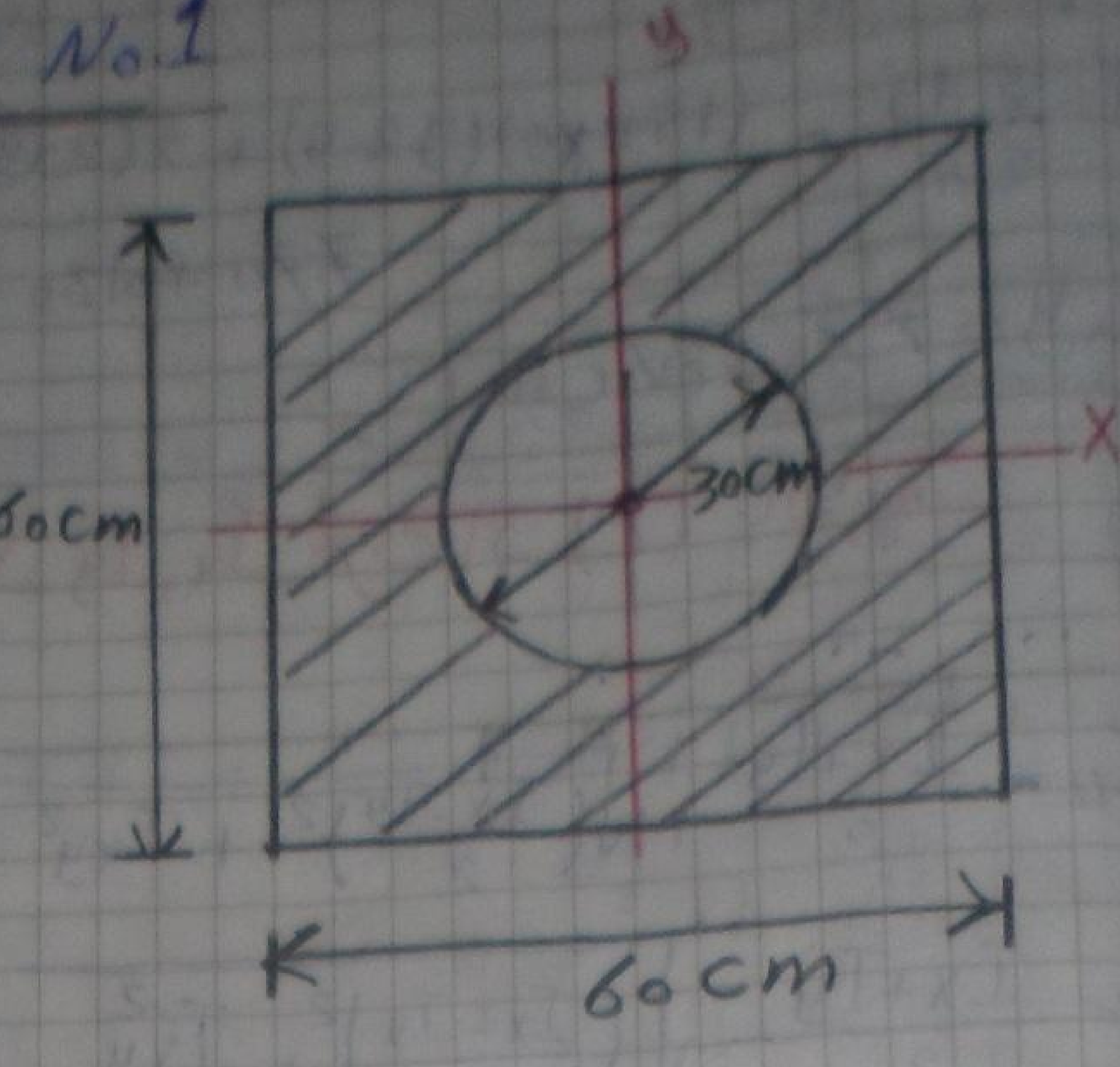
Sheet No.1

1

$\boxed{\bar{X} = 30\,Cm}$, $\boxed{\bar{y} = 30\,Cm}$



$I_X = [I_{X_1} + A\bar{y}^2]$

$I_X = \left[\frac{60^4}{12} + 3600(0)\right] - \left[\frac{\pi\, 30^4}{64} + 0\right]$

