TOPIC : WAVE OPTICS
EXERCISE # 1

SECTION (A)

1. We know I α A^2

$\Rightarrow \quad \frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} \quad \Rightarrow \quad \sqrt{\frac{4}{1}} = \frac{A_1}{A_2} \quad \Rightarrow \quad A_1 : A_2 = 2 : 1$

2. $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = \left(\sqrt{4I} + \sqrt{I}\right)^2 = 9I.$

$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = \left(\sqrt{4I} - \sqrt{I}\right)^2 = I.$

5. $I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (\sqrt{I} + \sqrt{4I})^2 = 9I$

$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2 = (\sqrt{I} - \sqrt{4I})^2 = I$

6. At point A, resultant intensity

$I_A = I_1 + I_2 = 5I;$ and at point B

$I_B = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\pi = 5I + 4I$

$I_B = 9I$ so $I_B - I_A = 4I.$

7. Phase difference will be 180°, if light rays incident from rarer to denser medium.

8. In a longitudinal wave, the particles of the medium oscillate about their mean or equilibrium position along the direction of propagation of the wave itself. Sound waves are longitudinal in nature. In trasverse wave, the particles of the medium oscillate about their mean or equilibrium position at right angles to the direction of propagation of wave itself. Light waves being electromagnetic are transverse waves.

9. Amplitude of the resultant wave

$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\Delta\phi}$

$\therefore A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\Delta\phi$

$A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\Delta\phi$

Given, $A = a_1 = a_2 = a$ (say), then

$a^2 = 2a^2 + 2a^2\cos\Delta\phi$

So $a^2 = 2a^2(1+\cos\Delta\phi)$

So $1+\cos\Delta\phi = \frac{1}{2}$

So $\cos\Delta\phi = -\frac{1}{2}$

So $\Delta\phi = 120^\circ = \frac{2\pi}{3}$ rad

10. Resultant intensity of two periodic waves is given by

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\delta$

where δ is the phase difference between the waves.

For maximum intensity, $\delta = 2n\pi$, n = 0, 1, 2, ...etc.

Therefore, for zero order maxima, $\cos\delta = 1$

$I_{max} = I_1 + I_2 + 2\sqrt{I_1 I_2} = (\sqrt{I_1} + I_2)^2$

For minimum intensity, $\delta = (2n - 1)\pi$,

n = 1, 2,......etc

Therefore, for Ist order minima, $\cos\delta = -1$

$I_{min} = I_1 + I_2\sqrt{I_1 I_2}$

$= (\sqrt{I_1} - \sqrt{I_2})$

Therefore,

$I_{max} + I_{min} = (\sqrt{I_1} + \sqrt{I_2})^2 + (\sqrt{I_1} - \sqrt{I_2})^2 = 2(I_1 + I_2)$

11. Phase difference = $\frac{2\pi}{\lambda}$ × path difference
Path difference between two points
$\Delta x = 15 - 10 = 5$ m

Time period, T = 0.05 s ⇒ frequency n = $\frac{1}{T} = \frac{1}{0.05}$ = 20 Hz

Velocity, v = 300 m/s ∴ Wavelength, λ = $\frac{v}{n} = \frac{300}{20}$ = 15 m
Hence, phase difference

$$\Delta\phi = \frac{2\pi}{\lambda}\times\Delta x = \frac{2\pi}{15}\times 5 = \frac{2\pi}{3}$$

SECTION (B)

1. Contrast indicates the ratio of maximum possible intensity on screen to the minimum possible intensity.

As $\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}$ so it only depends on the source intensity.

2. we know that $\beta = \frac{\lambda D}{d}$ & $\lambda_{yellow} > \lambda_{blue}$. ⇒ as λ decreases, so β also decreases.

5. The refractive index of air is slightly more than 1. When chamber is evacuated, refractive index decreases and hence the wavelength increases and fringe width also increases.

12. Slit width ratio = 1 : 9
Since slit width ratio is the ratio of intensity and intensity $\propto$ (amplitude)^2

$\therefore I_1 : I_2 = 1 : 9 \quad \Rightarrow a_1^2 : a_2^2 = 1 : 9 \Rightarrow a_1 : a_2 = 1 : 3$

$I_{max} = (a_1 + a_2)^2,\ I_{min} = (a_1 - a_2)^2 \Rightarrow \frac{I_{min}}{I_{max}} = \frac{1}{4}$

13. $\beta = \frac{\lambda D}{d} = \frac{5\times10^{-7}\times 2}{10^{-3}} m = 10^{-3} m = 1.0\ mm$.

