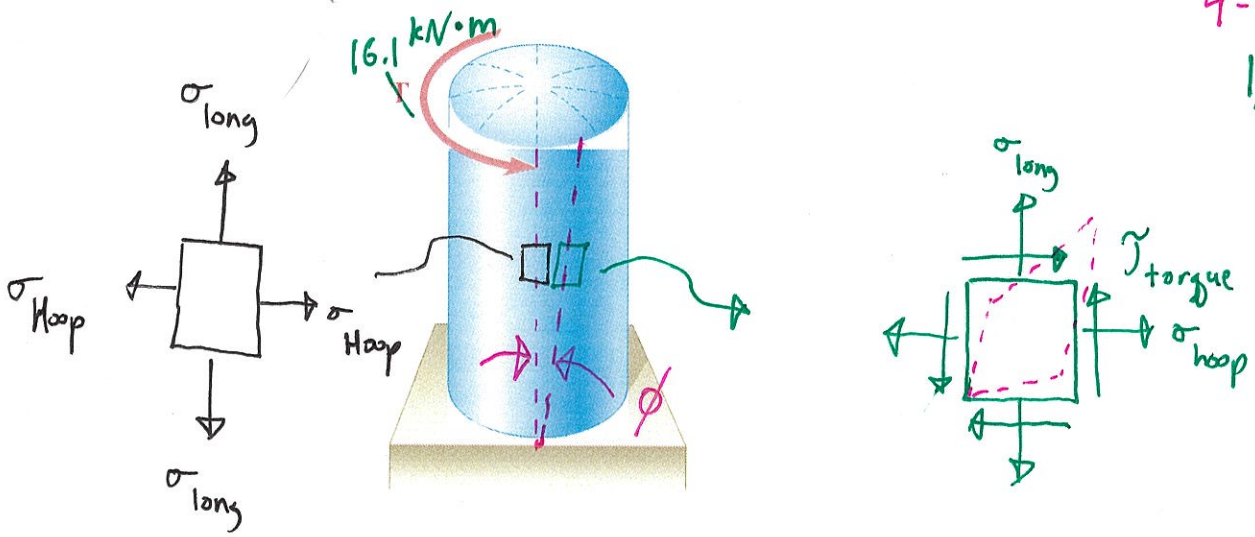
Do not round intermediate calculations. Give your final answer(s) to three significant figures.

4-8-2020
1/4



A torque of magnitude $T = 16.1$ kN · m is applied to the end of a tank containing compressed air under a pressure of 6.3 MPa. Knowing that the tank has a 212−mm inner diameter and a 15−mm wall thickness, determine the maximum normal stress and the maximal shearing stress in the tank.

σ_{max} = ____ MPa

τ_{max} = ____ MPa

$p = 6.3$ MPa

$d_i = 212^{mm} \rightarrow d_o = 212^{mm} + 2(15^{mm}) = 242^{mm}$

$t = 15^{mm}$

SHEAR

TORSION STRESS:

$$\tau = \frac{Tc}{J} = \frac{(16.1 \text{ kN·m})(121^{mm})}{13840726^{mm^4}} = 14.08 \text{ MPa}$$

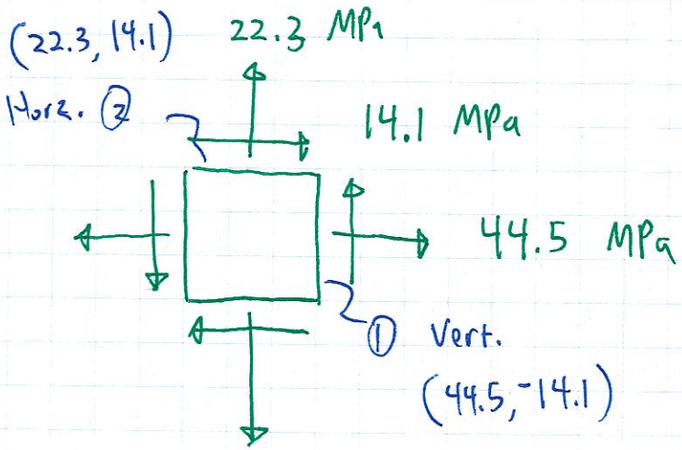
$$J = \frac{\pi}{2}\left(r_o^4 - r_i^4\right) = \frac{\pi}{2}\left((121^{mm})^4 - (106^{mm})^4\right) =$$

