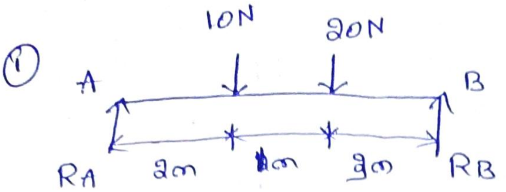
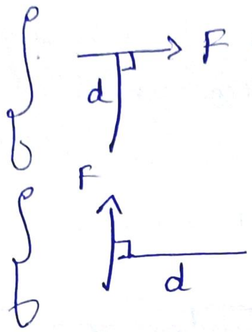
Problems on Moment of forces

(1)



$\circlearrowleft^{+}$ $\Sigma M_A = 0$

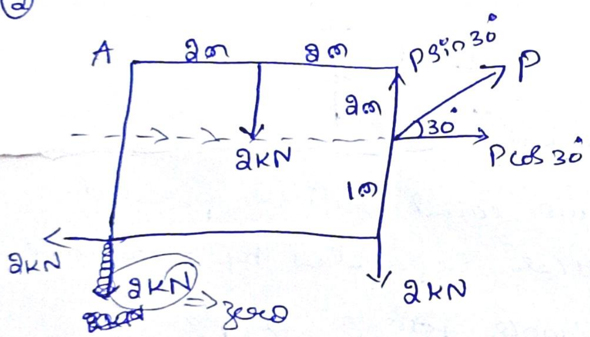


$10 \times 2 + 20 \times 3 - R_B \times 6 = 0$

$80 - R_B \times 6 = 0$

$\boxed{R_B = 13.333N}$

(2)



Given that, $\Sigma M_A = 0$

$2 \times 2 + 2 \times 4 + 2 \times 3 - P\sin 30 \times 4 - P\cos 30 \times 2 = 0$

$-P(4\sin 30 + 2\cos 30) = -18$

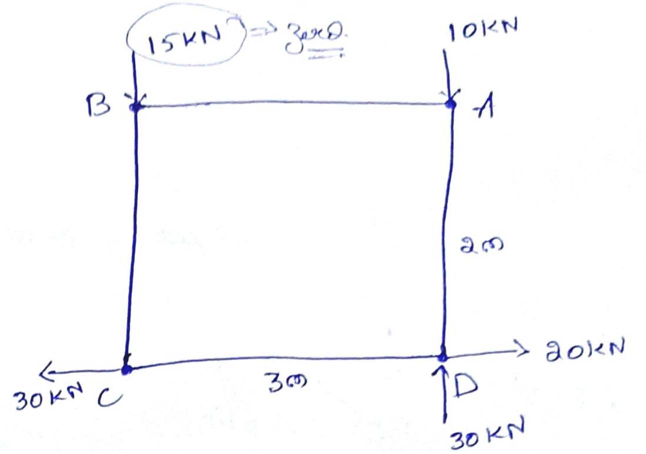
$P(3.732) = 18$

$\boxed{P = 4.823\ kN}$

Question:

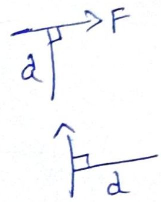
find the value of force P, so that moment about point A is zero as shown in fig.

(3) calculate the moment about point B for the force system shown in fig.



Solu:

$\circlearrowleft^{+}$ $\Sigma M_B =$

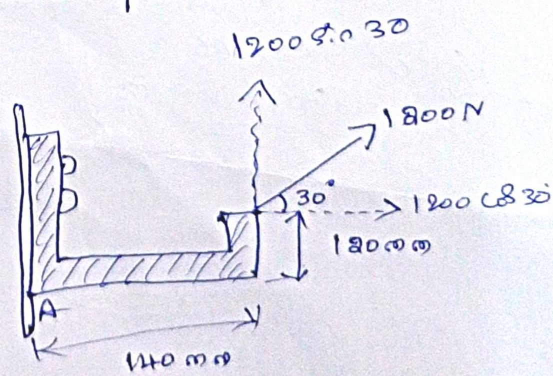


$= 10 \times 3 - 20 \times 2 - 30 \times 3 + 30 \times 2$

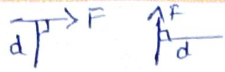
$= -40KN\text{-}m$

$\Sigma M_B = 40KN\text{-}m$ (Anti clockwise)

(4) A force of 1200 N acts on a bracket. find the moment of this force about A.