14. For brightness, path difference $= n\lambda = 2\lambda$. So second is bright.

16. $\theta = \frac{\lambda}{d};\theta$ can be increased by increasing λ, so here λ has to be increased by 10%

i.e., % Increase $= \frac{10}{100}\times 5890 = 589\text{Å}$

17. $n_1\lambda_1 = n_2\lambda_2 \Rightarrow 62\times5893 = n_2\times4358 \Rightarrow n_2 = 84.$

18. Fringe width

$\beta = \frac{\lambda D}{d}$ … (1)

Given: λ = 1000 Å = 10^{-5} cm, d = 3 cm, D = 70 cm putting given value in eq (i)

∴ $\beta = \frac{10^{-5}\times 70}{3}$ = 2.3 × 10^{-5} cm = 2.3 × 10^{-6} m

19. In interference fringe width = $\frac{\lambda D}{d}$ = w (given)

$$w' = \frac{\frac{\lambda \times 2D}{\frac{d}{2}}}{} = 4 \times \frac{\lambda D}{d} = 4w$$

20. For possible interference maxima on the screen the condition is

$$d \sin \theta = n\lambda$$

Given: d = sit - whidth = 2λ

$\therefore \quad 2\lambda \sin\theta = n\lambda \quad \Rightarrow \quad 2 \sin\theta = n$

The maximum value of $\sin\theta$ is 1 hence,

$n = 2 \times 1 = 2$

Thus, Eg. (i) Must be satisfied by 5 integer values ie, – 2 – 1, –1, 2. Hence the maximum number of possible interference maxima is 5.

21. Sustained inerferece is possible with coherent source only'

27. On increasing speed of electron, de Broglie wavelength associated with it will decrease $\left(\lambda = \frac{h}{mv}\right)$.

Since fringe width $\beta = \frac{D\lambda}{d}$, it will decrease.

SECTION (C)

2. Optical path N= μt

In medium (1), optical path = $\mu_1 d_1$

In medium (2), optical path = $\mu_2 d_2$ $\quad \therefore \quad$ Total path = $\mu_1 d_1 + \mu_2 d_2$

SECTION (D)

3. Shift $= \frac{\beta}{\lambda}(\mu - 1)\, t = \frac{\beta}{(5000 \times 10^{-10})}(1.5) \times 2 \times 10^{-6} = 2\beta$

i.e., 2 fringes upwards.

5. The film appears bright when the path difference $(2\mu t \cos r)$ is equal to odd multiple of $\frac{\lambda}{2}$

i.e. $2\mu t \cos r = (2n - 1)\,\lambda / 2$ where $n = 1, 2, 3$ .....

$$\therefore\ \lambda = \frac{4\mu t \cos r}{(2n-1)} = \frac{4 \times 1.4 \times 10{,}000 \times 10^{-10} \times \cos 0}{(2n-1)} = \frac{56000}{(2n-1)}\text{Å}$$

$\therefore \lambda = 56000\,\text{Å}\ \ 18666\,\text{Å},\ 8000\,\text{Å},\ 6222\,\text{Å},\ 5091\text{Å},\ 4308\,\text{Å},\ 3733\,\text{Å}.$

The wavelength which are not within specified range are to be refracted.

6. When a mica sheet is introduced in the path of one of interfering beams, the whole interference pattern is displaced by an amount $\frac{D}{d}$ $(\mu - 1)$ t in the direction of introduction of sheet.

SECTION (E)

1. $\beta = \frac{(a + b)\lambda}{2a(\mu - 1)\alpha}$

where a = distance between source and biprism = 0.3 m

b = distance between biprism and screen = 0.7 m.

α = Angle of prism = 1°, μ = 1.5, $\lambda = 6000 \times 10^{-10}$ m

Hence, $\beta = \frac{(0.3 + 0.7) \times 6 \times 10^{-7}}{2 \times 0.3(1.5 - 1) \times (1^{\circ} \times \frac{\pi}{180})} = 1.14 \times 10^{-4}$ m = 0.0114 cm.

12. Diffraction is obtained when the slit width is of the order of wavelength of EM waves (or light). Here wavelength of X-rays (1-100 Å) is very-very lesser than slit width (0.6 mm). Therefore no diffraction pattern will be observed.

13. Distance between the first dark fringes on either side of central maxima = width of central maxima

$= \frac{2\lambda D}{d} = \frac{2\times600\times10^{-9}\times2}{1\times10^{-3}}$ = 2.4 mm.

14. Position of first minima = position of third maxima i.e., $\frac{1\times\lambda_1 D}{d} = \frac{(2\times3+1)}{2}\frac{\lambda_2 D}{d} \Rightarrow \lambda_1 = 3.5\lambda_2$

15. Fringe width $W = \frac{2f\lambda}{a}$

$W \propto \frac{1}{a}$

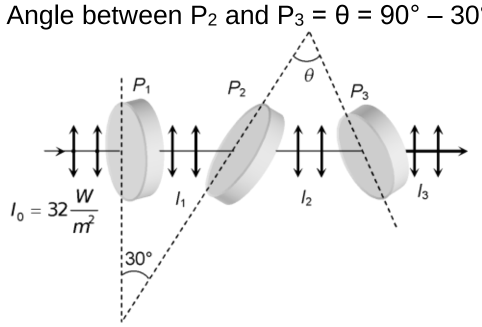
It means a increase and W decrease.

