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MOMENTS & PARALLEL COPLANNER FORCES

(ABU SIDDIQUE SIR)

Formulas: →

1) $R = \Sigma F_y$

2) $\bar{x} = \frac{|\Sigma M|}{|R|}$

where, $\bar{x}$ = distance of the resultant moment from the particular point.

3) Equilibrium:

* $\Sigma F_y = 0$
* $\Sigma H = 0$

There is only one independent point in a particular system where moment will be "zero".

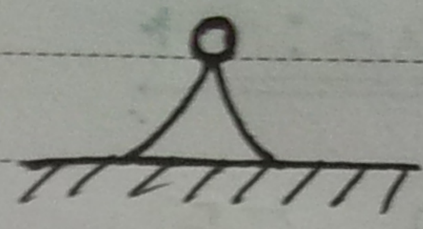
Clockwise → Positive direction of the moment.

Anticlockwise → Negative direction of the moment.

* Simple Supported Beams:-

1. Hinge: (similar to pin & unstable)

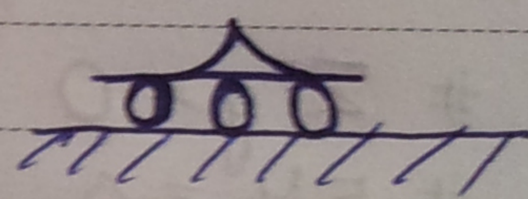
* Hinge supported can not take any moment.



Hinge support can resist verticle and horizontal forces.

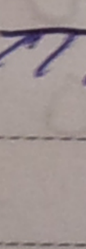
It has two reactions → verticle and horizontal.

2. Roller:



Roller support can not resist horizontal or inclined forces. So, it has only verticle load.

* Fixed Support :→



Fixed support can resist all kinds of loads and moments.
It is a very strong support.

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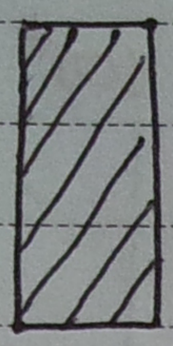
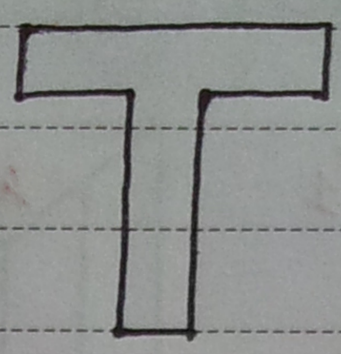
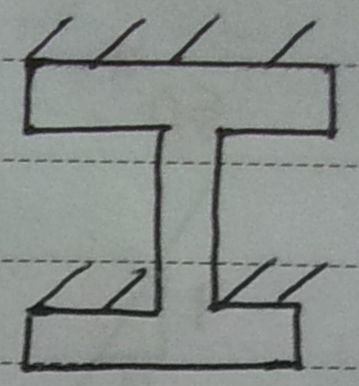
Different shapes of beams:

1) 

2) 

3) 

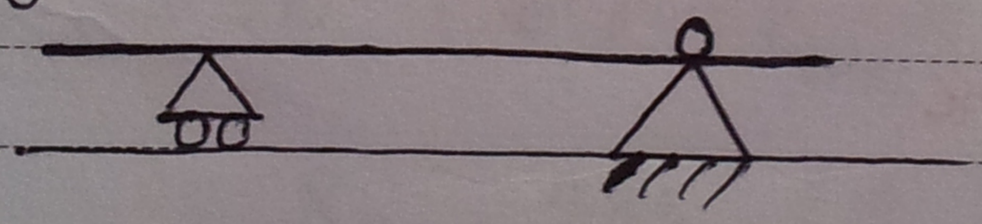
Cantilever Structure :- one side fixed.

Loads are of two types.

1) Live load (living beings)

2) Dead load

Over hanging beam : two ends থেকে বাড়তি থাকলে over hanging beam.



Statically Determined Beam : Equation থেকে যার value বের করা যায় তাই হল Statically Determined Beam.

Span length : দুটো support - এর থাকার length হল span length.

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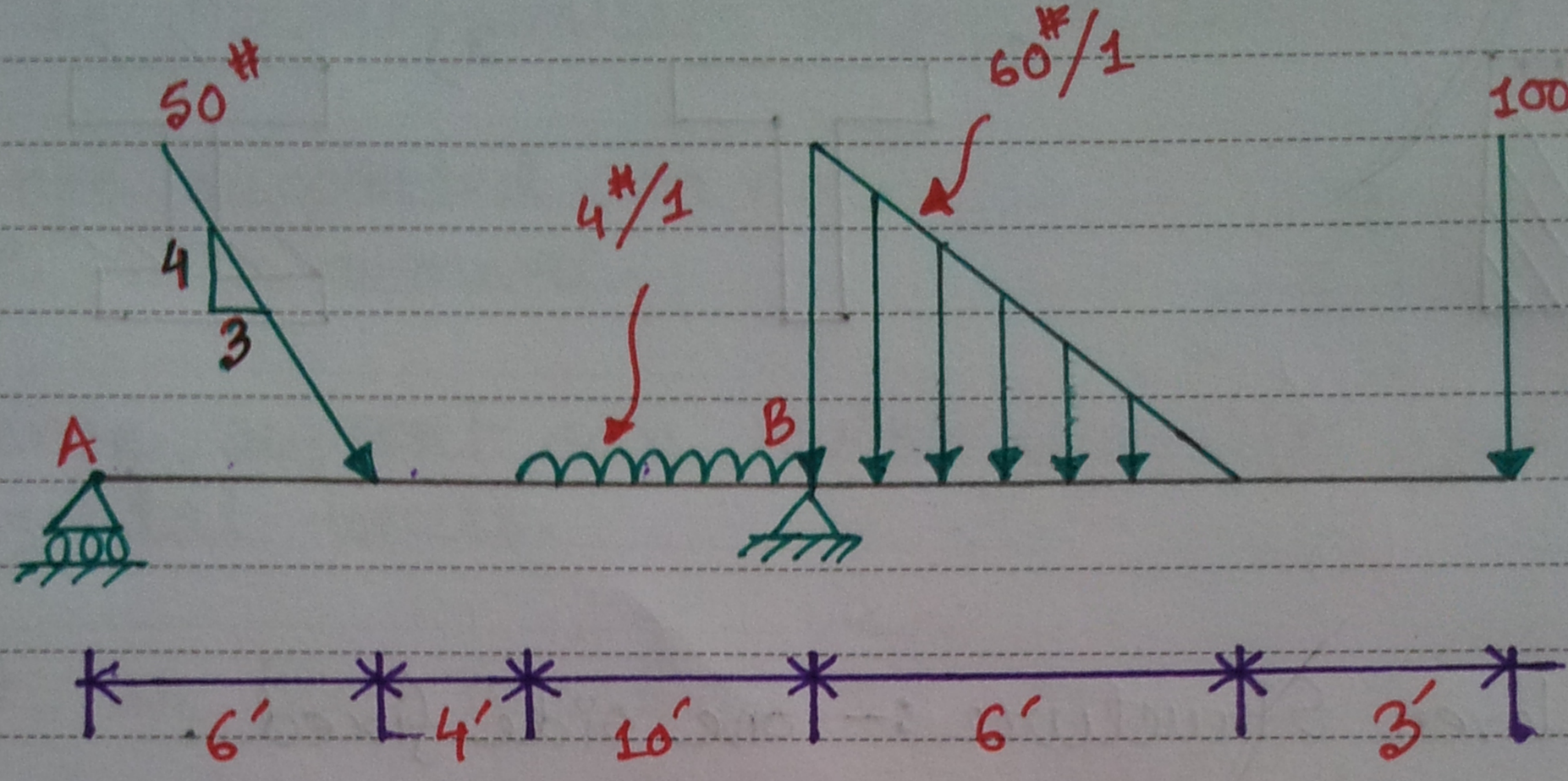
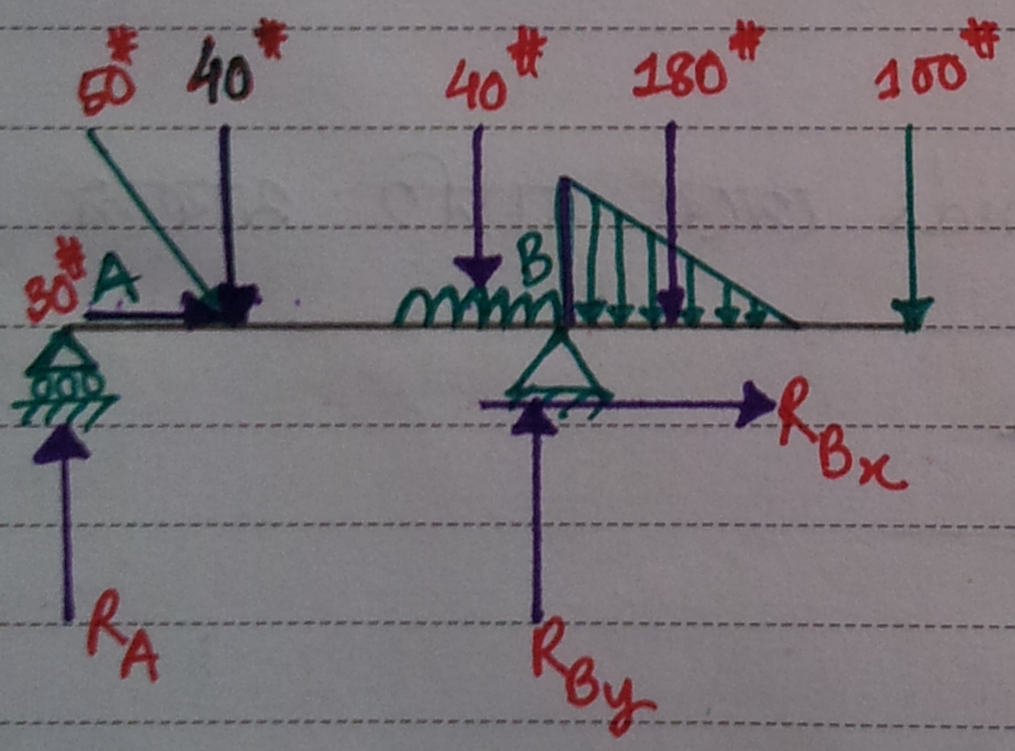
Problem:-1 Find out the reactions of A & B.



Soln:

** average load = $\frac{60+0}{2} \times 6 = 180^{\#}$



In equilibrium —

$\Sigma F_x = 0$

$\Rightarrow R_{Bx} + 30 = 0$

$\Rightarrow \boxed{R_{Bx} = -30^{\#} \ (\leftarrow)}$

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& $\Sigma F_y = 0$

$\Rightarrow -40 - 40 + R_A + R_{By} - 180 - 100 = 0$

$\Rightarrow R_A + R_{By} = 360$ ----(i)

Again, $\Sigma M_B = 0$

$\Rightarrow R_A \times 20 - 40 \times 14 - 40 \times 5 + 180 \times 2 + 100 \times 9 = 0$

$\Rightarrow \boxed{R_A = -25^{\#} \ (\downarrow)}$

From eqn (i) we get,

$\boxed{R_{By} = 360 + 25 = 385^{\#} \ (\uparrow)}$

Ans: $R_A = 25^{\#} \ (\downarrow)$; $R_{Bx} = 30^{\#} \ (\leftarrow)$

$R_{By} = 385^{\#} \ (\uparrow)$

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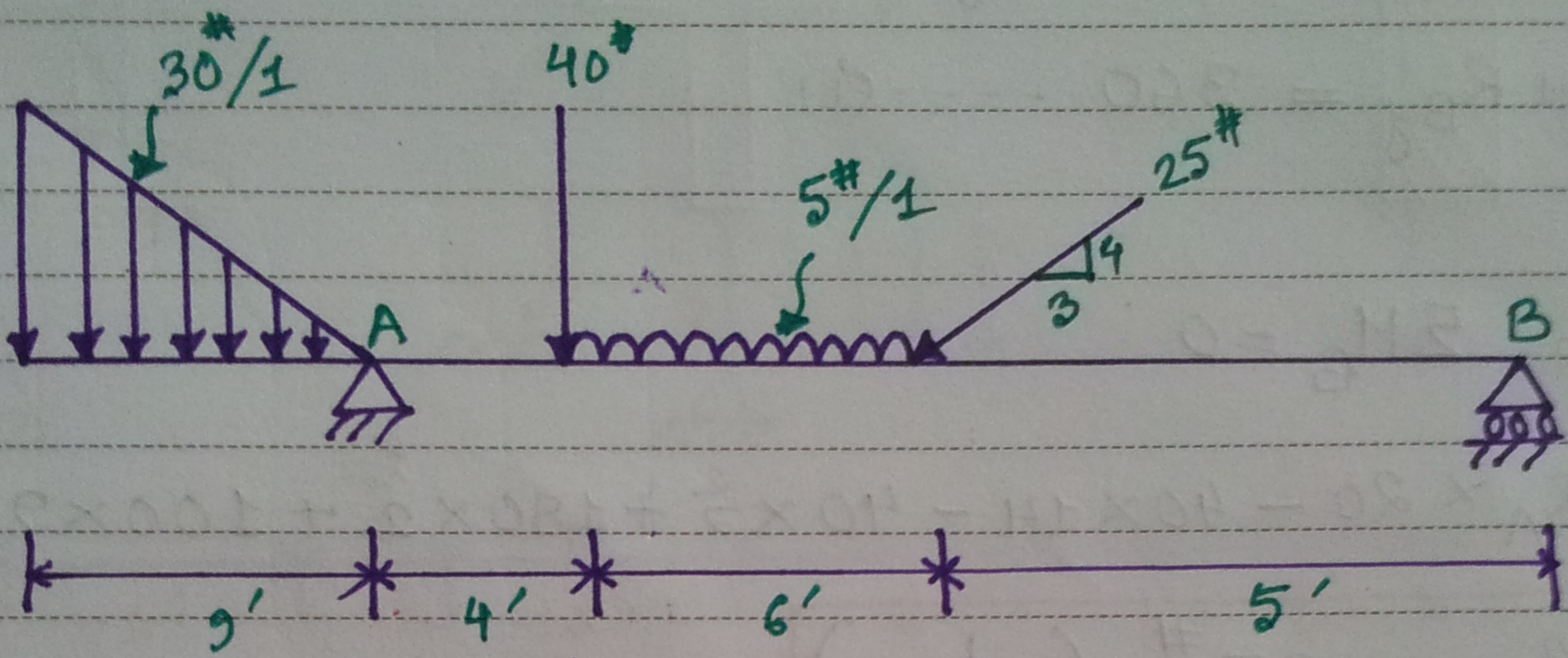
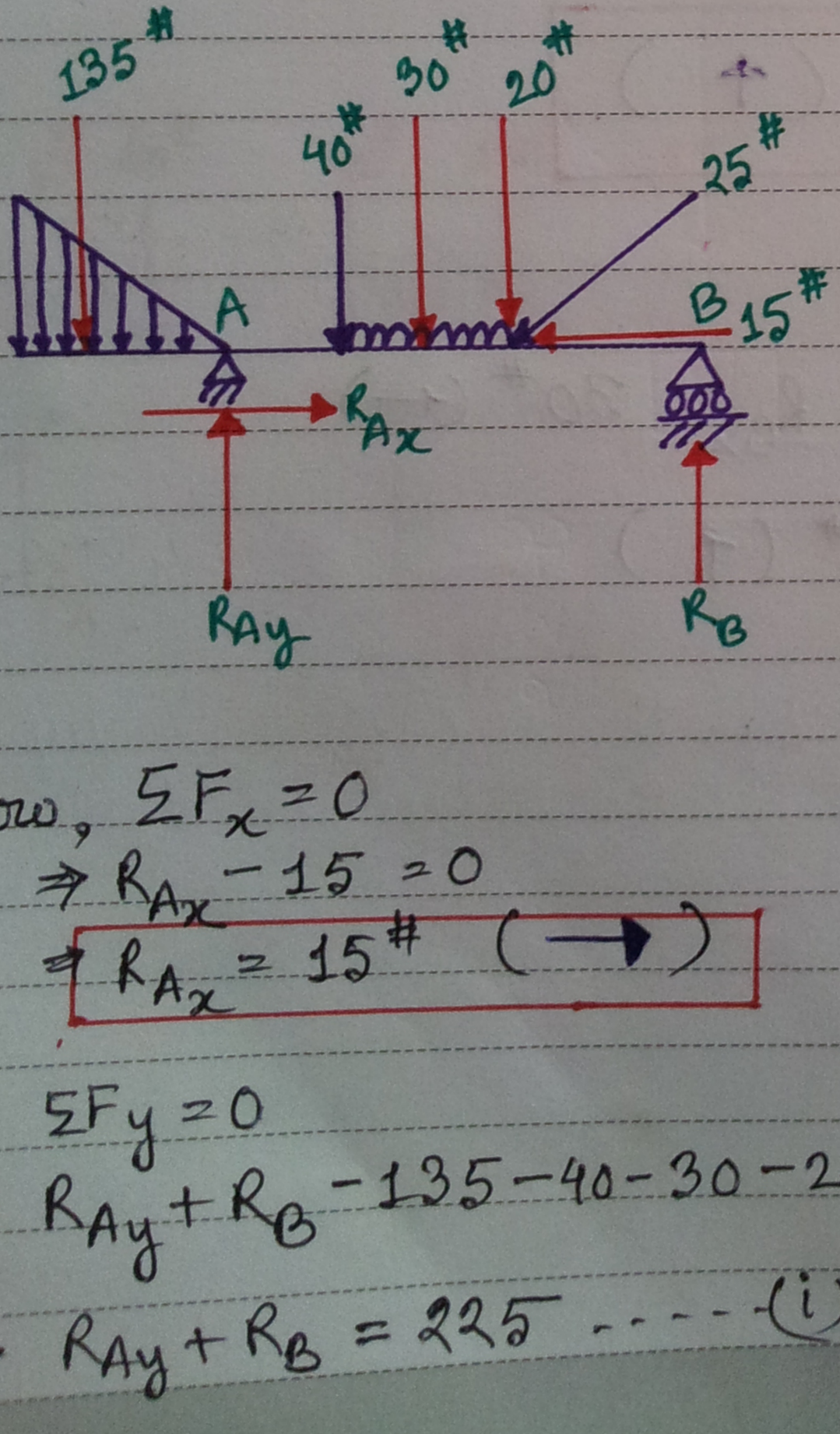
Problem:-2 Find out the reactions of A & B.



Soln:



Now, $\Sigma F_x = 0$

$\Rightarrow R_{Ax} - 15 = 0$

$\Rightarrow \boxed{R_{Ax} = 15^{\#} \ (\rightarrow)}$

& $\Sigma F_y = 0$

$\Rightarrow R_{Ay} + R_B - 135 - 40 - 30 - 20 = 0$

$\Rightarrow R_{Ay} + R_B = 225$ ----(i)

Again, $\Sigma M_A = 0$

$\Rightarrow -135 \times 6 + 40 \times 4 + 30 \times 7 + 20 \times 10 - R_B \times 15 = 0$

$\Rightarrow \boxed{R_B = -16^{\#} \ (\downarrow)}$

From eqn (i) we get,

$\boxed{R_{Ay} = 225 + 16 = 241^{\#} \ (\uparrow)}$

Ans: $R_{Ax} = 15^{\#} \ (\rightarrow)$; $R_{Ay} = 241^{\#} \ (\uparrow)$

$R_B = 16^{\#} \ (\downarrow)$.

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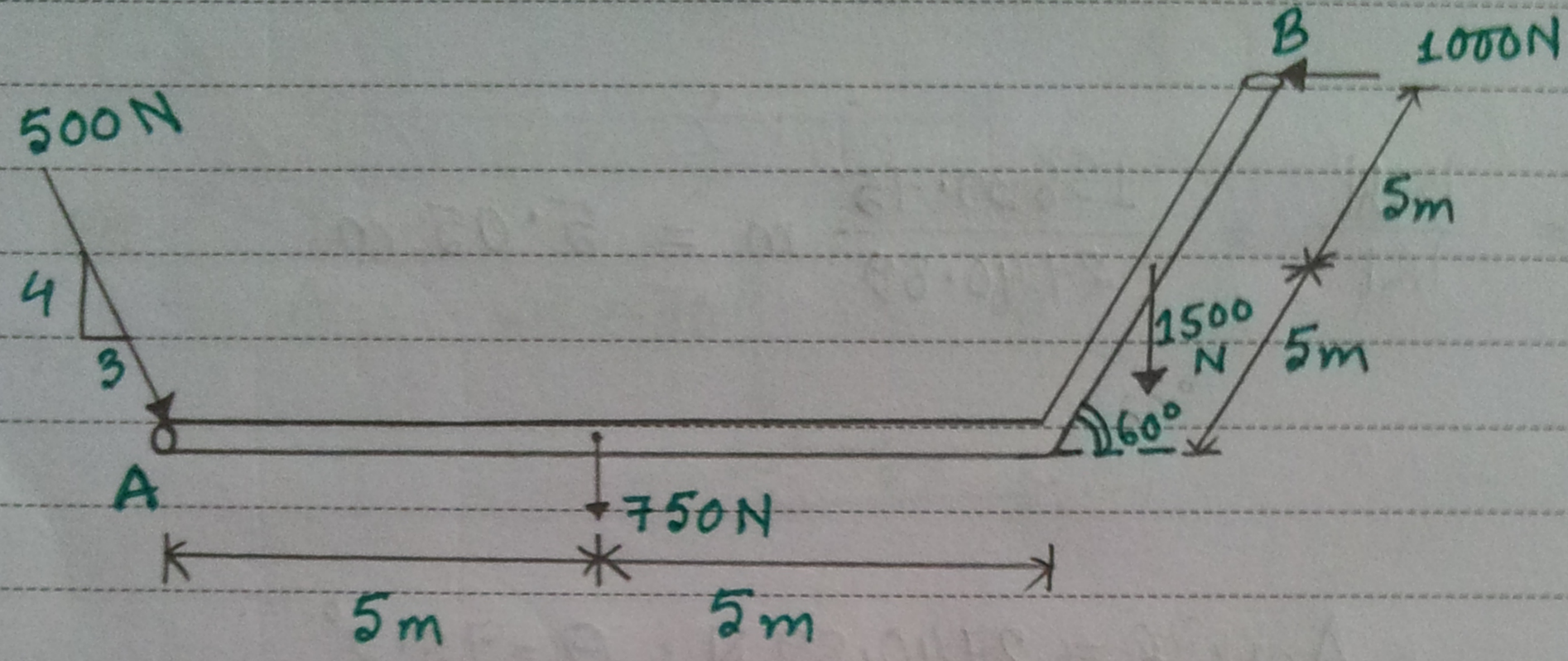
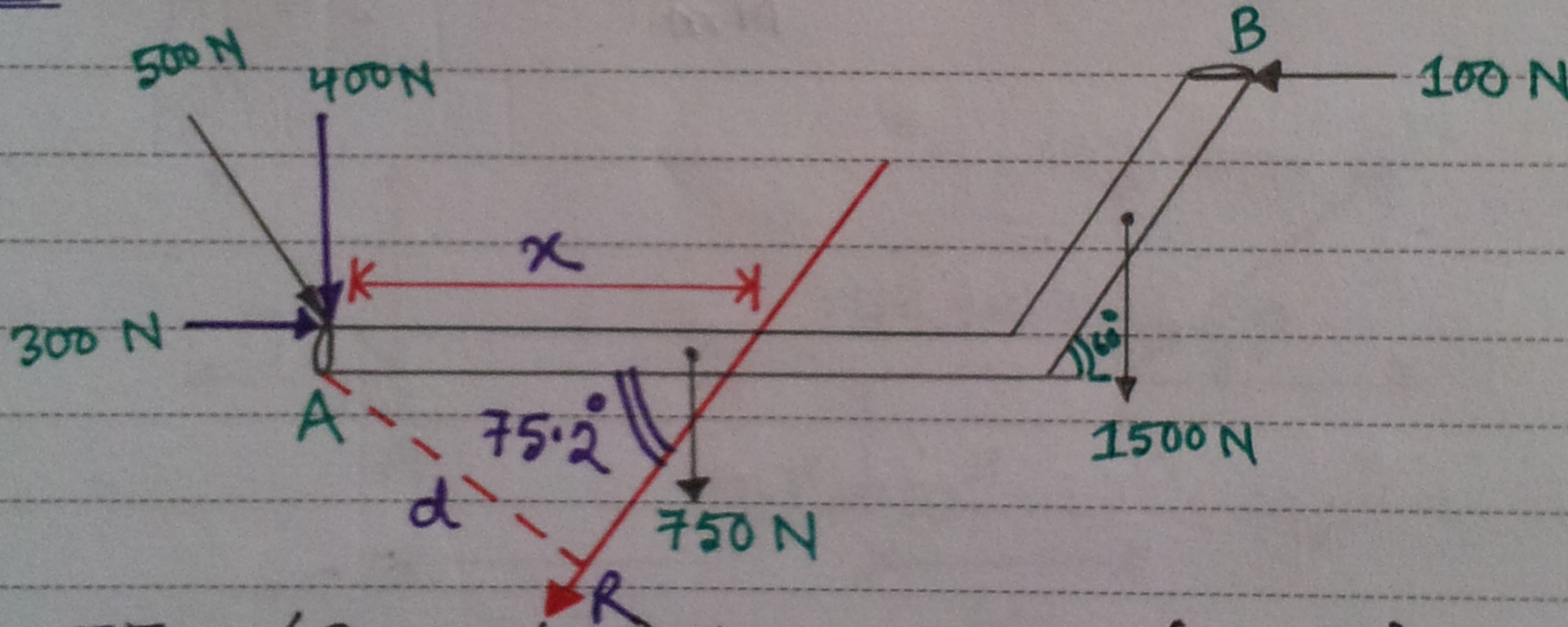
Problem:-3 Calculate R with direction and the moment.



