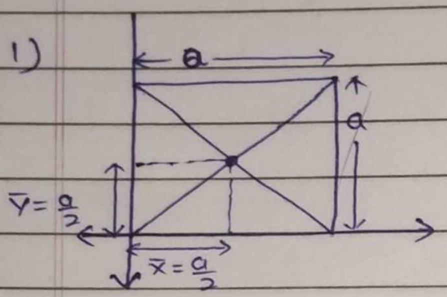
module - I

CENTROID OF PLANE LAMIANS

It is a defined as geometrical centre of body

A # Centroid of standard shapes

1)



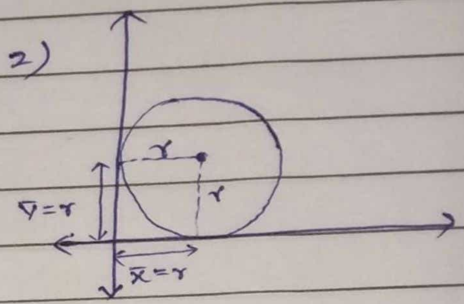
Square

$\bar{x} = \frac{a}{2}$

$\bar{y} = \frac{a}{2}$

$A = a^2$

2)

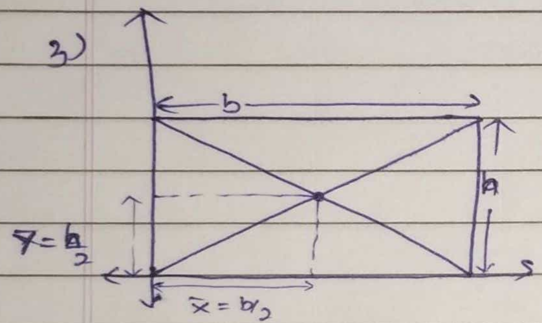


Circle

$\bar{x} = \bar{y} = r$

$A = \pi r^2$

3)

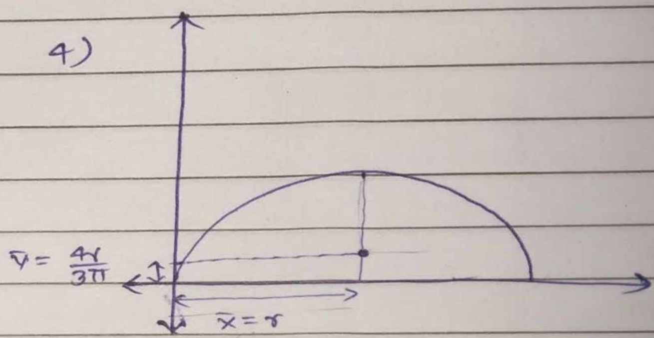


rectangle

$A = b \times h$

$\bar{y} = \frac{h}{2}$ $\quad \bar{x} = \frac{b}{2}$

4)

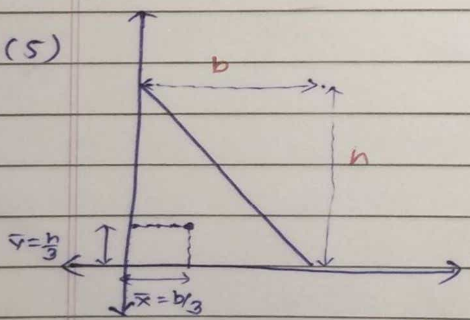


Semi - circle

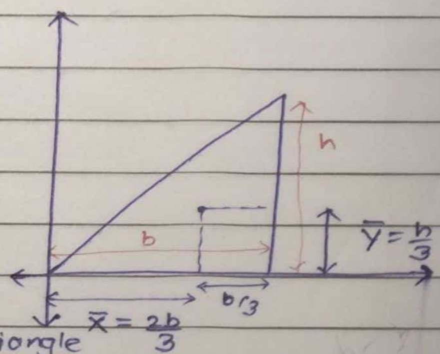
$A = \frac{\pi r^2}{2}$

$\bar{x} = r$ $\quad \bar{y} = \frac{4r}{3\pi}$

(5)



(6)



right angle triangle

$A = \frac{b \times h}{2}$

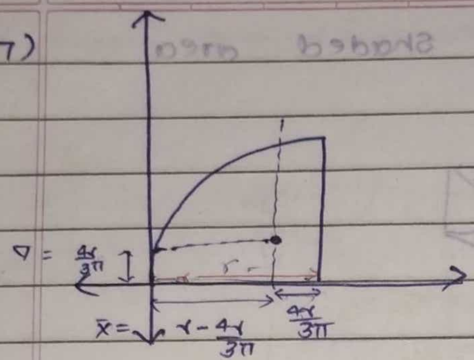
$\bar{x} = b/3$

$\bar{y} = h/3$

$\bar{x} = \frac{2b}{3}$

$\bar{y} = h/3$

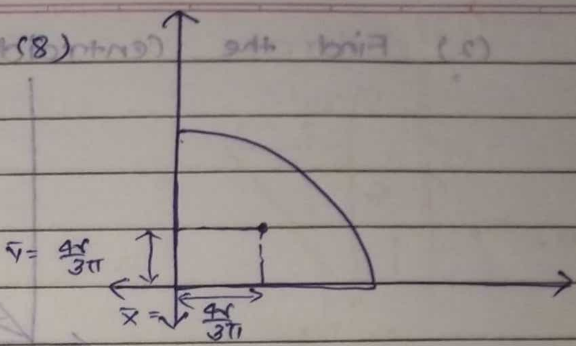
(7)



$\bar{x} = r - \frac{4r}{3\pi}$

$\bar{y} = \frac{4r}{3\pi}$

(8)

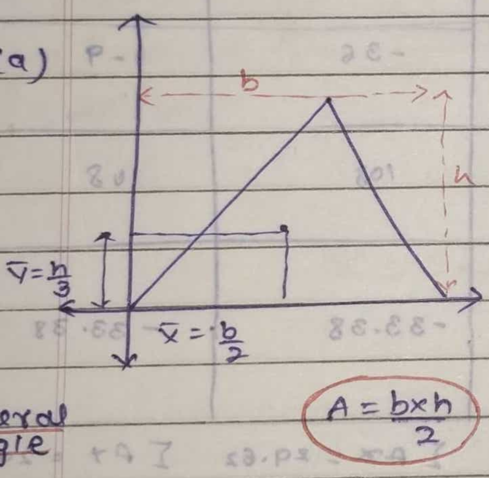


Quater - Circle

$A = \frac{\pi r^2}{4}$

$\bar{x} = \bar{y} = \frac{4r}{3\pi}$

(9)



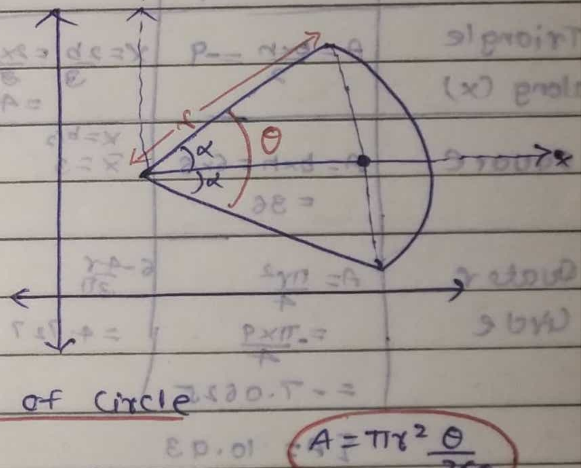
Equilateral triangle

$A = \frac{b \times h}{2}$

$\bar{x} = \frac{b}{2}$

$\bar{y} = h/3$

(10)