SECTION (F)

9. $I' = \frac{I}{2}\cos^2\theta = \frac{I}{6}$ or $\cos\theta = \frac{1}{\sqrt{3}}$ $\therefore$ θ = 55º

10. (b) Angle between P_1 and P_2 = 30° (given)

Angle between P_2 and P_3 = θ = 90° – 30° = 60°

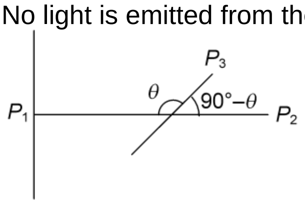


The intensity of light transmitted by P_1 is $I_1 = \frac{I_0}{2} = \frac{32}{2} = 16\frac{W}{m^2}$

According to Malus law the intensity of light transmitted by P_2 is $I_2 = I_1\cos^2 30° = 16\left(\frac{\sqrt{3}}{2}\right)^2 = 12\frac{W}{m^2}$

Similarly intensity of light transmitted by P_3 is $I_3 = I_2\cos^2\theta = 12\cos^2 60° = 12\left(\frac{1}{2}\right)^2 = 3\frac{W}{m^2}$

11. No light is emitted from the second Polaroid, so P_1 and P_2 are perpendicular to each other



Let the initial intensity of light is I_0. So Intensity of light after transmission from first polaroid = $\frac{I_0}{2}$.

Intensity of light emitted from P_3 $I_1 = \frac{I_0}{2}\cos^2\theta$

Intensity of light transmitted from last Polaroid i.e. from $P_2 = I_1\cos^2(90^\circ - \theta) = \frac{I_0}{2}\cos^2\theta.\sin^2\theta$

$= \frac{I_0}{8}(2\sin\theta\cos\theta)^2 = \frac{I_0}{8}\sin^2 2\theta$.

12. If I is the final intensity and I_0 is the initial intensity then

$I = \frac{I_0}{2}(\cos^2 30°)^5$ or $\frac{I}{I_0} = \frac{1}{2}\times\left(\frac{\sqrt{3}}{2}\right)^{10} = 0.12$

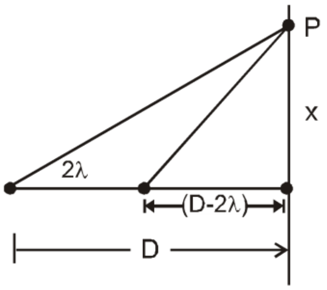
EXERCISE # 2

1. For constructive interference, we must have

$2d \sin\theta = n\lambda$

or $\sin\theta = \frac{n\lambda}{2d} = \frac{1\times 0.3\times 10^{-10}}{2\times 0.3\times 10^{-9}}$ = 0.05RAD = $\frac{0.05\times 180}{\pi}$ = 2.86°

$2d \sin\theta = n\lambda$ or $\sin\theta = \frac{n\lambda}{2d} = \frac{1\times 0.3\times 10^{-10}}{2\times 0.3\times 10^{-9}}$ = 0.05 rad = $\frac{0.05\times 180}{\pi}$ = 2.86°



2.

$\sqrt{D^2+x^2} - \sqrt{x^2+(D-2\lambda)^2} = \lambda$ $\Rightarrow$ $\sqrt{x^2+D^2} - \lambda = \sqrt{x^2+(D-2\lambda)^2}$

$x^2 + D^2 + \lambda^2 - 2\lambda\sqrt{x^2+D^2} = x^2+D^2+4\lambda^2-4\lambda D$

$2\lambda\sqrt{x^2+D^2} = -3\lambda^2+4\lambda D$

$4(x^2 + D^2) = (4D - 3\lambda)^2 \approx 16 D^2$

$x^2 + D^2 = 4D^2$

$x^2 = 3D^2$

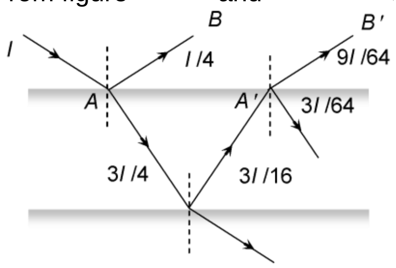
$x = \sqrt{3}D$

4. When we observe the colours of the thin film oil floating over the surface of water, The thickness of the film must be of the order of the wavelength of visible light. Therefore out of given options 5000 Å is the correct answer since range of wavelength of visible light is 4000 Å to 4900 Å.

