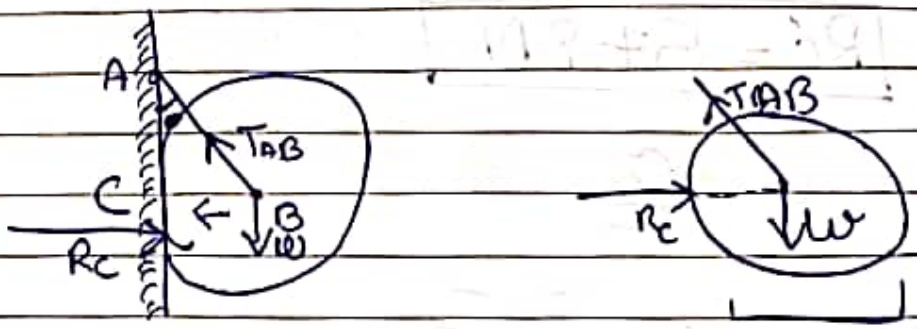
Free Body Diagram: CV: 2mfd.



Free body diagram

Equilibrium Condn:

$$\begin{cases} \Sigma fx = 0 \\ \Sigma fy = 0 \\ \Sigma M = 0 \end{cases}$$

It is a diagram in which it represents the all the forces with dirn & you remove all the support.

AB = 20cm. W = 100 N.
radius = 10cm.

Tension in AB = ?? & Rc = ??

Soln $\Sigma fx = 0$

$$Rc - TAB \sin 30^\circ = 0 \quad -(1).$$

$\Sigma fy = 0$ $\quad TAB \cos 30^\circ - W = 0 \quad -(2).$

$$TAB \cos 30^\circ - 100\,N = 0 - (2)$$

$$TAB = \frac{100}{0.87}$$

$$\boxed{TAB = 115.04\,N} \quad -(3)$$

$R_C = 115.6 \times 0.5$

$$\boxed{R_C = 57.8\,N}$$

Or

Applying Lamis Theorem

$$\frac{T_{AB}}{\sin 90^\circ} = \frac{R_C}{\sin 210} = \frac{100}{\sin 60^\circ}$$

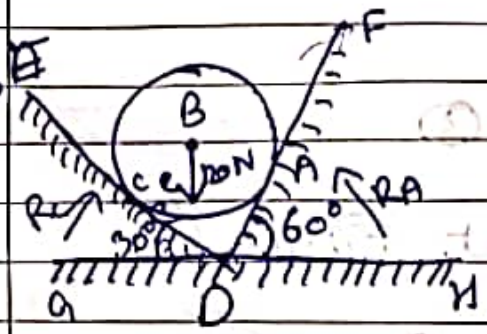
$$R_C = \frac{100 \times \sin 210}{\sin 60^\circ}$$

$$\boxed{R_C = 57.8\,N}$$

$$T_{AB} = \frac{100}{\sin 60^\circ}$$

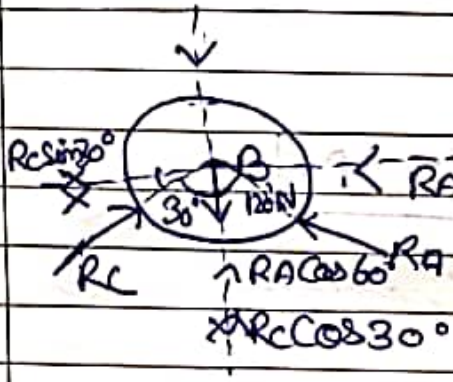
$$\boxed{T_{AB} = 115.5\,N}$$

Ques →



$R_C = ??$ & $R_A = ??$

Solⁿ



$\Sigma f_x = 0$

$R_C \sin 30 - R_A \sin 60° = 0.$

$\frac{R_C}{2} - \frac{\sqrt{3} R_A}{2} = 0$

$\frac{R_C}{2} = \frac{\sqrt{3} R_A}{2} \quad -(1).$

$\Sigma f_y = 0.$

$R_A \cos 60° + R_C \cos 30° - 120 = 0$

$\frac{R_A}{2} + \frac{\sqrt{3} R_C}{2} - 120 = 0.$

$\frac{R_A}{2} + \frac{\sqrt{3}}{2} \frac{R_C}{2} = 120 \quad -(2).$

From (1).

$\frac{\sqrt{3} R_A}{2} \cdot \frac{\sqrt{3}}{2} + \frac{R_A}{2} = 120$

$\frac{3}{2} R_A + \frac{R_A}{2} = 120$

$2R_A = 120$

$\boxed{R_A = 60\,N}$ — (3)

Now put (3) in (1)

$\frac{R_C}{2} = \frac{\sqrt{3} \times 60}{2} \cos 30$

$R_C = 60\sqrt{3}$

$\boxed{R_C = 103.92\ N}$

II.nd Method

Applying Lamis Theorem.

$\frac{T_{OB}}{\sin 120^\circ} = \frac{T_{HB}}{\sin 150^\circ} = \frac{120}{\sin 90^\circ}$

$\frac{R_C}{\sin 120} = \frac{R_A}{\sin 150} = \frac{120}{\sin 90^\circ}$

$R_A = 120 \times \sin 150$

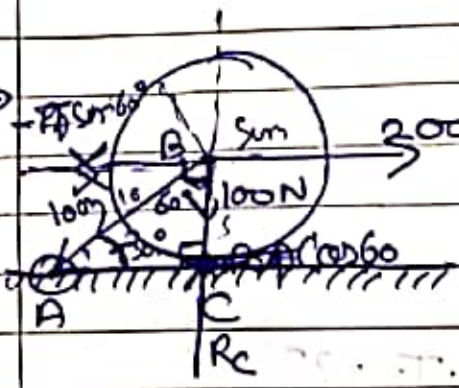
$\boxed{R_A = 60\,N}$

$\frac{R_C}{\sin 120} = \frac{120}{\sin 90^\circ}$

$R_C = \sin 120 \times 120$

$\boxed{R_C = 103.9\,N}$

Ques →



T = ?? & Rc = ??

