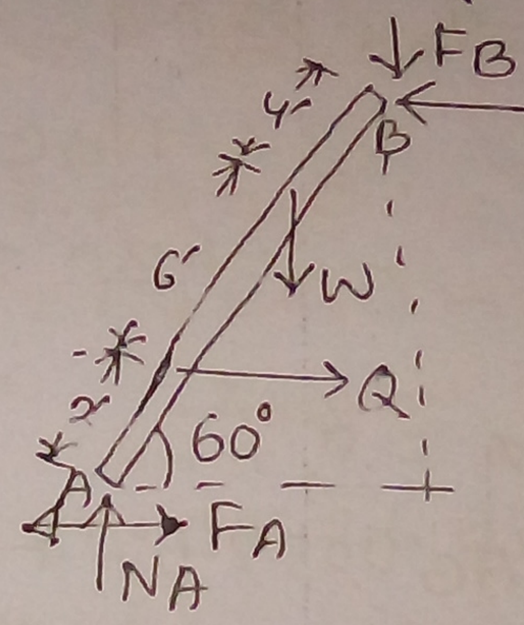
$\Sigma F_x = 0 \Rightarrow Q - N_B = 0 \quad \therefore Q = N_B = 900$.

$\therefore$ Q. spinning < Q. rolling.

So, the drum will be spinning. — Ans'r.

2002.04.07.2009

421.



$f_a = 0.2$

$f_b = 0.3$

$W = 500$ lb

$\Sigma F_x = 0$.

$\Rightarrow -f_A + Q - N_B = 0$.

$\Rightarrow Q = f_A + N_B$.

$\Rightarrow Q = 0.2 N_A + N_B$. — (I).

$\Sigma F_y = 0 \Rightarrow N_A + (-W) - F_B = 0$.

$\Rightarrow N_A - W + F_B = W + 0.3 N_B = 500 + 0.3 N_B$.

$\therefore N_A = 500 + 0.3 N_B$ — (II).

From (I), $Q = 0.2 (500 + 0.3 N_B) + N_B$.

$\therefore Q - 1.06 N_B - 100 = 0$. — (III).

When, Vertical F then Horz. dis. Horz. F then vert. dis

$\Sigma M_A = 0 \Rightarrow Q \times 2 \sin 60^\circ + W \times 8 \cos 60^\circ - N_B \times 12 \sin 60^\circ + F_B \times 12 \cos 60^\circ = 0$.

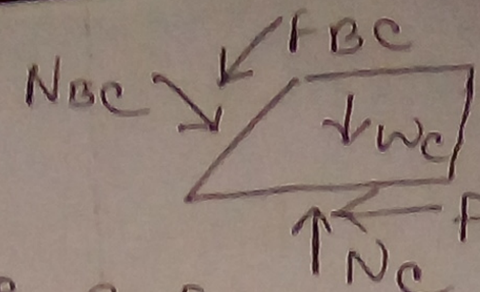
$\therefore 0.2Q - N_B + 230 = 0$. — (IV). [putting value of W, F_B].

From (III), (IV). $Q = 436.29$ lb.

$N_B = 94.34$. } Ans'r

*1200 lb

$\mu = \frac{1}{3}$.



$\Sigma F_x = 0$.

$\Rightarrow N_{BC}\cos 7.5° - F_{BC}\sin 7.5° - R - F_C = 0$.

$\Rightarrow F_C = 0.09 N_{BC} - 0.13 F_{BC} - 8000$

$\therefore N_C = 2.85 N_{BC} - 24000$. — (1).

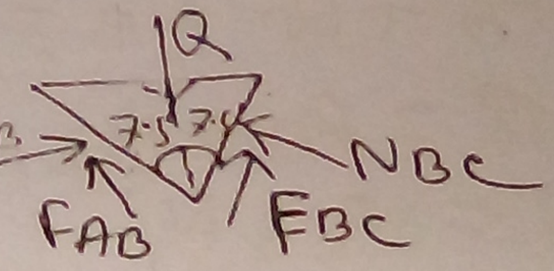
$\Sigma F_y = 0 \Rightarrow N_C - W_C - N_{BC}\sin 7.5° - F_{BC}\cos 7.5° = 0$

$\Rightarrow N_C = 0.13 N_{BC} + 0.33 N_{BC} + 5000$.