$2\mu t = \lambda/2$ or $2\mu t = \lambda$ for constructive or destructive interference

To see the floating layer of oil on water to be coloured its thickness should be of the order 100 nm (nanometer).

5. From figure $I_1 = \frac{I}{4}$ and $I_2 = \frac{9I}{64}$ $\Rightarrow$ $\frac{I_2}{I_1} = \frac{9}{16}$



By using $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{\frac{I_2}{I_1}}+1}{\sqrt{\frac{I_2}{I_1}}-1}\right) = \left(\frac{\sqrt{\frac{9}{16}}+1}{\sqrt{\frac{9}{16}}-1}\right) = \frac{49}{1}$

6. By using phase difference $\phi = \frac{2\pi}{\lambda}(\Delta)$ for path difference λ, phase difference $\phi_1 = 2\pi$ and for path difference λ/4, phase difference $\varphi_2 = \pi/2$.

Also by using $I = 4I_0\cos^2\frac{\phi}{2} \Rightarrow \frac{I_1}{I_2} = \frac{\cos^2(\varphi_1/2)}{\cos^2(\varphi_2/2)} \Rightarrow \frac{K}{I_2} = \frac{\cos^2(2\pi/2)}{\cos^2\left(\frac{\pi/2}{2}\right)} = \frac{1}{1/2} \Rightarrow I_2 = \frac{K}{2}.$

7. If shift is equivalent to n fringes then

$n = \frac{(\mu-1)t}{\lambda} \Rightarrow n \propto t \Rightarrow \frac{t_2}{t_1} = \frac{n_2}{n_1} \Rightarrow t_2 = \frac{n_2}{n_1}\times t \Rightarrow t_2 = \frac{20}{30}\times 4.8 = 3.2\text{ mm}.$

8. For maximum intensity on the screen

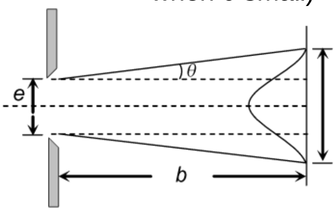
$d\sin\theta = n\lambda \Rightarrow \sin\theta = \frac{n\lambda}{d} = \frac{n(2000)}{7000} = \frac{n}{3.5}$

Since maximum value of $\sin\theta$ is 1

So $n = 0, 1, 2, 3,$ only. Thus only seven maximas can be obtained on both sides of the screen.

9. The direction in which the first minima occurs is θ (say). Then $e\sin\theta = \lambda$ or $e\theta = \lambda$ or, $\theta = \frac{\lambda}{e}$

($\because\ \theta = \sin\theta$ when θ small)



Width of the central maximum $= 2b\theta + e = 2b.\frac{\lambda}{e} + e$

10. Total phase difference = Initial phase difference + Phase difference due to path

$= 66^\circ + \frac{360^\circ}{\lambda}\times\Delta x = 66^\circ + \frac{360^\circ}{\lambda}\times\frac{\lambda}{4} = 66^\circ + 90 = 156^\circ$

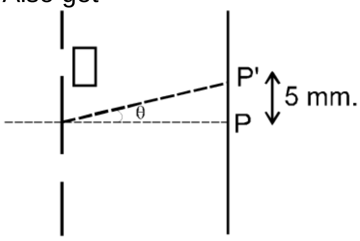
3. Fourth maxima will be at y = 4β.

⇒ y = $\frac{4\lambda D}{d}$ as $\lambda_{Green} > \lambda_{blue}$.

⇒ $\beta_{Green} > \beta_{blue}$ ⇒ $X_{Green} > X_{blue}$

Also get $\frac{X(\text{blue})}{X(\text{green})} = \frac{4360}{5460}$

15.



Clearly the central maxima at P(initially) shifts to P' where PP' = 5 mm.

So now, path difference at P' must be zero.

⇒ d sinθ = (μ – 1)t ⇒ d tanθ = (μ – 1)t

⇒ μ = 1 + $\frac{d.(PP')}{Dt}$; get μ = 1.2

18. For strong reflection.

2μt = $\frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}$ ......

⇒ λ = 4μt, $\frac{4\mu t}{3}, \frac{4\mu t}{5}, \frac{4\mu t}{7}$ ......

⇒ 3000 nm. 1000 nm, 600 nm, 430 nm, 333 nm. ⇒ only option is 600 nm.

