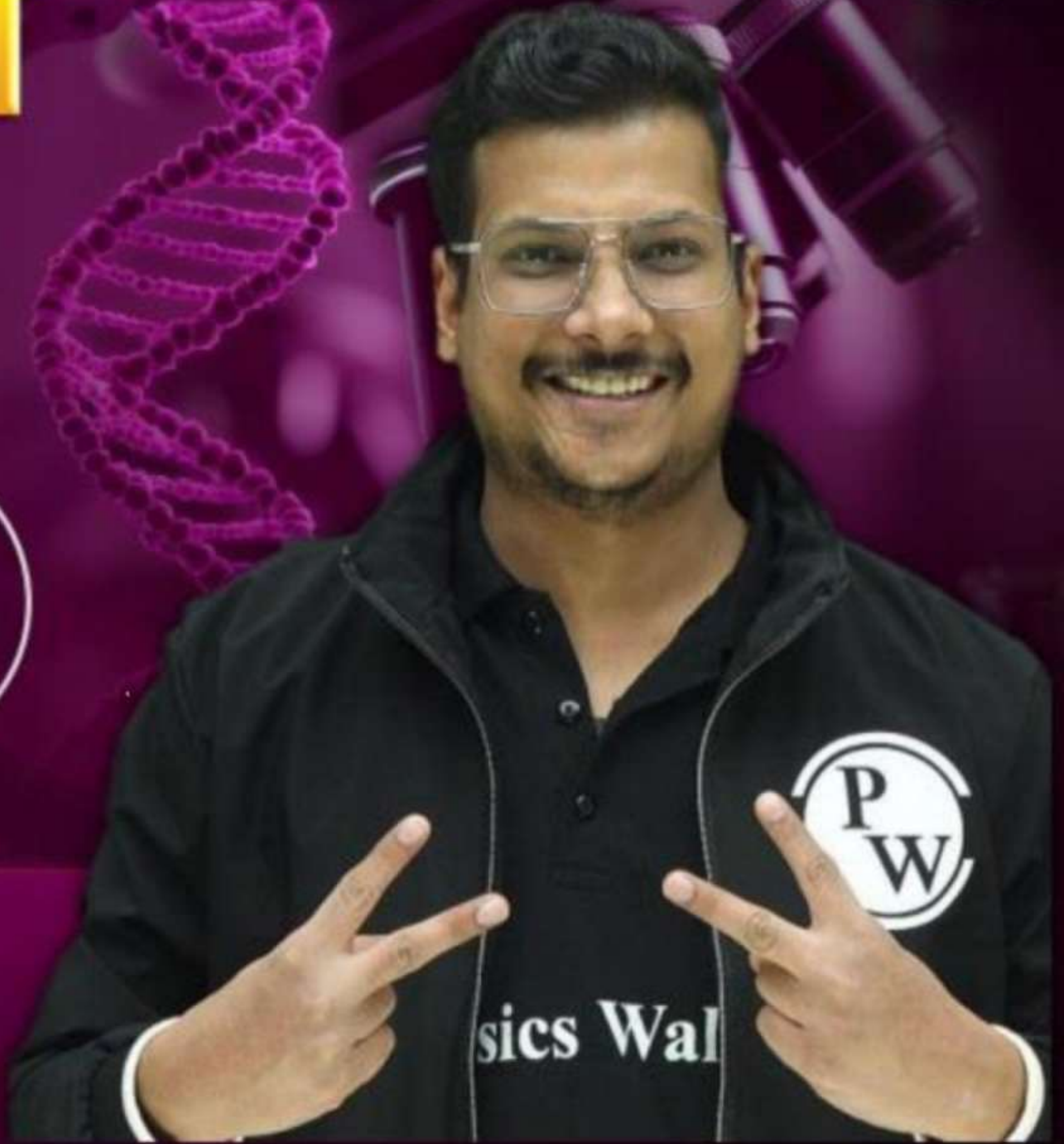
PRACHAND NEET

ONE SHOT

PHYSICS

Wave Optics [redacted]

TANUJ BANSAL SIR (TBS)



Topics *to be covered*

1. ✓ Theories of Light, Wavefront
2. ✓ Huygen's Wave Theory, Interference
3. ✓ YDSE,, Changes in YDSE
4. ✓ Diffraction, Polarization

चलिए शुरू करते हैं

TBS Army – Tanuj Sir

TANUJ SIR

JOIN MY OFFICIAL TELEGRAM CHANNEL

@PHYSICSBY_TANUJSIR

YAKEEN
NEET

Theories of Light

1. **Newton Corpuscle theory**

According to this theory, light consists of tiny elastic material particles called corpuscles.

