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Three masses 10 kg, 20 kg and 15 kg are attached at a point at radii of 20 cm.........

Question:
Three masses 10 kg, 20 kg and 15 kg are attached at a point at radii of 20 cm, 25 cm and 15 cm respectively. If the angle between successive masses is 60° and 90°. Determine analytically the balancing mass to be attached at radius of 30 cm.

Answer:

Given : $m_1 =$ 10 kg ; $m_2 =$ 20 kg ; $m_3 =$ 15 kg ;

$r_1 = 0.2$ m ; $r_2 = 0.25$ m; $r_3 = 0.15$ m; $r = 0.30$m

$\theta_1 = 0°$; $\theta_2 = 60°$; $\theta_3 = 150°$

Let m = Balancing mass, and

θ = The angle which the balancing mass makes

Since the magnitude of centrifugal forces are proportional to the product of each mass and its radius,

therefore

$m_1 \cdot r_1 = 10 \times 0.2 = 2$ kg-m

$m_2 \cdot r_2 = 20 \times 0.25 = 5$ kg-m

$m_3 \cdot r_3 = 15 \times 0.15 = 2.25$ kg-m

Resolving $m_1.r_1$, $m_2.r_2$, $m_3.r_3$ and $m_4.r_4$ horizontally,

$$\Sigma H = m_1 \cdot r_1 \cos\theta_1 + m_2 \cdot r_2 \cos\theta_2 + m_3 \cdot r_3 \cos\theta_3$$

$$= 2 \cos 0° + 5 \cos 60° + 2.25 \cos 150°$$

$$= \boxed{2.55 \text{ kg-m}}$$

Now resolving vertically,

$$\Sigma V = m_1 \cdot r_1 \sin\theta_1 + m_2 \cdot r_2 \sin\theta_2 + m_3 \cdot r_3 \sin\theta_3$$

$$= 2 \sin 0° + 5 \sin 60° + 2.25 \sin 150°$$

$$= \boxed{5.455 \text{ kg-m}}$$

$\therefore$ Resultant, $R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} = \boxed{6.02 \text{ kg-m}}$

We know that

$m \cdot r = R = 6.02$ m = 6.02 / 0.30 = 20.067 kg

and $\tan\theta' = \Sigma V / \Sigma H$ = $\boxed{\theta' = 64.94°}$