Soln

$$\frac{8}{10} = \frac{1}{2} = \frac{P}{H} = \sin\theta = \frac{1}{2}$$

$$\theta = 30°$$

$\Sigma fx = 0.$

$$-T\sin 60° + 200 = 0$$

$$T\sin 60° = 120$$

$$\frac{\sqrt{3}}{2}T = 200 \quad \text{--- (1)}$$

$$T = \frac{200}{\sqrt{3}} \quad \text{--- (1)}$$

T = 230.9N

$\Sigma fy = 0.$

T = 138.6N

$$Rc - 100 - T\cos 60° = 0$$

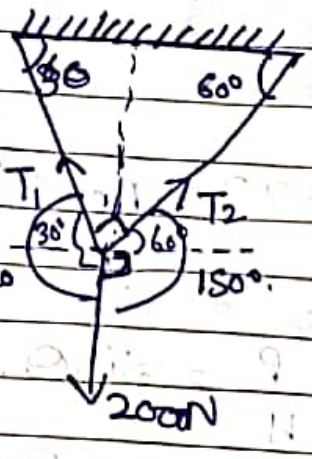
$$Rc - 100 - T \times \frac{1}{2} = 0.$$

From Eq' (1).

$$Rc - 100 - \frac{200}{\sqrt{3}} \times \frac{1}{2} = 0$$

Rc = 215.4N

Ques →



$T_1, T_2 = ??$

Sol

Sol^n Applying Lammis Theorem

$$\frac{T_1}{\sin 150^\circ} = \frac{T_2}{\sin 120^\circ} = \frac{200}{\sin 90}$$

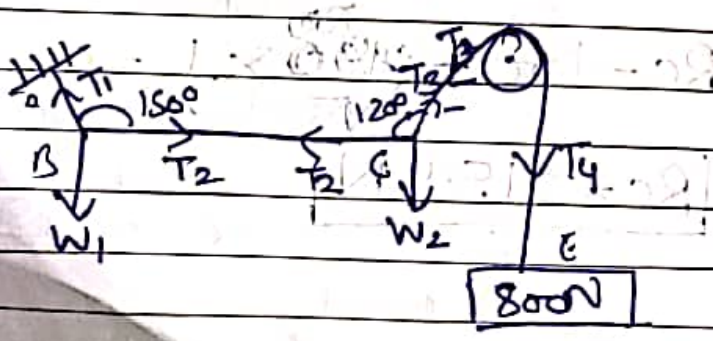
$$T_2 = 2000 \times \sin 120^\circ$$

$$\boxed{T_2 = 173.2N}$$

$$T_1 = 2000 \times \sin 150^\circ$$

$$\boxed{T_1 = 1000N}$$

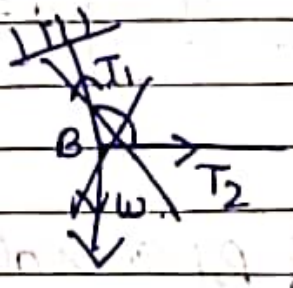
Ques →



$T_1, T_2, T_3; T_4 = ??$

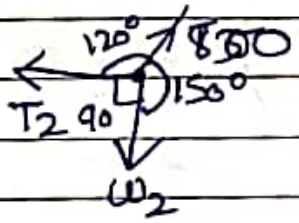
$W_1, W_2 = ??$

Soln First we will Apply Lami's Theorem at B.



Soln $T_3 = T_4 = 800\ N$

Applying Lamis Theoram At C.



$$\frac{T_2}{\sin 150} = \frac{800}{\sin 90} = \frac{W_2}{\sin 120°}$$

$$T_2 = 800 \times \sin 150°$$

$$\boxed{T_2 = 400\ N}$$

$$W_2 = 800 \times \sin 120°$$

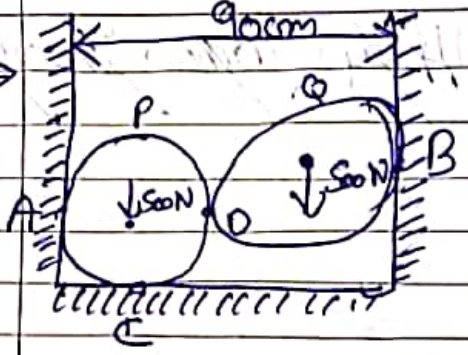
$$= 800 \times$$

$$\boxed{W_2 = 692.8\ N}$$

Applying Lami's Theoram At B.

$$\frac{T_1}{\sin 90} = \frac{400}{\sin 120} = \frac{W_1}{\sin 150}$$

$$\boxed{T_1 = 461.9\ N} \qquad \boxed{W_1 = 230.9}$$

Ques → 

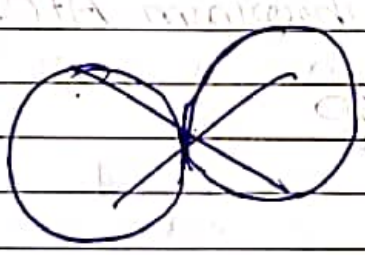
A. V. V. Imp Ques.

[| - Vertical - cos
— - Horizontal - sin]

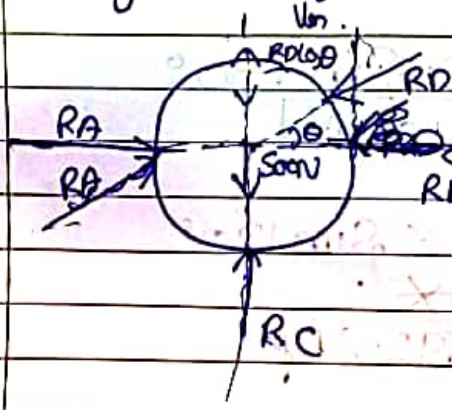
Radius of P & Q rollers are 25cm.

R_A, R_B & R_C = ??

Soln



Soln First we will make free body diagram of P roller.



