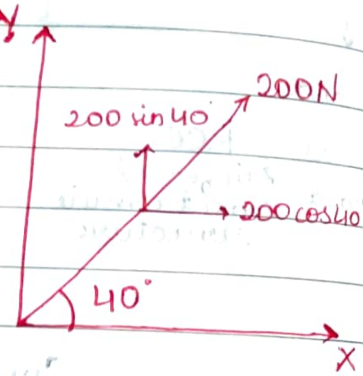
NUMERICALS :-

(2) 1. A force of 200 N is acting at a point making an angle of 40°. with the horizontal. Determine the components of the force along x & y directions.

→ Component along x direction



$F_x = F\cos\theta$

$= 200\cos 40°$

$F_x = 153.20\ N$

Component along y direction

$F_y = F\sin\theta$

$= 200\sin 40°$

$F_y = 128.55\ N$

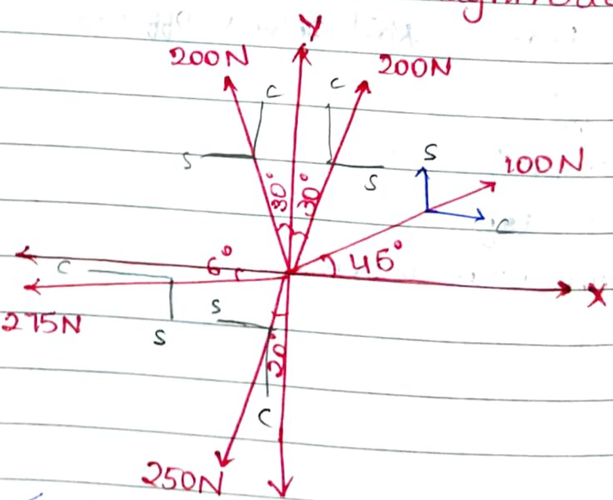
2. 5 coplanar forces are acting on a point as shown in the figure. Determine the resultant ~~in~~ magnitude & direction.

→ $R = ?$ $\theta = ?$

$R = \sqrt{\Sigma H^2 + \Sigma V^2}$

$R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right)$



$\Sigma F_x = 100\cos 45° + 200\ \cancel{\sin}\ 30° - 200\ \cancel{\sin}\ 30° - 275\cos 6°$
$- 250\ \overset{\sin}{\cancel{\cos}}\ 20°$

$\boxed{\Sigma F_x = -288.28\ N}$ $(\leftarrow)$

$\Sigma F_y = 100\sin 45° + 200\cos 30° + 200\cos 30° - 275\sin 6° - 250\cos 20°$

$\boxed{\Sigma F_y = +192.95\ N}$ $(\leftarrow)$

$\boxed{\Sigma F_y = 153.45\ N}$ $(\uparrow)$

$R = \sqrt{(-288.28)^2 + \cancel{(-192.95)^2}\ (153.45)^2}$

$\boxed{R = 326.57}$

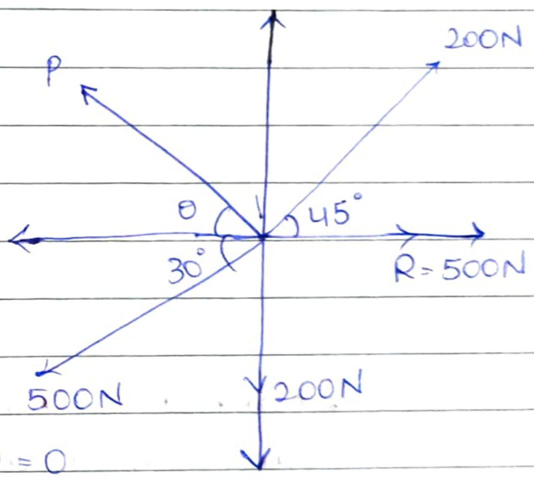
$\theta = \tan^{-1}\left(\frac{153.45}{288.28}\right)$

$\boxed{\theta = -28.02^\circ}$

3. 4 coplanar forces acting ~~on~~ at a point as shown in the figure. One of the forces unknown and its magnitude is shown as 'P'. The resultant has a magnitude of 500 N and ~~its~~ is acting along X-axis. Determine the unknown force P and its inclination with X axis.

→ $R = 500N = \Sigma F_x = R_x$

$R_y = \Sigma F_y = 0$



$\Sigma F_x = 500$

$200\cos 45 - P\cos\theta - 500\cos 30 = 500$

$\boxed{P\cos\theta = -791.59}$ — ①

$\Sigma F_y = 0$

$200\sin 45 + P\sin\theta - 500\sin 30 - 200 = 0$

$\boxed{P\sin\theta = 308.57}$ — ②

squaring & adding ① & ②,

$P^2\cos^2\theta + P^2\sin^2\theta = (-791.59)^2 + (308.58)^2$

$P^2(1) = 721836.34$

$\boxed{P = 849.6\ N}$

Divide ② & ①

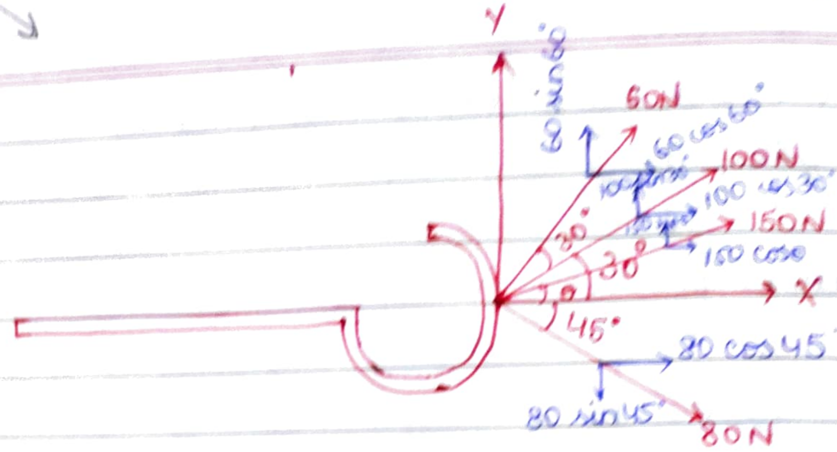
$\frac{\cancel{P}\sin\theta}{\cancel{P}\cos\theta} = \frac{308.57}{-791.59}$

$\tan\theta = -0.389$

$\theta = \tan^{-1}(-0.389)$

$\boxed{\theta = -21.25^\circ}$

4.



Forces acting on hook are shown in the fig. Determine the direction of force 150 N, such that the hook is pulled in x direction. Determine the resultant force in X-direction.

→ $\Sigma F_y = 60 \sin 60° + 100 \sin 30° + 150 \sin\theta - 80 \sin 45° = 0$

$150 \sin\theta = -45.39$

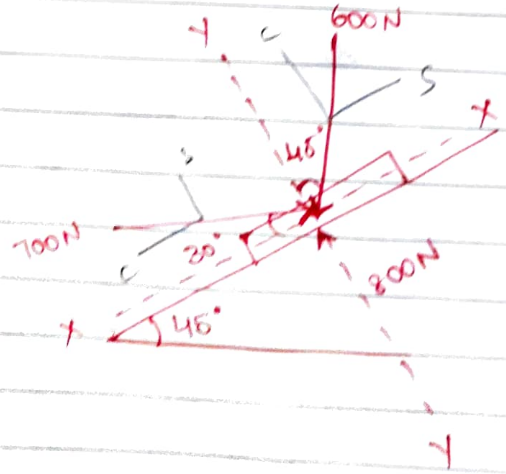
$\sin\theta = -0.3026$

$\theta = -17.61°$

$\Sigma F_x = 60 \cos 60° + 100 \cos 30° + 150 \cos(-17.61°) + 80 \cos 45° = R$

$R = 316.102$ N

5. Determine the resultant of the system of forces acting on a body as shown in the figure. Take the coordinate directions as shown in the fig itself.



$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

$\Sigma F_x = -600 \sin 45^\circ + 700 \cos 30$

$\Sigma F_x = 181.95 \text{ N}$

$\Sigma F_y = 800 - 600 \cos 45^\circ - 700 \sin 30^\circ$

$\Sigma F_y = 25.74 \text{ N}$

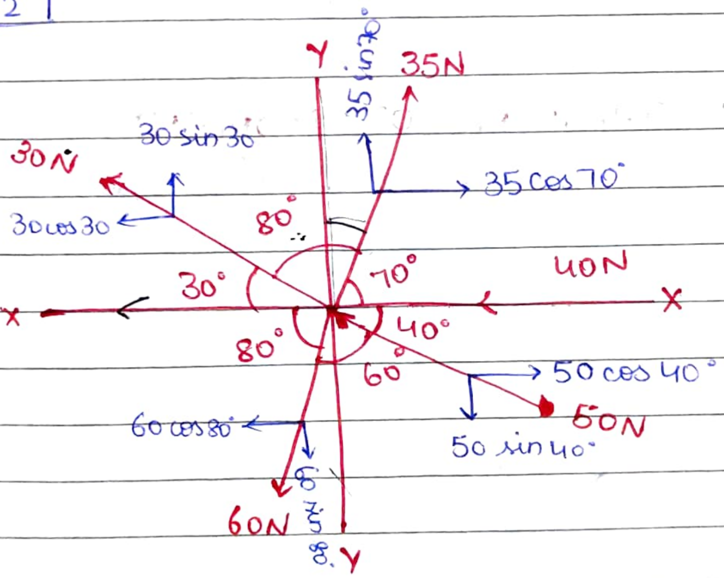
$R = \sqrt{(181.95)^2 + 25.74^2}$

$\boxed{R = 183.76 \text{ N}}$

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{25.74}{181.95}\right)$

$\boxed{\theta = 8.052^\circ}$

6.



angles made with x & y axes are only considered. Here 80° & 60° are not considered.