Soln:



Now, $\Sigma F_x = (300 - 1000)\,N = -700\,N$ (←)

& $\Sigma F_y = (-400 - 750 - 1500)\,N = -2650\,N$ (↓)

$\therefore \theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right)$:

$\Rightarrow \theta = \tan^{-1}\left(\frac{2650}{700}\right)$

$\therefore \theta = 75.2^0$

& $R = \sqrt{(700)^2 + (2650)^2}\,N = 2740.89\,N$

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Again, $\Sigma M_A = 750 \times 5 + 1500 \times (10 + 5\cos 60^\circ) - 1000 \times 10 \sin 60^\circ$

$= 13839.75$ Nm

$\therefore d = \frac{|\Sigma M_A|}{|R|} = \frac{13839.75}{2740.89}$ m $= 5.05$ m

Ans: $R = 2740.89$ N ; $\theta = 75.2^\circ$

& $\Sigma M = 13839.75$ Nm ; $d = 5.05$ m

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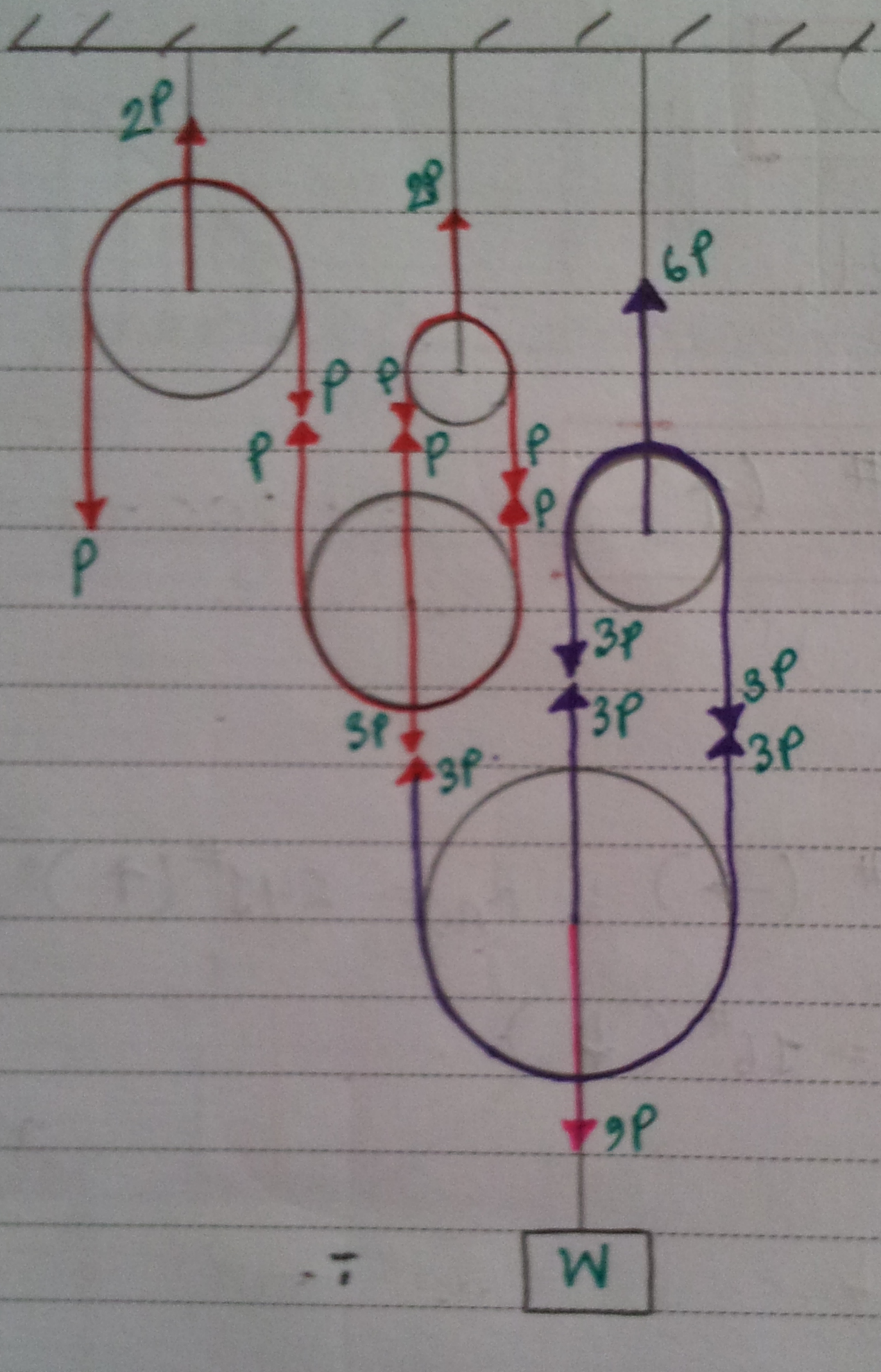
Q. P is what fraction of W ??

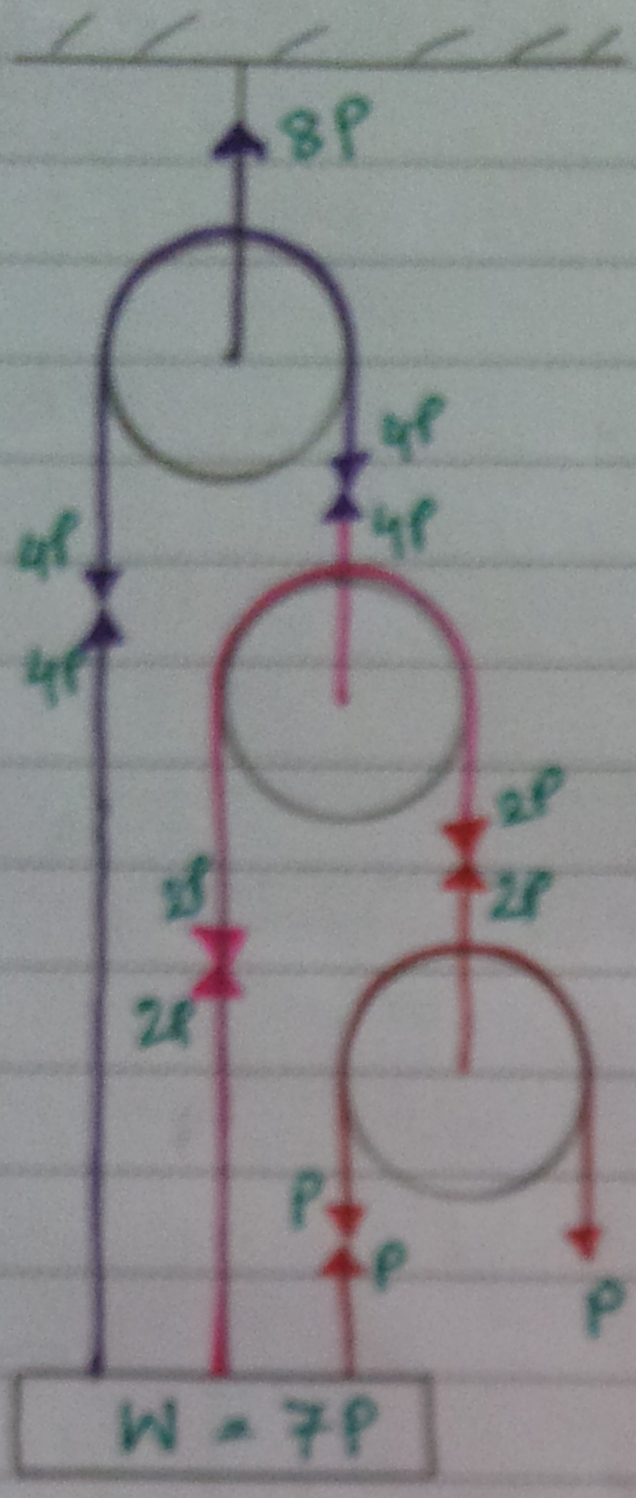
(1)



$\therefore$ So, $W = 9P$

$\Rightarrow P = \frac{W}{9}$

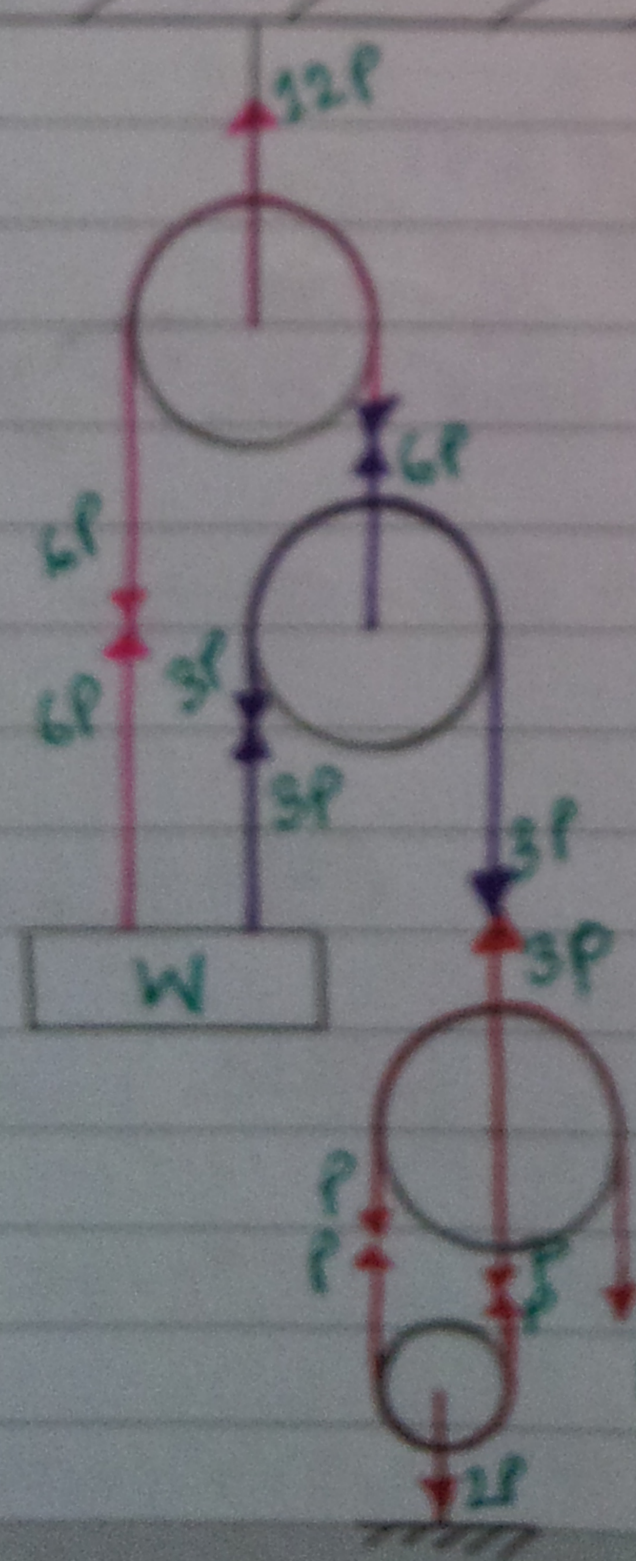
(2)



$W = 7P$

$\therefore P = \frac{W}{7}$.

(3)



$\therefore W = 9P$

$\Rightarrow P = \frac{W}{9}$

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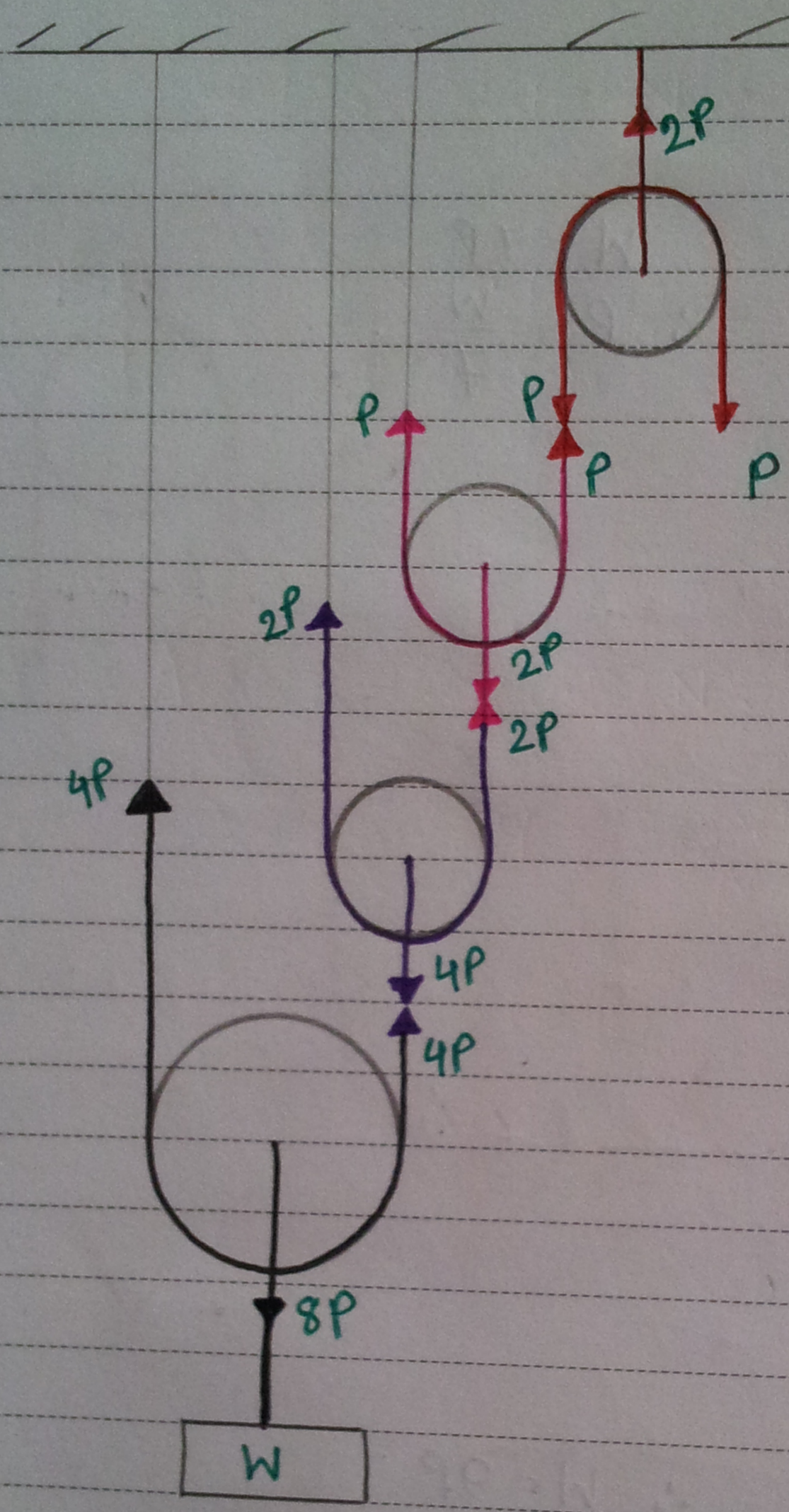
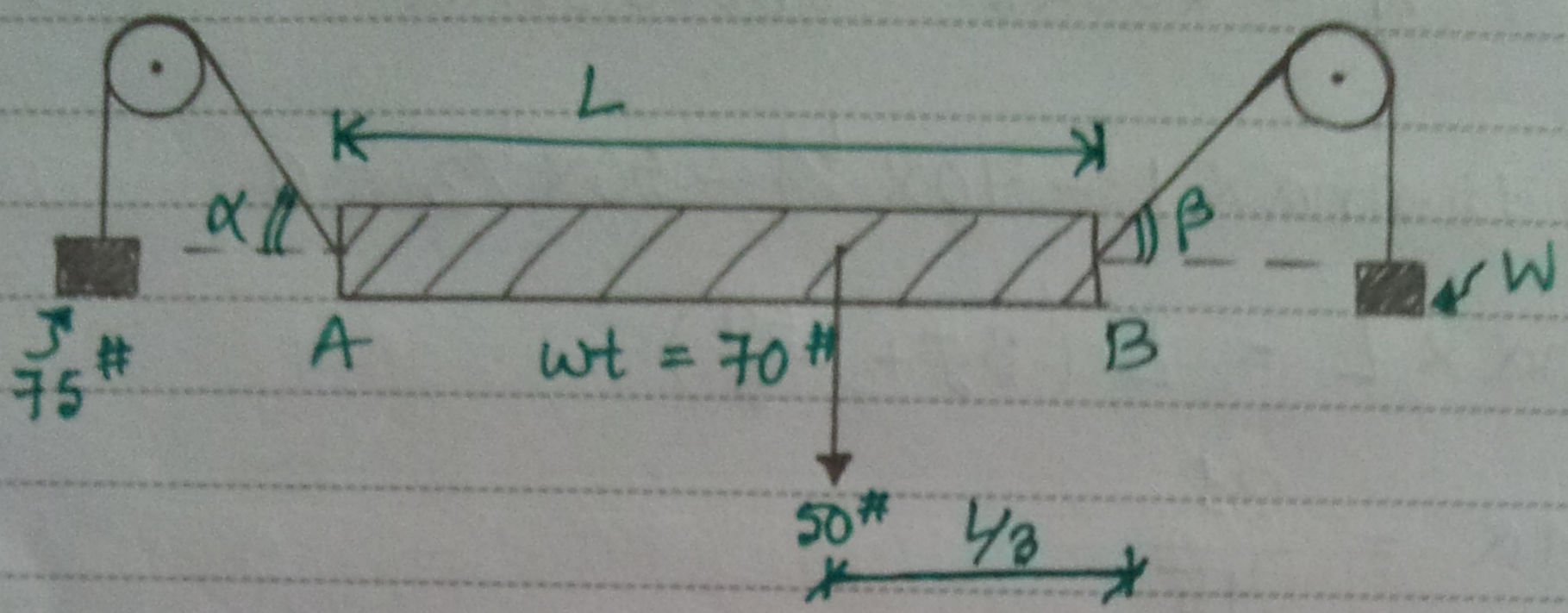
(4)



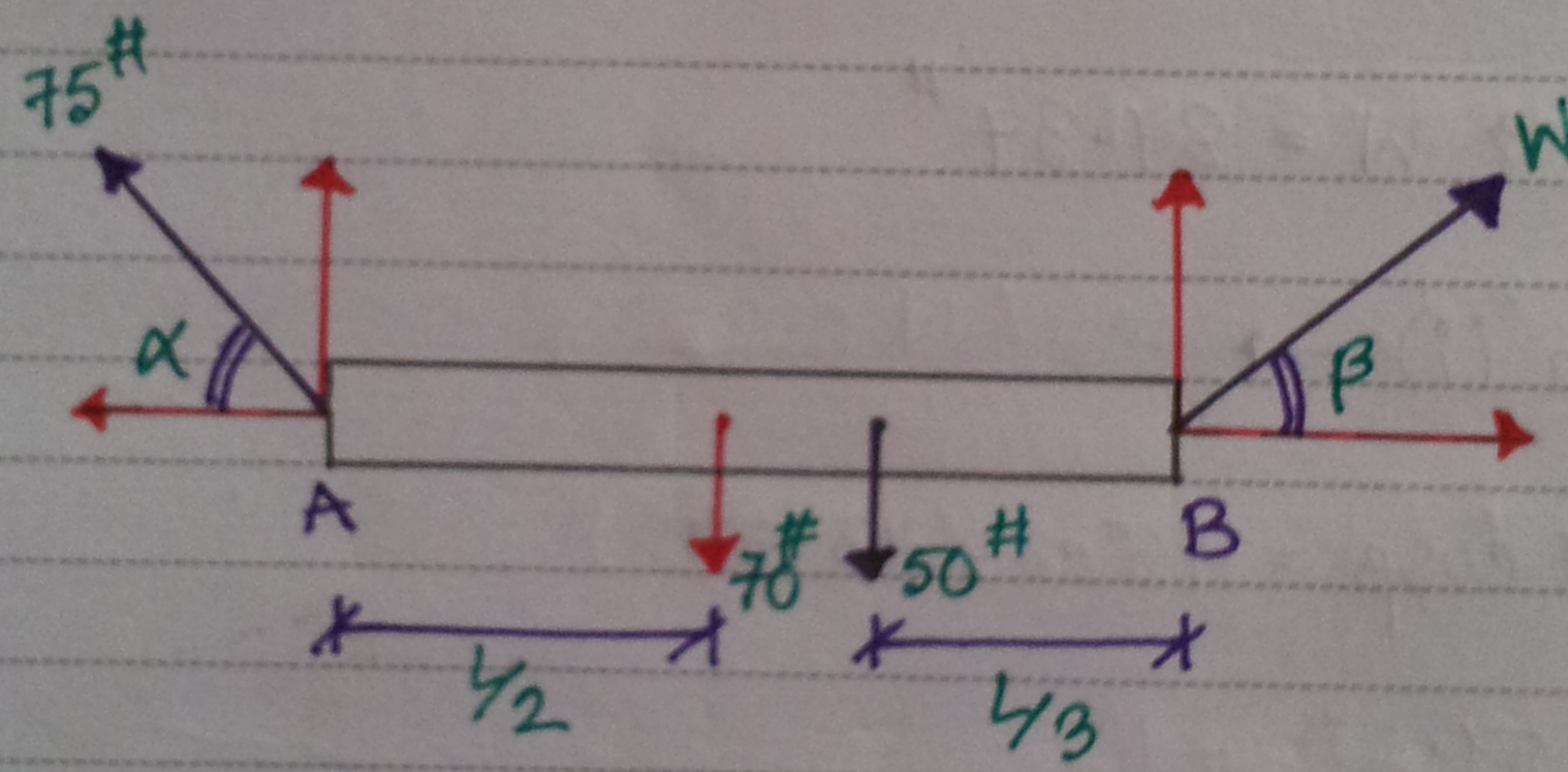
$\therefore \quad W = 8P$

Or, $P = \frac{W}{8}$

Problem :-4 Find out α, β, W.



