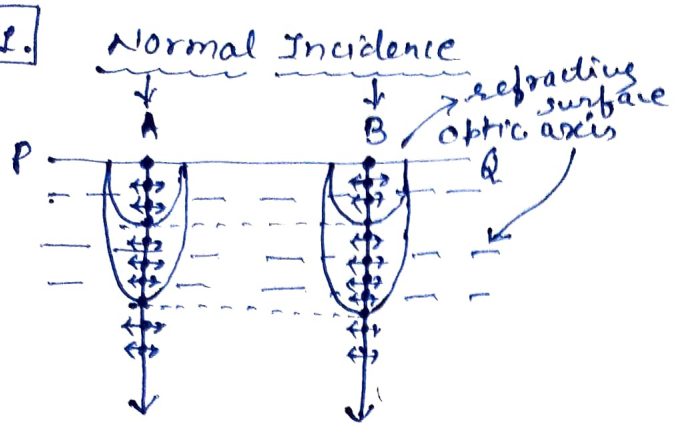
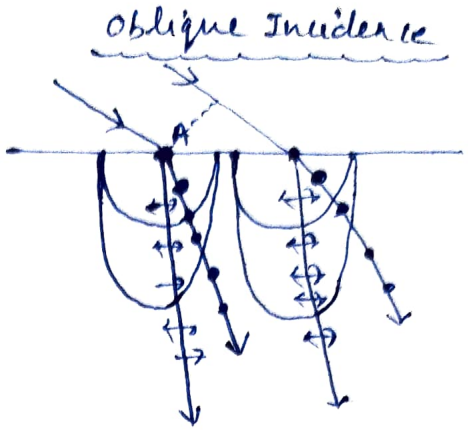
Solution sheet - Tutorial - 5, Physics-1 (Odd 2021)

Q1.



Optic axis parallel to refracting surface for maximum bi-refrengence with same path. So it can be used to make wave retarders (QWP, HWP).



maximum birefrengence with different path.

Q2. For QWP, $t_{min} = \frac{\lambda}{4(\mu_e - \mu_o)}$ or any odd multiple.

i.e $t = \frac{(2n+1)\lambda}{4(\mu_e - \mu_o)}$, where $n = 0, 1, 2, \ldots$

$\Rightarrow \lambda = \frac{51700}{(2n+1)} \Rightarrow$ $\lambda = 51700\,\text{Å}$ ($n=0$), $17233\,\text{Å}$ ($n=1$), $10340\,\text{Å}$ ($n=2$), $7386\,\text{Å}$ ($n=3$)

($51696 \approx 51700$) $5744\,\text{Å}$ ($n=4$), $4700\,\text{Å}$ ($n=5$) $\Rightarrow$

So λ in visible range $\ldots$ are $7386\,\text{Å}$, $5744\,\text{Å}$ & $4700\,\text{Å}$.

Similarly for HWP $\Rightarrow$

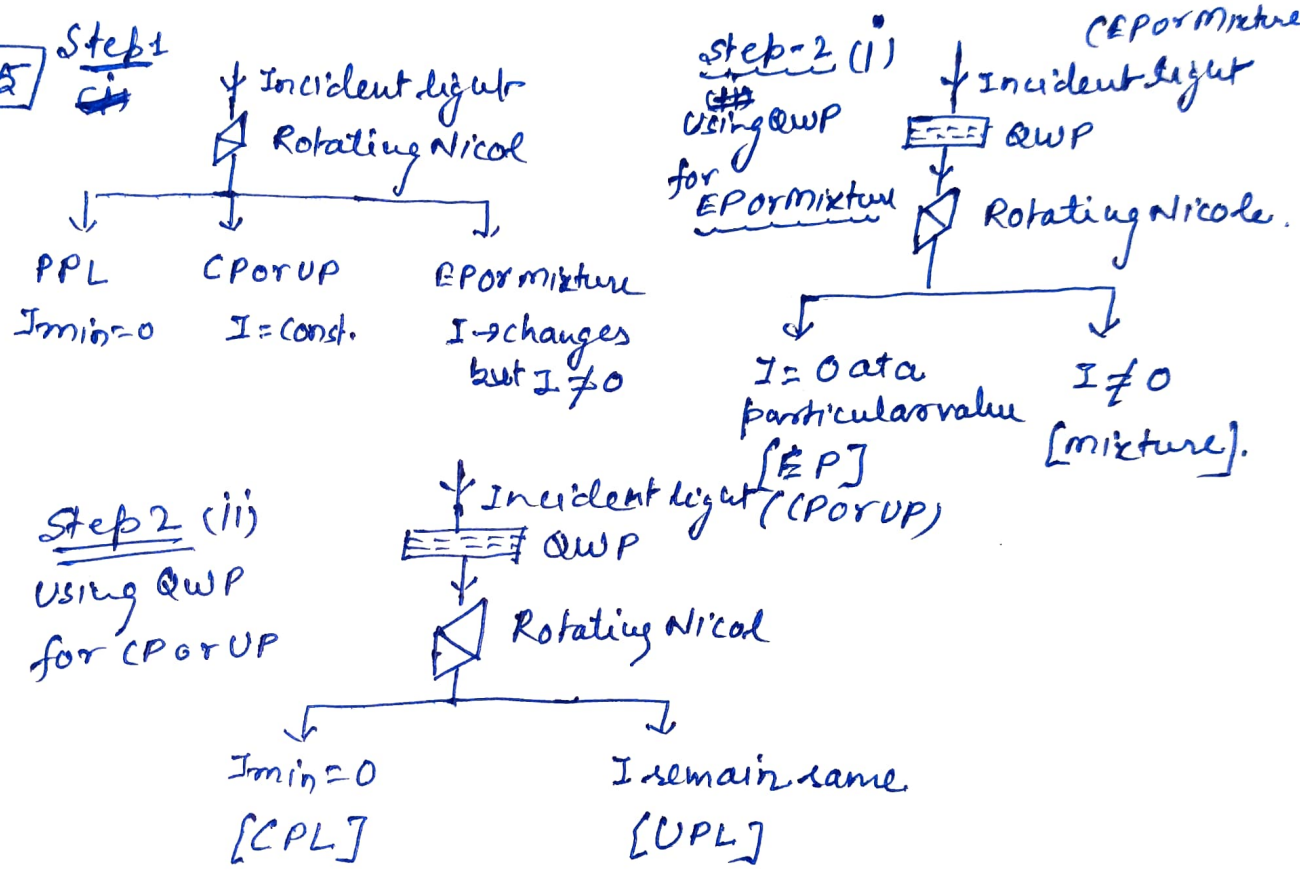
$\lambda = \frac{25850\,\text{Å}}{(2n+1)} \Rightarrow$ λ in visible range for HWP is $5170\,\text{Å}$ only.

