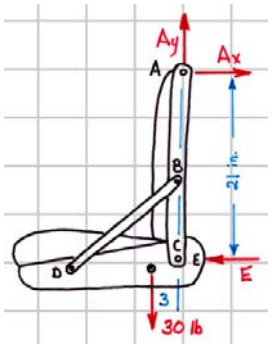
2-19*

From an overall free-body diagram of the seat, the equations of equilibrium give



$$\rightarrow \Sigma F_x = 0: \qquad A_x - E = 0$$

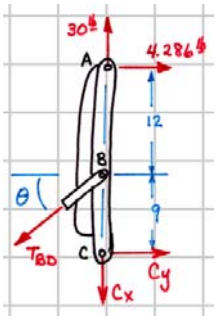
$$\uparrow \Sigma F_y = 0: \qquad A_y - 30 = 0$$

$$\circlearrowleft \Sigma M_A = 0: \qquad 3(30) - 21E = 0$$

$$E = 4.28571 \text{ lb}$$

$$A_x = 4.28571 \text{ lb} \qquad A_y = 30 \text{ lb}$$

Next, from a free-body diagram of the seat back, the equations of equilibrium give



$$\circlearrowleft \Sigma M_C = 0: \qquad 9(T_{BD}\cos\theta) - 21(4.28571) = 0$$

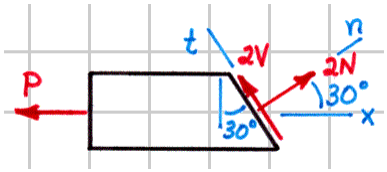
$$\theta = \tan^{-1}\frac{10}{12} = 39.806°$$

$$T_{BD} = 13.01707 \text{ lb}$$

$$\tau = \frac{V_B}{A} = \frac{13.01707}{\pi(3/8)^2/4} = 117.9 \text{ psi} \quad \text{.....Ans.}$$

2-41

There are two bolts and they each carry a normal force of N and a shear force of V. Equilibrium of the eyebar gives



$Z\ \Sigma F_n = 0:$ $\quad 2N - P\cos 30° = 0$

$\wedge\ \Sigma F_t = 0:$ $\quad 2V + P\sin 30° = 0$

$$N = \frac{P\cos 30°}{2} \le 12\left[\frac{\pi(0.5)^2}{4}\right] \text{ kip}$$

$$P \le 5.441 \text{ kip}$$

$$V = \frac{P\sin 30°}{2} \le 8\left[\frac{\pi(0.5)^2}{4}\right] \text{ kip}$$

$$P \le 6.283 \text{ kip}$$

$P_{\max} = 5.44$ kip ..... **Ans.**

2-61

The given values are

$$\sigma_x = 8 \text{ ksi} \qquad \sigma_y = 0 \text{ ksi} \qquad \theta_{aa} = 90° + \tan^{-1}\frac{3}{4} = 126.870°$$

$$\sigma_n = 8 \text{ ksi} \qquad 8 = (8)\cos^2 126.870° + (0) + 2\tau_{xy} \sin 126.870° \cos 126.870°$$

(a) $\tau_{xy} = \tau_h = \tau_v = -5.3333 \text{ ksi} \cong -5.33 \text{ ksi}$ ..... **Ans.**

$$\tau_{nt} = -(\sigma_x - \sigma_y)\sin\theta\cos\theta + \tau_{xy}(\cos^2\theta - \sin^2\theta)$$

$$= -[(8) - (0)]\sin\theta_{aa}\cos\theta_{aa} + (-5.3333)[\cos^2\theta_{aa} - \sin^2\theta_{aa}]$$

(b) $\tau_a = +5.33 \text{ ksi}$ ..... **Ans.**

2-73

The given values are

$$\sigma_x = 12 \text{ ksi} \qquad \sigma_y = -4 \text{ ksi} \qquad \tau_{xy} = -6 \text{ ksi}$$

$$\theta_p = \frac{1}{2}\tan^{-1}\frac{2\tau_{xy}}{\sigma_x - \sigma_y} = \frac{1}{2}\tan^{-1}\frac{2(-6)}{(12)-(-4)} = -18.435°, \quad 71.565°$$