Sol^n :-



In case of equilibrium —

Now, $\Sigma F_x = -75\cos\alpha + W\cos\beta = 0$

$\Rightarrow W\cos\beta = 75\cos\alpha$ ----(i)

& $\Sigma F_y = 0$

$\Rightarrow 75\sin\alpha - 120 + W\sin\beta = 0$

$\Rightarrow W\sin\beta = 120 - 75\sin\alpha$ ---(ii)

$(i)^2 + (ii)^2 \longrightarrow W^2 = (75)^2 + (120)^2 - 2\times 75\times 120\sin\alpha$

$\Rightarrow W^2 = 20025 - 18000\sin\alpha$ ----(iii)

Now, $\Sigma M_B = 75\sin\alpha \times L - 70\times L/2 - 50\times L/3 = 0$

$\Rightarrow 75\sin\alpha \times L = L\left(35 + \frac{50}{3}\right)$

$\Rightarrow \sin\alpha = \frac{31}{45}$

$\therefore \alpha = 43.54^\circ$

From eqn (iii) $\longrightarrow W^2 = 20025 - 18000\sin(43.5^\circ)$

$\rightarrow W = 87.37^{\#}$

& From eqn (i) $\rightarrow$

$87.37\cos\beta = 75\cos(43.5^\circ)$

$\rightarrow \beta = 51.5^\circ$

Ans: $\alpha = 43.5^\circ$; $\beta = 51.5^\circ$

$W = 87.37^{\#}$

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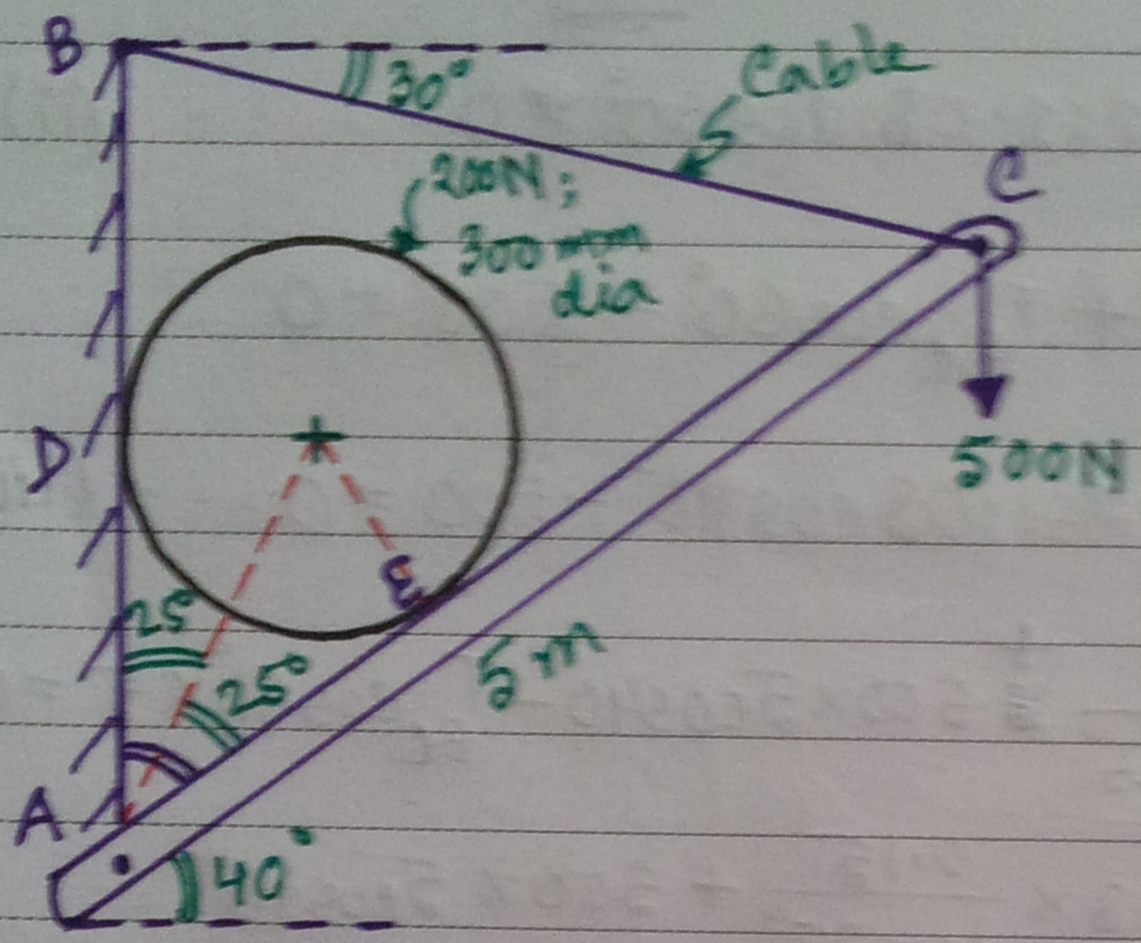
Problem:-5 Find out the reactions at A & B and the tension of the cable.



Soln:

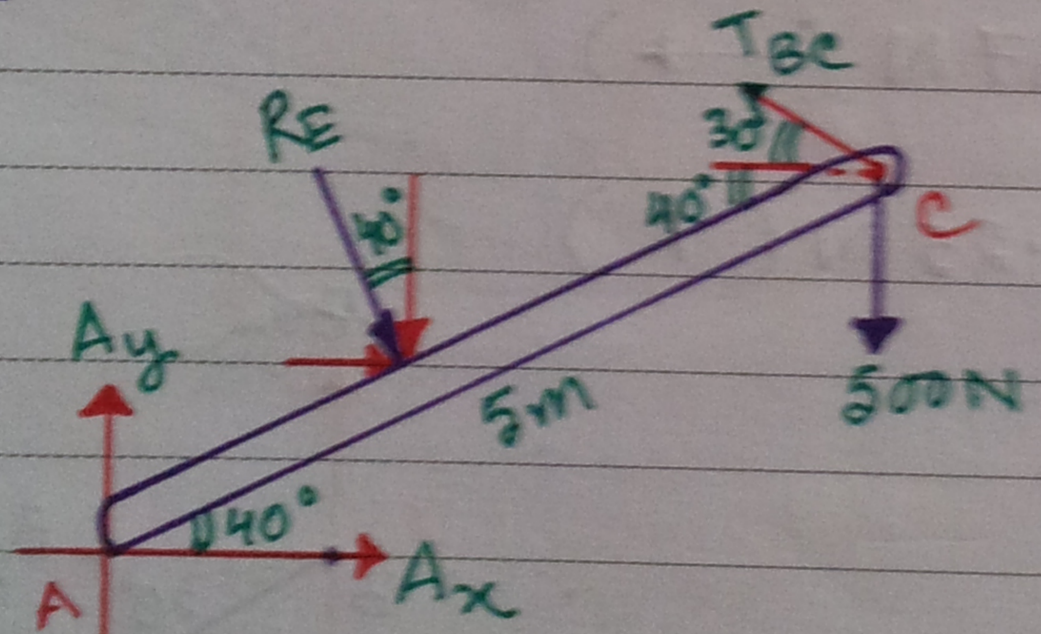


Figure-1

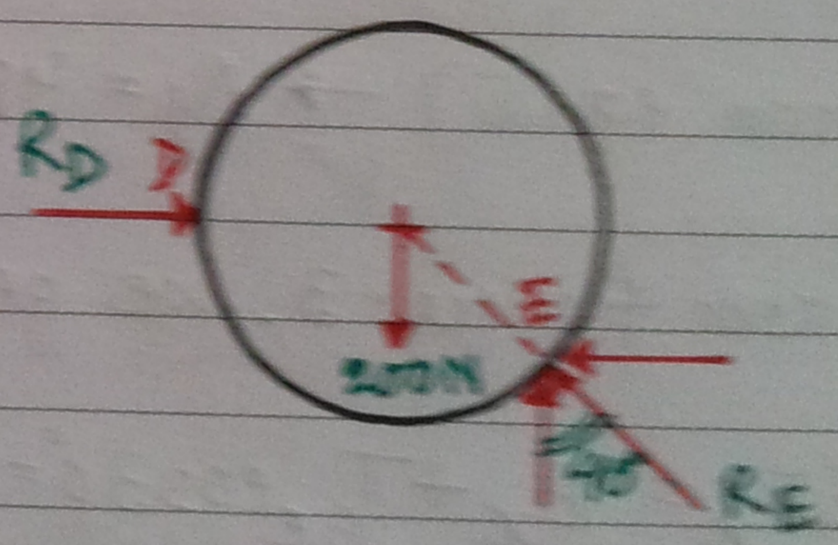


Figure-2

From figure-2 we get,

$$\Sigma F_x = R_D - R_E \cos 50^\circ = 0 \quad ---(i)$$

$$\& \Sigma F_y = R_E \cos 40^\circ - 200 = 0 \Rightarrow R_E = 261.08\,N$$

So, from (i) $\rightarrow$ $R_D = 167.82\,N$

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From figure-1, we get,

$$\Sigma F_x = A_x + R_E \cos 50^\circ - T_{BC} \cos 30^\circ = 0$$

$$\Rightarrow A_x - T_{BC} \cos 30^\circ + 261.08 \cos 50^\circ = 0 \quad \text{---(ii)}$$

$$\& \Sigma F_y = A_y - R_E \cos 40^\circ + T_{BC} \cos 60^\circ - 500 = 0$$

$$\Rightarrow A_y + T_{BC} \cos 60^\circ - 261.08 \cos 40^\circ - 500 = 0 \quad \text{---(iii)}$$

Again, $\Sigma M_A = R_E \times \frac{0.15}{\tan 25^\circ} + 500 \times 5 \cos 40^\circ - T_{BC} \cos 20^\circ \times 5 = 0$

$$\Rightarrow T_{BC} \cos 20^\circ \times 5 = 261.08 \times \frac{0.15}{\tan 25^\circ} + 500 \times 5 \cos 40^\circ$$

$$\therefore T_{BC} = 425.5 \text{ N}$$

From eq.(ii) $\rightarrow A_x = 200.67$ N ($\rightarrow$)

From eq(iii) $\rightarrow A_y = 487.25$ N ($\uparrow$)

From figure-2, we get,

$$\Sigma F_x = B_x + T_{BC} \cos 30^\circ = 0$$

$$\Rightarrow B_x = -368.5 \text{ N} \ (\leftarrow)$$

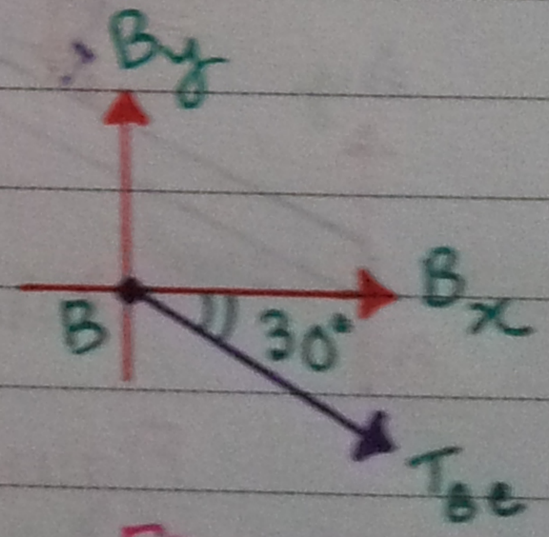

Figure-3

$$\& \Sigma F_y = B_y - T_{BC} \cos 60^\circ = 0$$

$$\Rightarrow B_y = 212.75 \text{ N} \ (\uparrow)$$

Ans: $A_x = 200.67$ N ($\rightarrow$); $A_y = 487.25$ N ($\uparrow$); $B_x = 368.5$ N ($\leftarrow$)
$B_y = 212.75$ N ($\uparrow$); $T_{BC} = 425.5$ N.

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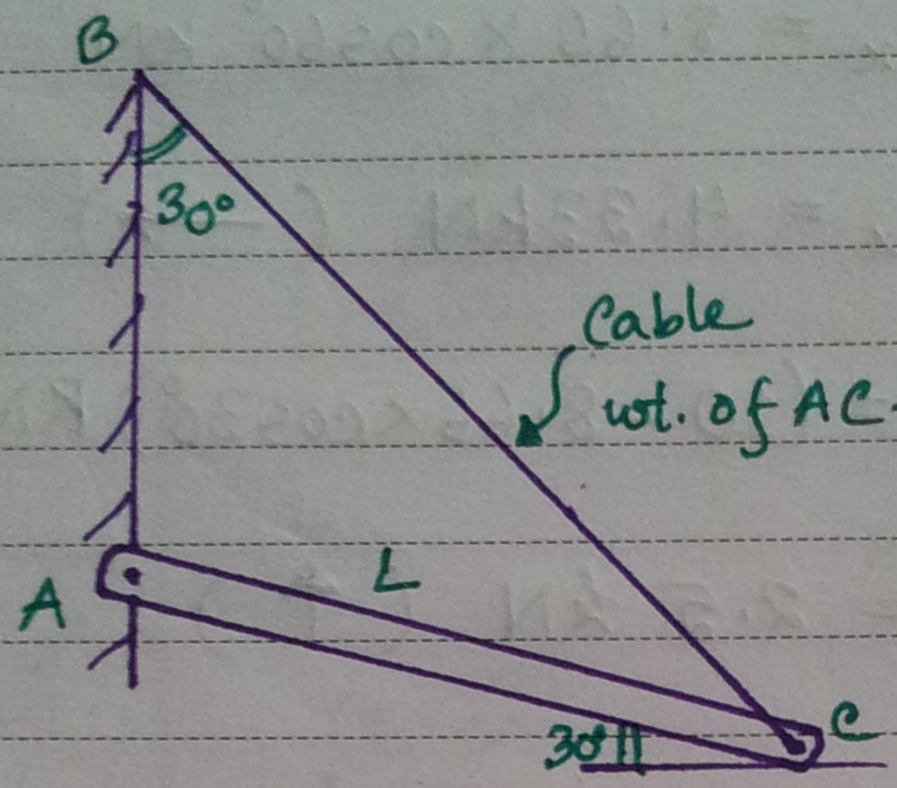
Problem: 6 Find out the reactions at A & B and the tension of the cable.



Soln:

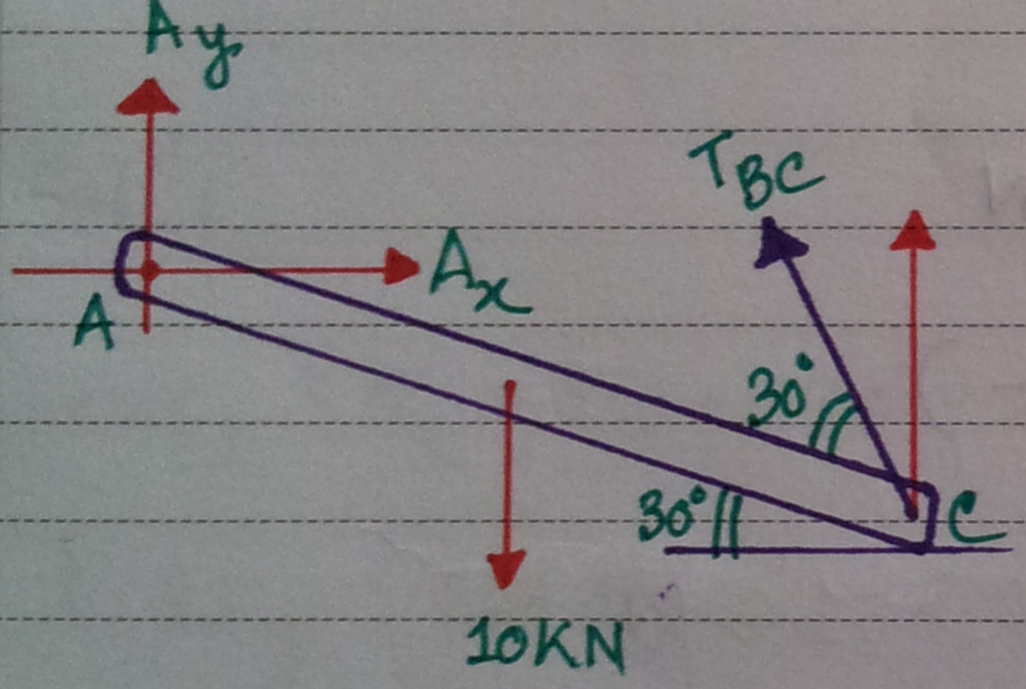


Figure-1

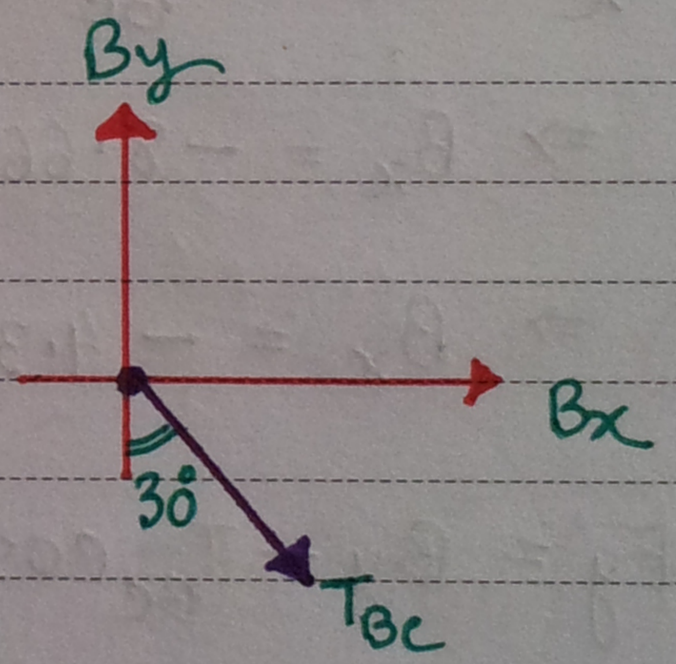


Figure-2

From figure-1 we get,

$\Sigma F_x = A_x - T_{BC}\cos 60^\circ = 0$ ----(i)

& $\Sigma F_y = A_y - 10 + T_{BC}\cos 30^\circ = 0$ ----(ii)

& $\Sigma M_A = 10 \times L/2 \cos 30^\circ + T_{BC}\cos 60^\circ \times L \sin 30^\circ - T_{BC}\cos 30 \times L\cos 30^\circ = 0$

$\Rightarrow 5\cos 30^\circ + T_{BC}\cos 60^\circ \sin 30^\circ - T_{BC}\cos^2 30^\circ = 0$

$\Rightarrow T_{BC} = 8.66\ kN$

From eqn (i) $\rightarrow$ $A_x = 8.66 \times \cos 60^\circ\ kN$

$\Rightarrow A_x = 4.33 kN\ (\rightarrow)$

& eqn (ii) $\rightarrow$ $Ay = (10 - 8.66 \times \cos 30^\circ)\ kN$

$\Rightarrow Ay = 2.5\ kN\ (\uparrow)$

Again From figure - 2 we get,

$\Sigma F_x = B_x + T_{BC} \cos 60^\circ = 0$

$\Rightarrow B_x = -8.66 \times \cos 60^\circ\ kN$

$\Rightarrow B_x = -4.33\ kN\ (\leftarrow)$

& $\Sigma Fy = By + T_{BC} \cos 30^\circ = 0$

$\Rightarrow By = 8.66 \times \cos 30^\circ\ kN$

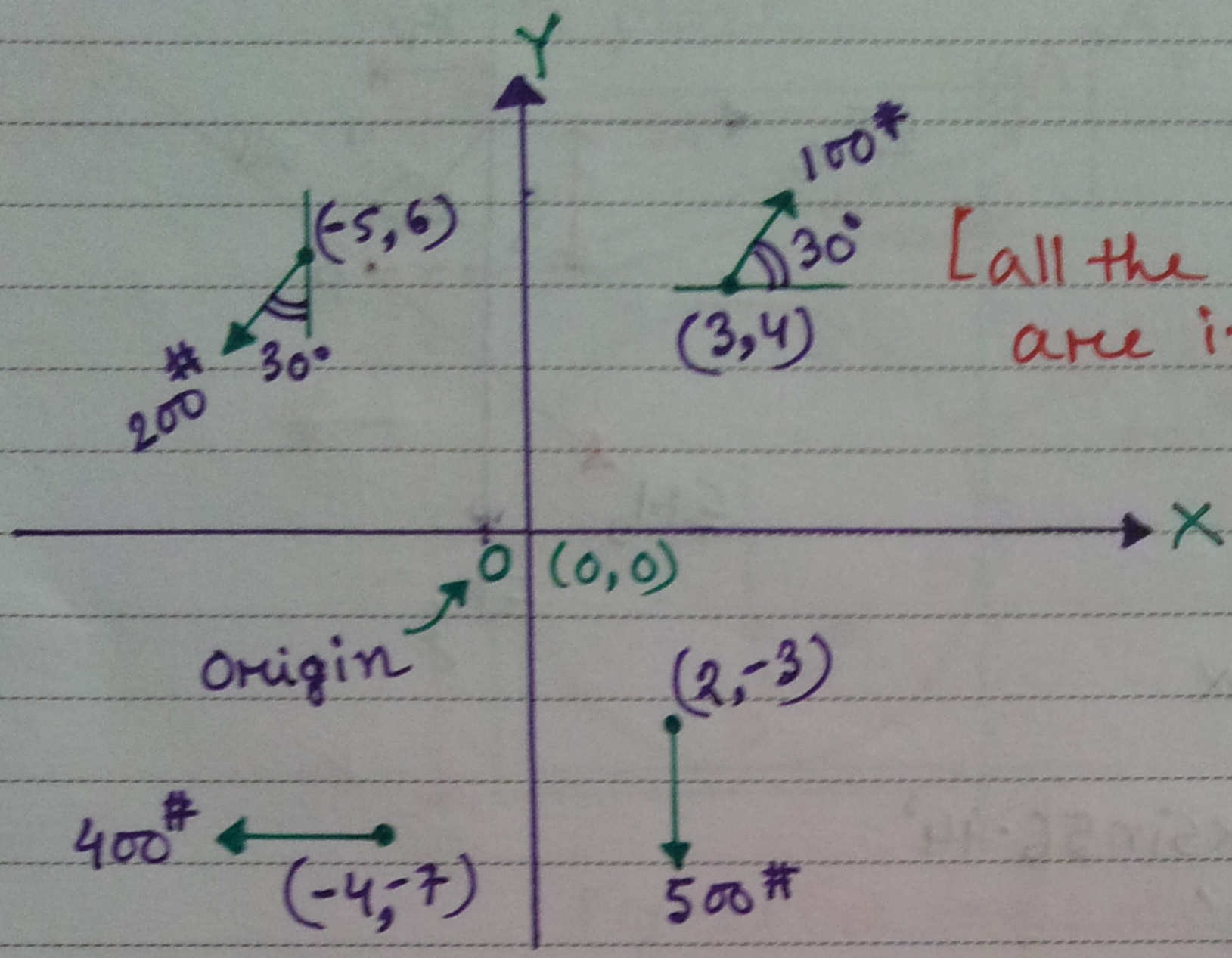
$\rightarrow By = 7.5\ kN\ (\uparrow)$

Ans: $A_x = 4.33\ kN(\rightarrow)$; $Ay = 2.5\ kN\ (\uparrow)$

$B_x = -4.33\ kN(\leftarrow)$; $By = 7.5\ kN(\uparrow)$

$T_{Be} = 8.66\ kN$.