$\therefore \boxed{I_X = 1040239.218\ Cm^4}$

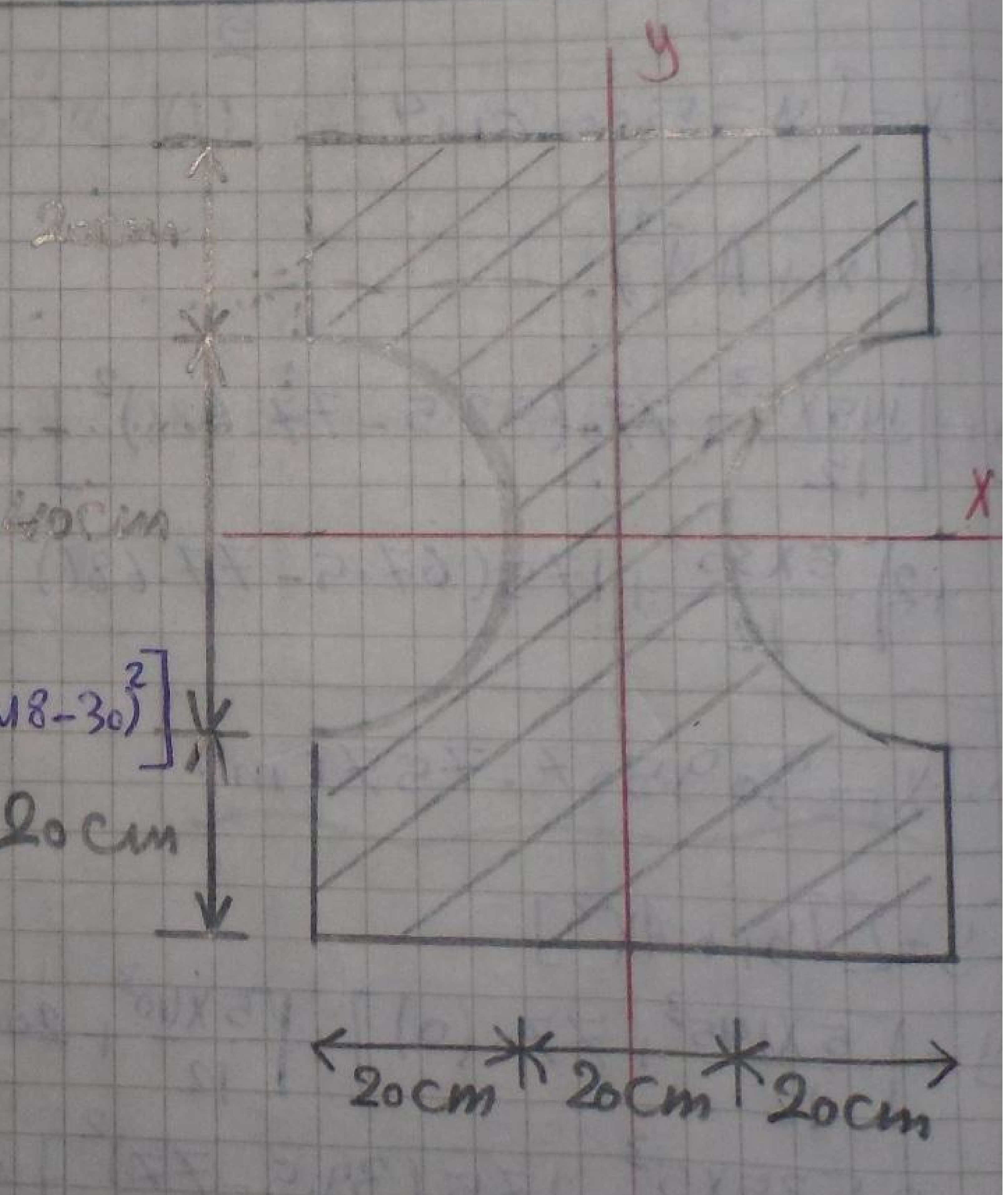
$I_y = [I_{y_1} + A\bar{X}^2]$

$I_y = \left[\frac{60^4}{12} + 0\right] - \left[\frac{\pi\, 30^4}{64} + 0\right]$

$\boxed{\therefore I_y = 1040239.218\ Cm^4}$ $\boxed{I_{xy} = 0}$

2

$\boxed{\bar{X} = 30\,Cm}$, $\boxed{\bar{y} = 40\,Cm}$



$I_X = \left[\frac{80^3 \times 60}{12} + 0\right] - 2\left[\frac{\pi(20^4)}{8} + 0\right]$

$\boxed{\therefore I_X = 2434336.294\ Cm^4}$

$I_y = \left[\frac{60^3 \times 80}{12} + 0\right] - 2\left[0.11(20^4) + (200\pi)(8.48-30)^2\right]$

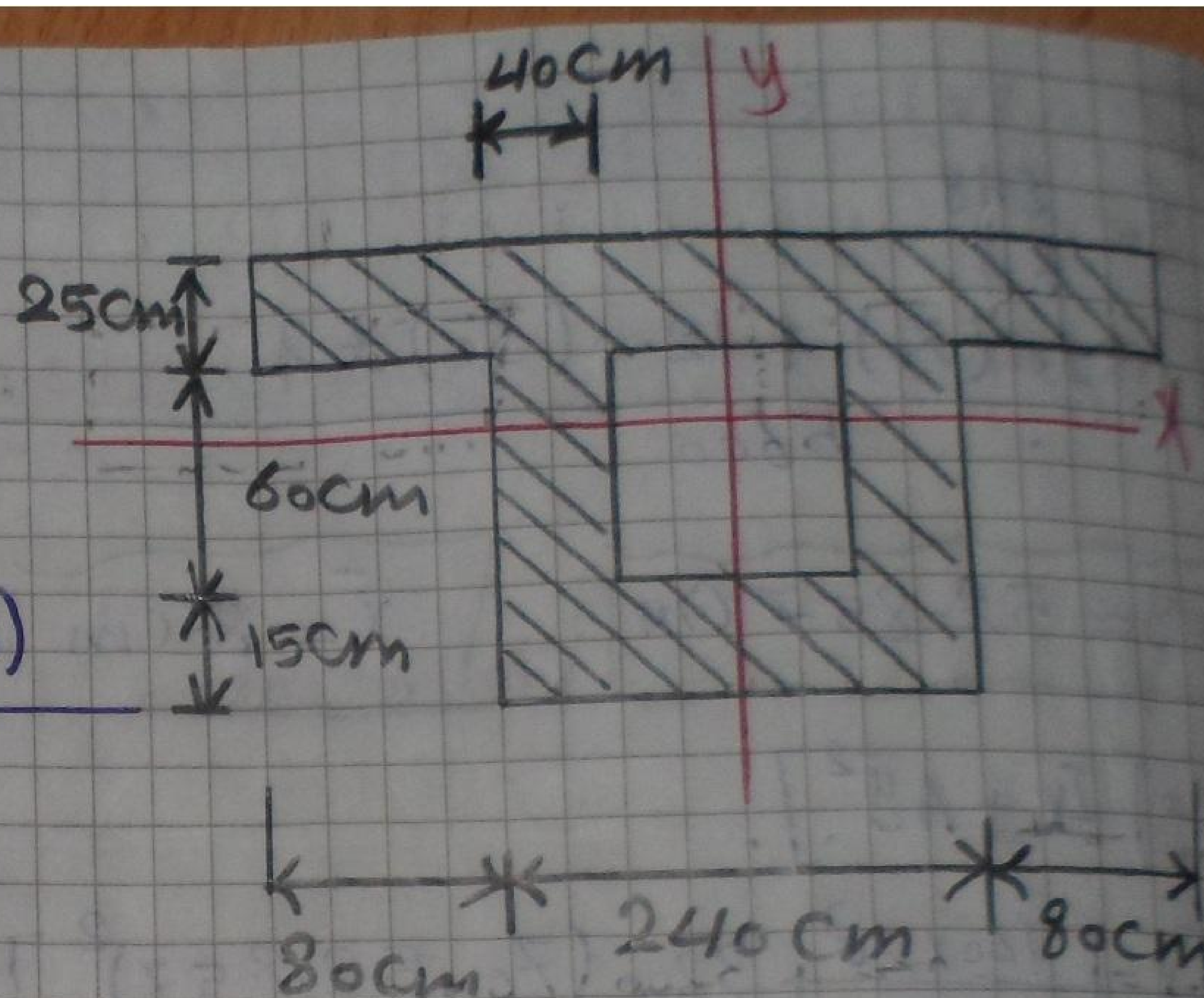
$\boxed{\therefore I_y = 822838.3078\ Cm^4}$

$\boxed{I_{xy} = 0}$

$\boxed{I_u = I_X}$ $\boxed{I_v = I_y}$

3

$\boxed{\bar{X} = 200\,cm}$



$$\bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A}$$

$$\bar{y} = \frac{10000(87.5) + 18000(37.5) - 9600(45)}{18400}$$

$$\boxed{\therefore \bar{y} = 60.761\,cm}$$

$$I_x = \left[\frac{400 \times 25^3}{12} + 10000(87.5 - 60.761)^2\right] + \left[\frac{240 \times 75^3}{12} + 18000(37.5 - 60.761)^2\right] - \left[\frac{160 \times 60^3}{12} + 9600(45 - 60.761)^2\right]$$

$$\boxed{\therefore I_x = 20582681.16\,cm^4}$$

$$I_y = \left[\frac{25 \times 400^3}{12} + 1000(0)\right] + \left[\frac{75 \times 240^3}{12} + 0\right] - \left[\frac{60 \times 160^3}{12} + 0\right]$$