$\Rightarrow 2.85 N_{BC} - 24000 = 0.13 N_{BC} + 0.33 N_{BC} + 5000$.

$\therefore N_{BC} = 12133.80$.

$\therefore F_{BC} = 4044.63$ lb.



$\Sigma F_x = 0$.

$\Rightarrow N_{AB}\cos 7.5° - F_{AB}\sin 7.5° - N_{BC}\cos 7.5° + F_{BC}\sin 7.5° = 0$. — (1).

$\therefore N_{AB} = N_{BC}$.

$\therefore N_{AB} = 12133.80$. $F_{AB} = 4044.63$ lb.

$\Sigma F_y = 0$.

$\Rightarrow N_{AB}\sin 7.5° + F_{AB}\cos 7.5° + F_{BC}\cos 7.5° + N_{BC}\sin 7.5° - Q = 0$.

$\therefore Q = 11187.66$ lb.

Ans:-

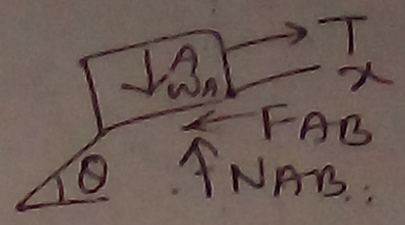
$W_A = 50$ lb

69.

$\Sigma F_y = 0$.

$\Rightarrow N_{AB} - W\cos\theta = 0$.

$\therefore N_{AB} = 50\cos\theta$. — (i).



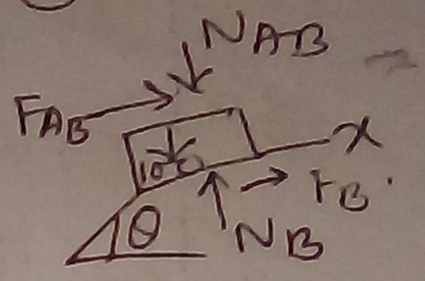
$\Sigma F_x = 0 \Rightarrow T - F_{AB} - 50\sin\theta = 0$.

$\Rightarrow T = F_{AB} + 50\sin\theta$. — (ii).

$\Sigma F_y = 0$.

$\Rightarrow N_B - N_{AB} - 100\cos\theta = 0$.

$\Rightarrow N_B = 150\cos\theta$. — (iii).



$\therefore \Sigma F_x = 0 \Rightarrow F_B + F_{AB} - 100\sin\theta = 0$.

$\Rightarrow 0.25 \times 150\cos\theta + 0.25 \times 50\cos\theta - 100\sin\theta = 0$.

$\therefore \theta = 26.57°$. — Ans:—

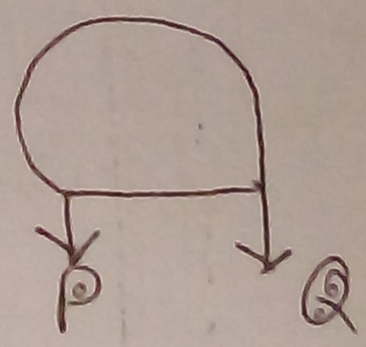
$\therefore$ From (ii) $T = 0.25 \times 50\cos 26.57° + 50\sin 26.57°$

$\therefore T = 33.54$ lb. — Ans:—

*2002

479.

(i) When, $P < Q$.



$\therefore Q = P e^{\theta f}$.

$= 500 (e^{\pi \times 0.4})$.

$= 1756.79$ lb.

(ii) When, $Q < P$.

$\therefore Q = \frac{500}{e^{\pi \times 0.4}} = 142.3$ lb.

$\therefore$ The range of the value of weight 142.3 lb and 1756.79 lb. — Ans:—

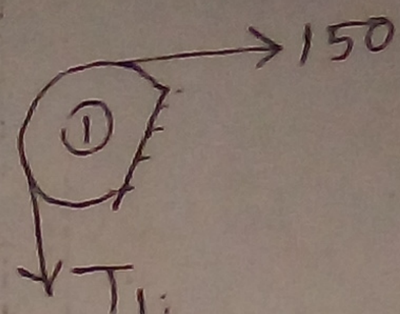
* [illegible]

* 2007.

480.

(i) $\therefore 150 = T_1 \cdot e^{\pi/2 \times 0.1}$.

