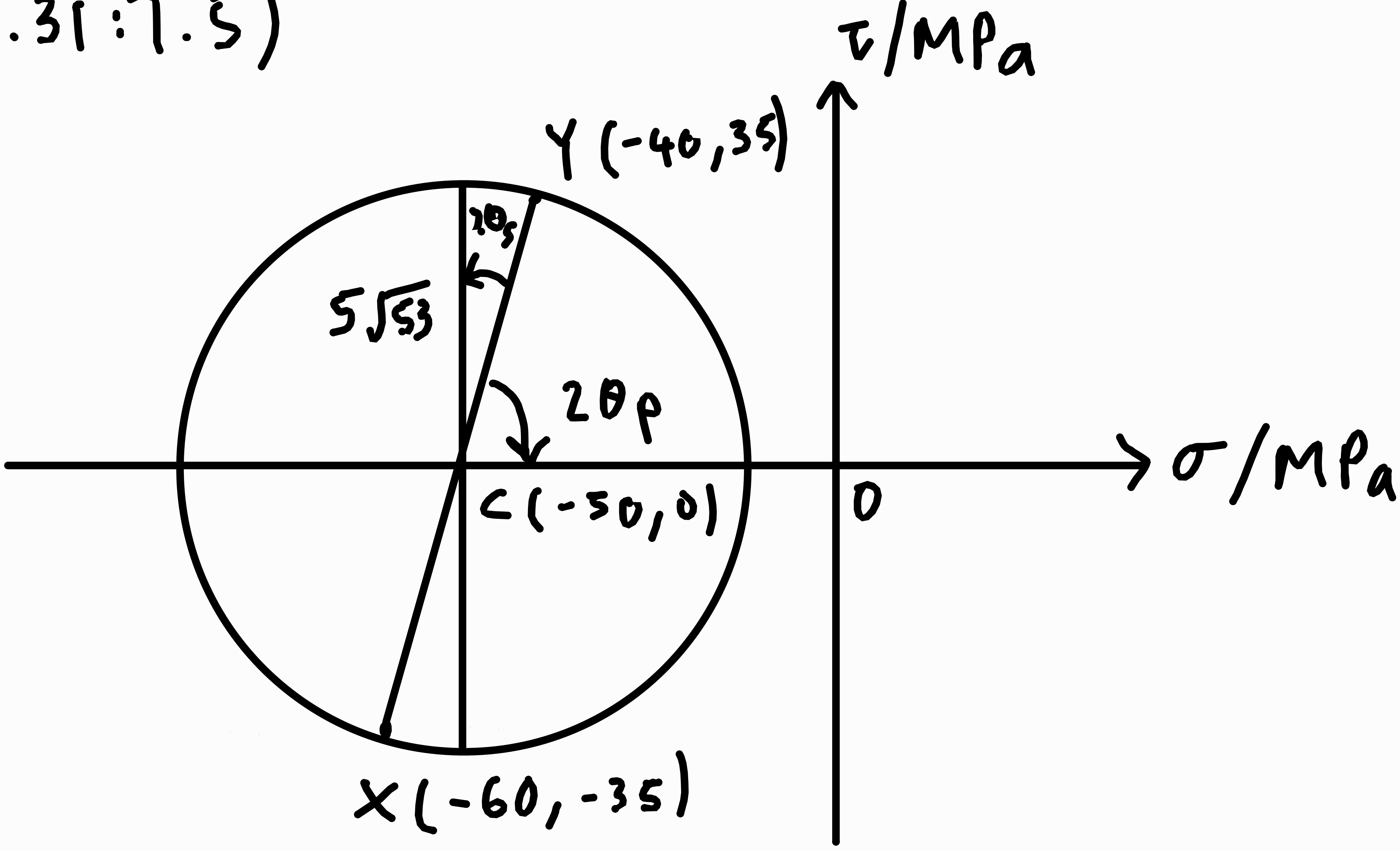
7.31:7.5)