Sector of circle

$A = \pi r^2 \frac{\theta}{360}$

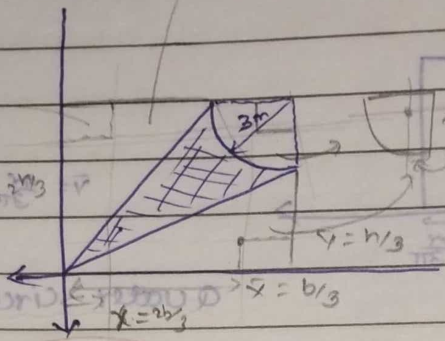
$\bar{x} = \frac{2r\sin\alpha}{3\alpha}$

$\bar{y} = 0$

α in radian

(−) sign In Area because get required Area

(2) Find the centroid of the shaded area



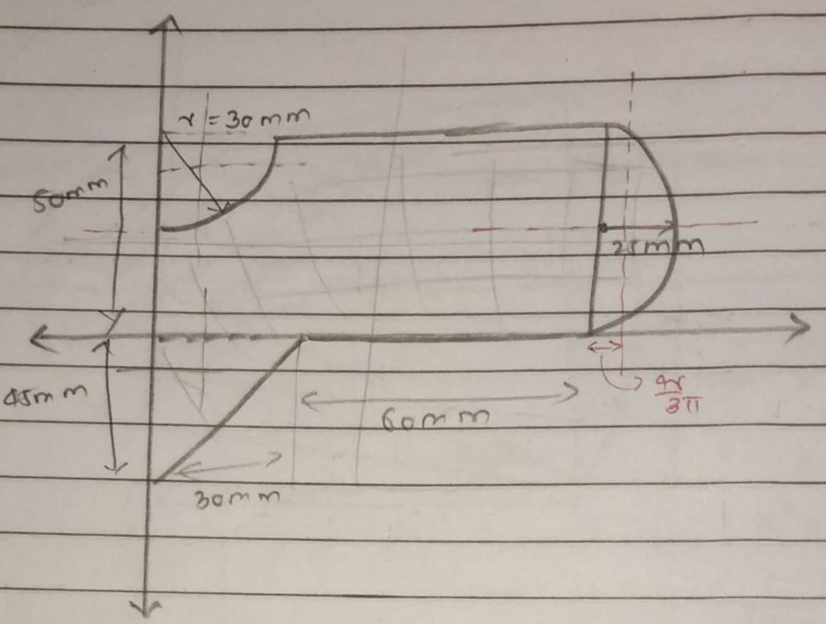
	Area = A	x	y	Ax	Ay
Triangle along (y)	$A = \frac{b \times h}{2} = \frac{3 \times 6}{2} = -9$	$\bar{x} = b/3 = \frac{3}{3} = 1$	$\bar{y} = \frac{2h}{3} = \frac{2 \times 6}{3} = 4$	−9	−36
Triangle along (x)	$A = \frac{b \times h}{2} = -9$	$\bar{x} = \frac{2b}{3} = \frac{2 \times 6}{3} = 4$	$\bar{y} = \frac{h}{3} = \frac{3}{3} = 1$	−36	−9
Square	$A = b \times h = 6 \times 6 = 36$	$x = b/2$, $\bar{x} = 3$	$y = h/2$, $\bar{y} = 3$	108	108
Quater Circle	$A = \frac{\pi r^2}{4} = \frac{-\pi \times 9}{4} = -7.0625$	$6 - \frac{4r}{3\pi} = 4.727$	$6 - \frac{4r}{3\pi} = 4.727$	−33.38	−33.38

$\Sigma A = 10.93$ $\quad \Sigma Ax = 29.62$ $\quad \Sigma Ay = 29.62$

$$\bar{x} = \frac{\Sigma Ax}{\Sigma A} = \frac{29.62}{10.93} = 2.709\,m$$

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{29.62}{10.93} = 2.709\,m$$

(2) Determine the centroid of the following plane are shown in figure



	Area	X	Y	AX	AY
Semicircle	$A = \frac{\pi r^2}{2} = \frac{\pi \times (25)^2}{2} = 981.74$	$= 90 + \frac{4r}{3\pi} = 100.61$	25	98772.86	24543.5
Quarter-circle	$A = \frac{\pi r^2}{4} = \frac{\pi \times (30)^2}{4} = -706.85$	$= \frac{4r}{3\pi} = \frac{4 \times 10}{\pi} = 12.73$	$50 - \frac{4r}{3\pi}$ 37.267	-8998.2	-26342.17
rectangle	$A = b \times h = 90 \times 50 = 4500$	45	25	202500	112500
right angle triangle	$A = \frac{b \times h}{2} = 90 \times 15$ 675	$\frac{30}{3} = 10$	$= -\frac{45}{3} = -15$	6750	-10125

$\Sigma A = 5449.89$

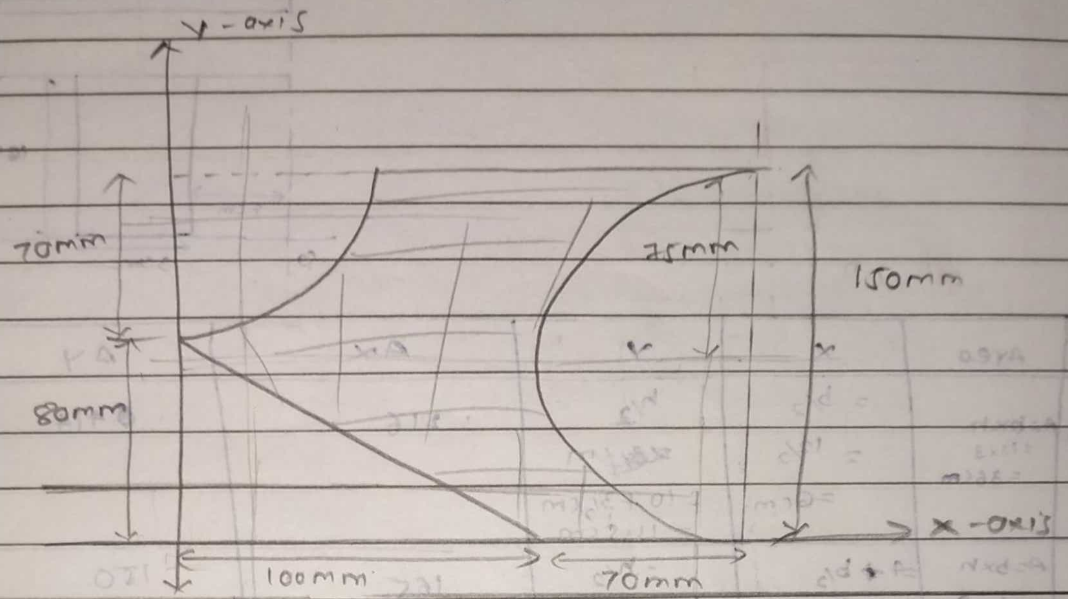
$\Sigma AX = 299029.66$ $\Sigma AY = 100576.33$

$\bar{X} = \frac{\Sigma AX}{\Sigma A} = \frac{299029.66}{5449.89} = \underline{54.86}$

$\bar{Y} = \frac{\Sigma AY}{\Sigma A} = \frac{100576.33}{5449.89}$

$= \underline{\underline{18.45}}$

(3) Determine the centroid of the following plane are shown in figure.