Determine the equillibrant of four system as shown in the fig

→ To find the equillibrant, first we have to calculate the resultant, eq. is the force which is having same magnitude & opp. direction of the resultant itself.

$\Sigma F_x = 35\cos 70^\circ - 40 - 50\cos 40 - 60\cos 80 - 30\cos 30$

$\Sigma F_x = -102.73\ N$

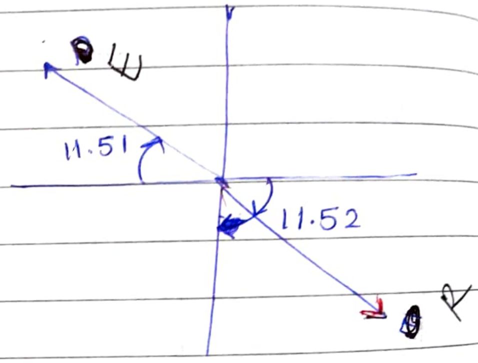
$\Sigma F_y = 35\sin 70 + 50\sin 40^\circ - 60\sin 80 + 30\sin 30^\circ$

$\Sigma F_y = 20.93\ N$

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = \sqrt{(-102.73)^2 + (20.93)^2}$

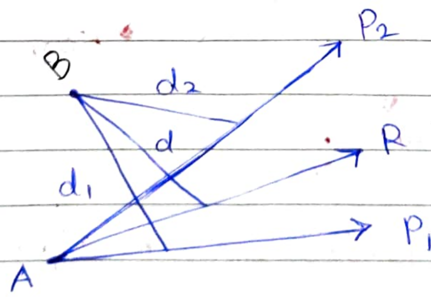
$\boxed{R = 104.8 N}$

$\theta = \tan^{-1}\left(\frac{20.93}{-102.72}\right) = -11.52$



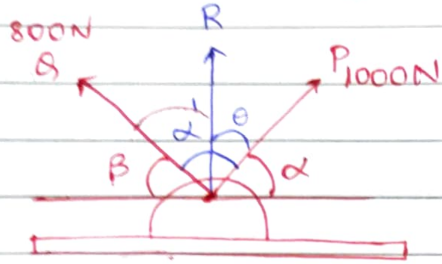
VARIGNON'S THEOREM OF MOMENTS

Statement:- The algebraic sum of the moments of individual forces of a force system about a point is equal to the moment of their resultant about the same point.



PROOF:- Let P_1 & P_2 be the 2 diff/. forces acting in a system where R be the resultant forces of P_1 & P_2.
Let B be the moment centre, and d, d_1, d_2 be the ⊥^{r} ~~dist~~ moment arms of the forces R, P_1, P_2 respectively from the centre B.
We need to PT $Rd = P_1 d_1 + P_2 d_2$

Forces are transmitted by 2 members as shown in the fig. If the resultant of these forces is 1400 N directed vertically upwards, find the angle α & β.



As 2 angles are unknown, parallelogram law is to be used.
Let α' be the angle b/w the forces P & Q where P = 1000 N & Q = 800 N.
R is the resultant acting upwards with the magnitude 1400 N and angle made by R with P is θ as shown in fig where angle b/w P & Q is α'.

$R^2 = P^2 + Q^2 + 2PQ\cos\alpha'$

$1400^2 = 1000^2 + 800^2 + 2(1000)(800)\cos\alpha'$

$\cos\alpha' = 0.2$

$\boxed{\alpha' = 78.46}$

$\tan\theta = \dfrac{Q\sin\alpha'}{P + Q\cos\alpha'}$

$\theta = \tan^{-1}\left(\dfrac{800\sin 78.46}{1000 + 800\cos 78.46}\right)$

$\boxed{\theta = 34.04}$

$\alpha = 90 - \theta$

$\alpha = 90 - 34.04$

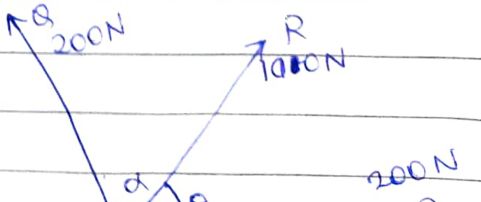
$\boxed{\alpha = 55.96}$ //

$\beta = 180 - (\alpha + \alpha')$

$\boxed{\beta = 45.58}$ //

Resolve a force of 100 N into 2 components each. Show the orientation of these components in a sketch.

As all the magnitudes are known, to find the angles, ▱ law is convenient. The 100 N force will be the resultant of 2 forces, each having a magnitude of 200 N. Sketch will be done by assuming one of the component to be horizontal.



$R^2 = P^2 + Q^2 + 2PQ\cos\alpha$

$100^2 = 200^2 + 200^2 + 2(200)(200)\cos\alpha$

$\boxed{\alpha = 151.04}$

$\tan\theta = \dfrac{Q\sin\alpha}{P + Q\cos\alpha}$

$\theta = \tan^{-1}\left(\dfrac{200\sin 151.04}{200 + 200\cos 151.04}\right)$

$\boxed{\theta = 75.51^\circ}$

Defin

A 100 N vertical force is applied to shaft at A as shown. Determine the effect of 100N force at O.

fig 2:

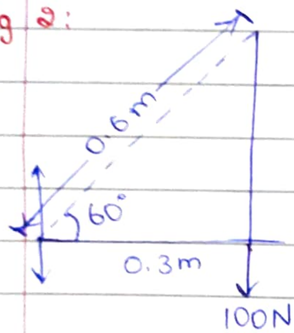


fig 3:-

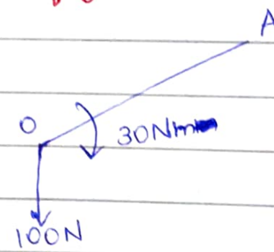
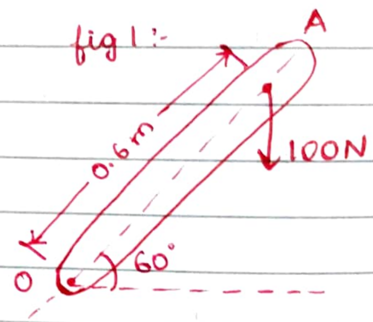


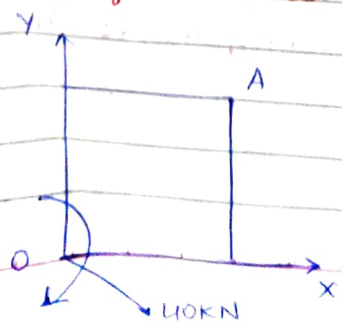
fig 1:-

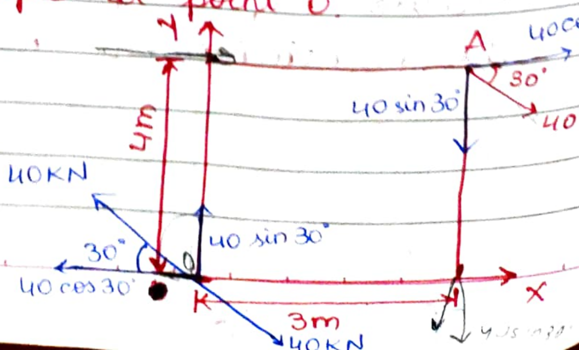


Apply equal & opp. force of 100N at point O, as shown in fig 2. The effect produced because of this is shown below

1. A downward force 100N @ O.
2. Moment of couple = $100 \times 0.3 = 30$ Nm (2)

Reduce the force acting @ A, as shown in the fig into a system of force and couple at point O.





couple = Force × ⊥ʳ distance

Moment of couple @ O = 40 cos 30 (4) + 40 sin 30 (3)
= 198.56 KNm //

NUMERICALS ON ~~NON~~ COPLANAR AND NON CONCURRENT FORCE SYSTEM :-

Definition: If 2 or more forces are acting in a single plane, but not passing through the single point, such force system is known as coplanar & non concurrent fo system.

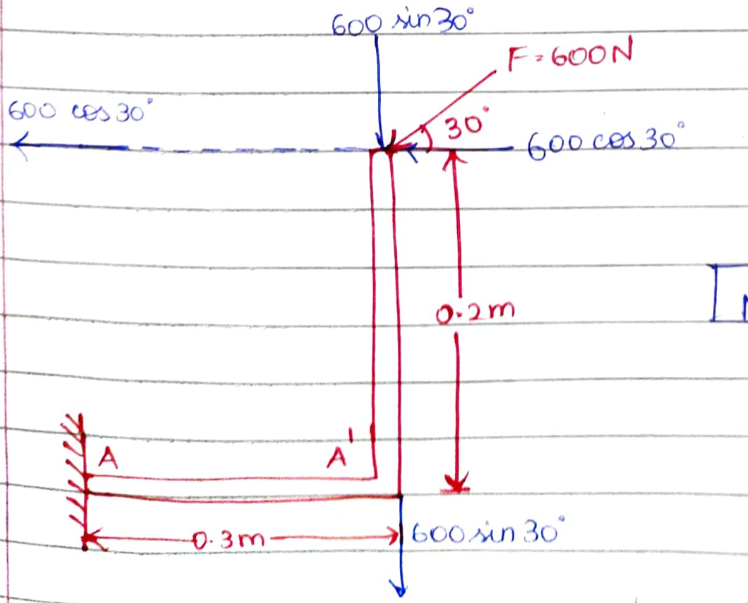
Magnitude of the resultant $R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

Direction of the resultant $\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right)$

Position of resultant: It means the calculation of d, x & y intercepts as shown in fig. where R.d = algebraic sum of moments of no. of forces about that point.

