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Subject- Mechanics.
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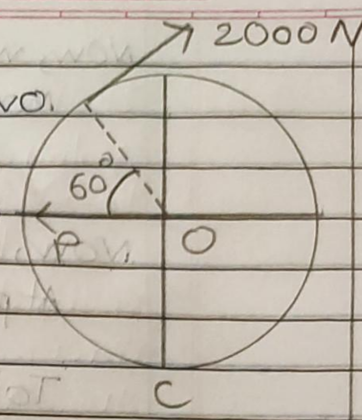
Topic - Assignment No-1

Assignment No. 1.

Q1.) If the combined moment of the two forces about C is zero, determine the magnitude R of the resultant, also find P.

Ans → $P = 3733.2\,N$, $R = 2236\,N$,

$\theta = 26.56^\circ$ second quadrant.



Ans → Given combined moment of two forces is zero $\therefore C = 0$

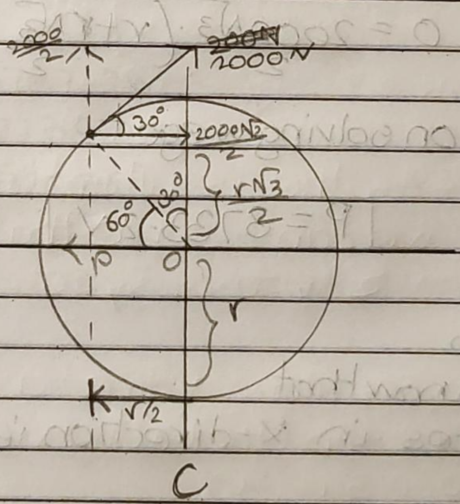
$\theta = 60^\circ$

$F = 2000\,N$

Find - Magnitude of P?

Magnitude & direction of Resultant R

Diagram



soln. The radius of the circle be r

The 2000N vector makes an angle 30° with the longitudinal axis

$\therefore$ from diagram

Alon x - direction $= 2000 \cos 30^\circ$ — (I)

Alon y - direction $= 2000 \sin 30^\circ$ — (II)

Now, we know that,

Moment = Force × Perpendicular distance

$= f \times d(\perp)$

Now, using Varigon's Theorem of Moments.

At point C.

Total Moment at C = Sum of individual moments of forces at C)

Now, Here,

· $P = r$ ∵ (from diagram) – (III)

Also, x-component of 2000N $= r + \frac{\sqrt{3}}{2}$ – (IV)

& Y-component of 2000N $= r/2$ – (V)

$\therefore 0 = \frac{2000\sqrt{3}}{2} \cdot \left(r + \frac{r\sqrt{3}}{2}\right) + 2000 \times \frac{1}{2} - P \times r$

on solving we get ∵ (from (I),(II),(III),(IV),(V))

$\boxed{P = 3733.2N}$

Now,

we know that

forces in x-direction is ~~2001.15 (Rx)~~ $\frac{2000\sqrt{3}}{2}$

∴

Resultant forces in x-direction = 2001.15 – (VI)

Also forces in Y-direction is $\frac{2000}{2}(\uparrow)$

∴ Resultant forces in y-direction is 1000N (R_y) – (VII)

From (vi) & (vii)

Total Resultant force = $\sqrt{(R_x)^2 + (R_y)^2}$

$\therefore \boxed{R = 2236 N}$

Now,

Angle made by resultant

$\Rightarrow$

$\tan\alpha = \frac{R_y}{R_x} = \frac{-1000}{2001.15} \Rightarrow \alpha = \tan^{-1}\left(\frac{-1000}{2001.15}\right)$

$\alpha = 26.56°$

(second Quadrant)

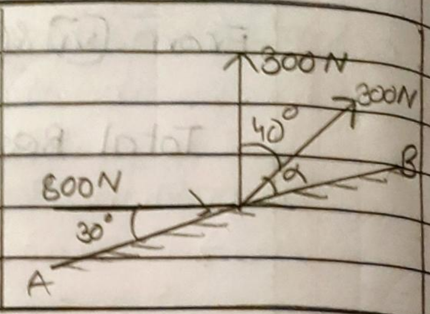
The required Ans are -

$P = 3733.2 N$

$R = 2236 N$

& $\alpha = 26.56°$

Q2.) If the resultant force system in figure is along the line AB, then find the magnitude of angle α and the magnitude of the resultant force.