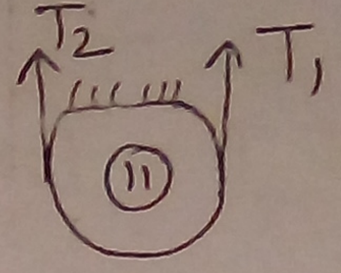
$\therefore T_1 = 128.29$ #



(ii) $\therefore T_1 = T_2 \cdot e^{\pi \times 0.1}$.

$\Rightarrow T_2 = \frac{128.29}{e^{\pi \times 0.1}}$

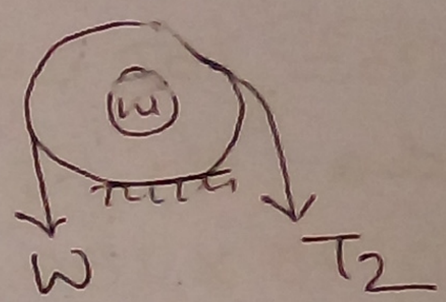
$\therefore T_2 = 65.4$ #.



(iii) $\therefore T_2 = W \cdot e^{\pi \times 0.1}$.

$\Rightarrow W = \frac{65.4}{e^{\pi \times 0.1}}$.

$\therefore W = 50$ # Ans.



* 2004.

Q 571. Let the no. of turns $= n$.

i) A we get, $\theta = 2n\pi$.

$\mu = \frac{1}{\pi}$.

ii) E. $\therefore$ we get, $1500 = 50\ e^{\frac{1}{\pi} \times 2n\pi}$.

$\Rightarrow e^{2n} = \frac{1500}{50}$.

$\Rightarrow 2n = 3.4$.

$\Rightarrow n = 1.75$.

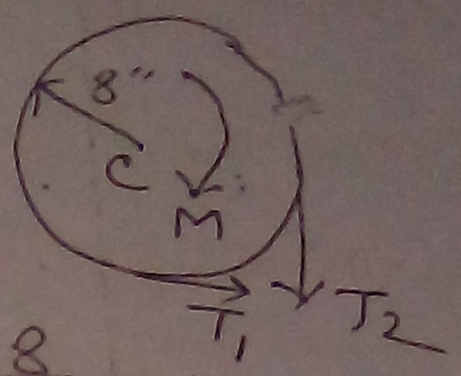
$\therefore n = 2$. Ans.

005]

72.

$\therefore T_1 = T_2 e^{\mu \frac{\pi}{2} \times 0.4}$

$\therefore T_1 = 6.59 T_2$. —①.

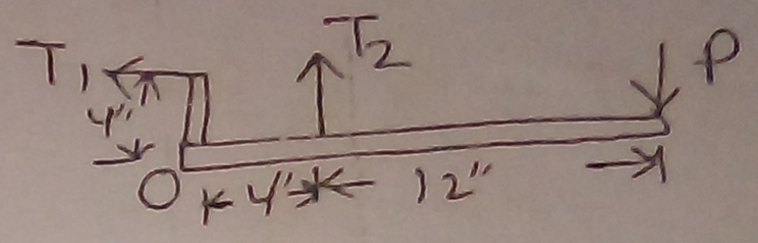


$\Sigma M_C = 0 \Rightarrow -200 + T_1 \times \frac{8}{12} - T_2 \times \frac{8}{12} = 0$.

$\Rightarrow T_1 - T_2 = 300$.

$\therefore T_2 = 53.67$ lb. $\therefore T_1 = 353.67$ lb.

$\Sigma M_O = 0$.



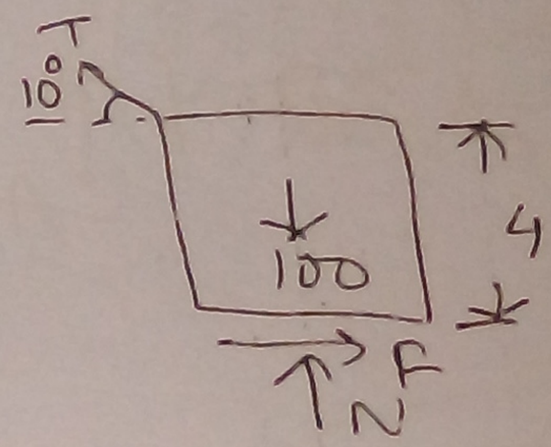
$\Rightarrow P \times 16 - 4T_1 - T_2 \times 4 = 0$.