$\sin\theta = \frac{3}{5}$ $\cos\theta = \frac{4}{5}$

$\Sigma f_x = 0$

$R_A - R_D \cos\theta = 0$

$R_A - \frac{4}{5} R_D = 0$ — (1)

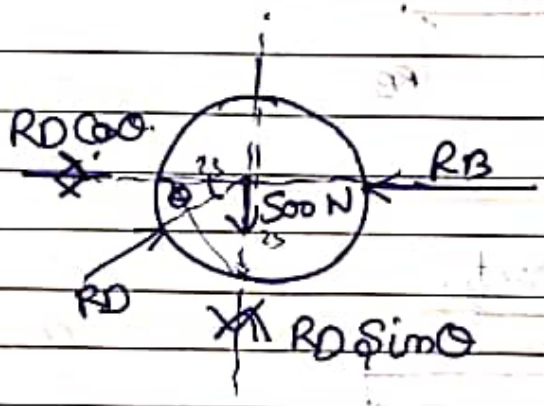
$R_A = \frac{4}{5} R_D$ — (1).

$\Sigma f_y = 0$

$R_C - 500 - R_D \sin\theta = 0$

$R_C = 500 + \frac{3}{5} R_D$ — (2)

Free body diagram of C.



$\Sigma f_x = 0$

$R_D \cos\theta - R_B = 0$

$R_B = R_D \cos\theta$

$R_B = \frac{4}{5} R_D$ — (3)

$\Sigma f_y = 0$.

$R_D \sin\theta - 500 = 0$

$R_D = 500 \times \frac{5}{3}$

$R_D = \frac{2500}{3}$ N

$R_C = 500 + \frac{3}{5} \times \frac{2500}{3}$

$R_C = 1000$ N

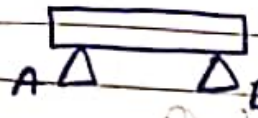
$R_D = 1666.6$ N

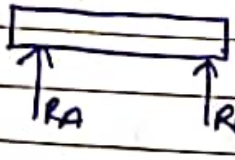
$R_D = 833$ N

$R_A = R_B = \frac{4}{5} \times \frac{500}{3} = 666.6$ N

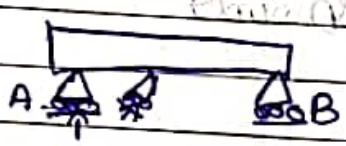
Types of Supports:

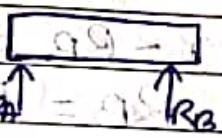
① Simple Support:





② Roller Support:

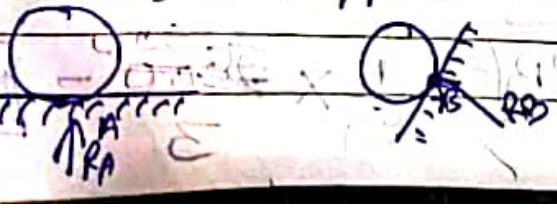




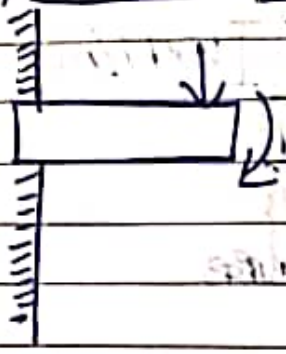
③ Hinged Support:

Support reaction depends on type of load.

④ Smooth Surface Support:

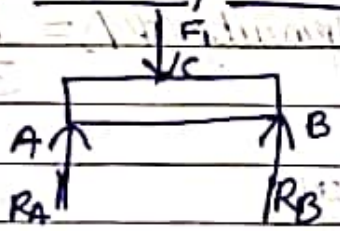


⑤ Fixed / Built in Support:

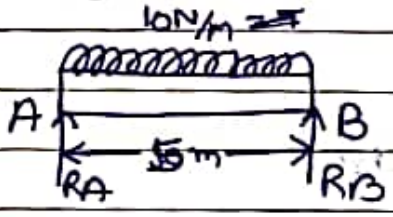


Types of Loads:

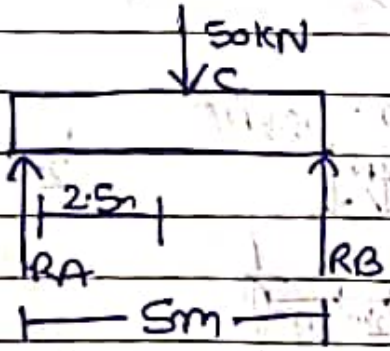
① Point load / Concentrated load:



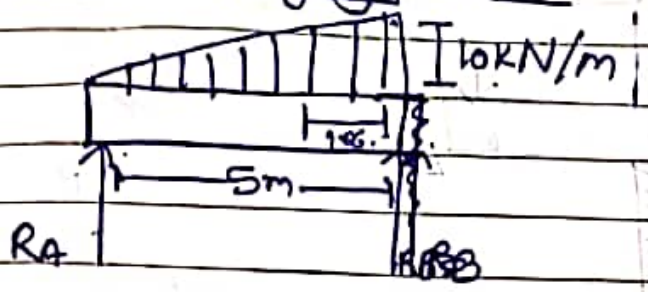
② Uniformly distributed load:



Total load = 10N/m x 5m
= 50kN.



③ Uniformly varying load

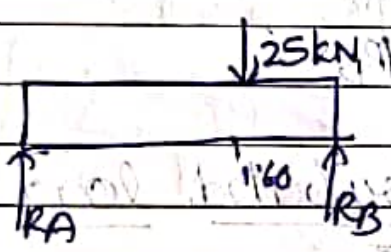


Total load = $\frac{1}{2} \times b \times h$

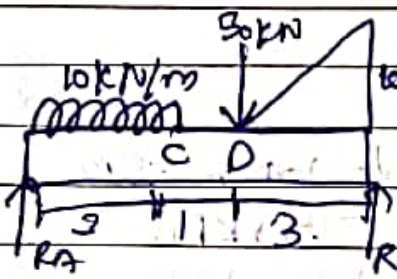
$= \frac{1}{2} \times 5 \times 10$

$= 25KN$

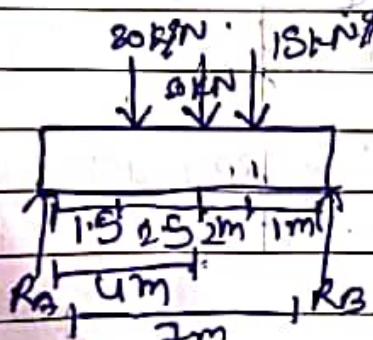
Centre of gravity of $\Delta = \frac{h}{3}$



Qu)



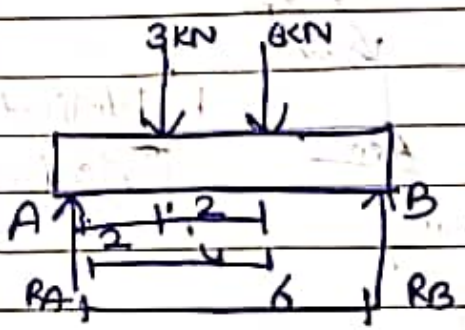
Solⁿ



$\frac{1}{2} \times 3 \times 10 = 15KN$

$\frac{B}{3}$

Ques →



Soln Applying Equilibrium cond^n.