	Area = A	x	y	Ax	Ay
Semicircle	$A = \frac{\pi r^2}{2} = \frac{\pi \times (75)^2}{2}$ $= -8835.72$	$170 - \frac{4r}{3\pi}$ $= 170 - \frac{4\times 75}{3\pi}$ $= 138.167$	$= 75$	-1220743.07	-662679
Quarter circle	$A = \frac{\pi r^2}{4} = \frac{\pi \times (70)^2}{4}$ $= -3848.45$	$\frac{4r}{3\pi} = \frac{4\times 70}{3\pi}$ $= 29.708$	$150 - \frac{4r}{3\pi}$ $= 120.292$	-114329.75	-462937.74
right angle triangle	$A = \frac{b\times h}{2}$ $= \frac{100\times 80}{2}$ $= 4000$	$\frac{b}{3} = \frac{100}{3}$ 33.33	$\frac{h}{3} = \frac{80}{3}$ 26.66	-133320	-106640
Rectangle	$A = b\times h$ $= 150\times 170$ 25500	85	75	2167500	1912500

$\Sigma A = 8815.83$ $\Sigma Ax = 699107.18$ $\Sigma Ay = 680243.26$

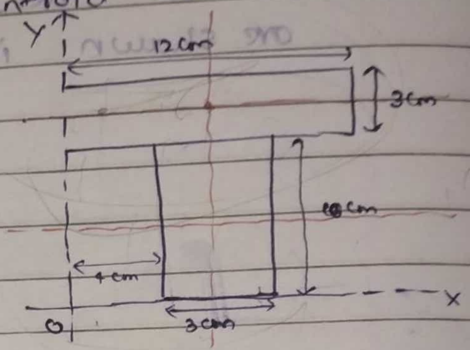
$$\bar{x} = \frac{699107.18}{8815.83}$$

$$\boxed{\bar{x} = 79.3}$$

$$\bar{y} = \frac{680243.26}{8815.83}$$

$$\boxed{\bar{y} = 77.161}$$

Find the co-ordinate of centroid of T-section



rectangle	Area	x	y	Ax	Ay
12 × 3	A = b×h = 12×3 = 36 cm	= b/2 = 12/2 = 6 cm	h/2 ~~3/2 cm~~ = 10 + 3/2 cm = 11.5 cm	216	414
3 × 10	A = b×h = 10×3 = 30	= 4 + b/2 = 4 + 3/2 = 5.5 cm	= h/2 = 5 cm	165	150
	ΣA = 66			ΣAx = 381	204

$$X = \frac{\Sigma Ax}{\Sigma A} = \frac{381}{66} = \underline{5.77 cm}$$

$$Y = \frac{\Sigma Ay}{\Sigma A} = \frac{564}{66}$$

$$Y = \underline{8.545} cm$$

B

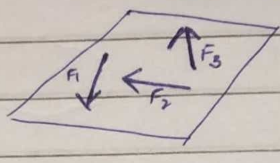
Coplanar System of force.

System of force : There are mainly seven types of system forces.

Imp Types of force :

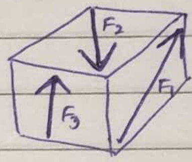
(1) Co-planar forces : ①

- The forces which are acting in the same plane.



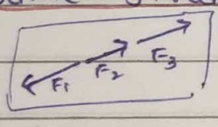
(2) Non-Coplanar forces : ②

- The forces which are acting in the different plane.



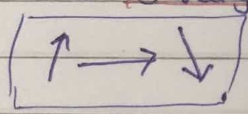
(3) Collinear forces : ③

- The force which are acting along the same straight line.



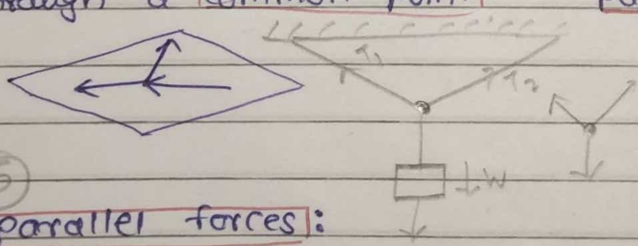
(4) Non-Collinear forces :

- The force which are not acting along the straight line.



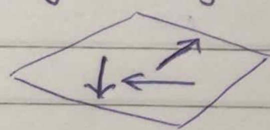
(5) Concurrent forces : ④

- The forces which are passing through a common point



(6) Non-Concurrent forces :

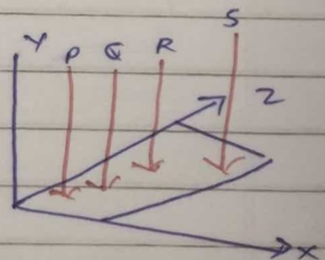
- The forces which are not passing through a common Point

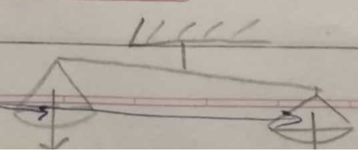


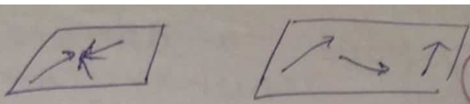
⑤

(7) parallel forces :

- The forces whose line of action are parallel to each other.







Resultant of two or more forces :

(6)

- When two or more Coplanar Concurrent or non-Concurrent forces acting on a body the resultant can be found out by using resolution procedure.

magnitude of resultant : $R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

force along x-direction

force along y-direction

direction :

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

angle of 'R' with x-axis

moment of force → when a Force acting on a body produces turning effect or rotational effect is called moment of force

(7)

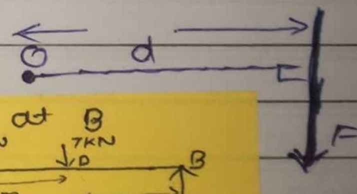
Moment : S.I Unit N-m

- It is the turning effect produced by a force.

- Force about any point is the product of magnitude of force and $\perp^{ar}$ distance about that point.

$\boxed{M_o = F \times d}$

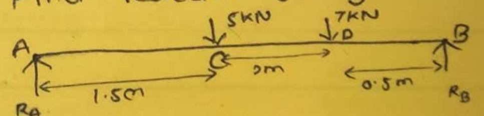
moment at point O



Couple

Two non-Collinear parallel forces having same magnitude But opposite direction forms a Couple.