X intercept : $x = \left|\frac{\Sigma M}{\Sigma F_y}\right|$ y intercept : $y = \left|\frac{\Sigma M}{\Sigma F_x}\right|$

Find the moment of the force F = 600N about A ~~as~~ asif



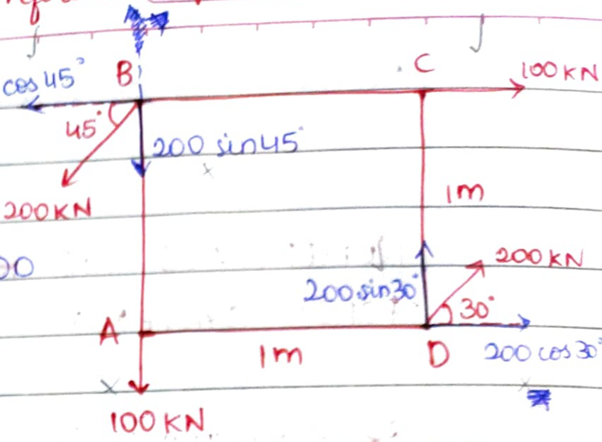
Moment of force F about A =
600 sin30 (0.3) − 600 cos 30 (0.2)

$\boxed{M_A = -13.92\ Nm}$

or

$M_A = 13.92\ Nm$ (↺) //

A rigid plane ABCD is subjected to the forces as if/. Compute the magnitude, direction and line of action of the resultant of the system with reference to point A.



$\cancel{A}$ $\Sigma F_x = -200\cos 45° + 200\cos 30° + 100$

$\boxed{\Sigma F_x = 131.78\ kN}$

$\Sigma F_y = -200\sin 45° + 200\sin 30° - 100$

$\boxed{\Sigma F_y = \cancel{58.57}\ -141.42\ kN}$

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

$\boxed{R = 193.3\ kN}$

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) \Rightarrow \boxed{\theta = -42.02°}$

The line of action at point A, which is having the force 100 KN which is directly passing through A, so the moment produced by 100 KN force about A is zero.

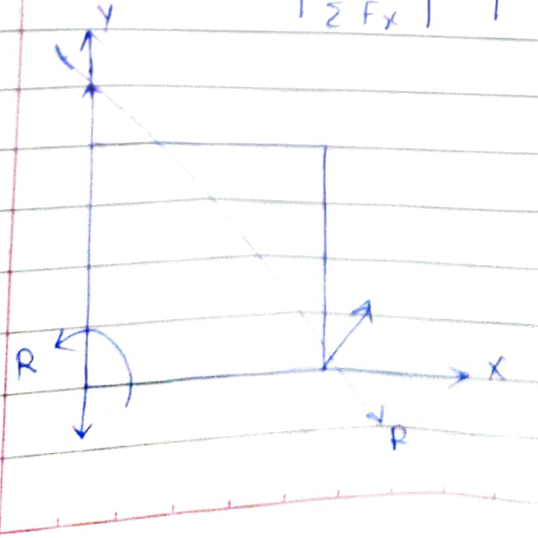
$\Sigma M_A = 100(0) + 200\sin 45(0) - 200\cos 45(1) + 100(1) + 200\cos 30(0) - 200\sin 30°(1)$

$\boxed{\Sigma M_A = -141.42\ kNm}$ or $\boxed{\Sigma M_A = 141.42\ kNm\ (\circlearrowright)}$

$d = \left|\frac{\Sigma M_A}{R}\right| = \left|\frac{-141.42}{193.3}\right| = 0.731\ m$

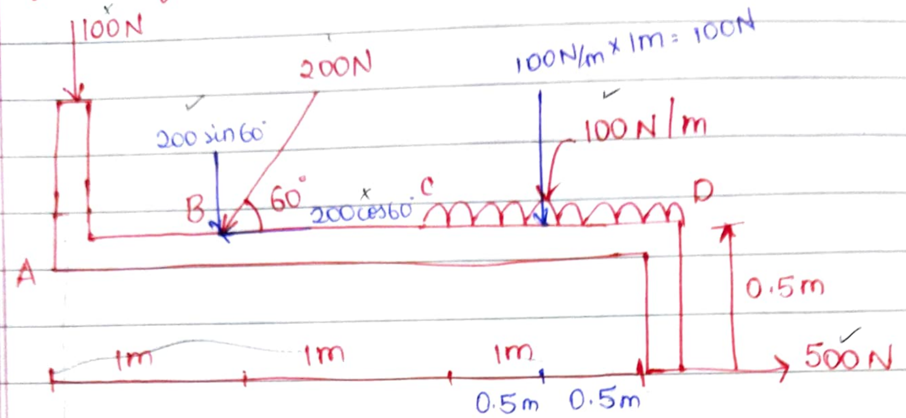
x intercept $= \left|\frac{\Sigma M_A}{\Sigma F_y}\right| = \left|\frac{-141.42}{-141.42}\right| = 1\ m$

y intercept $= \left|\frac{\Sigma M_A}{\Sigma F_x}\right| = \left|\frac{-141.42}{131.78}\right| = 1.073\ m$



direction &

1. Find the magnitude, position of the resultant wrt A of the force as shown in the fig.



$\Sigma F_x = -200\cos 60 + 500 = 400$ N

$\Sigma F_y = -100 - 200\sin 60 - 100 = -373.2$ N

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = 547.06$ N

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = -43.01^\circ$

$\Sigma M_A = 100(0) + 200\sin 60^\circ \overset{(1)}{} + 200\cos 60^\circ(0) + 100(2.5)$
$- 500(0.5)$

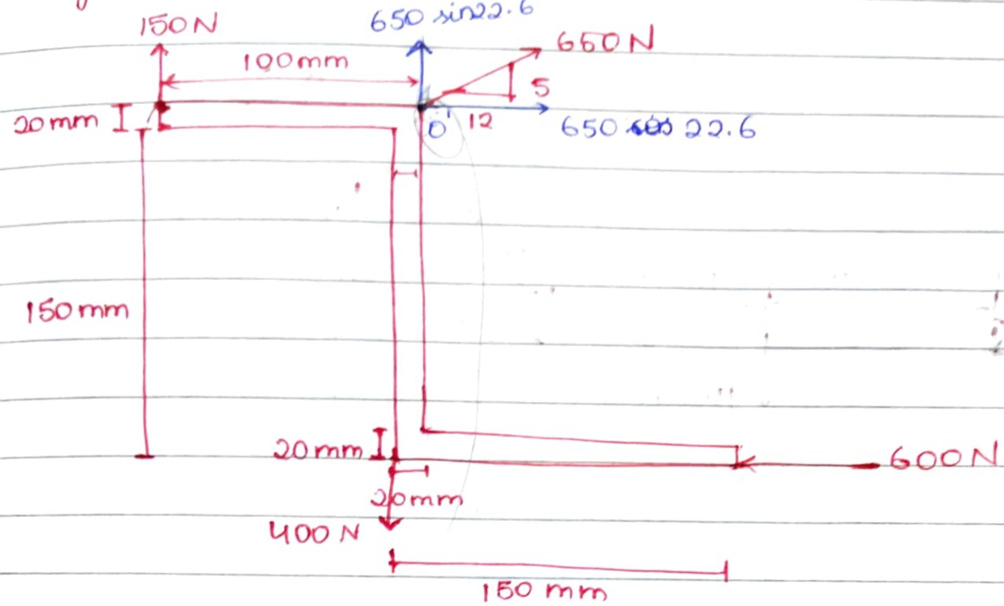
$\Sigma M_A = 173.2$ Nm

$d = \left|\frac{\Sigma M_A}{R}\right| = \frac{173.2}{547.06} = 0.316$ m

X intercept $= \left|\frac{\Sigma M_A}{\Sigma F_y}\right| = \frac{173.2}{-373.2} = 0.464$ m

Y intercept $= \left|\frac{\Sigma M_A}{\Sigma F_x}\right| = \frac{173.2}{400} = 0.433$ m

2. A Z shaped lamina of uniform width of 20mm is subjected to 4 forces as in fig. Find the equillibrant in magnitude and direction.



$\theta = \tan^{-1}\left(\frac{5}{12}\right)$

$\boxed{\theta = 22.6^\circ}$

$\Sigma F_x = -600 + 650 \cos 22.6$

$\boxed{\Sigma F_x = 0.08 \text{ N} \approx 0}$

$\Sigma F_y = -400 + 150 + 650 \sin 22.6$

$\boxed{\Sigma F_y = 0.2 \text{ N} \approx 0}$

$\boxed{R = 0}$

so imp. to find mom.

☆☆ When R = 0, the resultant can be a moment which will be same ~~at~~ about any point in the plane.

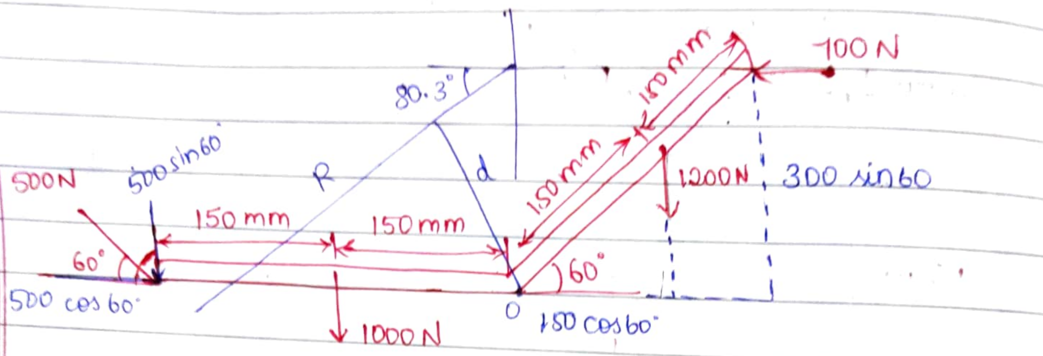
Let O' be the point where the 650 N is going to act in the plane taking moment of all the forces about O'.