$\Sigma fx = 0 \Rightarrow X$

$\Sigma fy = 0.$

$R_A + R_B - 3 - 6 = 0$

$R_A + R_B - 9 = 0.$

$\therefore R_A + R_B = 9 \quad -(1)$

$\Sigma m = 0$

Calculating moment at pt A.

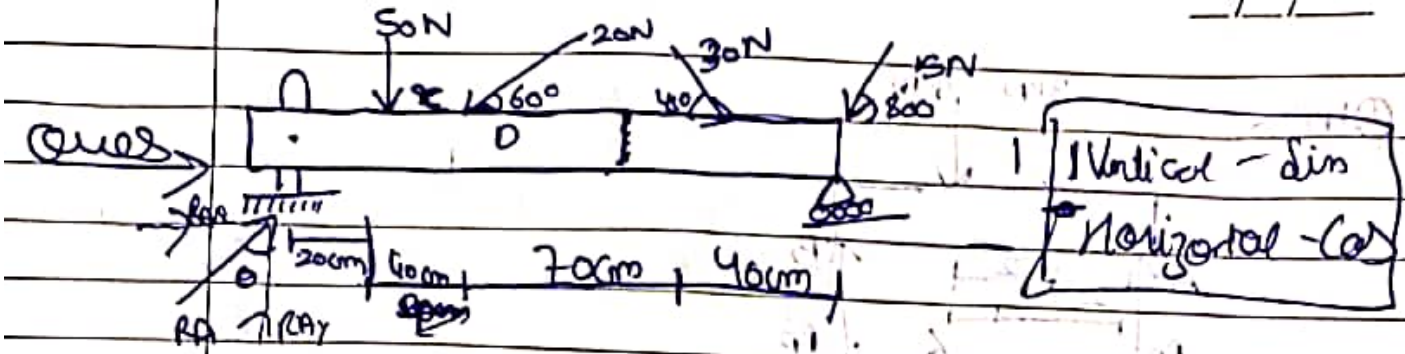
$0 - 3(2) - 6(4) + R_B(6) = 0.$

$-6 - 24 + 6R_B = 0$

$R_B = \frac{30}{6}$ KN

$\boxed{R_B = 5 \text{ KN}}$

$\boxed{R_A = 4 \text{ KN}}$



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

$$\tan\theta = \frac{R_{Ay}}{R_{Ax}}$$

$\Sigma f_x = 0$.

$R_{Ax} - 20\cos 60 + 30\cos 45 - 15\cos 80° = 0.$

$$R_{Ax} = 10 - \frac{30}{\sqrt{2}} + 15 \times 0.17$$

$$R_{Ax} = 10 - \frac{30}{\sqrt{2}} + 2.55$$

$\therefore R_{Ax} = -8.66N$ — (1)

will take Rx +ve.

$\Sigma f_y = 0$

$-50 + 20\sin 60 + 30\sin 45 - 15\sin 80 + R_{Ay} + R_B = 0.$ — *

$-50 - 17.3 - 21.2 - 14.8 + R_{Ay} + R_B = 0$

$R_{AY} + R_B = 103.3$ — (2)

$\Sigma M = 0$

Taking pt at A.

$0 - 50 \times 20 + 20 \sin 60 \times 60 + 0 + 0$
$- 30 \sin 45 \times 130 + - 15 \times 170 +$
$R_{AX} + R_B \times 170$

$-1000 - 1272 - 1924 - 2550 +$
$R_B = 0$
$R_B = 6746\ N$
$\times 170$

$R_{AY} = 103.3 = 6746$
$R_{AX} =$

$-1000 + 1038 - R_B = 42.9N.$

$R_{AY} = 103.3 - 42.9$
$R_{AY} = 60.4N$

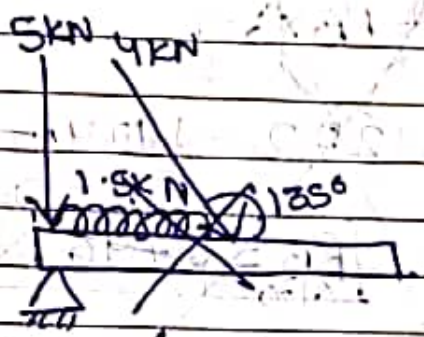
$R_A = \sqrt{(8.66)^2 + (60.4)^2}$
$= \sqrt{74.91 + 3648.16}$
$= \sqrt{3723.16}$

$R_A = 61.01\ N$

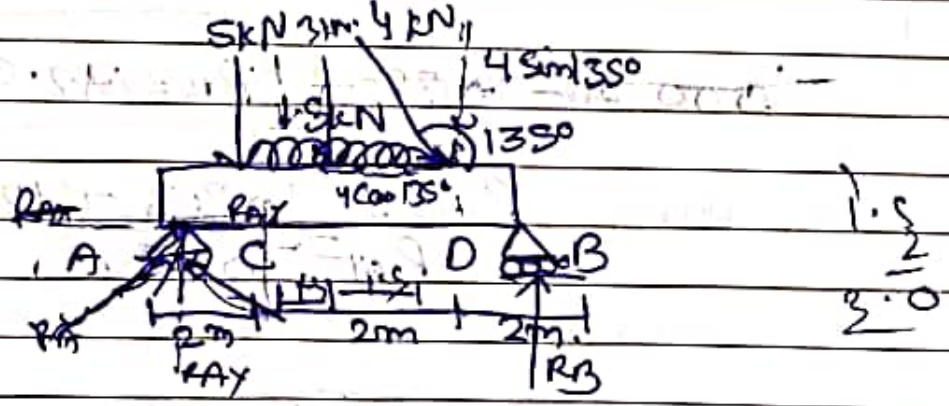
$\theta = \tan^{-1}\left(\frac{60.3}{8.66}\right) = 81.8^\circ$

Ques →

Ques



Ques



$\Sigma = 0$

Soln $\Sigma fx = 0$

$-R_{Ax} + 4\cos 135° = 0$

$R_A = \sqrt{R_{Ay}^2 + R_{Ax}^2}$ $+R_{Ax} = +2.83$

$\theta = \frac{R_{AX}}{R_{AY}}$ $\boxed{R_{AX} = 2.83}$ — (1)

$\Sigma fy = 0$.