Find reaction at B



$\boxed{\Sigma M_A = 0}$ --- Imp

↻ +ve

↺ −ve

Point A Point C Point D Point B

$(R_A \times 0) + (5 \times 1.5) + (3.5 \times 7) - (R_B \times 4) = 0$

$7.5 + 24.5 - R_B \times 4 = 0$

$4R_B = 32$ $R_B = 8\,KN$

Note :

The sum of all moment should be zero

of all forces

$\Sigma M = 0$

How to allocate the resultant a given force system

Varignon's theorem :

The sum of the moment of all the force about a point is equal to the moment ~~only~~ & of their resultant about the same point

or

The sum of the moment of all the force about a point is equal to the moment of their resultant about the same point.

$$\sum M_0 F = M_0 R$$

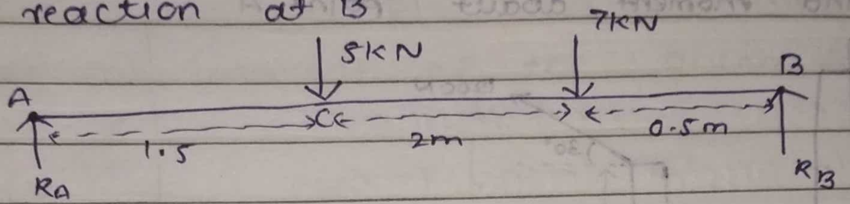
$$\sum M_0{}^F = M_0{}^R$$

Summation of moment of all all Forces w.r.t any point is equal to moment of resultant of that force w.r.t same point

$$\boxed{\sum M_A^F = M_A^R}$$

Imp (5M)

Find reaction at B



$\cancel{\Sigma F_x = 0}$

$\Sigma F_y = -R_A + 5 + 7 + R_B$

$= -(R_A + R_B) + 5 + 7$

$\cancel{R =}$

$+\circlearrowright \quad M_A = 0 \quad R_A \times 0 + 5 \times 1.5 + 3.5 \times 7\cancel{8} - R_B \times 4 = 0$

$7.5 + 3.5 \times 7 = R_B \times 4$

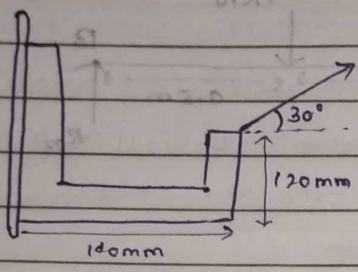
$R_B = \frac{\cancel{25}\,32}{4}$

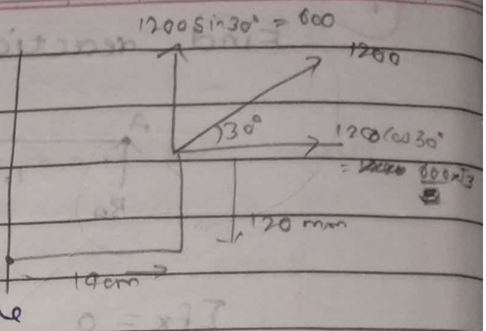
$R_B = 8\,kN$

moment wale question

$\boxed{\text{Moment force}}$: the force when act on a body produces the turning effect or rotational effect is called moment force

(1) Find moment about point A





↻ +ve ↺ −ve

$$\Sigma M_A = -(1200\sin 30^\circ)\times 140 + \left(1200\times\frac{\sqrt{3}}{2}\right)\times 120$$

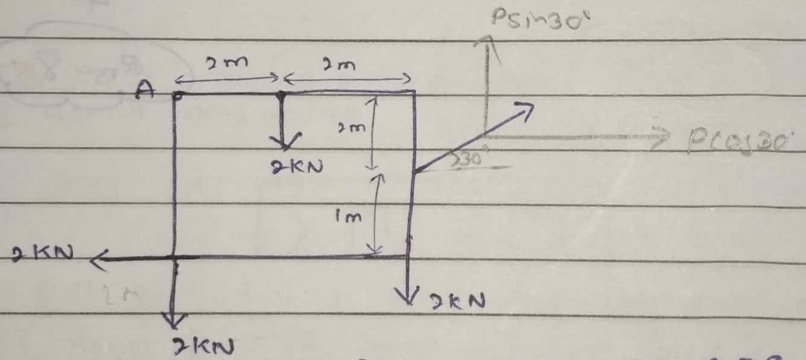
$$= -600\times 140 + 600\sqrt{3}\times 120$$

$$= -84000 + 124707.65$$

$$\boxed{\Sigma M_A = 40707.65}$$

(2) Find the value of force P, so that moment about point A is zero as shown in figure

⇒



↺ −ve

↻ +ve

moment of all the force about pt. A = 0

$$\boxed{\Sigma M_A = 0}\ (2\times 2) + (2\times 0) + (2\times 3) + (2\times 4) - (P\cos 30^\circ \times 2) - P\sin 30^\circ \times 4 = 0$$

$$4 + 0 + 6 + 8 + 0 - P\times\sqrt{3} \quad -\tfrac{4}{2}P = 0$$

$$\cancel{18 - \frac{P}{2} = 0}$$

$$\cancel{P = 16\times 2} \quad \cancel{\boxed{P = 32kN}}$$

$$\cancel{-P(2.732) = 16}$$

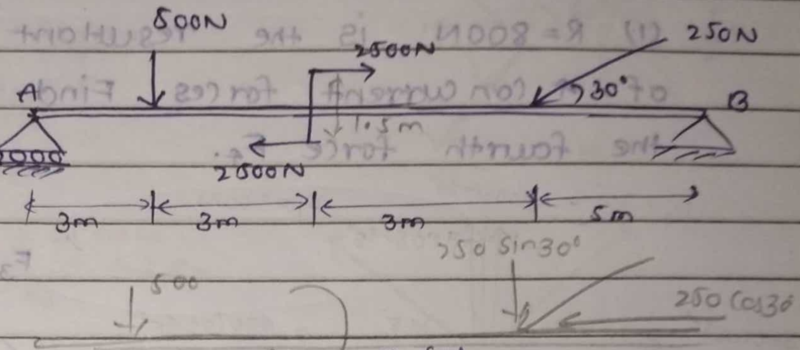
$$-(3.732)P + 18 = 0$$

$$P = \frac{18}{3.732}$$

$$\boxed{P = 4.825kN}$$

Couple : when a two equal an like parallel, non-collinear force acts on a body that couple will form.

(1) Compute the moment of the given force about support A.



m = fxd
2500 × 1.5
= 3750 N-m

+ve   -ve

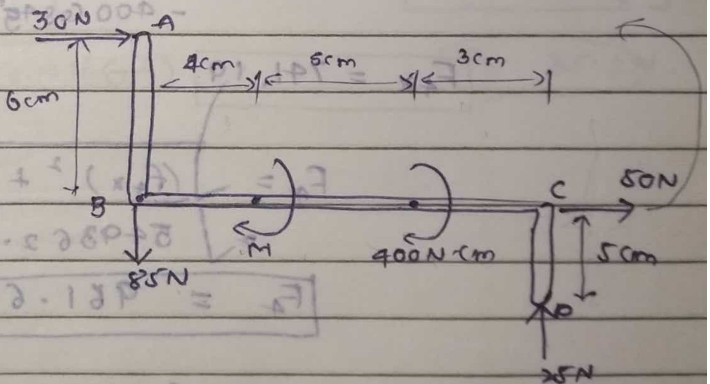
$\Sigma M_A = (500 \times 3) + 3750 + (250 \times \cos 30° \times 0) + (250 \sin 30° \times 9)$

$= 1500 + 3750 + 0 + \frac{250 \times 9}{2}$

$= 5250 + 1125$

$\boxed{\Sigma M_A = 6375 \text{ N-m}}$

(2) Find the moment of couple M, if the line of action of resultant of this force system is to pass through point A



$\Sigma M_A = (30 \times 0) + (85 \times 0) + M + 400 - (6 \times 50) - (25 \times 12)$

