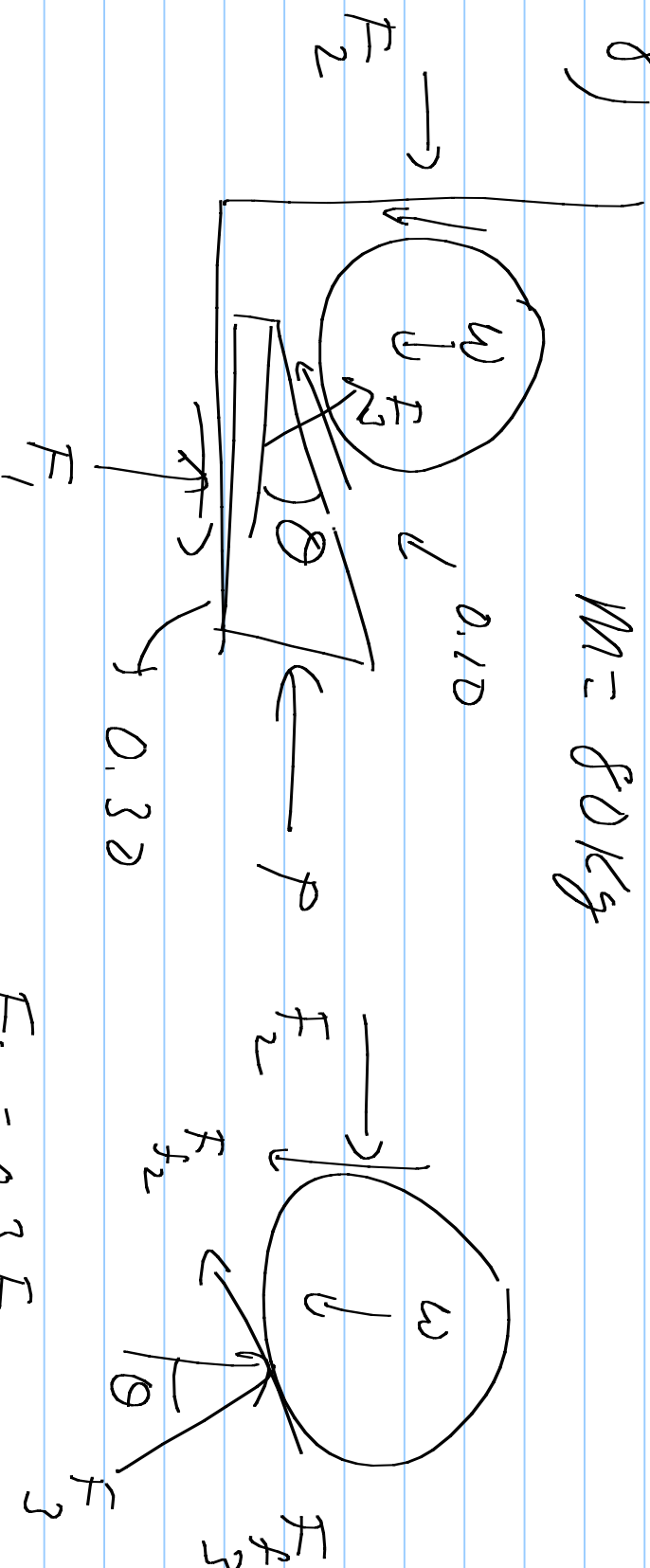


9-58)

$m = 80 \text{ kg}$



$$\sum M_o = 0 \Rightarrow F_{fr2} = F_{fr3}$$

$$0.3 F_2 = 0.1 F_3 \quad F_3 = \underline{3 F_2}$$

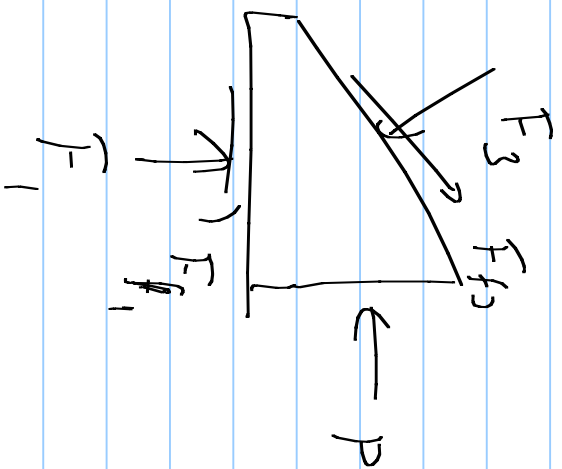
$$F_{fr2} = 0.3 F_2$$

$$F_{fr3} = 0.1 F_3$$

$$\sum F_y = -0.3F_2 - W + F_3 \cos \theta - F_{f3} \sin \theta = 0$$

$$\Rightarrow -0.3F_2 + 3F_2 \cos \theta - 0.3F_2 \sin \theta = W$$

$$F_2 = \frac{W}{3 \cos \theta - 0.3(1 + \sin \theta)}$$



$$\sum F_y = -F_3 \cos \theta + F_{f3} \sin \theta$$

$$+ F_1 = 0$$

$$F_1 = F_3 (\cos \theta - 0.1 \sin \theta)$$

$$= \frac{W (\cos \theta - 0.1 \sin \theta)}{\cos \theta - 0.1(1 + \sin \theta)}$$