Problem: 7 Find out the co-ordinate of P.



[all the dimensions are in foot]

Sol^{n}:

Here, $\Sigma F_x = 100\cos 30^\circ - 200\cos 60^\circ - 400 = -413.4^{\#}$ (←)

& $\Sigma F_y = 100\cos 60^\circ - 200\cos 30^\circ - 500 = -623.2^{\#}$ (↓)

Now, $\Sigma M_o = 100\cos 30^\circ \times 4 - 100\cos 60^\circ \times 3 - 200\cos 30^\circ \times 5$
$- 200\cos 60^\circ \times 6 + 400 \times 7 + 500 \times 2$

$= 2530.38^{\#}$ (↙)

$\therefore R = \sqrt{(-413.4)^2 + (-623.2)^2}^{\#} = 747.85^{\#}$

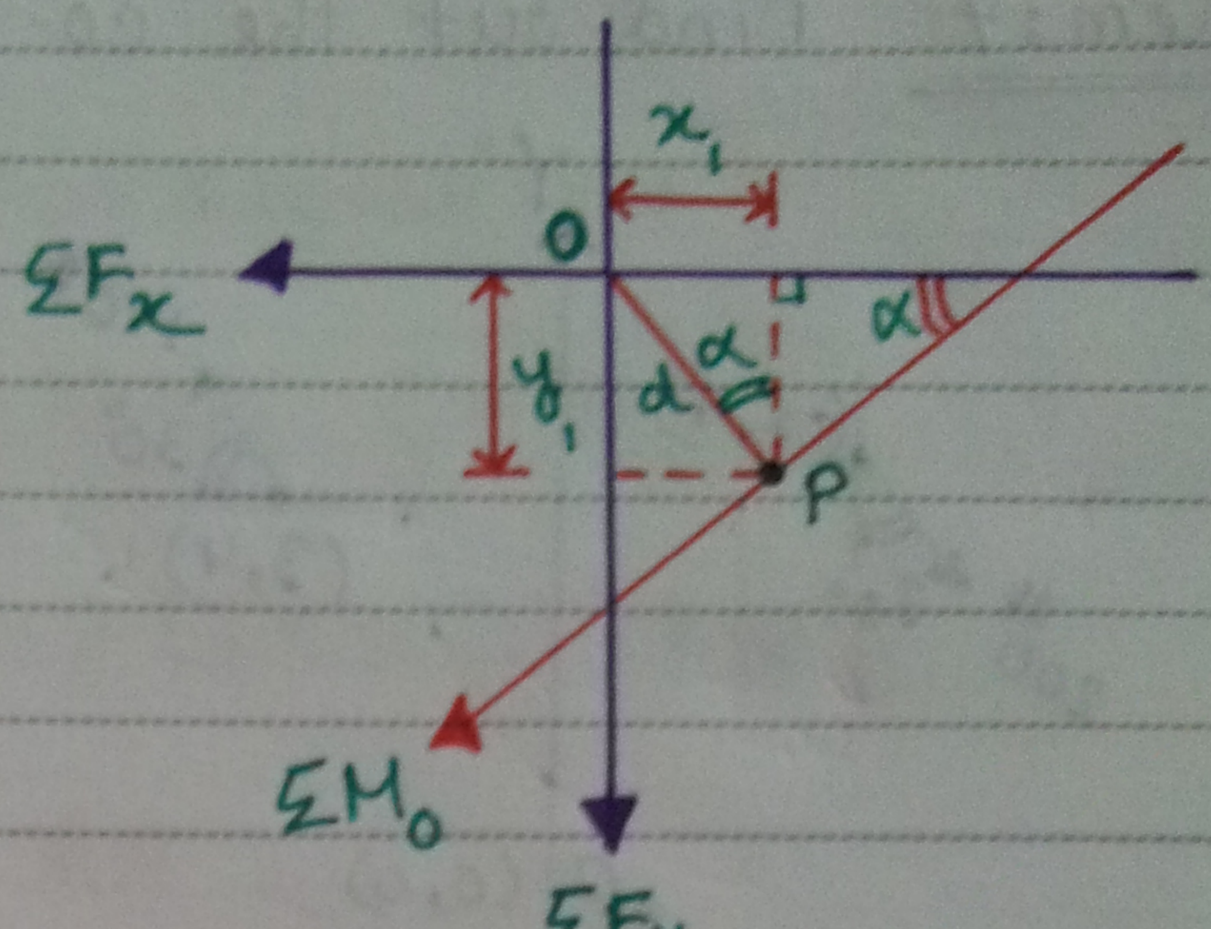
& $\alpha = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{-623.2}{-413.4}\right) = 56.44^\circ$

We know,

$$d = \frac{|\Sigma M_o|}{|R|}$$

$$= \left(\frac{2530.38}{747.85}\right)'$$

$$= 3.38'$$



Now, $x_1 = d\sin\alpha$

$= 3.38' \times \sin 56.44^\circ$

$= 2.82'$

& $y_1 = d\cos\alpha$

$= 3.38' \times \cos 56.44^\circ$

$= 1.87'$

∴ Co-ordinate of P = (2.82, −1.87)

Ans: (2.82, −1.87).

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Problem: 8 Find out the reactions of the pin and smooth plane.

(Fairies 265)

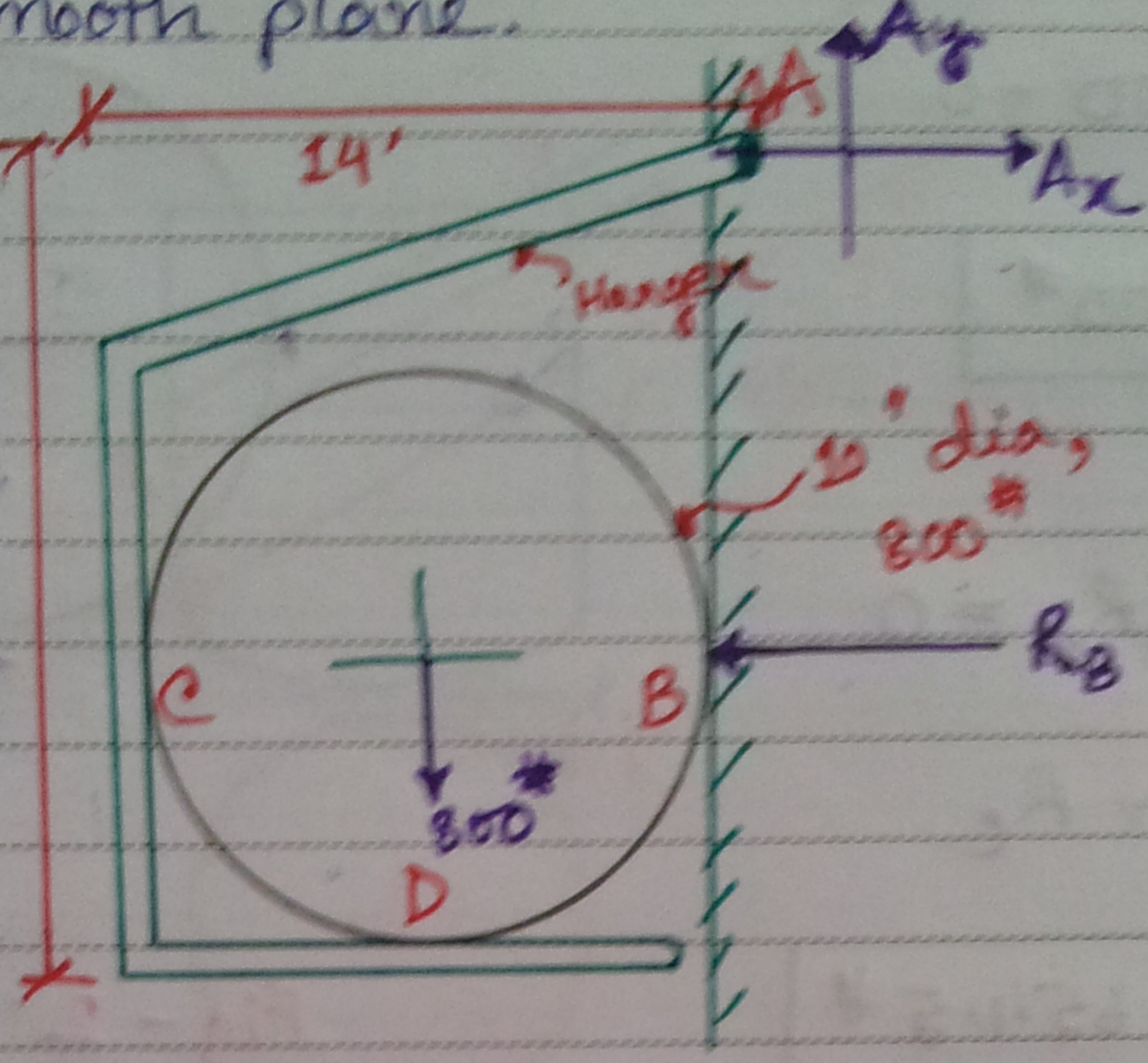

Fig-1: Full free body diagram

Sol^n:

From figure-1,

$$\Sigma F_x = -R_B + A_x = 0 \Rightarrow A_x = R_B \quad \text{----(i)}$$

$$\Sigma F_y = A_y - 800 = 0$$

$$\therefore A_y = 800\# \ (\uparrow)$$

& $\Sigma M_A = -800 \times 9 + R_B \times 11 = 0$

$$\Rightarrow R_B = 654.5\#$$

$\therefore$ from eq^n (i);

$$A_x = R_B = 654.5\#$$

$$\therefore A_x = 654.5\#$$

From figure (2),

$\Sigma F_y = R_D - 800 = 0$

$\therefore R_D = 800^{\#}$

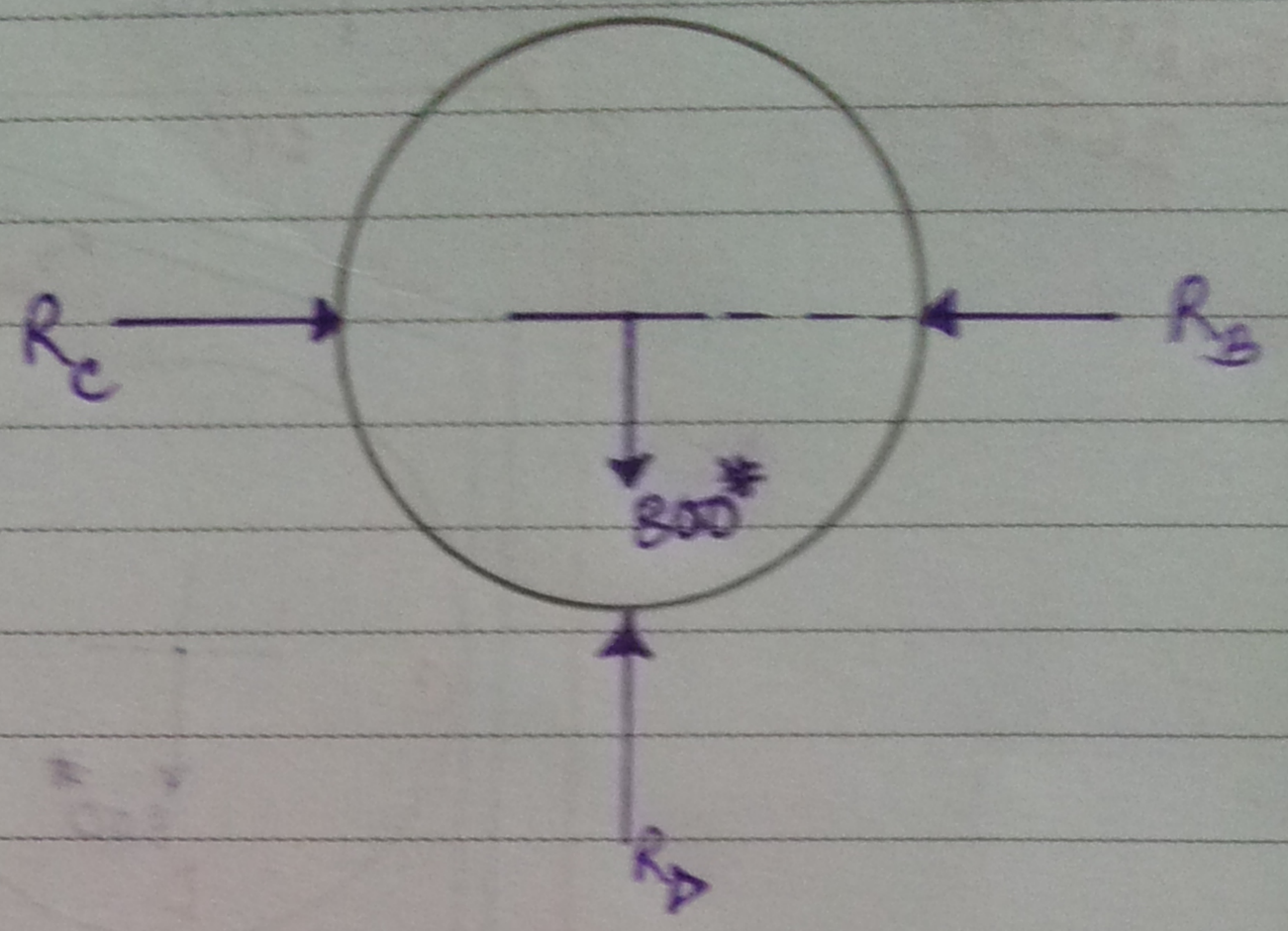

Fig - 2

& $\Sigma F_x = -R_B + R_C = 0$

$\Rightarrow R_B = R_C$

$\therefore R_C = 654.5^{\#}$

Ans: $A_x = 654.5^{\#}$; $A_y = 800^{\#}$

$R_B = 654.5^{\#}$; $R_C = 654.5^{\#}$; $R_D = 800^{\#}$

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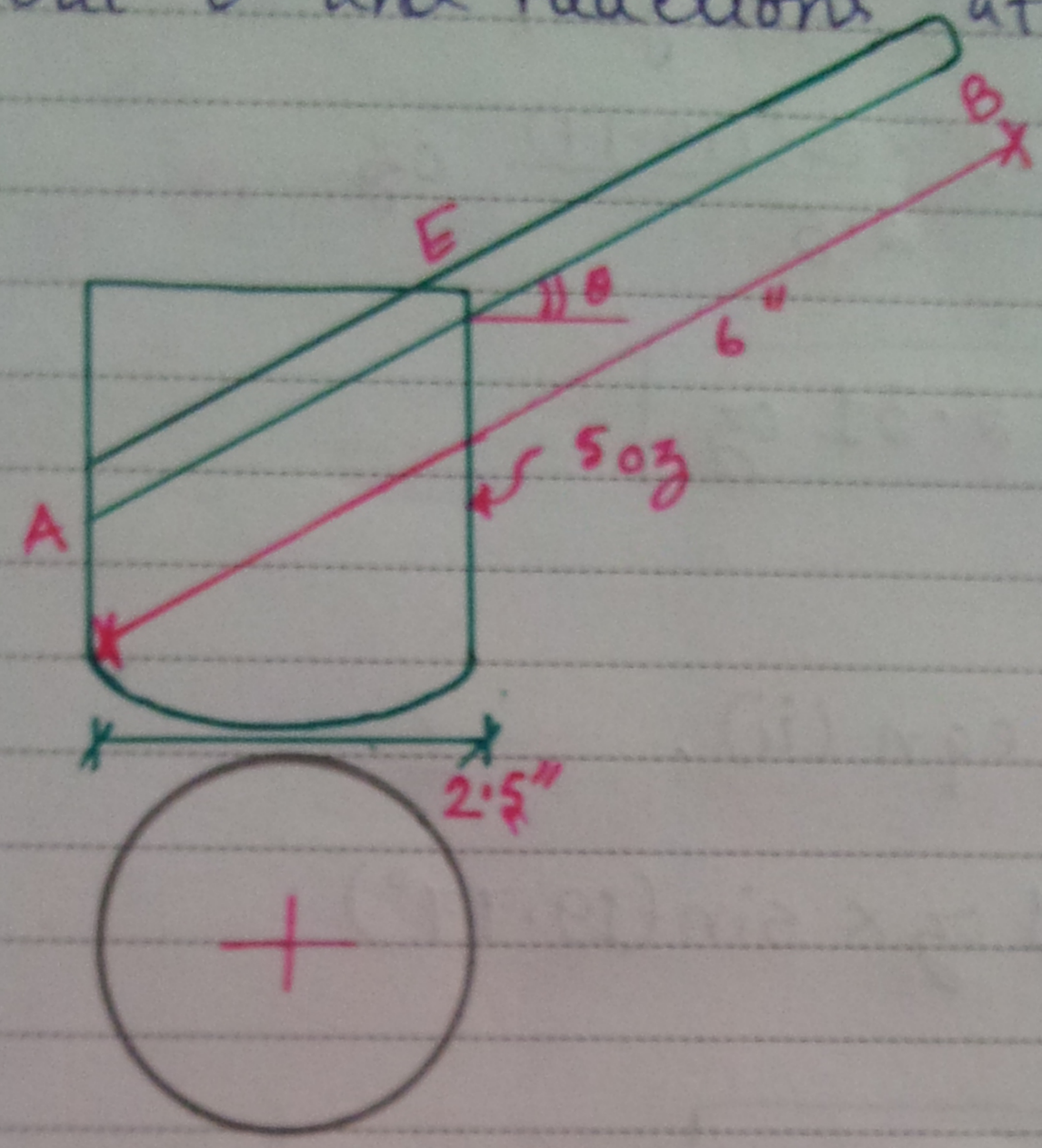
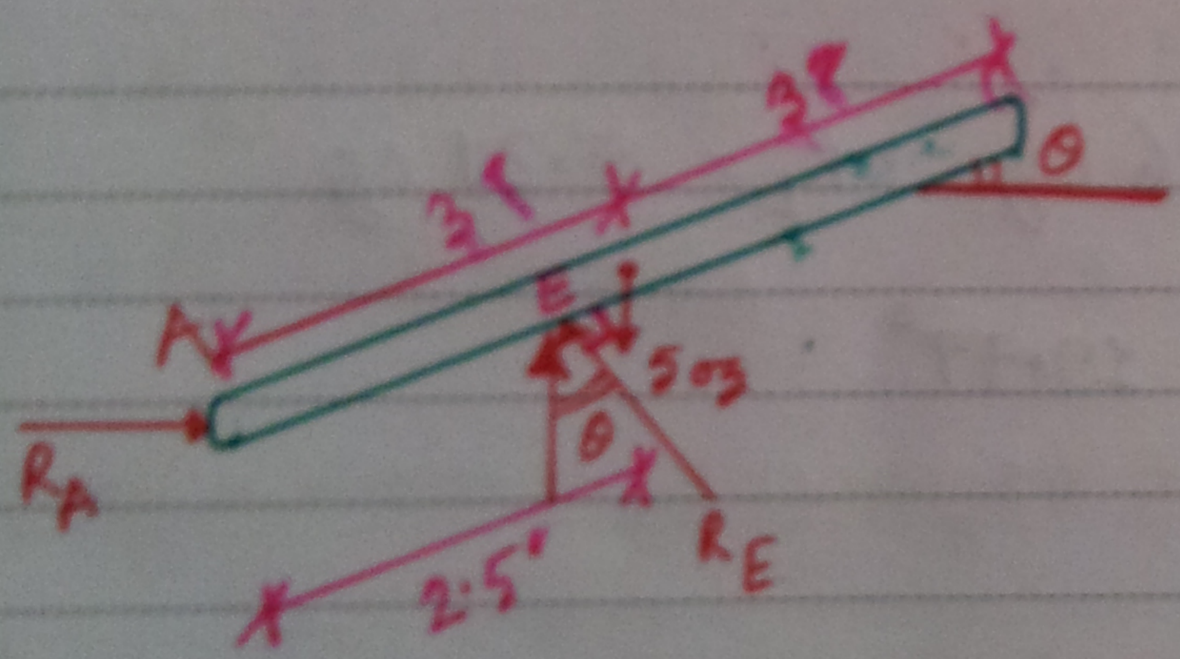
Problem: 9 Find out θ and reactions at A & E.

(Fairies 261)



Solution:



From figure -

$$\Sigma F_y = -5 + R_E \cos\theta = 0 \quad \text{---(i)}$$

$$\Sigma F_x = R_A - R_E \sin\theta = 0 \quad \text{---(ii)}$$

$$\& \ \Sigma M_A = 5 \times 3\cos\theta - R_E \times \frac{2.5}{\cos\theta} = 0$$

$$\therefore R_E = \frac{15\cos^2\theta}{2.5} \quad \text{---(iii)}$$

from eqn (ii) we get,

$$-5 + \frac{15\cos^3\theta}{2.5} = 0 \quad \Rightarrow \boxed{\theta = 19.77^\circ}$$

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from eqn (iii) we get,

$$R_E = \frac{15 \times \cos^2(19.77)}{2.5} \text{ oz}$$

$$\therefore R_E = 5.31 \text{ oz}$$

Now, from eqn (ii),

$$R_A = 5.31 \text{ oz} \times \sin(19.77°)$$

$$\therefore R_A = 1.796 \text{ oz}$$

Ans: $R_A = 1.796$ oz ; $R_E = 5.31$ oz

$\theta = 19.77°$.