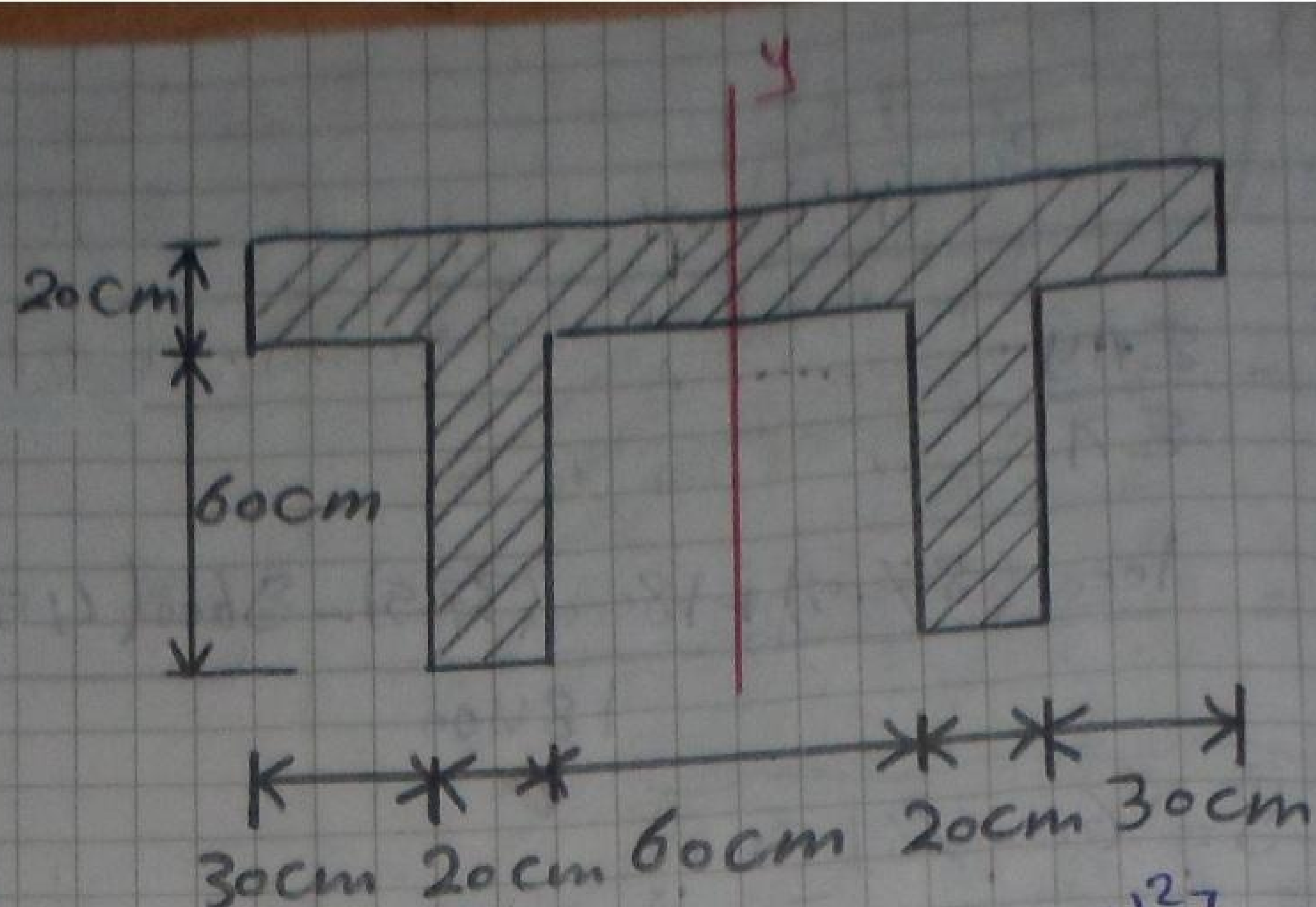
$$\boxed{\therefore I_y = 199253333.3\,cm^4}$$

$\boxed{I_{xy} = 0}$ $\boxed{I_x = I_v}$ $\boxed{I_y = I_u}$

(4)

$\bar{y} = \frac{\Sigma A y}{\Sigma A}$

$\bar{y} = \frac{3200(70) + 1200(30) * 2}{5600}$



$\boxed{\therefore \bar{y} = 52.857\ Cm}$ $\boxed{\bar{X} = 80\ Cm}$

$I_X = [I_{X_1} + A\bar{y}^2]$

$\therefore I_X = \left[\frac{160 \times 20^3}{12} + 3200(70 - 52.857)^2\right] + \left[\frac{20 \times 60^3}{12} + 1200(30 - 52.857)^2\right] * 2$

$\boxed{\therefore I_X = 3020952.381\ Cm^4}$

$I_y = [I_{y_1} + A\bar{X}^2]$

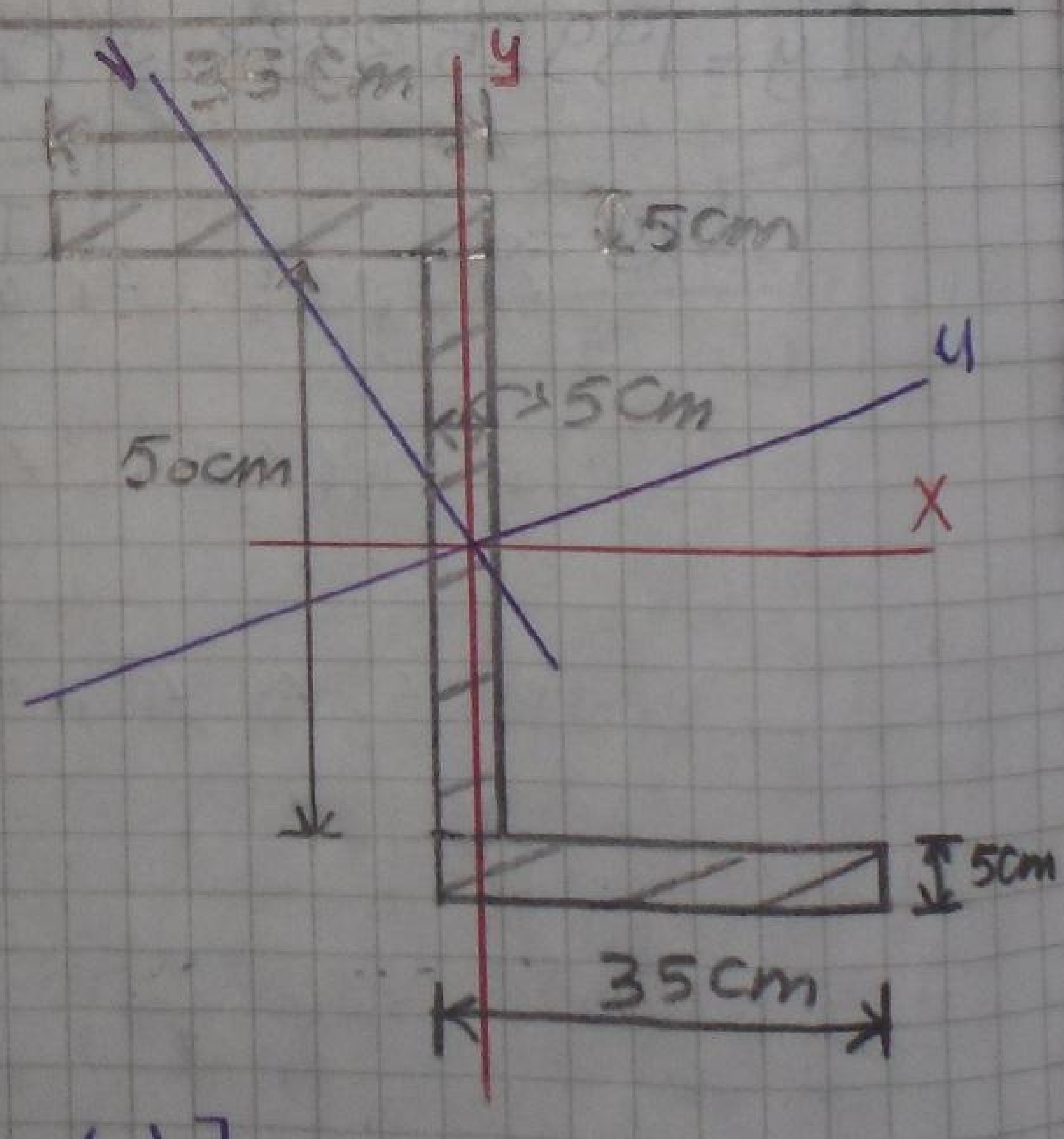
$\therefore I_y = \left[\frac{20 \times 160^3}{12} + 0\right] + \left[\frac{60 \times 20^3}{12} + 1200(40 - 80)^2\right] * 2$