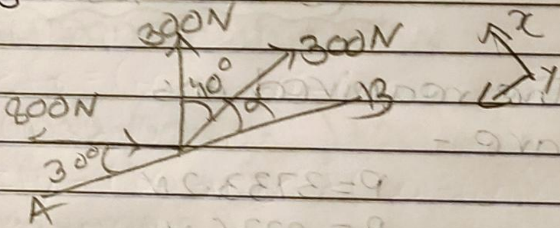


Ans : $\alpha = 25.19°$, $R = 1085.04N$

Ans → Given: Resultant along AB is zero.

Find:- ① Angle (α) ② Resultant force (R)

Free body diagram



Soln:- As the resultant is along AB we can assume that

$\Sigma F_y = 0 \therefore R_y = 0$

Here.

forces along y direction are

① $300 \cdot \sin(40+\alpha)$

② $300 \sin(\alpha)$

③ $800 \sin 30°$

Addin (I),(II),(III)

$\therefore 300 \sin(40+\alpha) + 300 \sin\alpha - 800 \sin 30° = 0$

$\therefore \sin(40+\alpha) + \sin\alpha = 1.33$

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we know,

$$2\sin A \cos B = \sin(A+B) + \sin(A-B)$$

here consider, $A = 20+\alpha$, $B = 20$

$$\therefore 2\sin(20+\alpha)\cos(20) = 1.33$$

$\Rightarrow$ ~~$\alpha = 25$~~

$$\boxed{\alpha = 25.19}$$

Now, Resultant (R) along AB direction is

$$\therefore R = 800\frac{\sqrt{3}}{2} + 300\cos(40+\alpha) + 300\cos\alpha$$

$$= 800\cos 30 + 300\cos(65.19) + 300\cos(25.19)$$

$$\therefore \boxed{R = 1085.04\ N}$$

The required Ans are-

$\alpha = 25.19°$

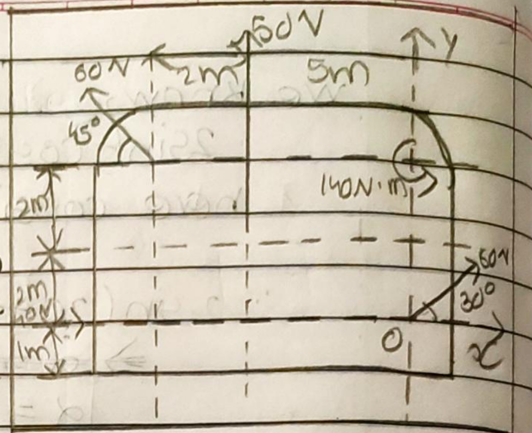
$R = 1085.04N$

Q4) Determine the resultant of four forces and one couple that acts on the plate. Locate its position with respect to origin O.

Ans: R = 167.65 N, θ = 74.16°

First quadrant d = 1.723 m

w.r.t O clockwise rotation at O



Ans → Given :- 4 forces & a couple.

Find - Resultant force.
& its location w.r.t O.

Here,

$$R_x = \Sigma f_x = (80)\cos 30^\circ - (60)\cos 45^\circ + 40$$
$$= 66.855\,N$$

similarly, $R_y = \Sigma f_y = (80)\sin 30^\circ + (50) + (60)\sin 45^\circ$
$$= 132.426\,N$$

$\therefore$ $\vec{R} = (66.855)\hat{i} + (132.426)\hat{j}$

The resultant force is $(R) = \sqrt{(R_x)^2 + (R_y)^2} = \boxed{148.35\,N}$

Now, By using Varignon's Theorem of Moments

Total Moment at O = Sum of moment of individual forces at O

$\Rightarrow (148.35) \times d = 140 - 50 \times 5 + 60\cos 45(4) - (60\sin 45)(7)$

