41.58. **Identify and Set Up:** \( L_x^2 + L_y^2 + L_z^2 = L^2 \). \( L^2 = l(l+1)\hbar^2 \). \( L_z = m_l\hbar \).

**Execute:**
(a) \( L_x^2 + L_y^2 = L^2 - L_z^2 = l(l+1)\hbar^2 - m_l^2\hbar^2 \) so \( \sqrt{L_x^2 + L_y^2} = \sqrt{l(l+1) - m_l^2} \).

(b) This is the magnitude of the component of angular momentum perpendicular to the z-axis.

(c) The maximum value is \( \sqrt{l(l+1)\hbar} = L \), when \( m_l = 0 \). That is, if the electron is known to have no z-component of angular momentum, the angular momentum must be perpendicular to the z-axis. The minimum is \( \sqrt{l\hbar} \) when \( m_l = \pm l \).

**Evaluate:** For \( l \neq 0 \) the minimum value of \( L_x^2 + L_y^2 \) is not zero. The angular momentum vector cannot be totally aligned along the z-axis. For \( l \neq 0 \), \( \vec{L} \) must always have a component perpendicular to the z-axis.