$\boxed{\therefore I_y = 10746666.67\ Cm^4}$

$\boxed{I_u = I_y}$ $\boxed{I_v = I_X}$ $\boxed{I_{Xy} = 0}$

(5)

$\bar{X} = \frac{\Sigma A \bar{X}}{\Sigma A} = \frac{175(17.5) + 250(32.5) + 175(47.5)}{600}$



$\boxed{\therefore \bar{X} = 32.5\ Cm}$

$\bar{y} = \frac{\Sigma A \bar{y}}{\Sigma A} = \frac{175(57.5) + 250(30) + 175(2.5)}{600}$

$\boxed{\therefore \bar{y} = 30\ Cm}$

$I_X = [I_{X_1} + A\bar{y}^2]$

$\therefore I_X = \left[\frac{35 \times 5^3}{12} + 175(57.5 - 30)^2\right] + \left[\frac{5 \times 50^3}{12} + 250(0)\right]$
$+ \left[\frac{35 \times 5^3}{12} + 175(2.5 - 30)^2\right]$

$\boxed{\therefore I_X = 317500\ Cm^4}$

$I_y = [I_{y_1} + A\bar{X}^2]$

$$\therefore I_y = \left[\frac{5\times35^3}{12} + 175(17.5-32.5)^2\right] + \left[\frac{50\times5^3}{12} + 0\right] + \left[\frac{5\times35^3}{12} + 175(47.5-32.5)^2\right]$$

$$\boxed{I_y = 115000\ Cm^4}$$

$$I_{xy} = \left[I_{x_1y_1} + A\bar{x}\bar{y}\right]$$

$$I_{xy} = \left[0 + 175(17.5-32.5)(57.5-30)\right] + \left[0 + 250(0)(0)\right] + \left[0 + 175(47.5-32.5)(2.5-30)\right]$$

$$\boxed{\therefore I_{xy} = -144375\ Cm^4}$$

$$I_{u,v} = \frac{I_x + I_y}{2} \pm \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + (I_{xy})^2}$$

$$I_{u,v} = \frac{317500 + 115000}{2} \pm \sqrt{\left(\frac{317500 - 115000}{2}\right)^2 + (-144375)^2}$$

$$\boxed{\therefore I_u = 392589.7378\ Cm^4}$$

$$\boxed{\therefore I_v = 39910.2622\ Cm^4}$$

$$\tan 2\theta = \frac{-2I_{xy}}{I_x - I_y} = \frac{-2(-144375)}{317500 - 115000}$$

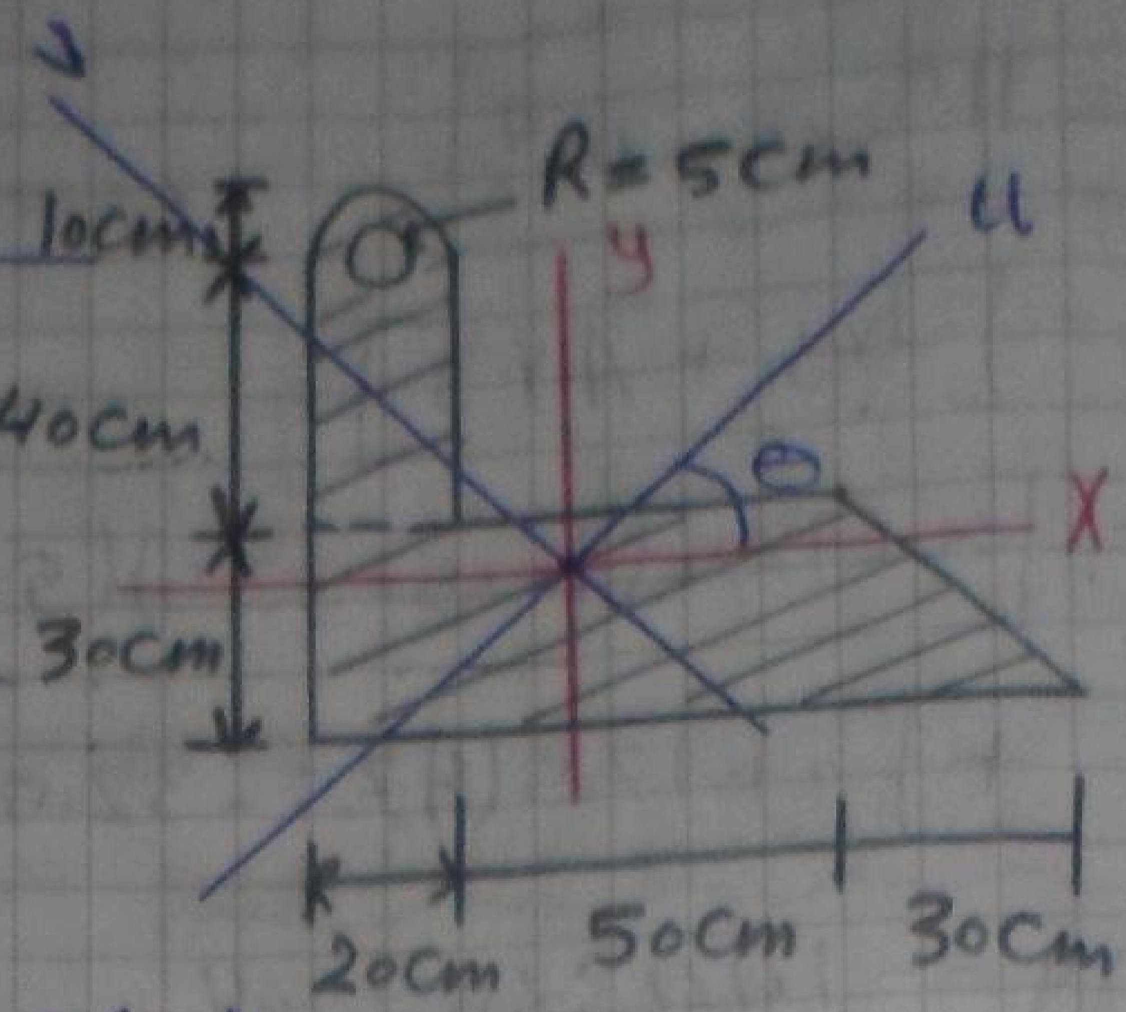
$$\therefore \tan 2\theta = \frac{+}{+}\ 1.426$$