$= M - \cancel{300} + 400 - \cancel{300}$

$= M - 600 + 400$

$= M - 200$

moment of about point A = 0

$\boxed{\Sigma M_A = 0}$

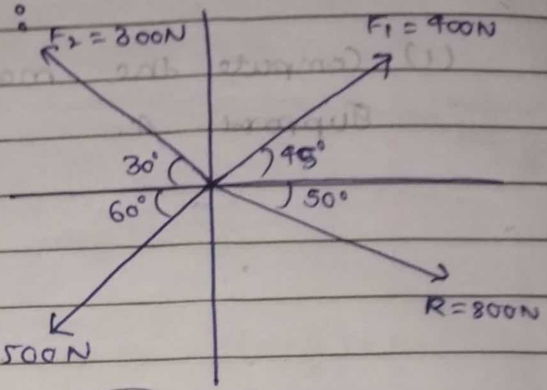
$M - 200 = 0$

$\boxed{M = 200 \text{ Ncm}}$

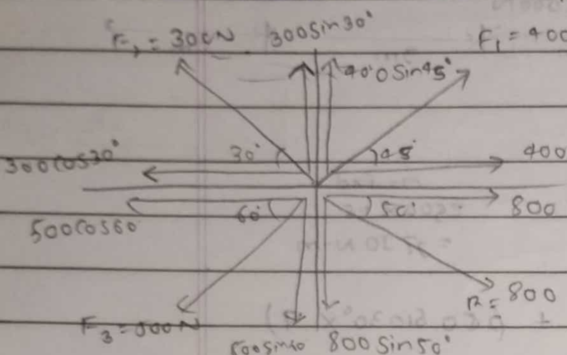
Note : $\sum f_x = R_x$ $\sum f_y = R_y$

Date______
Page______

(1) # Determine unknown forces :



(1) R = 800N is the resultant of 4 concurrent forces. Find the fourth force F_4.



$R = 800$ $\theta = 50°$

$R_x = R\cos 50°$ $R_y = R\sin 50°$

$\sum F_x = R_x$

$400\cos 45° \cancel{+800\cos 50°} - 300\cos 30° - 500\cos 60° + (F_{4x}) = 800\cos 50°$

$F_{4x} = 250 + 300 \times \frac{\sqrt{3}}{2} + 800\cos 50° - 400\cos 45°$

$\boxed{F_{4x} = 741.19}$ $(\rightarrow)$

$\sum F_y = R_y$

$300\sin 30° + 400\sin 45° - 500\sin 60° + (F_{4y}) = -800\sin 50°$

$F_{4y} = 500\sin 60° - 300\sin 30° - 400\sin 45° - 800\sin 50°$

$\boxed{F_{4y} = -612.6}$ $(\downarrow)$

$$F_4 = \sqrt{(F_{4x})^2 + (F_{4y})^2}$$

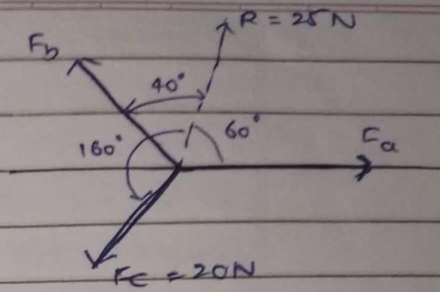
$$= \sqrt{549362.61 + 375355.68}$$

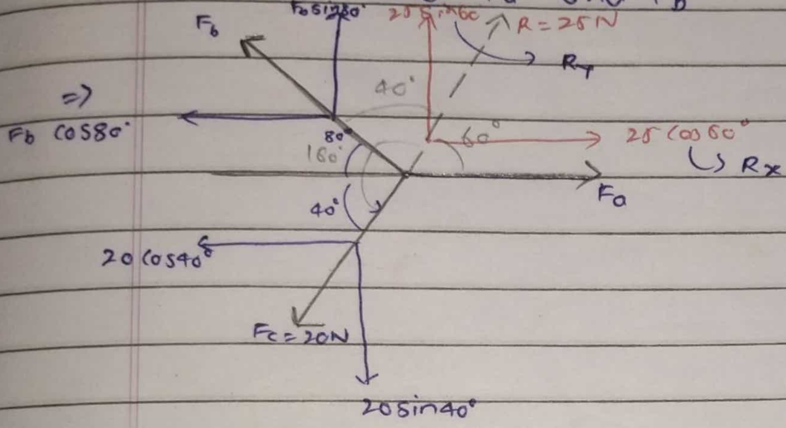
$$\boxed{F_4 = 961.6\,N}$$

$$\theta_4 = \tan^{-1}\left(\frac{F_{4y}}{F_{4x}}\right) = \tan^{-1}\left(\frac{612.6}{741.19}\right)$$

$$\boxed{\theta_4 = 39.57}$$

(2) A force R = 25 N has components F_a, F_b and F_c as shown in figure. $F_c = 20N$, Find F_a and F_b





$\Sigma F_x = R_x$

$= 25 \cos 60°$

$-F_b \cos 80° - 20 \cos 40° + F_a$

$F_a - F_b(0.17) - 15.32 = \frac{25}{2}$

$F_a - 0.17F_b = 12.5 + 15.32$

$\boxed{F_a - 0.17F_b = 27.82}$

$F_a = 27.82 + (0.17)35.2$

$\boxed{F_a = 33.80N}$

$\Sigma F_y = R_y$

$F_b \sin 80° - 20 \sin 40° = 25 \sin 60$

$(0.98)F_b - 20 \sin 40°$

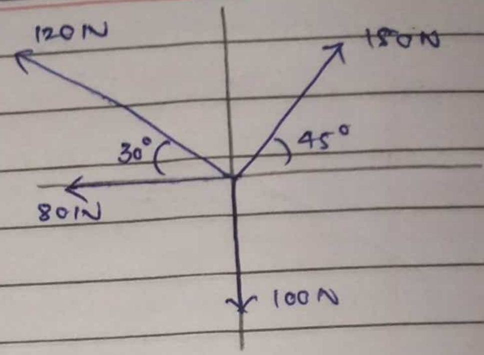
$(0.98)F_b - 12.85 = 21.65$

$\boxed{F_b = \frac{34.5}{0.98}}$

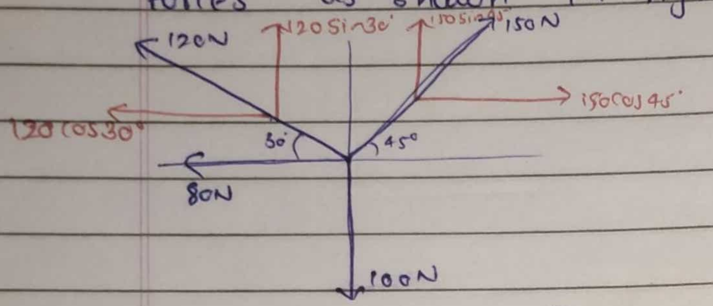
$F_b = 35.2N$

Date
Page

(2) # Resultant of Concurrent fore Systems :



★ (1) Find the resultant System of Four Concurrent forces as shown in figure



$\Sigma f_x = -80 - 120 \times \frac{\sqrt{3}}{2}$ & $\Sigma f_y = -100 + 120 \times \frac{1}{2} + 150 \times \frac{1}{\sqrt{2}}$