$M_{O'} = 650 \sin 22.6 (0) + 650 \cos 22.6 (0) + 600(170) - 400(20) + 150(100)$

$\boxed{M_{O'} = 109 \text{ Nm} \circlearrowleft}$

Equillibrant = 109 Nm ↻ //

3. A system of forces acting on a bell crank as if. Find the magnitude, direction and point of application of the resultant w.r.t O.



$\Sigma F_x = 500\cos 60^\circ - 700$

$\boxed{\Sigma F_x = -450\text{ N}}$

$\Sigma F_y = -500\sin 60^\circ - 1000 - 1200$

$\boxed{\Sigma F_y = \cancel{1766.98\text{ N}}\ 2633.01\text{ N}}$

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

$\boxed{R = 2671.18\text{ N}}$

$\theta = \tan^{-1}\left(\Sigma F_y / \Sigma F_x\right)$

$\boxed{\theta = -80.3^\circ}$

$M_o = 500\cos 60^\circ(0) - 500\sin 60^\circ(300) - 1000(150) + 1200(150\cos 60^\circ) - 700(300\sin 60)$

$\boxed{M_o = 371.769\text{ Nm}}$

x intercept $= \left|\dfrac{M_o}{\Sigma F_y}\right| = \left|\dfrac{371.769}{2633.01}\right| = 0.141\text{ m}$ //

y intercept $= \left|\dfrac{M_o}{\Sigma F_x}\right| = \left|\dfrac{371.769}{-450}\right| = 0.8261\text{ m}$ //

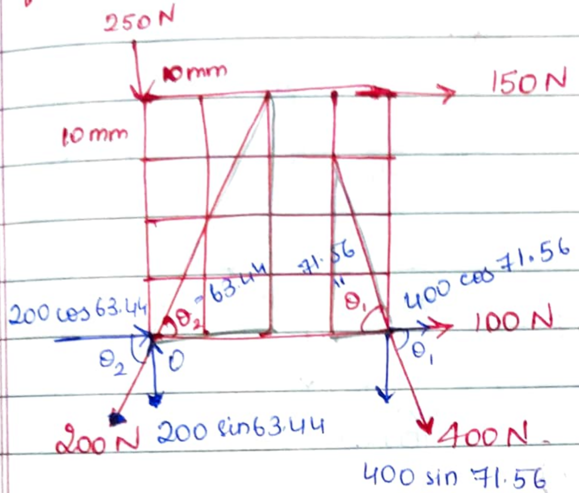
$d = \left|\dfrac{\Sigma M_o}{R}\right|$

$\boxed{d = 0.139\text{ m}}$

classmate

Date ______
Page ______

4. Determine the resultant of system of forces as if/. acting on a 40mm x 40mm size lamina. Each grid is of size 10mm x 10mm. Determine x & y intercept also.



$\tan\theta_1 = \frac{30}{10} \Rightarrow \theta_1 = \tan^{-1}(3)$

$\boxed{\theta_1 = 71.56^\circ}$

$\tan\theta_2 = \frac{40}{20} \Rightarrow \theta_2 = \tan^{-1}(2)$

$\boxed{\theta_2 = 63.44^\circ}$

$\Sigma F_x = 200\cos 63.44 + 400\cos 71.56 + 150 + 100$

$\Sigma F_x = 465.98\ N$

$\Sigma F_y = -200\sin 63.44 - 400\sin 71.56 - 250$

$\Sigma F_y = -450.58\ N$

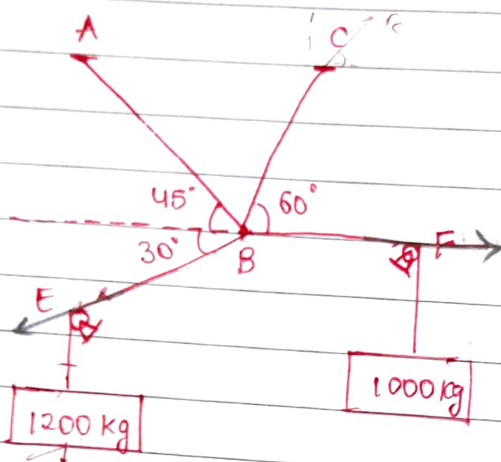
~~X intercept~~ =

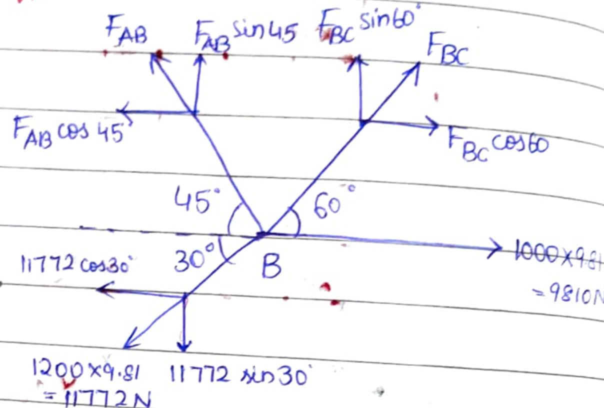
$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

$\boxed{R = 648.19\ N}$

$\boxed{\theta = -44.03^\circ}$

5. Find the forces in the cables AB & CB asif. The remaining two cables pass over frictionless pulleys E & F & supports 1200 kg & 1000 kg resp. All the forces are concurrent at point B. The FBD of B asif.





Applying equillibrium Eqn. $\Sigma F_x = 0$, $\Sigma F_y = 0$

$\Sigma F_x = 0$

$9810 + F_{BC}\cos 60 - F_{AB}\cos 45 - 11772\cos 30 = 0$

$0.5F_{BC} - 0.707F_{AB} = 384.851$ — (1)

$\Sigma F_y = 0$

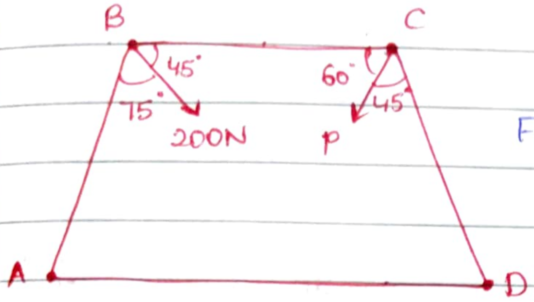
$F_{BC}\sin 60 + F_{AB}\sin 45° - 11772\sin 30 = 0$

$0.86F_{BC} + 0.707F_{AB} = 5886$ — (2)

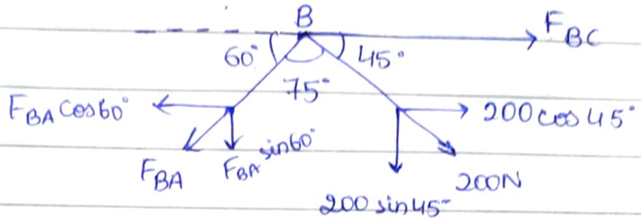
$\boxed{F_{AB} = 2701.77N}$

$\boxed{F_{BC} = 4590.56N}$

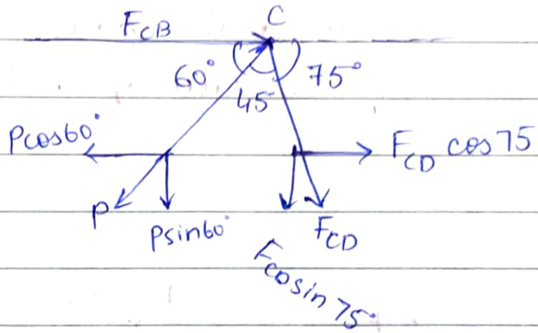
6. In a 4 bar mechanism as fig. bars are hinged at A, B, C & D. Find the force P that will prevent movement of bars. Also find the forces in bars, AB, BC & CD.



FBD @ B



FBD @ C



Applying equillibrium eqn @ joint B

$\Sigma F_x = 0$

$F_{BC} + 200\cos 45° - F_{BA}\cos 60° = 0$

$F_{BC} - 0.5F_{BA} + 141.42 = 0$

$0.5F_{BA} - F_{BC} = 141.42$ — (1)

$\Sigma F_y = 0$

$-F_{BA}\sin 60 - 200\sin 45 = 0$

$F_{BA} = \dfrac{-200\sin 45}{\sin 60}$

$\boxed{F_{BA} = -163.29\text{ N}}$ (c)

Substituting F_{BA} in (1)

$F_{BC} = 0.5(-163.29) - 141.42$

$\boxed{F_{BC} = -223.07\text{ N}}$ (c)

(-ve) sign indicates compressive force.

@ C : $\Sigma F_x = 0$

$+F_{CB} - P\cos 60° + F_{CD}\cos 75 = 0$

$-223.07 - 0.5P + 0.258F_{CD} = 0$ — (2)

$\Sigma F_y = 0$

$-P \sin 60^\circ - F_{CD} \sin 75^\circ = 0$

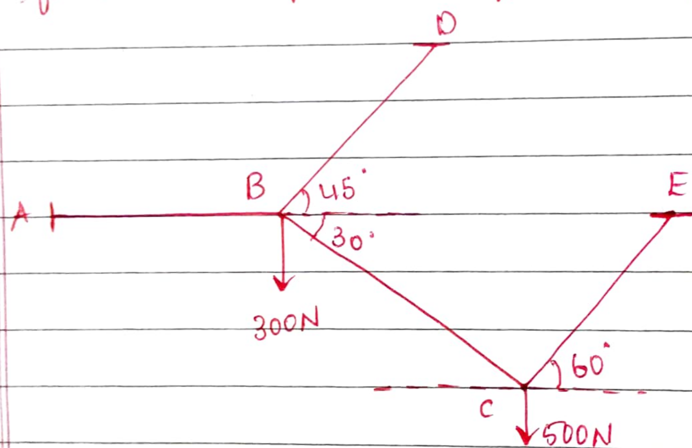
$0.866P + 0.965 F_{CD} = 0 \quad - (3)$

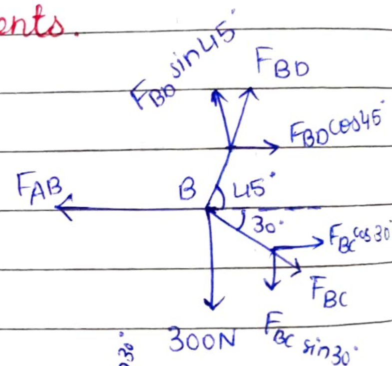
Solving (2) & (3)

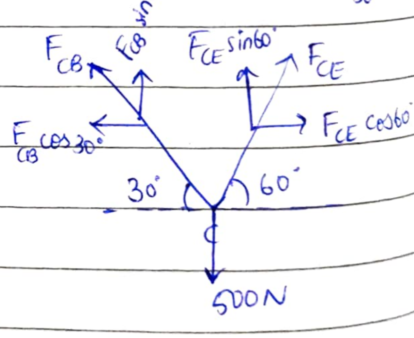
$\boxed{F_{CD} = -273.99\text{ N} = 273.99\text{ N (c)}}$ //

$\boxed{P = 304.7\text{ N}}$

7. Below fig. shows a system of cables in equillibrium, under cond^n 2 vertical loads of 300 N & 500 N. Determine the forces developed in different segments.







