

Q. No. 5)

Sol'n

First find resultant of force & moment at origin.

$$\vec{R} = 840\vec{i} + 30\vec{j}$$

M<sub>OR</sub>

$$= -50\vec{j} + 90\vec{j} + (8\vec{k} \times 40\vec{i})$$

$$= -50\vec{j} + 90\vec{j} + 320\vec{j}$$

$$= 90\vec{i} + 270\vec{j}$$

pitch  $p = \frac{\vec{R} \cdot \vec{M}_{OR}}{R^2}$

$$= \frac{(40\vec{i} + 30\vec{j}) \cdot (90\vec{i} + 270\vec{j})}{(\sqrt{40^2 + 30^2})^2}$$

$$= \frac{3600 + 8100}{2500}$$

$$= \frac{11700}{2500}$$

$$p = 4.68$$

couple vector  $\vec{M}_1 = p \cdot \vec{R}$

$$= 4.68 \times (40\vec{i} + 30\vec{j})$$

$$= 187.2\vec{i} + 140.4\vec{j}$$

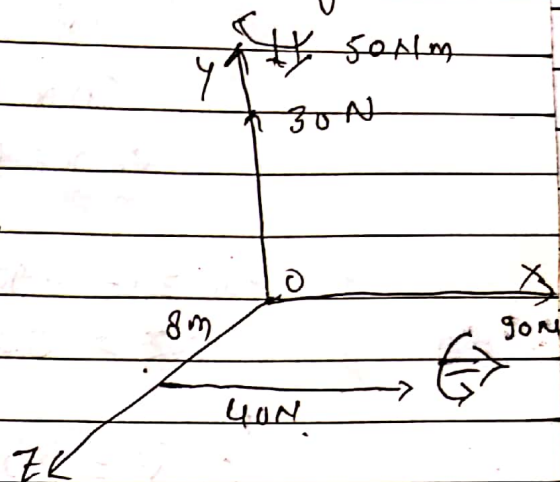
To find line of action

$$\vec{M}_1 + \vec{r} \times \vec{R} = \vec{M}_{OR}$$

$$187.2\vec{i} + 140.4\vec{j} + (x\vec{i} + y\vec{j} + z\vec{k}) \times (40\vec{i} + 30\vec{j}) = 90\vec{i} + 270\vec{j}$$

For xz plane  $y = 0$

$$187.2\vec{i} + 140.4\vec{j} + (x\vec{i} + z\vec{k}) \times (40\vec{i} + 30\vec{j}) = 90\vec{i} + 270\vec{j}$$



$$30x\vec{k} + 40z_1\vec{j} - 90z_1\vec{i} = -97.2\vec{i} + 129.6\vec{j}$$

Equating the coeff.

$$30x = 0$$

$$\therefore x = 0$$

$$+30z_1 = +97.2$$

$$\therefore z_1 = 3.24$$

$$\therefore \vec{V} = 3.24\vec{k}$$

$$\therefore \vec{M}_1 = 187.2\vec{i} + 140.4\vec{j}$$



Q.1) ans

The subdivision of mechanics that is concerned with the force that act on bodies at rest under equilibrium condition is called static.

The subdivision of mechanics that is concerned with the motion of material object in relation to the physical factor that affect them too.

$$\vec{v} = \vec{v}_r + \vec{v}_\theta$$

$$= v_r \vec{e}_r + v_\theta \vec{e}_\theta$$

$$a_r = \ddot{v} - r\dot{\theta}^2$$

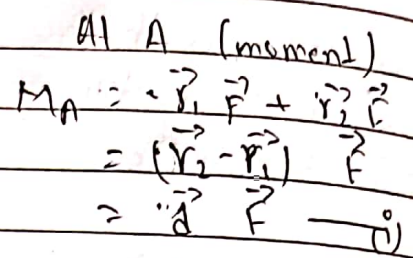
$$= r\ddot{\theta} + 2\dot{r}\dot{\theta}$$

