① A ray of light is incident on glass surface of R.I 1.732 at polarizing angle. Calculate the angle of refraction of the ray.

Soln:- $\mu = 1.732$

$\tan i_p = \mu$

$i_p = \tan^{-1}(\mu) = \tan^{-1}(1.732)$

$i_p = 59.99 = 59^\circ 59'$

$\because i_p + r = 90^\circ$

$r = 90^\circ - 59^\circ 59'$

$r = 30^\circ 1'$

② Three refractive indices of three materials used as polarizer are 1.54, 1.60 and 1.73 respectively. Find angle of polarization and angle of refraction for each materials.

Soln:- $\mu_1 = 1.54, \quad \mu_2 = 1.60, \quad \mu_3 = 1.73$

$\tan i_p = \mu$

$i_p = \tan^{-1}(\mu)$

$(i_p)_1 = \tan^{-1}(\mu_1) = \tan^{-1}(1.54) = 57^\circ$

$r_1 = 90^\circ - (i_p)_1 = 33^\circ$

Similarly $(i_p)_2 = 57.99 = 57^\circ 59'$

$r_2 = 32^\circ 1'$

$(i_p)_3 = 59^\circ 58' \quad r_3 = 30^\circ 2'$

③ An ordinary ray of light is incident on flint glass at $62^\circ 24'$. The reflected and the refracted rays are found to be perpendicular to each other. Calculate the refractive index of flint glass.

Soln: when reflected and refracted rays are perpendicular to each other, then $i = \theta_B = i_p$

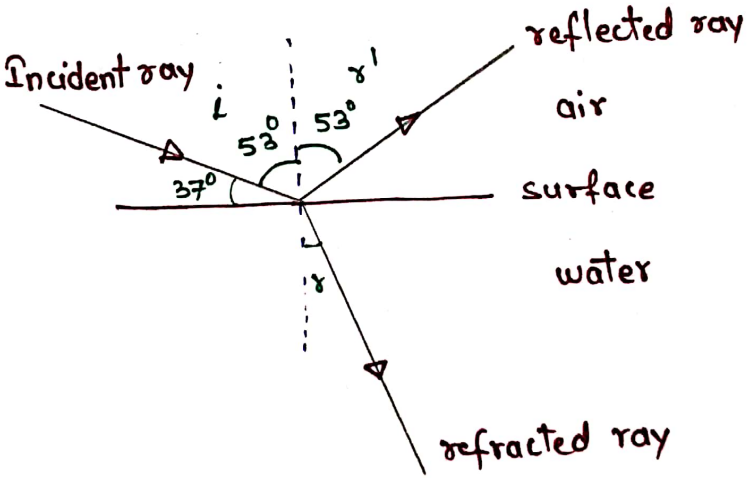
$$\tan i_p = \mu$$

$$\mu = \tan 62^\circ 24'$$

$$\mu = 1.9128$$

④ When Sun is at 37° angle from horizon then reflected light from water is totally polarized. Find refractive index of water.

Soln:



$$\therefore i = i_p = \theta_B = 53^\circ$$

$$\mu = \tan i_p = \tan 53^\circ = 1.327$$

$$\mu = 1.327$$

⑤ For what angle of incidence will light incident on a bucket filled with water having RI of 1·33 to be completely polarized after reflection.

Soln:- $\mu_2 = 1{\cdot}33, \quad \mu_1 = 1$

$i_p = \tan^{-1}(_1\mu_2)$

$i_p = 53^\circ 3'$

$\therefore \quad i = \underline{53^\circ 3'}$

⑥ Two beams of plane polarized light having mutually 1^{qr} planes of polarization are seen through a polaroid. When intensity of first is max then second has zero intensity. A rotation of 60° makes two makes appear equally. Find the ratio of initial intensities of two beams.

Soln: $I = I_0 \cos^2\theta$

Initially $\theta_A = 0^\circ, \quad \theta_B = 90^\circ$

After rotation

$\theta_A' = 60^\circ, \quad \theta_B' = 30^\circ$

$\because \quad I_A' = I_B'$

$I_A \cos^2\theta_A' = I_B \cos^2\theta_B'$

$\therefore \quad \frac{I_A}{I_B} = \frac{\cos^2\theta_B'}{\cos^2\theta_A'} = \frac{\cos^2 30^\circ}{\cos^2 60^\circ} = \frac{3}{1}$