$$= 13840726^{mm^4}$$

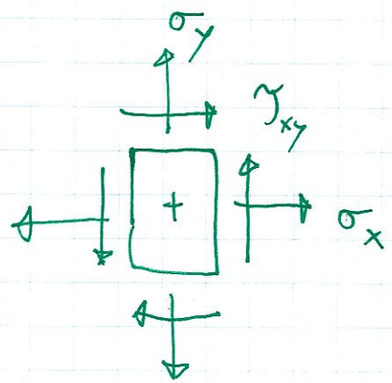
PRESSURE STRESS:

$$\sigma_{long} = \frac{pr}{2t} = \frac{(6.3 \text{ MPa})(106^{mm})}{2(15^{mm})} = 22.26 \text{ MPa}$$

$$\sigma_{hoop} = \frac{pr}{t} = \frac{(6.3 \text{ MPa})(106^{mm})}{(15^{mm})} = 44.52 \text{ MPa}$$



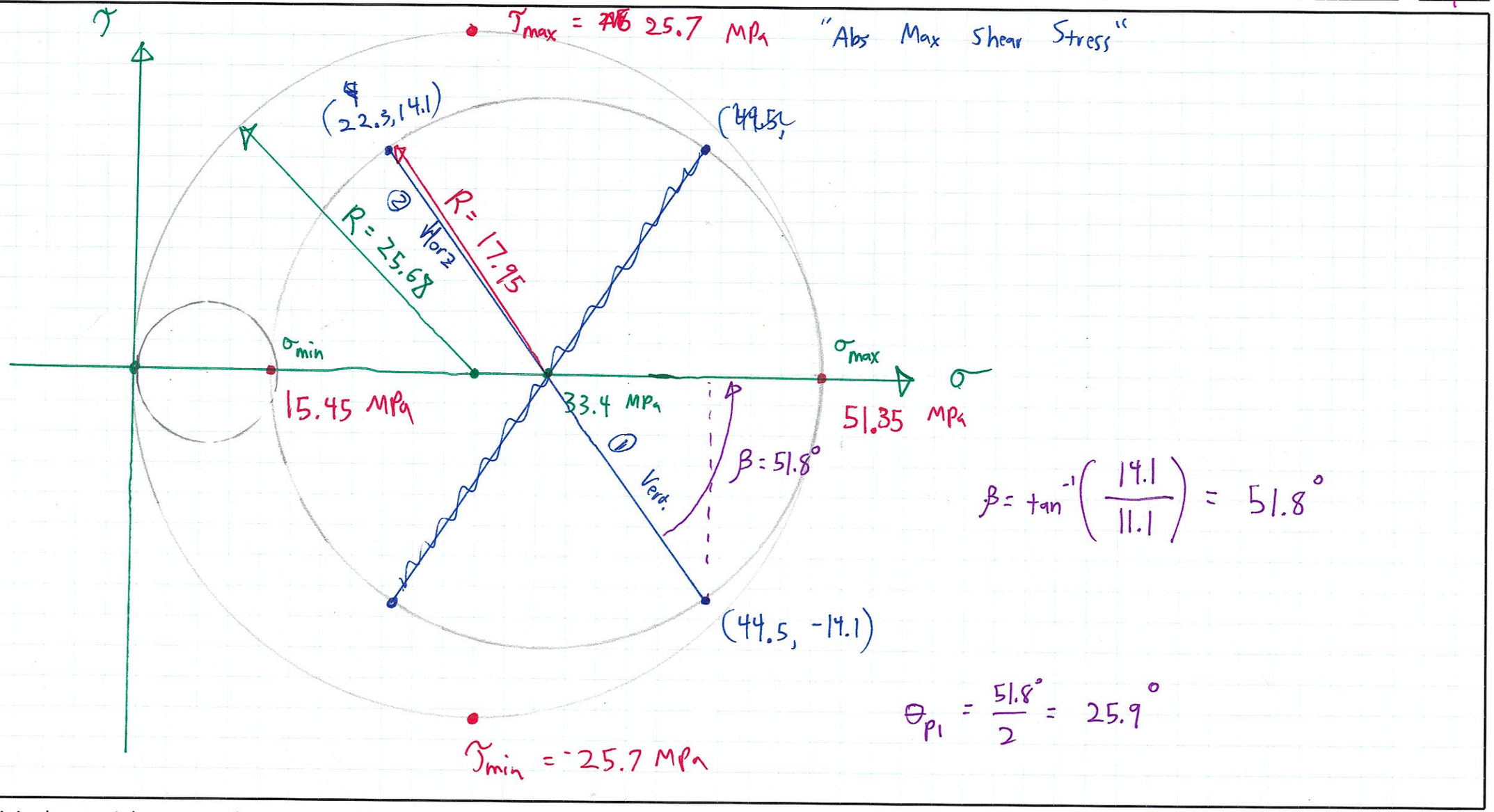
POS. SIGN CONV.