Reflection ✓
Refraction ✓
Inteference ×
Diffraction ×
Polarization ×

This chapter

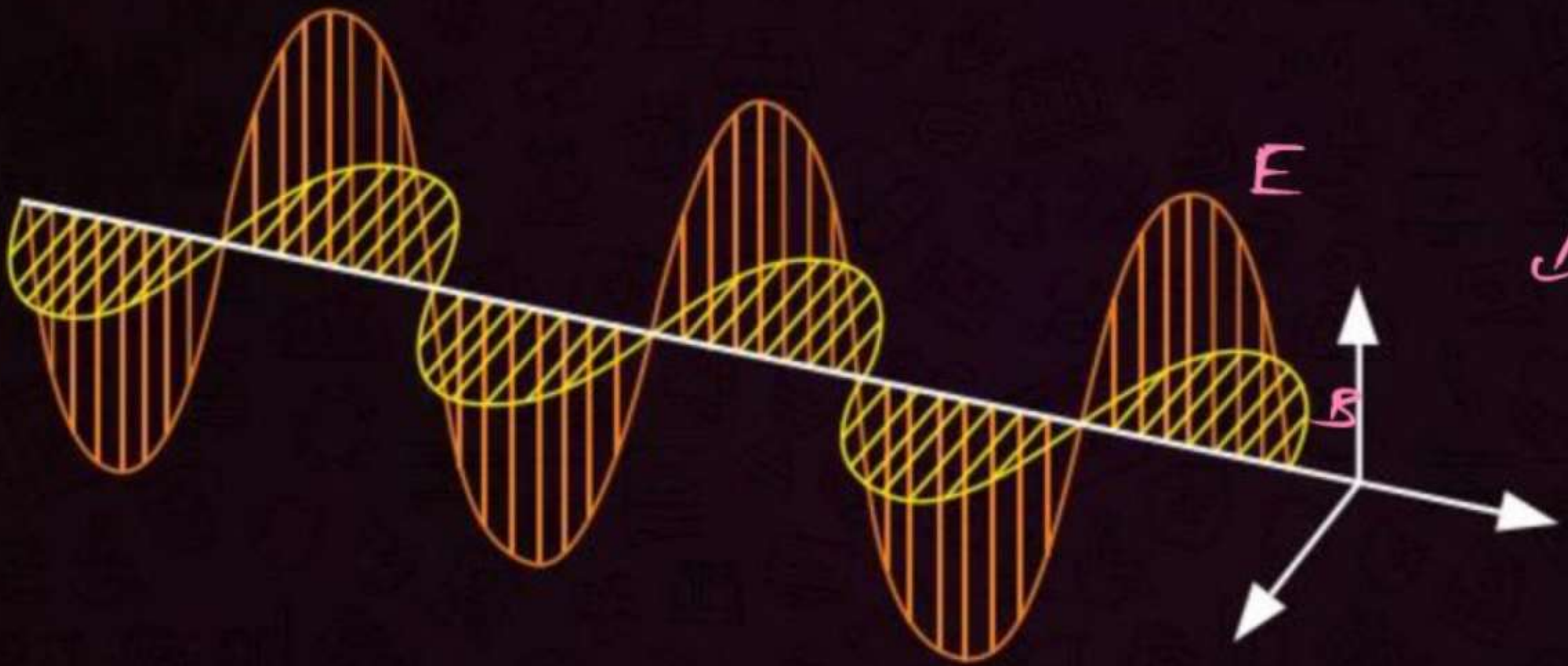
2. **Huygen's Wave theory**

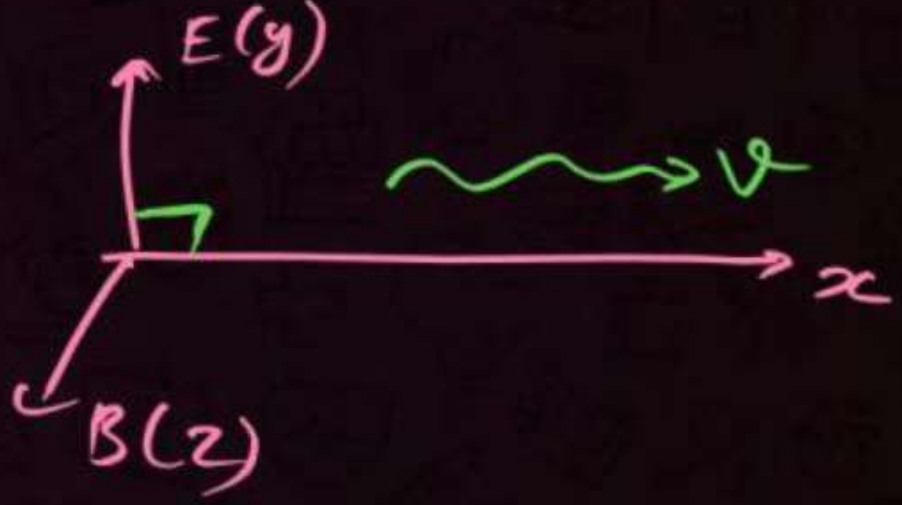
- Light is a wave. ✓
- Longitudinal wave ✗

Reflection ✓
Refraction ✓
Interference ✓
Diffraction ✓
Polarization ✗

3. Maxwell's Electromagnetic theory – (EM)

Light is transverse and non-mechanical wave





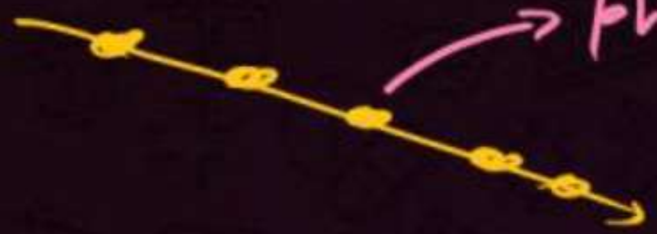
Polarization ✓

Photo-electric effect ✗

4. Einstein's Quantum theory

Light propagates in the form of packets of light energy called quanta.

(photon)



→ photon

$E = h\nu = \frac{hc}{\lambda}$

Photo-electric effect ✓

Interference ×

Diffraction ×

Polarization ×

Moglie
⇓
Cousin

5. De-Broglie theory

→ Particle & wave nature

Depending on situation, one character dominates.

Light shows dual nature.

↓

Dogli

QUESTION

Electromagnetic wave theory could not explain..........

① Interference

② Diffraction

③ Polarization

[✓ ④ Photoelectric effect]

QUESTION

According to quantum theory light propagates in the form of ......

① Particle

② Wave

[✓ ③ Packet of energy (photon)]

