1. (Prob. 8.35) In general $\lambda = \lambda_0/n$. In this problem their are two different values of $n$, one for ordinary and the other for extraordinary waves. For quartz, from Table 8.1 on p. 341, these are 1.5443 and 1.5533, respectively, so that $\lambda_o = \lambda_0/n_o = 589.3nm/1.5443 = 381.6nm$ and $\lambda_e = \lambda_0/n_e = 589.3nm/1.5533 = 379.4nm$. In both cases the frequencies are the same as the vacuum frequencies $\nu = \nu_0 = c/\lambda_0 = 3 \times 10^8 m/s/589.3 \times 10^{-9} m = 5.091 \times 10^{14} Hz$.

For calcite the two frequencies are the same: the only changes are the two indices of refraction, giving $\nu_o = 589.3nm = 1.6584 = 355.3nm$ and $\nu_e = 589.3nm/1.4864 = 396.5nm$.

2. (Prob. 8.41) This problem is based upon the fact that if linearly polarized light is incident on a half-wave plate with the polarization at angle $\theta$ to the fast axis then the transmitted light will have the same intensity but with its polarization rotated by $2\theta$, now making an angle $\theta$ with the fast axis, but on the other side (see Fig. 8.38). Here we want the 10 half-wave plates to rotate the polarization by a total of 90°, so $2\theta = 90^\circ/10 = 9^\circ$, so at each stage the polarization must be at 4.5° to the fast axis of the next half-wave plate. This can be accomplished if the fast axis of the first plate is at 4.5° to the vertical, with each successive plate rotated by 9° relative to the previous, with the last (10th) plate at 4.5° above the horizontal. In detail, the orientations of the optic axes of the ten half-wave plates relative to the vertical in degrees are: 4.5, 13.5, 22.5, 31.5, 40.5, 49.5, 58.5, 67.5, 76.5, and 85.5 = 90-4.5, while the directions of the linear polarizations are 0, 9, 18, 27, 36, 45, 54, 63, 72, 80, and 90. Assuming the incident light is natural with intensity I, after passing through the first polarizer it will be polarized in the vertical direction with intensity I/2. Each half-wave plate will rotate the polarization by 9° but keep the intensity unchanged. After the last plate, therefore, the light will be polarized horizontally but still have the intensity I/2. It will therefore pass through the 2nd polarizer unchanged: still horizontally polarized and with intensity one-half the incident intensity. (The stack of half-wave plates has properties similar to those of a twisted liquid crystal used in liquid crystal displays, as described in Sec. 8.12)

3. (Prob. 8.48) Because the rotary power of a solution is proportional to the concentration, and $10g/1000cm^3 = 0.01g/cm^3$, the rotary power of the solution is $0.01 \times 66.45^\circ/10cm = 0.06645^\circ/cm$. After travelling 1m through this solution the polarization will be rotated by $0.06645^\circ/cm \times 100cm = 6.645^\circ$ from the
initial vertical polarization direction.

4. (Prob. 8.50) From Eqns. 8.32 and 8.40, and using the fact that the electric field between the plates is just the potential difference divided by the plate separation,

\[ \Delta \phi = (2\pi/\lambda_0)\ell \Delta n = 2\pi \ell KE^2 = 2\pi \ell K(V/d)^2. \]

5. (Prob. 8.72 ) This problem can be simplified by noting that, from the fact that \( \cos 30^\circ = \sqrt{3}/2 \) and the half-angle formulas, \((\sqrt{3} + 1)/(2\sqrt{2}) = \cos 15^\circ \) and \((\sqrt{3} - 1)/(2\sqrt{2}) = \sin 15^\circ \). (These expressions can be checked numerically using a calculator.) The given Jones matrix is just

\[ \mathbf{A} = \begin{pmatrix} \cos 15^\circ & \sin 15^\circ \\ -\sin 15^\circ & \cos 15^\circ \end{pmatrix}. \]

This is just the matrix for a rotation by 15°. (You might find it interesting to show that the square of \( \mathbf{A} \) is the Jones matrix for a 30° rotation.) As a check one can apply it to polarizations in the x (horizontal) and y (vertical) directions, which, according to Eqn. 8.56 are described by a Jones vectors \( \mathbf{E}_h \) and \( \mathbf{E}_v \) with 1’s in the upper and lower positions, respectively. Applying \( \mathbf{A} \) to \( \mathbf{E}_h \) gives

\[ \begin{pmatrix} \cos 15^\circ & \sin 15^\circ \\ -\sin 15^\circ & \cos 15^\circ \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} \cos 15^\circ \\ -\sin 15^\circ \end{pmatrix}, \]

which is the Jones vector for linear polarization 15° below the horizontal. Applying \( \mathbf{A} \) to \( \mathbf{E}_v \) gives

\[ \begin{pmatrix} \cos 15^\circ & \sin 15^\circ \\ -\sin 15^\circ & \cos 15^\circ \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} \sin 15^\circ \\ \cos 15^\circ \end{pmatrix}, \]

which is the Jones vector for linear polarization at 15° to the right of the vertical direction. In other words, in both cases the given Jones matrix rotates the polarization by 15° in the clockwise direction. The matrix \( \mathbf{A} \) could represent a slab of optically active material of thickness such that the rotation angle \( \beta \) in Eqn. 8.38 is \( \pi/12 = 15^\circ \).