$\therefore \quad I_A : I_B = \underline{3:1}$

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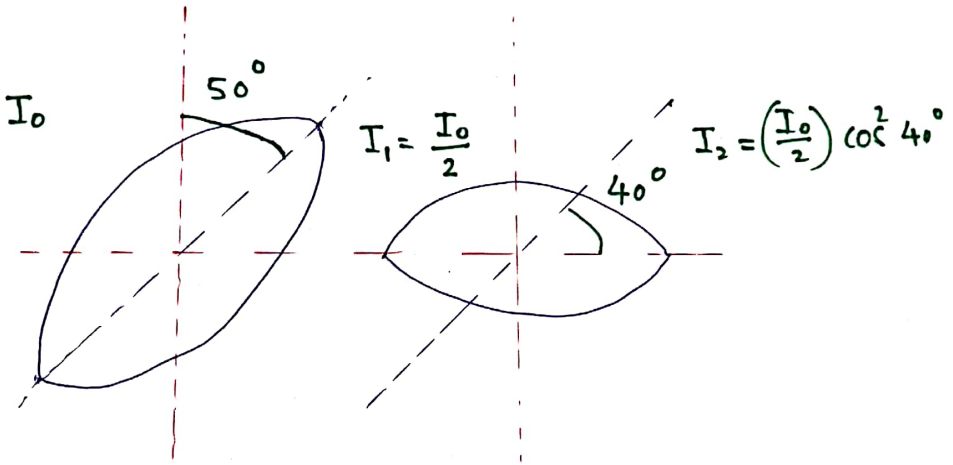
(7) An unpolarized light is incident on two polaroids The axes of first makes an angle of 50° with the vertical and the axes of second polaroid is horizontal. What is the intensity of light after it has passed through second polaroid?

Soln:-



Let I_0 = intensity of incident light

The intensity of light after passing through first polarizer = $\frac{I_0}{2}$ $\therefore$ $I_1 = \frac{I_0}{2}$

The intensity of light passing through second polarizer

$$I_2 = I_1 \cos^2\theta$$

$$I_2 = \left(\frac{I_0}{2}\right)\cos^2 40$$

$$I_2 = \left(\frac{I_0}{2}\right)(0.7660)^2$$

$$I_2 = (0.2933)(I_0)$$

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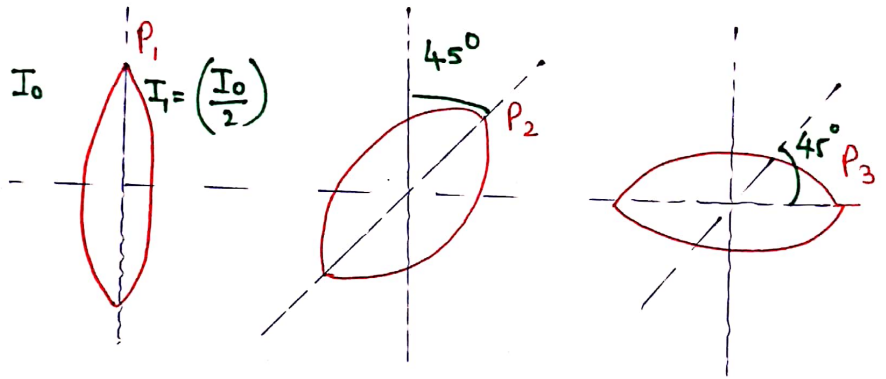
(8) Unpolarized light of intensity I_0 is incident on three polarizing filters. The axes of the second filter is oriented at 45° to that of the first, while the axes of the third is oriented at 90° to that of the first. What is the intensity of light transmitted through third filter.

Soln:



The intensity of light from first polarizer

$$I_1 = \left(\frac{I_0}{2}\right)$$

for second

$$I_2 = (I_1)\cos^2 45°$$

$$I_2 = \left(\frac{I_0}{2}\right)\left(\frac{1}{\sqrt{2}}\right)^2 = \left(\frac{I_0}{4}\right)$$

for third

$$I_3 = (I_2)\cos^2 45°$$

$$I_3 = \left(\frac{I_0}{4}\right)\left(\frac{1}{2}\right) = \frac{I_0}{8}$$

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(9) A polarizer and analyzer are oriented such that amount of transmitted light maximum. Through what angle should either be turned so that the intensity of transmitted light is reduced to (a) 0.75 (b) 0.25 times of the max. intensity?

Soln: $I = I_0 \cos^2\theta$

(a) $I = 0.75\, I_0$

$\therefore 0.75 = \cos^2\theta$

$\therefore \cos\theta = \frac{\sqrt{3}}{2}$

$\theta = \underline{\underline{30^\circ}}$

(b) $I = 0.25\, I_0$

$0.25 = \cos^2\theta$

$\cos\theta = \frac{1}{2}$

$\theta = \underline{\underline{60^\circ}}$