When $\theta_p = -18.435°$

$$\sigma_n = \sigma_x \cos^2\theta + \sigma_y \sin^2\theta + 2\tau_{xy}\sin\theta\cos\theta$$

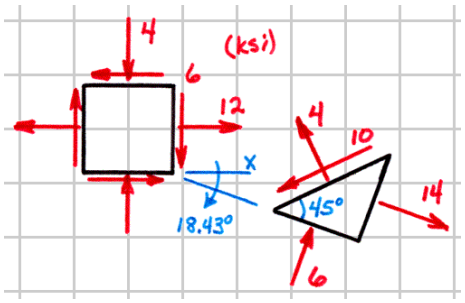
$$= (12)\cos^2\theta_p + (-4)\sin^2\theta_p + 2(-6)\sin\theta_p\cos\theta_p$$

$$= 14.000 \text{ ksi} = \sigma_{p1}$$

$$\sigma_{p2} = \sigma_x + \sigma_y - \sigma_{p1} = -6.000 \text{ ksi}$$

$$\tau_{\max} = \tau_p = (\sigma_{p1} - \sigma_{p2})/2 = 10.000 \text{ ksi}$$

$$\sigma_{n45} = (\sigma_{p1} + \sigma_{p2})/2 = 4.000 \text{ ksi}$$



(a) $\sigma_{p1} = 14.00 \text{ ksi (T)} \measuredangle 18.43°$ ..... **Ans.**

$\sigma_{p2} = 6.00 \text{ ksi (C)} \measuredangle 71.57°$ ..... **Ans.**

$\tau_{\max} = \tau_p = 10.00 \text{ ksi}$ ..... **Ans.**

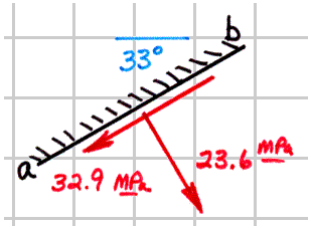
2-80

(a) The given values are

$$\sigma_x = -27 \text{ MPa} \qquad \sigma_y = 45 \text{ MPa} \qquad \tau_{xy} = 0 \text{ MPa} \qquad \theta_{ab} = -57°$$

$$\sigma_n = (-27)\cos^2(-57°) + (45)\sin^2(-57°) + (0)$$

$\sigma_{ab} = 23.6 \text{ MPa(T)}$ ..... **Ans.**



$$\tau_{nt} = -\left[(-27) - (45)\right]\sin(-57°)\cos(-57°) + (0)$$

$\tau_{ab} = -32.9 \text{ MPa}$ ..... **Ans.**

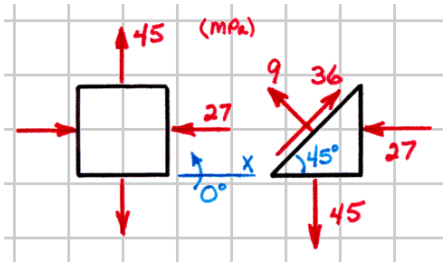
(b) Since there are no shear stresses on the horizontal and vertical surfaces, they are principal surfaces and the stresses on them are principal stresses.

$$\sigma_{p1} = \sigma_y = 45 \text{ MPa}$$

$$\sigma_{p2} = \sigma_x = -27 \text{ MPa}$$

$$\tau_{\max} = \tau_p = \left(\sigma_{p1} - \sigma_{p2}\right)/2 = 36.00 \text{ MPa}$$

$$\sigma_{n45} = \left(\sigma_{p1} + \sigma_{p2}\right)/2 = 9.00 \text{ MPa}$$



$\sigma_{p1} = 45.0 \text{ MPa (T)} \uparrow$ ..... **Ans.**

$\sigma_{p2} = 27.0 \text{ MPa (C)} \rightarrow$ ..... **Ans.**

$\tau_{\max} = \tau_p = 36.0 \text{ MPa}$ ..... **Ans.**

(若題目有要求要畫圖請同學一定要畫，請勿只用正負角度對應，
請至少畫出三角形上的角度、應力方向與大小，如上圖示。考試時將會嚴格扣分)

