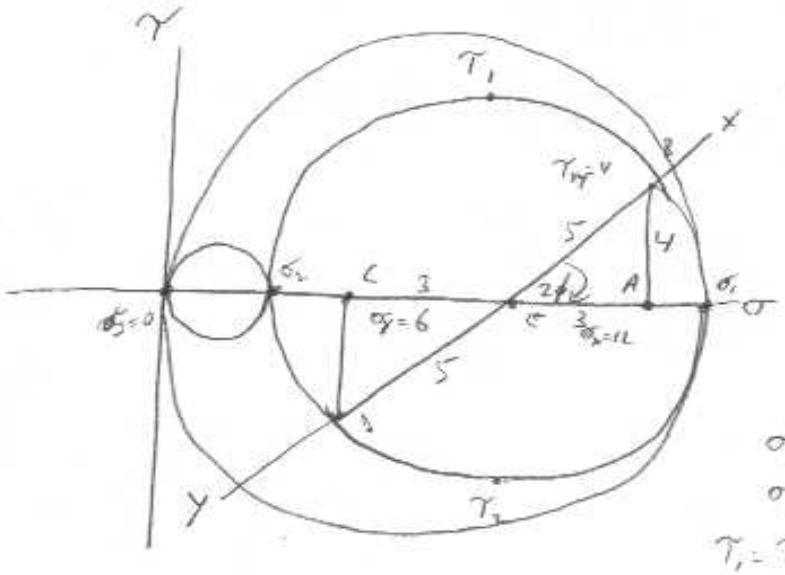
(2.1) NOTE: All unspecified stress components are equal to zero.

(a) $\sigma_x = 12 \quad \sigma_y = 6 \quad \tau_{xy} = 4$ CW



$3^2 + 4^2 = EB^2$

$5 = EB$

$\sin(2\phi) = \frac{4}{5} = 0.8$

$2\phi = 53.13°$

$\phi = 26.565°$

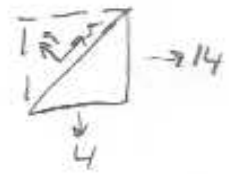
$\sigma_1 = 14$ @ $\tau = 0$

$\sigma_2 = 4$ $\qquad \sigma_3 = 0$

$\tau_1 = \tau_2 = 5$ @ $\sigma = 9$

OR $\tan(2\phi) = \frac{2\tau_{xy}}{\sigma_x - \sigma_y} = \frac{2(4)}{12-6} = 1.333$