Subject :

Date : 2 Dimensional Frames

Sun Mon Tue Wed Thu Fri Sat

Problem : 10 Find out the pin reactions at A & B and the force of the member CF & DE if force member(s).

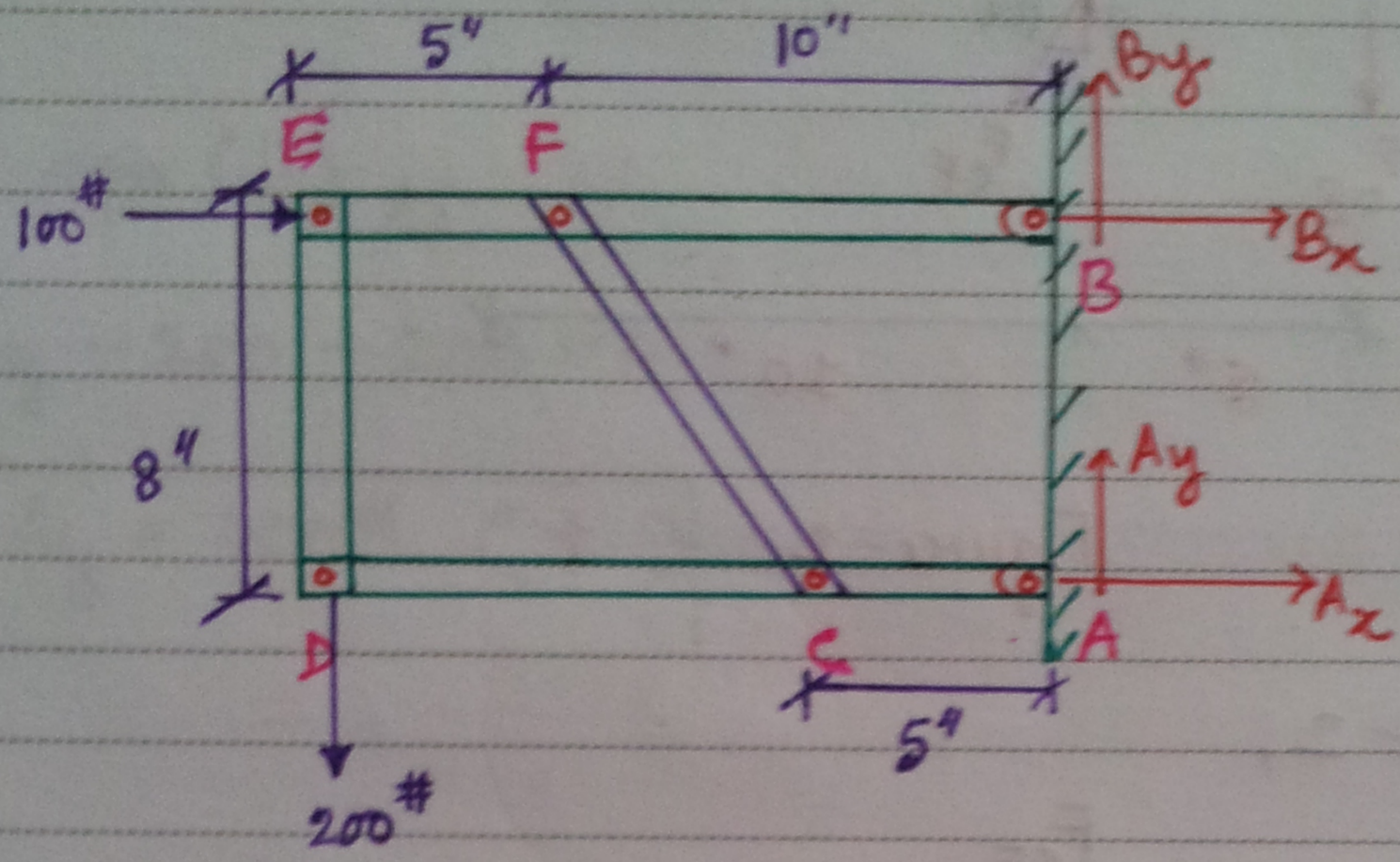

Figure-1

Soln: From figure-1,

$$\Sigma F_x = 100 + A_x + B_x = 0 \text{ ---(i)}$$

$$\Sigma F_y = -200 + A_y + B_y = 0 \text{ ---(ii)}$$

$$\Sigma M_B = -200 \times 15 - A_x \times 8 = 0$$

$$\Rightarrow A_x = -375^{\#} \ (\leftarrow)$$

from eqn (i), $B_x + 100 - 375 = 0$

$$\therefore B_x = 275^{\#} \ (\rightarrow)$$

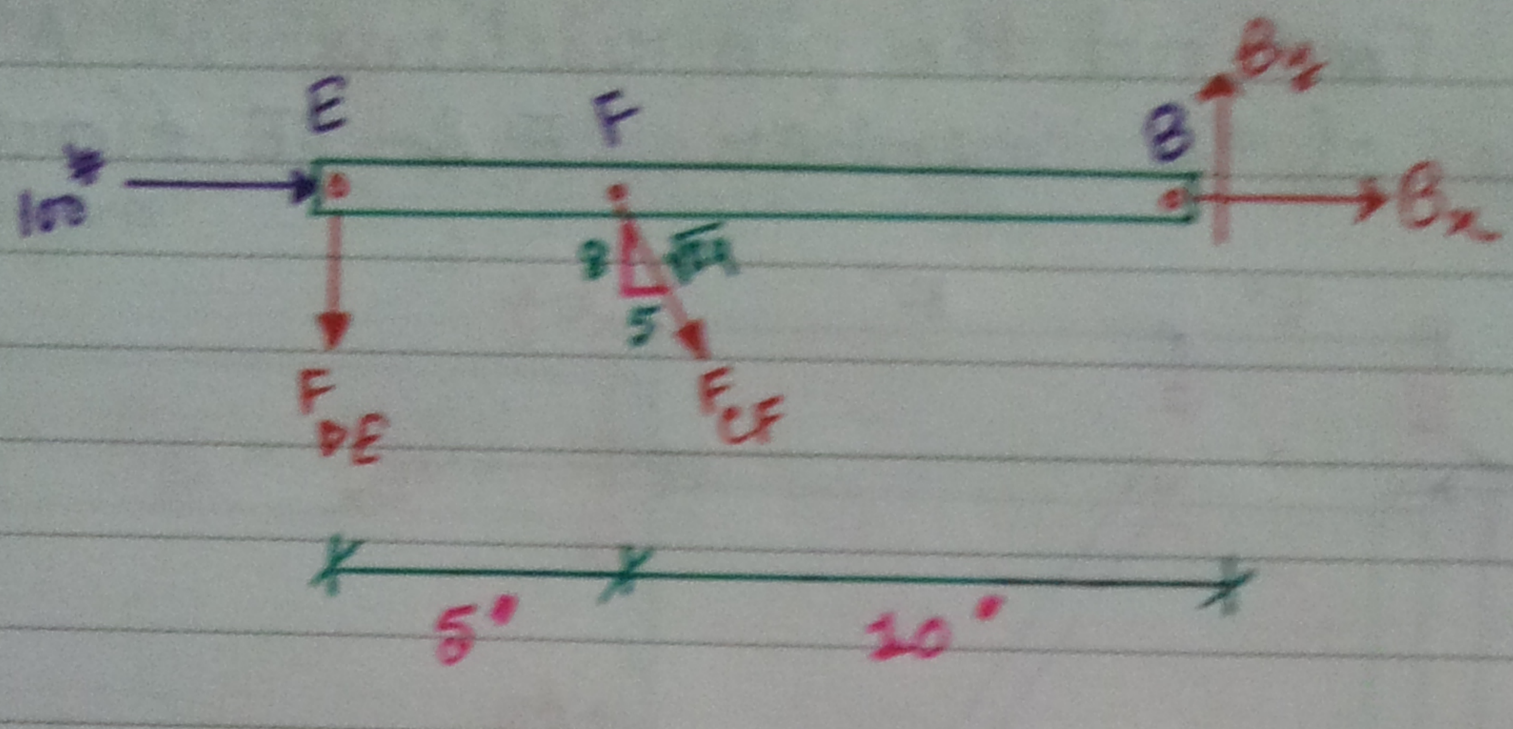

Figure-2

From figure-2,

$$\Sigma F_x = 100 + B_x + \frac{F_{CF}}{\sqrt{89}} \times 5 = 0$$

$$\Rightarrow 100 + 275 + \frac{F_{CF}}{\sqrt{89}} \times 5 = 0$$

$$\therefore F_{CF} = -707.55\,\#\ (C)$$

$$\Sigma F_y = -F_{DE} - \frac{F_{CF}}{\sqrt{89}} \times 8 + B_y = 0 \quad \text{---- (iii)}$$

$$\& \ \Sigma M_B = -F_{DE} \times 15 - \frac{F_{CF}}{\sqrt{89}} \times 8 \times 10 = 0$$

$$\Rightarrow -F_{DE} \times 15 + \frac{707.55}{\sqrt{89}} \times 80 = 0$$

$$\therefore F_{DE} = 400\,\#\ (T)$$

Now, from, eq (iii),

$$B_y - 400 + \frac{707.55}{\sqrt{89}} \times 8 = 0$$

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$\therefore B_y = -200^{\#}\ (\downarrow)$

From eqn (ii),

$A_y - 200 - 200 = 0$

$\therefore A_y = 400^{\#}\ (\uparrow)$

Ans: $A_x = 375^{\#}(\leftarrow)$; $A_y = 400^{\#}(\uparrow)$; $B_x = 275^{\#}(\rightarrow)$;

$B_y = 200^{\#}(\downarrow)$; $F_{DE} = 400^{\#}\ (T)$; $F_{CF} = 707.55^{\#}\ (C)$.

Subject :
Date :

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Problem: 11: Find out the pin reaction at A, B & E and calculate force in the member CF.

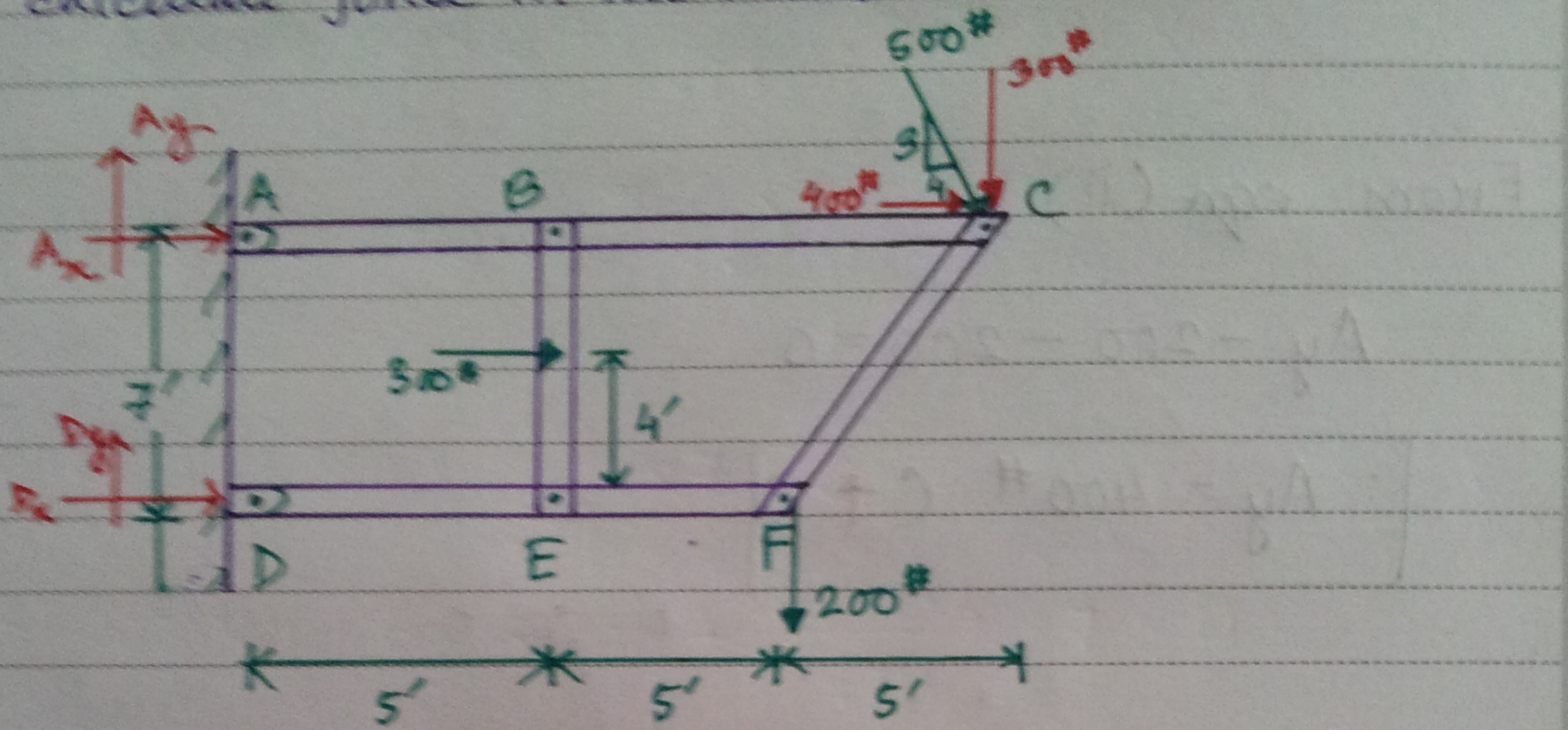

Figure - 1

Solution: From figure-1,

$$\Sigma M_D = A_x \times 7 + 300 \times 4 + 200 \times 10 + 300 \times 15 + 400 \times 7 = 0$$

$$\therefore \boxed{A_x = -1500^{\#}} \ (\longleftarrow)$$

$$\Sigma F_x = A_x + D_x + 300 + 400 = 0$$

$$\Rightarrow -1500 + D_x + 300 + 400 = 0$$

$$\therefore \boxed{D_x = 800^{\#} \ (\longrightarrow)}$$

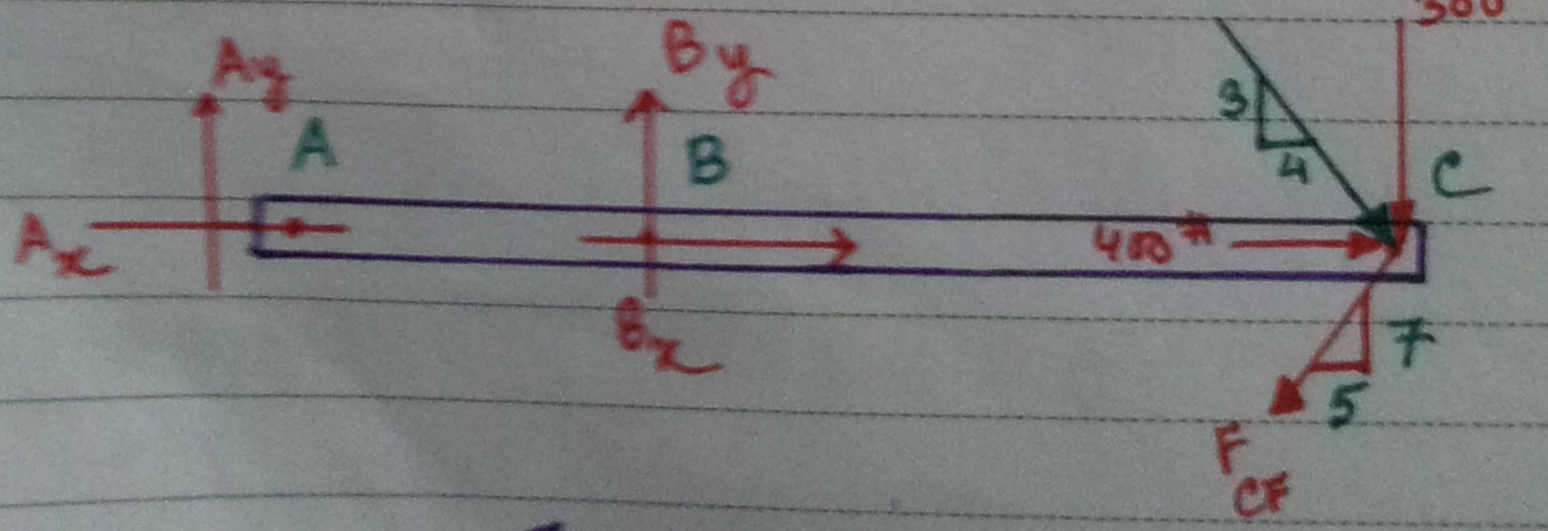

Fig - 2

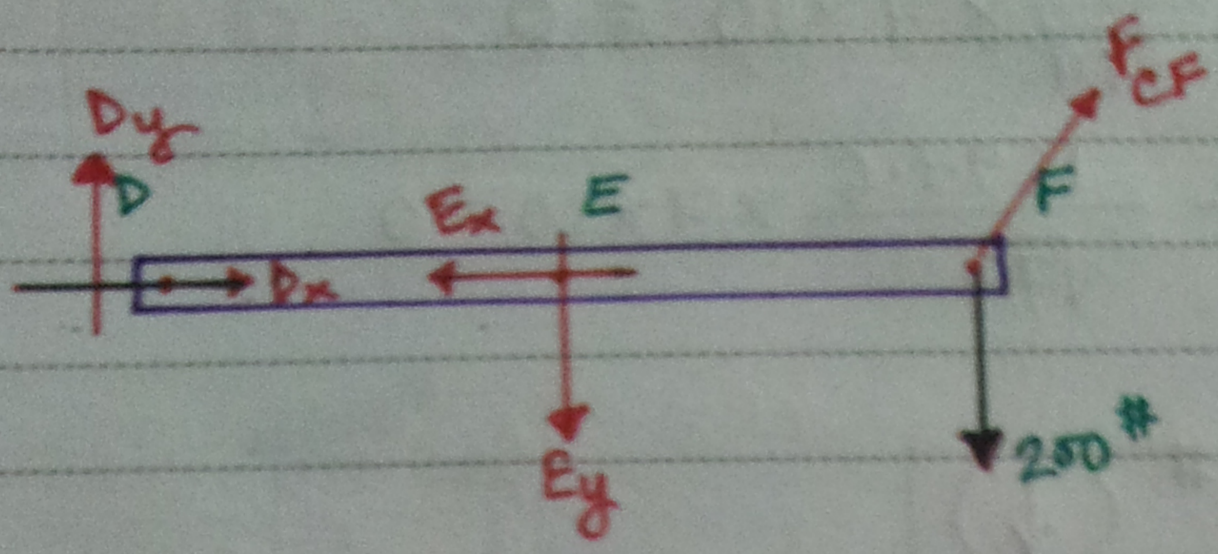

Figure-4

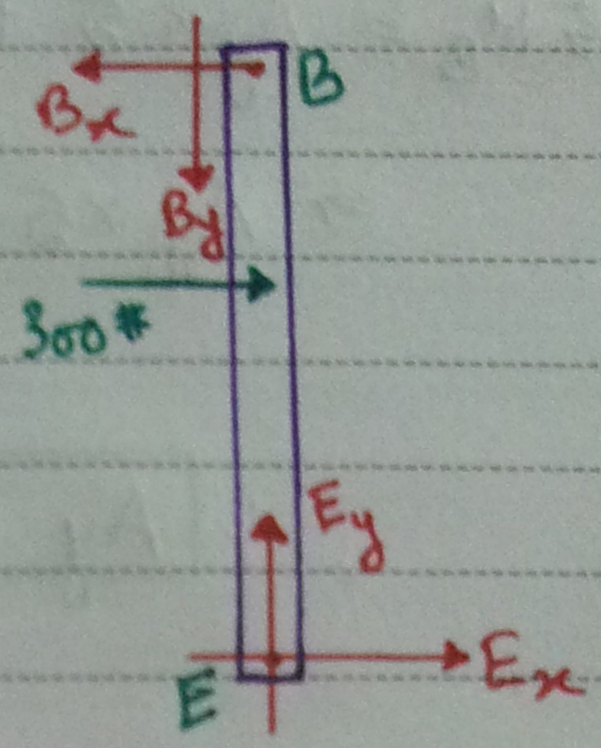

Figure-3

From figure-3,

$$\Sigma M_E = 300 \times 4 - B_x \times 7 = 0$$

$$\therefore B_x = 171.43^{\#} (\leftarrow)$$

$$\Sigma F_x = -B_x + E_x + 300 = 0$$

$$\Rightarrow -171.43 + E_x + 300 = 0$$

$$\therefore E_x = -128.57^{\#} (\leftarrow)$$

$$\Sigma F_y = -B_y + E_y = 0$$

$$\rightarrow B_y = E_y \text{ ----- (i)}$$

From figure-2,

$$\Sigma F_x = A_x + B_x + 400 - \frac{F_{CF}}{\sqrt{74}} \times 5 = 0$$

$$\Rightarrow -1500 + 171.43 + 400 - \frac{F_{CF}}{\sqrt{74}} \times 5 = 0$$

$$\therefore F_{CF} = -1597.6^{\#} (C)$$

Subject :
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$$\Sigma M_B = A_y \times 5 + 300 \times 10 + \frac{F_{CF}}{\sqrt{74}} \times 7 \times 10 = 0$$

$$\Rightarrow A_y \times 5 + 300 \times 10 + \frac{1597.6}{\sqrt{74}} \times 7 \times 10 = 0$$

$$\therefore \boxed{A_y = 2000.04^{\#} (\downarrow)}$$

$$\Sigma F_y = A_y + B_y - 300 - \frac{F_{CF}}{\sqrt{74}} \times 7 = 0$$

$$\Rightarrow 2000.04 + B_y - 300 + \frac{1597.6}{\sqrt{74}} \times 7 = 0$$

$$\therefore \boxed{B_y = -3000^{\#} (\downarrow)}$$

From equation (i), we get,

$$\boxed{E_y = -3000^{\#} (\downarrow)}$$

Ans: $A_x = 1500^{\#} (\leftarrow)$; $A_y = 2000.04^{\#} (\downarrow)$; $B_x = 171.43^{\#} (\rightarrow)$

$B_y = -3000^{\#} (\downarrow)$; $E_x = 128.57^{\#} (\leftarrow)$; $E_y = 3000^{\#} (\downarrow)$

$F_{CF} = 1597.6^{\#} (C)$

Problem: 12 Identify the pin reaction at A, the two force member(s) and the force of them.

