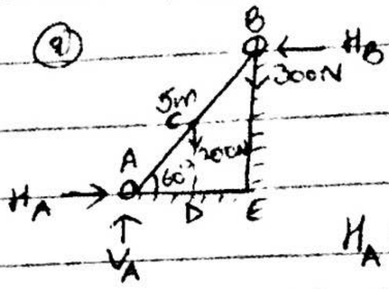
20/10/20

* Tutorial Sheet 3

(2)



$H_A = ?$

$H_A = H_B$ - ①

$V_A = 300 + 200$ - ②

$V_A = 500N$

$\Sigma M_A = 0$

$\Rightarrow 200 AD + 300 AE - H_B BE = 0$

$\frac{AD}{2.5} = \frac{1}{2}$ $AD = 1.25m$

$\frac{AE}{5} = \frac{1}{2}$ $AE = 2.5m$

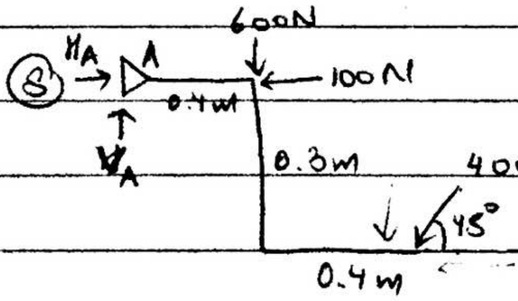
$\frac{BE}{5} = \frac{\sqrt{3}}{2}$ $BE = 4.330m$

$\Rightarrow 200 \times 1.25 + 300 \times 2.5 - H_B \times 4.330 = 0$

$\Rightarrow \frac{250 + 750}{4.330} = H_B = 230.9$

$H_B = H_A = 230.9 N$

(3)



$H_A - 100 - 400 \cos 45^\circ = 0$ - ①

$H_A = 100 + 282.88 = 382.88$

$V_A = 600 + 400 \sin 45^\circ$ - ②

$= 882.84$

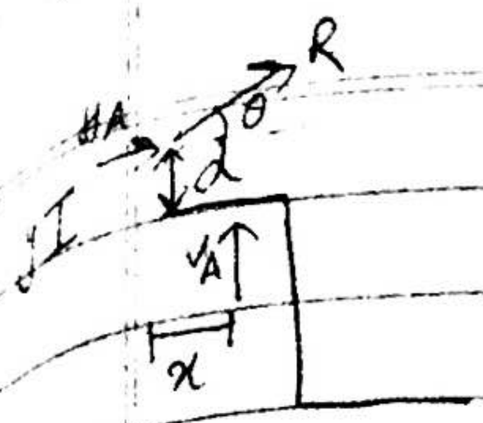
$M_A = 600 \times 0.4 + 400 \cos 45^\circ \times 0.3$