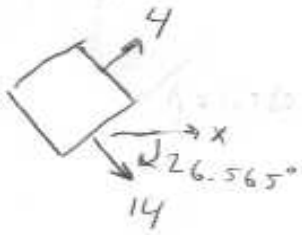
$\phi = 26.565°$



$\sigma_1, \sigma_2 = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

$= \frac{12+6}{2} \pm \sqrt{\left(\frac{12-6}{2}\right)^2 + 4^2}$

$= 9 \pm 5 = 4, 14$

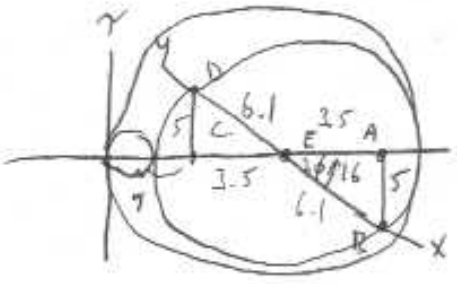


$\tau_1, \tau_2 = \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

$= \pm \sqrt{\left(\frac{12-6}{2}\right)^2 + 4^2}$

$= \pm 5$

(b) $\sigma_x = 16$ $\sigma_y = 9$ $\tau_{xy} = 5$ ccw



$EB = 6.1$ $\sigma_1 = 18.6$

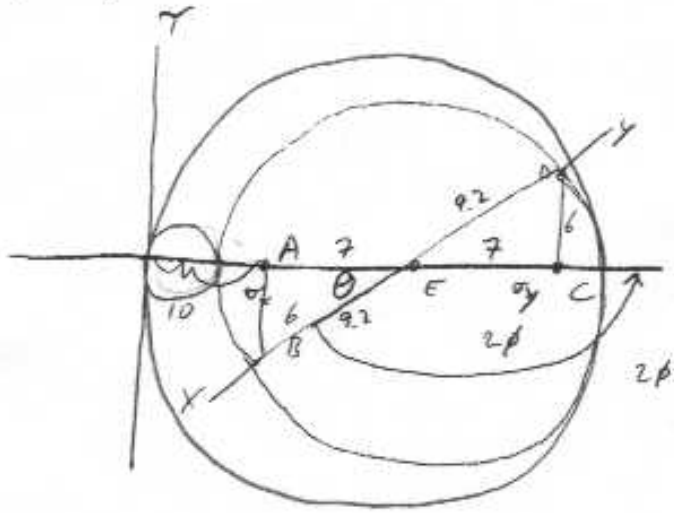
~~$2\phi = 49$~~ $\sigma_2 = 6.4$

$2\phi = 55.1°$

$\phi = 27.55°$

$\tau_1 = \tau_2 = 6.1$ @ $\sigma = 12.5$

(c) $\sigma_x = 10$ $\sigma_y = 24$ $\tau_{xy} = 6$ ccw



$ER = 9.2$

$\sigma_1 = 26.2$

$\sigma_2 = 7.8$

$\tau_1 = \tau_2 = 9.2$

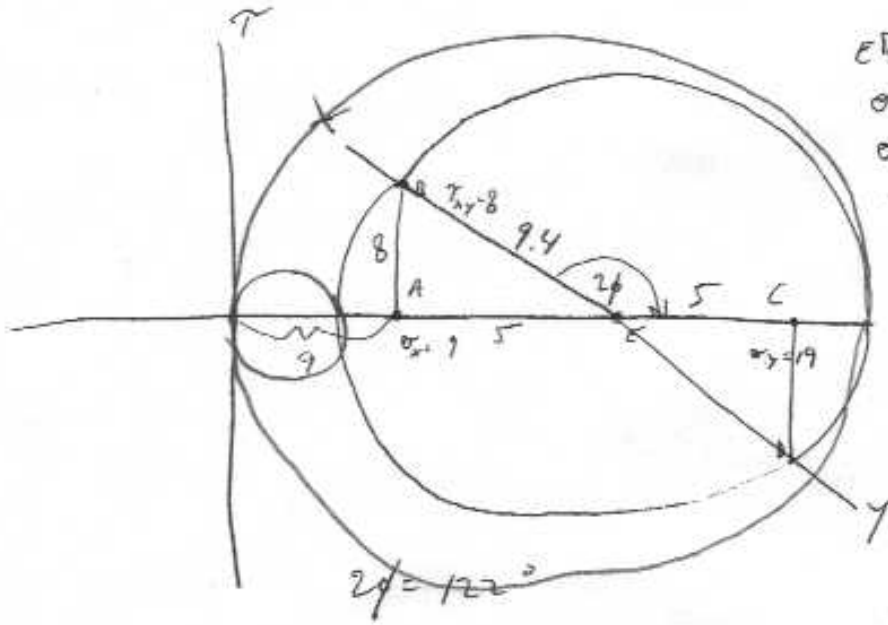
θ

$\sigma = 17$

$2\phi = 180 - \theta = 139.3$

$\phi = 69.65°$

(d) $\sigma_x = 9$ $\sigma_y = 19$ $\tau_{xy} = 8$ cw



$ER = 9.4$

$\sigma_1 = 23.4$

$\sigma_2 = 4.6$

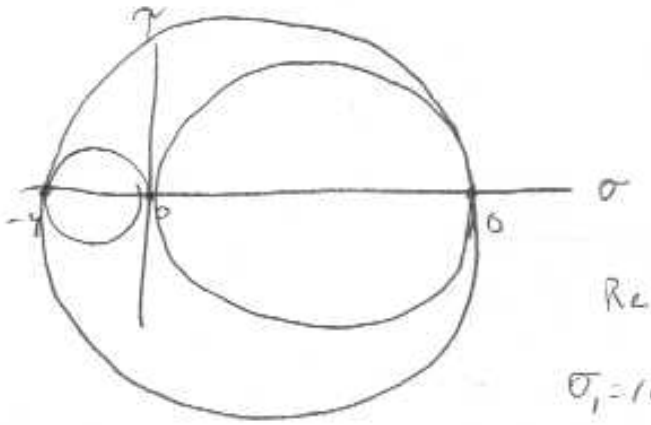
$\tau_{1,2} = 9.4$

θ

$\sigma = 14$

$2\phi = 122°$

(2.5) (a) $\sigma_x = 10$ $\sigma_y = -4$

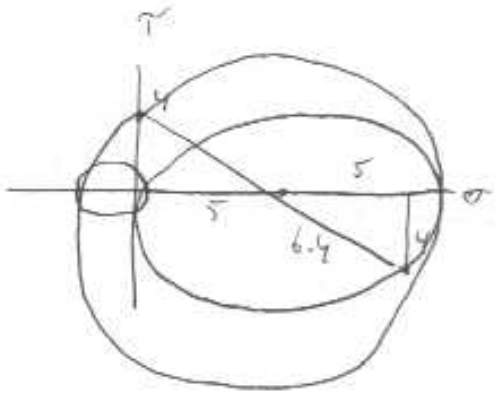


