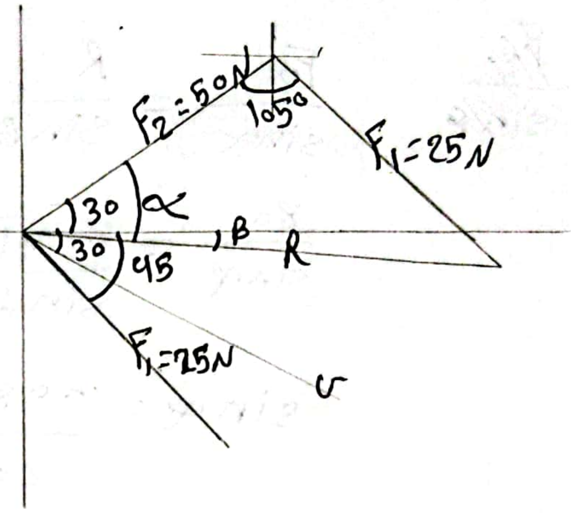
Statics
sheet (1)

Q1:- In each of the following figures, determine the magnitude and direction of the resultant of the two forces shown

(1) $R = \sqrt{F_1^2 + F_2^2 - 2F_1F_2\cos\theta}$



$R = \sqrt{25^2 + 50^2 - 2\times50\times25\cos105}$

$R = 61{,}4\,N$

$\dfrac{F_1}{\sin\alpha} = \dfrac{R}{\sin\theta}$ $\quad\because \alpha = 30 + \beta$

$\dfrac{25}{\sin(30+\beta)} = \dfrac{61{,}4}{\sin105}$

$61{,}4\sin(30+\beta) = 25\sin105$

$\sin(30+\beta) = \dfrac{25(\sin105)}{61{,}4}$

$\sin(30+\beta) = {,}39$

$30 + \beta = 23{,}16$

$\beta = -6{,}84$

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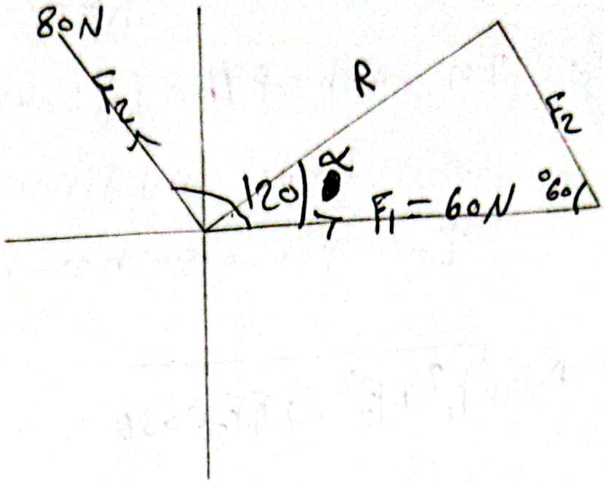
Long
case

