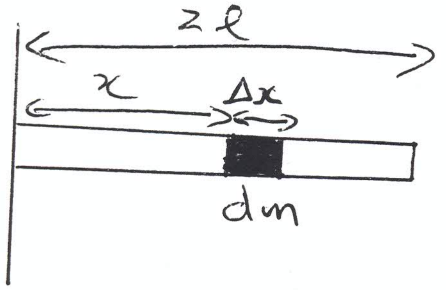
1979, Q. 9, RIGID BODY MOTION

Parallel Axes theorem (Dictation)



Density $\rho = \frac{m}{2l} = \frac{\Delta m}{\Delta x}$

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

$\Delta I = (\rho \, \Delta x) \, x^2$

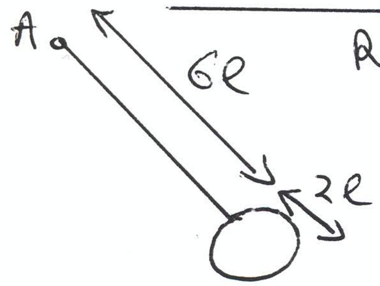
$\Delta I = \rho x^2 \Delta x$

$dI = \rho x^2 dx$

$I = \int_0^{2l} \rho x^2 dx \Rightarrow I = \rho \int_0^{2l} x^2 dx$

$\Rightarrow I = \rho \left. \frac{x^3}{3} \right|_0^{2l}$

$\Rightarrow I = \frac{\rho (2l)^3}{3} = \frac{(\rho 2l) 4l^2}{3} = \frac{4ml^2}{3}$



Rod mass m, length 6l,
Disc mass m, diameter 2l

Total mass = 2m

ABOUT A: $I_{pendulum} = I_{Rod} + I_{DISC}$.

// axes theorem $\Rightarrow I_{DISC} = \frac{1}{2} ml^2 + m(7l)^2 = \frac{99}{2} ml^2$

$I_{Rod} = \frac{4}{3} m \left(\frac{\text{length Rod}}{2} \right)^2 = \frac{4}{3} m (3l)^2 = 12 ml^2$

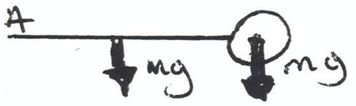
$\therefore$ About A $I_{pendulum} = 12ml^2 + \frac{99}{2} ml^2 = \frac{123}{2} ml^2$

For small oscillations $T = 2\pi \sqrt{\frac{I_{pendulum}}{(\text{Mass}) \cdot g \, (\text{Distance A to C of G of pendulum})}}$

$I_{pendulum} = \frac{123}{2} ml^2$, Total mass $= 2m$

To find distance find C of G of system:

Take (A) Sum of moment = moment of Sum.



Let $\bar{x}$ be dist of C of G from A.

$mg(3l) + mg(7l) = 2mg\bar{x}$

$10l = 2\bar{x}$

$\bar{x} = 5l$

$\therefore T = 2\pi \sqrt{\frac{\frac{123}{2} ml^2}{(2m) g (5l)}} = 2\pi \sqrt{\frac{123 l}{20 g}}$