$$\sum F_x = F_1 + F_2 \sin \theta + F_3 \cos \theta - P = 0$$

$$P = 0.3 F_1 + F_3 (\sin \theta + 0.1 \cos \theta)$$

$$= \frac{0.3 W (\cos \theta + 0.1 \sin \theta)}{\cos \theta - 0.1 (1 + \sin \theta)} + \frac{W (\sin \theta + 0.1 \cos \theta)}{\cos \theta - 0.1 (1 + \sin \theta)}$$

$$= \frac{W [\sin \theta + 0.4 \cos \theta + 0.03 \sin \theta]}{\cos \theta - 0.1 (1 + \sin \theta)} = \frac{W (1.03 \sin \theta + 0.4 \cos \theta)}{\cos \theta - 0.1 (1 + \sin \theta)}$$

$$\sum F_x = F_2 - F_1 \cos \theta - F_3 \sin \theta = 0$$

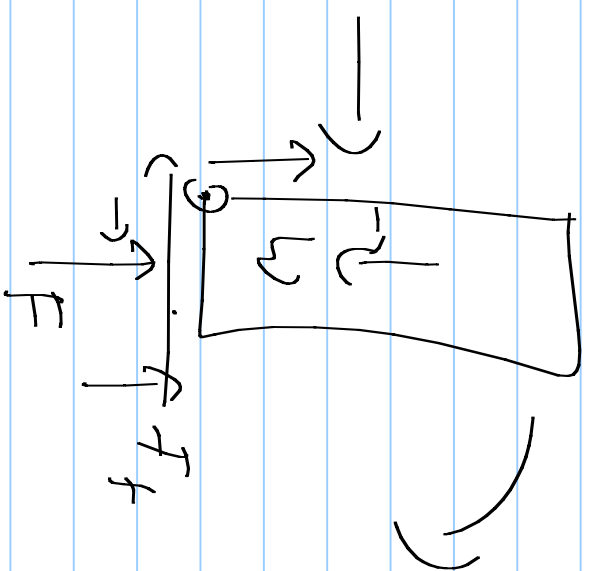
$$\frac{W}{3 \cos \theta - 0.3(1 + \sin \theta)} = \frac{0.1 F_3 \cos \theta - F_3 \sin \theta}{0} = 0$$

$$W = 3 \cos \theta - 0.3(1 + \sin \theta) \quad \left[\sin \theta + 0.1 \cos \theta \right]$$

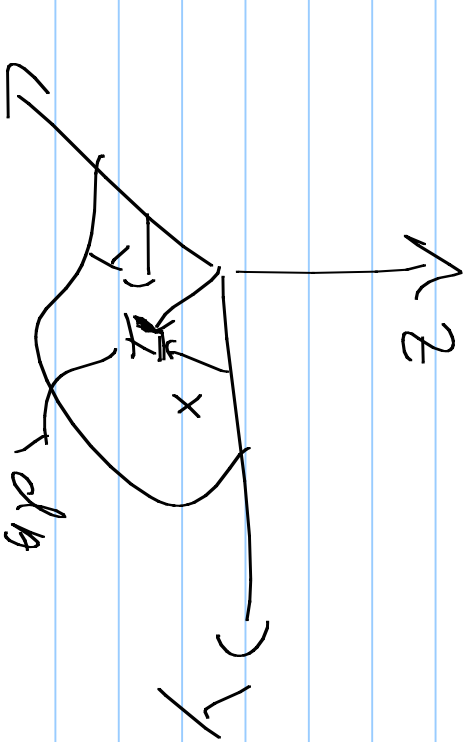
$$1 = 3 \sin \theta + 0.3 \cos \theta = \sqrt{9.09} \sin(\theta + \beta)$$

$$\cos \beta = \frac{3}{\sqrt{9.09}}, \quad \sin \beta = \frac{0.3}{\sqrt{9.09}}$$

$$\begin{aligned} \sin(\theta + \beta) &= \frac{1}{\sqrt{9.09}} \quad \theta = \sin^{-1} \left(\frac{1}{\sqrt{9.09}} \right) - \beta \\ P &= 584.8 \text{ N} \end{aligned}$$



Second Moment



$$dI_x = y^2 dA$$

$$I_x = \iint_R y^2 dA$$

$$I_y = \iint_R x^2 dA$$

$$I_z = I_x + I_y$$

Diagram of a rectangular region in the xy -plane. The region is shaded with diagonal lines. The x -axis is labeled x and the y -axis is labeled y . The region is bounded by $x=0$, $x=a$, $y=0$, and $y=b$. The origin is labeled O . The region is also labeled with x' and y' axes.