$R=\sqrt{F_1^2+F_2^2-2F_1F_2\cos\theta}$



$=\sqrt{60^2+80^2-2*60*80\cos 60}$

$R=20\sqrt{13}\ N$

$\frac{F_2}{\sin\alpha}=\frac{R}{\sin\theta}$

$\frac{80}{\sin\alpha}=\frac{20\sqrt{13}}{\sin 60}$

$\sin\alpha=\frac{80\sin 60}{20\sqrt{13}}$

$\alpha=73,89°$

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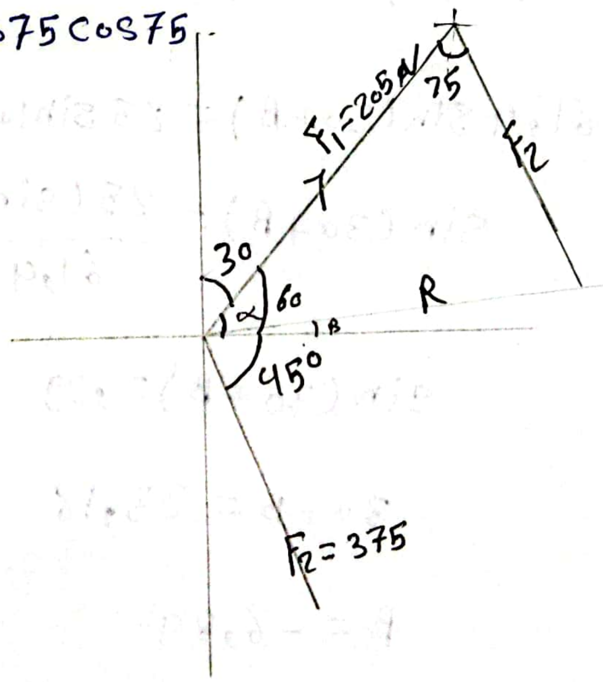
③ $R=\sqrt{250^2+375^2-2*250*375\cos 75}$



$R=393,2N$

$\cancel{\alpha}\ \alpha=60-\beta$

$\frac{R}{\sin 75}=\frac{F_2}{\sin\alpha}$

$\frac{393,2}{\sin 75}=\frac{375}{\sin(60-\beta)}$

$\sin(60-\beta)=\frac{375\sin 75}{393,2}$

$\sin(60-\beta)=67,1°=\alpha$

$60-\beta=67,1\qquad \beta=-7,1°$

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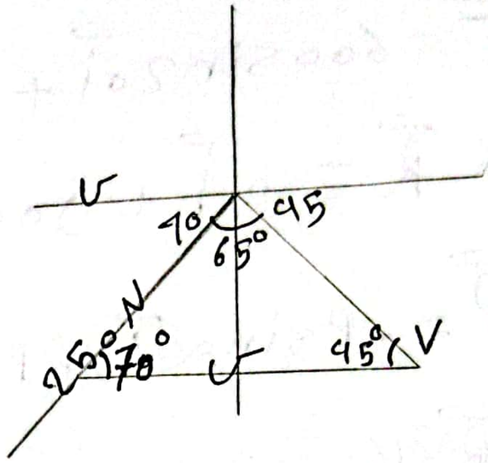
Q2:- Determine the components of the F force acting along the u and v



$$\frac{F_v}{\sin 70} = \frac{F_u}{\sin 65} = \frac{F}{\sin 45}$$

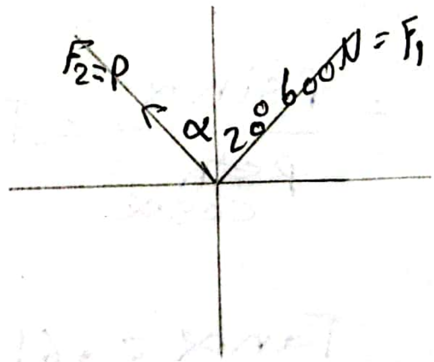
$$\frac{F_v}{\sin 70} = \frac{250}{\sin 45}$$

$$\boxed{F_V = 332,2 N}$$

$$\frac{F_u}{\sin 65} = \frac{250}{\sin 45}$$

$$\boxed{F_u = 320,4 N}$$

Q3:- Knowing that $\alpha = 30°$ determine the magnitude of the force so that the resultant force is vertical