Q3. Here $t_{min} = \frac{\lambda}{2(\mu_e - \mu_o)} = 27.47\,\mu m \approx 27.5\,\mu m$ Ans

Q4 (a) By using calcite crystal, we can see two images because of double refraction. Yes we can see only one image too, if we further put a rotating polaroid over crystal.

(b) Either elliptically polarized or, partially polarized light.

Q5



Q6. If $E_x(z,t) = \hat{i}\, E_{ox} \cos(kz-\omega t)$ ---(1)

and $E_y(z,t) = \hat{j}\, E_{oy} \cos(kz-\omega t+\delta)$ -(2)

If $E_{ox} = E_{oy} = E_o$ and $\delta = -\pi/2$ or $-\pi/2 \pm 2m\pi$ (270 or 270 ± 360)

$$E_y(z,t) = \hat{j}\, E_o \sin(kz-\omega t)$$

$$\Rightarrow \boxed{\vec{E}(z,t) = E_o\left[\hat{i}\cos(kz-\omega t) + \hat{j}\sin(kz-\omega t)\right]} \text{ [L CP]}$$

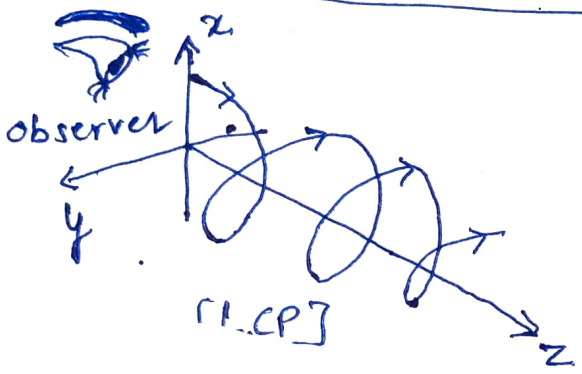
If $E_{0x} = E_{0y} = E_0$ and $\delta = \frac{\pi}{2}$ or $\frac{\pi}{2} \pm 2m\pi$ [90 or 90 ± 360]

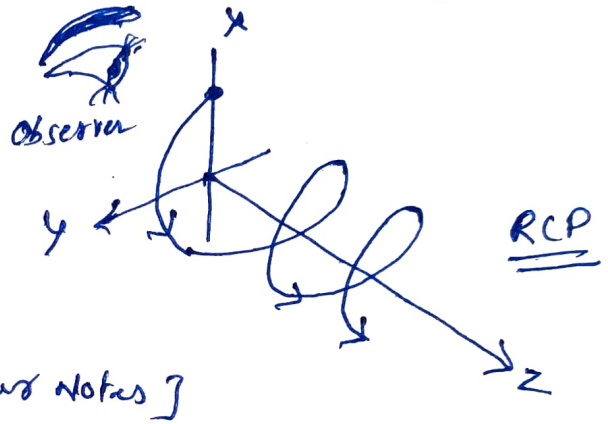
$$E_x(z,t) = \hat{i}\, E_0 \cos(kz - \omega t)$$

$$E_y(z,t) = \hat{j}\, E_0 \cos\left(kz - \omega t + \frac{\pi}{2}\right)$$

$$= -\hat{j}\, E_0 \sin(kz - \omega t)$$

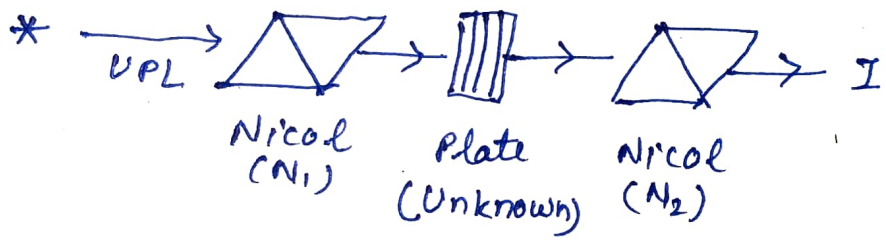
$$\Rightarrow \boxed{\vec{E}(z,t) = E_0 [\hat{i} \cos(kz - \omega t) - \hat{j} \sin(kz - \omega t]} \quad [RCP]$$





[Rest refer to your Notes]

Q7



(i) If $I_{min} = 0$ for crossed N_1 and N_2 ⇒ Glass plate

(ii) If $I_{min} \neq 0$ for rotating N_2 ⇒ QWP

(iii) If $I_{min} = 0$ for rotating N_2 except crossed N_1 and N_2 ⇒ HWP