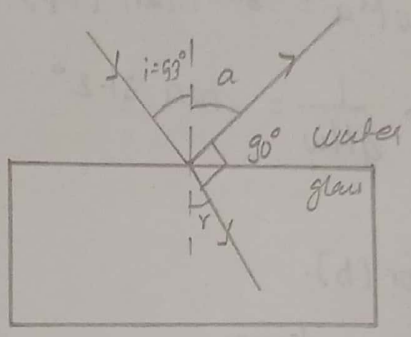
CHAPTER 8: POLARIZATION

<Q·1>: Light travelling in water strikes a glass plate at an angle of incidence of 53·0°, part of the beam is reflected. If the reflected and refracted ray make angle of 90°, what is the refractive index of glass?

Sol^n:



Given,

angle of incidence (i) = 53°

reflected angle (a) = 53°

Here, 53° is the angle of polarization as reflected ray ⊥ refracted ray.

We know,

$$_{w}\mu_{g} = \tan(\theta_p)$$

or, $\frac{_{a}\mu_{g}}{_{a}\mu_{w}} = \tan 53°$ $\quad \therefore {}_{a}\mu_{g} = 1.33 \times \tan 53° = 1.76$

<Q·2>: Unpolarized light travelling in a liquid with refractive index μ is incident on the surface of the liquid above which there is air. If the light ray is incident on the surface at angle of 31·2° with respect to normal, the light reflected back into the liquid is completely polarized.

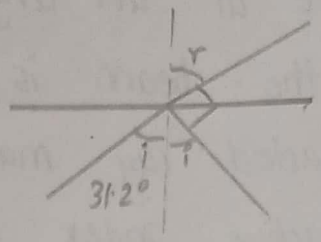
a) What is the refractive index of liquid?

b) what angle does the refractive light travelling in air make with the normal to the surface?

Sol^n:

Given,
angle of incidence $(i) = 31.2°$

Here, $i = \theta_p$ ie, angle of polarization.



For (a):
Here,

$_wM_a = \tan(\theta_p)$

or $\frac{1}{{}_aM_w} = \tan 31.2°$ $\quad \therefore {}_aM_w = 1.65$

For (b).
From figure,

$i + r + 90° = 180°$

or, $31.2° + r + 90° = 180°$

$\therefore r = 58.8°$

(4): Calculate the specific rotation of the sugar solution if plane of polarization is turned through 26.4°, transversely 20cm length and 20% sugar solution.

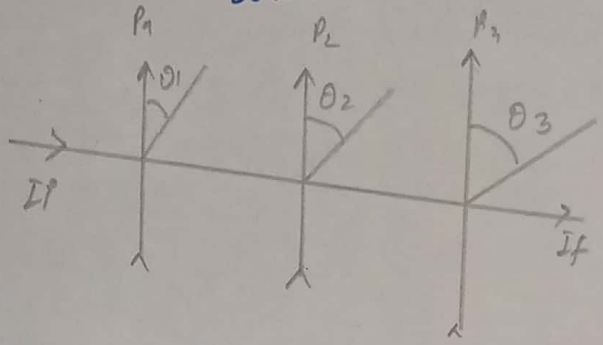
Soln:

Given,
length $(l) = 20$ cm
concentration $(C) = 20\% = 0.2$
angle of turning $(\theta) = 26.4°$
Now, we know,

$$S = \frac{100\,\theta}{LC} = \frac{10 \times 26.4°}{20 \times 0.2} = 66 \text{ deg dm}^{-1} \text{g}^{-1} \text{cm}^3$$

<Q·37: Three polarizing plates whose planes are parallel are centered on a common axis. A linearly polarized beam of light of light with the plane of polarization parallel to the vertical reference direction is incident from the left on the first disk with intensity $I_1 = 10.0$ unit. Calculate the transmitted intensity I_f when $\theta_1 = 20°$, $\theta_2 = 40°$, $\theta_3 = 60°$

Solution.



Given,

$I_1 = 10$ units.

$\theta_1 = 20°$

$\theta_2 = 40°$

$\theta_3 = 60°$

$\therefore$ Angle bet^n P_1 and $P_2 = \theta_2 - \theta_1$
$= 20°$

$\therefore$ Angle bet^n P_3 and $P_2 = \theta_3 - (\theta_2 + \theta_1)$
$= 20°$

From Mallus law,

$I_A = I_1 \times \cos^2 20°$

and,

$I_B = I_1 \cos^2 20° \cos^2 20°$

and

$I_f = I_1 \cos^2 20° \cdot \cos^2 20° \cdot \cos 20°$

$\therefore I_f = 6.88$ units