1.19 A half-wave plate has a phase retardation of $\Gamma = \pi$. Assume that the plate is oriented so that the azimuth angle (i.e., the angle between the x axis and the slow axis of the plate) is ψ.

(a) Find the polarization state of the transmitted beam, assuming that the incident beam is linearly polarized in the y direction.

(b) Show that a half-wave plate will convert right-handed circularly polarized light into left-handed circularly polarized light, and vice versa, regardless of the azimuth angle of the plate.

(c) E7 is a nematic liquid crystal with $n_o = 1.52$ and $n_e = 1.75$ at $\lambda = 577$ nm. Find the half-wave plate thickness at this wavelength, assuming the plate is made in such a way that the surfaces are parallel to the directors (i.e., a-plate).