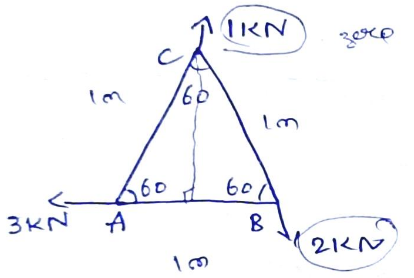
⑥ Soluⁿ:



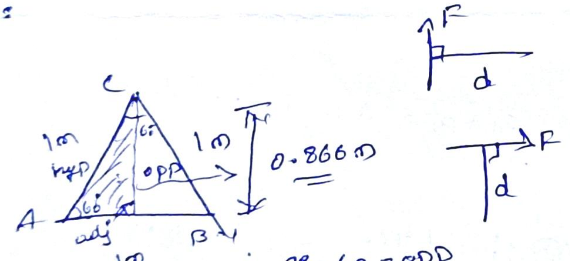
$\circlearrowright + \Sigma M_A = -1800 \sin 30 \times 140$
$+ 1200 \cos 30 \times 180$
$= 40707.658$ N-mm

(clockwise)

⑤ Find the algebraic sum of moment of all the forces as shown in fig about C. consider:
$AB = BC = CA = 1m$.



Soluⁿ:



$\sin 60 = \frac{opp}{1}$

$opp = 1 \sin 60$
$= 0.866$ m

$\circlearrowright + \Sigma M_C = 3 \times 0.866$
$= 2.598$ KN-m

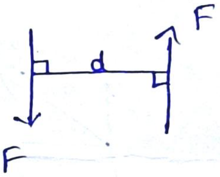
Module:03 (Theory)

Moment of force:

when a force is applied on a body, it has the tendency to turn the body about some point. The turning tendency of the force about a point is called moment of the force about that point.

it is also referred as Torque.

Couples & Torque:



"Two equal unlike parallel forces separated by a definite distance form a couple"

Couple = Fd
= one of the force × the distance b/w the forces

Torque is another name for the total moment of a couple.

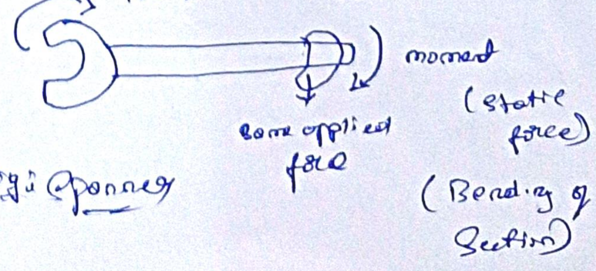


fig: spanner

Generally: (Moment of force)

Moment of force:

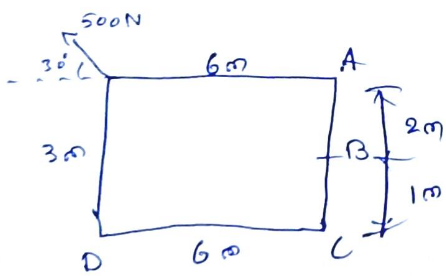
is the general term for a turning force. (cause by single force)

Torque: is a specific type of moment that causes twisting or Rotation around an axis. (cause by twisting force)

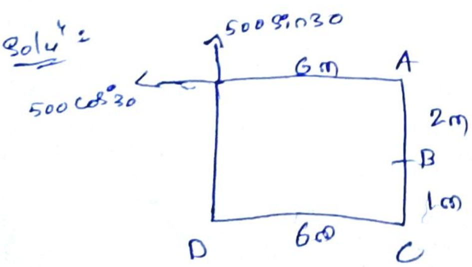
Couple: is a specific system of two equal & opposite force that creates a net moment (torque) without causing any translational movement. (always involves two forces)

Problems:

⑥ find the moment of 500N force about the points A, B, C & D as shown in fig



Solu^n:



$M_A = 500 \sin 30 \times 6$

$= 1500$ N-m (clockwise)

$M_B = 500 \sin 30 \times 6 - 500 \cos 30 \times 2$

$= 633.97$ N-m (clockwise)

$M_C = 500 \sin 30 \times 6 - 500 \cos 30 \times 3$

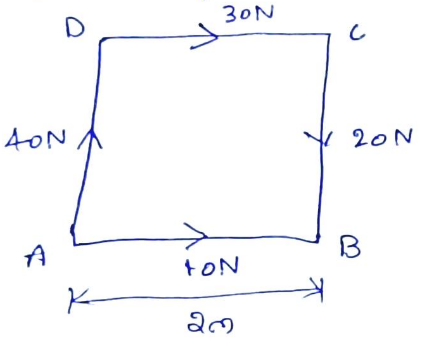
$= 200.96$ Nm (clockwise)

$M_D = -500 \cos 30 \times 3$

$= 1299.96$ Nm (Anticlockwise)