19. (1) Interference is a phenomenon in which two waves of same frequency superpose to give resultant intensity different from sum of their seperate intesity. so, it cannot exhibit particles nature of light.
(2) Diffraction is a phenomenon in which light bends at sharp ends of an obstacle or a hole. So it also can't exhibit particle's nature of light.
(3) Polarisation of light is a property owing to which a light ray after emerging through a crystal (a special kind like tourmaline) have vibrations in a plane perpendicular to its direction of propagation. So, it also can't explain particle's nature of light.
(4) Photoelectric effect states that light travels in the form of bundles or packets of energy, called photons. This effect is explained on the basis of quantum nature of light. So, it clearly explain the particle's nature of light. Hence, choice (4) is correct.

20. In interference we know that

$$I_{max} = \left(\sqrt{I_1} + I_2\right)^2 \quad \text{and} \quad I_{min} = \left(\sqrt{I_1} \sim I_2\right)^2$$

Under normal conditions (when the widths of both the slits are equal)

$I_1 \approx I_2 = I$ (say)

$\therefore$ $I_{max} = 4I$ and $I_{min} = 0$

When the width of one of the slits is increased. Intensity due to that slit would increase, while that of the other will remain same. So let :

$I_1 = I$ and $I_2 = \eta I$ $(\eta > 1)$

Then $I_{max} = I(1+\sqrt{\eta})^2 > 4I$ and $I_{min} = I(\sqrt{\eta}-1)^2 < 0$

$\therefore$ Intensity of both maximum and minima is increased.

21. Path difference due to slab should be integral multiple of λ or

$\Delta x = n\lambda$

or $(\mu - 1)\, t = n\lambda$ $n = 1, 2, 3, ...$

or $t = \dfrac{n\lambda}{\mu - 1}$

For minimum value of t, $n = 1$ $\therefore$ $t = \dfrac{n\lambda}{\mu - 1} = \dfrac{\lambda}{1.5 - 1} = 2\lambda$

22. PR = d

PO = d secθ and CO = PO cos 2θ = d secθ cos 2θ

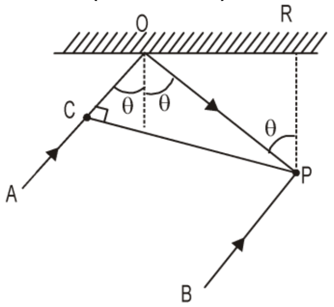
path difference between the two rays is,

$\Delta p = CO + OP + \lambda/2 = d\sec\theta\cos 2\theta + d\sec\theta + \lambda/2$ (one is reflected, while another is direct)

Therefore condition for constructive interference path difference should be

$\Delta p = \lambda, 2\lambda, 3\lambda$ ....

or $d\sec\theta\,(1 + \cos 2\theta) + \dfrac{\lambda}{2} = \lambda$



or $\left(\dfrac{d}{\cos\theta}\right)(2\cos^2\theta) = \dfrac{\lambda}{2}$ or $\cos\theta = \dfrac{\lambda}{4d}$

23. Let nth minima of 400 nm coincides with m th minima of 560 nm, then

$(2n-1)\left(\dfrac{400}{2}\right) = (2m-1)\left(\dfrac{560}{2}\right)$ or $\dfrac{2n-1}{2m-1} = \dfrac{7}{5} = \dfrac{14}{10} =$.........

i.e. 4th minima of 400 nm coincides with 3rd minima of 560 nm.

Location of this minima is,

$$Y_1 = \frac{(2\times 4-1)(1000)(400\times 10^{-6})}{2\times 0.4} = 14 \text{ mm}$$

Next 11th minima of 400 nm will coincide with 8th minima of 560 nm.
Location of this minima is,

$$Y_2 = \frac{(2\times 11-1)(1000)(400\times 10^{-6})}{2\times 0.1} = 42 \text{ mm}$$

$\therefore$ Required distance = $Y_2 - Y_1$ = 28 mm. Hence, the correct option is (D).

24. On increasing speed of electron, de Broglie wavelength associated with it will decrease $\left(\lambda = \frac{h}{mv}\right)$.

Since fringe width $\beta = \frac{D\lambda}{d}$, it will decrease.

25. Intensity of one slit = $\frac{I}{4}$

$\therefore \quad \frac{I}{4} = \frac{I}{4} + \frac{I}{4} + 2\frac{I}{4}\cos\phi \quad \Rightarrow \quad \cos\phi = -\frac{1}{2} \quad \Rightarrow \quad \phi = \frac{2\pi}{3}$

Also $\frac{\phi}{2\pi} = \frac{\Delta}{\lambda} \quad \Rightarrow \quad \Delta = \frac{2\pi}{3\times 2\pi}\times\lambda = \frac{\lambda}{3}$

$\therefore \quad d\sin\theta = \frac{\lambda}{3} \quad \Rightarrow \quad \sin\theta = \frac{\lambda}{3d} \quad \Rightarrow \quad \theta = \sin^{-1}\left(\frac{\lambda}{3d}\right)$