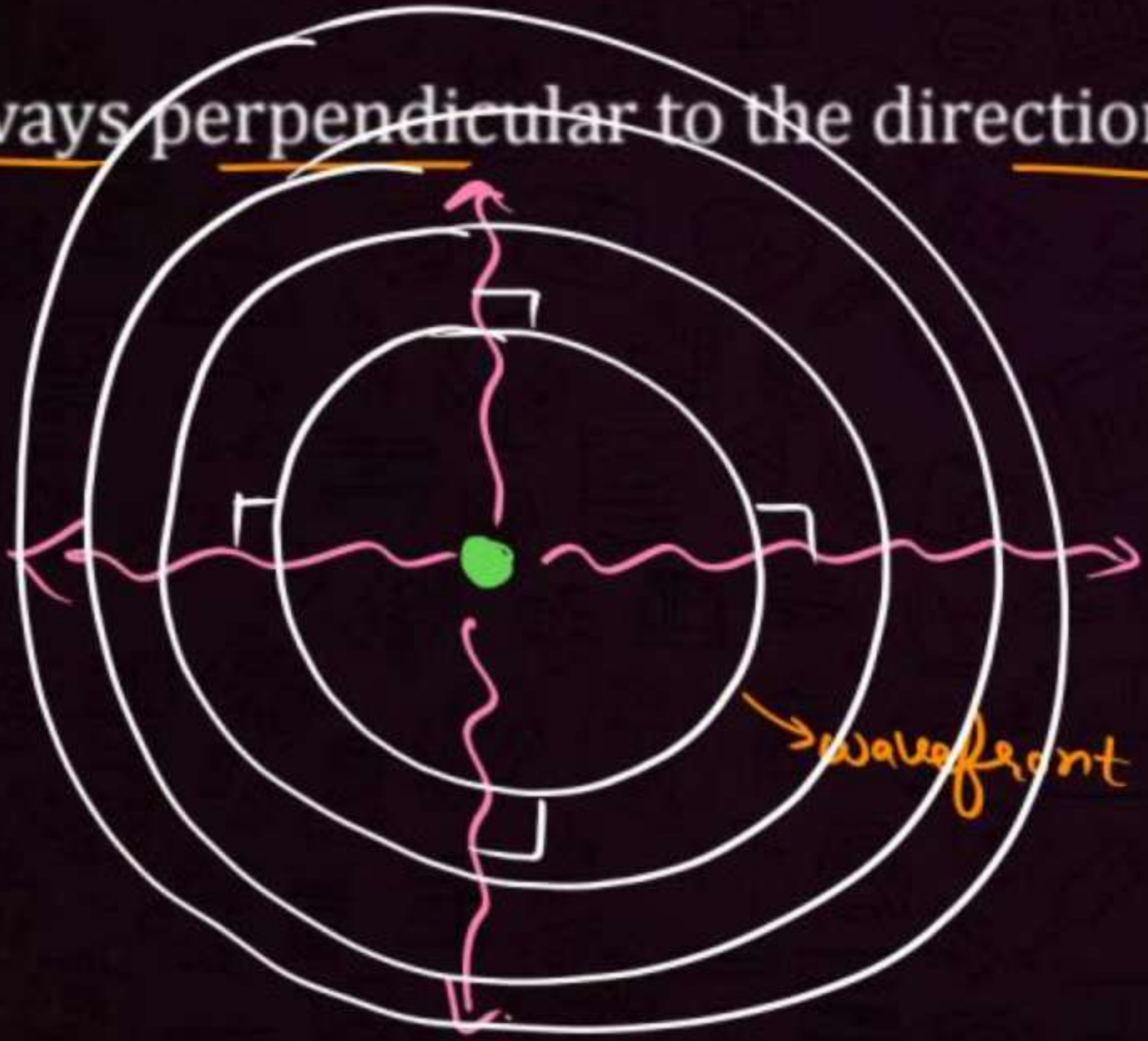
④ None of the above

Wave-front

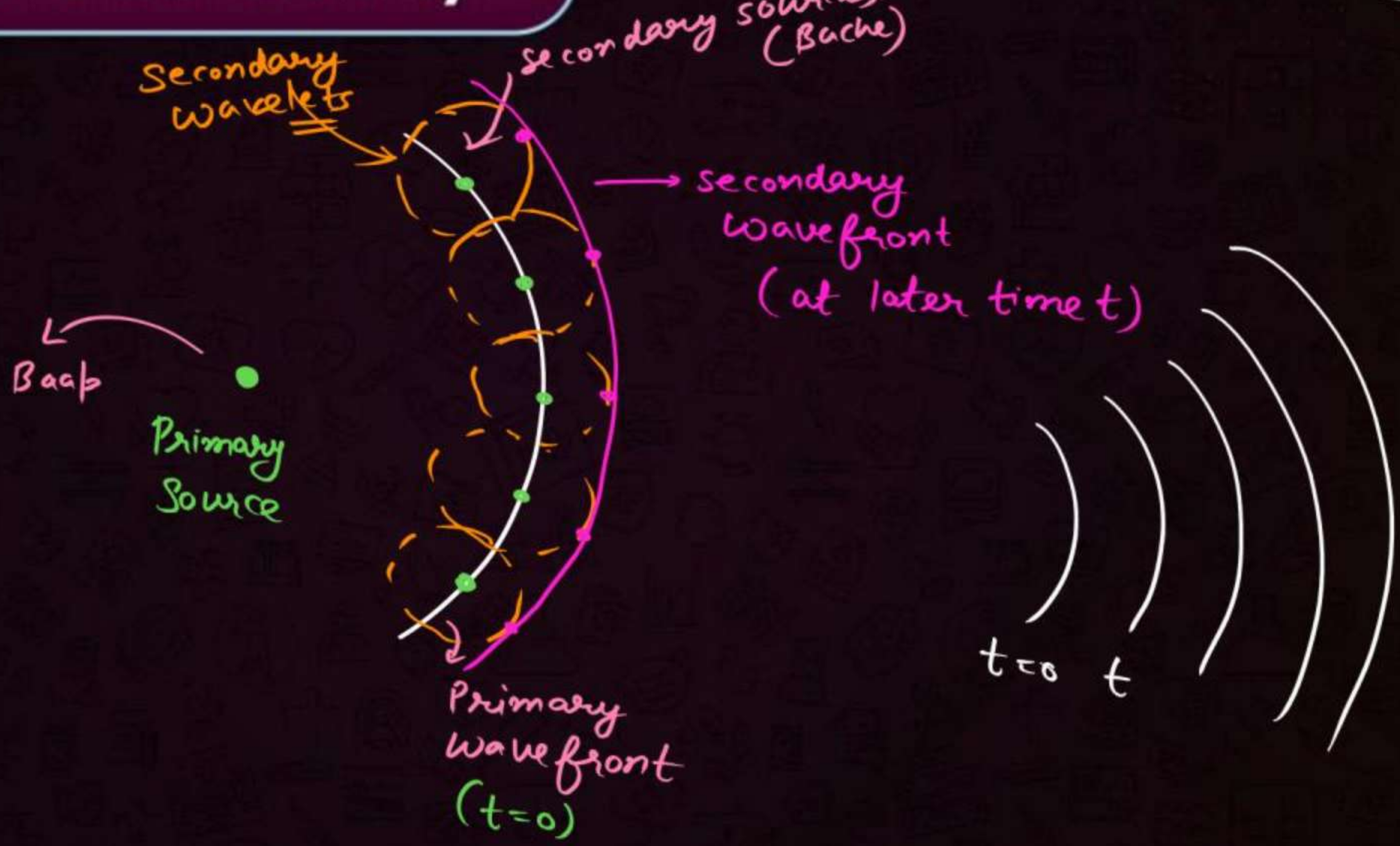
(path)

1. The locus of all the points vibrating in the same phase is called wave-front

2. It is always perpendicular to the direction of propagation of wave.



Huygen's Wave Theory



1. Each point on wavefront acts as source of secondary disturbance/wavelets, which travel uniformly in all the directions with speed of light.