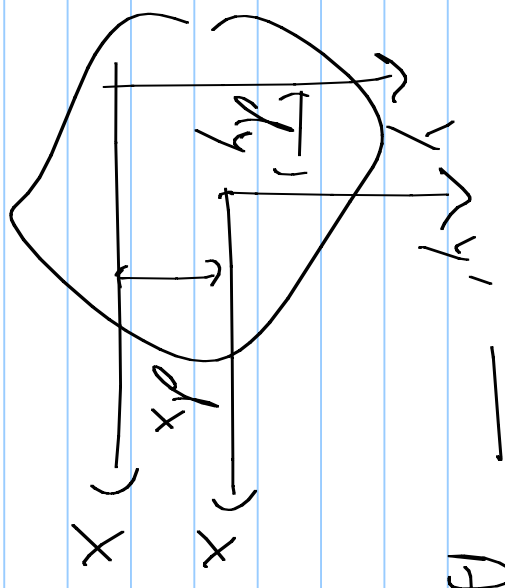
$$I_{x'} = \int_0^a \int_0^b y^2 dy dx = \frac{a b^3}{3}$$

$$I_y = \int_0^a \int_0^b x^2 dy dx = \frac{a^3 b}{3}$$

$$I_{x'} = \int_{-a/2}^{a/2} \int_{-b/2}^{b/2} y^2 dy dx = \frac{a b^3}{12}$$

$$I_{y'} = \int_{-a/2}^{a/2} \int_{-b/2}^{b/2} x^2 dy dx = \frac{a^3 b}{12}$$

$$\frac{a^3 b}{12} + \left(\frac{a}{2}\right)^2 \cdot \frac{ab}{12} = \frac{a^3 b}{12} + \frac{a^2 b}{4} = \frac{a^3 b}{3}$$

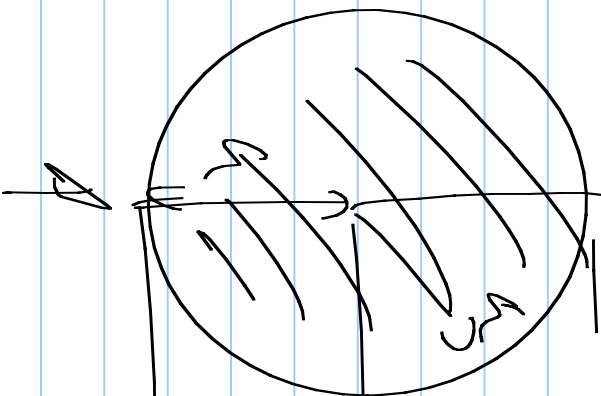


$$I_x = \iint_R (y' + dy)^2 dA$$

$$= \iint_R (y')^2 dA + 2dy \iint_R y' dA$$

$$+ d_y^2 \left(\iint_{\Omega} dA \right)$$

$$I_x = I_{x'} + A d_y^2$$



$$I_x = \iint_{\Omega} y^2 dA$$

$$= \int_0^{2\pi} \int_0^{\pi} r^2 \sin^2 \theta \, r \, dr \, d\theta$$

$$= \int_0^{2\pi} \sin^2 \theta \, d\theta \cdot \int_0^a r^3 \, dr$$

$$= \int_0^{2\pi} \frac{1 - \cos(2\theta)}{2} \, d\theta \cdot \frac{a^4}{4} = \frac{\pi a^4}{4}$$

$$I_x = I_y = \frac{\pi a^4}{4}$$

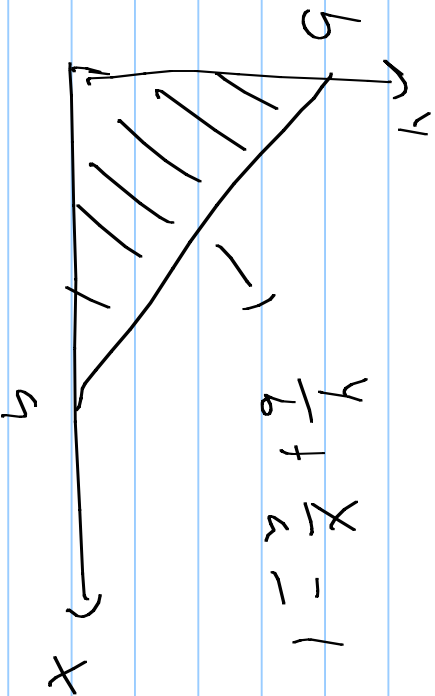
$$I_{x_2} = I_y + a^2 \pi a^2$$

$$\begin{aligned} I_{x_2} &= I_x = \frac{\pi a^4}{4} \\ &= \frac{\pi a^4}{4} + \pi a^4 = \frac{5\pi a^4}{4} \end{aligned}$$