Remember $\sigma_1 > \sigma_2 > \sigma_3$

$\sigma_1 = 10$ $\sigma_2 = 0$ $\sigma_3 = -4$

$\tau_{1,2} = \frac{10-0}{2} = 5$ $\tau_{2,3} = \frac{0-(-4)}{2} = 2$ $\tau_{2,3} = \frac{10-(-4)}{2} = 7$

(b) $\sigma_x = 10$ $\tau_{xy} = 4$ ccw



$\sigma_1 = 11.4$

$\sigma_2 = 0$

$\sigma_3 = -1.4$

$\tau_{1,2} = 5.7$

$\tau_{2,3} = 0.7$

$\tau_{1,3} = 6.4$

(c) $\sigma_x = -2 \quad \sigma_y = -8 \quad \tau_{xy} = 4 \text{ cw}$

$$\tan(2\phi) = \frac{2(4)}{-2+8} = 1.333$$

$$\phi = 26.565$$

$$\sigma_1, \sigma_2 = \frac{-2-8}{2} \pm \sqrt{\left(\frac{-2+8}{2}\right)^2 + 4^2}$$

$$= -5 \pm 5$$

$$= -10, 0$$

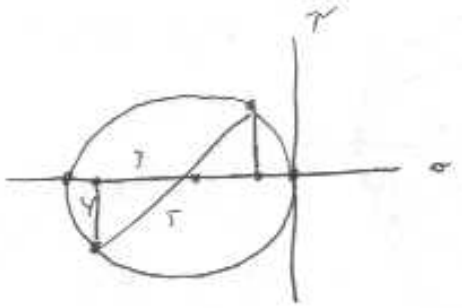
$\Rightarrow \sigma_1 = 0, \sigma_2 = 0 \quad \sigma_3 = -10$

$\tau_{1,2} = 0 \quad \tau_{2,3} = 5 \quad \tau_{1,3} = 5$

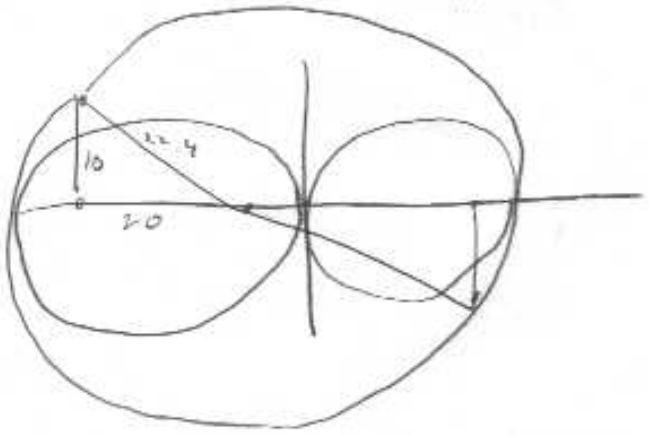
$$\tau_{1,2} = \pm \sqrt{\left(\frac{-2+8}{2}\right)^2 + 4^2}$$

$$= \pm 5$$

MOHR'S CIRCLE:



(d) $\sigma_x = 10 \quad \sigma_y = -30 \quad \tau_{xy} = 10 \text{ ccw}$



$\sigma_1 = 12.4$

$\sigma_2 = 0$

$\sigma_3 = -32.4$

$\tau_{1,2} = 6.2$

$\tau_{2,3} = 16.2$

$\tau_{1,3} = 22.4$

2.9

$d = 0.5"$

$\ell = 72"$

$F = 2000$ lb.