2. The common tangent to these wavelets in the forward direction is called secondary ↑ wavefront.

QUESTION

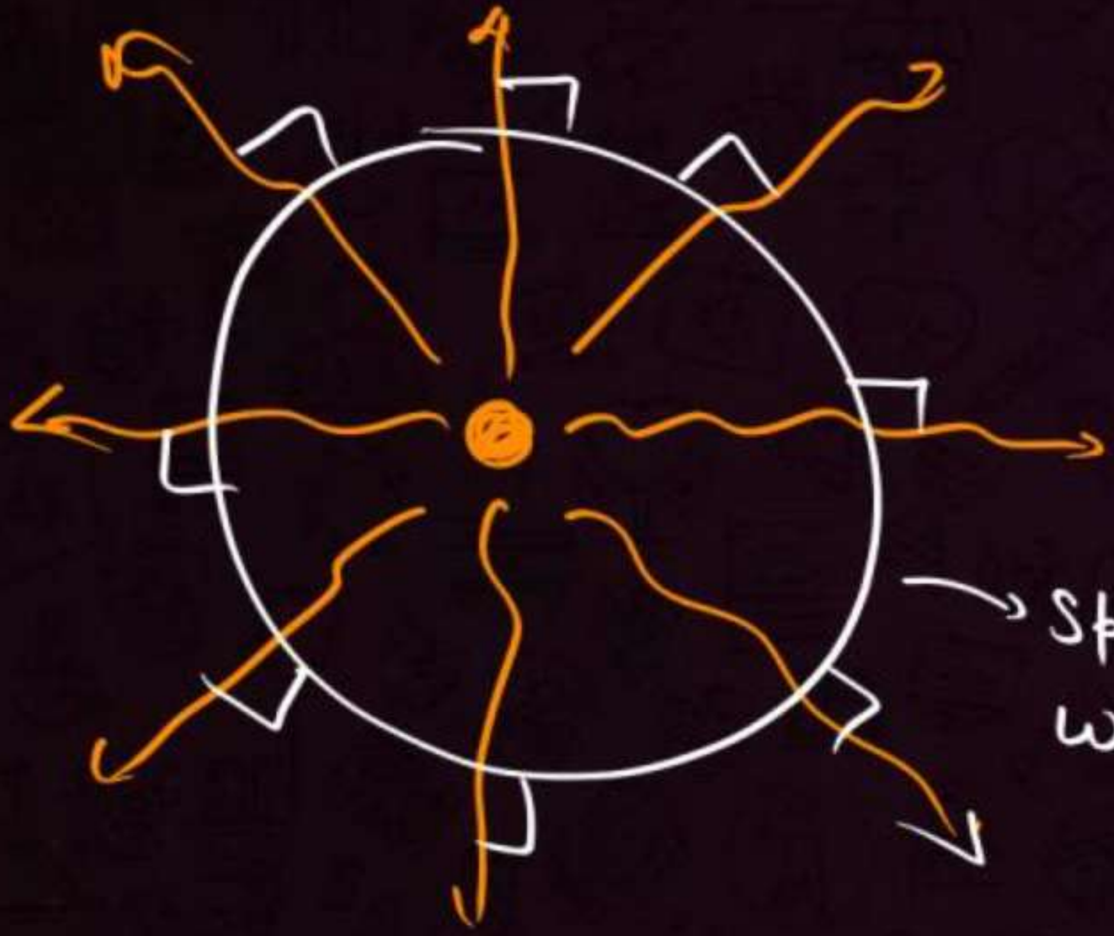
Huygen's principle of secondary wavelets may be used to

→ Refraction → 12th derivation

1. Explain Snell's law ✓
2. Find velocity of light in vacuum ✗
3. Find new position of a wavefront ✓
4. ✓ Both (a) and (c) are correct

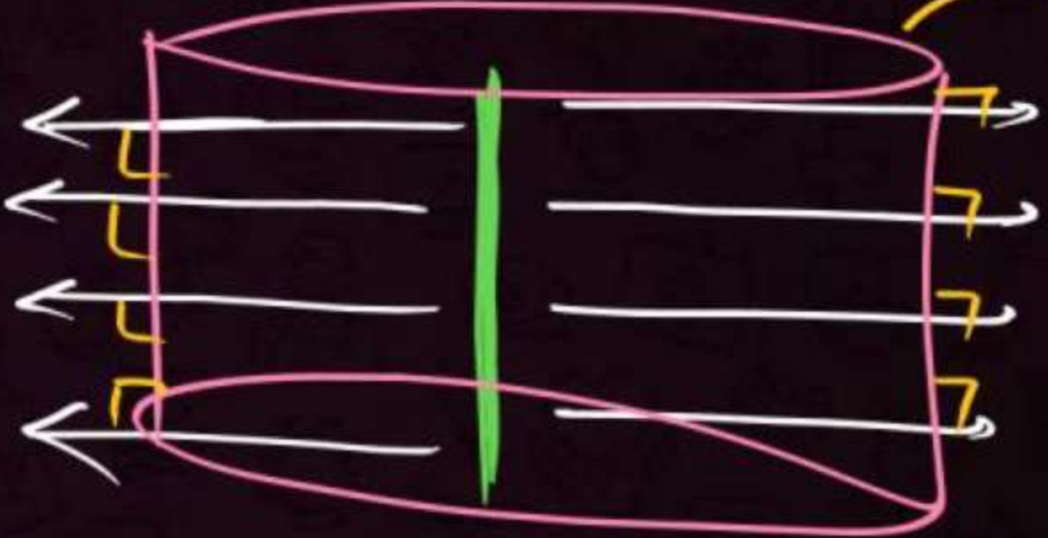
Shape of Wave-fronts

① Point source (Bulb)



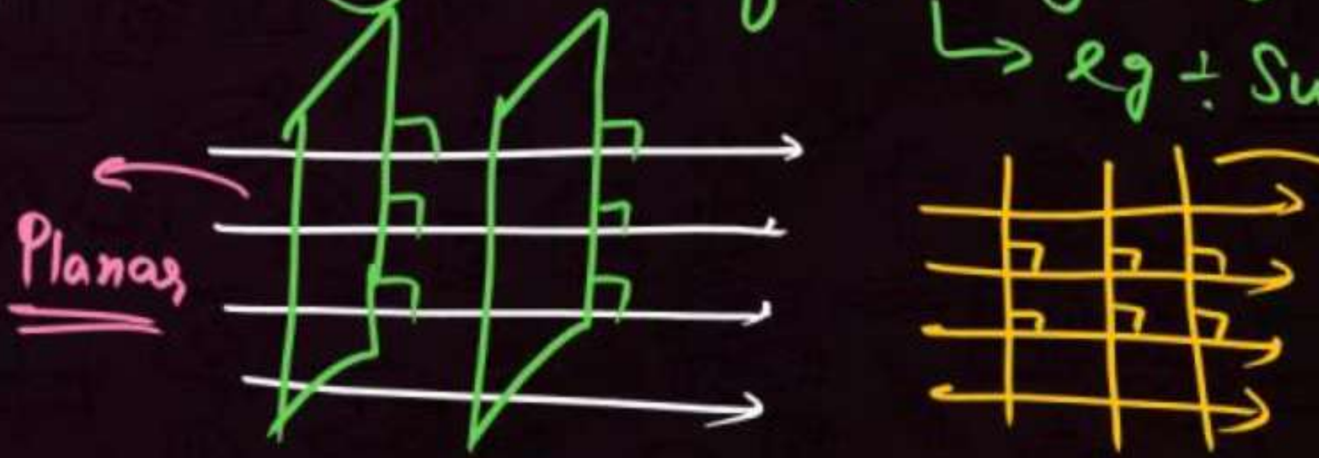
Spherical wavefront

② Line source (eg: Tube-Light)



cylindrical W.F.