$$2\theta_p = \tan^{-1}\left(\frac{35}{10}\right)$$

$$\theta_p = -37.02730205^\circ, 52.97269795^\circ$$

$$\approx -37^\circ, 53^\circ$$

$$\sigma_{max} = -50 + 5\sqrt{53}$$

$$= -13.59945055 \text{ MPa}$$

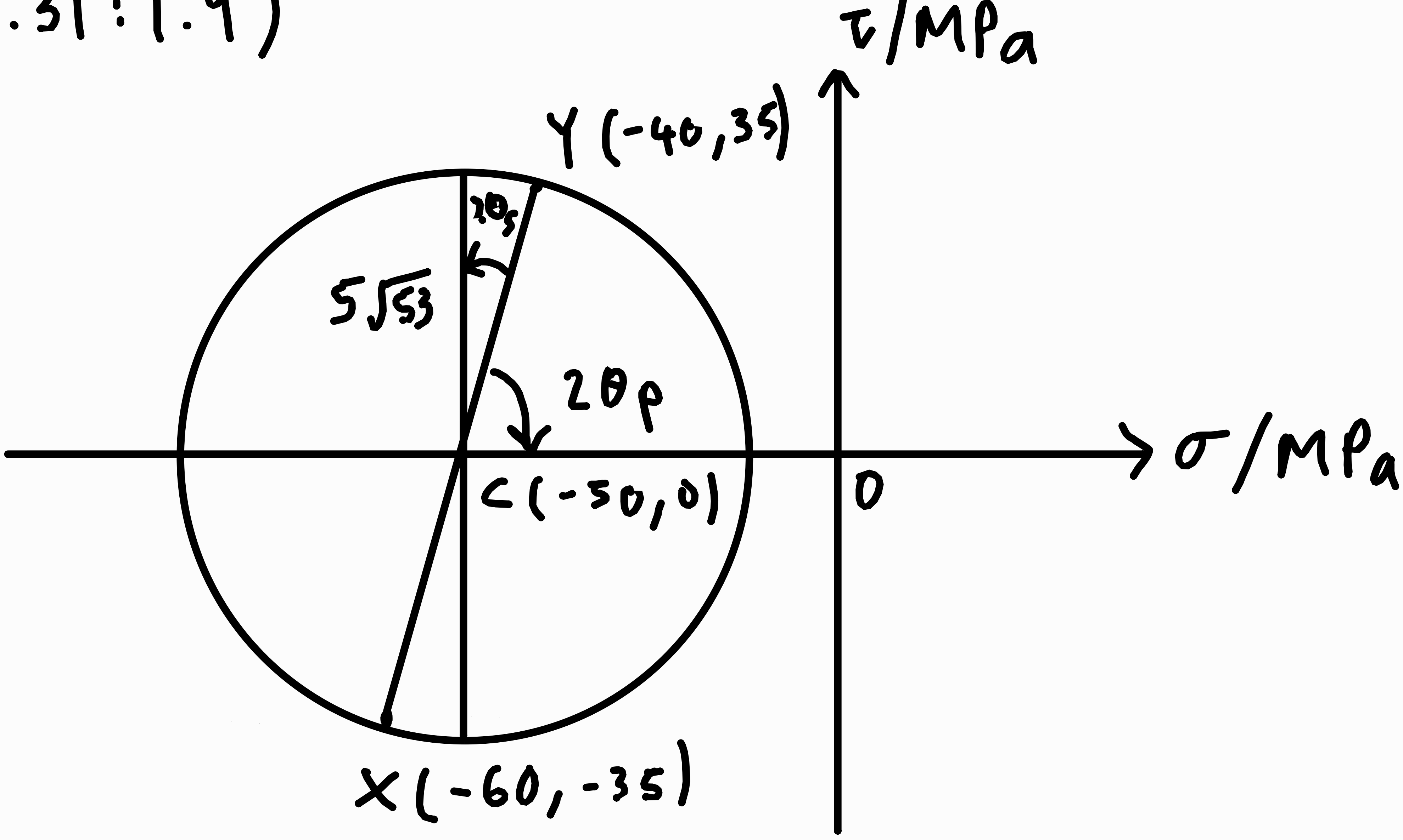
$$\approx -13.6 \text{ MPa}$$

$$\sigma_{min} = -50 - 5\sqrt{53}$$

$$= -86.40054945$$

$$\approx -86.4 \text{ MPa}$$

7.31 : 7.9)



$$2\theta_s = \tan^{-1}\left(\frac{10}{5\sqrt{53}}\right)$$

$$\theta_s = 7.680697695°, 97.68069769°$$

$$\approx 8°, 98°$$

$$\tau_{max} = 5\sqrt{53}\ MPa$$

$$= 36.40054945\ MPa$$

$$\approx 36.4\ MPa$$

$$\sigma' = -50\ MPa$$

7.85) $\tau_{max} < \frac{\sigma_Y}{2}$

$$\tau = \frac{Tc}{J}$$

$$= \frac{1500 \times 22 \times 10^{-3}}{\frac{1}{2}\pi(22 \times 10^{-3})^4}$$

$$= 89681598.29 Pa$$

$$\approx 89.68159829 MPa$$

From Mohr's circle, no τ_{max} (out-of-plane)