$$J_z = I_x + I_y = \frac{\pi a^4}{2}$$

$$J_{z_2} = I_{x_2} + I_{y_2} = \frac{3\pi a^4}{2}$$

$$\frac{y}{b} + \frac{x}{a} = 1 \Rightarrow y = b \left(1 - \frac{x}{a}\right)$$



$$I_X = \iint_R y^2 dA = \int_0^a \int_0^{b(1-\frac{x}{a})} y^2 dy dx = \int_0^a \frac{b^3}{3} \left(1 - \frac{x}{a}\right)^3 dx$$

$$= \frac{b^3}{3} \int_0^a \left(1 - \frac{x}{a}\right)^3 dx = \frac{ab^3}{12}$$

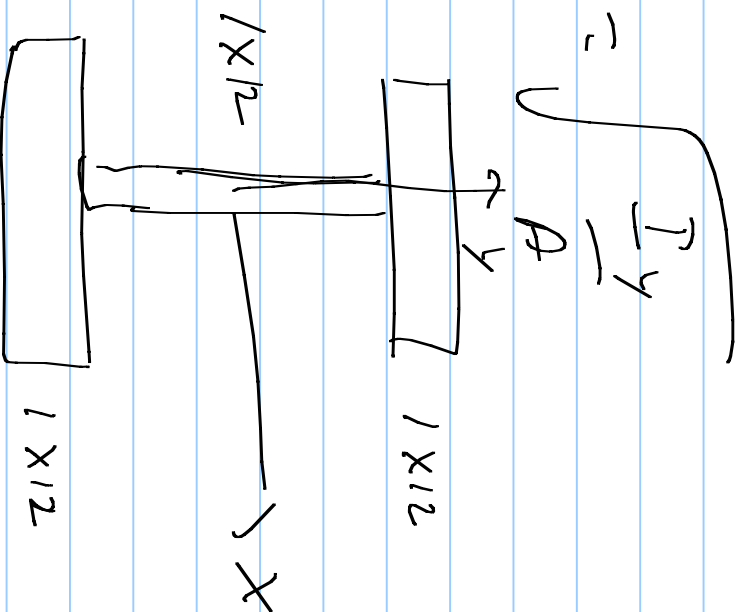
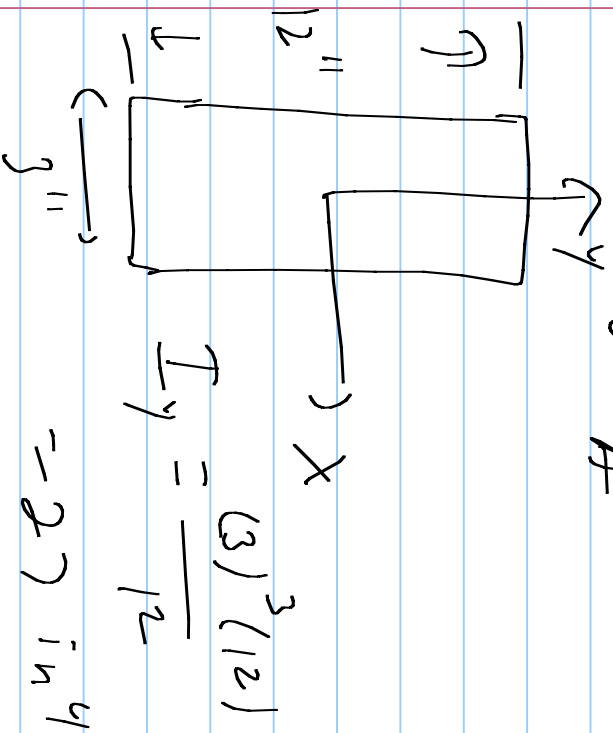
$$I_Y = \iint_R x^2 dA = \int_0^a \int_0^y x^2 dx = b \int_0^a x^2 \left(1 - \frac{x}{a}\right) dx$$

$$= \frac{bx^3}{3} - \frac{bx^4}{4a} \Big|_0^y = \frac{a^3 b}{3} - \frac{a^3 b}{12}$$

Radius of Gyration

$$K_x = \sqrt{\frac{I_x}{A}}$$

$$K_y = \sqrt{\frac{I_y}{A}}$$



$$I_X = \frac{(12)^3}{12} = 432 \text{ in}^4$$

$$K_X = \sqrt{\frac{432}{36}} = \sqrt{12} \approx 3,464 \text{ in}$$

$$K_Y = \sqrt{\frac{27}{36}} = 0,866$$