$$\vec{a} = \vec{a}_r + \vec{a}_\theta$$

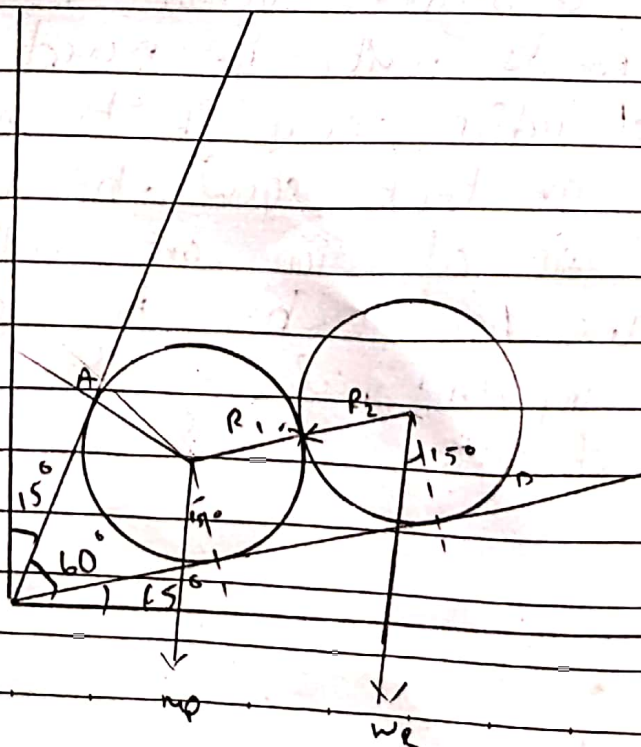
$$= (\ddot{v} - r\dot{\theta}^2) \vec{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta}) \vec{e}_\theta$$

Q.N.3) (a)

$\Rightarrow$  Force is called a sliding vector if a force produce different effects if it is moved to different line of action, even if its magnitude, direction & sense are kept equal. The vector with specific line of action are called sliding vector. The point where they are applied is not important as long as it is in their line of action.

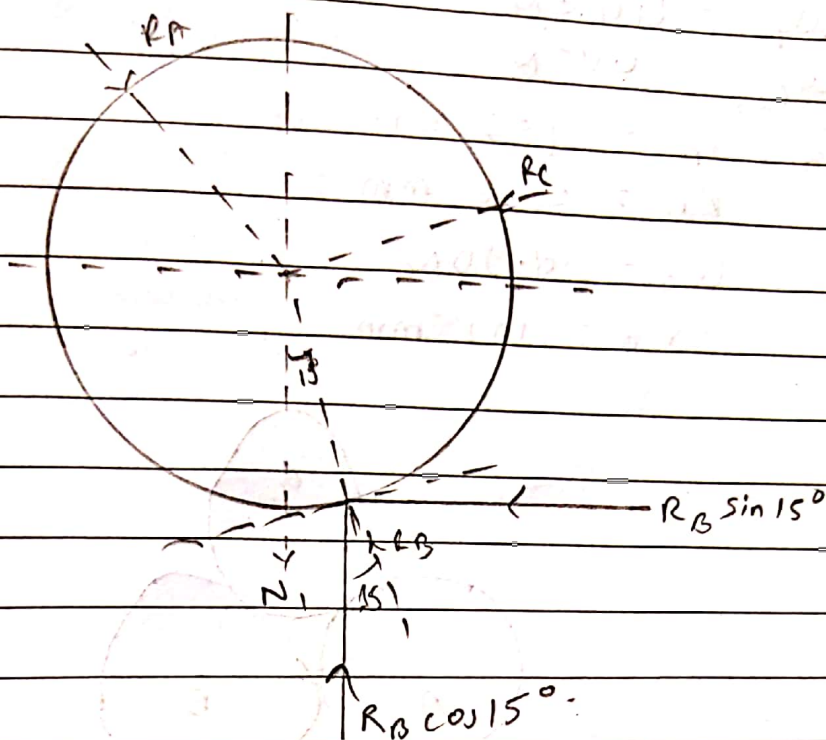

$$M_B = \vec{r} \times \vec{F} \quad \text{--- (2)}$$

A diagram illustrating the geometric setup for finding the area of the shaded region. It shows a 30-degree angle formed by two rays meeting at a vertex. A line bisects this angle. Two circles, labeled P and Q, are drawn such that they are tangent to both rays of the angle and to each other. The point of tangency of circle P with the lower ray is marked with a 15-degree angle from the vertex. Similarly, the point of tangency of circle Q with the upper ray is marked with a 15-degree angle from the vertex. The region between the two rays and outside the two circles is shaded.

