

Equilibrium

Conditions of equilibrium (C.O.E)

$$\sum M = 0, \sum f_y = 0, \sum f_x = 0$$

Types of Support

Pg-22

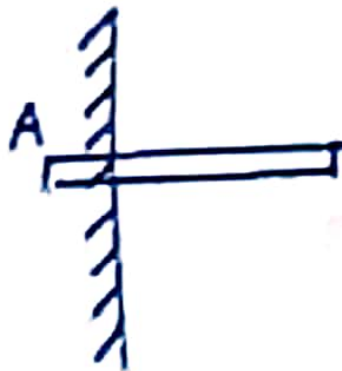
1) Roller



2) Hinged



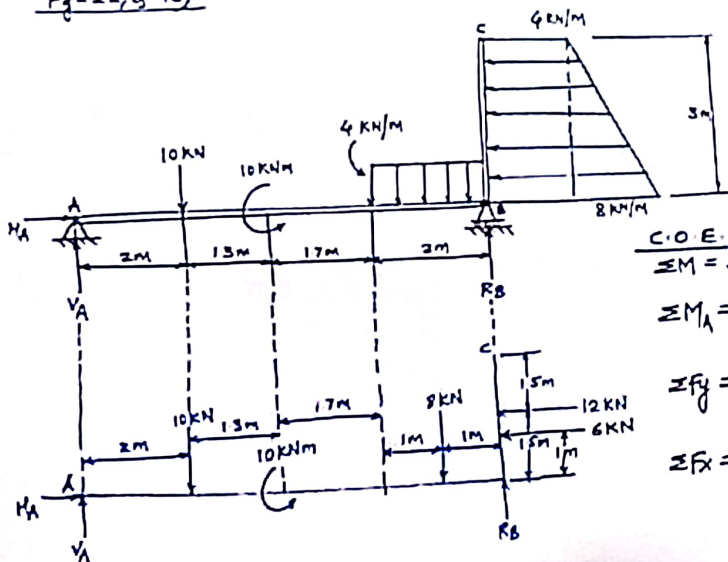
3) Fixed



Equilibrium (C.O.E)

$$\sum F_x = 0$$

Pg-22, Q-13)



C.O.E.

$$\sum M = \sum F_y = \sum F_x = 0$$

$$\sum M_A = -(10 \times 2) + 10 - (8 \times 6) + (R_B \times 7) + (6 \times 1) + (12 \times 1.5) = 0$$

$$R_B = 4.85 \text{ kN} (\uparrow)$$

$$\sum F_y = V_A - 10 - 8 + R_B = 0$$

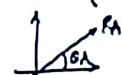
$$V_A = 13.15 \text{ kN} (\uparrow)$$

$$\sum F_x = H_A - 6 - 12 = 0$$

$$H_A = 18 \text{ kN} (\rightarrow)$$

$$R_A = \sqrt{H_A^2 + V_A^2} = 22.29 \text{ kN}$$

$$\theta_A = \tan^{-1} \left(\frac{V_A}{H_A} \right) = 36.15^\circ$$

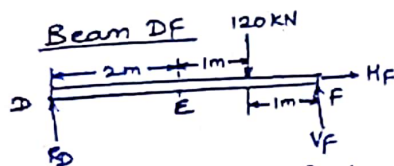
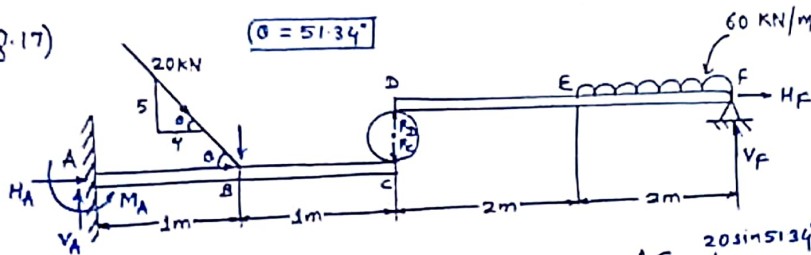




= 0

Q.17)