$$\vec{F_1} = 600 \sin 20 \vec{i} + 600 \cos 20 \vec{j}$$

$$\vec{F_2} = -P \sin 30 \vec{i} + P \cos 30 \vec{j}$$

$$\vec{R} = 0 \vec{i} + R \vec{j}$$

$$600 \sin 20 - P \sin 30 = 0$$

$$\boxed{P = \frac{600 \sin 20}{\sin 30} = 410,4 N}$$

$$R = 600 \cos 20 + P \cos 30$$

$$\boxed{R = 919,2 N}$$

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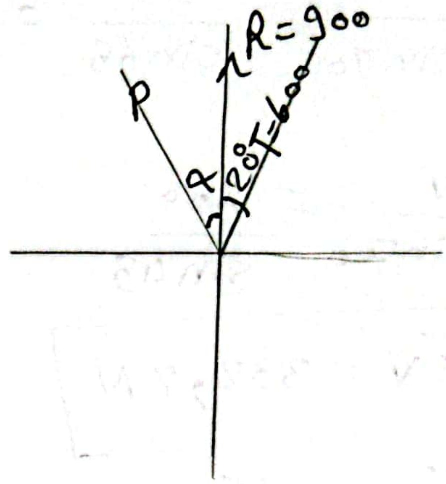
4:- Determin the magnitude and direction of the Force P so that the resultant is a Vertical Force of 900 N



$$\vec{T} = 600\sin 20\,\vec{i} + 600\cos 20\,\vec{J}$$

$$\vec{R} = 0\,\vec{i} + 900\,\vec{J}$$

$$\vec{P} = -P\sin\alpha\,\vec{i} + P\cos\alpha\,\vec{j}$$

$$\vec{R} = (600\sin 20) - (P\sin\alpha)\vec{i} + (600\cos 20) + (P\cos\alpha)\vec{J}$$

$$\therefore 600\sin 20 - P\sin\alpha = 0 \Rightarrow \boxed{P\sin\alpha = 600\sin 20} \quad 1$$

$$600\cos 20 + P\cos\alpha = 900 \Rightarrow \boxed{P\cos\alpha = 900 - 600\cos 20} \quad 2$$

$$P_x = P\sin\alpha = 600\sin 20 \quad , P_y = P\cos\alpha = 900 - 600\cos 20$$

$$\frac{P_x}{P_y} = \frac{P\sin\alpha}{P\cos\alpha} = \tan\alpha = \frac{600\sin 20}{900 - 600\cos 20}$$

$$\tan\alpha = ,61 \qquad \boxed{\therefore \alpha = 31,4^\circ}$$

$$\therefore P = \frac{600\sin 20}{\sin\alpha} = \frac{600\sin 20}{\sin 31,4} = 393,86\,N$$

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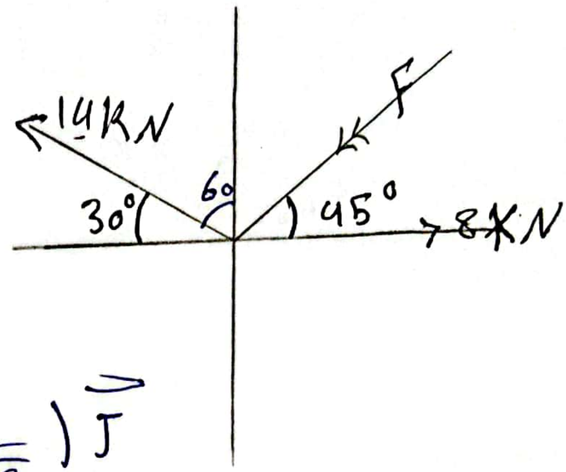
Q5:- Determine the magnitude of force F so that the resultant force of three forces is as small as possible

Let $F_1 = 8KN$, $F_2 = 14KN$, $F_3 = F$



$\vec{F_1} = 8\vec{i}$

$\vec{F_2} = -14\cos 30\,\vec{i} + 14\sin 30\,\vec{J}$

$\vec{F_3} = -F\cos 45\,\vec{i} - F\sin 45\,\vec{J}$

$$\vec{R} = \left(8 - 7\sqrt{3} - \frac{F}{\sqrt{2}}\right)\vec{i} + \left(7 - \frac{F}{\sqrt{2}}\right)\vec{J}$$

$$R^2 = \left(8 - 7\sqrt{3} - \frac{F}{\sqrt{2}}\right)^2 + \left(7 - \frac{F}{\sqrt{2}}\right)^2$$

$$2R\frac{dR}{dF} = 2 \times \frac{-1}{\sqrt{2}}\left(8 - 7\sqrt{3} - \frac{F}{\sqrt{2}}\right) + 2 \times \frac{-1}{\sqrt{2}}\left(7 - \frac{F}{\sqrt{2}}\right)$$