Applying equillibrium eqn' @ B

$\Sigma F_x = 0$

$-F_{AB} + F_{BD} \cos 45^\circ + F_{BC} \cos 30^\circ = 0$

$-F_{AB} + 0.707 F_{BD} + 0.866 F_{BC} = 0 \quad - (1)$

$\Sigma F_y = 0$

$-300 - F_{BC} \sin 30^\circ + F_{BD} \sin 45^\circ = 0$

$0.707 F_{BD} - 0.5 F_{BC} = 300 \quad - (2)$

@ C :- $\Sigma F_x = 0$

$$F_{CE}\cos 60 - F_{CB}\cos 30^\circ = 0 \quad \cancel{③}$$

$$0.5F_{CE} - 0.866F_{CB} = 0 \quad - ③$$

$\Sigma F_y = 0$

$$F_{CB}\sin 30^\circ + F_{CE}\sin 60^\circ = 500 \quad \cancel{④}$$

$$0.5F_{CB} + 0.866F_{CE} = 500 \quad - ④$$

$\boxed{F_{CE} = 433.01\text{ N}}$ $\boxed{F_{CB} = 250.01\text{ N}}$

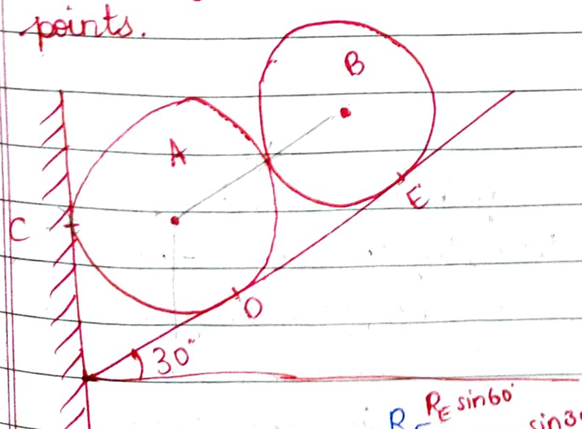
Substitute F_{CB} in ②

$\boxed{F_{BO} = 601.13\text{ N}}$

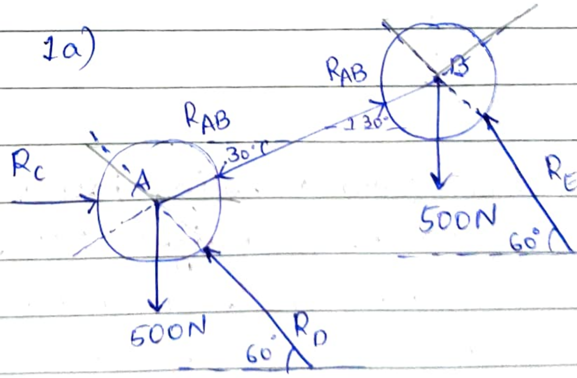
Substitute F_{BC} & F_{BD} in ①

$\boxed{F_{AB} = 641.50\text{ N}}$

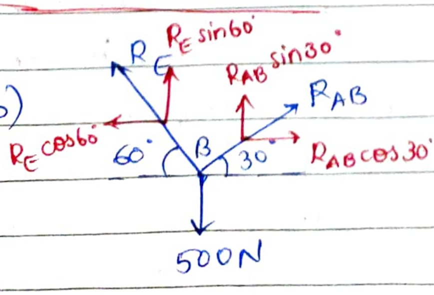
8. 2 identical ~~loaders of~~ rollers, each of weight 500 N are supported by an inclined plane, making an angle of 30° to the horizontal and a vertical wall as/f.
i) Sketch the FBD of 2 rollers.
ii) Assuming a smooth surface, find the reacⁿ at support points.



1a)

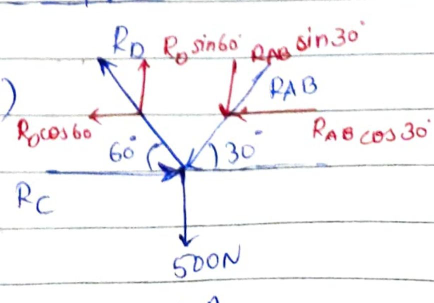


1b)



FBD @ B

1c)



FBD@A

→ @ B :- $\Sigma F_x = 0$

$-R_E \cos 60^\circ + R_{AB} \cos 30^\circ = 0$

$0.866\, R_{AB} - 0.5\, R_{E} = 0$ — ①

$\Sigma F_y = 0$

$R_E \sin 60^\circ + R_{AB} \sin 30^\circ - 500 = 0$

$0.5\, R_{AB} + 0.866\, R_E = 500$ — ②

Solving ① & ②

$\boxed{R_{AB} = 250.01\ N}$ $\boxed{R_E = 433.01 N}$

@ A :- $\Sigma F_x = 0$

$R_C - R_D \cos 60^\circ - R_{AB} \cos 30^\circ = 0$

$R_C - 0.5 R_D - 216.51 = 0$ — ③

$\Sigma F_y = 0$

$R_D \sin 60^\circ - R_{AB} \sin 30^\circ - 500 = 0$

$0.866\, R_D - 125.005 - 500 = 0$

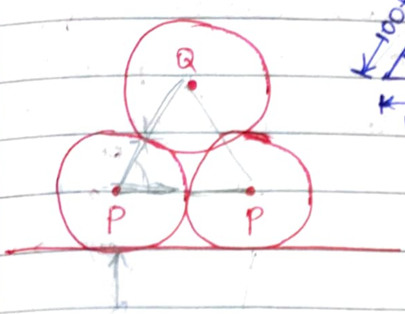
$\boxed{R_D = 721.71\ N}$

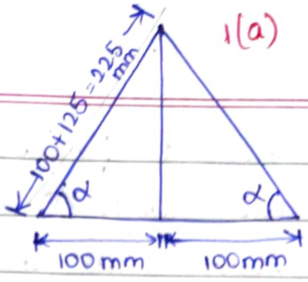
Subs R_D in ③

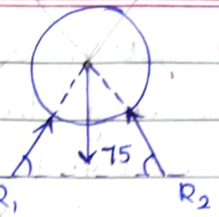
$\boxed{R_C = 577.36\ N}$

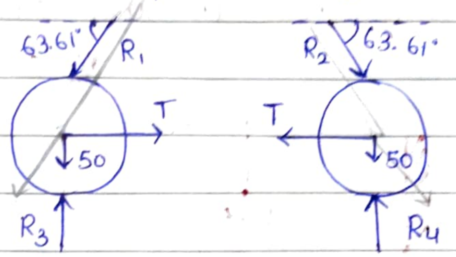
9. 2 round solid identical cylinders each of radius 100mm & weight 50N, tied together by a thread of length 200mm, rests on a horizontal surface. They hold a 3rd homogeneous cylinder of radius 125 mm & weight 75 N place asif/. Calculate the tension in the thread and reaction all the contact surfaces.

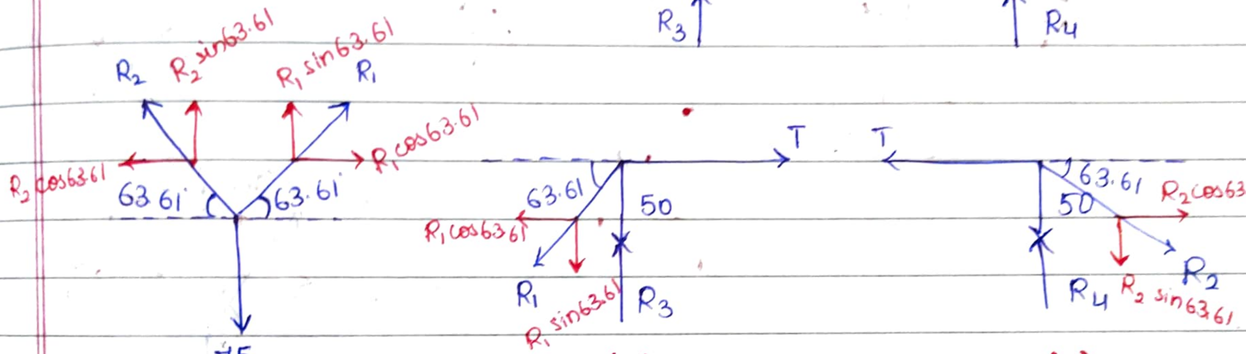
The Δ joined by the lines joining the centres of 3 cylinders asif in 1(a). There is no reacⁿ b/w 2 horizontal cylinders as they tend to move away from each other due to upper cylinder.



