1. Randomly polarized light is incident on 3 linear polarizers whose transmission axes make angles of 0°, 20°, and 50° with the vertical respectively. What fraction (or per cent) of the incident irradiance is transmitted through the final polarizer?

2. (a1) A laser beam shines from glass \((n = 1.50)\) into water \((n = 1.33)\). Sketch the light ray incident on the interface, showing the parallel and perpendicular polarizations \([TE \text{ and } TM]\) (using appropriate symbols). Show also the transmitted and reflected ray with their polarizations. Assume that the incident angle is the polarizing angle.
(a2) At what incident angle is the reflected light completely polarized?
(b1) If the same laser is incident from the water into the glass, what will change about your diagram in (a)?
(b2) Calculate the polarizing angle in this case.

3. (a) How thick should a quarter-wave plate made from MgF2 \([n_\perp = 1.3836, n_r = 1.3957]\) be for light of wavelength 405 nm be? Show calculation.
(b) How thick should a half-wave plate made from calcite \([n_\perp = 1.6557, n_r = 1.4852]\) be for light of wavelength 633 nm be? Show calculation.

4. P&P, Ch. 15 #4

5. Briefly explain how to make a circular polarizer from a piece of polaroid material and a waveplate. Be specific about angles and type of wave-plate. Should the incoming light hit the polaroid first or the wave plate first?

6. 3 polarizers are set up as follows:
• polaroid 1 has its transmission axis horizontal
• polaroid 2 is rotating at a constant frequency of 0.5 Hz; at \(t = 0\), its axis is horizontal
• polaroid 3 has its transmission axis vertical.
Sketch the intensity (= irradiance) of light transmitted by these polarizers as a function of time from \(t = 0\) to \(t = 2\) sec.

7. You are given 2 cases of 2 waves that superpose (i.e., are at the same place at the same time).
For Case A:
\[E_1 = E_{01} \sin (kz - \omega t)\]  
this electric vector points in the +x direction
\[E_2 = E_{01} \sin (kz - \omega t + \pi/2)\]  
this electric vector points in the +x direction
(a1) What direction is the resultant wave \([E_1 + E_2]\) traveling in?
(a2) Is this resultant wave linearly polarized? If so, in what direction?
(a3) What is the amplitude of the resultant wave?

For Case B:
\[E_1 = E_{01} \sin (kz - \omega t)\]  
this electric vector points in the +x direction
\[E_2 = E_{01} \sin (kz - \omega t + \pi/2)\]  
this electric vector points in the +y direction
(b1) What direction is the resultant wave \([E_1 + E_2]\) traveling in?
(b2) Is this resultant wave linearly polarized? If so, in what direction?
(b3) What is the amplitude of the resultant wave?
(c) Compare and contrast the Case A and Case B resultant waves: what is similar about them? what is different?