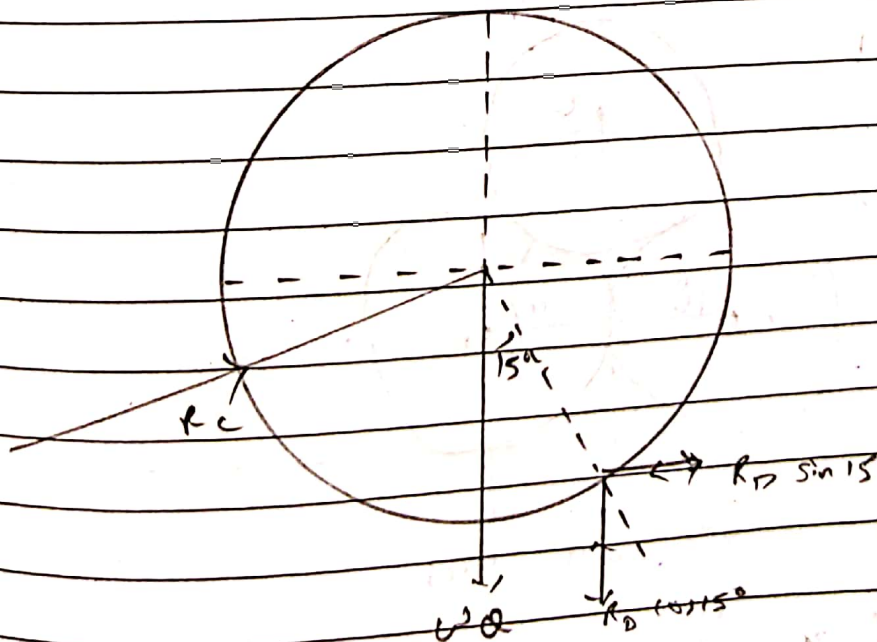




Roller P



Roller Q



Q 4 Sol<sup>n</sup>.

$$W_A = 4445 \text{ N}$$

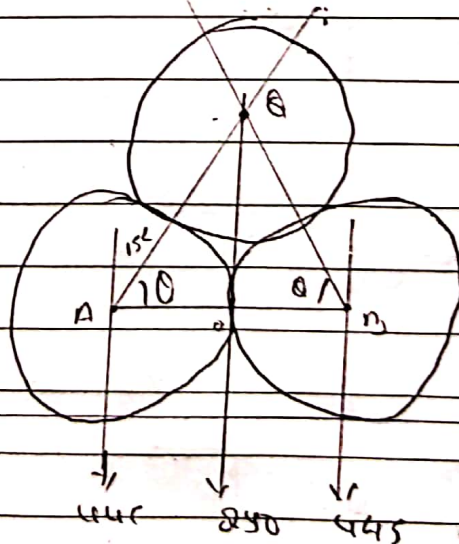
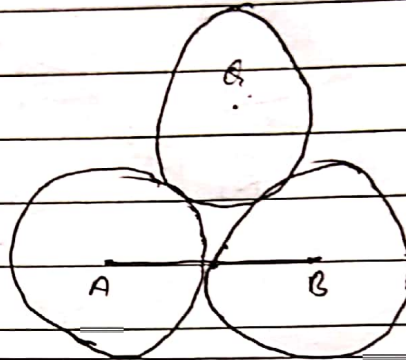
$$W_B = 4455 \text{ N}$$