$$R\frac{dR}{dF} = \frac{-1}{\sqrt{2}}\left[\left(8 - 7\sqrt{3} - \frac{F}{\sqrt{2}}\right) + \left(7 - \frac{F}{\sqrt{2}}\right)\right]$$

$$0 = \frac{-1}{\sqrt{2}}\left(15 - 7\sqrt{3}\right.$$

$$15 - 7\sqrt{3} = \frac{2F}{\sqrt{2}}$$

$$\boxed{F = 2{,}03}$$ #

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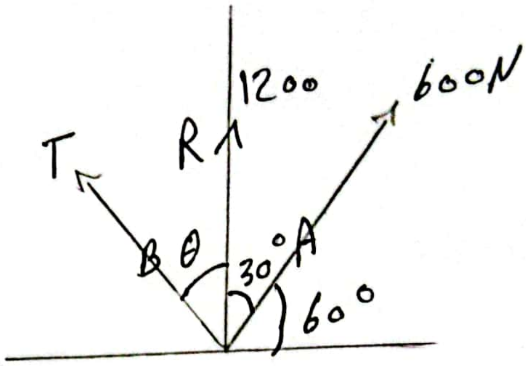
Q6:- If the resultant force acting on the post is to be 1200 vertically upward, determine the force T in rope B and the corresponding angle θ



$$\vec{T}_A = 600\cos60\,\vec{i} + 600\sin60\,\vec{j}$$

$$\vec{T}_B = -T\sin\theta\,\vec{i} + T\cos\theta\,\vec{j}$$

$$\vec{R} = 0\,\vec{i} + 1200\,\vec{j}$$

$$\vec{R}_x = 600\cos60 - T\sin\theta = 0 \Longrightarrow \boxed{T\sin\theta = 600\cos60} \quad (1)$$

$$\vec{R}_y = 600\sin60 + T\cos\theta = 1200 \Longrightarrow \boxed{T\cos\theta = 1200 - 600\sin60} \quad (2)$$

$$\cancel{\tan\theta =} \quad \frac{T\sin\theta}{T\cos\theta} = \tan\theta = \frac{600\cos60}{1200 - 600\sin60}$$

$$\tan\theta = ,44 \quad \boxed{\theta = 23,79^\circ}$$

$$\therefore T = \frac{600\cos60}{\sin23,79} = 743,7N$$

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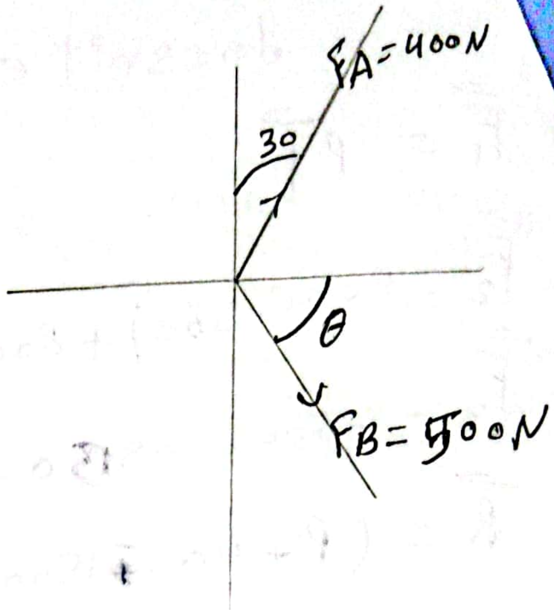
Q7 :- Determine the magnitude of the resultant Force if $\theta = 60°$