MOHR'S SIGN FOR SHEAR

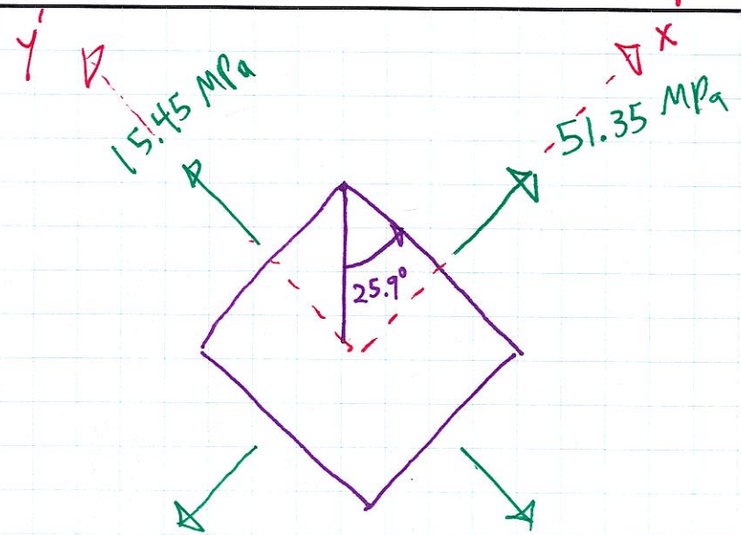
$$\sigma_{AVG,\ CENTER} = \frac{\sigma_x + \sigma_y}{2} = \frac{44.5\ MPa + 22.3\ MPa}{2} = 33.4\ MPa$$

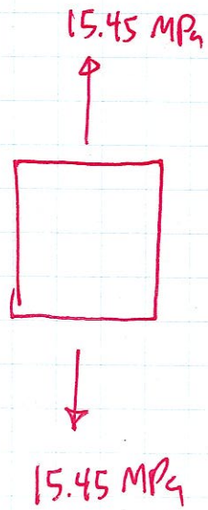
$$RAD = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left(\frac{44.5 - 22.3}{2}\right)^2 + 14.1^2} = 17.95\ MPa$$



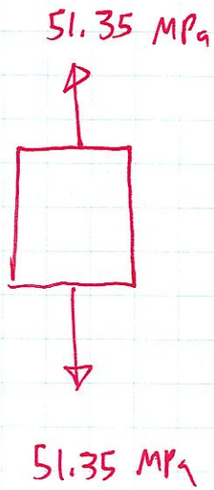
$$\beta = \tan^{-1}\left(\frac{14.1}{11.1}\right) = 51.8^\circ$$

$$\theta_{p1} = \frac{51.8^\circ}{2} = 25.9^\circ$$





"looking down x' axis"



"looking down y' axis"