$150 \times \frac{1}{\sqrt{2}}$

$= -100 + 60 + 105.06$

$\boxed{\Sigma f_y = 66.06}$ $(\uparrow)$

$= \cancel{-200}\ -80 - 60 \times \sqrt{3} + 106.06$

$= 80 - 103.9 + 106.06$

$\boxed{\Sigma f_x = -77.86}$ $(\leftarrow)$

$R = \sqrt{(\Sigma f_x)^2 + (\Sigma f_y)^2}$

$= \sqrt{(6062.41) + (4363.92)}$

$= \sqrt{\ }$

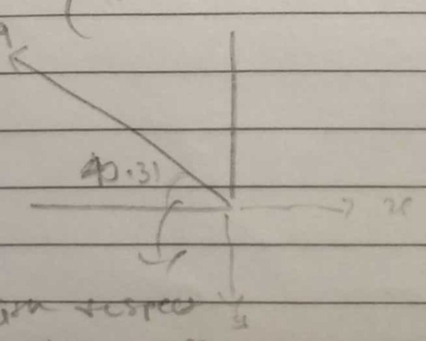
$\boxed{R = 102.109}$

location y = +ve $\theta = \tan^{-1}\left(\frac{66.06}{77.86}\right)$

x = -ve

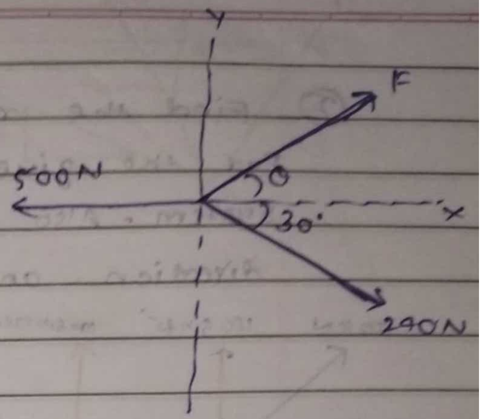
which quadrant $\boxed{\theta = 40.31}$

(-ve),

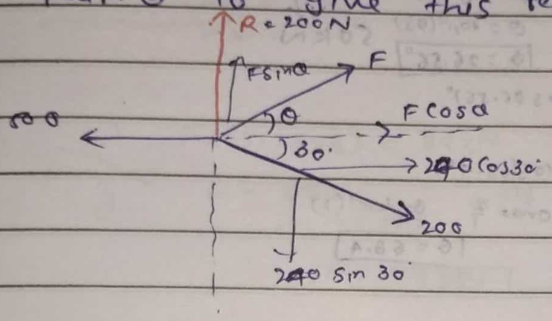


θ → with respect to x-axis

1) (3) The force system shown in fig has a resultant of 200N point up along the Y-axis. Compute the value of force F and angle θ required to give this resultant



=)



$\Sigma f_x = 0$

$\Sigma f_y = R$

$\Sigma f_y = 200N$

$\Sigma f_x = 0$

$-500 + F\cos\theta + 240\cos 30° = 0$

$-500 + F\cos\theta + 207.84 = 0$ $\quad +292.15$

$\boxed{F\cos\theta = +292.15}$

$\Sigma f_y = 200$

$F\sin\theta - 240 \times \frac{1}{2} = 200$ (120)

$\boxed{F\sin\theta = 320}$

$$\frac{F\sin\theta}{F\cos\theta} = \frac{320}{+292.15}$$

$\tan\theta = 1.095$

$\theta = \tan^{-1}(1.095)$

$\boxed{\theta = 47.59°}$

$F\sin(47.59°) = 320$

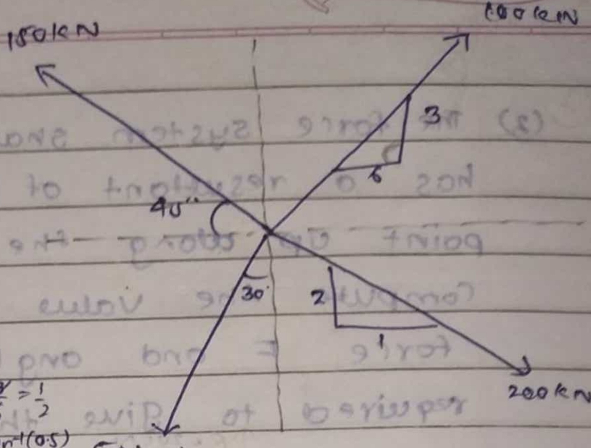
$F(0.738) = 320$

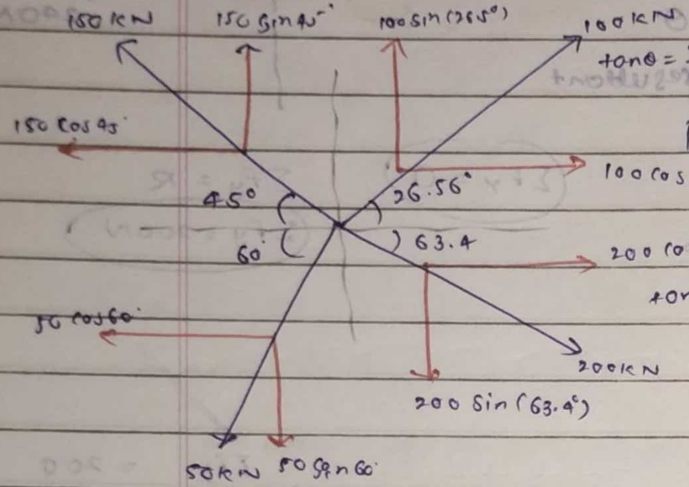
$F = \frac{320}{0.738}$

$\boxed{F = 433.6N}$

through slope
find angle

(2) Find the resultant for the given force System. Also find the direction and position





$\tan\theta = \frac{y}{x} = \frac{3}{6} = \frac{1}{2}$

$\theta = \tan^{-1}(0.5)$

$\boxed{\theta = 26.56°}$

$\tan\theta = \frac{2}{1}$ $\theta = \tan^{-1}(2)$

$\boxed{\theta = 63.4}$

$$\Sigma F_x = 100\cos(26.56°) + 200\cos(63.4°) - 150\cos 45° - 50\cos 60°$$

$$= 84.44 + 89.55 \quad -150\tfrac{1}{\sqrt{2}} \quad -25$$

$$= 148.99 - 150\tfrac{1}{\sqrt{2}}$$

$$= 148.99 - 106.06$$

$$\boxed{\Sigma F_x = 42.92}$$

$$\Sigma F_y = 150 \times \frac{1}{\sqrt{2}} + 100\sin(26.5°) - 50 \times \frac{\sqrt{3}}{2} - 200\sin(63.4°)$$

$$= 106.06 - 43.3 + 44.61 - 178.8$$

$$\boxed{\Sigma F_y = -71.46}$$

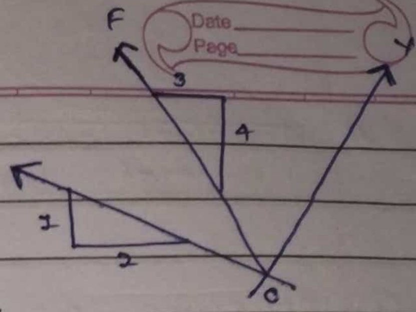
$$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{71.46}{42.92}\right)$$