③ Source far away (infinity)
↳ eg: Sun

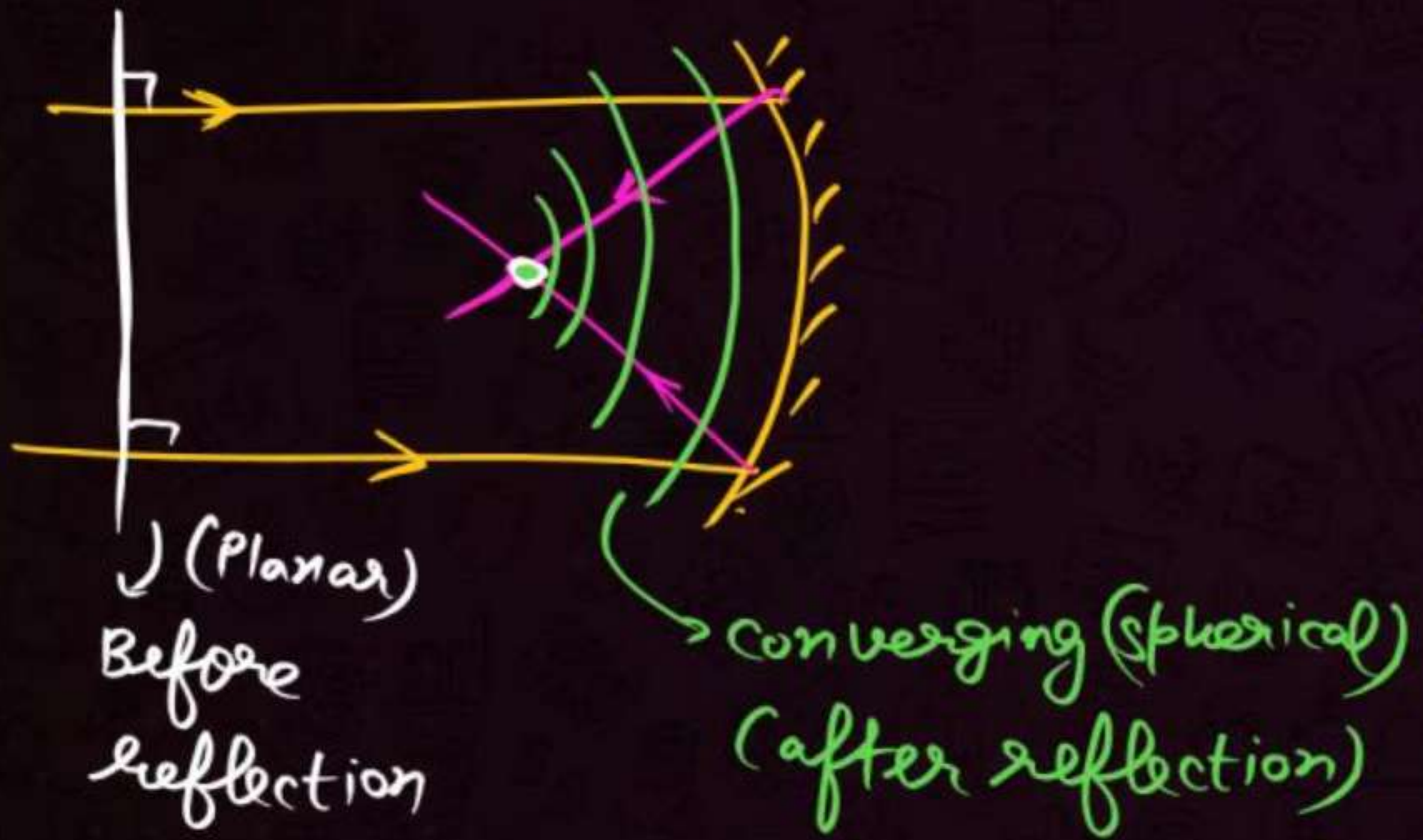


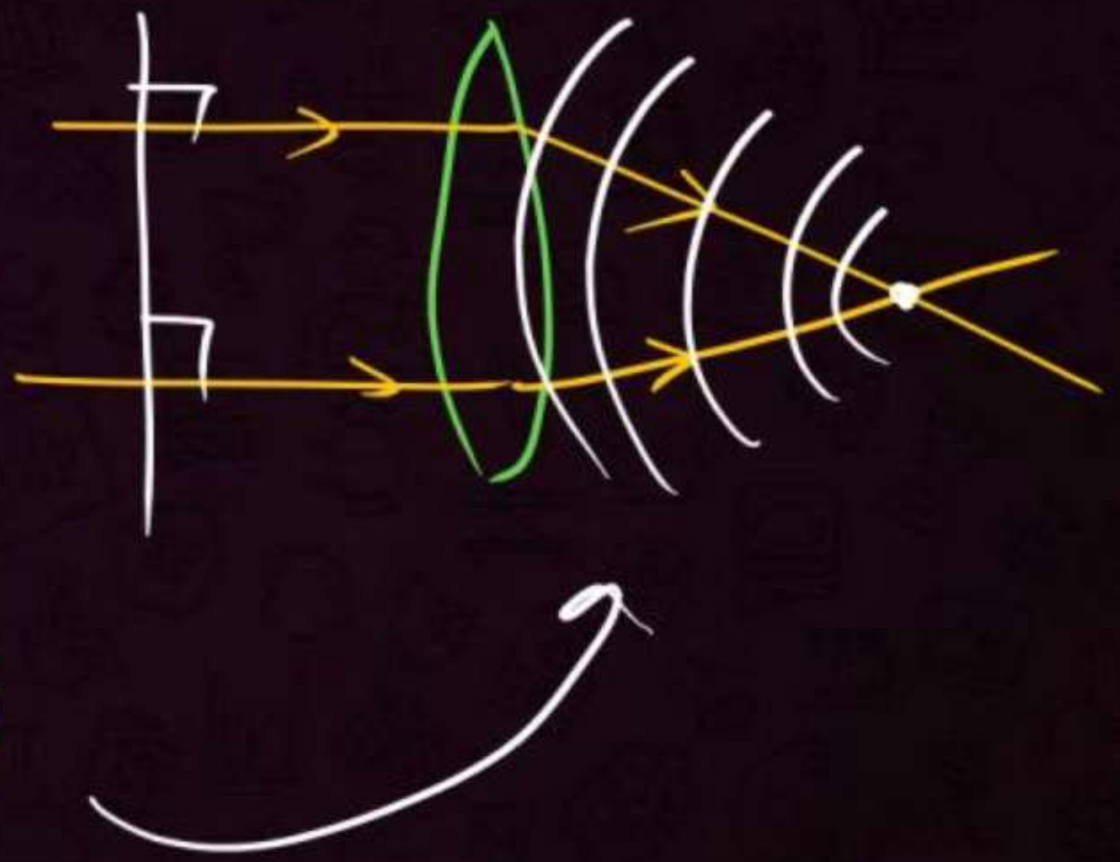
Planar