$-5 - 3 - 4 - 4\sin 135° + R_{AY} + R_D = 0$

$-5 - 3 - 4 - 2.83 + R_{AX} + R_{AY} = 0$

$\boxed{R_{AX} + R_{AY} = 14.83}$ — (2)

$\Sigma M = 0$.

By pt. A.

$0 + 5 \times 2 + 3 \times 1.5 - 4 \times 4 + R_{By} \cdot 0 + R_B = 0$.

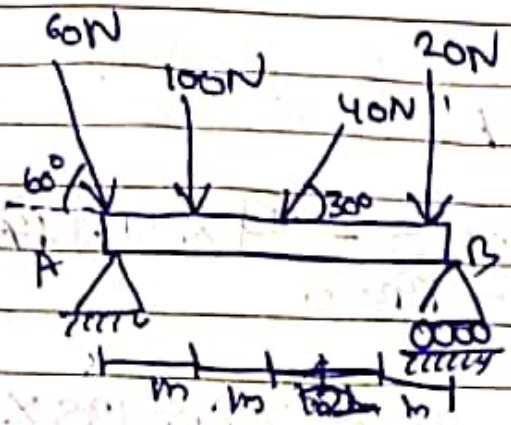
$-10 - 4.5 - 16 = -48 \sin 135 \times 6 + R_B = 0$

$-10 - 4.5 - 16 - 16.98 + R_B = 0$

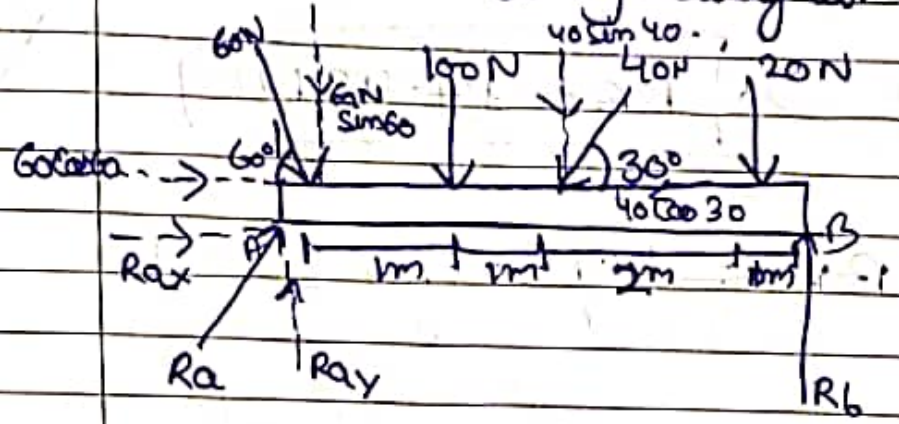
$$R_B = 47.48\ N$$

$R_{By} = 14.83$

Ques →



Sol^n The free body diagram:



By Equilibrium Conditions:

(i) $\Sigma y = 0$.

$-60 \sin 60 - 100 - 40 \sin 40 - 20 + Ray + Rb = 0$.

$Ray + Rb = 60 \sin 60 + 100 + 40 \sin 40 + 20$

$Ray + Rb = 60 \sin 60 + 40 \sin 40 + 120$.

$= 51.96 + 20.74 + 120$

$$\boxed{Ray + Rb = 191.96} \quad -(1)$$

(ii) $\Sigma x = 0$.

$60\cos 60° + -40\cos 30° + Rax = 0$

$30 - 34.64 + Rax = 0$

$$\boxed{Rax = 4.64} \quad -(2)$$

(iii) $\Sigma m = 0$.

Taking moment at pt A.

$(\curvearrowleft -(100 \times 1) - (40\sin 30 \times 2) + (20 \times 4) + R_6 \times 5 = 0$

$-100 - 40 - 80 + (R_6 \times 5) = 0$.

$R_6 = \frac{220}{5}$

$$\boxed{R_6 = 44N} \quad -(3)$$

Put value of Eqn (3) in (1)

$Ray = 191.96 - 44$

$$\boxed{Ray = 147.96\,N} \quad -(4)$$

Total reaction at hing suppot

$Ra = \sqrt{Rax^2 + Ray^2}$

$= \sqrt{(47.96)^2 + (4.64)^2}$

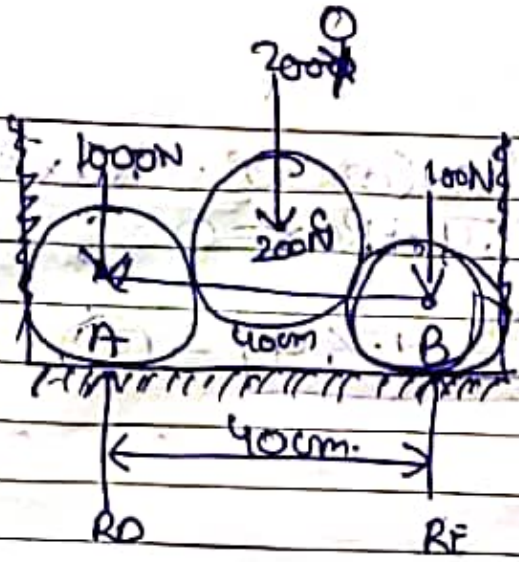
$= \sqrt{21892.2 + 21.5}$

$= \sqrt{21913.7}$

$$\boxed{Ra = 148\,N} \quad -(5)$$

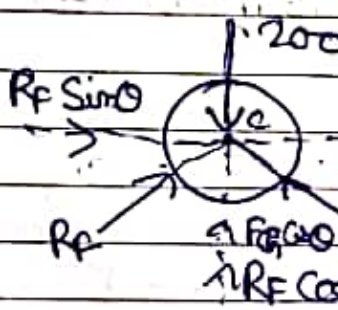
$\theta = \tan^{-1}\left(\frac{Ray}{Rax}\right) = \tan^{-1}\left(\frac{147.96}{4.64}\right) = \boxed{88.20°}$