$$\therefore 2\theta = 54.96^\circ$$

$$\boxed{\therefore \theta = 27.48^\circ}$$

$$\bar{X} = \frac{\Sigma A\bar{x}}{\Sigma A}$$

$$\therefore \bar{X} = \frac{50\pi(10) + 800(10) + 2100(35) + 450(80) - 25\pi(10)}{3428.539}$$



$$\boxed{\therefore \bar{X} = 34.5\ \text{Cm}}$$

$$\bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A}$$

$$\therefore \bar{y} = \frac{50\pi(74.24) + 800(50) + 2100(15) + 450(10) - 25\pi(70)}{3428.539}$$

$$\boxed{\therefore \bar{y} = 23.965\ \text{Cm}}$$

$$I_x = \left[I_{x_1} + A\bar{y}^2\right]$$

$$\therefore I_x = \left[0.11(10^4) + 50\pi(74.24 - 23.965)^2\right] + \left[\frac{20\times40^3}{12} + 800(50 - 23.965)^2\right] + \left[\frac{70\times30^3}{12} + 2100(15 - 23.965)^2\right] + \left[\frac{30\times30^3}{36} + 450(10 - 23.965)^2\right] - \left[\frac{\pi(10^4)}{64} + 25\pi(70 - 23.965)^2\right]$$

$$\boxed{I_x = 1316659.302\ \text{Cm}^2}$$

$$I_y = \left[I_{y_1} + A\bar{x}^2\right]$$

$$I_y = \left[\frac{\pi(10^4)}{8} + 50\pi(10 - 34.5)^2\right] + \left[\frac{40\times20^3}{12} + 800(10 - 34.5)^2\right] + \left[\frac{30\times70^3}{12} + 2100(35 - 34.5)^2\right] + \left[\frac{30\times30^3}{36} + 450(80 - 34.5)^2\right] - \left[\frac{\pi(10^4)}{64} + 25\pi(10 - 34.5)^2\right]$$

$$\boxed{\therefore I_y = 2369583.808\ \text{Cm}^4}$$

$$I_{xy} = \left[I_{x_1y_1} + A\bar{x}\bar{y}\right]$$

$$\therefore I_{xy} = \left[0 + 50\pi(10-34.5)(74.24-23.965)\right] + \left[0 + 800(10-34.5)(50-23.965)\right]$$
$$+\left[0 + 2100(35-34.5)(15-23.965)\right] + \left[\frac{30^4}{72} + 450(80-34.5)(10-23.965)\right]$$
$$-\left[0 + 25\pi(10-34.5)(70-23.965)\right]$$

$$\boxed{\therefore I_{xy} = -899281.7782\ Cm^4}$$

$$I_{u,v} = \frac{I_x + I_y}{2} \pm \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + I_{xy}^2}$$

$$\therefore I_{u,v} = \frac{1316659.302 + 2369583.808}{2} \pm \sqrt{\left(\frac{1316659.302 - 2369583.808}{2}\right)^2 + (899281.77)^2}$$

$$\boxed{\therefore I_u = 2885172.523\ Cm^4}$$

$$\boxed{\therefore I_v = 801070.587\ Cm^4}$$

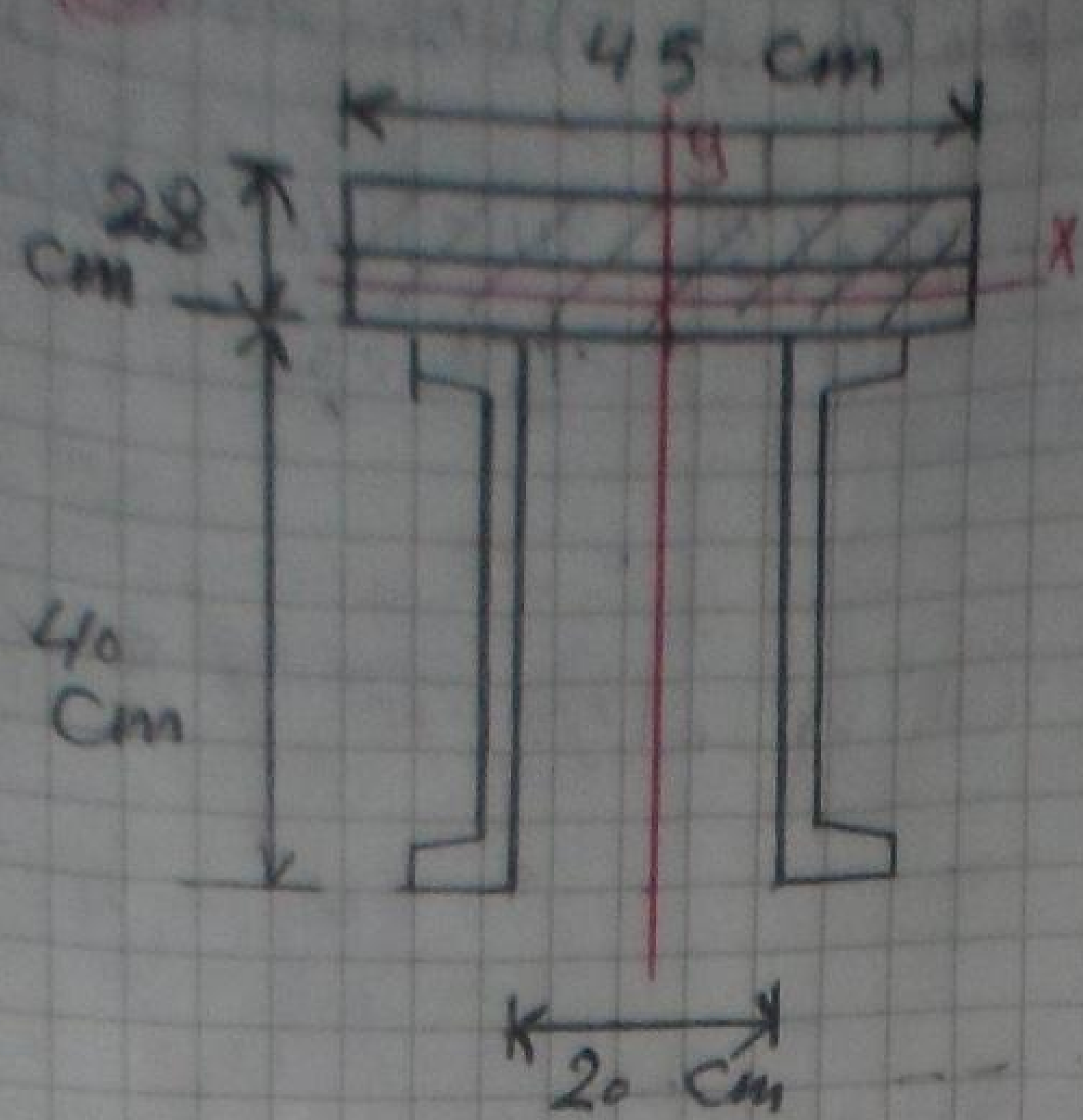
$$\tan 2\theta = \frac{-2I_{xy}}{I_x - I_y} = \frac{-2(-899281.7782)}{1316659.302 - 2369583.808}$$