26. $\beta = \frac{\lambda D}{d}$

$\underbrace{\text{VIBGYOR}}$ λ increase

$\lambda_R > \lambda_G > \lambda_B$ So $\beta_R > \beta_G > \beta_B$

27. $\beta = \frac{\lambda D}{d} \quad \therefore \quad \lambda_2 > \lambda_1$ so $\beta_2 > \beta_1$

No of fringes in a given width (m) = $\frac{y}{\beta} \quad \Rightarrow \quad m_2 < m_1$

3rd maximum of $\lambda_2 = \frac{3\lambda_2 D}{d} = \frac{1800D}{d} \quad \Rightarrow$ 5th minimum of $\lambda_1 = \frac{9\lambda_1 D}{2d} = \frac{1800D}{d}$

So, 3rd maxima of λ_2 will meet with 5th minimum of λ_1

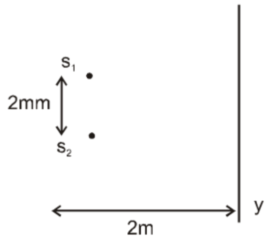
Angular sepration = $\frac{\lambda}{d} \Rightarrow$ Angular seperation for λ_1 will be lesser

EXERCISE # 3
PART - I

1. $y = \frac{n\lambda D}{d} \quad \therefore \quad n_1\lambda_1 = n_2\lambda_2$

$n_1\, 12000 = n_2\, 10000$

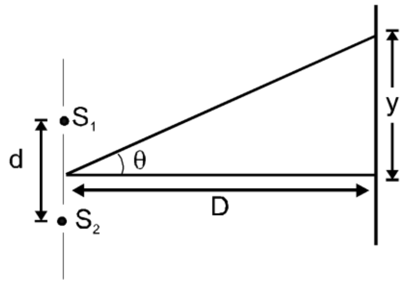
$y_{compon} = 6\, n_1 = 5n_2$



here $y_{common} = \dfrac{5(12000\times10^{-10})}{2\times10^{-3}}$

$= 5\ 5\ 12 \times 10^{-4}$ $= 60 \times 10^{-4}$ m $= 6 \times 10^{-3}$ m $= 6$ mm

2.



θ = $\dfrac{Y}{D} = \dfrac{n\lambda D}{dD}$ so $\theta = \dfrac{\lambda}{d}$

$v \uparrow \lambda \downarrow \theta \downarrow$

3. $d = 1\text{mm} = 10^{-3}\text{m}$

$D = 1$ mm

$\lambda = 500\text{nm} = 500\times10^{-9}\text{m}$ width of central maxima in single slit pattern = $\dfrac{2\lambda D}{a}$ fring width in double slit exp.

$\beta = \dfrac{\lambda D}{d}$ so required condition $\Rightarrow$ $\dfrac{10\lambda D}{d} = \dfrac{2\lambda D}{a}$

$a = \dfrac{d}{5} = \dfrac{1}{5}\times10^{-3}\text{m} = 0.2$ mm

4. Width of central maxima = $\dfrac{2\lambda D}{a}$

5. Path difference between the extreme rays at first minima = $a \sin\theta = \lambda$

$a \sin(30°) = \lambda \quad \Rightarrow \quad a = 2\lambda$

Path difference between the extreme rays at first secondary maxima = $a \sin\theta' = \dfrac{3\lambda}{2}$

$(2\lambda)\sin\theta' = \dfrac{3\lambda}{2} \quad \Rightarrow \quad \theta' = \sin^{-1}\left(\dfrac{3}{4}\right)$

6. Position of Ist minima

$$y = \frac{\lambda D}{a} = \frac{(5\times10^{-8})(0.6)}{0.02\times10^{-2}}$$

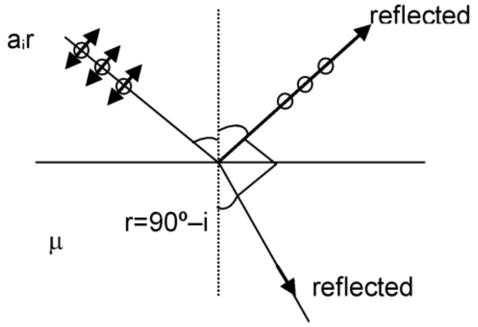
$y = 0.15$ cm

7. R.P. $\propto \dfrac{1}{\lambda}$ so $\dfrac{R.P_1}{RP_2} = \dfrac{\lambda_2}{\lambda_1} = \dfrac{6000}{4000} = \dfrac{3}{2}$

8. In air distance of 5th dark, fringe = $\dfrac{9}{2}\beta = \dfrac{9}{2}\dfrac{\lambda_0 D}{d}$

So, $8\dfrac{\lambda_0}{n}\cdot\dfrac{D}{d}=\dfrac{9}{2}\dfrac{\lambda_0 D}{d}$ $\Rightarrow$ So, $n=\dfrac{16}{9}=1.78$ Ans.