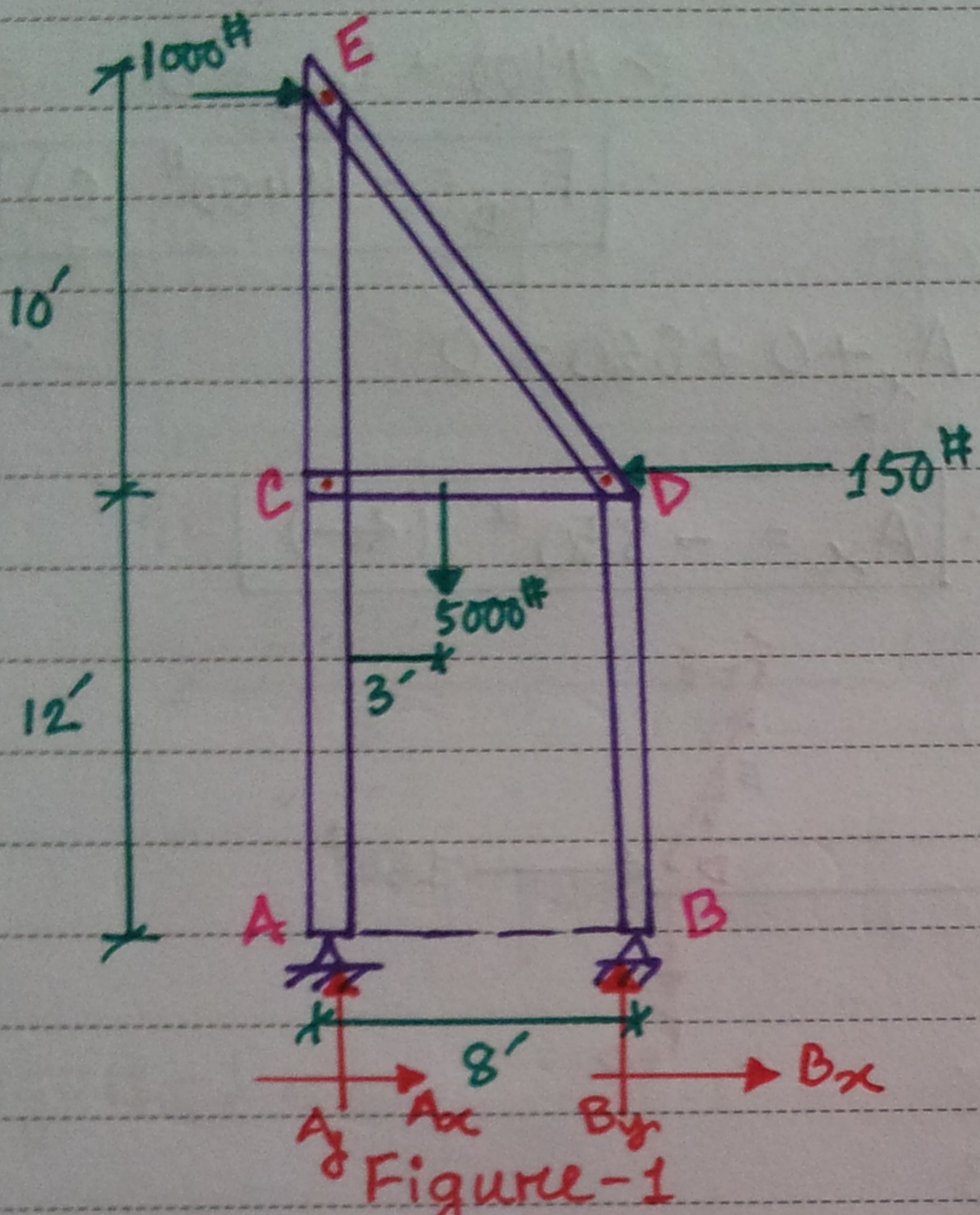

Figure-1

Solution: Here, two force members are DE & BD.

From fig-1,

$\Sigma M_B = A_y \times 8 - 5000 \times 5 - 150 \times 12 + 1000 \times 22 = 0$

$\therefore \boxed{A_y = 600^{\#} (\uparrow)}$

$\Sigma F_y = A_y + B_y - 5000 = 0$

$\Rightarrow 600 - 5000 + B_y = 0$

$\therefore B_y = 4400^{\#} (\uparrow)$

$\Sigma F_x = A_x + B_x + 1000 - 150 = 0 \quad \Rightarrow A_x + B_x + 850 = 0$ ------(i)

From fig-2, $\Sigma F_x = B_x = 0$

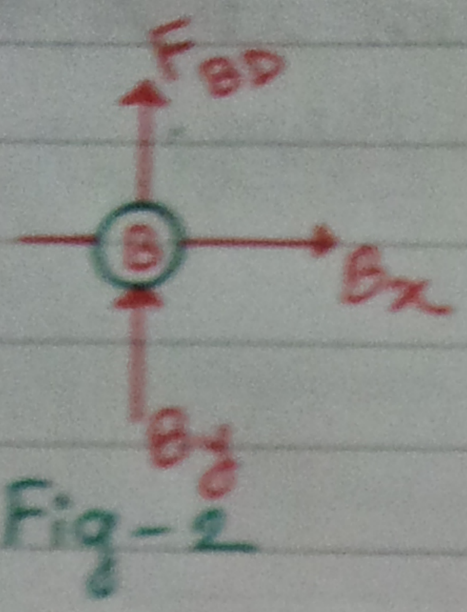

Fig-2

& $\Sigma F_y = B_y + F_{BD} = 0$

$\Rightarrow 4400 + F_{BD} = 0$

$\therefore \boxed{F_{BD} = -4400^{\#} \ (c)}$

From eqn (i), we get, $A_x + 0 + 850 = 0$

$\therefore \boxed{A_x = -850^{\#} \ (\leftarrow)}$

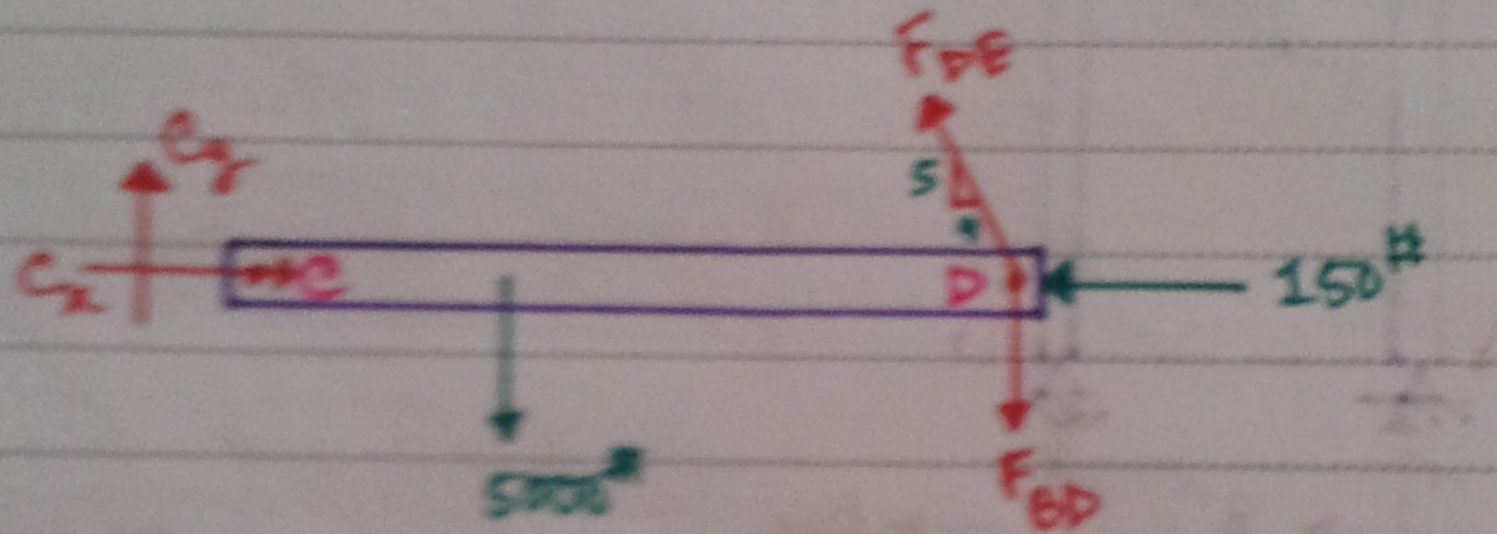

Fig-3

From fig-3,

$\Sigma M_c = +5000 \times 3 + F_{BD} \times 8 - F_{DE} \times \frac{5}{\sqrt{41}} \times 8 = 0$

$\Rightarrow 5000 \times 3 + (-4400) \times 8 - F_{DE} \times \frac{5}{\sqrt{41}} \times 8 = 0$

$\therefore \boxed{F_{DE} = -3233.57^{\#} \ (c)}$

Ans: $A_x = 850^{\#} \ (\leftarrow)$; $A_y = 600^{\#} \ (\uparrow)$

$F_{DE} = 3233.57^{\#} \ (c)$; $F_{BD} = 4400^{\#} \ (c)$

Problem: 13 Find the reactions at pin A & B and force in the two force members.

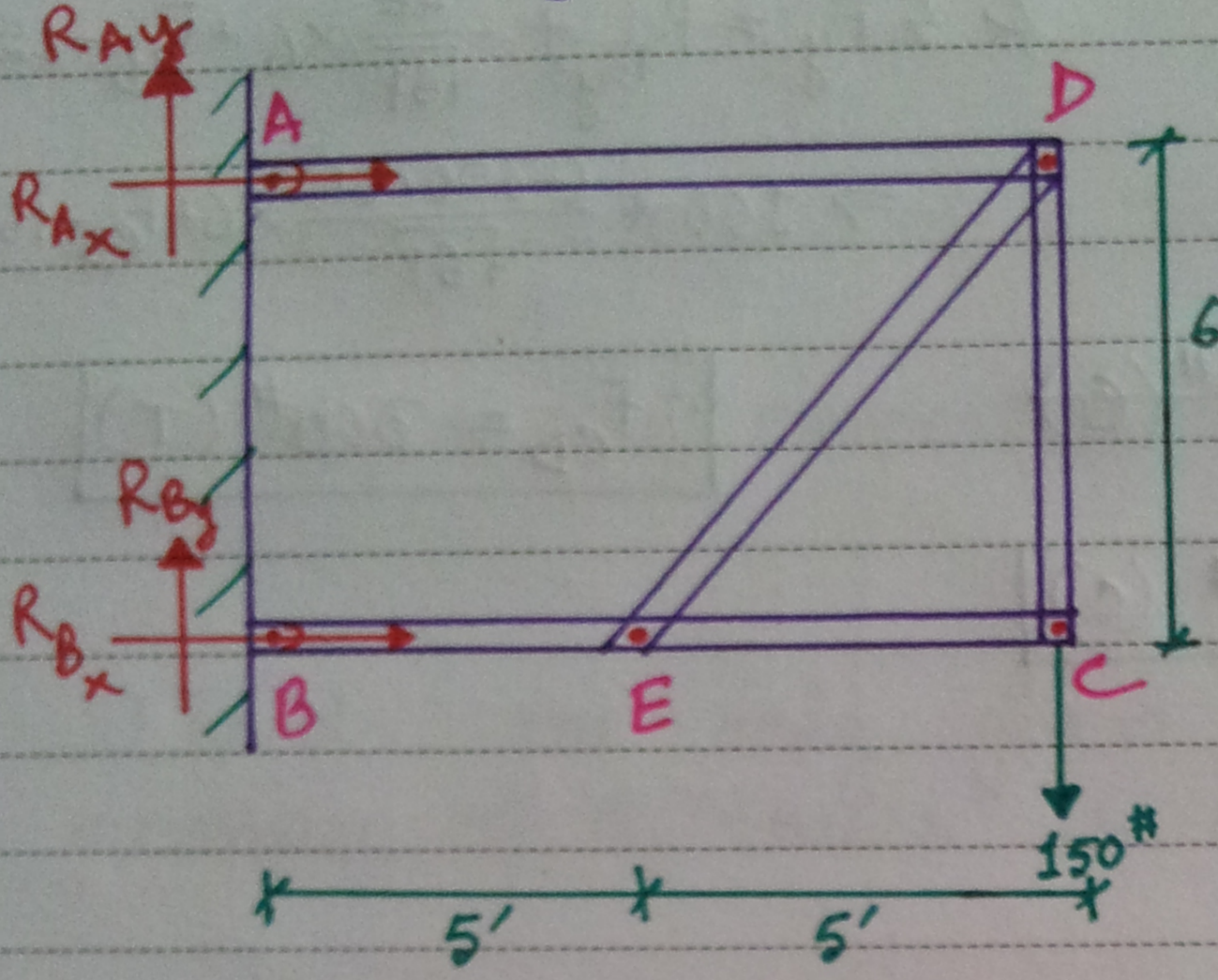

Figure-1

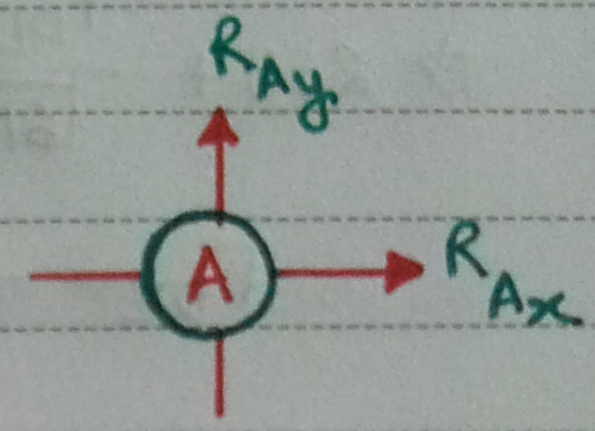

Figure-2

From figure-2,

$$\Sigma F_y = \boxed{R_{Ay} = 0^{\#}}$$

From figure-1,

$$\Sigma M_B = R_{Ax} \times 6 + 150 \times 10 = 0 \quad \& \quad \Sigma F_x = R_{Ax} + R_{Bx} = 0$$

$$\therefore \boxed{R_{Ax} = -250^{\#} (\leftarrow)} \qquad \Rightarrow -250 + R_{Bx} = 0$$

$$\therefore \boxed{R_{Bx} = 250^{\#} (\rightarrow)}$$

$$\Sigma F_y = R_{By} + R_{Ay} - 150 = 0$$

$$\Rightarrow R_{By} + 0 - 150 = 0 \qquad \therefore \boxed{R_{By} = 150^{\#} (\uparrow)}$$

Here two force members are AD, CD & DE.

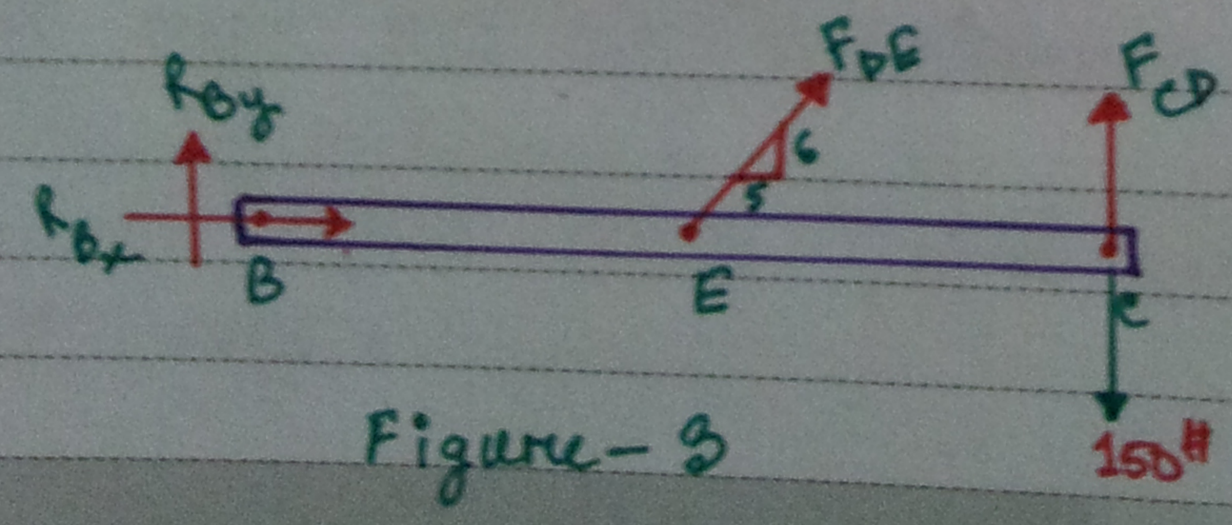

Figure-3

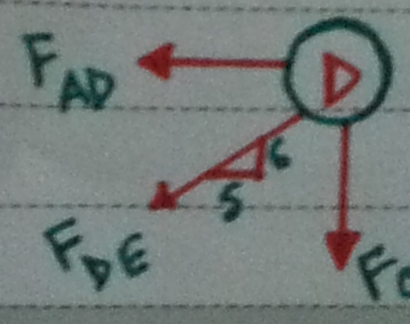

Figure-4

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From figure-3,

$$\Sigma F_x = R_{Bx} + \frac{F_{DE}}{\sqrt{61}} \times 5 = 0 \qquad \& \quad \Sigma F_y = R_{By} + \frac{F_{DE}}{\sqrt{61}} \times 6 + F_{CD} - 150 = 0$$

$$\Rightarrow 250 + \frac{F_{DE}}{\sqrt{61}} \times 5 = 0 \qquad \Rightarrow 150 + \frac{(-390.51)}{\sqrt{61}} \times 6 + F_{CD} - 150 = 0$$

$$\therefore F_{DE} = -812.27^{\#} \text{ (c)} \qquad \therefore \boxed{F_{CD} = 300^{\#} \text{ (T)}}$$

$$\therefore \boxed{F_{DE} = -390.51^{\#} \text{ (c)}}$$

From figure-4,

$$\Sigma F_x = -F_{AD} + \frac{F_{DE}}{\sqrt{61}} \times 5 = 0$$

$$\Rightarrow F_{AD} = \frac{390.51}{\sqrt{61}} \times 5$$

$$\therefore \boxed{F_{AD} = +250^{\#} \text{ (T)}}$$

Ans: $R_{A_x} = 250^{\#} (\leftarrow)$; $R_{Ay} = 0^{\#} (\uparrow)$; $R_{B_x} = 250^{\#} (\rightarrow)$

$R_{By} = 150^{\#} (\uparrow)$; $F_{AD} = 250^{\#} (T)$; $F_{DE} = 390.51^{\#} (c)$

$F_{CD} = 300^{\#} (T)$

Problem: 14

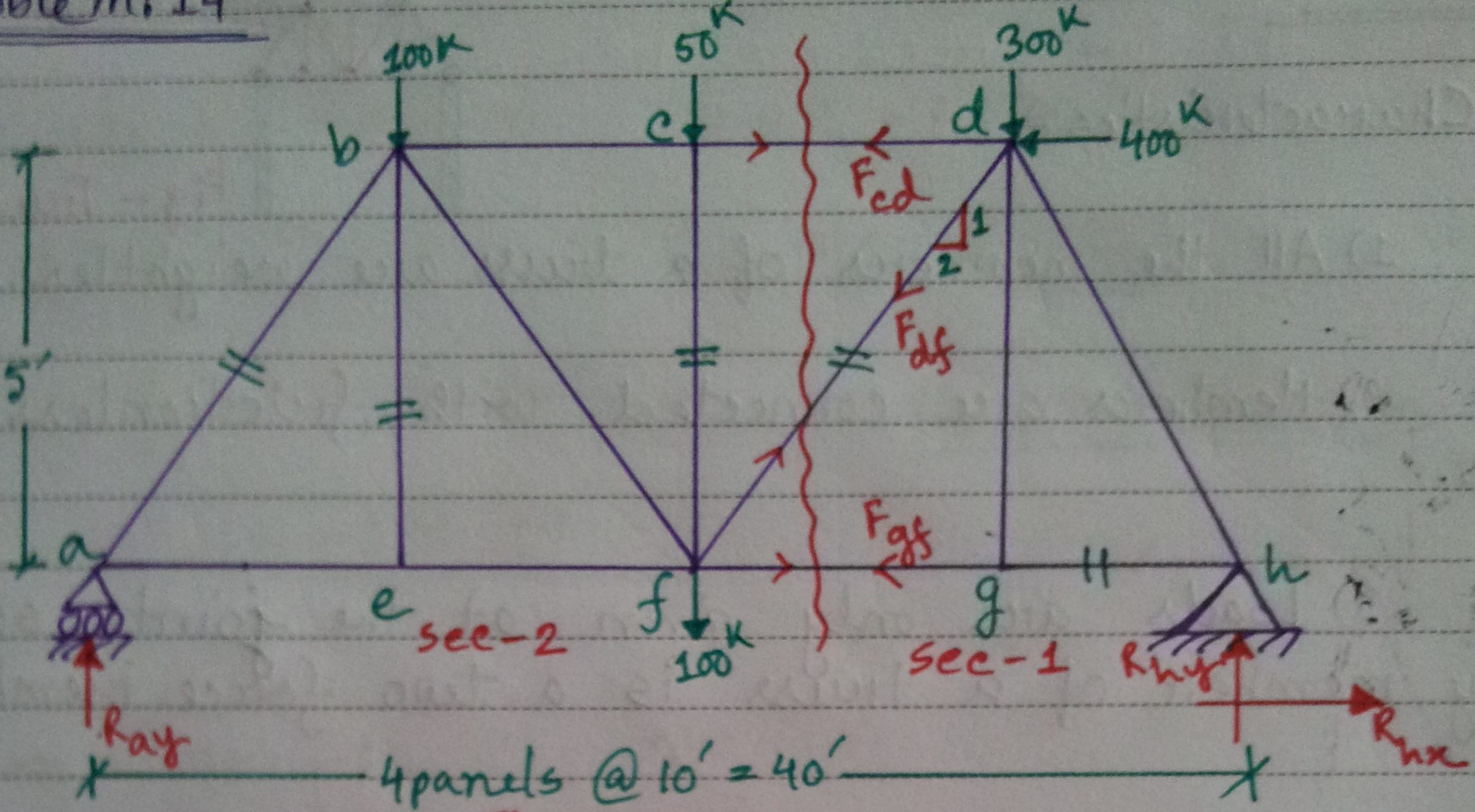


Figure-1

Solution:

From figure-1,

Here, $\Sigma M_h = R_{ay} \times 40 - 100 \times 30 - 50 \times 20 - 100 \times 20 - 300 \times 10 - 400 \times 5 = 0$

