Hints for Homework (tutorial) 8

Exercise I:

1. Recall: what is the name of the optical phenomenon present in sugars? Is it reciprocal? What does reciprocal mean in this context?
2. Recall: what is the name of the optical phenomenon in this case? Is it reciprocal? What does reciprocal mean in this context? What is the relation between the rotation angle and the magnetic field?
3. Note that V<0. What is the convention for the rotation direction? As a result, in which direction will the rotation be? Align the second polarizer to be parallel to the rotated light.
4. Does a "round trip" lead to a rotation of 2β or of zero for the Faraday effect?

Answers: 1. Optical activity is reciprocal, i.e., the rotation angle (measured with respect to fixed axes) changes with the propagation direction.

2. The Faraday effect is non-reciprocal, i.e. the rotation angle (measured with respect to fixed axes) does not change with the propagation direction. $\beta = VB_0 d$; B_0~1.047T. 3. For V<0 the rotation direction will be in the clockwise direction with the magnetic field pointing towards you. P' should be oriented at -45° with respect to P. 4. 2β=-90°. Light will be blocked!

Exercise II:

1. What is the expression for the rotation angle in terms of n_R and n_L ? What is the expression for ρ?
2. What thickness gives the right rotation angle? $\alpha = \rho d$
3. What is Biot's law? Find an expression for the constant C using the answer for ρ in II.1 and the value for the wavelength given in the problem set. Find the rotation angle as a function of wavelength. Use this to find an expression for the intensity.
4. What will happen when the cosine of the answer to II.3 is equal to zero? Find the corresponding wavelength.

Answers: 1. $\alpha = \frac{\pi}{\lambda}\ n_R - n_L\ \ d$ >0 =>levorotatory; $\rho = \pm\frac{\pi}{\lambda}\ n_R - n_L$ (sign convention not consistent); ρ =+/- 2047°/m; 2. d~2.2 mm; 3. Biot's law: $\rho = \frac{C}{\lambda^2}$; $C = \rho_0 \lambda_0^2$; $\alpha\ \lambda\ = \rho_0 d_0 \left(\frac{\lambda_0^2}{\lambda^2}\right)$; $I = I_0 \cos^2\left(\frac{\pi}{4}\left(1 - \frac{\lambda_0^2}{\lambda^2}\right)\right)$; 4. The spectrum will be discontinuous since there will be no transmission for $\cos^2\left(\frac{\pi}{4}\left(1 - \frac{\lambda_0^2}{\lambda^2}\right)\right) = 0$; i.e., for $\lambda = \frac{\lambda_0}{\sqrt{3+4m}}$, $m \in \mathbb{N}$; λ~365 nm wavelength closest to λ_0.