$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\frac{\sigma_Y}{2} = \sqrt{\frac{\sigma_x^2}{4} + \tau_{xy}^2}$$

$$\frac{250}{2} = \sqrt{\frac{\sigma_x^2}{4} + 89.68159829^2}$$

$$15625 = \frac{\sigma_x^2}{4} + 8042.789071$$

$$\sigma_x = 174.1517836 MPa$$

$$F_p = 174.1517836 \times \pi \times 22^2$$

$$= 264803.1585$$

$$\approx 264.8 kN$$

7.86) $\sigma_{max}^2 - \sigma_{max}\sigma_{min} + \sigma_{min}^2 < \sigma_Y^2$

$$\tau = \frac{Tc}{J}$$

$$= \frac{1500 \times 22 \times 10^{-3}}{\frac{1}{2}\pi(22 \times 10^{-3})^4}$$

$$= 89681598.29 Pa$$

$$\approx 89.68159829 MPa$$

$$\sigma_{max,min} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \frac{\sigma_x}{2} \pm \sqrt{\frac{\sigma_x^2}{4} + \tau_{xy}^2}$$

Let $a = \frac{\sigma_x}{2}$, $b = \sqrt{\frac{\sigma_x^2}{4} + \tau_{xy}^2}$,

$$(a+b)^2 - (a+b)(a-b) + (a-b)^2 = \sigma_Y^2$$

$$\cancel{a^2} \cancel{+2ab} + b^2 \cancel{- a^2} + b^2 + a^2 \cancel{-2ab} + b^2 = \sigma_Y^2$$

$$a^2 + 3b^2 = \sigma_Y^2$$

$$\frac{\sigma_x^2}{4} + 3\left(\frac{\sigma_x^2}{4} + \tau_{xy}^2\right) = \sigma_Y^2$$

$$\sigma_x^2 + 3(89.68159829^2) = 250^2$$

$$\therefore \sigma_x = 195.8867856 MPa$$

$$F_p = \sigma_x A = 195.8867856 \times \pi(22)^2$$

$$= 297851.8995 N$$

$$\approx 297.9 kN$$

8.44) $J = \frac{1}{2}\pi(36^4 - 31^4) \times 10^{-12}$

$= 1.18767124 9 \times 10^{-6} \, m^4$

$\tau_{twist} = \frac{Tc}{J}$

$= \frac{(9+3) \times 120 \times 36 \times 10^{-3}}{1.187671249 \times 10^{-6}}$

$= 43648442.32 \, Pa$

$= 43.64844232 \, MPa$

$\tau_{bend} = \frac{VQ}{It}$

$= \frac{(9-3) \times 10^3 \times \left(\frac{2}{3}(36^3 - 31^3)\right) \times 10^{-9}}{\frac{1}{2} \times 1.187671249 \times 10^{-6} \times 2 \times 5 \times 10^{-3}}$

