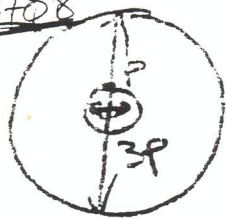
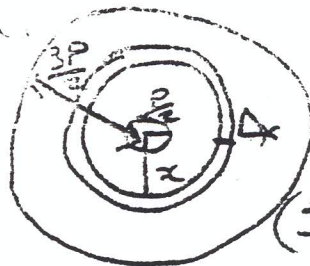


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Let ρ = mass per unit area.
 mass = $4m$
 Cut into strips Δx wide.



$$\Delta I = \Delta m x^2$$

$$\Delta I = \rho(\Delta \text{area})x^2$$

$$\Delta I = \rho(\Delta x \cdot 2\pi x)x^2$$

$$\Rightarrow I = \int_0^R \rho 2\pi x^3 dx \quad (5 \text{ marks})$$

$$= \rho 2\pi \left[\frac{x^4}{4} \right]_0^R \quad (5 \text{ marks})$$

$$= \frac{\rho 2\pi}{4} \left[\left(\frac{3\rho}{2}\right)^4 - \left(\frac{\rho}{2}\right)^4 \right]$$

$$= \frac{\rho 2\pi}{4} \frac{30\rho^4}{16}$$

$$= \frac{\rho 2\pi}{4} 5\rho^4 \quad (5 \text{ marks})$$

$$= m 5\rho^2 \text{ etc} *$$

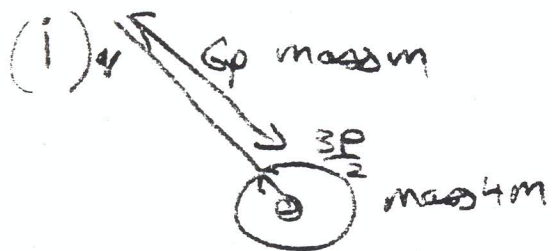
$$* \frac{\text{Mass}}{\text{Area}} = \rho$$

$$\frac{4m}{\pi(R^2 - r^2)} = \rho$$

$$\frac{4m}{\pi\left(\left(\frac{3\rho}{2}\right)^2 - \left(\frac{\rho}{2}\right)^2\right)} = \rho$$

$$\frac{4m}{\pi(2\rho^2)} = \rho$$

$$\Rightarrow m = \frac{\rho 2\rho^2 \pi}{4}$$



$$I_{\text{system}} = I_{\text{rod}} + I_{\text{annulus}}$$

$$= \frac{1}{3} m (3p)^2 + \left[5mp^2 + 4m \left(\frac{15p}{2}\right)^2 \right]$$

$$= 12mp^2 + 5mp^2 + 225mp^2$$

$$= 242mp^2 \quad (5 \text{ marks})$$

Total mass = $m + 4m = 5m$.

dist of CG from axis of rotation: $\Rightarrow \rho \left[m(3p) + 4m\left(\frac{15p}{2}\right) \right] = 5mh$

$$\Rightarrow \frac{33p}{5} = h \quad (5 \text{ marks})$$

$$T = 2\pi \sqrt{\frac{I}{mgh}} \Rightarrow T = \sqrt{\frac{242mp^2}{5mg \left(\frac{33p}{5}\right)}} = 2\pi \sqrt{\frac{22p}{3g}}$$

(5 marks)

(ii) Equivalent simple pendulum

$$T = 2\pi \sqrt{\frac{l}{g}} \Rightarrow 2\pi \sqrt{\frac{l}{g}} = 2\pi \sqrt{\frac{22p}{3g}}$$

$$\Rightarrow l = \frac{22p}{3} \text{ ged}$$

(5 marks)