1(a)


1(b)


1(c)
1(d)




1(b) 1(c) 1(d)

→ $\cos\alpha = \frac{\cancel{225}}{1} \frac{100}{225} = \cancel{63} \Rightarrow \boxed{\alpha = 63.61^\circ}$

1(b) :- $\Sigma F_x = 0$

$R_1 \cos 63.61 = R_2 \cos 63.61$

$\boxed{R_1 = R_2}$

$\Sigma F_y = 0$

$R_2 \sin 63.61 + R_1 \sin 63.61 = 75$

$R_1 = \frac{75}{0.895 \times 2}$

$\boxed{R_1 = 41.89N = R_2}$

1(d) :- $\Sigma F_y = 0$

$R_4 = R_2 \overset{\sin}{\cancel{\cos}} 63.61 + 50$

$\boxed{R_4 = 87.52N}$

1(c) :- $\Sigma F_x = 0$

$T - R_1 \cos 63.61 = 0$

$T = 41.89 \times 0.444$

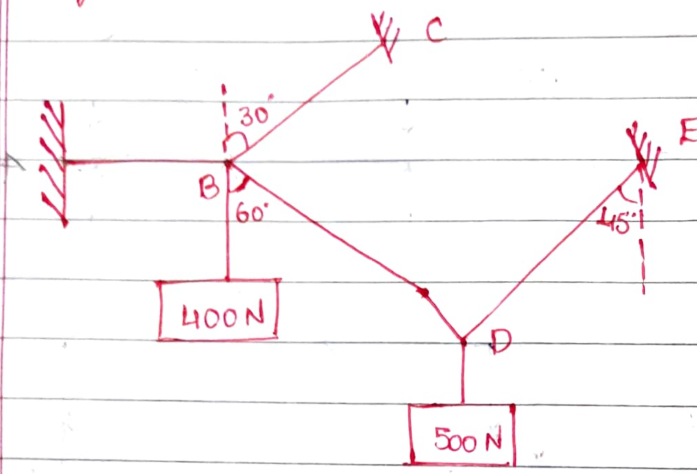
$\boxed{T = 18.59\ N}$

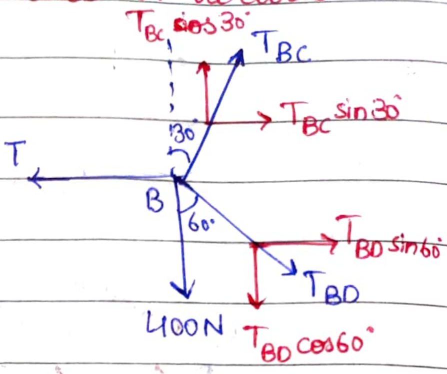
$\Sigma F_y = 0$

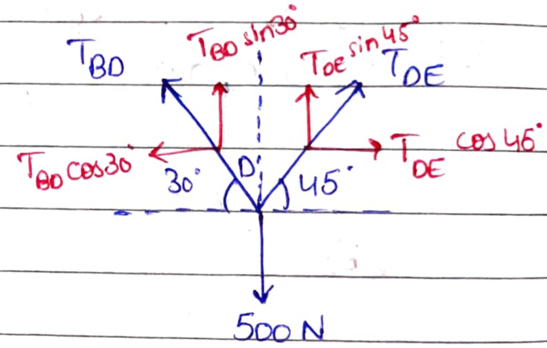
$R_3 - R_1 \sin 63.61 - 50 = 0$

$\boxed{R_3 = 87.52N}$

10. The system of connected flexible cables as fig. supporting two loads 400 N & 500 N at points B & D resp. Determine the tension in the ~~cables in~~ various segments in the cable.







→ @ B :- $\Sigma F_x = 0$

$T_{BC}\sin 30° + T_{BD}\sin 60° = T$ — ①

$\Sigma F_y = 0$

$T_{BC}\cos 30° - T_{BD}\cos 60° = 400$ — ②

• @ D :- $\Sigma F_x = 0$

$T_{DE}\cos 45° = T_{BD}\cos 30°$

$T_{DE} = T_{BD}\dfrac{\cos 30}{\cos 45}$

$\boxed{T_{DE} = 1.224\, T_{BD}}$

$\Sigma F_y = 0$

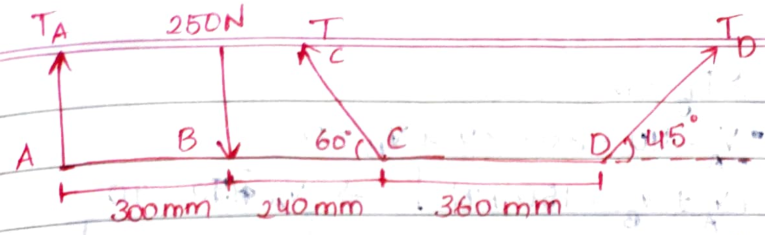
$T_{BD}\sin 30° + T_{DE}\sin 45° = 500$

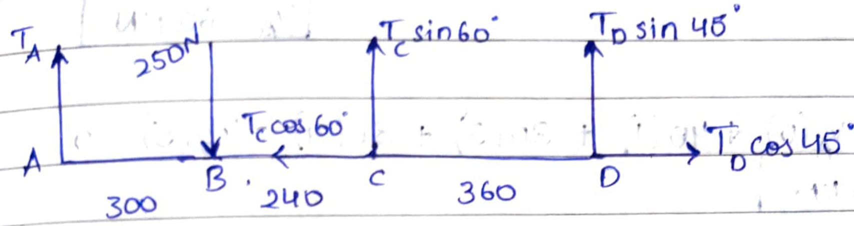
$0.5T_{BD} +$

11. A light beam ~~co~~ ABCD carries a load 250 N at B as fig. It is supported by 3 strings at A, B & C. Determine the tension in the strings.

↓

Normal force on strings.





$\Sigma F_y = 0$

$T_A - 250 + T_C \sin 60° + T_D \sin 45° = 0$

$\boxed{T_A = 138.36\ N}$

$\Sigma F_x = 0$

$T_D \cos 45° = T_C \cos 60°$

$\sqrt{2} T_D = T_C$

$\boxed{T_C = 81.72}$

$\Sigma M_A = 0$

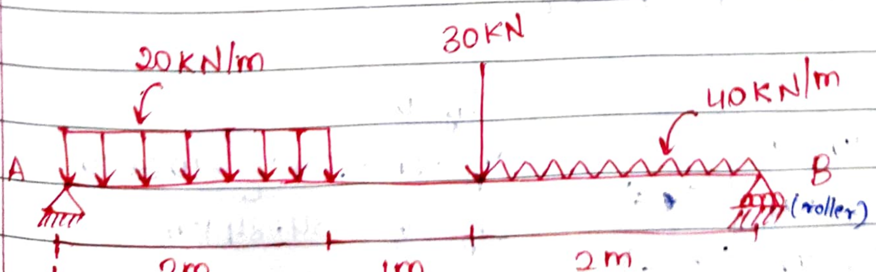
$T_A(0) + 250(300) - T_C \sin 60°(540) + T_C \cos 60°(0) - T_D \sin 45°(900)$