$= 11360045.98 \, Pa$

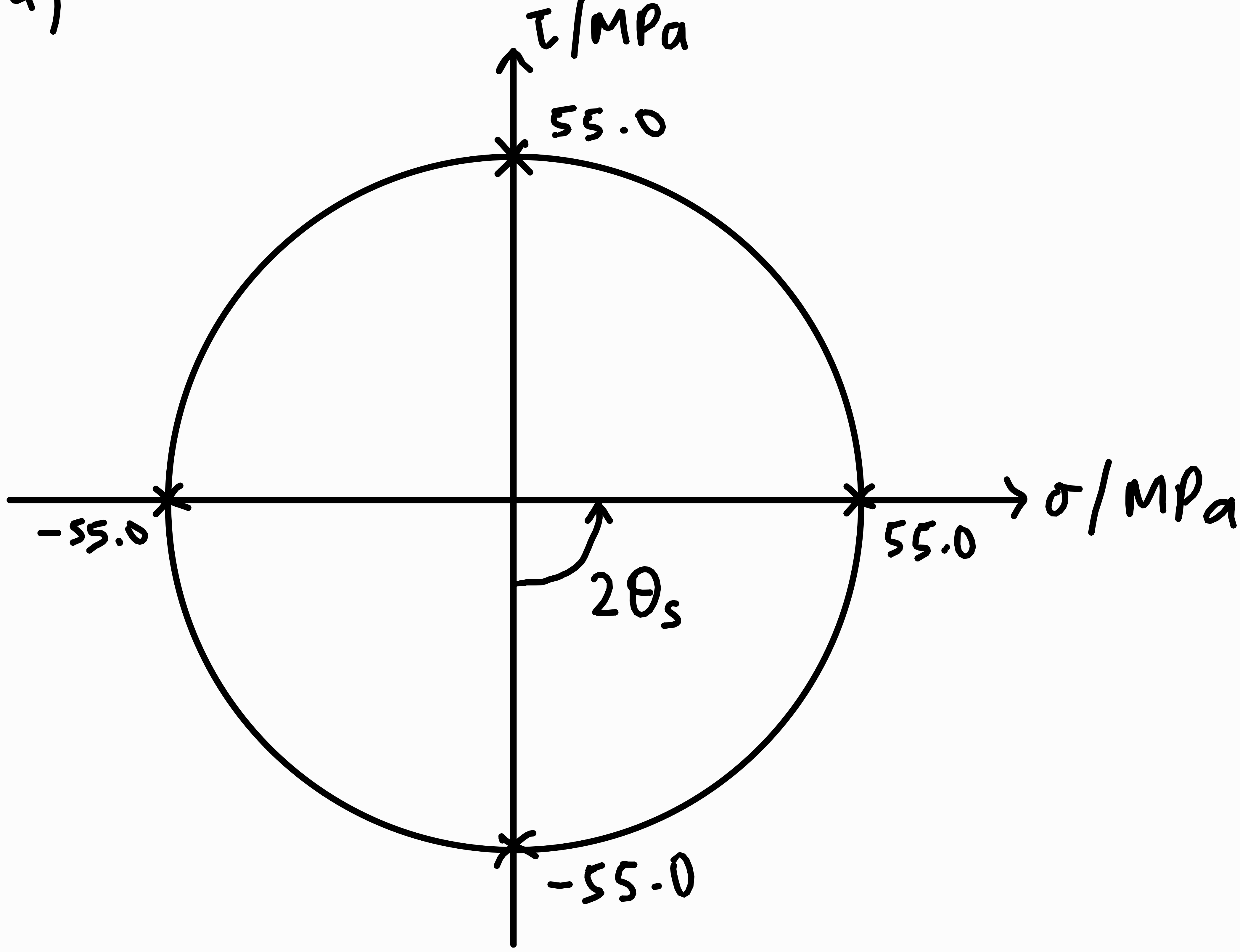
$= 11.36004598 \, MPa$

$\tau = 43.64844232 + 11.36004598$

$= 55.00848831 \, MPa$

$\approx 55.0 \, MPa$

8.44)



$\sigma_{max} = 55.0 MPa$

$\sigma_{min} = -55.0 MPa$

$2\theta_p = -90°$

$\theta_p = -45°, 45°$

$\tau_{max} = 55.0 MPa$

7.167)
$$J = \frac{1}{2}\pi\left(231^4 - 225^4\right)\times 10^{-12}$$
$$= 4.469005022\times 10^{-4}\ m^4$$

$$\tau_{twist} = \frac{Tc}{J}$$
$$= \frac{500\times 5\times 231\times 10^{-3}}{4.469005022\times 10^{-4}}$$
$$= 1292233.947\ Pa$$

$$\sigma_{bend} = \frac{My}{I}$$
$$= \frac{5\times 750\times 231\times 10^{-3}}{\frac{1}{2}\times 4.469005022\times 10^{-4}}$$
$$= 3876701.842\ Pa$$

$$\sigma_{hoop} = \frac{1.2\times 10^{6}\times 225\times 10^{-3}}{6\times 10^{-3}}$$
$$= 45\ MPa$$

$$\sigma_{long} = \frac{1}{2}\times 45$$
$$= 22.5\ MPa$$

7.167)

$$\sigma_x = \sigma_{bend} + \sigma_{long}$$

$$= 3876701.842 \times 10^{-6} + 22.5$$

$$= 26.37670184\ MPa$$

$$\sigma_y = \sigma_{hoop}$$

$$= 45\ MPa$$

$$\tau_{xy} = \tau_{twist}$$

$$= 1292233.947\ Pa$$

$$= 1.292233947\ MPa$$

$$\sigma_{max,min} = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \frac{26.37670184 + 45}{2} + \sqrt{\left(\frac{26.37670184 - 45}{2}\right)^2 + 1.292233947^2}$$

$$= 35.68835092 + 9.40088704\ MPa$$

$$= 45.08923796$$

$$\approx 45.1\ MPa$$

$$\tau_{max(in\text{-}plane)} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= 9.40088704\ MPa$$

$$\approx 9.40\ MPa$$