Tensile Stress: $\sigma = \frac{F}{A}$ $A = \pi \left(\frac{0.5}{2}\right)^2 = 0.196$

$\sigma = \frac{2000}{0.196} = \underline{10185.9 \text{ psi}}$

Total deformation: $\delta = \frac{F\ell}{AE} = \frac{2000 \cdot 72}{0.196 \cdot 27.6 \times 10^6}$

TABLE A5: 27.6 Mpsi = E $= 0.027"$

UNIT STRAINS: $\epsilon = \frac{\delta}{\ell} = \frac{0.027}{72} = 0.00037"$

CHange in rod diameter: $\nu = -\frac{\epsilon_d}{\epsilon_\ell} = 0.305$

$G = 10.6$ Mpsi

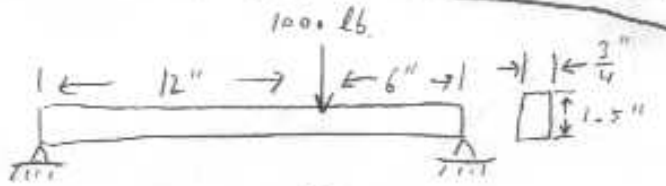
TABLE A-5

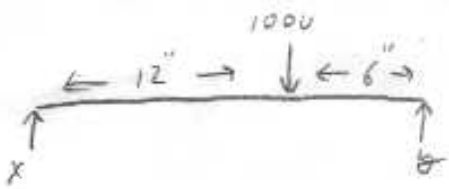
$\epsilon_d = (0.305)(-1)(0.00037)$

$= -0.00011$

$\Delta d = \epsilon_d \cdot d = -0.00011 \cdot \frac{1}{2} = \underline{-0.000055"}$

2.26a





$y \cdot 18 - 1000 \cdot 12 = 0$

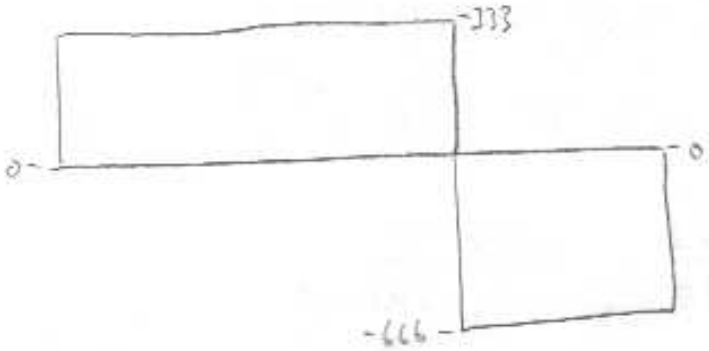
$y = 666.66$ lb.

$X + y - 1000 = 0$

$X = 333.33$ lb.

$\tau_{max} = \frac{3V}{2A} = \frac{3(666)}{2(1.5 \cdot .75)} = 888$ psi

↳ Neutral Axis on $\overline{AB}$

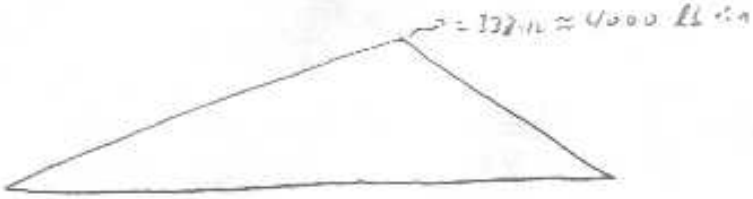


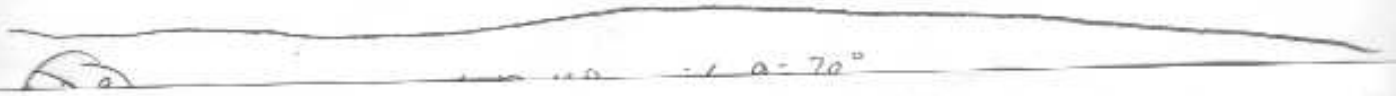
$A = 1.125$

$I = \frac{bh^3}{12} = 0.2$

$\sigma = \frac{Mc}{I} = \frac{4000(.75)}{0.2} = 15000$ psi

↳ Bottom surface at A





(2.29) $d = 15\ mm \quad \tau \le 110\ MPa \quad \theta = 30$

Find: ℓ.

$$\tau_{max} = \frac{Tr}{J} \qquad T = \frac{\tau J}{r}$$

$$\theta = \frac{T\ell}{GJ} \qquad \ell = \frac{GJ\theta}{T} = \frac{G\cancel{J}\theta r}{T\cancel{J}}$$

$$\ell = \frac{(73.1 \times 10^9\ Pa)\left(30^\circ \cdot \frac{\pi}{180}\right)\left(\frac{15}{2} \cdot 0.001\right)}{110 \times 10^6\ Pa}$$

TABLE 2-5

$$= \boxed{2.6\ m}$$