$\vec{FA} = 400 \sin 30 \,\vec{i} + 400 \cos 30 \,\vec{j}$

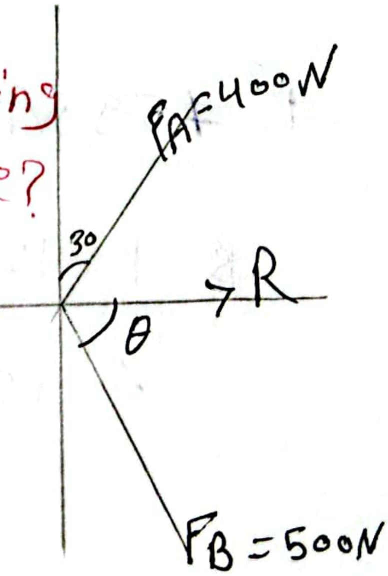
$\vec{FB} = 500 \cos 60 \,\vec{i} - 500 \sin 60 \,\vec{j}$

$\vec{R} = 450 \,\vec{i} + (200\sqrt{3} - 250\sqrt{3})\,\vec{j}$

$R = \sqrt{R_x^2 + R_y^2} = \sqrt{450^2 + (-50\sqrt{3})^2} = \boxed{458{,}25\,N}$

$\tan\theta = \dfrac{R_y}{R_x}$ $\quad \theta = \tan^{-1} \dfrac{-50\sqrt{3}}{450} = \boxed{-10{,}89°}$

Q8 :- Determine the angle θ for connecting member B and Determining the magnitude of resultant Force?



$FA = 400 \sin 30 \,\vec{i} + 400 \cos 30 \,\vec{j}$

$FB = 500 \cos\theta \,\vec{i} - 500 \sin\theta \,\vec{j}$

$\vec{R} = \vec{R}\,\vec{i} + 0\,\vec{j}$

$\vec{R} = (400 \sin 30 + 500 \cos\theta)\,\vec{i} + (200\sqrt{3} - 500 \sin\theta)\,\vec{j}$

$200\sqrt{3} - 500 \sin\theta = 0$ $\quad \boxed{\theta = \sin^{-1}\left(\dfrac{200\sqrt{3}}{500}\right) = 43{,}85°}$

$\boxed{\therefore R = \sqrt{R_x^2 + R_y^2} = 560{,}58\,N}$

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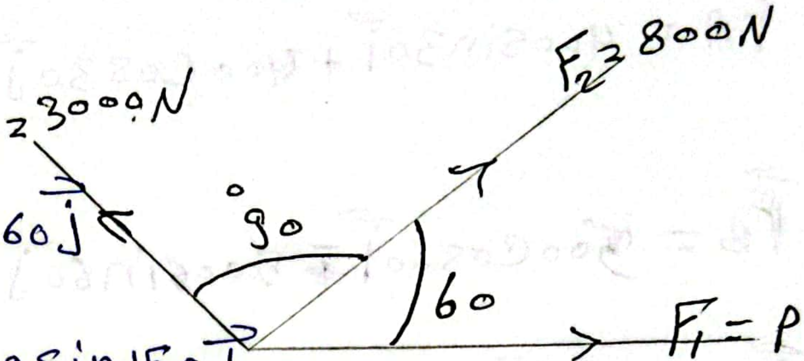
actor Eg:- Determine the rang of values for the magnitude of force P so that the R forcce doesn't exceed 2400 N.