$\theta = 51.34^\circ$



$$\sum M_F = (120 \times 1) - (R_D \times 4) = 0$$

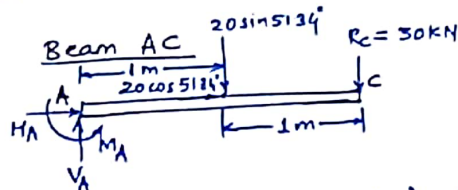
$$R_D = 30 \text{ kN}$$

$$\sum F_y = R_D - 120 + V_F = 0$$

$$V_F = 90 \text{ kN}$$

$$\sum F_x = H_F = 0$$

$$H_F = 0$$



$$\sum M_A = -(20 \sin 51.34^\circ \times 1) - (30 \times 2) + M_A = 0$$

$$M_A = 75.61 \text{ kNm}$$

$$\sum F_y = V_A - 20 \sin 51.34^\circ - 30 = 0$$

$$V_A = 45.61 \text{ kN} (\uparrow)$$

$$\sum F_x = H_A + 20 \cos 51.34^\circ = 0$$

$$H_A = -12.49 \text{ kN}$$

$$H_A = 12.49 \text{ kN} (\leftarrow)$$

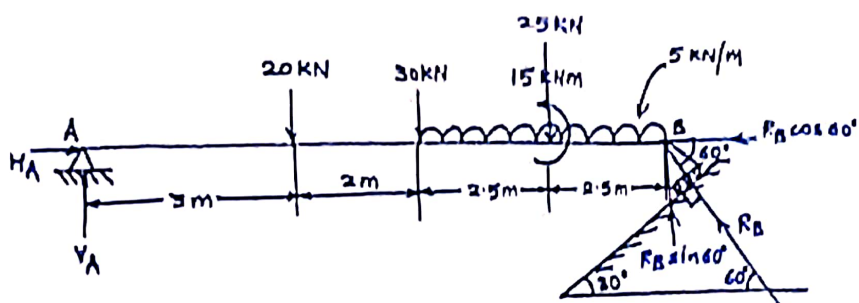
$$R_A = 47.28 \text{ kN}$$

$$\theta_A = 74.69^\circ$$



2 kN/m

3



$$\sum M_A = -(20 \times 3) - (30 \times 5) - (25 \times 7.5) + (R_B \sin 60^\circ \times 10) + 15 = 0$$

$$\boxed{R_B = 44.16 \text{ kN}} \quad (\nwarrow)$$

$$\sum F_y = V_A - 20 - 30 - 25 + R_B \sin 60^\circ = 0$$

$$\boxed{V_A = 36.75 \text{ kN}} \quad (\uparrow)$$

$$\sum F_x = H_A - R_B \cos 60^\circ = 0$$

$$\boxed{H_A = 22.08 \text{ kN}} \quad (\rightarrow)$$

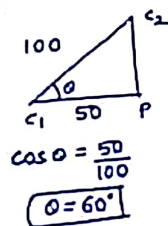
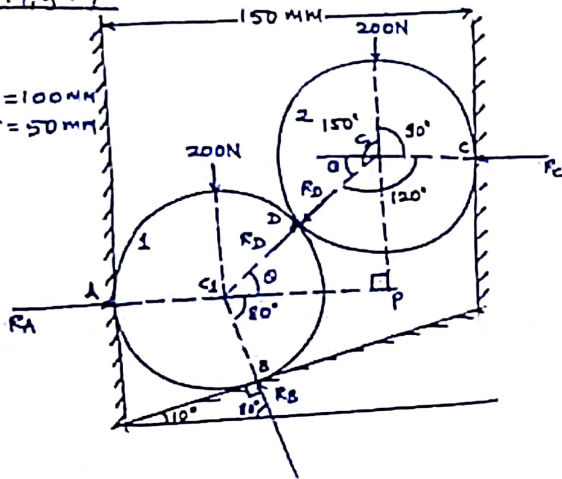
$$R_A = 42.87 \text{ kN}$$

$$\theta_A = 53^\circ$$

A small vector diagram shows the reaction force R_A acting at an angle θ_A to the horizontal axis (x-axis). The vertical axis is labeled y and the horizontal axis is labeled x.