$\Rightarrow 148.35 \times d = -237.279$

$d = -1.6\,m$

$\therefore$ As ('d') is -ve the resultant is rotating in clockwise direcon at O

To find angle (θ) madeby the resultant (R) with the horizontal,

$$\tan\theta = \frac{R_y}{R_x} \Rightarrow \theta = \tan^{-1}\left(\frac{132.426}{66.855}\right)$$

$$\therefore \boxed{\theta = 63.2^\circ} \text{ (1st Quadrant)}$$

$\therefore$ The required Ans is

$R = 148.35N$

$\theta = 63.2^\circ$

1st Qudrant is the position with respect to origin

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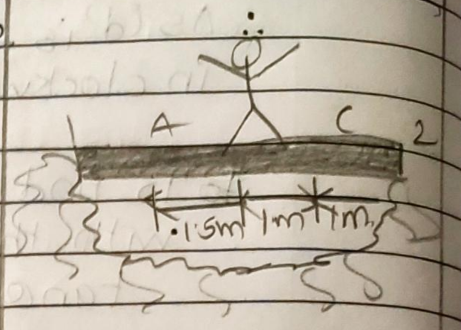
Q7) A 90 Kg man stands on the small foot bridge at point B. The man is to be replaced by two persons, one at A and one at C, so that the external effects on the bridge are not to be altered in the process. What should be the mass of each of the new persons?



Ans - $m_A = 36$ Kg, $m_C = 54$ Kg

Ans → Given: weight of Man = 90 Kg
Find - mass of two men?

soln - From the diagram

$x + y = 90$ — ①

using Varignon's Theorem,

$\tau_z = 10y(1) + 10x(3.5) - 900(2)$ — ②

Now put ① in ②

$180 = 90 - x + 3.5x$

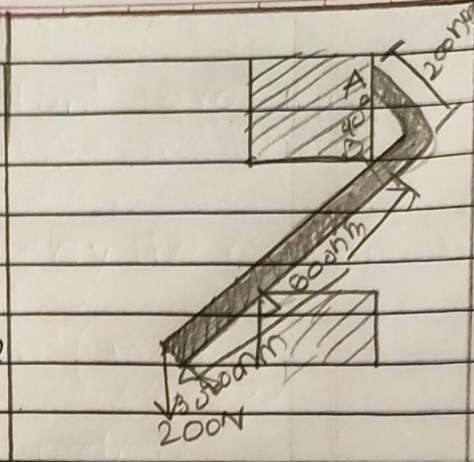
$\therefore x = \frac{90}{2.5} = 36$ kg

$\therefore y = 90 - 36$
$= 54$ kg

∴ The mass of two men will be.

$M_A = 36$ kg $M_C = 54$ kg

Q9) The smooth pipe rests against the wall at the points of contact A, B, & C. Determine the reaction at these points needed to support the vertical force of 200N. Neglect the pipe's thickness in the calculations.



Ans - $R_A = 115\,N, (\rightarrow)$, $R_B = 53.1\,N, 60^\circ$ fourth quadrant
$R_C = 284\,N, 60^\circ$ second quadrant.

Ans → Given : vertical force = 200N
Find - Reactions at point A, B, C

Soln : using equilibrium

$\Sigma f_x = 0$

$R_A + R_B \cos 60 - R_C \cos 60 = 0$

$\Sigma f_y = 0$

$R_C \sin 60 - R_B \sin 60 - 200 = 0$

Using Varignon's Theorem at B

$M_B = 0$

$0 = \left(-R_A \times \frac{200}{\sin 60^\circ}\right) \left(-R_C \times 500\right) + \left(200 \times 900\right)$

$0 = -230.94 R_A - 500 R_C + 1\cdot 55884.57$

solving equations we get

$R_A = 115\,N\,(\rightarrow)$

$R_B = 53.1\,N\,(\searrow 60^\circ)$

$R_C = 284\,N\,(30^\circ)$

∴ The reaction are required as above.