SAP - ID - 60004200132
Name - Ayush Jain

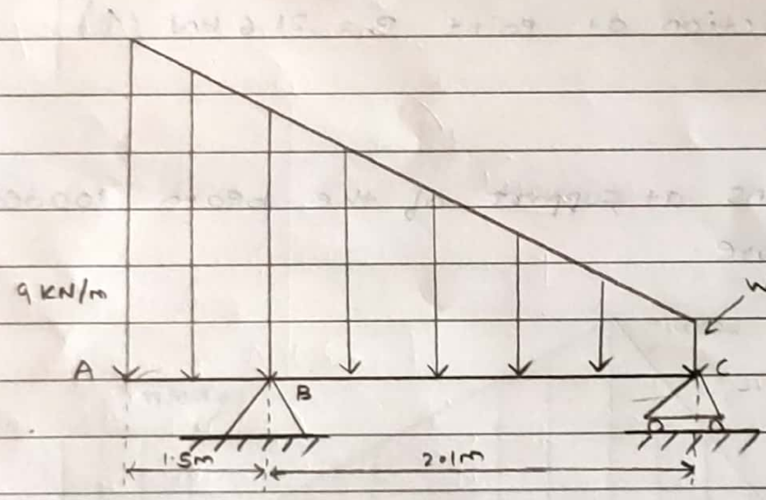
DATE:

Engineering Mechanics

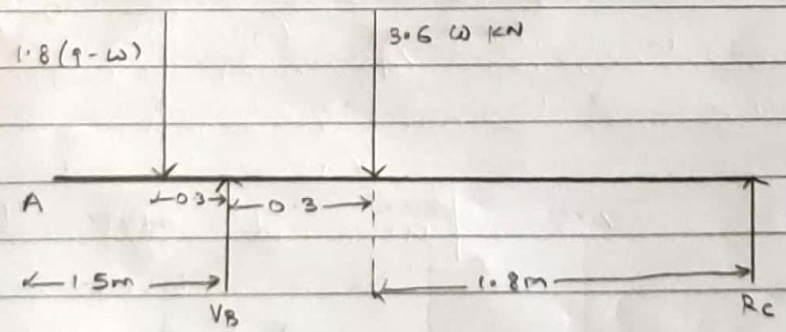
Assignment - 2

Beam Reaction and Equilibrium

2.3) Determine the intensity of distributed load w kN/m at the end C of the beam ABC for which the reaction at C is zero. Also calculate the reaction at B.



Solution FBD:



For moment at B ($\Sigma M_B = 0$)

$\Sigma M_B = -(3.6\omega \times 0.3) + (1.8(9 \cdot \omega) \times 0.3) + (2.1 \times R_C)$

$\because R_C = 0$ ... given

$\therefore \Sigma M_B = 0 = -1.08W + 4.86 - 0.54\omega$

$1.62\omega = 4.86$

$\therefore \boxed{W = 3\,kN}$

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For R_B, $\Sigma F_y = 0$ $[\because H_B = 0, \because \Sigma F_x = 0]$

($\uparrow$ +ve)