Pg-14, Q-13)

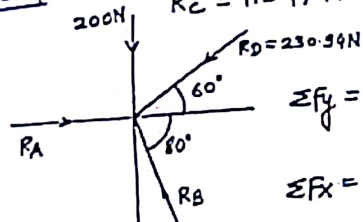
$\phi = 100 \text{ mm}$
 $\gamma = 50 \text{ mm}$



$$\frac{200}{\sin 120^\circ} = \frac{R_D}{\sin 90^\circ} = \frac{R_C}{\sin 150^\circ}$$

$$R_D = 230.94 \text{ N}$$

$$R_C = 115.47 \text{ N}$$

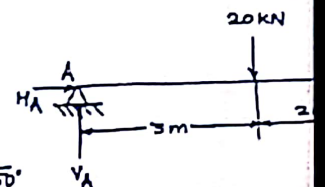


$$\sum F_y = -200 + R_B \sin 80^\circ - R_D \sin 60^\circ = 0$$

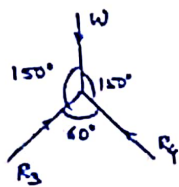
$$R_B = 406.17 \text{ KN}$$

$$\sum F_x = R_A - R_B \cos 80^\circ - R_D \cos 60^\circ = 0$$

$$R_A = 186 \text{ KN}$$



Q.30) Pg-18)

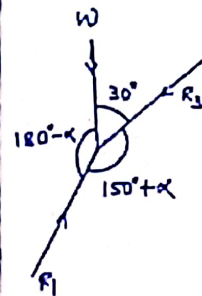
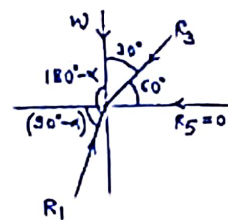
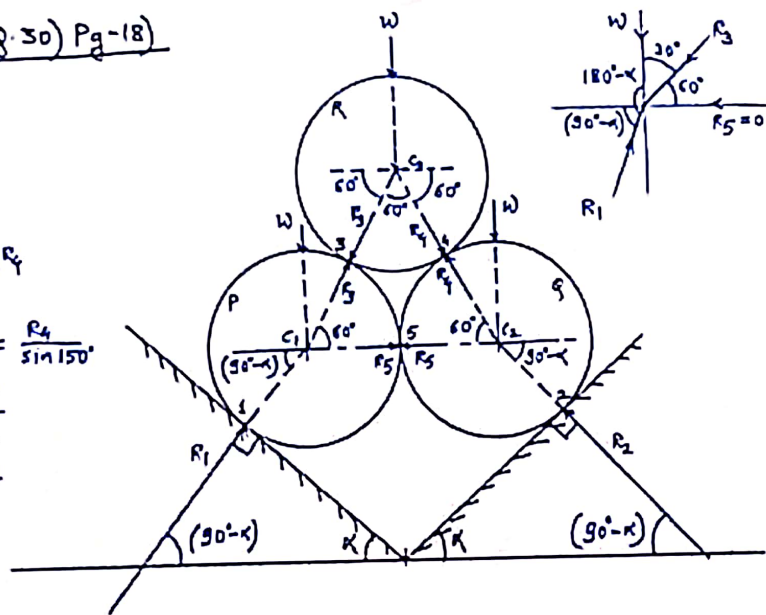


$$\frac{W}{\sin 60^\circ} = \frac{R_3}{\sin 150^\circ} = \frac{R_4}{\sin 150^\circ}$$