Ques →



T, RA & RB

Soln Free body Diagram of C



$\theta = 41.81$

$\Sigma f_x = 0$

$R_F \frac{2}{3} - R_A \frac{2}{3} = 0$

$R_F \frac{2}{3} = R_A \frac{2}{3}$

$\boxed{R_F = R_A}$ — (1)

$\Sigma f_y = 0$

$-200 + R_F \cos\theta + R_A \cos\theta = 0.$

$-200 + R_F\, 0.76 + R_A\, 0.76 = 0.$

$R_F + R_A = +\frac{200}{0.76}$

$\boxed{R_F = R_A = 131.6\ N}$

$\Sigma Fx=0$.

$T + RF \sin\theta = 0$.

$T - 13146 \times \frac{3}{3} = 0$

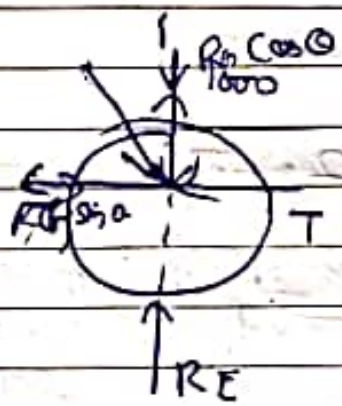
$T = 8944.6\,N$

$\Sigma Fy=0$.

$RD + RF\cos\theta - 1000 = 0$.

$RD - 13146 \times 0.76 - 1000 = 0$

$RD = 2000\,N$



$\Sigma Fx=0$.

$RG \sin\theta - T = 0$

$T = RG \sin\theta$

$T = 87.7\,N$

$T = 894.6\,N$

$\Sigma Fy=0$

$-RG\cos\theta - 1000 + RE = 0$.

$RE = 2000\,N$

Analysis of Frames: (CV-2mp):

Two types:

→ Perfect frame.
→ Imperfect frame.

$n \neq 2j-3$

Deficient → $n < 2j-3$
Redundant → $n > 2j-3$

$n = 2j-3$

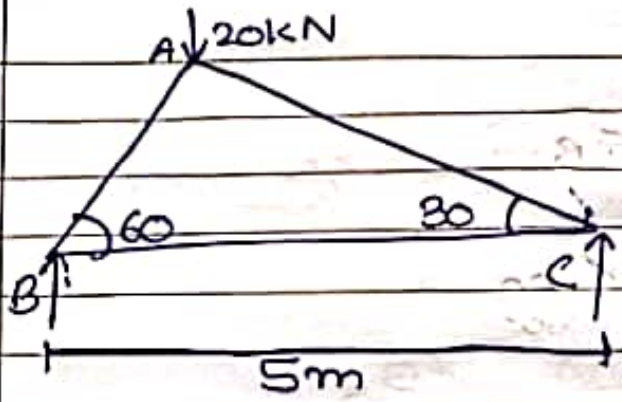
↳ perfect frame (If eqn satisfy this eqn)

n = no. of members
j = no. of joints

3 Methods of Analysis of Frames:

→ Methods of joints.
→ Methods of Sections.
→ Graphical Method. ✗ ↳ not in use any doing.

Ques →



Soln

Assume

Member	Force (N)	Nature
AB	17.32kN	Compressive
BC	8.66kN	Tensile
AC	10 kN	Compressive

① Calculate reaction at supports.

R_B & R_C

$\Sigma fx = 0$

$\Sigma fy = 0$

$\Sigma M = 0$

$BD = 2.5 \times \frac{1}{2} = 1.25$

$R_B + R_C = 20$ — ①

Taking pt about B:

$-20 \times BD + R_C \times 5 = 0$

$5R_C = 20BD$

$R_C = \frac{20 \times 1.25}{5}$

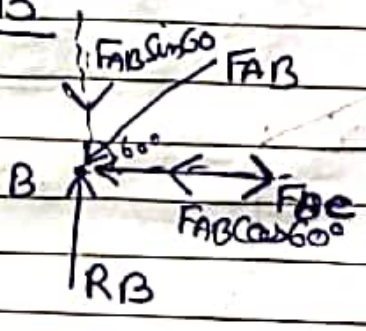
$R_C = 5kN$

$R_B = 15kN$

2 1.25 5.00

__/__/__

Joint B



$\Sigma fx = 0$

$\Sigma fy = 0.$

$FBC = FAB \cos 60.$

$RB = FAB \sin 60$

$\frac{15}{\sqrt{3}/4} = FAB$

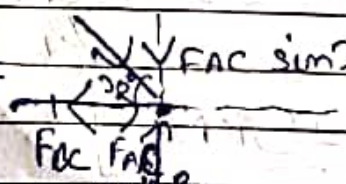
$FAB = \frac{15 \times 2}{\sqrt{3}}$

$FAB = \frac{15}{0.4}$ | $17.3 = FAB$

$FBC = \frac{17.3}{2}$

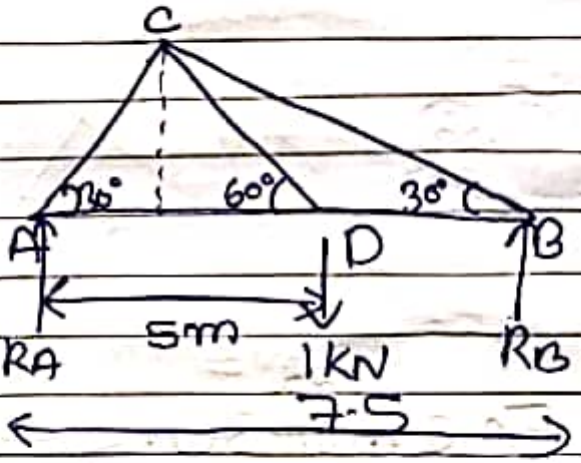
$FBC = 8.65KN$

Joint C



$FAC = \frac{8.65}{\cos 30} = 10KN$

Ques →



Soln

Members.	Force (KN)	Nature
AC	0.68	Comp
CD	1.15	Tensile
AD	0.59	Tensile
CB	1.35	Comp
DB	1.15 KN	Tensile