2-93

The given values for use in drawing Mohr's circle are

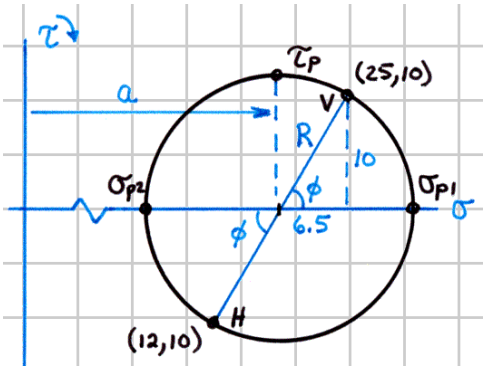
$$\sigma_x = 25 \text{ ksi}$$

$$\sigma_y = 12 \text{ ksi}$$

$$\tau_{xy} = -10 \text{ ksi}$$

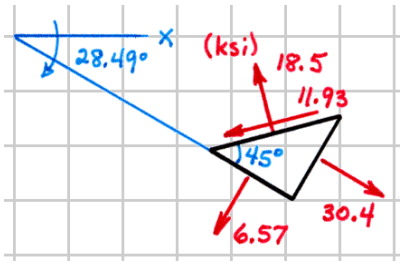
$$\sigma_z = \sigma_{p3} = 0 \text{ ksi}$$

$$a = \frac{25+12}{2} = 18.50 \text{ ksi}$$



$$R = \sqrt{6.5^2 + 10^2} = 11.927 \text{ ksi}$$

$$\theta_{p1} = \frac{\phi}{2} = \frac{1}{2}\tan^{-1}\frac{10}{6.5} = 28.488° \text{ (CW)}$$



$\sigma_{p1} = 18.5 + 11.9 = 30.4$ ksi (T) ∠ 28.49° ..... **Ans.**

$\sigma_{p2} = 18.50 - 11.93 = 6.57$ ksi (T) ∠ 61.51° ..... **Ans.**

$\tau_p = R = 11.93$ ksi ..... **Ans.**

$\tau_{\max} = (\sigma_{\max} - \sigma_{\min})/2 = (30.427 - 0)/2 \cong 15.21$ ksi (out of plane) ..... **Ans.**

(同2-80，請注意 τ max不一定等於 τ p)

(題目限制用Mohr's circle解題，請務必將Mohr's circle畫出)

2-95

The given values for use in drawing Mohr's circle are

$$\sigma_x = 8 \text{ ksi}$$

$$\sigma_y = 0 \text{ ksi}$$

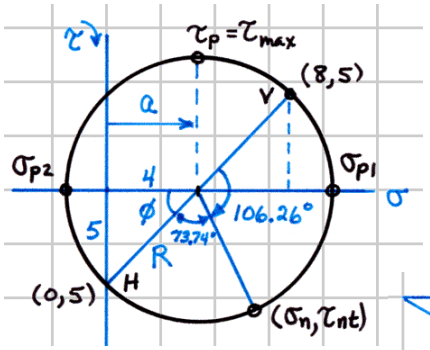
$$\tau_{xy} = -5 \text{ ksi}$$

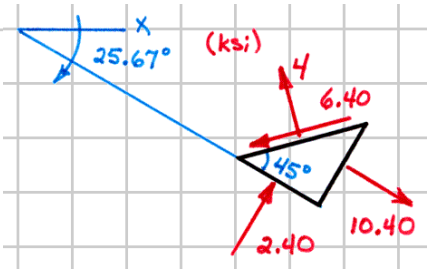
$$\sigma_z = \sigma_{p3} = 0 \text{ ksi}$$

$$a = \frac{8+0}{2} = 4.00 \text{ ksi}$$

$$R = \sqrt{4^2 + 5^2} = 6.403 \text{ ksi}$$

$$\theta_{p1} = \frac{\phi}{2} = \frac{1}{2}\tan^{-1}\frac{5}{4} = 25.670° \text{ (CW)}$$