$$R_3 = \frac{W \sin 150^\circ}{\sin 60^\circ}$$

$$R_3 = 0.577 W$$

$$R_4 = 0.577 W$$



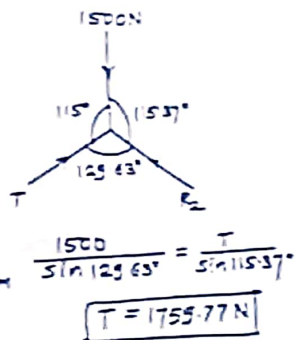
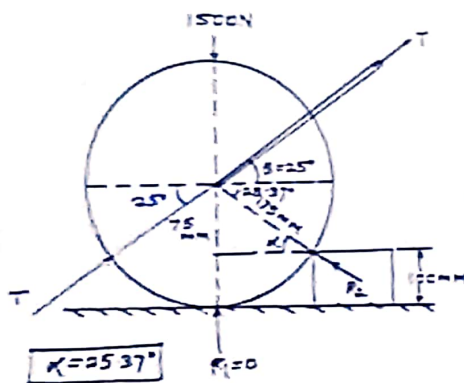
$$\frac{W}{\sin(150^\circ + \alpha)} = \frac{R_1}{\sin 30^\circ} = \frac{R_3}{\sin(180^\circ - \alpha)}$$

$$R_3 = \frac{W \sin(180^\circ - \alpha)}{\sin(150^\circ + \alpha)}$$

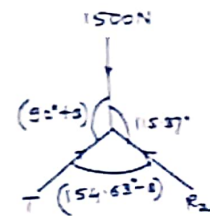
$$0.577 W = \frac{W \sin(180^\circ - \alpha)}{\sin(150^\circ + \alpha)}$$

$$\alpha = 10.88^\circ$$

29, P2-18)



$$360^\circ - 115.37^\circ - (90^\circ + \theta)$$



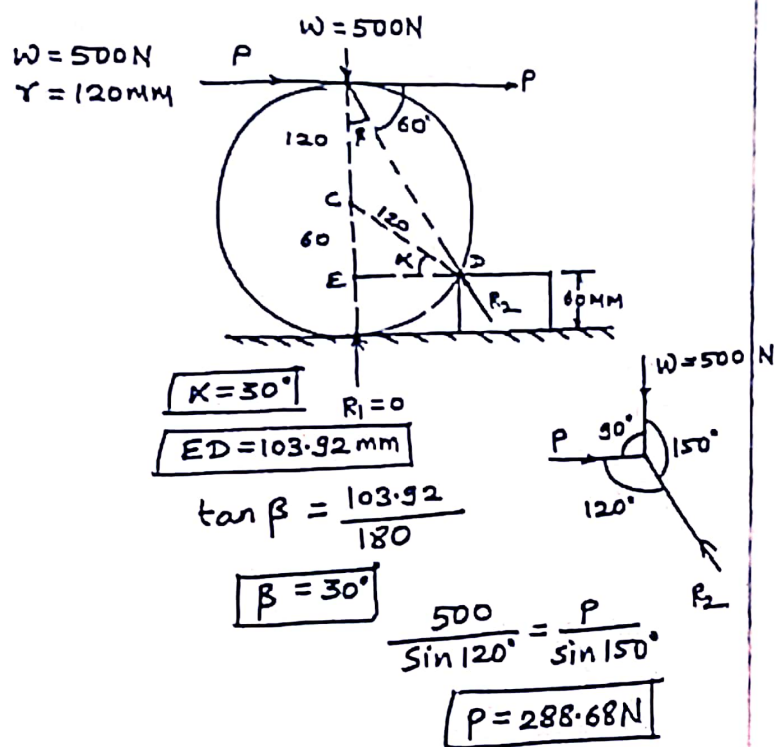
$$\frac{1500}{\sin(154.63^\circ - \theta)} = \frac{T}{\sin(115.37^\circ)}$$