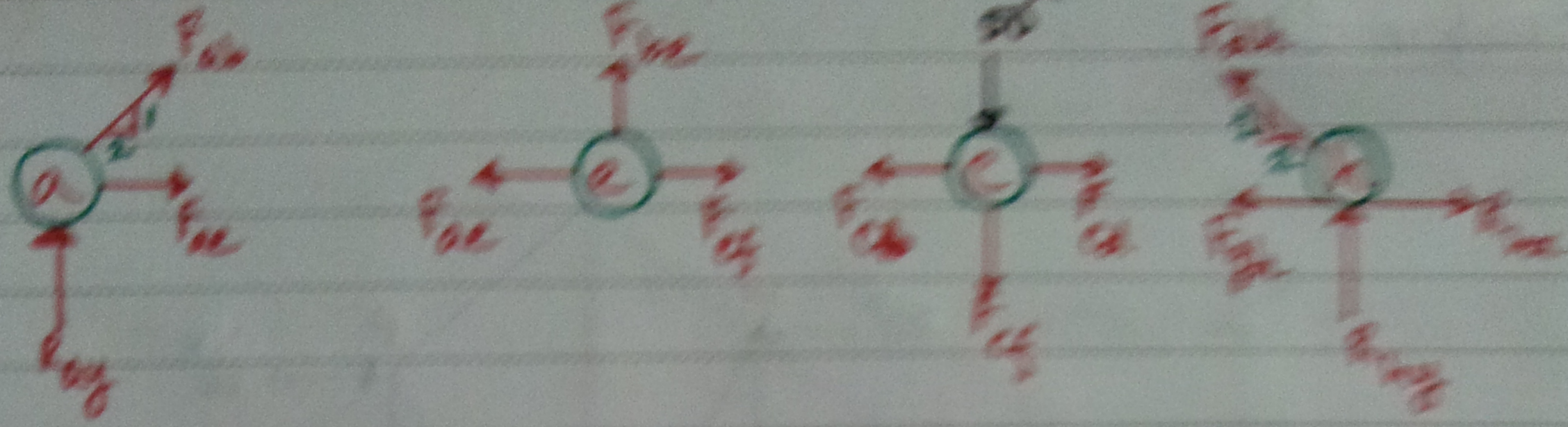
$\therefore R_{ay} = 275^K (\uparrow)$

$\Sigma F_y = R_{ay} - 100 - 50 - 100 - 300 + R_{hy} = 0$

$\Rightarrow 275 - 100 - 50 - 100 - 300 + R_{hy} = 0$

$\therefore R_{hy} = 275 (\uparrow)$

$\Sigma F_x = R_{hx} - 400 = 0 \Rightarrow R_{hx} = 400^K (\rightarrow)$



From joint a,

$$\Sigma F_y = P_{ay} + \frac{F_{ab}}{\sqrt{5}} \times 1 = 0$$

$$\therefore P_{ay} \Rightarrow 275 + \frac{F_{ab}}{\sqrt{5}} \times 1 = 0 \quad \therefore \boxed{F_{ab} = -614.92^k \text{ (c)}}$$

From joint e, $\Sigma F_y = F_{be} = 0$

$$\therefore \boxed{F_{be} = 0^k}$$

From joint c, $\Sigma F_y = -50 - F_{cf} = 0$

$$\therefore \boxed{F_{cf} = -50^k \text{ (c)}}$$

From joint b, $\Sigma F_y = P_{by} + \frac{F_{db}}{\sqrt{5}} \times 1 = 0 \Rightarrow 275 + \frac{F_{db}}{\sqrt{5}} \times 1 = 0$

$$\therefore F_{db} = -614.92^k \text{ (c)}$$

& $\Sigma F_x = P_{bx} - F_{gb} - \frac{F_{db}}{\sqrt{5}} \times 2 = 0 \Rightarrow 400 - F_{gb} + \frac{614.92}{\sqrt{5}} \times 2 = 0$

$$\therefore \boxed{F_{gb} = 950^k \text{ (T)}}$$

From sec-1 of figure-1, $\Sigma F_y = -300 - \frac{F_{df}}{\sqrt{5}} \times 2 - P_{by} = 0$

$$\therefore \boxed{F_{df} = -95.9^k \text{ (c)}}$$

(Ans)

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Trusses :-

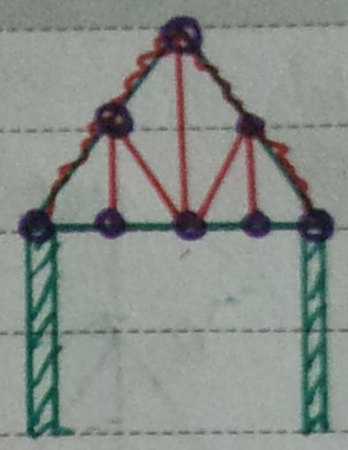

Fig - Truss

- Characteristics -

1) All the members of a truss are weightless.

2) Members are connected with frictionless pins.

3) Loads are only given at the joints, so every member of a truss is a two force member.

- There are two methods for calculating forces in a truss —

1) Joint Method
2) Section Method.

Support এর সাথে যে member থাকবে তার জন্য joint method use করা যাবে।

যেকোন joint-এ 2টা member hor. + 1টা member ver./ 2টা member ver. + 1টা mem hor. হলে সেখানে joint method use হবে।

* Section method-এ পুরো truss কে এমনভাবে ২টা section এ ভাগ করতে হবে যে minimum member কাটা যায়।

* Moment চাওয়া থেকে point section-এর ভিতরে/বাইরেও থাকতে পারে।

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Problem-15:

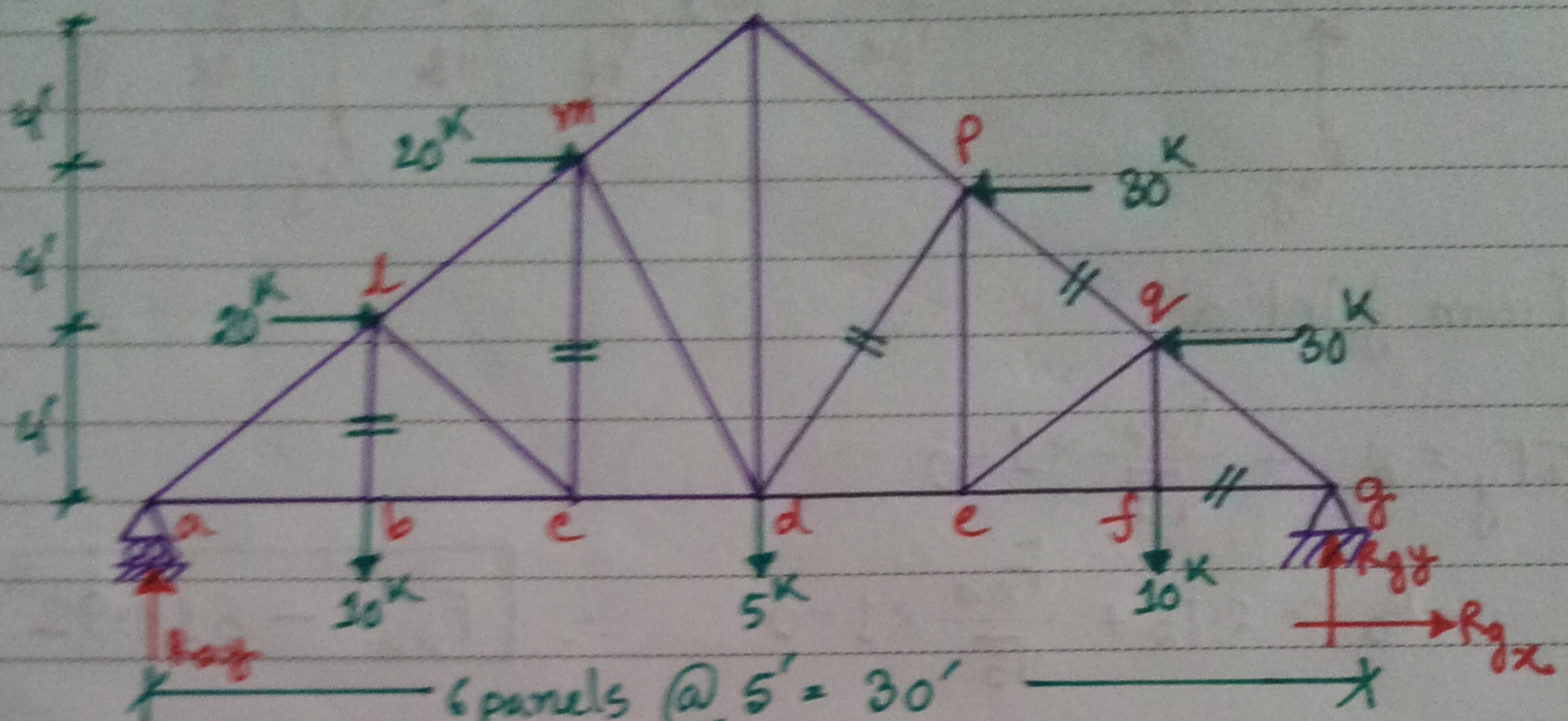
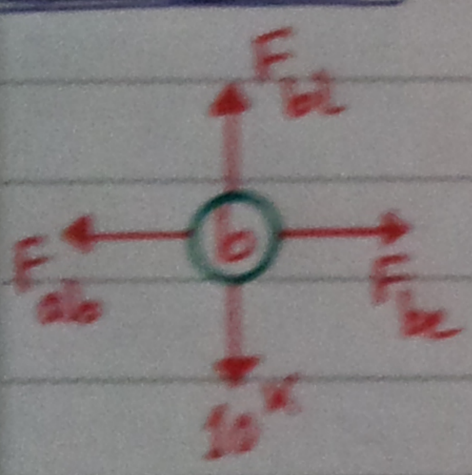


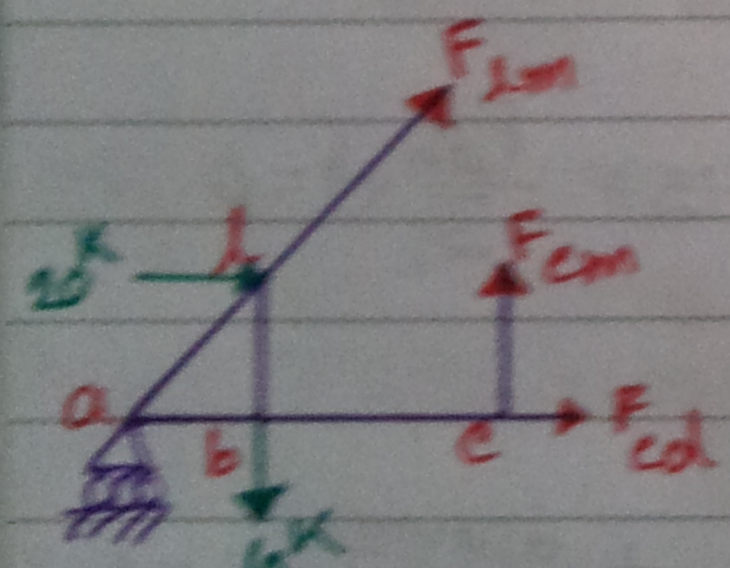
Figure-1

Solution:



From joint b, $\Sigma F_y = 0 \Rightarrow F_{bl} - 10 = 0$

$\Rightarrow \boxed{F_{bl} = 10^K \text{ (T)}}$

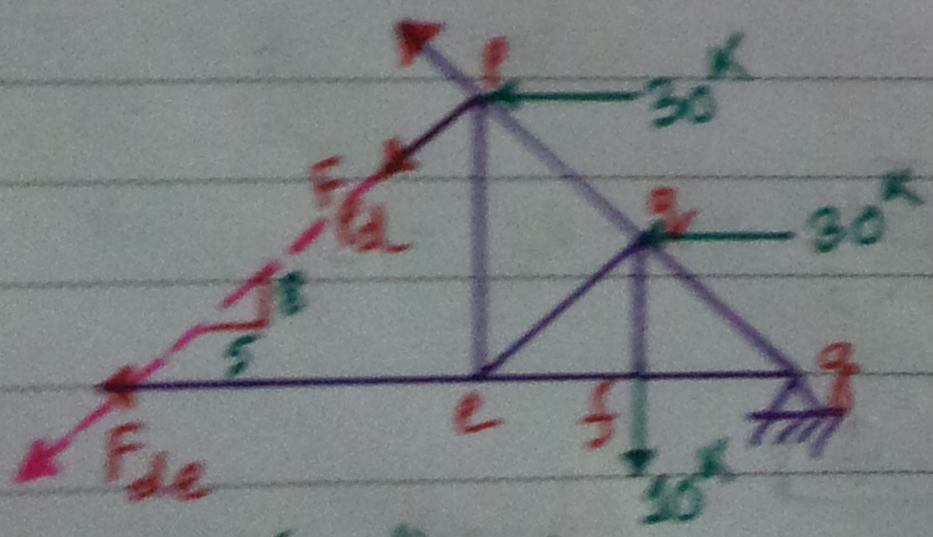


From section-1,

$\Sigma M_b = 20 \times 4 + 10 \times 5 - F_{cm} \times 10 = 0$

$\therefore \boxed{F_{cm} = 13^K \text{ (T)}}$

Section-1

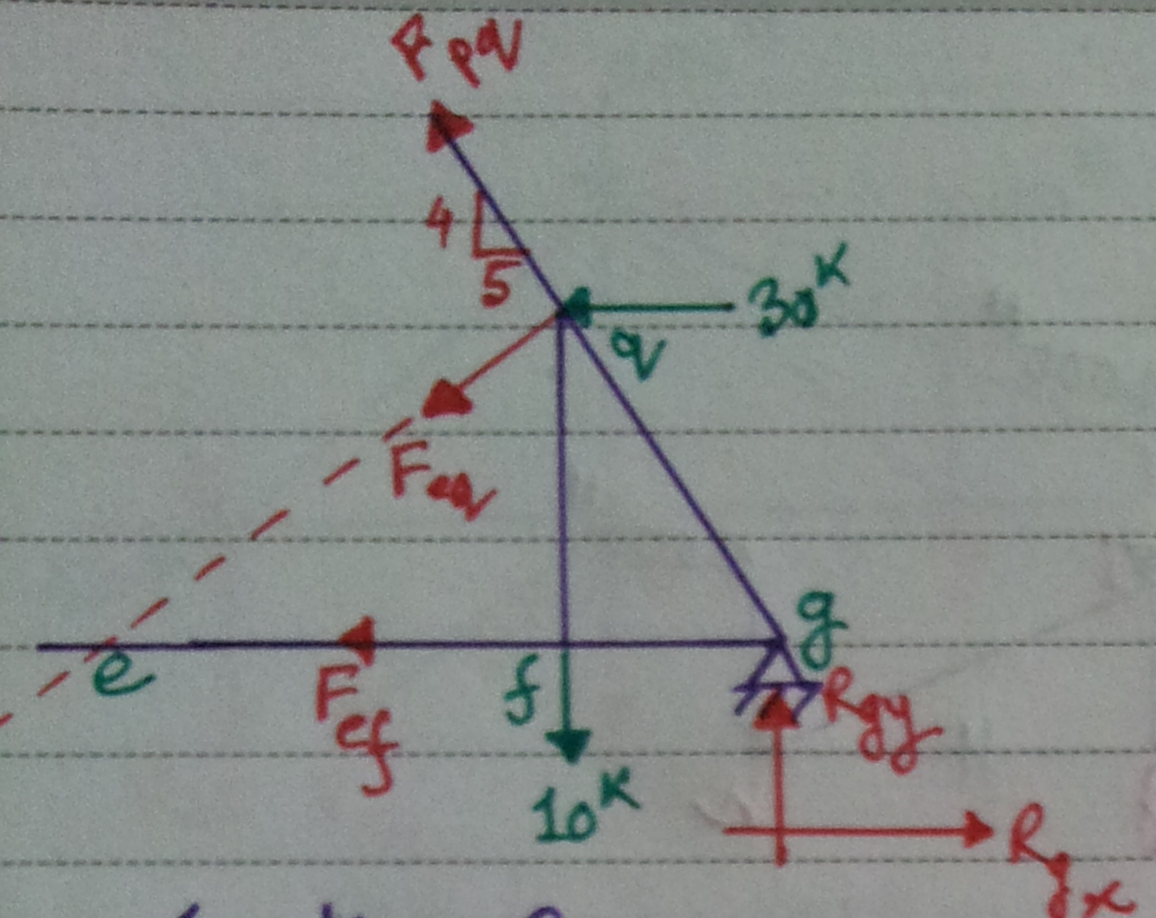


Section-2

From section-2,

$\Sigma M_g = -30 \times 4 - 30 \times 8 - 10 \times 5 - \frac{F_{pd}}{\sqrt{89}} \times 8 = 0$
$\times 15$

$\therefore \boxed{F_{pd} = -32.23^K \text{ (c)}}$



From section-3,

$$\Sigma M_e = -30\times4 - \frac{F_{pq}}{\sqrt{41}}\times4\times10 + 10\times5 - R_{gy}\times10 = 0$$

$$\Rightarrow F_{pq} = (-120+50-85)\times\frac{\sqrt{41}}{40} \quad [\text{from (ii)}]$$

$$\therefore \boxed{F_{pq} = -24.81^{k}\,(c)}$$

Section-3

From figure-1,

$$\Sigma M_a = -R_{gy}\times30 + 20\times4 + 20\times8 - 30\times4 - 30\times8 + 10\times5 + 5\times15 + 10\times25 = 0$$

$$\therefore \boxed{R_{gy} = 8.5^{k}\,(\uparrow)} \quad ----\text{(i)}$$

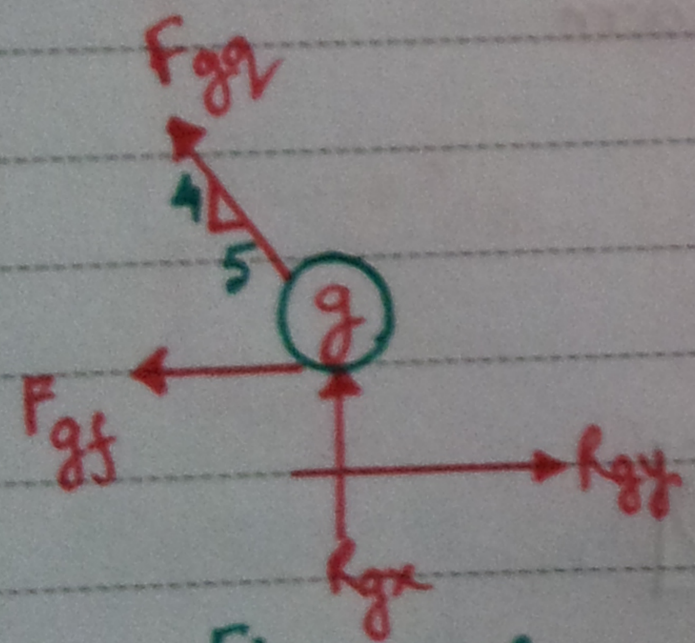


Figure-2

From joint g in figure-2,

$$\Sigma F_y = R_{gy} + \frac{F_{gq}}{\sqrt{41}}\times4 = 0$$

$$\therefore F_{gq} = -13.61^{k}\,(c)$$

$$\text{k}\Sigma F_x = R_{gx} - F_{gf} - \frac{F_{gq}}{\sqrt{41}}\times5 = 0$$

$$\therefore \boxed{F_{gf} = 30.63^{k}\,(T)}$$

(Ans)

Problem : 16

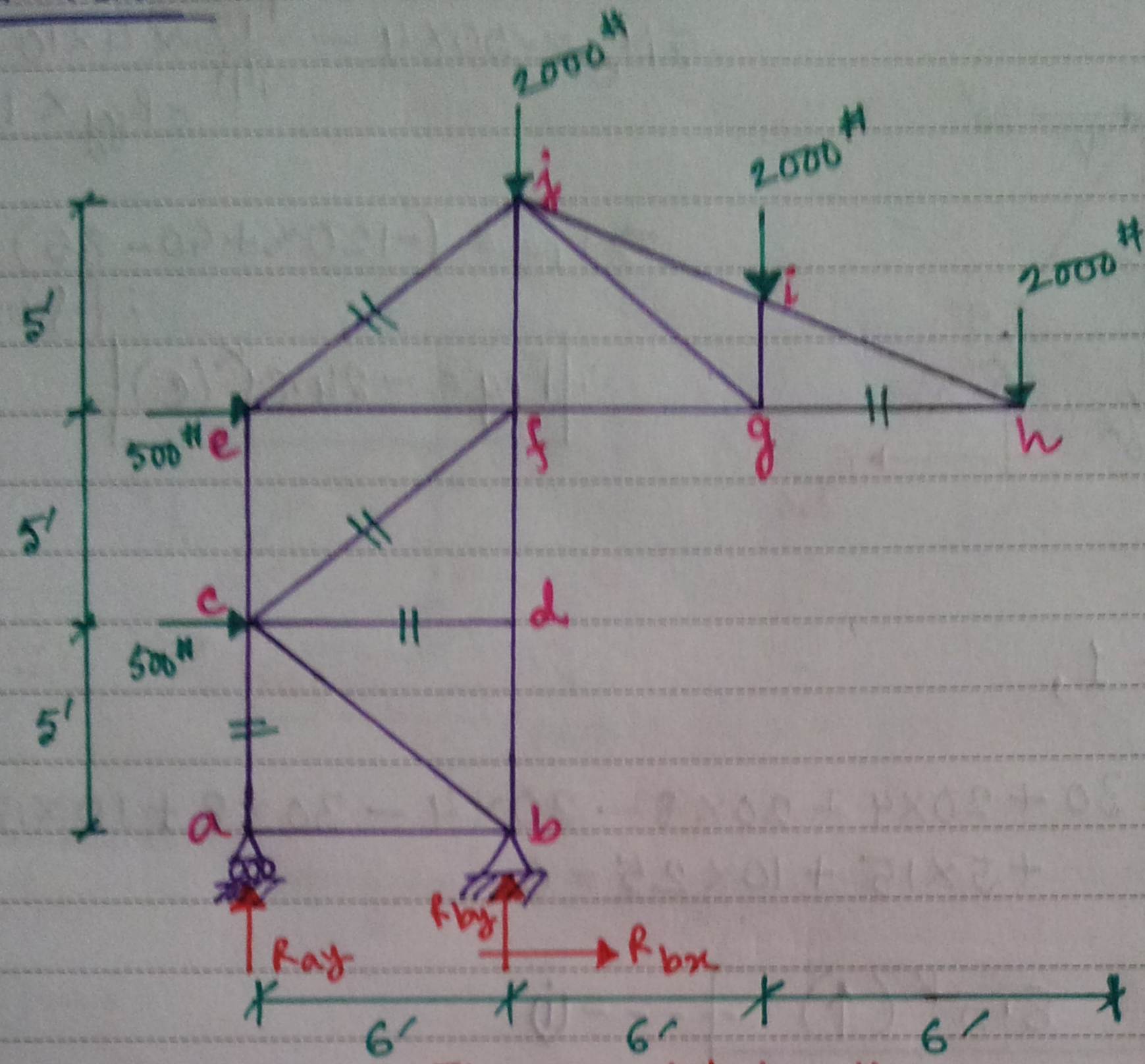
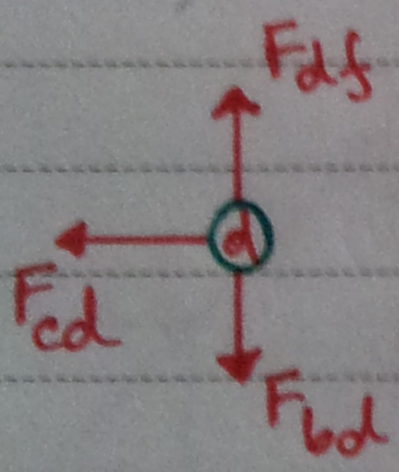


