20 -R -KIN -DK - 9

## Intermediate   Composite Bodies    Homework

Inspiration: None

Reword: Picture is too complex for webwork. Could use for video solution or just scrap

For her design competition, a student attempts to use a thin sheet of metal to form a chassis. She drills two cylindrical holes and cuts out two rectangular plates before realizing she messed up. As she tosses it into the recycling bin, the sheet rotates about its original center of mass, G. If the sheet has a mass moment of inertia of 0.00226 kgm², what is its density? The sheet has a thickness of 3mm. Assume the cylindrical holes have a diameter equivalent to the thickness of the plate.
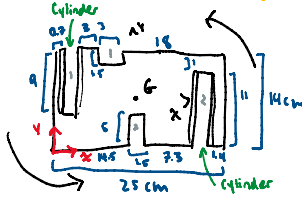


**Sheet:**  $V = 0.25 \times 0.14 \times 0.003 = 0.000105$     $m = \rho V$

$$I_{zz} = \frac{1}{12} m (a^2 + b^2)$$     $CoG = [12.5, 7]$

$$= \frac{1}{12} \rho (0.000105)(0.25^2 + 0.14^2)$$

**Cylinder 1:**  $m = \rho V = \rho \pi r^2 h = \rho \pi (0.0015)^2 (0.09)$

$$I_{G_{C1}} = \frac{1}{12} m l^2 + md^2 = \frac{1}{12} \rho \pi (0.0015)^2 (0.09)^3 + \rho \pi (0.0015)^2 (0.09)(0.01419725)$$

$\sqrt{141.9725}$   $d^2 = 1419725$

2.5   11.05
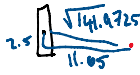
**Cylinder 2:**  $m = \rho V = \rho \pi r^2 h = \rho \pi (0.0015)^2 (0.11)$

$$I_{G_{C2}} = \frac{1}{12} ml^2 + md^2 = \frac{1}{12} \rho \pi (0.0015)^2 (0.11)^3 + \rho \pi (0.0015)^2 (0.11)(0.01221525)$$

1.5  10.75   $d^2 = 0.01221525$

**Plate 1:**  $m = \rho V = \rho (0.03 \times 0.015 \times 0.003) = 0.00000135 \rho$

$$I_{G_{P1}} = \frac{1}{12} m (a^2 + b^2) + md^2 = \frac{1}{12}(0.00000135)\rho(0.03^2 + 0.015^2) + 0.00000135 \rho (0.00880625)$$

7  6.25   $d^2 = 0.00880625$

**Plate 2:**  $m = \rho V = \rho (0.05 \times 0.015 \times 0.003) = 0.00000225$

$$I_{G_{P2}} = \frac{1}{12} m (a^2 + b^2) + md^2 = \frac{1}{12}(0.00000225)\rho(0.05^2 + 0.015^2) + 0.00000225 \rho (0.00278125)$$

4.5  2.75   $d^2 = 0.00278125$

**Total:**  $I_G = 2.36 = \frac{1}{12}\rho(0.000105)(0.25^2 + 0.14^2) - \left(\frac{1}{12}\rho\pi(0.0015)^2(0.09)^3 + \rho\pi(0.0015)^2(0.09)(0.01419725)\right)$

$$- \left(\frac{1}{12}\rho\pi(0.0015)^2(0.11)^3 + \rho\pi(0.0015)^2(0.11)(0.01221525)\right) - \left(\frac{1}{12}(0.00000135)\rho(0.03^2 + 0.015^2) + 0.00000135\rho(0.00880625)\right)$$

$$- \left(\frac{1}{12}(0.00000225)\rho(0.05^2 + 0.015^2) + 0.00000225\rho(0.00278125)\right)$$

$0.00236 = 0.718375 \times 10^{-6} \rho - 0.009461316 \times 10^{-6} \rho - 0.01026192 \times 10^{-6} \rho - 0.012015 \times 10^{-6} \rho - 0.00676875 \times 10^{-6} \rho$

$= 0.679948014 \times 10^{-6} \rho$

$\boxed{\rho = 3471.36 \text{ kg/m}^3}$