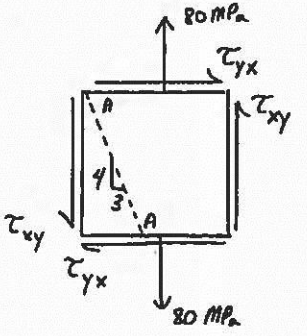
Worksheet: The stresses on the horizontal and vertical planes at a point are shown in the figure to the right. The normal stress on a plane A-A at this point is found to be 80 MPa in tension.

Find:

a) The magnitude and direction of the shear stresses, $\tau_{xy} = \tau_{yx}$

b) The magnitude and direction of the shear stress on the inclined plane A-A



FOR THIS EXAMPLE, $\sigma_x = 0$

$\sigma_y = 80$ MPa

$\sigma_n = 80$ MPa

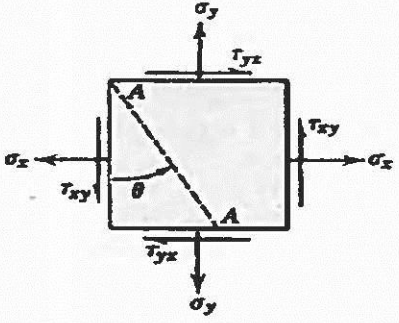
$\theta = \tan^{-1}\left(\frac{3}{4}\right) = 36.87^\circ$

a)

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

$$80 = \left(\frac{0+80}{2}\right) + \left(\frac{0-80}{2}\right)\cos[2(36.87^\circ)] + \tau_{xy}\sin[2(36.87^\circ)]$$

$\tau_{xy} = 53.3$ MPa in the positive directions shown ANS.



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

$$\tau_{nt} = -\left(\frac{0-80}{2}\right)\sin[2(36.87^\circ)] + 53.3\cos[2(36.87^\circ)]$$

$\tau_{nt} = 53.3$ MPa in the positive direction as shown ANS