$$\therefore \tan 2\theta = \pm 1.708$$

$$\therefore 2\theta = 180 - 59.652$$

$$\boxed{\therefore \theta = 60.17^\circ}$$

8

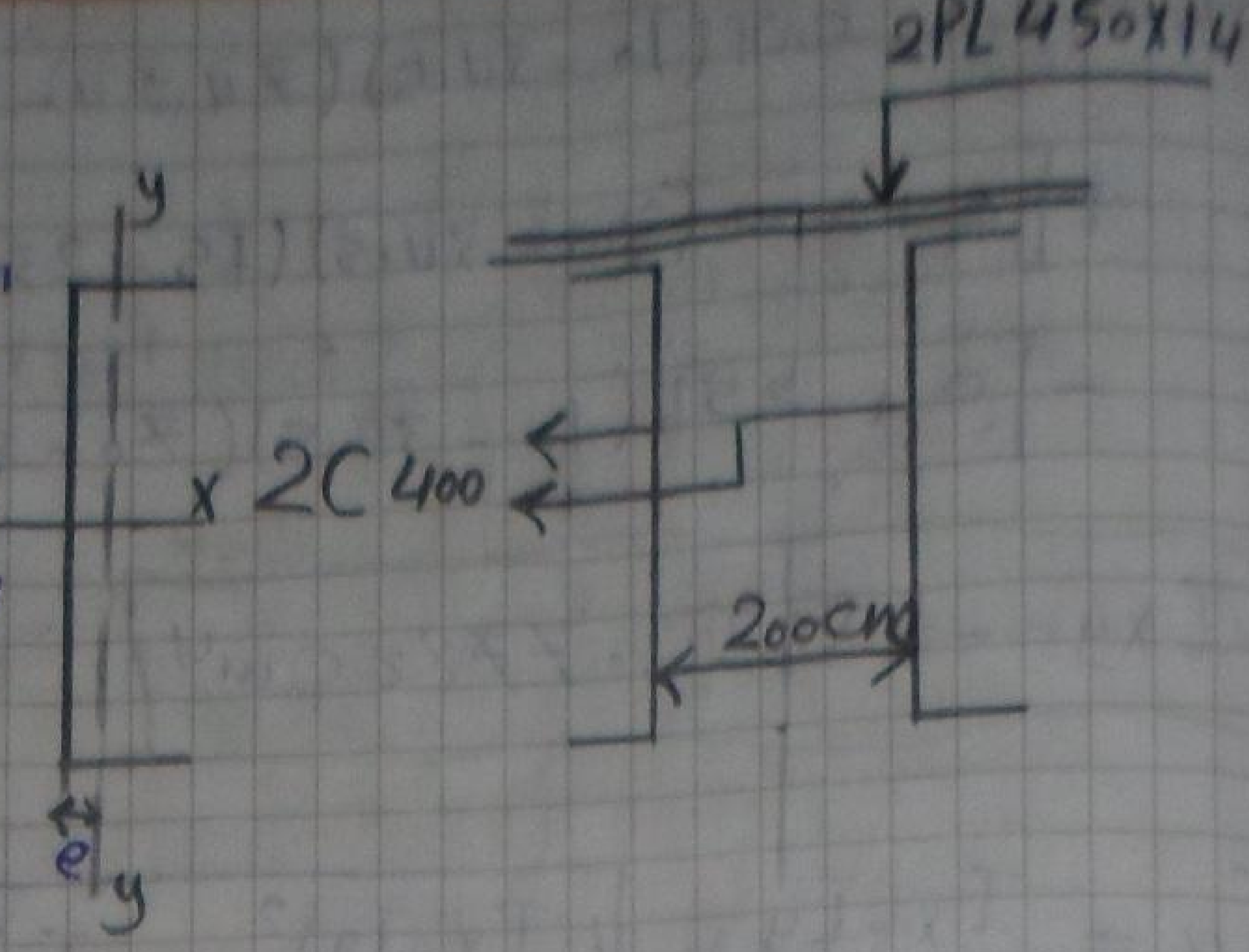


$e = 2.65 \text{ Cm}$

$A = 75 \text{ Cm}^2$

$I_x = 12000 \text{ Cm}^4$

$I_y = 1200 \text{ Cm}^4$



$\boxed{\bar{X} = 22.5 \text{ Cm}}$

$$\bar{y} = \frac{\Sigma A \bar{y}}{\Sigma A}$$

$$\therefore \bar{y} = \frac{126 \quad (41.4) + 2(75)(20)}{276}$$

$\boxed{\therefore \bar{y} = 29.77 \text{ Cm}}$

$$I_x = \left[I_{x_1} + A \bar{y}^2 \right]$$

$$\therefore I_x = \left[\frac{45 \times 2.8^3}{12} + 126 \quad (41.4 - 29.77)^2 \right] + 2\left[12000 + 75(20 - 29.77)^2 \right]$$