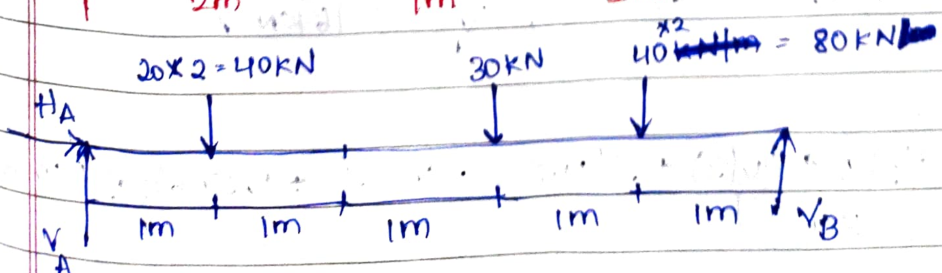
$T_D \cos 45 (0) = 0$

$75000 - 661.36 T_D - 636.39 T_D = 0$

$\boxed{T_D = 57.79\ N}$

12. Determine the support reac^{n}s for the beam AB loaded and supported as if.





$\Sigma F_x = 0$

$H_A = 0$

$\Sigma F_y = 0$

$V_A - 40 - 30 - 80 + V_B = 0$

$\boxed{V_A + V_B = 150\ KN}$ $\Rightarrow V_A = 150 - 90$

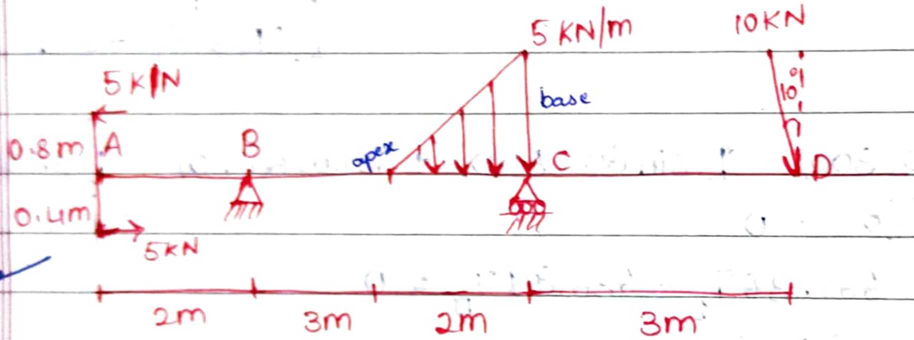
$\boxed{V_A = 60\ KN}$

$\Sigma M_A = 0$

$H_A(0) + V_A(0) + 40(1) + 30(3) + 80(4) - V_B(5) = 0$

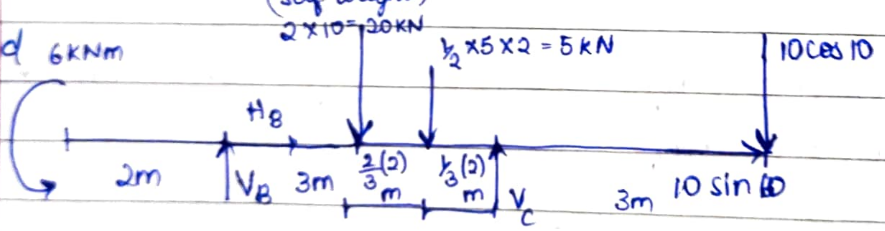
$\boxed{V_B = 90\ KN}$

13. A beam ABCD having self weight 2KN/m is subjected to additional load as in fig. Find support reac^n at B & C.



couple
↓
moment
↓
Force x P.d

(self weight)·



$\Sigma F_x = 0$

$H_B + 10 \sin 10 = 0$

$\boxed{H_B = -1.736\ KN}$ $(\leftrightarrow)$

$H_B = 1.736\ KN\ (\leftarrow)$

$\Sigma F_y = 0$

$V_B - 20 - 5 + V_C - 10 \cos 10 = 0$

$V_B + V_C = 34.84\ KN$

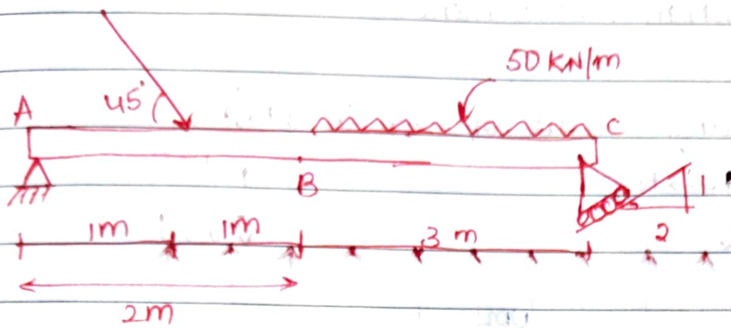
$\boxed{V_B = 3.96\ KN}$

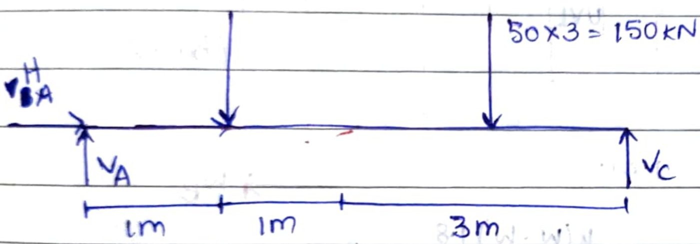
$\Sigma M_B = 0$

$-6 + V_B(0) + H_B(0) + 20(3) + 5(4.33) - V_C(5) + 10 \sin 10(0) + 10 \cos 10(8)$

$\boxed{V_C = 30.88\ KN}$

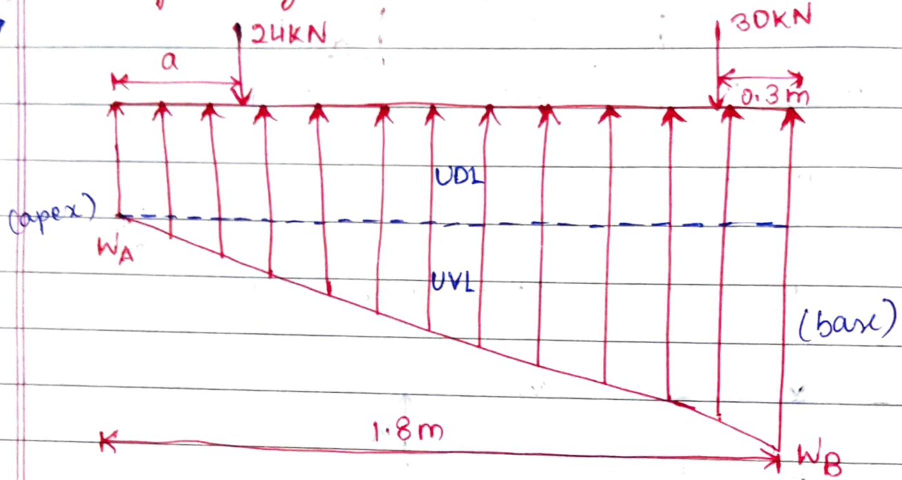
14. For the beam with the loading as fig. Find the support reacns.

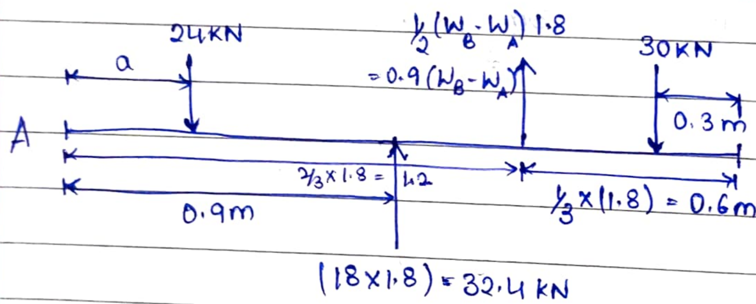




15. The beam supports 2 concentrated loads and rests on the soil which exerts a linearly distributed reac^n as if.
If $w_A = 18\,kN/m$. Determine
a) distance a
b) corresponding value of w_B in kN/m.

→





$\Sigma F_y = 0$

$-24 - 30 + 32.4 + 0.9(W_B - W_A) = 0$

$0.9(W_B - W_A) = 21.6$

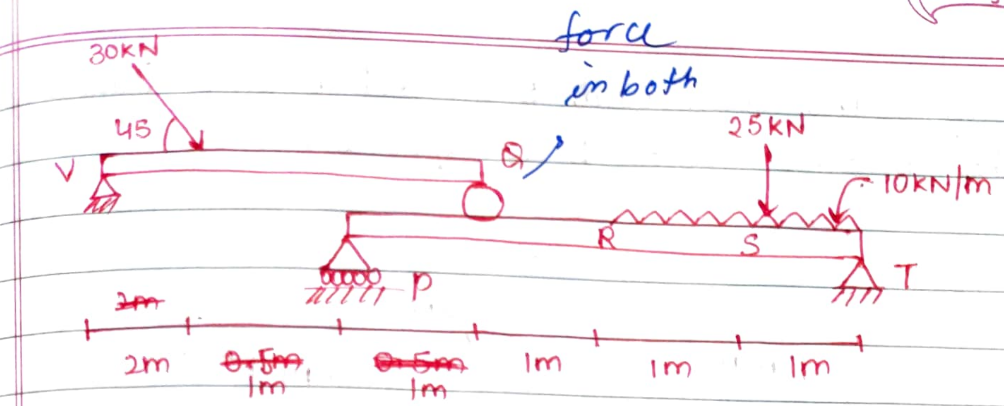
$\boxed{W_B = 42\,kN/m}$

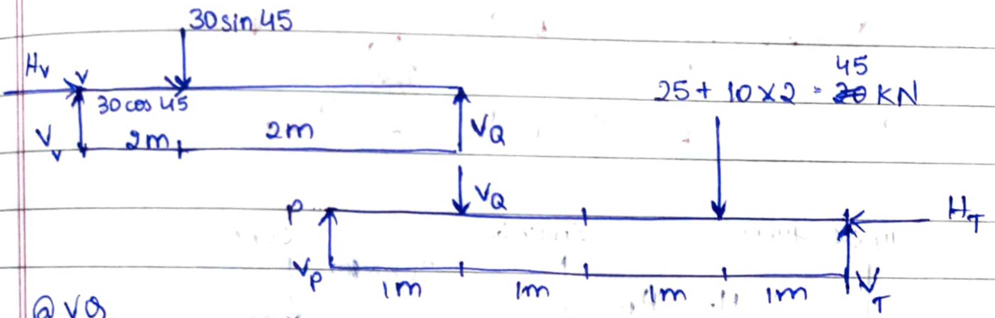
$\Sigma M_A = 0$

$24(a) - 32.4(0.9) - 21.6(\cancel{0.3}\,1.2) + 30(1.5) = 0$

$\boxed{a = 0.42\,m}$

16. Determine the rxns and supports P, Q, T and V for the beam as if





@ VQ

$\Sigma F_x = 0$

$H_V - \cancel{H_T} + 30\cos 45 = 0$

$H_V = -21.21$ KN

$\boxed{H_V = 21.21 \ (\leftarrow)}$

$\Sigma F_y = 0$

$V_V - 30\sin 45 + V_Q = 0$

$V_V + V_Q = 21.21$

$\boxed{V_V = 10.61 \text{ KN}}$

$\Sigma M_V = 0$

$30\sin 45(2) - V_Q(4) = 0$

$\boxed{V_Q = 10.6 \text{ KN}}$

@ PT

$\Sigma F_x = 0$

$H_T = 0$

$\Sigma F_y = 0$

$V_P - V_Q - 20 - 25 + V_T = 0$

$V_P + V_T = 55.61$

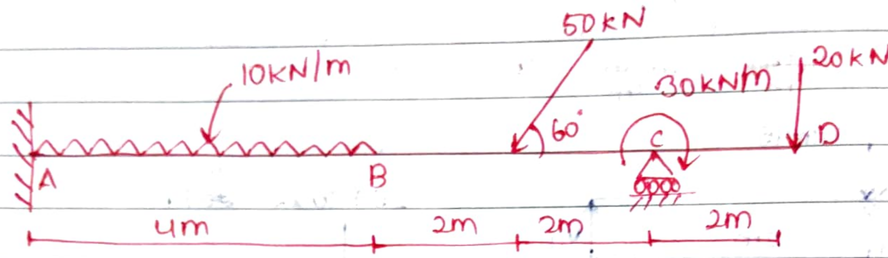
$\boxed{V_T = 36.4 \text{ KN}}$

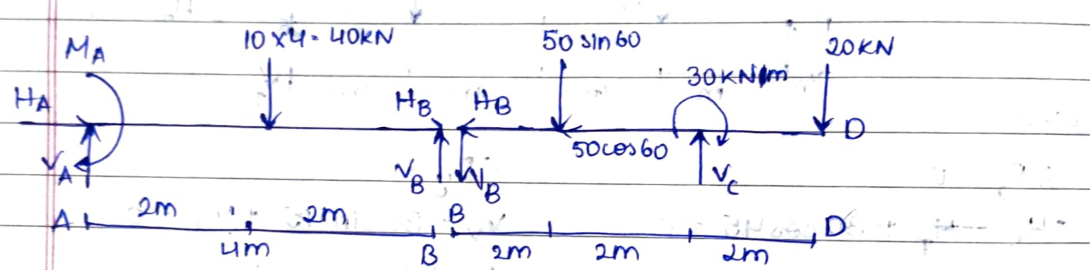
$\Sigma M_T = 0$

$V_P(4) - 10.6(3) - \overset{45}{\cancel{20}}(1) = 0$

$\boxed{V_P = 19.2 \text{ KN}}$

17. Analyse the compound beam ABCD asif. Find the rxn @ the internal hinge B & supports A & C.





When we are replacing the internal hinge in FBD both the spans will have the rxn at both the