$$T = \frac{1500 \sin(115.37^\circ)}{\sin(154.63^\circ - \theta)}$$

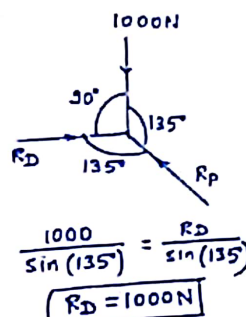
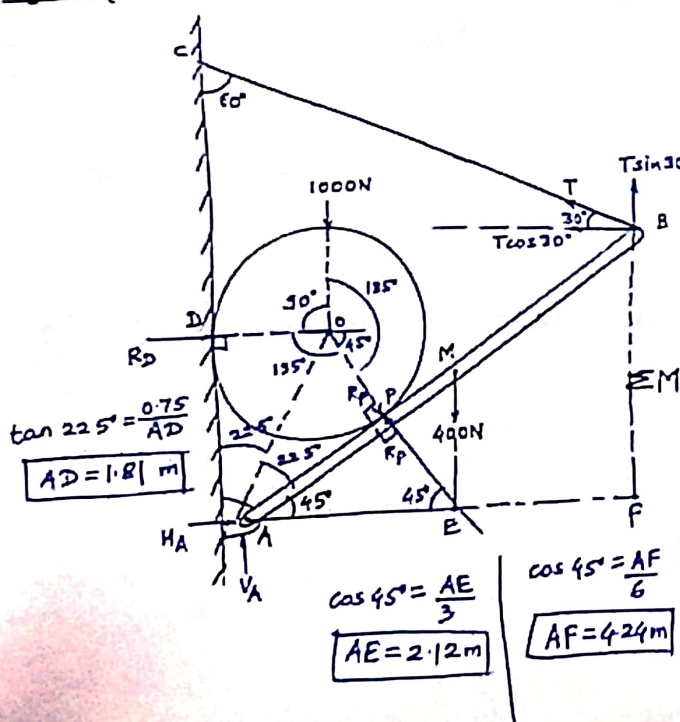
$$\sin(154.63^\circ - \theta) = \sin 90^\circ = 1$$

$$\theta = 64.63^\circ$$

$$T = 1355.33 \text{ N}$$



$$Q-11, 12 \quad Y = 0.75 \text{ m}$$



$$\sum M_A = -(400 \times 2.12) - (1000 \times 0.75) + (T \sin 30^\circ \times 4.24) + (T \cos 30^\circ \times 4.24) - (RD \times 1.81) = 0$$

$$T = 588.4 \text{ N}$$

$$\sum F_y = V_A - 1000 - 400 + T \sin 30^\circ = 0$$

$$V_A = 1105.8 \text{ N} \quad (\uparrow)$$

$$\sum F_x = H_A + RD - T \cos 30^\circ = 0$$

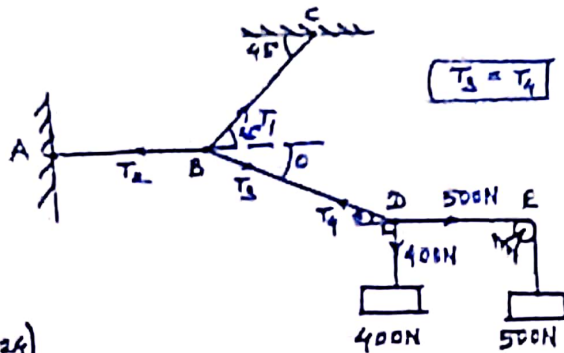
$$H_A = -490.43 \text{ N}$$

$$H_A = 490.43 \text{ N} \quad (\leftarrow)$$

$$W = 50$$

$$Y = 12$$

Find T_{AC}



$$T_3 = T_4$$

$$\sin 30^\circ \times 4.24 + (T \cos 30^\circ \times 4.24) - (R_D \times 1.81) = 0$$

$$N$$

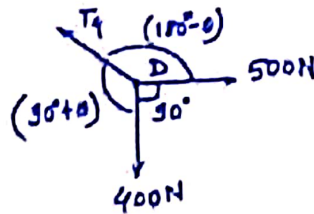
$$-400 + T \sin 30^\circ = 0$$

$$105.8 \text{ N} \quad (1)$$

$$T \cos 30^\circ = 0$$

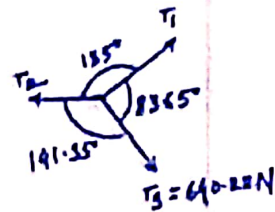
$$450.43 \text{ N}$$

$$1043 \text{ N} \quad (\leftarrow)$$



$$\theta = 38.65^\circ$$

$$T_4 = 640.22 \text{ N}$$



$$T_1 = 565.48 \text{ N} = T_{AC}$$