9. (1) $\sin i=\mu\sin(90-i)$
$\mu=\tan i$
$i=\tan^{-1}(-\mu)$
in this case, the reflected ray will be totally polarized with its electrical vector perpendicular to the plane of incidence.



10. $\beta=\dfrac{\lambda D}{d}$, so angle subtended by a fringe $\theta=\dfrac{\beta}{D}=\dfrac{\lambda}{d}$ $\Rightarrow$ $\theta\propto\dfrac{1}{d}$
$\dfrac{\theta_1}{\theta_2}=\dfrac{d_2}{d_1}$ $\Rightarrow$ $\dfrac{0.20^o}{0.21^o}=\dfrac{d_2}{2mm}$
$d_2=1.90$ mm

11. For double slit experiment

Angular width for first minima $=\dfrac{\lambda}{2d}\propto\lambda$

$\dfrac{\theta}{\theta'}=\dfrac{\lambda}{\lambda'}=\dfrac{\lambda}{\left(\dfrac{\lambda}{\mu}\right)}=\mu$ $\Rightarrow$ $\theta'=\dfrac{\theta}{\mu}=\dfrac{0.2^o}{\left(\dfrac{4}{3}\right)}=0.15^o$

12. The path difference between the light rays at fifth minima is $5\lambda-\dfrac{\lambda}{2}=\dfrac{9\lambda}{2}$

13. $\theta_0=\dfrac{2\lambda}{a}$ $\Rightarrow$ $\theta_0\propto\lambda$
$\dfrac{\theta_0}{\theta_1}=\dfrac{\lambda_0}{\lambda_1}$ $\Rightarrow$ $\dfrac{\theta_0}{\theta_1}=\dfrac{6000}{\lambda_1}$
$(\theta_1=.7\theta_0)$ $\Rightarrow$ $\dfrac{\theta_0}{.7\theta_0}=\dfrac{6000}{\lambda_1}$ $\Rightarrow$ $\lambda_1=4200$ A^o

PART - II

1. $\Delta x_1=0$
$\Delta\phi=0^o$
$I_1=I_0+I_0+2I_0\cos0^o=4I_0$
$\Delta x_2=\dfrac{\lambda}{4}$

$\Delta\theta = \frac{2\pi}{\lambda}.\frac{\lambda}{4} = \left(\frac{\pi}{2}\right)$

$I_2 = I_0 + I_0 + 2I_0 \cos\frac{\pi}{2} = 2I_0$

$\frac{I_1}{I_2} = \frac{4I_0}{2I_0} = \frac{2}{1}$.

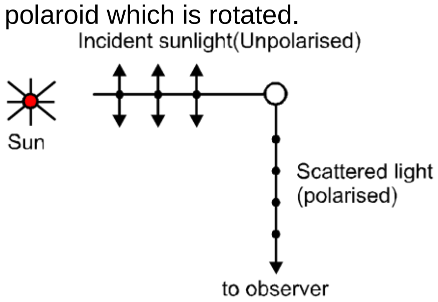
2. For coherent sources :

$I_1 = 4I_0$

For incoherent sources

$I_2 = 2I_0$ $\frac{I_0}{I_2} = \frac{2}{1}$.

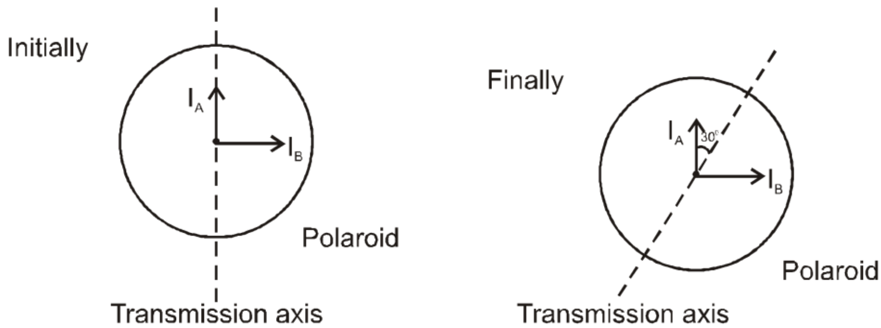
3. The light from a clear blue portion of the sky shows a rise and fall of intensity when viewed through a polaroid which is rotated.



4. **S_1 :** When light reflects from deuser med. (Glass) a phase dift of π is generated.
S_2 : Centre maxima or minima depends on thickness of the lens.

5. It will be concentric circles

6.