Shown by a line

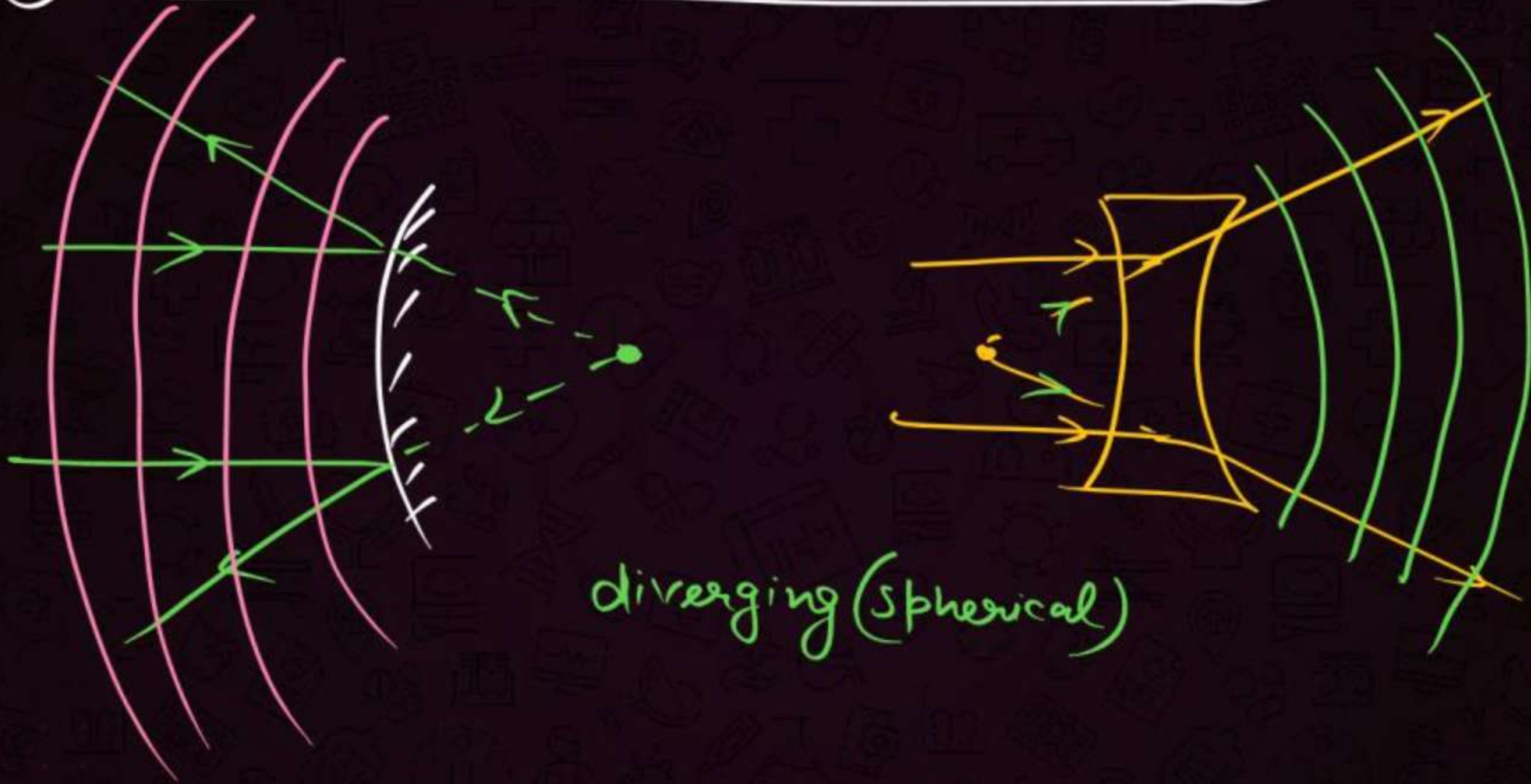
Wave-fronts from optical devices

① Concave Mirror & Convex Lens (in air)