Problems on Varignon's Theorem:

① ABCD is a square of 2m side. Along sides AB, CD, DC & AD the forces of 10N, 20N, 30N & 40N are acting respectively. Find the magnitude, direction & the position of the resultant of the forces from point A. Refer the given figure,



Solu^n: (Non-con-current forces)

$$\left\{ \begin{array}{l} R = \sqrt{\Sigma fx^2 + \Sigma fy^2} \\ \theta = \tan^{-1}\left|\frac{\Sigma fy}{\Sigma fx}\right| \end{array} \right.$$

$\Sigma fx =$

$\Sigma fy =$

By Varignon's theorem,

$$\boxed{\Sigma MA = R \times d}$$

we need to find, Resultant of forces from point "A".

$\Rightarrow \xrightarrow{+} \Sigma fx = 30 + 10 = 40N$

$+\uparrow \Sigma fy = 40 - 20 = 20N$

$R = \sqrt{\Sigma fx^2 + \Sigma fy^2}$

$= \sqrt{40^2 + 20^2}$

$\boxed{R = 44.72N}$

$\theta = \tan^{-1}\left[\frac{\Sigma fy}{\Sigma fx}\right]$

$= \tan^{-1}\left[\frac{20}{40}\right]$

$\boxed{\theta = 26.56°}$

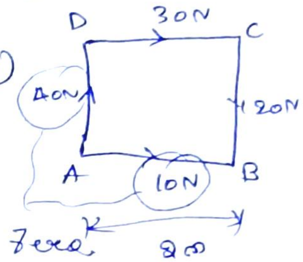
By, Varignon's theorem,

$\boxed{\Sigma MA = R \times d}$

$? = 44.72 \times d$

$\overset{+}{\curvearrowright} \Sigma MA = 20 \times 2 + 30 \times 2$

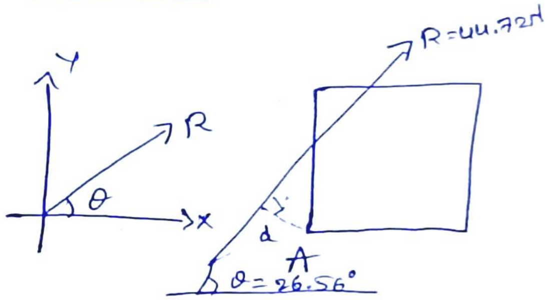
$= 100 \text{ N-m}$ (clockwise)



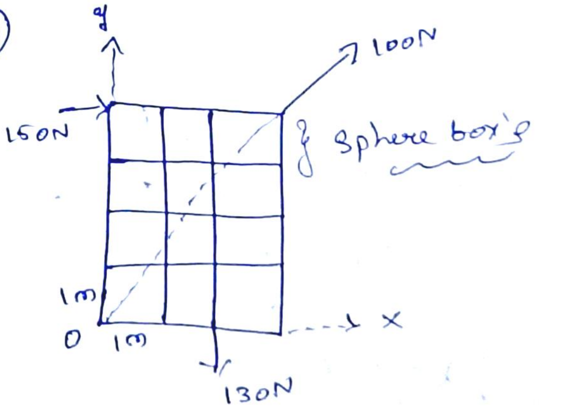
$\therefore \Sigma MA = R \times d$

$100 = 44.72 \times d$

$\boxed{d = 2.24m}$

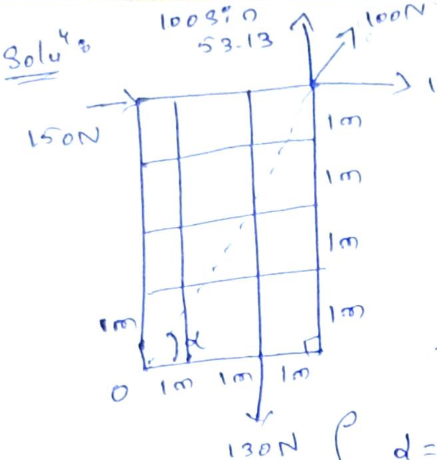


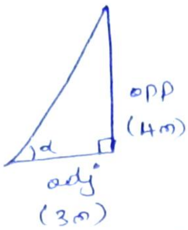
②



Calculate the Resultant of the force & its X & Y intercept

Solu^n:





$\alpha = \tan^{-1}\left(\frac{opp}{adj}\right)$

$= \tan^{-1}\left(\frac{4}{3}\right)$

$\boxed{\alpha = 53.13'}$

$\xrightarrow{+} \Sigma f_x = 150 + 100 \cos 53.13$

$= \underline{210 N}$

$+\uparrow \Sigma f_y = 100 \sin 53.13 - 130$

$= \underline{-50N}$

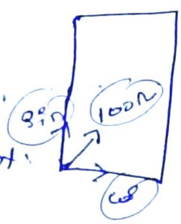
$R = \sqrt{210^2 + 50^2} = \boxed{R = 215.87N}$