$\Rightarrow P = \frac{4 \times 353.67 + 4 \times 53.67}{16}$

$\therefore P = 101.84$ #. Ans:—

*[2008]

482. When A is sodeing,



$\Sigma F_y = 0$.

$\Rightarrow N - 100 + T \sin 10^\circ = 0$.

$\Rightarrow N = 100 - T \sin 10^\circ$. —①.

But. $F = 0.3N = 30 - 0.052T$. —⑪.

$\therefore F_x = 0$.

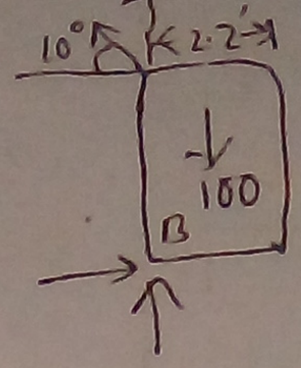
$\Rightarrow F - T \cos 10^\circ = 0$.

$\Rightarrow F = T \cos 10^\circ$.

$\Rightarrow 30 - 0.052T = T \cos 10^\circ$.

$\therefore T = 20$ #.

a when, A is tip then,



t $\Sigma M_B = 0$.

$\Rightarrow 100 \times 1.1 - T\cos 10^\circ = 0$.

Ft $\therefore T = 27.02$ #.

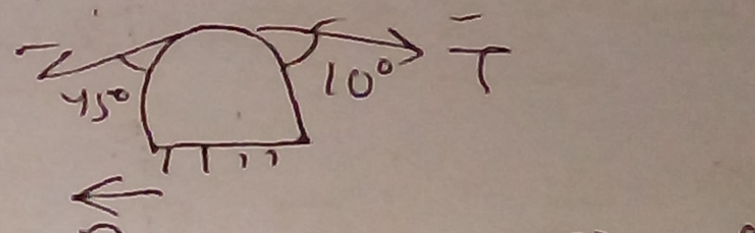
$\therefore 20 > 27.02$.

so, The body is tip. therefore,

o $T = 27.02$ #.

$\therefore P = T.e^{\theta f}$.

$= 27.02 \times e^{0.31\pi \times 0.3}$



$\theta = 45^\circ + 10^\circ$

$= \frac{55\pi}{180}$

$= 0.31\pi$.

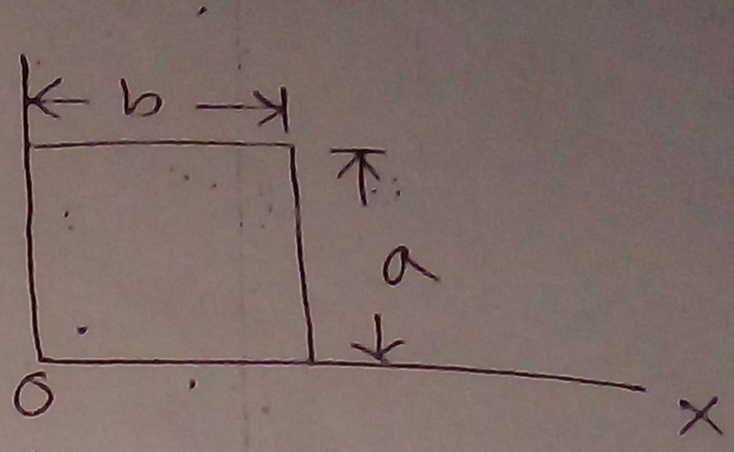
i) $\therefore P = 37.4$ #.

Ans'r

ii).

MOMENT OF INERTIA.

(*)



$\therefore Ix = \frac{1}{3} \cdot ba^3 \cdot = 216 \cdot in^4.$

$\therefore Iy = \frac{1}{3} ab^3 = 54 \ in^4.$

$a = 6$ in.

$b = 3$ in.