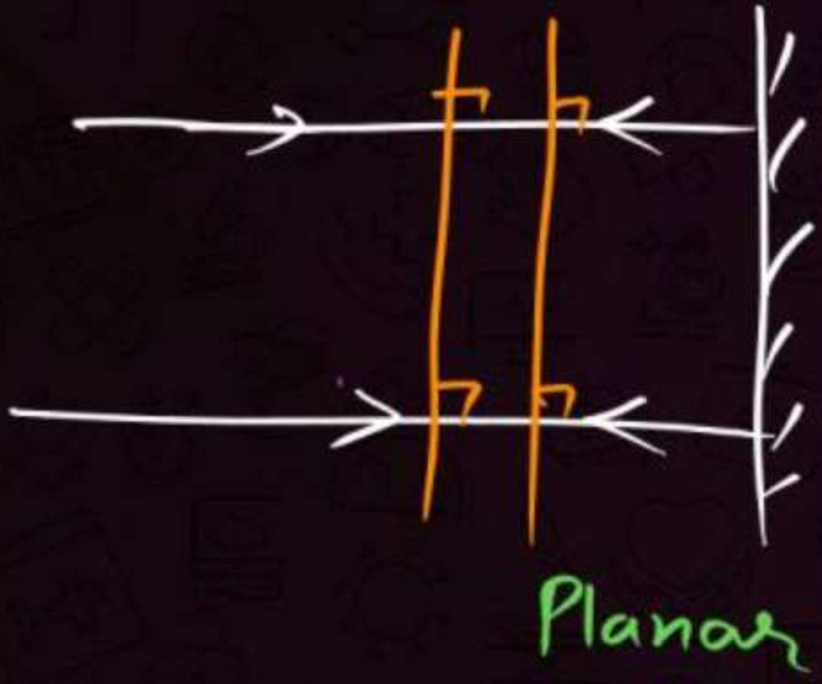


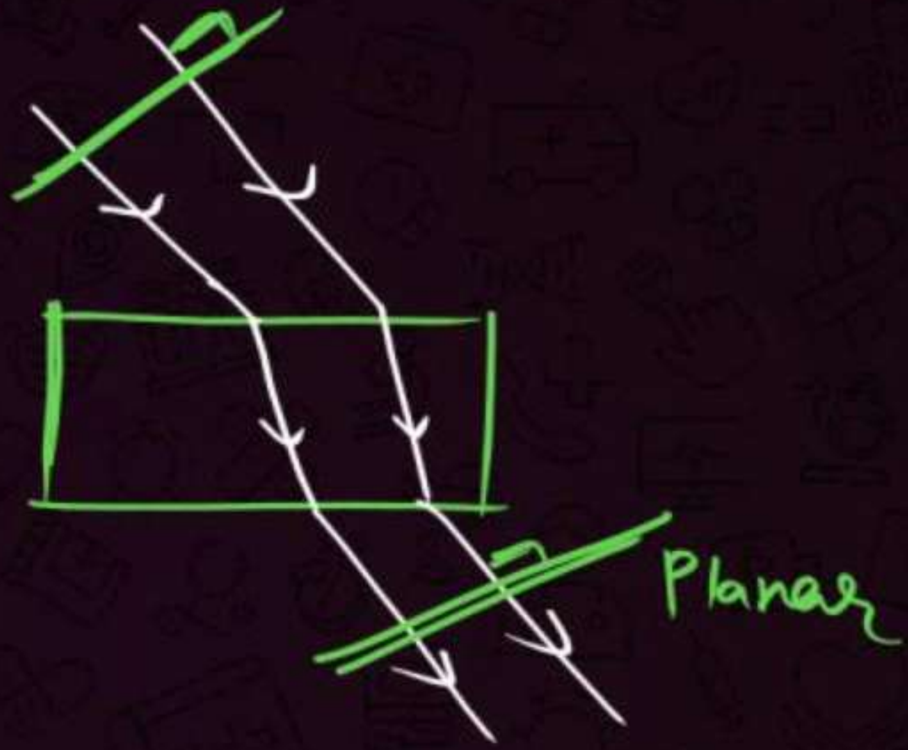


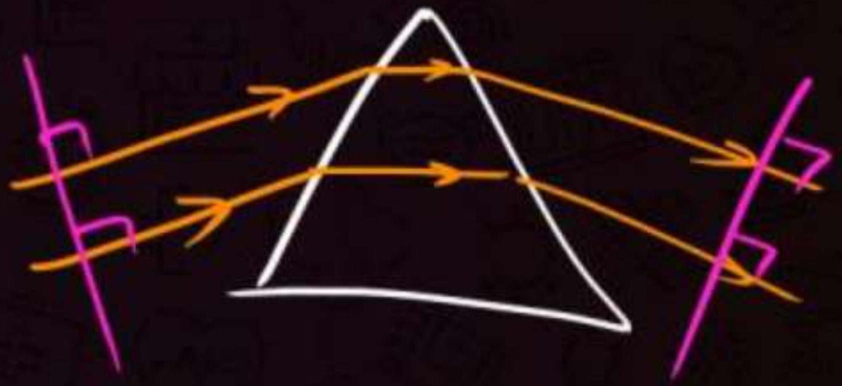
(2) Convex Mirror & concave Lens (in air)



③ Plane Mirror, Glass Slab, Prism







QUESTION

The shape of reflected wavefronts in case of reflection of plane wave from concave mirror is

↓
converging spherical

① [✓ Spherical]

② Plane

③ Cylindrical

④ Both (b) and (c)

QUESTION

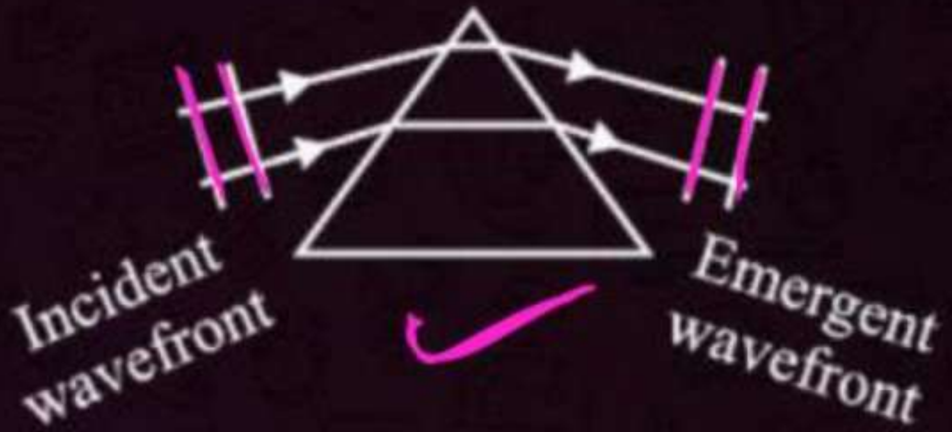
Shapes of wavefront is shown in following figures. The correct shape of wavefront according to the directions of rays are represented in figures