→ AB:- $\Sigma F_x = 0$ $\quad$ $\Sigma F_y = 0$

$H_A + H_B = 0$ $\quad$ $V_A - 40 + V_B = 0$

$\boxed{H_A = +25\text{ KN}}$ $\quad$ $V_A + V_B = 40$

$\boxed{\cancel{H_A = 25\text{ KN} (\leftarrow)}}$ $\quad$ $\boxed{\cancel{V_A = 35.85\text{ KN}}}$ $\boxed{V_A = 44.15\text{ KN}}$

$\Sigma M_A = 0$

$H_A(0) + V_A(0) + M_A + 40(2) + H_B(0) - V_B(4) = 0$

$M_A - 4V_B = -80$

$\boxed{M_A = -96.6\text{ KNm}}$ or $\boxed{M_A = 96.6\text{ KNm} \circlearrowleft}$

BD:- $\Sigma F_x = 0$ $\quad$ $\Sigma F_y = 0$

$-H_B - 50\cos 60 = 0$ $\quad$ $-V_B - 50\sin 60 + V_C - 20 = 0$

$H_B = -25\text{ KN}$ $\quad$ $\boxed{V_C - V_B = 63.3\text{ KN}}$

$\boxed{H_B = 25\text{ KN} (\rightarrow)}$ $\quad$ $V_B = -4.15$

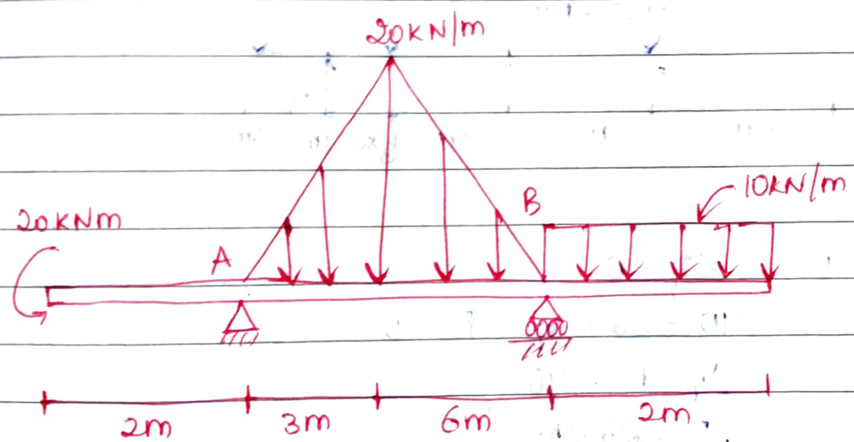
$\boxed{V_B = 4.15 (\uparrow)}$

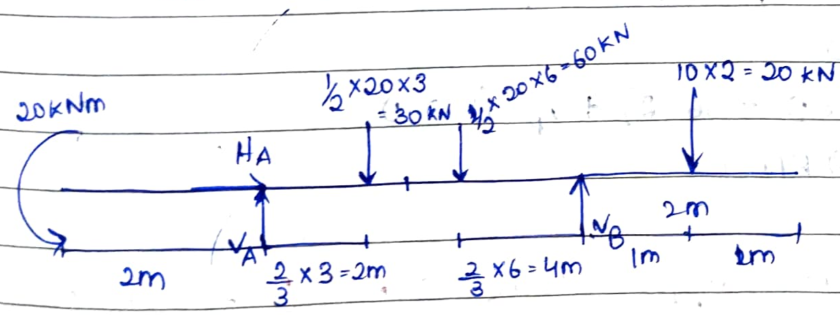
$\Sigma M_B = 0$

$\cancel{V_B(0)} + \cancel{H_B(0)} + 50 \sin 60 (2) + 50 \cancel{\cos 60} (0) \mp V_C (4) + 20(6) + 30 = 0$

$\boxed{V_C = 59.15 \text{ KN}}$

18. Find the support rxns at the supports of the beam loaded as is/





$\Sigma F_x = 0$

$H_A = 0$

$\Sigma F_y = 0$

$V_A - 30 - 60 + V_B - 20 = 0$

$V_A + V_B = 110$

$\boxed{V_A = 50 \text{ KN}}$

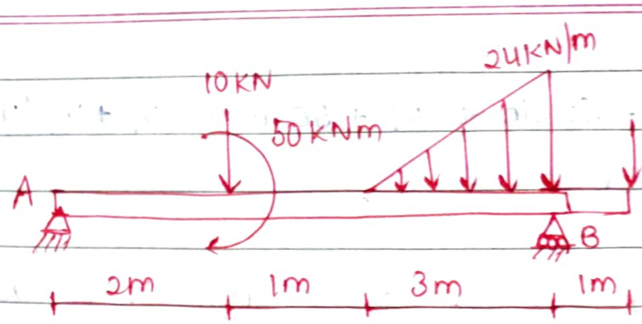
$\Sigma M_A = 0$

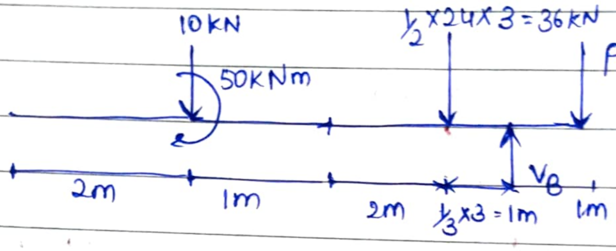
$-20 + 30(2) + 60(5) - V_B(9) + 20(10) = 0$

$\boxed{V_B = 60 \text{ KN}}$

Find analytically support rxn at B and load P for beam a/f if support rxn at A = 0

19.





apex se 2/3
base se 1/3

$\Sigma F_x = 0$ $\quad$ $\Sigma F_y = 0$

$$-10 - 36 + V_B - P = 0$$

$$V_B - P = 46$$

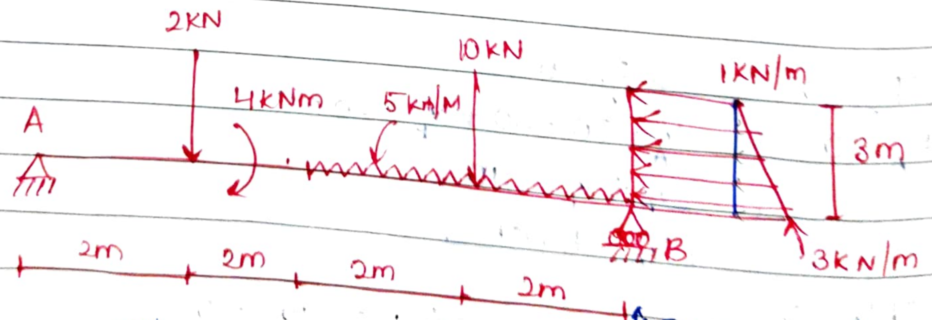
$$\boxed{P = 26\ KN}$$

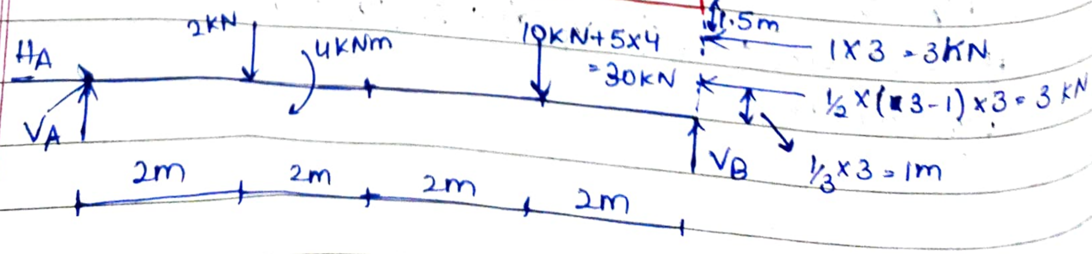
$\Sigma M_P = 0$

$$-10(5) + 50 - 36(2) + V_B(1) = 0$$

$$\boxed{V_B = 72\ KN}$$

20. Find the support rxns at A & B for the beam a/f





$\Sigma F_x = 0$

$H_A - 3 - 3 = 0$

$\boxed{H_A = 6 kN}$

$\Sigma F_y = 0$

$\cancel{30}$

$V_A - 2 - 30 + V_B = 0$

$V_A + V_B = 32 kN$

$\boxed{V_A = 9.44 kN}$

$\Sigma M_A = 0$

$2(2) + 4 + 30(6) - V_B(8) - 3(1) - 3(1.5) = 0$

$\boxed{V_B = 22.56 kN}$