$\therefore Pxy = Ixy = \frac{a}{2} \times \frac{b}{2} \times a \times b.$

$= 81 \ in^4.$

$\therefore \tan 2\theta = \frac{2Pxy}{Iy - Ix} = \frac{2 \times 81}{54 - 216}.$

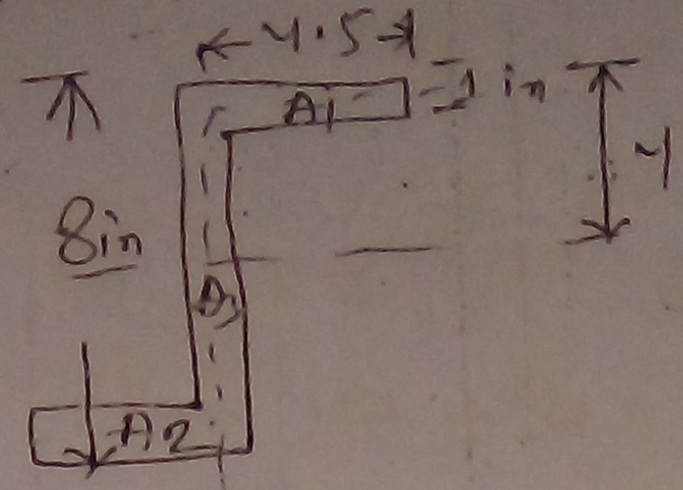
$\therefore -\theta = -\pi/8.$

$\therefore Imax = \frac{Ix + Iy}{2} + \sqrt{\left(\frac{Ix - Iy}{2}\right)^2 + (Pxy)^2}.$

$= 250 \ in^4.$

$\therefore Imin = \frac{Ix + Iy}{2} - \sqrt{\left(\frac{Ix - Iy}{2}\right)^2 + (Pxy)^2}$

$= 20.4 \ in^4.$



$\therefore (Pxy)_1 = \bar{P} + (A\,dx\,dy)_1$

$= 0 + 4 \times 2.5 \times 3.5$

$= 35\ in^4.$

$\therefore (Pxy)_2 = \bar{P} + (A\,dx\,dy)_2$

$= 0 + 4 \times (-2.5)(-3.5)$

$= 35\ in^4.$

i) $\therefore (Pxy)_3 = 0 + 0 = 0$

ii) $\therefore Pxy = 35 + 35 + 0 = 70\ in^4.$

$\therefore I_{y1} = \frac{1 \times y^3}{12} + 4 \times 1 \times (2.5)^2$

$= 30.33\ in^4.$

$\therefore I_{y2} = \frac{1 \times y^3}{12} + 4 \times 1 \times (2.5)^2$

$= 30.33\ in^4.$

$\therefore I_{y3} = \frac{(1)^3 \times 8}{12} + 4 \times 1 \times (0)^2$

$= 0.67\ in^4.$

$\therefore I_y = 61.33 \text{ in}^4$.

$\therefore I_{x_1} = \frac{(1^3)\times 4}{12} + 4\times 1\times(3.5)^2$.

$= 40.33 \text{ in}^4$.

$\therefore I_{x_2} = \frac{4\times 1^3}{12} + 4\times 1\times(3.5)^2$

$= 40.33 \text{ in}^4$.

$\therefore I_{x_3} = \frac{1\times 8^3}{12} + 1\times 8\times 0^2$

$= 42.67 \text{ in}^4$.

$\therefore I_x = (40.33 + 40.33 + 42.67) \text{ in}^4$.

$= 141.33 \text{ in}^4$.

$\therefore I_{max} = \frac{I_x + I_y}{2} + \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + (P_{xy})^2}$

$= 181.87 \text{ in}^4$.

$\therefore I_{min} = \frac{I_x + I_y}{2} - \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + (P_{xy})^2}$

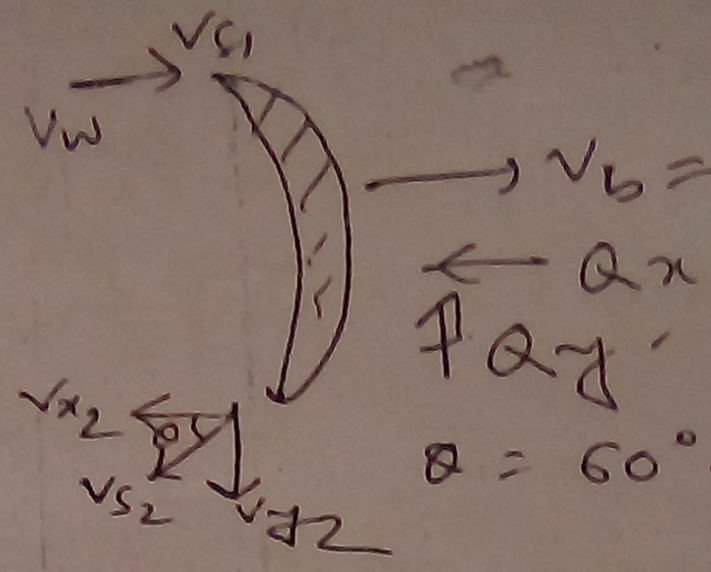
$= 20.5 \text{ in}^4$.

