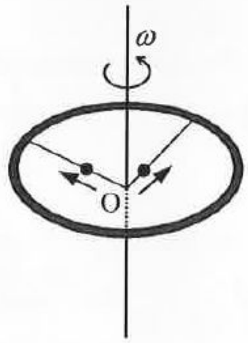
A ring of mass M and radius R is rotating with angular speed ω about a fixed vertical axis passing through its centre O with two point masses each of mass $\frac{M}{8}$ at rest at O. These masses can move radially outwards along two massless rods fixed on the ring as shown in the figure. At some instant the angular speed of the system is $\frac{8}{9}\omega$ and one of the masses is at a distance of $\frac{3}{5}R$ from O. At this instant the distance of the other mass from O is



(A) $\frac{2}{3}R$ (B) $\frac{1}{3}R$ (C) $\frac{3}{5}R$ (D) $\frac{4}{5}R$

Solution

Consider the system of ring and two point masses. Since net torque is zero about O, angular momentum of the system is conserved about O.

Conservation of angular momentum (COAM) about O gives,

$$MR^2\omega + 0 + 0 = MR^2\frac{8}{9}\omega + \frac{M}{8}\left(\frac{3}{5}R\right)^2\frac{8}{9}\omega + \frac{M}{8}r^2\frac{8}{9}\omega$$

$$\therefore R^2 = \frac{8}{9}R^2 + \frac{1}{25}R^2 + \frac{1}{9}r^2$$

$$\therefore R^2\left(1 - \frac{8}{9} - \frac{1}{25}\right) = \frac{1}{9}r^2$$

$$\therefore R^2\left(\frac{225 - 200 - 9}{9 \times 25}\right) = \frac{1}{9}r^2$$

$$\therefore R^2\left(\frac{16}{25}\right) = r^2$$

$$\therefore r = \frac{4}{5}R$$

Hence, Option (D).