$\Sigma fx = 0$

$\Sigma fy = 0$

$RA + RB = 1KN.$

$\Sigma M = 0$

$1 \times 5 = RB \times 7.5$

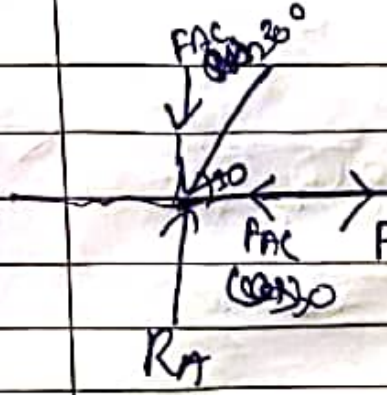
$RB = \frac{5}{7.5}$

$RB = 0.66\ KN$

$RA = 1 - 0.66$

$RA = 0.34\ KN$

Joint A



$$F_{AB} = F_{AC} \cos 30.$$

$$F_{AC} = \frac{R_A}{\sin 30}$$

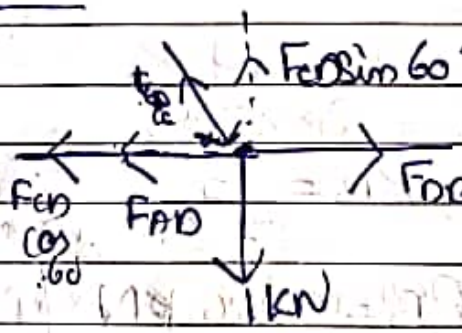
$$= R_A \, 0.34 \times 2$$

$$\boxed{F_{AC} = 0.68\ KN}$$

$$F_{AB} = 0.68 \times \cos 30$$

$$\boxed{F_{AB} = 0.59\ KN}$$

Joint D



$$\Sigma f_x = 0$$

$$+ F_{CD} \cos 60° - F_{AD} = F_{DB}.$$

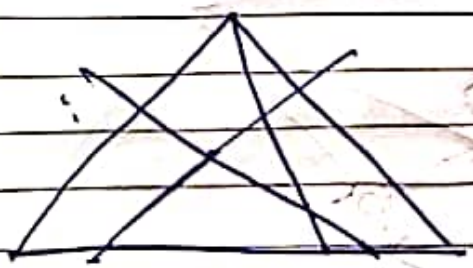
$$\Sigma f_y = 0$$

$$F_{CD} \sin 60° = 1$$

$$F_{CD} = \frac{1}{\sin 60}$$

1.15N = F

Soln:-



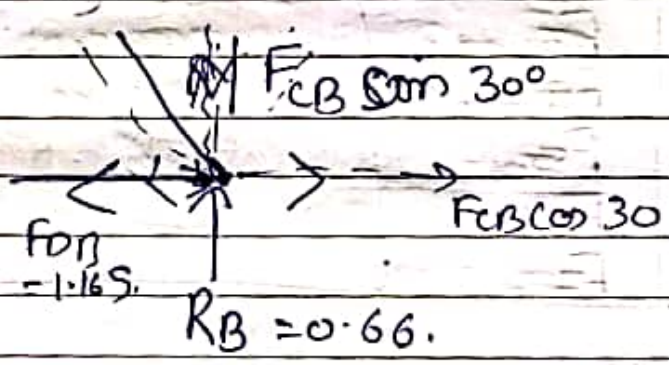
$F_{DB} = F_{CD}\cos 60° + 0.59$

$= 1.15 \times \cos 60° + 0.59$

$= 0.575 + 0.59$

$F_{DB} = 1.165\,kN$

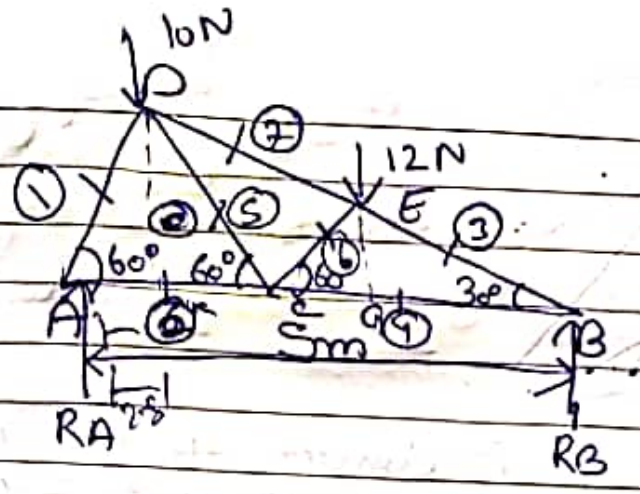
Joint at B



$F_{CB} = \dfrac{1.165}{\cos 30}$

$F_{CB} = 1.35\,N$

Ques 2 →



Soln

Members	Force (KN)	Nature
F_1		
F_2		
F_3		
F_4		
F_5		
F_6		
F_7		

$\Sigma fx = 0$

$\Sigma fy = 0$.

$-RA - RB + 10 + 12 = 0$

$RA + RB = 22\,KN$ — (1).

$\Sigma M = 0$.

~~$\sin\theta = \frac{DF}{}$~~

$\cos\theta = \frac{AF}{DA}$

$AF = DA\cos 60° = \frac{DA}{2}$

$-10 \times AF - 12 \times AG + RB \times 3 = 0$.

$RB = 10 \times AF + 12 \times AG$.