$+ 400 \sin 45^\circ \times 0.8$

$= 240 + 84.86 + 226.3$

$= 551.12 N$

$R = \sqrt{H_A^2 + V_A^2} = 962.27N$

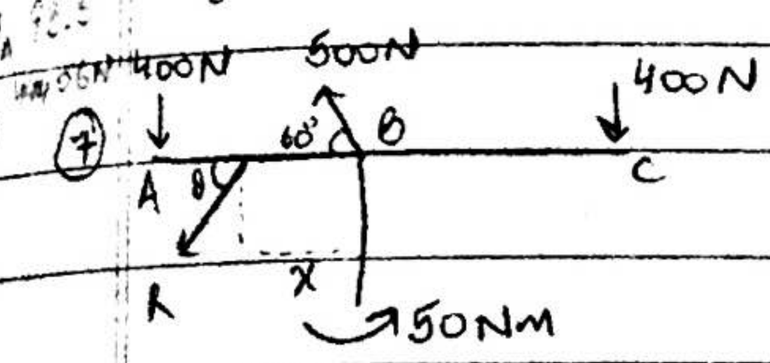


$$d = \frac{M_A}{R} = 0.572m$$

$$x = \frac{M_A}{V_A} = 0.624m$$

$$y = \frac{M_A}{H_A} = 1.439m$$

$$\theta = \tan^{-1}\left(\frac{V_A}{H_A}\right) = 66.5^\circ$$



$\Sigma f_x = 0 \Rightarrow 500\cos 60^\circ = 250N$

$\Sigma f_y = 0 \Rightarrow 800 - 500\sin 60^\circ$

$= 366.99N$

$R = \sqrt{f_x^2 + f_y^2} = 444.05N$

$\theta = \tan^{-1}\left(\frac{366.99}{250}\right) = 56.74^\circ$

$\Sigma M_B = 0$

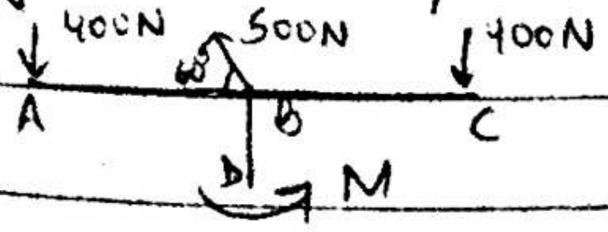
$\Rightarrow -400 \times 0.5 + 400 \times 0.4 - 50 = x \times 444.05 \sin 56.74^\circ$

$\Rightarrow -200 + 160 - 50 = x \times 444.05 \times 0.83$

$\Rightarrow -310 = -368.57x$

$\Rightarrow \boxed{x = 246.23mm}$

If resultant passes through B →

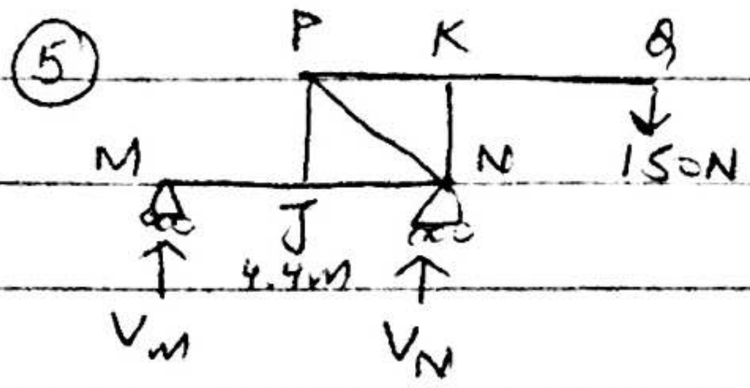


Let 'M' be couple applied anti-clockwise so that resultant passes through B.

$\Sigma M_B = 0 \Rightarrow 400(0.5) + M - 400(0.4) = 0$

$\Rightarrow M = -40$ NM (clockwise)

(5)



$V_M + V_N = 150$ -①

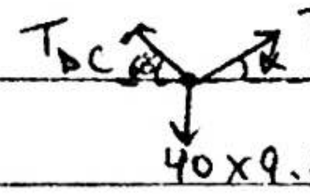
$\Sigma M_M = 0$

$\Rightarrow -V_N \times 4.4 + 150 \times 6.2 = 0$

$\boxed{V_N = 211.36N}$

$\boxed{V_M = -61.36N}$

(2) (FBD)$_D$



$T_{DC} = 30 \times 9.81 = 294.3N$

$294.3\sin 60^\circ + T_{DA}\sin x = 392.4$

$T_{DA}\sin x = 137.83$ -①

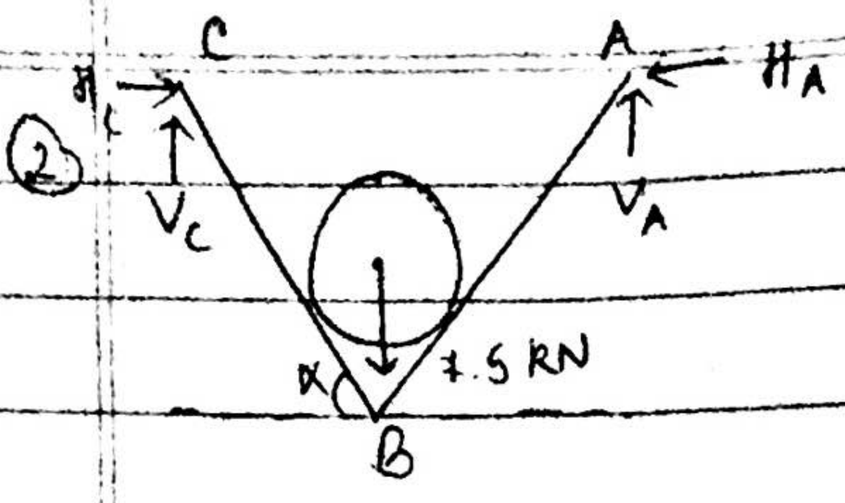
$294.3\cos 60^\circ = T_{DA}\cos x = 147.15$ -②