Figure- Whole diagram

Solution:-

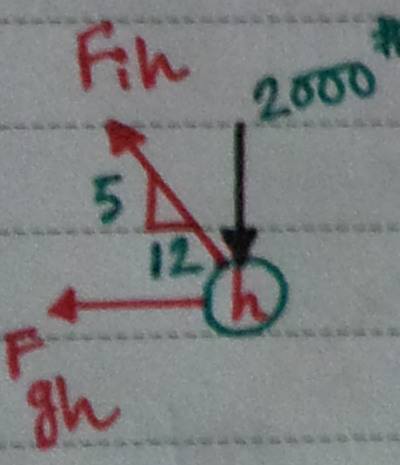


From figure-1,

$$\Sigma F_x = -F_{cd} = 0$$

$$\therefore \boxed{F_{cd} = 0^{\#} \text{ (T)}}$$

Figure-1



Figre-2

From figure-2, $\Sigma F_y = -2000 + \frac{F_{ih}}{13} \times 5 = 0$

$$\therefore F_{ih} = 5200^{\#} \text{ (T)}$$

$$\& \Sigma F_x = -F_{gh} - \frac{F_{ih}}{13} \times 12 = 0$$

$$\therefore \boxed{F_{gh} = -4800^{\#} \text{ (c)}}$$

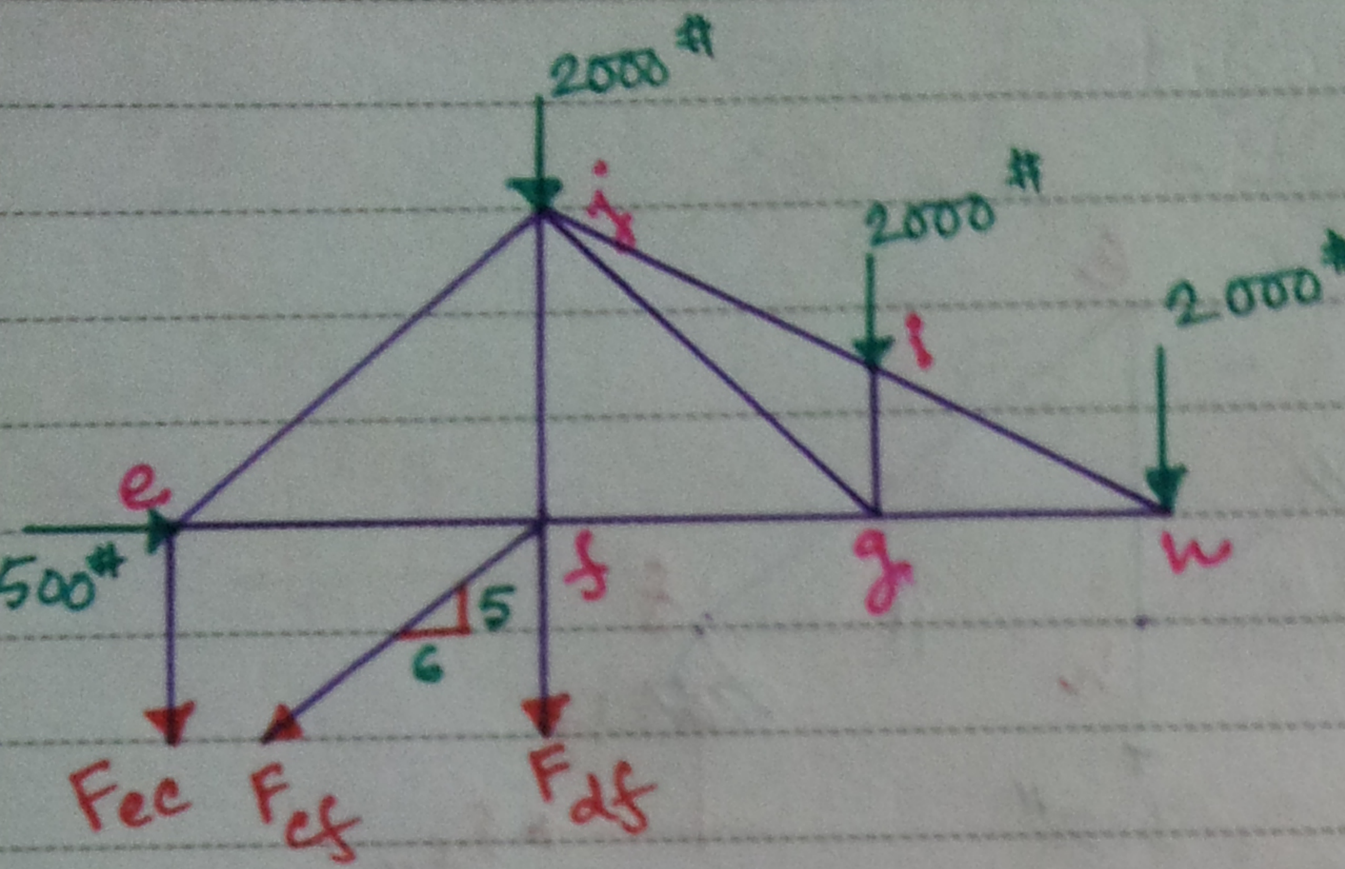


Figure-3-section-1

From section-1,

$$\Sigma F_x = 500 - \frac{F_{cf}}{\sqrt{61}} \times 6 = 0$$

$$\therefore \boxed{F_{cf} = 650.85\ \#\ (T)}$$

From the Whole diagram,

$$\Sigma M_b = R_{ay} \times 6 + 500 \times 5 + 500 \times 10 + 2000 \times 6 + 2000 \times 12 = 0$$

$$\therefore R_{ay} = -7250\ \#\ (\downarrow)$$

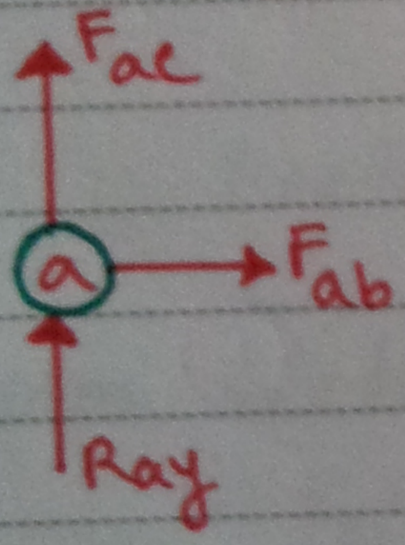
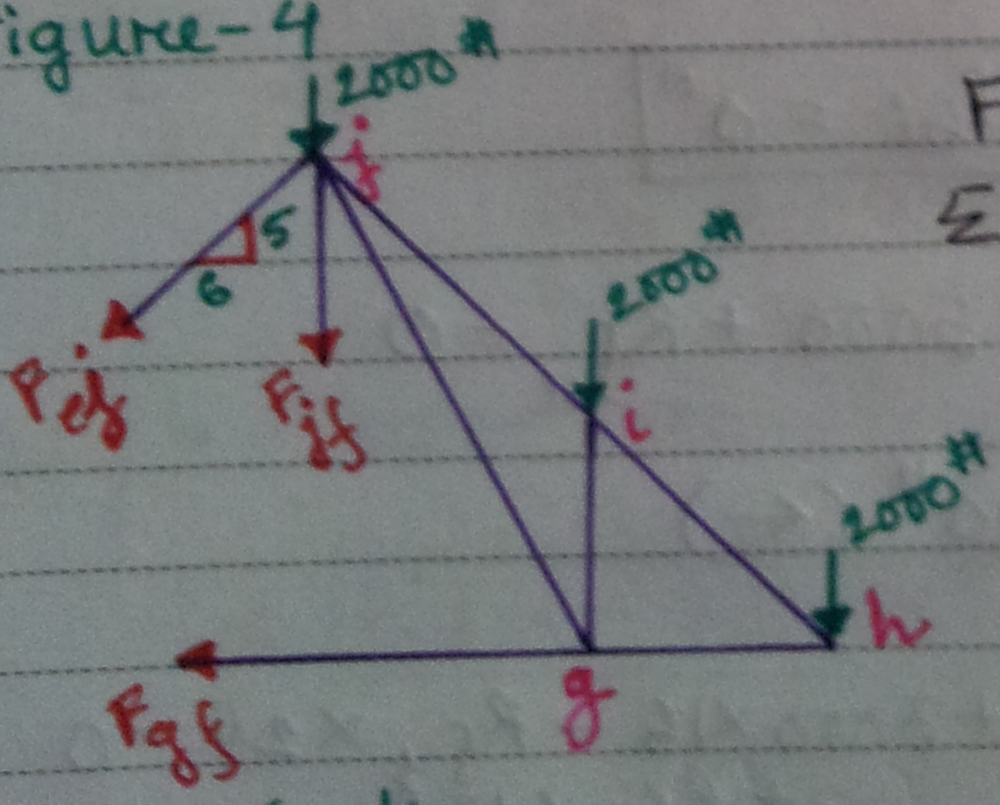


Figure-4

From joint a in figure-4,

$$\Sigma F_y = F_{ac} + R_{ay} = 0$$

$$\therefore \boxed{F_{ac} = +7250\ \#\ (T)}$$



Section-2

From sec-2,

$$\Sigma M_f = 2000 \times 6 + 2000 \times 12 - \frac{F_{ej}}{\sqrt{61}} \times 5 \times 6 = 0$$

$$\therefore \boxed{F_{ej} = 9372.3\ \#\ (T)}$$

(Ans)

Problem : 17

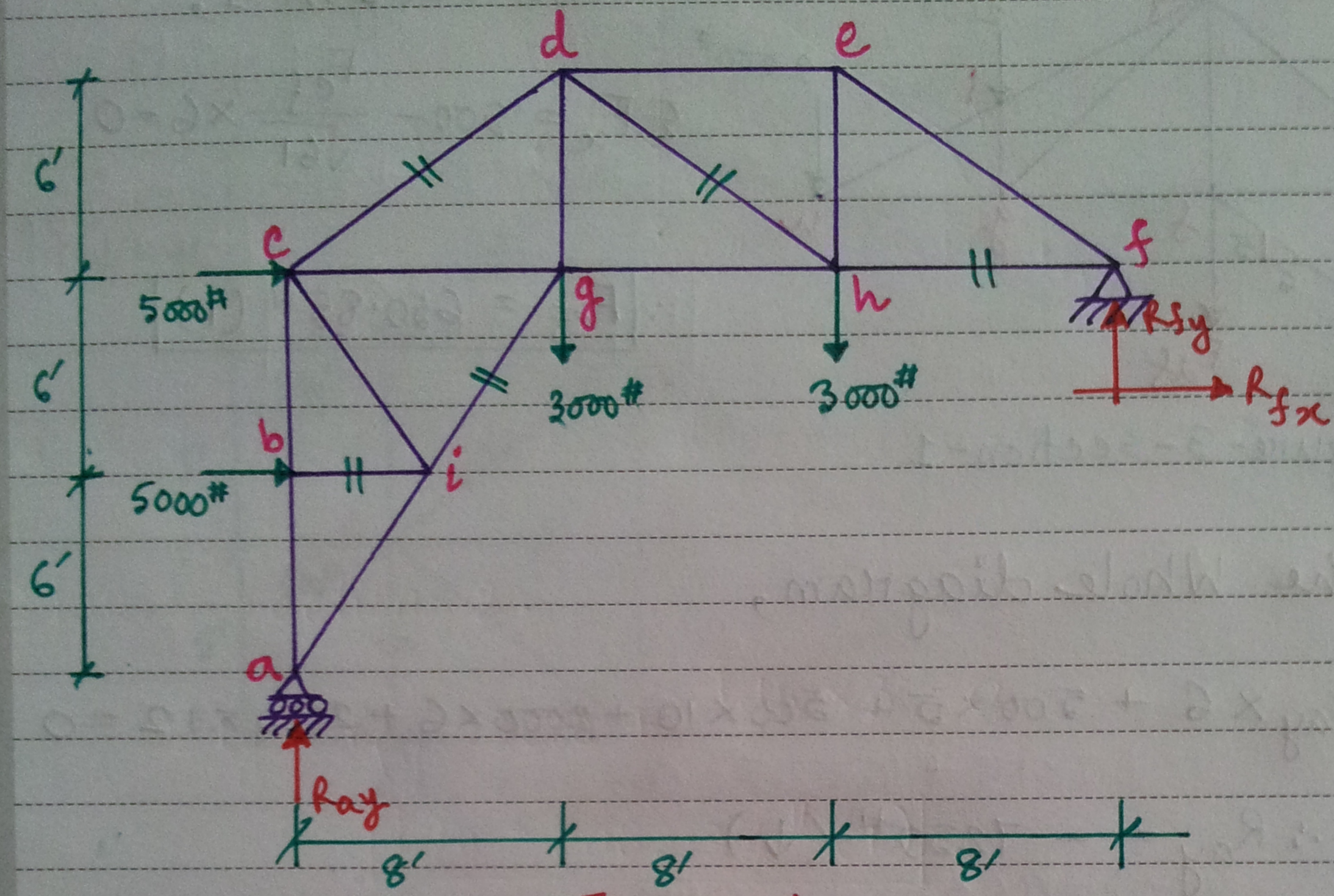
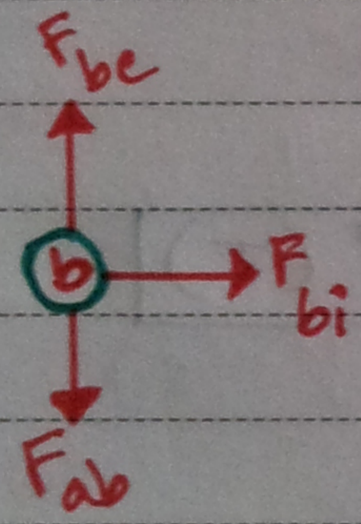


Figure-1

Solutions:



From joint b,

$$\Sigma F_x = F_{bi} = 0$$

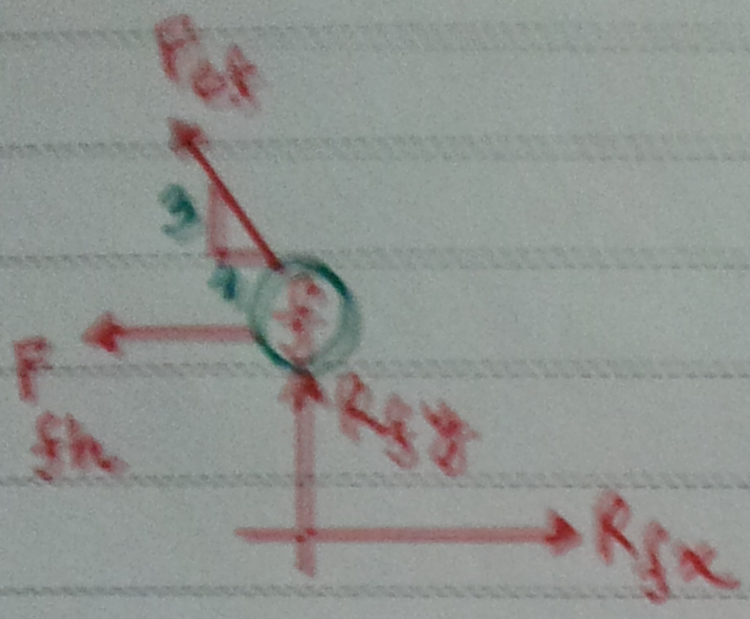
$$\therefore \boxed{F_{bi} = 0^{\#}}$$

From figure-1, $\Sigma F_x = 5000 + 5000 + R_{fx} = 0$

$$\therefore R_{fx} = -10000^{\#} \ (\leftarrow)$$

& $\Sigma M_a = 5000\times6 + 5000\times12 + 3000\times8 + 3000\times16 - R_{fy}\times24 + R_{fx}\times12 = 0$

$$\therefore R_{fy} = 1750^{\#} \ (\uparrow)$$



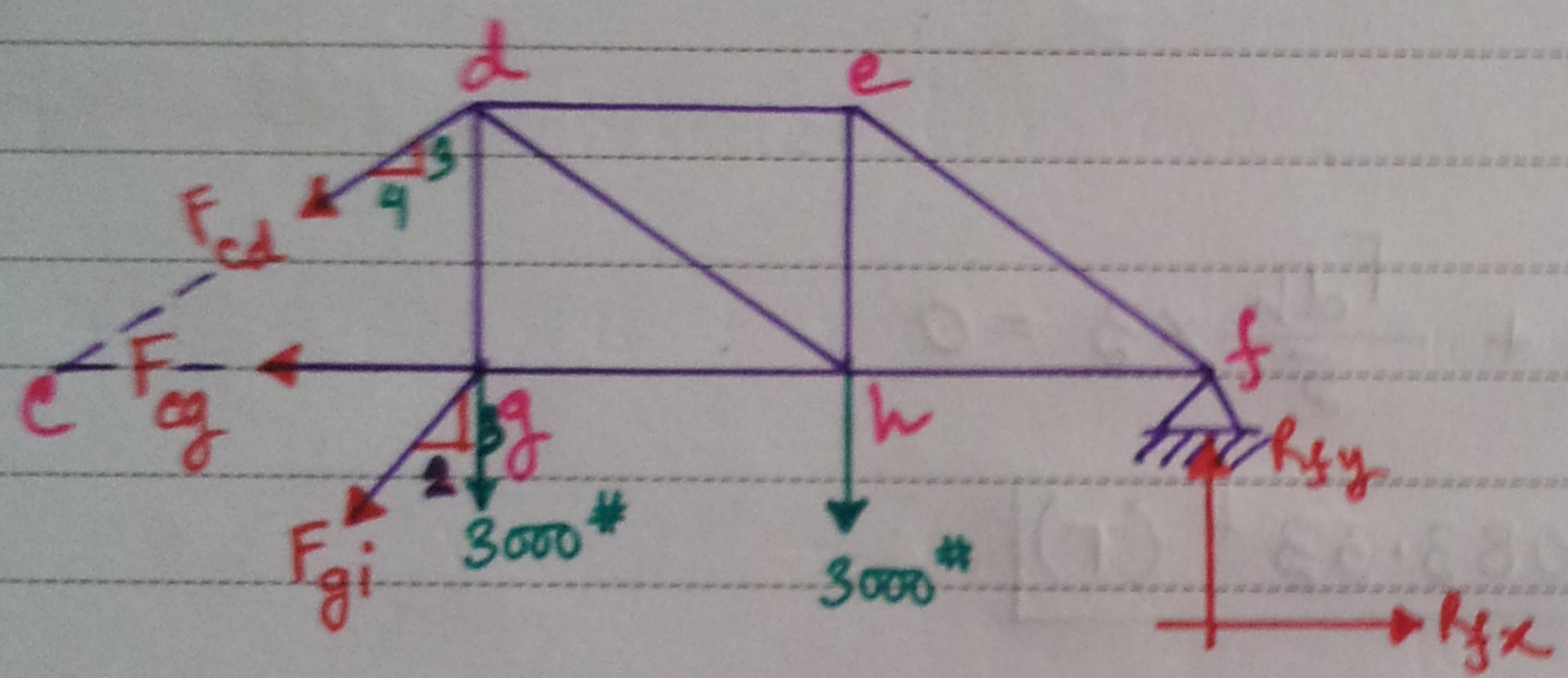
From joint-f,

$$\Sigma F_y = R_{fy} + \frac{F_{ef}}{\sqrt{25}} \times 3 = 0$$

$$\therefore F_{ef} = -2916.67^{\#} (c).$$

& $$\Sigma F_x = R_{fx} - F_{fh} - \frac{F_{ef}}{5} \times 4 = 0$$

$$\therefore \boxed{F_{fh} = -12333.34^{\#} (c)}$$



Section - 1

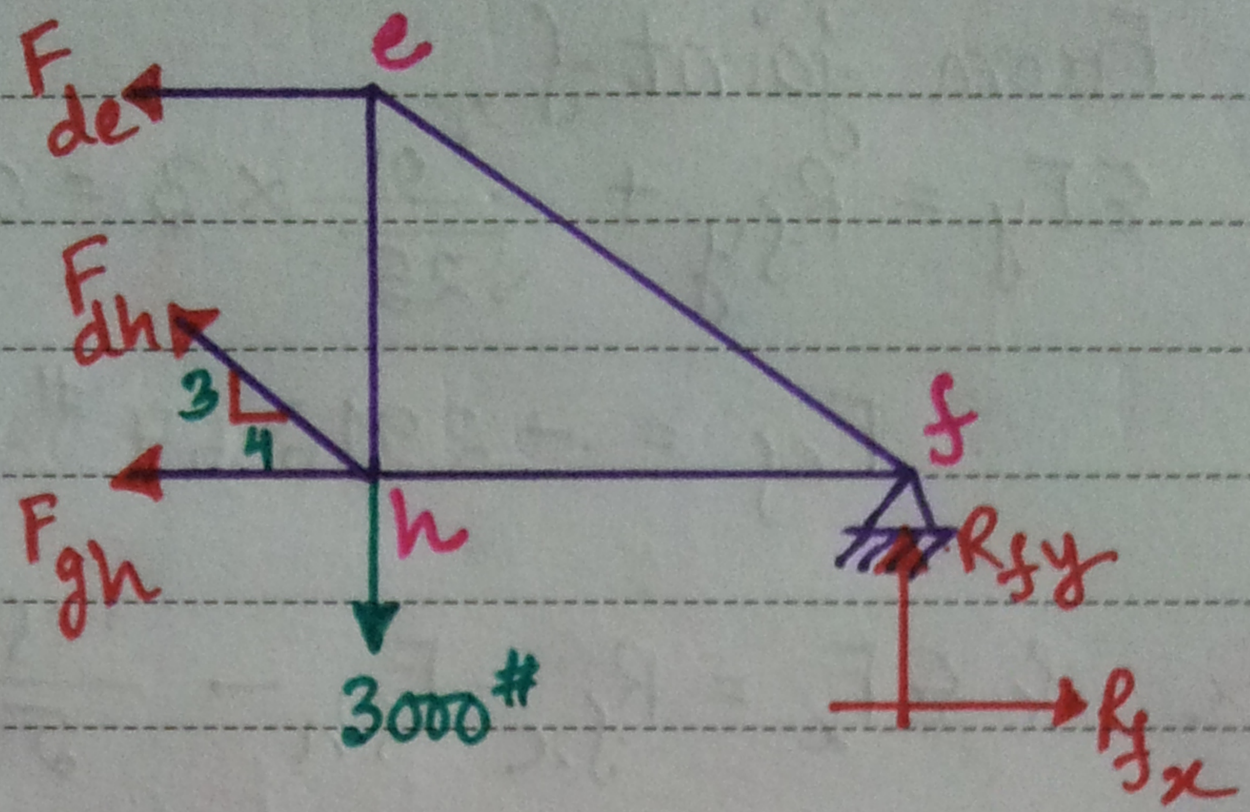
From section-1,

$$\Sigma M_c = \frac{F_{gi}'}{\sqrt{13}} \times 3 \times 8 + 3000 \times 8 + 3000 \times 16 - R_{fy} \times 24 = 0$$

$$\therefore \boxed{F_{gi}' = -4506.94^{\#} (c)}$$

& $$\Sigma F_y = -3000 - 3000 + R_{fy} - \frac{F_{gi}'}{\sqrt{13}} \times 3 - \frac{F_{cd}}{5} \times 3 = 0$$

$$\therefore \boxed{F_{cd} = -833.33^{\#} (c)}$$



Section-2

From section-2,

$$\Sigma F_y = R_{fy} - 3000 + \frac{F_{dh}}{5} \times 3 = 0$$

$$\therefore \boxed{F_{dh} = 2083.33\ \#\ (T)}$$

(Ans)