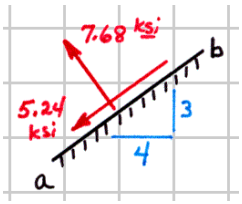
(a) $\sigma_{p1} = 4.00 + 6.40 = 10.40 \text{ ksi (T)} \measuredangle 25.67°$ .....**Ans.**

$\sigma_{p2} = 4.00 - 6.40 = -2.40 \text{ ksi} = 2.40 \text{ ksi (C)} \measuredangle 64.33°$ .....**Ans.**

$\tau_{\max} = \tau_p = R = 6.40 \text{ ksi}$ .....**Ans.**

(b) $\sigma_{ab} = 4.00 + 6.403\cos 54.920° = 7.68 \text{ ksi (T)}$ .....**Ans.**

$\tau_{ab} = 6.403\sin 54.920° = 5.24 \text{ ksi (CCW)} = +5.24 \text{ ksi}$ .....**Ans.**



(同2-80，請注意 τ max不一定等於 τ p)

(題目限制用Mohr's circle解題，請務必將Mohr's circle畫出)

2-119*

The given values for use in drawing Mohr's circle are

$$\sigma_x = 13 \text{ ksi}$$

$$\sigma_y = 7 \text{ ksi}$$

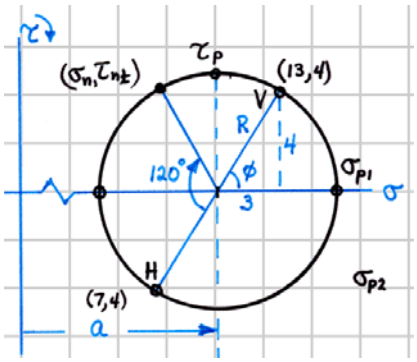
$$\tau_{xy} = -4 \text{ ksi}$$

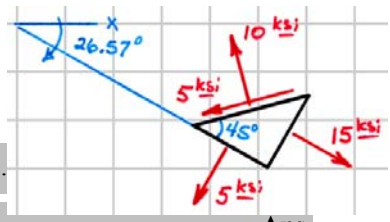
$$\sigma_z = \sigma_{p3} = 0 \text{ ksi}$$

$$a = \frac{13+7}{2} = 10.00 \text{ ksi}$$

$$R = \sqrt{3^2 + 4^2} = 5.00 \text{ ksi}$$

$$\theta_{p1} = \frac{\phi}{2} = \frac{1}{2}\tan^{-1}\frac{4}{3} = 26.57° \text{ (CW)}$$



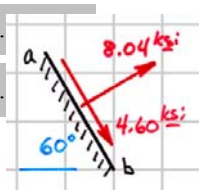


(a) $\sigma_{p1} = 10.00 + 5.00 = 15.00 \text{ ksi (T)} \measuredangle 26.57°$

$\sigma_{p2} = 10.00 - 5.00 = 5.0 \text{ ksi (T)} \measuredangle 63.43°$ **Ans.**

$\tau_p = R = 5 \text{ ksi}$

$\tau_{\max} = (\sigma_{\max} - \sigma_{\min})/2 = (15-0)/2 = 7.50 \text{ ksi (out of plane)}$



(b) $\sigma_{ab} = 10 - 5.00\cos 66.870° = 8.04 \text{ ksi} = 8.04 \text{ ksi (T)}$ **Ans.**

$\tau_{ab} = 5.00\sin 66.870° = 4.60 \text{ ksi (CW)} = -4.60 \text{ ksi}$ **Ans.**

(同2-80，請注意 τ max不一定等於 τ p)

(題目限制用Mohr's circle解題，請務必將Mohr's circle畫出)