$\tan x = 0.93$

$x = 43.06^\circ$

$\boxed{T_{DA} = 201.57N}$

$\boxed{m = 20.54 kg}$



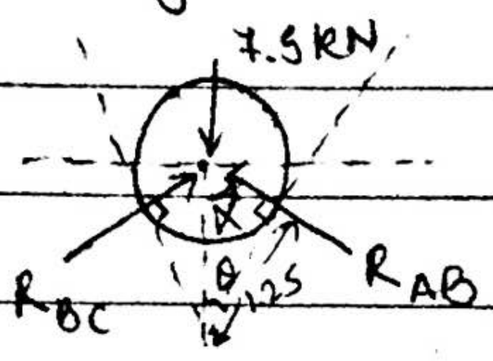
$H_A = H_c$

$V_c + V_A = 7.5$

$\boxed{V_c = V_A = 3.75\,kN}$

(due to symmetry of strings)

(FBD) cylinder



$\tan\theta = \frac{1}{1.25}$

$\theta = 38.66°$

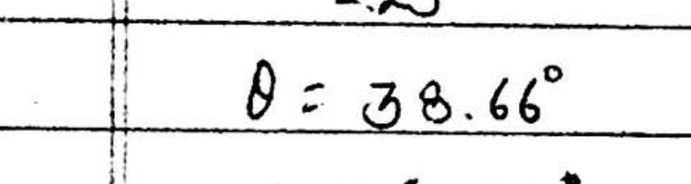
$\therefore \alpha = 51.34°$

from symmetry, $R_{BC} = R_{AB}$

$\Sigma f_y = 0 \Rightarrow 2R_{AB}\cos\alpha = 7.5$

$\Rightarrow \boxed{R_{AB} = \frac{7.5}{2\times\cos\alpha} = 6\,kN}$

(FBD) wall / AB side



$\Sigma M_B = 0$

$\Rightarrow R_{AB}\times 1.25 = A_x\times 2.5 + A_y\times 2$

$\Rightarrow \frac{6\times 1.25 - 2\times 3.75}{2.5} = A_x = 0$

$\Sigma f_x = 0 \Rightarrow R_{AB}\cos\theta + B_x = A_x$

$\Rightarrow B_x = -6\cos 38.66$

$\boxed{B_x = -4.69\,kN}$

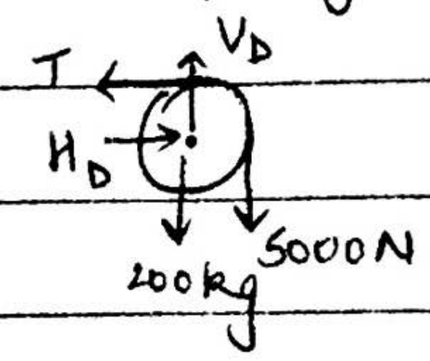
$\Sigma f_y = 0$

$\Rightarrow R_{AB}\sin\theta + B_y = A_y$

$\Rightarrow B_y = 3.75 - 6\sin 38.66°$

$\boxed{B_y = 0}$

(3) (FBD) pulley



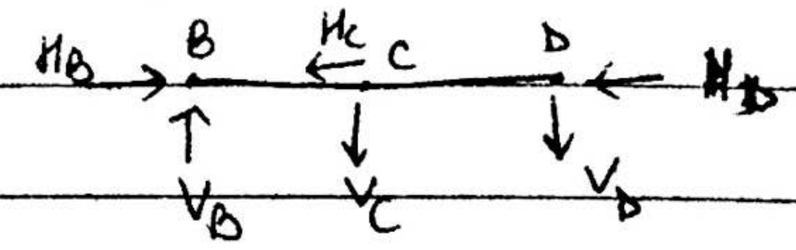
$\boxed{T = 5000\,N}$

$\boxed{H_D = 5000\,N}$

$V_D = 5000 + 200\times 9.81$

$\boxed{V_D = 6962\,N}$

(FBD) BCD



$\Sigma M_B = 0$

$\Rightarrow V_C\times 4 + V_D\times 5.9 = 0$

$\Rightarrow \boxed{V_C = -\frac{6962\times 5.9}{4} = -10268.95\,N}$

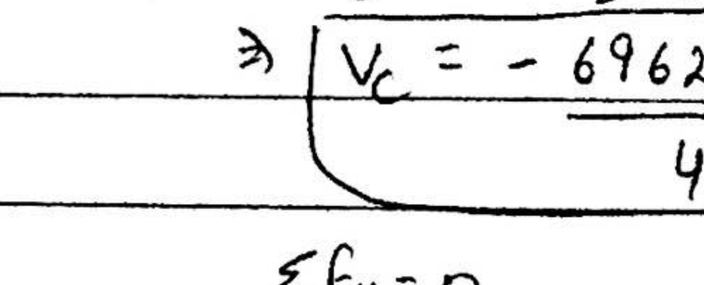