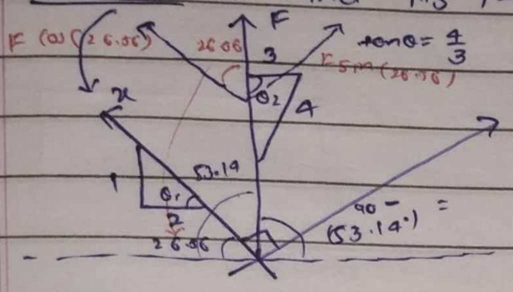
$$\theta = \tan^{-1}(1.664)$$

$$\boxed{\theta = 58.99}$$

Imp

(3) In the given figure, x component of force F is 893N, Find its Y-component





$\tan\theta = \left(\frac{1}{2}\right)$

$(\theta_1 = 26.56)$

$F\cos(26.56) = 893N$

$F = \frac{893}{\cos(26.56)} = 998.36$

$\boxed{F = 998.3N}$

Y-component of F $= F\sin(26.56)$

$= 998.3 \times \sin(26.56)$

$\boxed{\text{Y component} = 446.498N}$

(4)

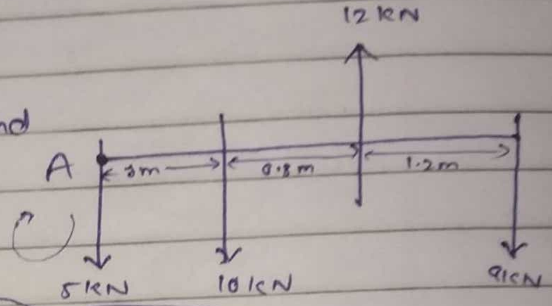
Note :-
$\Sigma f_x = R_x$
$\Sigma f_y = R_y$

Varigons theorem
$\Sigma M_o F = M_o R$
used when ever you have find the exact position of resultant in non-concurrent coplanar system

+ve ↻ ↺ -ve

③ # Resultant of parallel and General force System

(1) Determine the magnitude and position of the resultant with respect



$\Sigma f_x = 0$ ← No any force in x-direction

=> $\Sigma f_y = R$

$-5 - 10 - 9 + 12 = R$

$R = -12$

$\boxed{R = 12N}(\downarrow)$

At point A force 5kN distance zero

using V.T

Resultant downward hai

$\Sigma M_A F = \Sigma M_A R$

$(-5 \times 0) - (10 \times 1) + (12 \times 1.8) - (9 \times 3) = -R \times d$

$0 - 10 + 21.6 - 27 = -12 \times d$

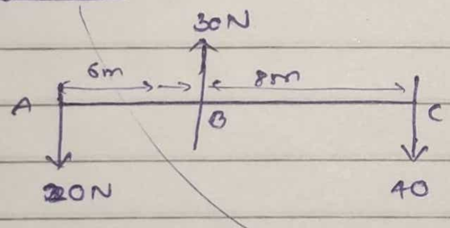
$-37 + 21.6 = -12 \times d$

$\cancel{-}15.4 = \cancel{-}12 \times d$

$\boxed{d = \frac{15.4}{12} = 1.283 m}$

Imp Note:
(1) If resultant is Horizontal then $\boxed{\Sigma F_x = R \quad , \Sigma F_y = 0}$
(2) If resultant is vertical then $\boxed{\Sigma F_x = 0 \quad , \Sigma F_y = R}$
(3) If resultant is zero then $\boxed{\Sigma F_x = 0 , \Sigma F_y = 0}$

(2) A bar ABC carrying forces 20N at A downward, 30N at B upward and 40N at downward. Compute the resultant force and locate its position from point A. If AB = 6m and BC = 8m



$\Sigma f_x = 0$

$\Sigma f_y = -20 + 30 - 40$

$\Sigma f_y = -30N$

$R = \sqrt{(\Sigma f_x)^2 + (\Sigma f_y)^2}$

$= \sqrt{0 + (30)^2}$

$\boxed{R = 30N}(\downarrow)$

Resultant is Acting vertically downword

using Varigons theorem

$\Sigma M_A F = M_A R$

$-(20 \times 0) + (30 \times 6) - (40 \times 14) = -R \times d$

$180 - 560 = -30 \times d$

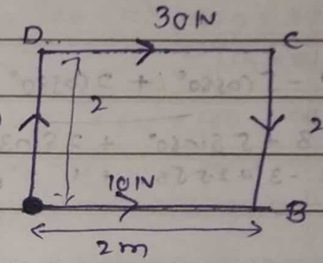
$\frac{\cancel{-}380}{\cancel{-}30} = d$

$\boxed{d = 12.66 m}$

Date ______
Page ______

Imp

(3) ABCD is square of 2m side. Along sides AB, CB, DC and AD the force of 10N, 20N, 30N and 40N are acting respectively. Find the magnitude, direction and the position of the resultant of the forces from point A.



$\rightarrow \quad \Sigma F_x = 30 + 10 = 40N \Rightarrow +ve$

$\uparrow \quad \Sigma F_y = 40 - 20 = 20N \Rightarrow +ve$

$R = \sqrt{(40)^2 + (20)^2}$

$= \sqrt{1600 + 400}$

$= \sqrt{2000}$

$\boxed{R = 44.72N}$

$\theta = \tan^{-1}\left(\frac{20}{40}\right)$

$\boxed{\theta = 26.56^\circ}$

By Varignon's theorem

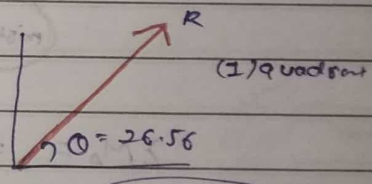
$\Sigma M_A = R \times d$

$(40 \times 0) + (10 \times 0) + (30 \times 2) + (20 \times 2) = 44.72 \times d$

$0 + 0 + 60 + 40 = 44.72 \times d$

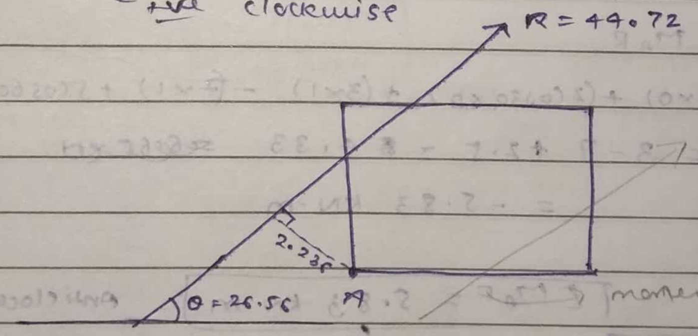
$\frac{100}{44.72} = d$

$\boxed{d = 2.236}$



$\Sigma M_A = 100\ N\text{-}m$

+ve clockwise

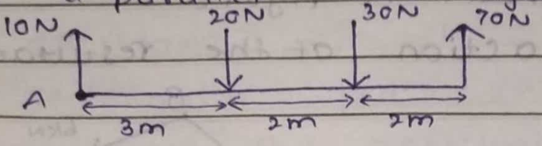


Resultant; in 1st quadrant

because ΣF_x & ΣF_y +ve

moment ag or -ve hota the anticlockwise

(5) locate the resultant with magnitude and direction For a parallel force system shown in fig.