$\theta = \tan^{-1}\left(\frac{50}{210}\right) \boxed{\theta = 13.398°}$

Note: Moment always @ origin

$\overset{+}{\circlearrowright} \Sigma M_O = 150 \times 4 + 130 \times 2$

$= \underline{860 \ N\text{-}m}$



$\Rightarrow$ To find X-Intercept:

$\Sigma M_O = \Sigma f_y \times x$

zero

$860 = -50 \times x$

$\boxed{x = -17.2m}$

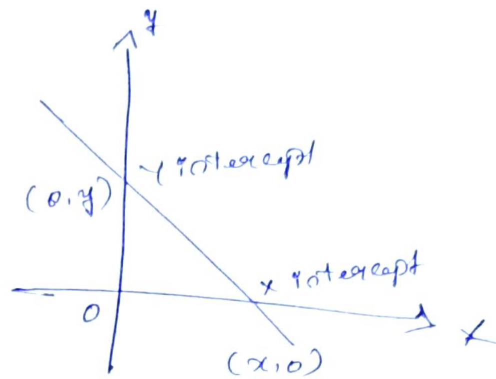
$\Rightarrow$ To find Y-intercept

$\Sigma M_O = \Sigma f_x \times y$

$860 = 210 \times y$

$\boxed{y = 4.095m}$

Concept of X & Y intercept:



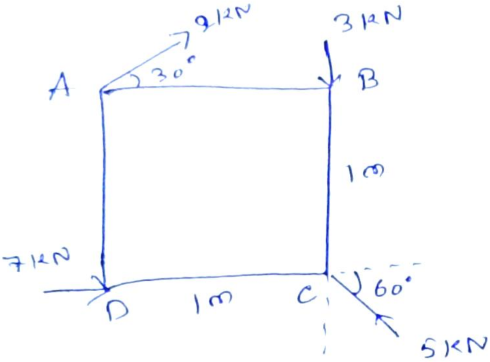
The point where the straight line crosses the X-axis & Y-axis.

Statement: V's T:

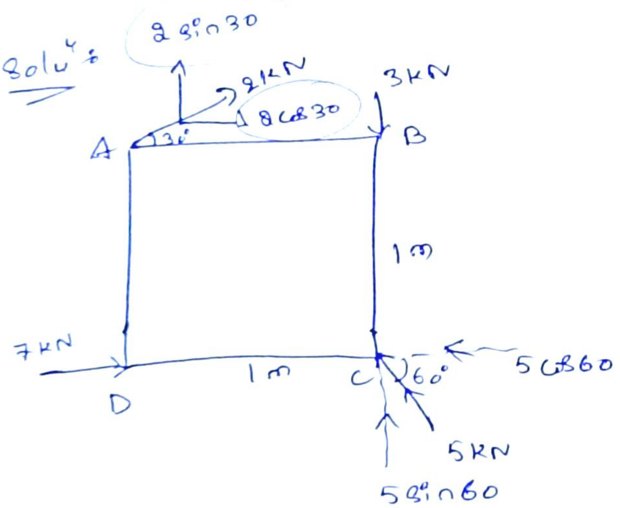
if a no of coplanar forces are acting on a particle,

The algebraic sum of moments of all the forces about any point is equal to the moment of their Resultant force about the same point.

(3) Four coplanar forces equal to 2 KN, 3 KN, 5 KN & 7 KN are acting on a square body having its side as 1 m as shown in fig. Determine magnitude, direction & position of a single resultant force from point A, which will keep the body in equilibrium.



Solu^n:



$\xrightarrow{+} \Sigma f_x = 7 - 5\cos 60 + 2\cos 30$

$= 6.23\,KN$

$\overset{+}{\uparrow} \Sigma f_y = 2\sin 30 - 3 + 5\sin 60$

$= 2.33\,KN$

$\boxed{R = 6.65\,KN}$ $\boxed{\theta = 20.5°}$

By Varignon's theorem:

$\boxed{\Sigma M_A = R \times d}$

$\Sigma M_A = 3\times 1 - 7\times 1 - 5\sin 60\times 1 + 5\cos 60\times 1$

$= -5.83\,KN\text{-}m$

$= 5.83\,KN\text{-}m$ (Anticlockwise)

$\Sigma M_A = R \times d$

$5.83 = 6.65 \times d$

$\boxed{d = 0.88\,m}$