$\Sigma f_y = 0$

$\Rightarrow V_B = V_C + V_D$

$\Rightarrow V_B = -10268.95 + 6962$

$\boxed{V_B = -3306.95\,N}$

(FBD) AECf



$\Sigma M_A = 0$

$\Rightarrow 1400\times 1.3 + 5000\times 3.1 + H_c\times 2.5 = V_c\times 4$

$\Rightarrow \boxed{H_c = -23358.32\,N}$

④ O(0,0,0)

A(6,0,0)

B(0,5,0)

C(0,0,-3)

D(0,0,3)

$\vec{F}_{AB} = |F_{AB}|\left(\frac{-6\hat{i}+5\hat{j}}{7.81}\right)$

$\vec{F}_{AC} = |F_{AC}|\left(\frac{-6\hat{i}-3\hat{k}}{6.7}\right)$

$\vec{F}_{AD} = |F_{AD}|\left(\frac{-6\hat{i}+3\hat{k}}{6.7}\right)$

$\Sigma F_x = 0$

$\Rightarrow -0.77 F_{AB} - 0.89 F_{AC} - 0.89 F_{AD} = 0$

$\Sigma F_y = 0$

$\Rightarrow 0.64 F_{AB} - 600 = 0$

$\therefore \boxed{F_{AB} = 937.5\,N}$

$\Sigma F_z = 0$

$\Rightarrow -0.45 F_{AC} + 0.45 F_{AD} = 0$

$\therefore F_{AC} = F_{AD}$

$-721.875 = 1.78 F_{AC}$

$\Rightarrow \boxed{F_{AC} = -405.55\,N}$

$\boxed{F_{AD} = -405.55\,N}$

$\Sigma F_y = 0$

$\Rightarrow V_A - P = 0$

$\Rightarrow \boxed{V_A = P}$

$\Sigma M_A = 0$

$\Rightarrow P \times 5 + M_E \times 5 = 0$

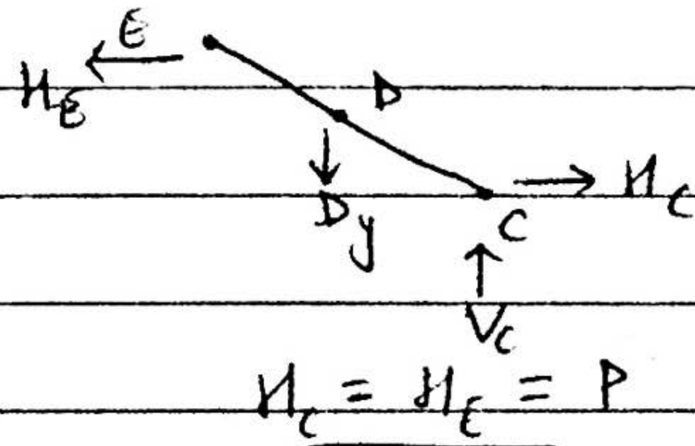
$\Rightarrow \boxed{M_E = -P}$

$(FBD)_{pulley}$

$D_x = 0$

$\boxed{D_y = 2P}$

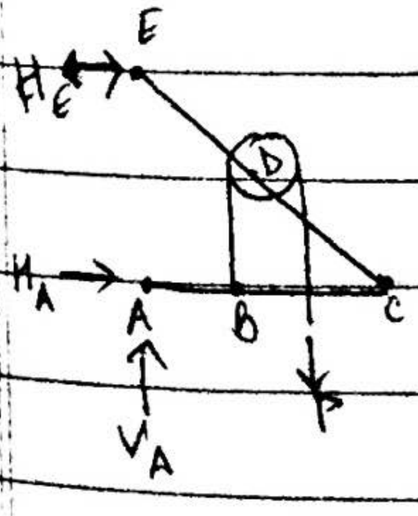
$(FBD)_{EDC}$



$M_c = M_E = P$

$\boxed{V_c = 2P}$

⑥



$\Sigma F_x = 0$

$\Rightarrow M_A + (+M_E) = 0$

$\Rightarrow \boxed{M_A = -M_E}$