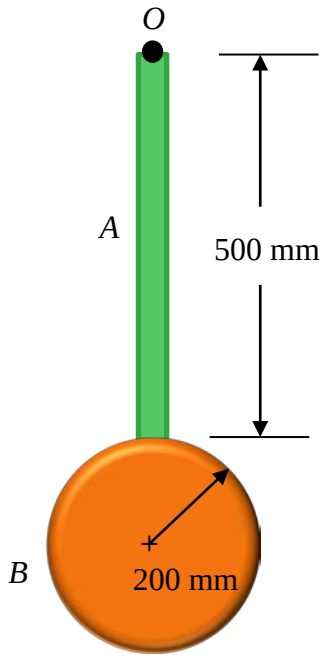
4-4. The assembly consists of a sphere of $m_B \sim N(25, 3^2)$ kg and a rod of $m_{OA} \sim N(15, 1^2)$ kg. If m_B and m_{OA} are independent, determine the moment of inertia of the assembly about *O*.

Note: The moments of inertia for the sphere and thin rod follow respectively:

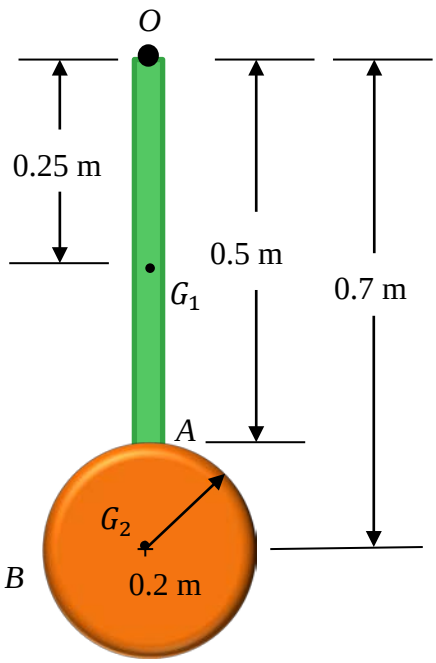
$$(I_G)_B = \frac{2}{5}mr^2$$

$$(I_G)_{OA} = \frac{1}{12}ml^2$$

The parallel axis theorem may be applied to find the moment of inertia in each section going through point *O*.



Solution:



System

$$I_O = \Sigma I_G + md^2$$

$$d_{G1} = \frac{l_{OA}}{2} = 0.25 \text{ m}$$

$$d_{G2} = l_{OA} + r = 0.7 \text{ m}$$

$$I_G = \left(\frac{1}{12}l^2 + d_{G1}^2\right)m_{OA} + \left(\frac{2}{5}r^2 + d_{G2}^2\right)m_B$$

Thus

$$\mu_{I_G} = \left(\frac{1}{12}l^2 + d_{G1}^2\right)\mu_{m_{OA}} + \left(\frac{2}{5}r^2 + d_{G2}^2\right)\mu_{m_B} = 13.90 \text{ kg} \cdot \text{ m}^2$$

$$\sigma_{I_G} = \sqrt{\left(\frac{1}{12}l^2 + d_{G1}^2\right)^2 (\sigma_{OA})^2 + \left(\frac{2}{5}r^2 + d_{G2}^2\right)^2 (\sigma_B)^2} = 1.52 \text{ kg} \cdot \text{ m}^2$$

Therefore, $I_G \sim N(13.90, 1.52^2)$ kg $\cdot$ m^2 **Ans.**