⇒

using varignon's theorem

$\Sigma f_x = 0$

$\Sigma f_y = 10 - 20 - 30 + 70$

$= 30N$

$R = \sqrt{(\Sigma f_x)^2 + (\Sigma f_y)^2}$

$R = \sqrt{(0)^2 + (30)^2}$

$\boxed{R = 30N}$ (↑) +ve

$\Sigma M_A F = R \times d$

consider point A in 10N force

$\Sigma M_A F = (10 \times 0) + (20 \times 3) + (30 \times 5) - (70 \times 7)$

$= 0 + 60 + 180 - 490$

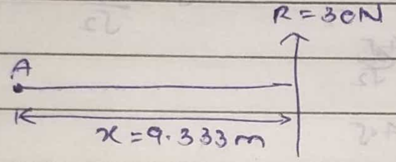
$\boxed{\Sigma M_A = 280 \text{ N-m}}$ +ve anticlockwise

$\boxed{\Sigma M_A = 28 \text{ N-m}}$

$280 = R \times d$

$280 = 30 \times d$ $\quad d = \frac{280}{30}$

$\boxed{\cancel{d = 2.83m}}$ $\boxed{d = 9.33m}$



(6) A system of force acting on a bell crank as shown in fig. Determine the magnitude, direction and point of application of the resultant with respect to O.

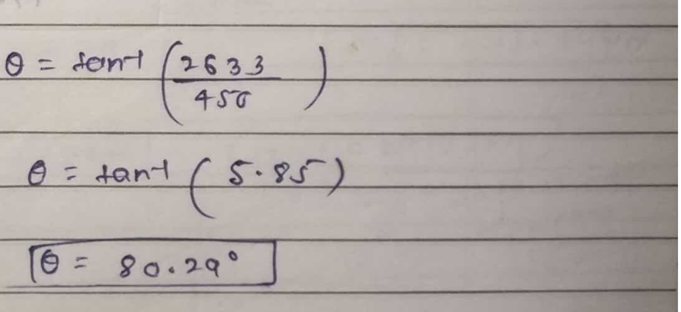
$\Sigma F_x = \overset{250}{500 \times \frac{1}{2}} - 700 = -450N$ $\boxed{(\leftarrow)}$

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

$\Sigma f_y = -500 \times \frac{\sqrt{3}}{2} - 1200 - 1000$

$= -2633$

$\boxed{\Sigma f_y = 2633 (\downarrow)}$



$R = \sqrt{(450)^2 + (2633)^2}$

$R = \sqrt{202500 + 6932689}$

$\boxed{R = 2671.1N}$

$\theta = \tan^{-1}\left(\frac{2633}{450}\right)$

$\theta = \tan^{-1}(5.85)$

$\boxed{\theta = 80.29°}$

*** 5 marks

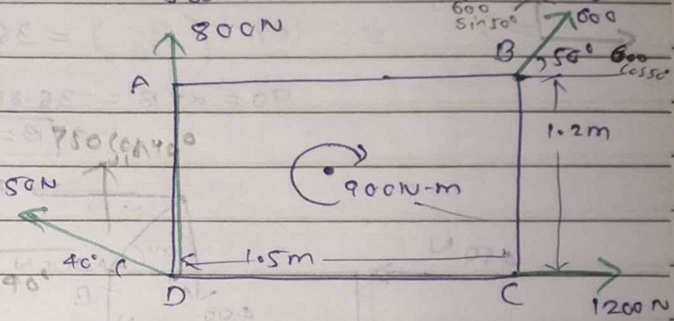
10 marks

(Note): ① Varignon's theorem

d → ⊥ar distance b/w resultant and moment centre

The ② $\bar{x} = \frac{\Sigma M}{\Sigma F_y}$ Imp $\bar{y} = \frac{\Sigma M}{\Sigma F_x}$ Imp

The resultant of the force system acting on the rectangular plate shown in fig. Also find the point where the resultant will the x-axis / y-axis. also find shift the resultant to point B



$\Sigma F_x = -750\cos 40^\circ + 1200 + 600\cos(50^\circ)$

$\Sigma F_x = -574.53 + 1200 + 385.67$

$\boxed{\Sigma F_x = 1011.14\,N} \rightarrow$

$\Sigma F_y = 800 + 750\sin 40^\circ + 600\sin 50^\circ$

$\boxed{\Sigma F_y = 1741.71\ N} \uparrow$

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{1741.71}{1011.14}\right)$

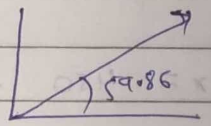
$\boxed{\theta = 59.86^\circ}$

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

$= \sqrt{(1741.7)^2 + (1011.41)^2} =$

$= 2013.94\,N$

(x, y)
(+, +)



using Varignon's theorem

$\Sigma M_B^F = M_B^R$ --- (1)

$\Sigma M_B^F = -(1200 \times 1.2) + (750\cos 40^\circ \times 1.2) + (750\sin 40^\circ \times 1.5) + (800 \times 1.5) + 900$

$= -1440 + 689.43 + 723.13 + 1200 + 900$

$\Sigma M_B^F = 1172.56 + 900 = 2072.56$

$(M_B^R = R \times d)$ $\boxed{M_B^R = 2013.94 \times d}$

$2072.56 = 2013.94 \times d$

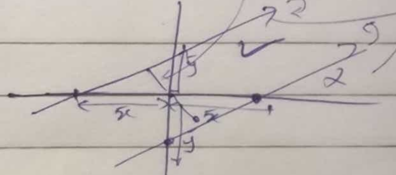
$\bar{y} = \frac{\Sigma M}{\Sigma F_x}$ Imp $= \frac{2072.56}{1011.14} = 2.049$

$\boxed{\cancel{d = 0.582m}}$

$(d = 1.0291071m)$

which is right According to moment direction

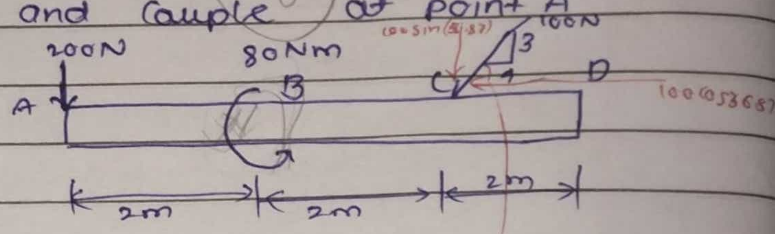
$\bar{x} = \frac{\Sigma M}{\Sigma F_y} = \frac{2072.56}{1741.71} = 1.1899$



Shifting of a force :

(1) Resolve the system of forces shown ~~in fig.~~ into a force and couple at point A

⟹



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

$\theta = 36.87°$

$\Sigma F_x = -100\cos(36.87°)$

$\boxed{\Sigma F_x = -80N}$ $\boxed{\Sigma F_x = 80N}(\leftarrow)$

$\Sigma F_y = -200 - 100\sin(36.87°)$

$\boxed{\Sigma F_y = -260N}$ $\boxed{\Sigma F_y = 260N}(\downarrow)$

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

$= \sqrt{(80)^2 + (260)^2} = 272.03 kN$

$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = \tan^{-1}\left(\frac{260}{80}\right)$

$\theta = 72.89°$

Using Varignon's theorem

$\Sigma M_A F = M_A R$; $\Sigma M_A F = R \times d$

$\Sigma M_A F = (200 \times 0) + [100\cos(36.87°) \times 0] + [100\sin(36.87°) \times 4] - 80$

$= 100\sin(36.87°) \times 4 - 80$

$= 240 - 80$

$\boxed{\Sigma M_A F = 160 \text{ N-m}}$

$160 = R \times d$

$160 = 272.03 \times d$

$d = \frac{160}{272.03}$ $\boxed{d = 0.588 m}$