9–62. Determine (a) the principal stress and (b) the maximum in-plane shear stress and average normal stress. Specify the orientation of the element in each case.

**Construction of the Circle:** In accordance with the sign convention, \( \sigma_x = 8 \text{ ksi} \), \( \sigma_y = 4 \text{ ksi} \), and \( \tau_{xy} = 6 \text{ ksi} \) Hence,

\[
\sigma_{max} = \frac{\sigma_x + \sigma_y}{2} = \frac{8 + 4}{2} = 6.00 \text{ ksi} \quad \text{Ans}
\]

The coordinates for reference point A and C are

\[
A(8, 6) \quad C(6.00, 0)
\]

The radius of the circle is

\[
R = \sqrt{(8 - 6.00)^2 + 6^2} = 6.325 \text{ ksi}
\]

a)  
**In-Plane Principal Stresses:** The coordinates of points B and D represent \( \sigma_1 \) and \( \sigma_2 \) respectively.

\[
\sigma_1 = 6.00 + 6.325 = 12.3 \text{ ksi} \quad \text{Ans}
\]

\[
\sigma_2 = 6.00 - 6.325 = -0.325 \text{ ksi} \quad \text{Ans}
\]

**Orientation of Principal Plane:** From the circle

\[
\tan 2\theta_1 = \frac{6}{8 - 6.00} = 3.00
\]

\[
\theta_1 = 35.8^\circ \quad \text{(Counterclockwise)} \quad \text{Ans}
\]

b)  
**Maximum In-Plane Shear Stress:** Represented by the coordinates of point E on the circle.

\[
\tau_{max} = R = 6.32 \text{ ksi} \quad \text{Ans}
\]

**Orientation of the Plane for Maximum In-Plane Shear Stress:** From the circle

\[
\tan 2\theta_2 = \frac{8 - 6.00}{6} = 0.3333
\]

\[
\theta_2 = 9.22^\circ \quad \text{(Clockwise)} \quad \text{Ans}
\]