$\vec{F_1} = P\vec{i}$



$\vec{F_2} = 800\cos 60\,\vec{i} + 800\sin 60\,\vec{j}$

$\vec{F_3} = -3000\cos 30 + 3000\sin 150\,\vec{j}$

$\vec{R} = (P + 400 - 1500\sqrt{3})\vec{i} + (200\sqrt{3} + 1500)\vec{j}$

$R = \sqrt{Rx^2 + Ry^2}$

$2400^2 = (P + 400 - 1500\sqrt{3})^2 + (200\sqrt{3} + 1500)^2$

$2400^2 = P^2 - 2 * 2198{,}1 P + 2198{,}1^2 + 2198{,}82^2$

$P^2 - 4396 P + 3880103{,}16 = 0$

$P = 1222{,}63\,N$ or $P = 3173{,}57\,N$

$\therefore 1222{,}63 \leq P \leq 3173{,}57\,N$

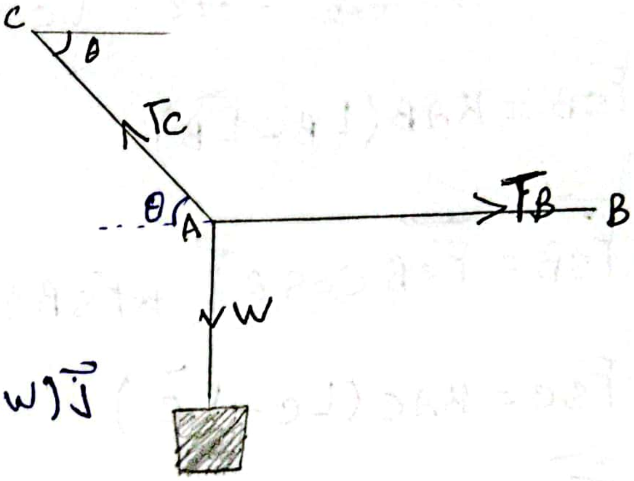
Talong

P10:- IF AB ALways remains horizontal, determine the smallest angle θ to which the crate can be hoisted.

$\vec{T_B} = T_B \vec{i} + 0 \vec{j}$

$\vec{T_C} = -T_C \cos\theta \vec{i} + T_C \sin\theta \vec{j}$

$\vec{W} = 0 \vec{i} - W \vec{j}$



$\vec{R} = (T_B - T_C \cos\theta)\vec{i} + (T_C \sin\theta + W)\vec{j}$

$\sum \vec{R_x} = 0$

$T_B - T_C \cos\theta = 0$

$\cos\theta = \frac{T_B}{T_C}$ $\boxed{\therefore T_C \geq T_B}$ ① $\Rightarrow T_C = T_{max}$

$\sum \vec{R_y} = 0$

$T_C \sin\theta - W = 0$

$\boxed{\sin\theta = \frac{W}{T_C}}$ ②

$\boxed{\therefore \sin\theta = \frac{W}{T_{max}}}$ #

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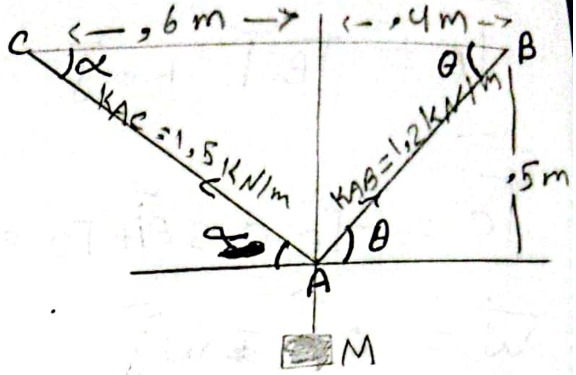
Q_{11}:- Determine the unstretched Length of each spring



$L_B = \sqrt{,4^2 + ,5^2} = ,64 \quad \acute{L}_B = ??$

$L_C = \sqrt{,6^2 + ,5^2} = ,78 \quad \acute{L}_C = ??$

$F_{SB} = K_{AB}(L_B - \acute{L}_B)$

$\vec{F}_{SB} = \vec{F}_{SB} \cos\theta \, \vec{i} + F_{SB} \sin\theta \, \vec{j}$

$F_{SC} = K_{AC}(L_C - \acute{L}_C)$

$\vec{F}_{SC} = -F_{SC} \cos\alpha \, \vec{i} + F_{SC} \sin\alpha \, \vec{j}$

$\vec{W} = -Mg \, \vec{j}$

$\Sigma F_x = 0$

$\vec{F}_x = F_{SB}\left(\frac{,4}{,64}\right) - F_{SC}\left(\frac{,6}{,78}\right) = 0 \Rightarrow \boxed{\frac{,4}{,64} F_{SB} = \frac{,6}{,78} F_{SC}}$