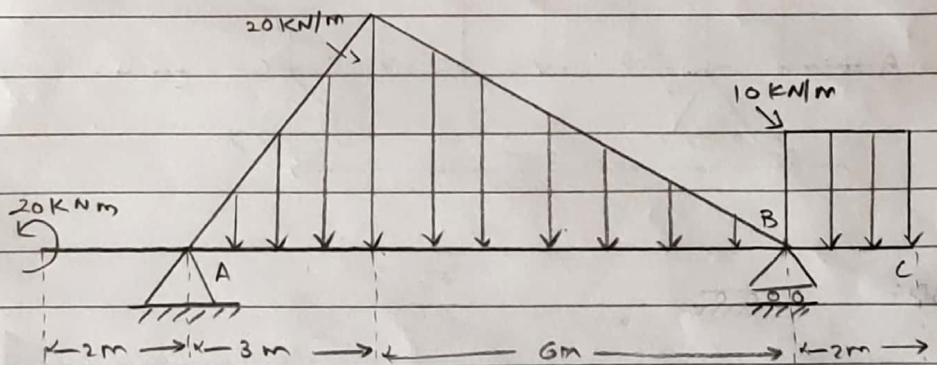
$\therefore \Sigma F_y = 0$

$\Sigma F_y = -1.8(9.w) + R_B - 3.6w + R_C = 0$

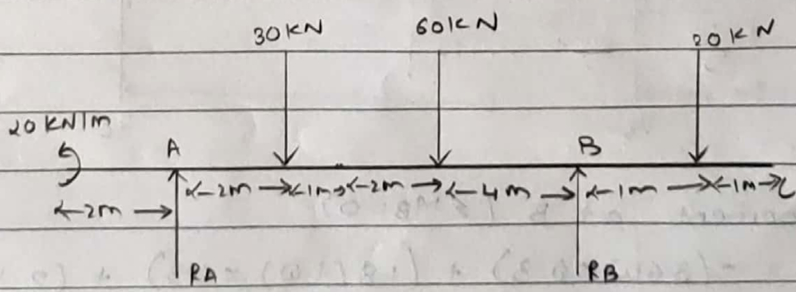
$\therefore \boxed{R_B = 21.6\ KN}$

$\therefore$ W = 3KN, reaction at point B = 21.6 kN ($\uparrow$)

2.4) Find the reactions at support of the beam loaded as shown in the figure.



$\longrightarrow$ FBD



Now moment at A ($\Sigma M_A = 0$)

$\Sigma M_A = 0 = -(30 \times 2) - (60 \times 5) + 9 \times R_B - (20 \times 10) + 20$

$\therefore 9R_B = 60 + 300 + 200 - 20 = 540$

$\therefore \boxed{R_B = 60\ kN}$

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Now, for HA and VA

$\Sigma F_x = 0$

$\therefore \boxed{HA = 0}$

$\Sigma F_y = 0$

$\therefore VA - 30 - 60 + RB - 20 = 0$

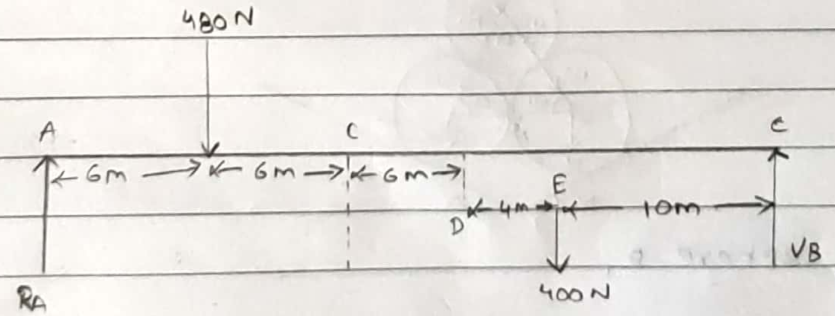
$\therefore VA = 110 - 60$

$\therefore VA = RA = 50 KN$

$\therefore$ $\boxed{\text{Reaction at } A = 50 KN (\uparrow), \text{ Reaction at } B = 60 KN (\uparrow)}$

2.7) Find the reactions at supports of the beam loaded as shown in the figure.

→ FBD:



$\therefore$ Moment at A ($\Sigma MA = 0$)

$\Sigma MA = 0 = -(6 \times 480) - (22 \times 400) + 32 VB$

$\therefore \boxed{VB = 365 N}$

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For HB, $\Sigma F_x = 0$

$\therefore \Sigma F_x = H_B = 0N$

$$\boxed{\therefore R_B = V_B = 365\ N}$$

For RA,

$\Sigma F_y = 0 \quad (\uparrow +ve)$

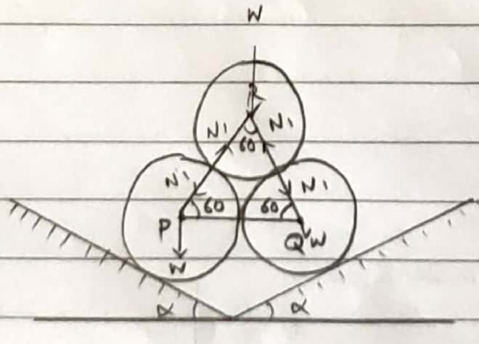
$\therefore \Sigma F_y = 0 = RA - 480 - 400 + V_B$