PLANE MOTION

2005.

(M). $v_w = 200$ ft/s. $M = \frac{5}{32.2} = 0.155$ slugs

$\Delta t = 1$ sec.



$\therefore v_{s2} = -200 \cos 60°$.

$= -100$.

$v_{s1} = 200$.

$R_x = -Q_x$.

$\Delta t = 1$ sec.

$\therefore R_x \Delta t = m(v_{s2} - v_{s1})$.

$\Rightarrow -Q_x \cdot 1 = 0.155(-100 - 200)$.

$\therefore Q_x = 46.5$ lb.

again, $R_y = -Q_y$. $v_{y1} = 0$. $v_{y2} = -v_{s2} \sin 60°$

$= -173.2$ lb

$\therefore R_y \Delta t = m(v_{y2} - v_{y1})$.

$\Rightarrow -Q_y \times 1 = 0.155(-173.25 - 0)$.

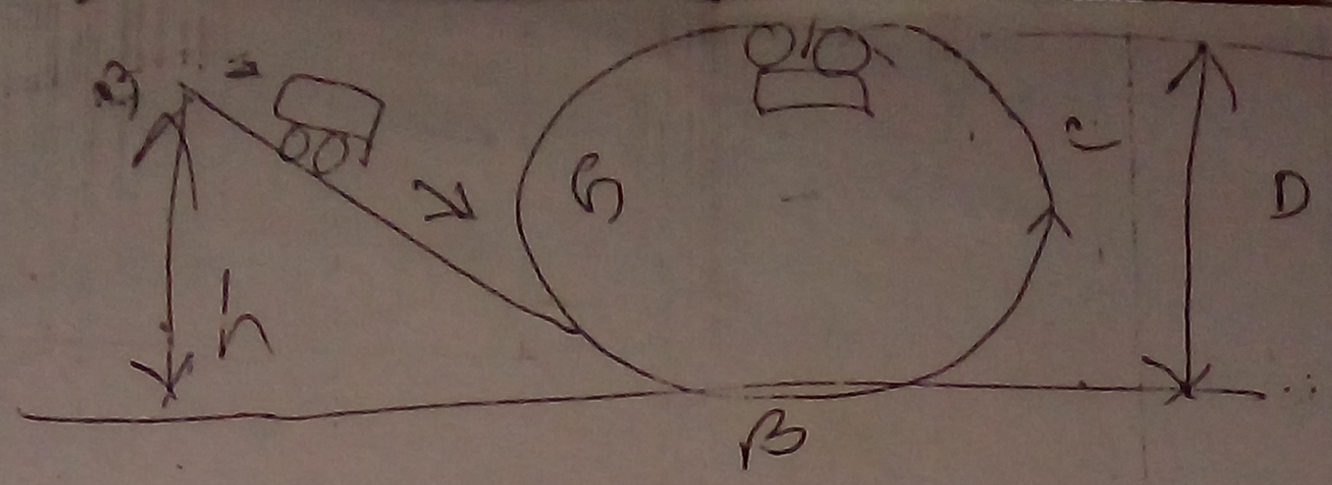
$= 26.87$.

$\therefore Q_y =$

$\therefore R = \sqrt{Q_x^2 + Q_y^2}$

$= 53.69$ lb.

Ans



For E position.

$\Sigma F_y = 0 \Rightarrow N - w = 0 \Rightarrow \frac{wv^2}{gr} = w.$

$\Rightarrow v^2 = gr$ — (1).

Again, $mg(h-D) = \frac{1}{2}mv^2.$

$\Rightarrow h = \frac{v^2}{2g} + D.$

$\Rightarrow h = \frac{gr}{2g} + D = \frac{r}{2} + D.$

$= \frac{20}{2} + 40 = 50.$

For C. position,

$mg\left(h - \frac{D}{2}\right) = \frac{1}{2}mv_c^2.$

$\Rightarrow 2g(50-20) = v_c^2.$

$\Rightarrow v_c^2 = 60g.$

$\Rightarrow v_c = \sqrt{60g}.$

$\therefore v_c = \sqrt{60g}$ — Ans;