$\Downarrow$

$\boxed{F_{SB} = \frac{16}{13} F_{SC}}$ (1)

$\Sigma F_y = 0$

$\vec{F}_y = F_{SB}\left(\frac{,5}{,64}\right) + F_{SC}\left(\frac{,5}{,78}\right) - \overset{W}{\cancel{9,81M}} = 0$

$\boxed{\frac{,5}{,64} F_{SB} + \frac{,5}{,78} F_{SC} = W}$ (2)

بالتعويض ب (1) في (2)

$\boxed{\therefore F_{SC} = ,624 W}$ $\boxed{F_{SB} = ,768 W}$

$,768 W = 1,2(,64 - \acute{L}_B)$

$\boxed{\acute{L}_B = ,64 - ,64 W}$

$,624 W = 1,5(,78 - \acute{L}_C)$

$\boxed{\acute{L}_C = ,78 - ,416 W}$

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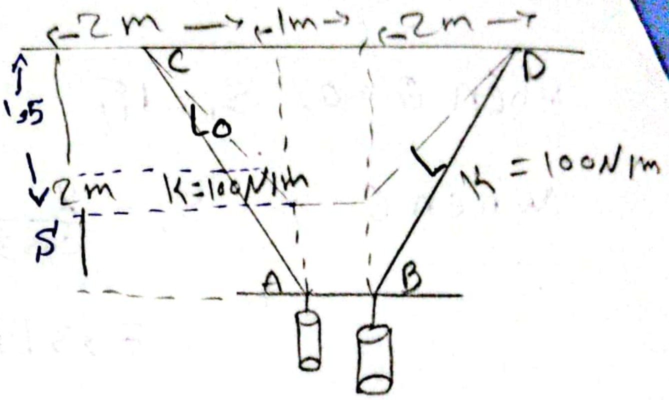
Q12:- Determine the Mass of each of the two cylinders

$\boxed{S = ,5m}$

$L = \sqrt{2^2 + 2^2} = 2\sqrt{2}$

$L_o = \sqrt{2^2 + 1{,}5^2} = 2{,}5$



$F_{sp} = K(L - L_o)$

$= 100(2\sqrt{2} - 2{,}5) = 32{,}8$

$\Sigma F_x = 0$

$T_{AB} - F_{sp}\cos\theta = 0$

$\boxed{T_{AB} = 32{,}8 * \frac{2}{2\sqrt{2}} = 23{,}19}$

$\Sigma F_y = 0$

$F_{sp}\sin\theta - m_A\, a =$

$\frac{32{,}8}{\sqrt{2}} = m_A * 9{,}8$

$\boxed{m_A = 2{,}37\ Kg}$

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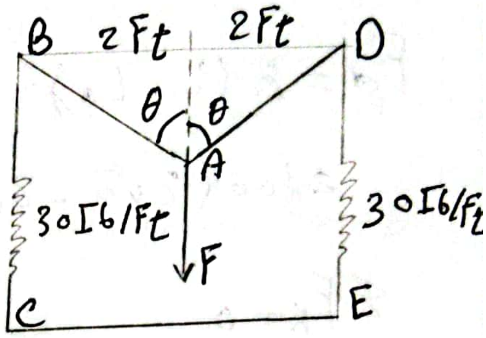
Q13:- Determine the vertical Force F that must be applied so that $\theta = 30°$.

when $\theta = 0$ $S_1 = 1 Ft$

when $\theta = 30$ $S_2 = \frac{2}{\cos 30} - 2$

$= ,31 Ft$



$St = S_1 + S_2 = 1,31 Ft$

$F_s = K\,St = 30 \times 1,31 = 39,3 Ib$

$\Sigma F_x = 0$ $F_s \cos\theta - F_s \cos\theta = 0$

$\Sigma F_y = 0$ $F_s \sin\theta + F_s \sin\theta - F = 0$

$2 F_s \sin\theta = F$

$2 F_s \sin 30 = F$

$F = F_s$

$\boxed{F = 39,3}$

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