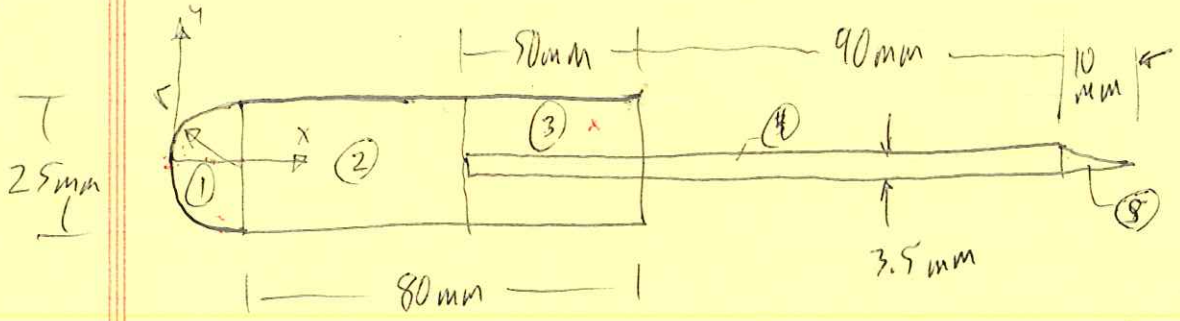
PROB. 5.129



$\rho_p = 1030 \frac{kg}{m^3}$, $v_p = \frac{1}{\rho_p} = 9.71 \times 10^{-4} \frac{m^3}{kg}$

$\rho_s = 7860 \frac{kg}{m^3}$, $v_s = \frac{1}{\rho_s} = 1.27 \times 10^{-4} \frac{m^3}{kg}$

LOCATE CG.

$W = mg$, $m = \rho V$

FOR A COMPOSITE BODY,

$$\bar{X} = \frac{\Sigma \bar{X}_i W_i}{\Sigma W_i} = \frac{\Sigma \bar{X}_i \rho_i V_i g}{\Sigma \rho_i V_i g}$$

$$\bar{Y} = \frac{\Sigma \bar{Y}_i W_i}{\Sigma W_i} = \frac{\Sigma \bar{Y}_i \rho_i V_i}{\Sigma \rho_i V_i}$$

DUE TO SYMMETRY, $\bar{Y} = 0$, $\bar{Z} = 0$

USE FIG. 5.21 ON p. 253.

HEMISPHERE: (1)

$$\bar{X} = \frac{3a}{8} = \frac{3(12.5)}{8} = 4.69 \text{ mm}$$

$$\bar{X}_1 = 12.5 - 4.69 = 7.81 \text{ mm}$$

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$$V_1 = \frac{2}{3}\pi a^3 = \frac{2\pi}{3}(12.5\,mm)^3 = 4091\,mm^3$$

CYLINDER (2):

$$\bar{X}_2 = 12.5 + \frac{30}{2} = 27.5\,mm$$

$$V_2 = \pi r^2 L = \pi(12.5)^2(30) = 1.47 \times 10^4\,mm^3$$

HOLLOW CYLINDER (3):

$$\bar{X}_3 = 12.5 + 30 + \frac{50}{2} = 67.5\,mm$$

$$V_3 = \pi(r_o^2 - r_i^2)L$$

$$= \pi\left[(12.5)^2 - \left(\frac{3.5}{2}\right)^2\right](50)$$

$$V_3 = 2.41 \times 10^4\,mm^3$$

CYLINDER (4):

$$\bar{X}_4 = 12.5 + 30 + \frac{140}{2} = 112.5\,mm$$

$$V_4 = \pi r^2 L = \pi\left(\frac{3.5}{2}\right)^2(140) = 1347\,mm^3$$

CONE (5):

$$\bar{X} = \frac{h}{4}$$

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$$\bar{X}_5 = 12.5 + 80 + 90 + \frac{(10)}{4} = 185 \text{ mm}$$

$$V_5 = \frac{\pi}{3} a^2 h = \frac{\pi}{3}\left(\frac{3.5}{2}\right)^2 (10) = 32.1 \text{ mm}^3$$

~~$\bar{X}_1 \rho_p V_1 = (7.81)(1030a$~~

$$\bar{X}_1 \rho_p V_1 = (7.81\text{mm})\left(1030 \frac{\text{Kg}}{\text{m}^3}\right)(4091 \text{mm}^3)\left(\frac{\text{m}}{1000\text{mm}}\right)^4 = 3.29 \times 10^{-5} \text{ Kg-m}$$

$$\bar{X}_2 \rho_p V_2 = (27.5\text{mm})\left(1030 \frac{\text{Kg}}{\text{m}^3}\right)(1.47 \times 10^4 \text{mm}^3)\left(\frac{\text{m}}{1000\text{mm}}\right)^4 = 4.16 \times 10^{-4} \text{ Kg-m}$$

$$\bar{X}_3 \rho_p V_3 = (67.5\text{mm})\left(1030 \frac{\text{Kg}}{\text{m}^3}\right)(2.41 \times 10^4 \text{mm}^3)\left(\frac{\text{m}}{1000\text{mm}}\right)^4 = 1.67 \times 10^{-3} \text{ Kg-m}$$

$$\bar{X}_4 \rho_s V_4 = (112.5\text{mm})\left(7860 \frac{\text{Kg}}{\text{m}^3}\right)(134 \text{mm}^3)\left(\frac{\text{m}}{1000\text{mm}}\right)^4 = 1.19 \times 10^{-3} \text{ Kg-m}$$

$$\bar{X}_5 \rho_s V_5 = (185\text{mm})\left(7860 \frac{\text{Kg}}{\text{m}^3}\right)(32.1 \text{mm}^3)\left(\frac{\text{m}}{1000\text{mm}}\right)^4 = 4.67 \times 10^{-5} \text{ Kg-m}$$

$$\rho_p V_1 = \left(1030 \frac{\text{Kg}}{\text{m}^3}\right)(4091 \text{mm}^3)\left(\frac{\text{m}}{1000\text{mm}}\right)^3 = 4.21 \times 10^{-3} \text{ Kg}$$

$$\rho_p V_2 = 1.51 \times 10^{-2} \text{ Kg}$$

$$\rho_p V_3 = 2.48 \times 10^{-2} \text{ Kg}$$

$$\rho_s V_4 = 1.06 \times 10^{-2} \text{ Kg}$$

$$\rho_s V_5 = 2.52 \times 10^{-4} \text{ Kg}$$

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$$\bar{\chi} = \frac{\Sigma \bar{\chi}_i \rho_i V_i}{\Sigma \rho_i V_i}$$

$$= \frac{3.29 \times 10^{-5} + 4.16 \times 10^{-4} + 1.67 \times 10^{-3} + 1.19 \times 10^{-3} + 4.67 \times 10^{-5}}{4.21 \times 10^{-3} + 1.51 \times 10^{-2} + 2.48 \times 10^{-2} + 1.06 \times 10^{-2} + 2.52 \times 10^{-4}}$$

$$\bar{\chi} = 0.0611 \text{ m} = 61.1 \text{ mm}$$

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