$= 5 \times DA + 12 \times AG$

Tan θ =

$\tan 60° = \frac{DA}{FA}$

ΔADB

$\frac{AD}{AB} = \cos 60°$

$AD = AB \cos 60°$

$= 5 \times \frac{1}{2}$

$= 2.5m$

$5 \times 2.5 + 12 \times 0.625$

$12.5 + 7.5$

$= 20KN$

$R_A = 16KN$

1.925

FG. = 4

$AF = \frac{H}{B} = \frac{B}{H} = \cos 60°$

$= \frac{AF}{2.5} = \cos 60$

$AF = 2.5 \times \frac{1}{2}$

$= 1.25m$

$\cos 60° = \frac{EC}{CB}$

$EC = 2.5 \times \frac{1}{2}$

$= 1.25$

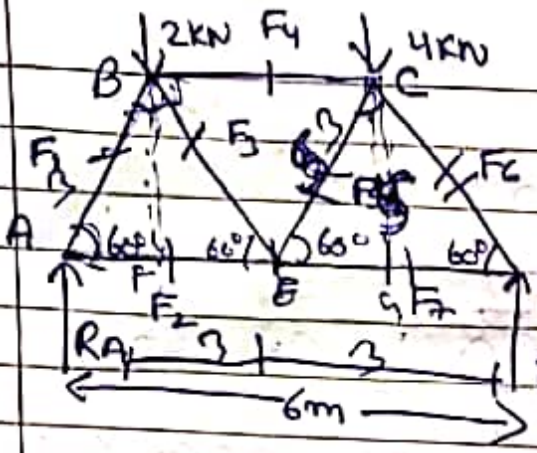
$AG = 2.5 + 0.625$

$= 3.125.$

$\cos 60° = \frac{CG}{1.25} = 1.25 \times \frac{1}{2}$

0.625

Ques →



Soln:

Members	Force (KN)	Nature
F1 = -7	4.04 KN	Compressive
F2 = -6.06	2.02 KN	Tensile
F3 = -3	1.73 KN	tensile
F4 = 8.56	2.89 KN	Compressive
F5 = -11.08	2.89	Tensile
F6 = 4.04	7 KN 4.04 KN	Compressive
F7 = 2.02	11.08	Tensile

$\Sigma fx = 0$

$\Sigma fy = 0.$

$-2 - 4 + R_A + R_B = 0$

$R_A + R_B = 6 \quad -(1)$

$\Sigma M = 0.$

$-2 \times AF - 4 \times AG + R_B \times 6 = 0.$

$R_b \times 6 = 2 \times AF + 4 \times AG$

$\cos 60° = \frac{AF}{AB}$ $\quad AF = 3 \times \cos 60$

$AF = 1.5F$

~~EE~~ = AE = 3M

AG = AE + EG.

$\cos 60° = \frac{EG}{CE}$

EG = 3 × Cos 60°

= 1.5m.

AG = 3 + 1.5

= 4.5m.

$\Sigma M = 0$.

$R_6 \times 6 = 2 \times 1.5 + 4 \times 4.5$

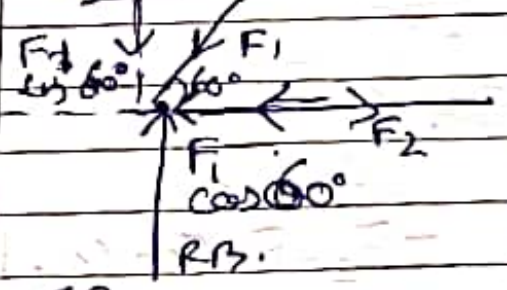
$R_6 = \frac{3 + 18}{6}$

$R_6 = \frac{21}{6}$

$R_6 = 3.5\,KN$

$R_A = 2.5\,KN$

Joint A



$\Sigma fy = 0$

$F_2 = F_1 \sin 60°$

$= 2.03\,kN$

$\Sigma fx = 0$ cos

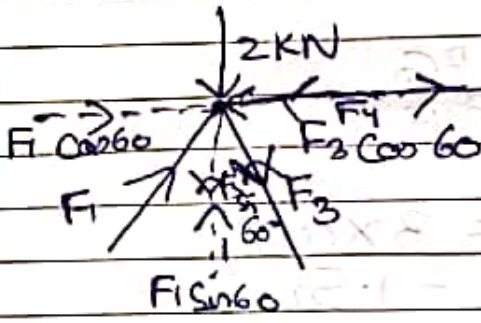
$-F_1 \sin 60 + R_B = 0$

$F_1 = \frac{R_B}{\sin 60}$

$= \frac{3.5}{\sin 60°}$

$F_1 = 4.04\,kN$

Joint B



$\Sigma f_y = 0$.

$F_1 \sin 60 + F_3 \sin 60 - F_4 = 2$

$2.02 + 3.5 - F_4 = 2$

$F_4 = 2.89\ kN$

$\Sigma f_x = 0$.

$F_3 \sin 60 + F_1 \sin 60 = 2$

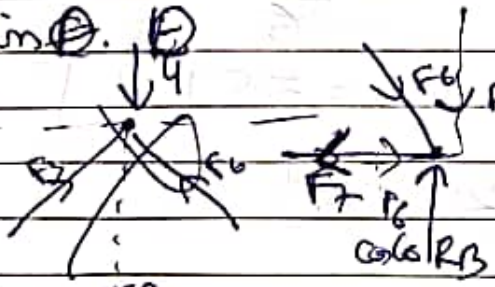
$F_3 \sin 60 + 3.5 = 2$

$F_3 = \frac{2 - 3.5}{\sin 60}$

$= -1.73$

$F_3 = 1.73$

Joint G.



$\Sigma f_y = 0$

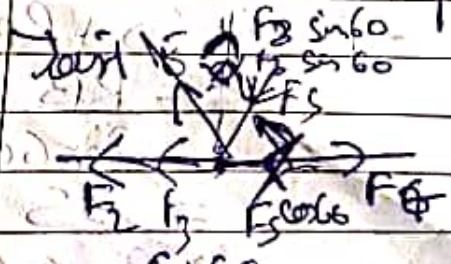
$F_6 \cos 60 = F_7 = 2.02$

$\Sigma f_y = 0$

$R_B = F_6 \sin 60$

$F_6 = 4.04\ kN$

Joint C.



$\Sigma f_x = 0$.

$-F_2 - F_3 \sin 60 - F_5 \cos 60 + F_7 = 0$.

$-6.06 - 1.5 - F_5 \cos 60 + 2.02 = 0$

$-F_5 \cos 60 = 5.54$

$F_5 = 11.08$