$\boxed{\therefore I_x = 55442.624 \text{ Cm}^4}$

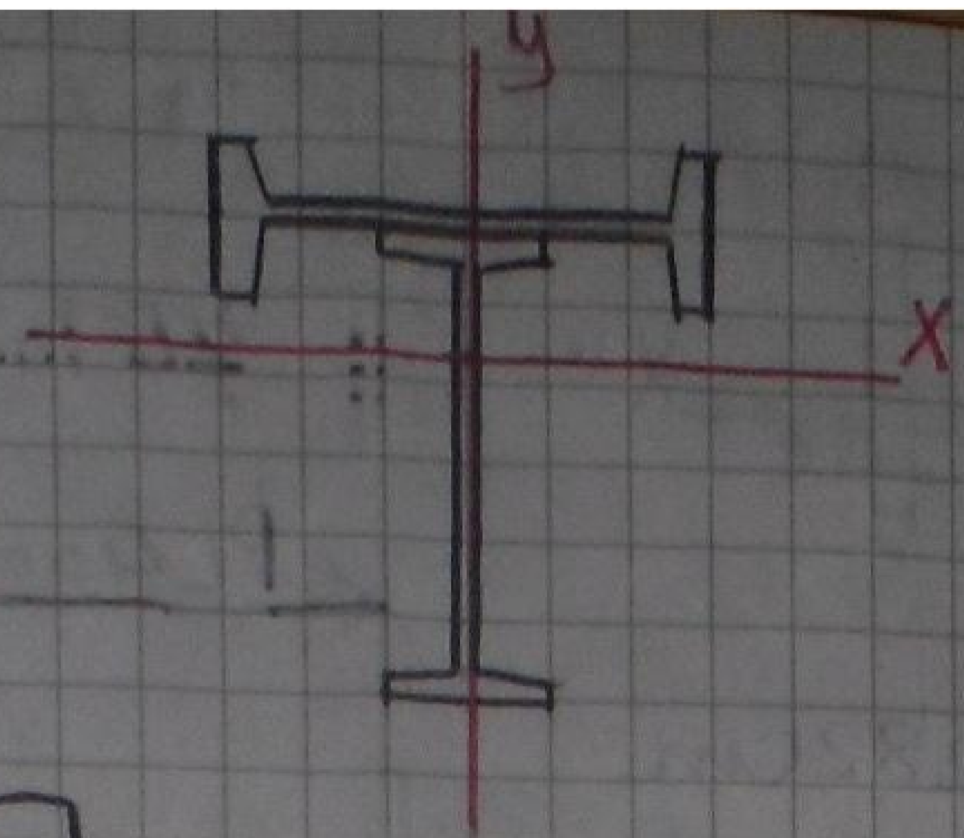
$$I_y = \left[I_{y_1} + A \bar{x}^2 \right]$$

$$\therefore I_y = \left[\frac{2.8 \times 45^3}{12} + 126 \quad (0) \right] + 2\left[1200 + 75(9.85 - 22.5)^2 \right]$$