$$r_B = r_A = 152 \text{ mm}$$

$$AB = 406 \text{ mm}$$

$$W_G = 890 \text{ N}$$

$$r_G = 152 \text{ mm}$$



Taking right angle triangle AOG

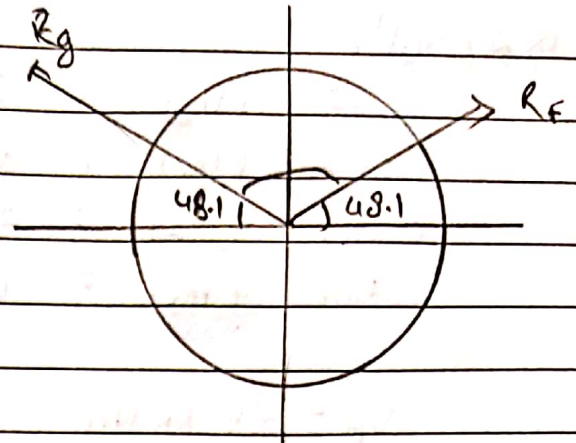
$$AO = \frac{406}{2} = 203$$

$$\cos \theta = \frac{b}{h} = \frac{203}{304}$$

~~Q.2) 507 N~~,  $\theta = 48.1^\circ$

by Lami's theorem

$$\frac{R_g}{\sin 138.1} = \frac{R_f}{\sin 138.1} = \frac{Q}{\sin 83.8}$$



$$R_g = R_f = 597.6 \text{ N}$$

Now,  $\sum F_x = 0$

$$-592.8 \cos 48.1 + 592.8 \cos 48.1 = 0$$

$$F_y = 0$$

$$R_A + R_B - 597.8 \sin 48.1 - 597.8 \sin 48.1 - 445 - 445 = 0$$

$$[\because R_A = R_B] \quad 2R_A = 890 + 444.94$$

$$R_A = 667.47 \text{ N} = R_B$$



Q.2) Sol<sup>n</sup>,

$$\text{speed } (V_0) = 24 \text{ km/hr}$$

$$\text{length } (m_1) = 39 \text{ m}$$

$$\text{accle. } (m_2) = 2.7 \text{ m/s}^2$$

$$\text{time } (m_3) = 8 \text{ sec}$$

$$V_A = 24 \text{ km/hr} \\ = 6.67 \text{ m/s.}$$

$$\vec{a}_A = 0 \quad (\text{since velocity const.})$$

now,

$$x_A = (x_A)_0 + V_A t \\ = 0 + 6.67 \times 8 \\ = 53.36 \text{ m}$$

ie:

$$\vec{x}_A = \vec{r}_A = 53.36 \text{ (}\rightarrow\text{)}$$

For automobile 'B'

$$a_B = -2.7 \text{ m/s}^2 = -2.7 \text{ m/s}^2 \text{ (}\downarrow\text{)}$$

$$V_B = (V_B)_0 + at = 0 + (-2.7) \times 8 \\ = -21.6 \text{ m/s (}\downarrow\text{)}$$

now,

$$y_B = (y_B)_0 + (V_B)_0 t + \frac{1}{2} a t^2 \\ = 0 + 0 \times 8 + \frac{1}{2} \times (-2.7) \times 8^2 \\ = -93.07 \text{ m}$$

$$\vec{y}_B = \vec{r}_B = 93.07 \text{ m (}\downarrow\text{)}$$



motion of B relative to A

$$\vec{v}_{B/A} = \vec{v}_B - \vec{v}_A = -93.07\vec{i} - 53.36\vec{j}$$

$$\begin{aligned} |\vec{v}_{B/A}| &= \sqrt{(93.07)^2 + (-53.36)^2} \\ &= 107.28 \text{ m} \end{aligned}$$

∴

$$\begin{aligned} \alpha &= \tan^{-1} \left( \frac{93.07}{53.36} \right) \\ &= 60.17^\circ \end{aligned}$$

again,

$$\vec{v}_{B/A} = \vec{v}_B - \vec{v}_A = -21.6\vec{j} - 6.67\vec{i}$$

$$\begin{aligned} |\vec{v}_{B/A}| &= \sqrt{(-21.6)^2 + (-6.67)^2} \\ &= 22.60 \text{ m/s} \end{aligned}$$

$$\begin{aligned} \theta &= \tan^{-1} \left( \frac{21.6}{6.67} \right) \\ &= 72.83^\circ \end{aligned}$$

also,

$$\vec{a}_{B/A} = \vec{a}_B - \vec{a}_A = 2.7 \text{ m/s}^2$$

∴

$$\phi = \tan^{-1} \left( \frac{2.7}{0} \right) = 90^\circ$$