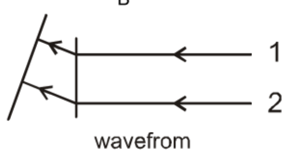


$I_A \cos^2 30^0 = I_B \cos^2 60^0$

$\Rightarrow \quad I_A \frac{3}{4} = I_B . \frac{1}{4}$

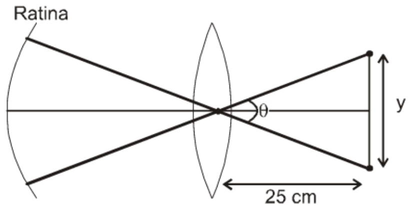
$\frac{I_A}{I_B} = \frac{1}{3}$

7.



Ray 2 will travel faster than 1,
so beam will bend upward

8.



Resolving angle of necked eye is given by:

$\theta = 1.22\dfrac{\lambda}{D}$

$\dfrac{y}{25 \times 10^{-2}} = \dfrac{1.22 \times 500 \times 10^{-9}}{0.25 \times 2 \times 10^{-2}}$

y = 30 × 10^{-6} m = 30 µm

9. b → radius of spot.

b = a + $\dfrac{\lambda L}{a}$ geometrical spread + spread due to diffraction $\dfrac{db}{da}$ = 0

⇒ $1 - \dfrac{\lambda}{a^2}L = 0$

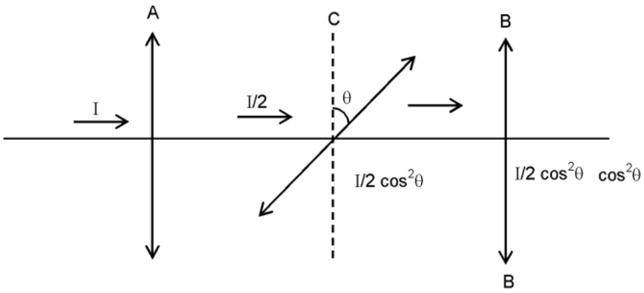
⇒ $a^2 = L\lambda$

⇒ $a = \sqrt{L\lambda}$

$b_{min.} = \sqrt{L\lambda} + \dfrac{\lambda L}{\sqrt{L\lambda}}$

$b_{min.} = 2\sqrt{L\lambda}$

$b_{min.} = \sqrt{4L\lambda}$



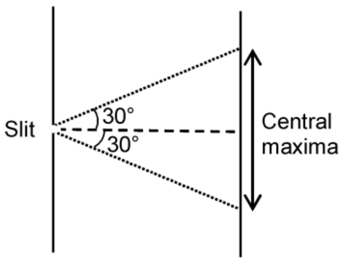
10.

$\dfrac{I}{2}\cos^2\theta = \dfrac{I}{8}$

$\cos^2\theta = \dfrac{1}{4}$

$\cos\theta = \dfrac{1}{\sqrt{2}}$

⇒ θ = 45°



11.

Semi-angular width = 30°

$a\sin\theta = \lambda$

$a\sin 30° = \lambda$

Fringe width $\beta = \frac{\lambda D}{d} = \frac{a\sin 30° D}{d}$

$\Rightarrow \quad 10^{-2} = \frac{10^{-6} \times \frac{1}{2} \times 0.5}{d}$

$\Rightarrow \quad d = \frac{5}{2} \times 10^{-5} = 25\mu m$

12. $\left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2 = \frac{16}{1}$

$\Rightarrow \frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}} = \frac{4}{1}$

$\Rightarrow 3\sqrt{I_1} = 5\sqrt{I_2}$

$\Rightarrow \frac{I_1}{I_2} = \frac{25}{9}$

13. $d \sin\theta = n\lambda$

$n = \frac{0.32 \times 10^{-3} \times 1/2}{500 \times 10^{-9}} = \frac{2500}{8} = 320$

$\therefore \quad n_{max} = 320$

_______$\therefore$ Total number of maxima between the two lines = 2 × 320 + 1 = 641

14. $x_1 = 2d$

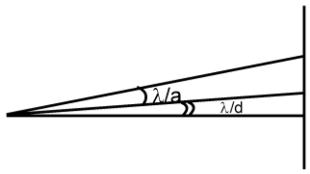
$x_2 = \sqrt{5}d$

$\Delta x = x_2 - x_1$

$\sqrt{5}d - 2d = \frac{\lambda}{2}$

$d = \frac{\lambda}{2(\sqrt{5} - 2)}$

15.



Angle subtended by first and second diffraction minima on the screen = $\frac{\lambda}{a}$

angular fringe width = $\frac{\lambda}{d}$

no. of bright fringes = $\frac{\frac{\lambda}{a}}{\frac{\lambda}{d}} = \frac{d}{a} = \frac{19.44}{4.05} = 4.81$