$\boxed{\therefore I_y = 47665.88 \quad \text{Cm}^4}$

$\boxed{I_{xy} = 0}$ $\boxed{I_v = I_y}$ $\boxed{I_u = I_x}$

8



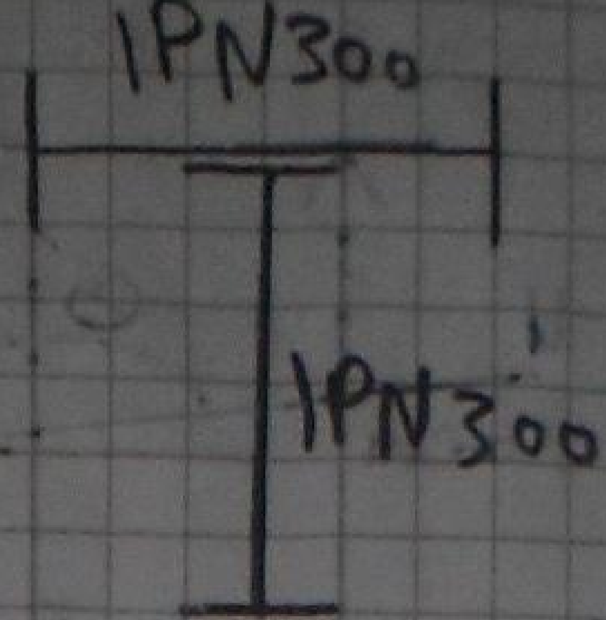
For IPN 300

$S = 1.08\ cm$

$A = 69\ cm^2$

$I_x = 9800\ cm^4$

$I_y = 451\ cm^4$



$$\boxed{\bar{X} = 15\ cm}$$

$$\bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A}$$

$$\therefore \bar{y} = \frac{69(30.54) + 69(15)}{138}$$

$$\boxed{\therefore \bar{y} = 22.77\ cm}$$

$$I_x = [I_{x_1} + A(\bar{y}^2)]$$

$$\therefore I_x = [451 + 69(30.54 - 22.77)^2] + [9800 + 69(15 - 22.77)^2]$$

$$\boxed{\therefore I_x = 18582.460\ cm^4}$$

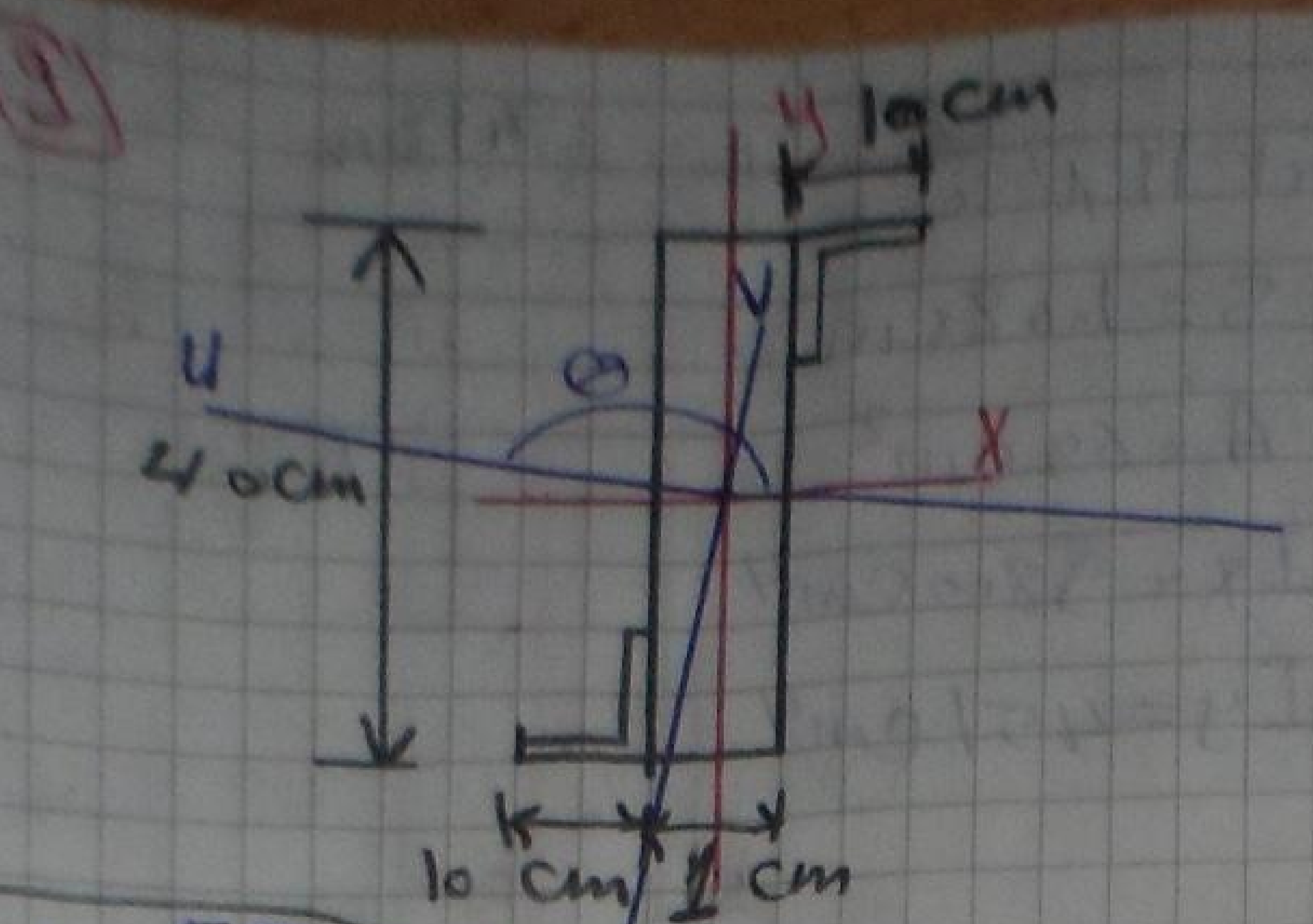
$$I_y = [I_{y_1} + A\bar{x}^2]$$

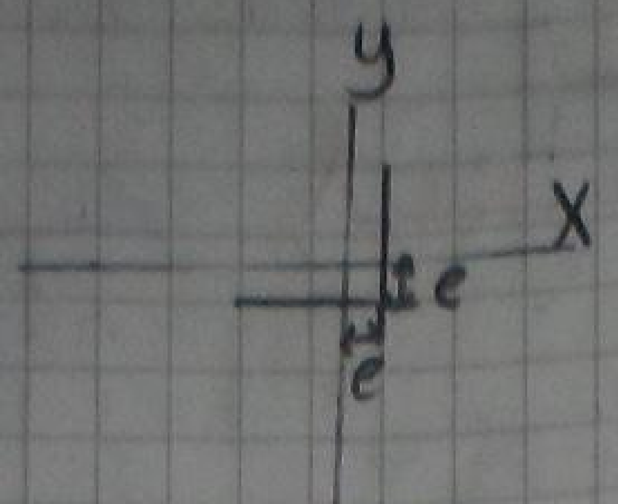
$\therefore I_y = [451 +$ [redacted] $(0)] + [\overset{9800}{\cancel{451}} + 0]$

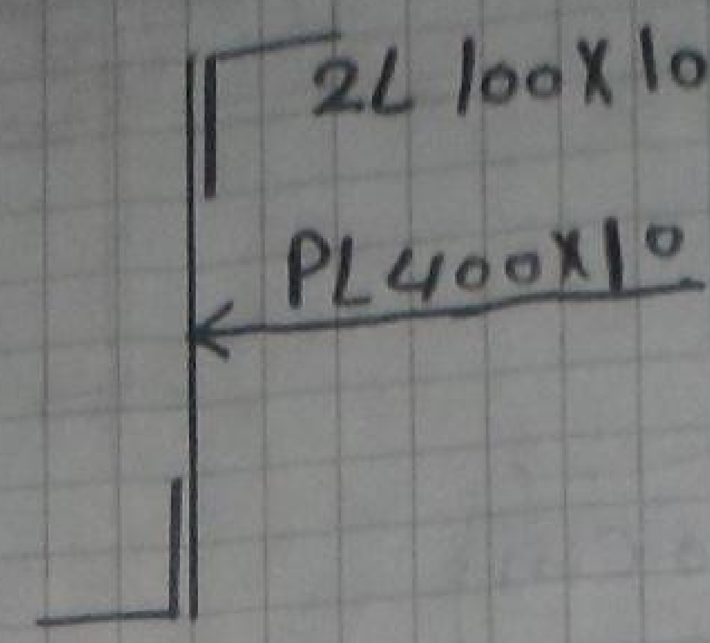
$$\boxed{\therefore I_y = 902\ cm^4}$$

$$\boxed{I_{xy} = 0} \quad \boxed{I_u = I_x} \quad \boxed{I_v = I_u}$$

9







$e = 2.82\,cm$

$A = 19.2\,cm^2$

$I_x = I_y = 177\,cm^4$

$I_{max} = 280\,cm^4$

$\boxed{\bar{x} = 5.5\,cm}$

$$\bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A} = \frac{19.2(37.18) + 40(20) + 19.2(2.82)}{78.5}$$

$\boxed{\bar{y} = 20\,cm}$

$$I_x = [I_{x_1} + A\bar{y}^2]$$

$$I_x = \left[177 + 19.2(37.18 - 20)^2\right] + \left[\frac{1 \times 40^3}{12} + 4000(0)\right] + \left[177 + 19.2(2.82 - 20)^2\right]$$

$$\therefore \boxed{I_x = 17021.18\,cm^4}$$

$$I_y = [I_{y_1} + A\bar{x}^2]$$

$$\therefore I_y = \left[177 + 19.2(13.82 - 5.5)^2\right] + \left[\frac{40 \times 1^3}{12} + 0\right] + \left[177 + 19.2(7.18 - 5.5)^2\right]$$

$$\therefore \boxed{I_y = 780.59\,cm^4}$$

For (L):

$$I_u = \frac{I_x + I_y}{2} + \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + I_{xy}^2}$$

$$\therefore 280 = 177 + I_{xy}$$

$$\boxed{\therefore I_{xy} = 103\,cm^4}$$

$$I_{xy} = \left[I_{x_1 y_1} + (A \bar{x} \bar{y}) \right]$$

$$\therefore I_{xy} = \left[103 + 19.2(13.82 - 10.5)(37.18 - 20) \right] + \left[0 + 0 \right]$$
$$+ \left[103 + 19.2(7.18 - 10.5)(2.82 - 20) \right]$$

$$\boxed{\therefore I_{xy} = 2396.244\ Cm^4}$$

$$I_{u,v} = \frac{I_x + I_y}{2} \pm \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + I_{xy}^2}$$

$$I_{u,v} = \frac{780.59 + 17021.18}{2} \pm \sqrt{\left(\frac{17021.18 - 781.59}{2}\right)^2 + (2369.244)^2}$$

$$\boxed{\therefore I_u = 17359.277\ cm^4}$$

$$\boxed{I_v = 442.493\ Cm^4}$$

$$\tan 2\theta = \frac{-2 I_{xy}}{I_x - I_y} = \frac{-2(2369.244)}{17021.18 - 780.59}$$

$$\cancel{\therefore \tan 2\theta = \frac{-}{+} 2.17 \times 10^{3}}$$

$$\cancel{\therefore 2\theta = 360 - 0.124}$$

$$\cancel{\boxed{\therefore \theta = 179.94^\circ}}$$

$$\tan 2\theta = \frac{-}{+} 0.292$$

$$2\theta = 360 - 16.3^\circ$$

$$\boxed{\theta = 171.87^\circ}$$