$\therefore RA = 480 + 400 - 365$

$$\boxed{\therefore R_A = 515\ N}$$

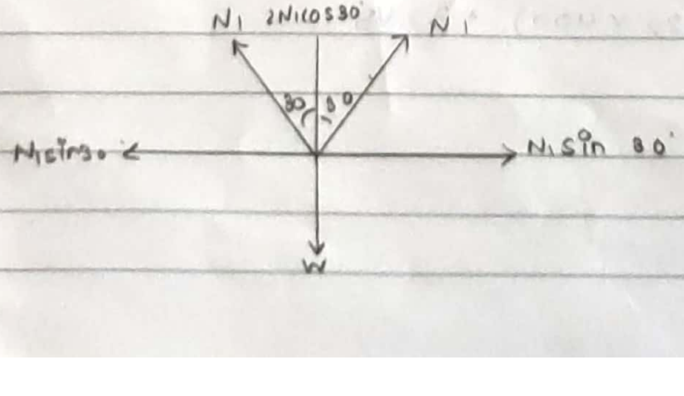
$\therefore$ Reaction at A = 515N (↑) Reaction at B = 365 N (↑)

2.11) Three identical spheres P, Q, R of weight W are arranged on smooth inclined surface as show in the figure. Determine the angle α which will prevent the arrangement from collapsing.



Consider sphere R,

→ FBD,



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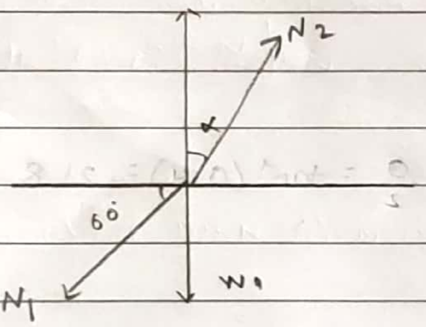
$\therefore$ From the above FBD, we have

$W = 2N_1 \cos 30°$

$\therefore \frac{W}{\sqrt{3}} = N_1$ — (i)

By Lami's Theorem,



$$\frac{W}{\sin(150+\alpha)} = \frac{N_1}{\sin(180-\alpha)} = \frac{N_2}{\sin 30}$$

$$\therefore \frac{N_1}{\sin\alpha} = \frac{W}{\sin(150+\alpha)}$$

$$\therefore \sqrt{3}\sin\alpha = \sin(150+\alpha)$$

$$\therefore \sqrt{3} = \frac{\cot\alpha}{2} - \frac{\sqrt{3}}{2}$$

$$\therefore \cot\alpha = 2\sqrt{3} + \sqrt{3} = 5.196$$

$$\therefore \tan\alpha = 0.1924$$

$$\therefore \alpha = \tan^{-1}(0.1924)$$

$$\therefore \boxed{\alpha = 10.89°}$$

$\therefore$ The required value of α is $10.89°$

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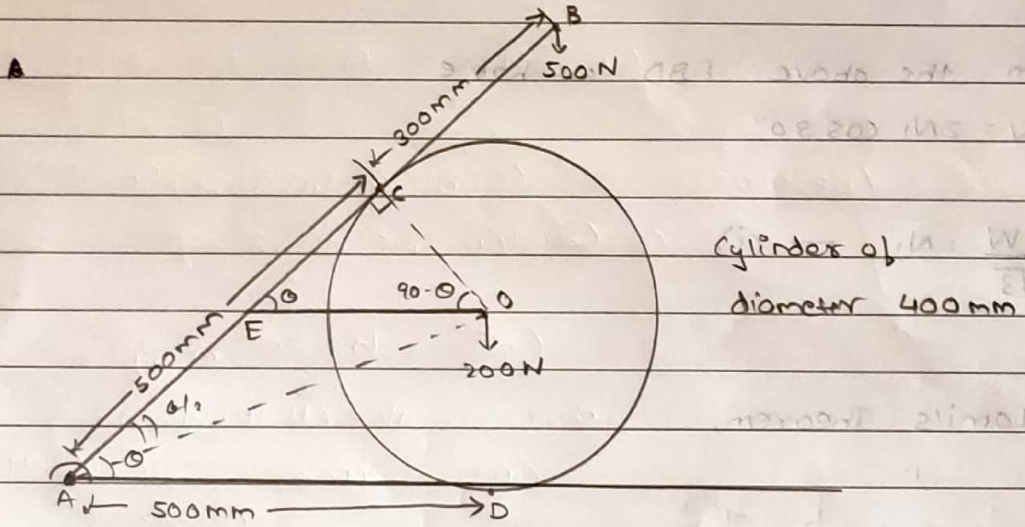
2.18)



$\Delta OAD \sim \Delta OAE$

$\tan\left(\frac{\theta}{2}\right) = \frac{200}{500}$ $\qquad \frac{\theta}{2} = \tan^{-1}(0.4) = 21.8$

$\therefore \theta = 43.6°$

For RD,

Moment at point A ($\Sigma M_A = 0$)

$\Sigma M_A = 0$

$(-200 \times 500) + (500 \times R_D) - 500 \times 800 \cos 43.6°$

$0 = -(200 \times 500) + 500 R_D - (500 \times 579.337)$

$\therefore \boxed{R_D = 779.337 N}$ — (i)

NOW, $\Sigma F_x = 0$

$\therefore H_A = 0$

$\Sigma F_y = 0$

$\therefore V_A + R_D - 200 - 500 = 0$

$\therefore V_A = R_A = 79.337 N \ (\downarrow)$ — (2)

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Now,

$\Sigma F_x = 0$

$-T + R_C \cos(46.4) = 0$

$\therefore T = R_C \cos(46.4)$ — (3)

$\Sigma F_y = 0$

$-R_C \sin(46.4) + V_A - 500 = 0$

$\therefore R_C = -800N$ — (4)

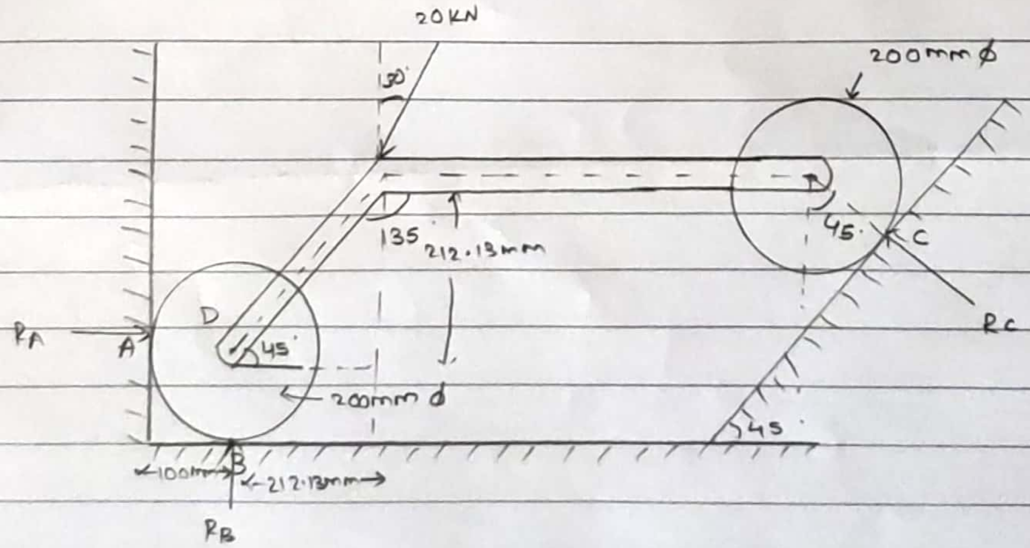
$\therefore T = -800 \cos(46.4)$

$\therefore \boxed{T = -551.69\ N}$

$\therefore$

i) Reaction at hinge A = 79.337N (↓)
2) Tension in the wire = 551.69N
3) Reaction at C = 800N (46.4°)
4) Reaction at D = 779.337 N

2.20)



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Moment at point D ($\Sigma M_D = 0$)

$$\Sigma M_D = 0 = (212.13 \times 20 \sin 30) - (212.13 \times 20 \cos 30) + (512.13 \times R_C \cos 45) + (212.13 \times R_C \sin 45)$$

$\therefore R_C = 3.03$ kN (45°)

Now,

$\Sigma F_x = 0$

$\Sigma F_x = 0 = R_A - 20 \sin 30 - 3.03 \sin 45$

$\therefore R_A = 12.142$ kN ($\longrightarrow$)

$\Sigma F_y = 0$

$\Sigma F_y = 0 = R_B - 20 \cos 30 + 3.03 \cos 45$

$\therefore R_B = 15.178$ kN ($\uparrow$)

$\therefore$

Reaction at A	= 12.142 kN ($\longrightarrow$)
Reaction at B	= 15.178 kN ($\uparrow$)
Reaction at C	= 3.03 kN (45°)