① (i) and (ii) both

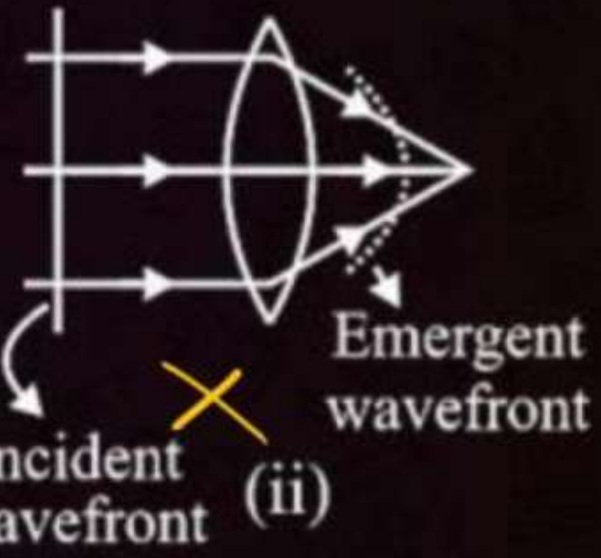
② (ii) and (iii) both

[✓ ③] (i) and (iii) both

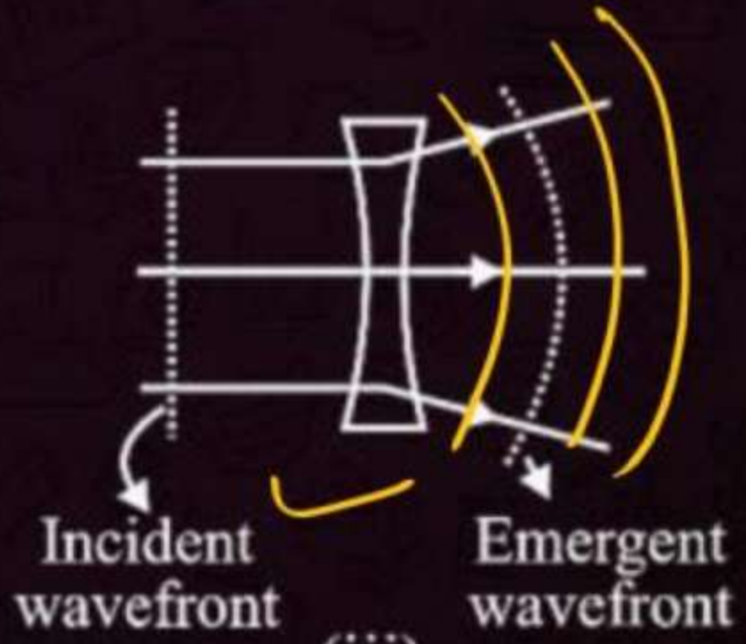
④ (iii) and (iv) both



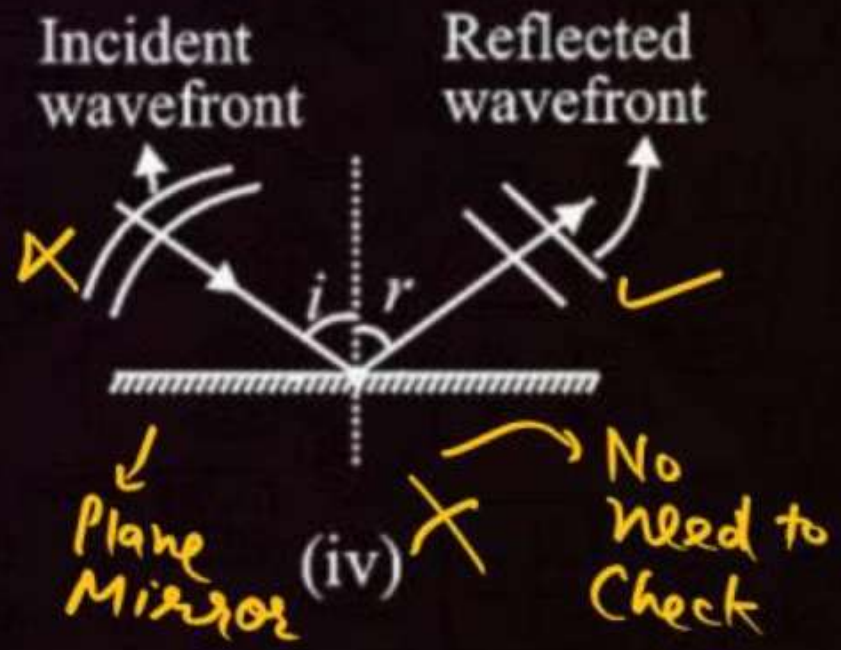
(i)



(ii)



(iii)



(iv)

Super-position of waves

↓ vector addition

The resultant displacement of a wave at any instant is the vector addition of the displacement due to individual waves.

$$\boxed{\text{Phase difference} = \Delta\phi = \phi}$$

$$y_1 = \underline{A_1} \sin(\underline{\omega t - kx})$$

$$y_2 = \underline{A_2} \sin(\underline{\omega t - kx} + \boxed{\phi})$$

$$\boxed{\vec{y} = \vec{y}_1 + \vec{y}_2}$$

Coherent Sources

The sources which have zero phase difference or constant phase difference between them (i.e. time independent)

eg :- ① $y_1 = A_1 \sin(\omega t - kx)$

$y_2 = A_2 \sin(\omega t - kx)$

$$\boxed{\Delta\phi = 0}$$

Coherent ✓

② $y_1 = A_1 \sin(\omega t - kx)$

$y_2 = A_2 \sin(\omega t - kx + \phi)$

$\Delta\phi = \phi \rightarrow$ const.

Coherent ✓

③ $y_1 = A_1 \sin(\underbrace{\omega_1 t - kx}_{\phi_1})$

$y_2 = A_2 \sin(\underbrace{\omega_2 t - kx}_{\phi_2})$

$\omega_1 \neq \omega_2$

$f_1 \neq f_2$

$$\Delta\phi = \phi_2 - \phi_1$$

$$= (\omega_2 t - kx) - (\omega_1 t - kx)$$

$$= \omega_2 t - \cancel{kx} - \omega_1 t + \cancel{kx}$$

$$\Delta\phi = (\omega_2 - \omega_1) t$$

↳ time dependent

coherent ✗

Incoherent ✓

Interference

→ Type of super-position

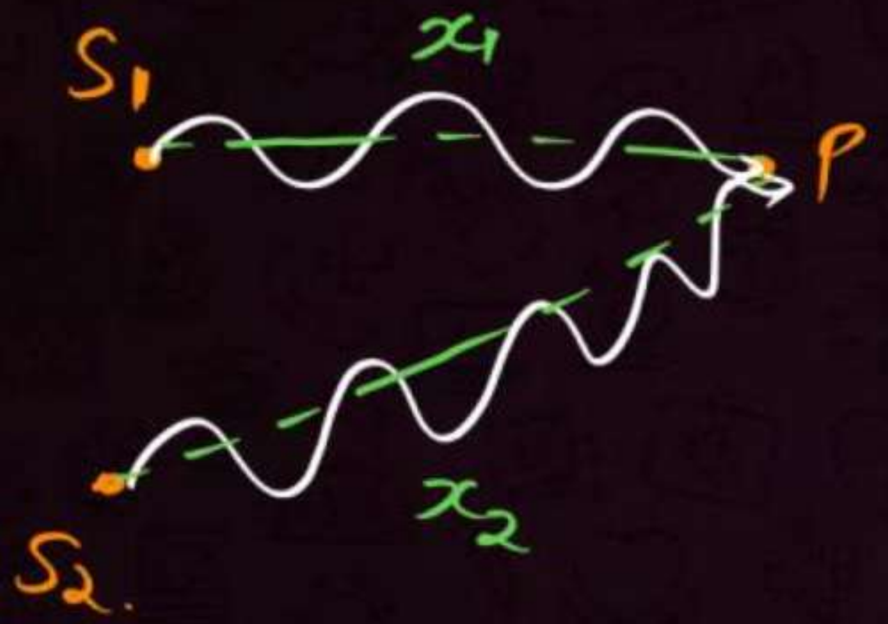
The superposition of waves with same frequency and same wavelength.

$f_1 = f_2$ $\qquad$ $\lambda_1 = \lambda_2$

$$\omega_1 = \omega_2 \longleftrightarrow k_1 = k_2$$

$\omega = 2\pi f$ $\qquad$ $k = \frac{2\pi}{\lambda}$

Path Difference and Phase Difference



$$\Delta x = x_2 - x_1 = x$$

$$\Delta\phi = \phi_2 - \phi_1 = \phi$$

$$\boxed{\begin{array}{c} \Delta\phi = \frac{2\pi}{\lambda}\Delta x \\ \hline \Delta x = \frac{\lambda}{2\pi}\Delta\phi \end{array}}$$

$$\Longrightarrow \boxed{\Delta\phi = k\,\Delta x}$$

QUESTION

Interference occurs in which of the following waves? [AIIMS 1999]

Learn

① Transverse

② Longitudinal

③ Electromagnetic

[✓ ④ All of these.]

QUESTION

The ratio of path difference and the corresponding phase difference is.....

[✓ ① $\lambda/2\pi$]

$$\frac{\Delta x}{\Delta \phi} = \frac{\lambda}{2\pi}$$

② π/λ

③ λ/π

④ $2\pi/\lambda$

Ques

- $\Delta x = \frac{\lambda}{6} \longrightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \frac{\pi}{3}$

- $\Delta x = \frac{\lambda}{3} \longrightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \frac{2\pi}{3}$

Learn ←

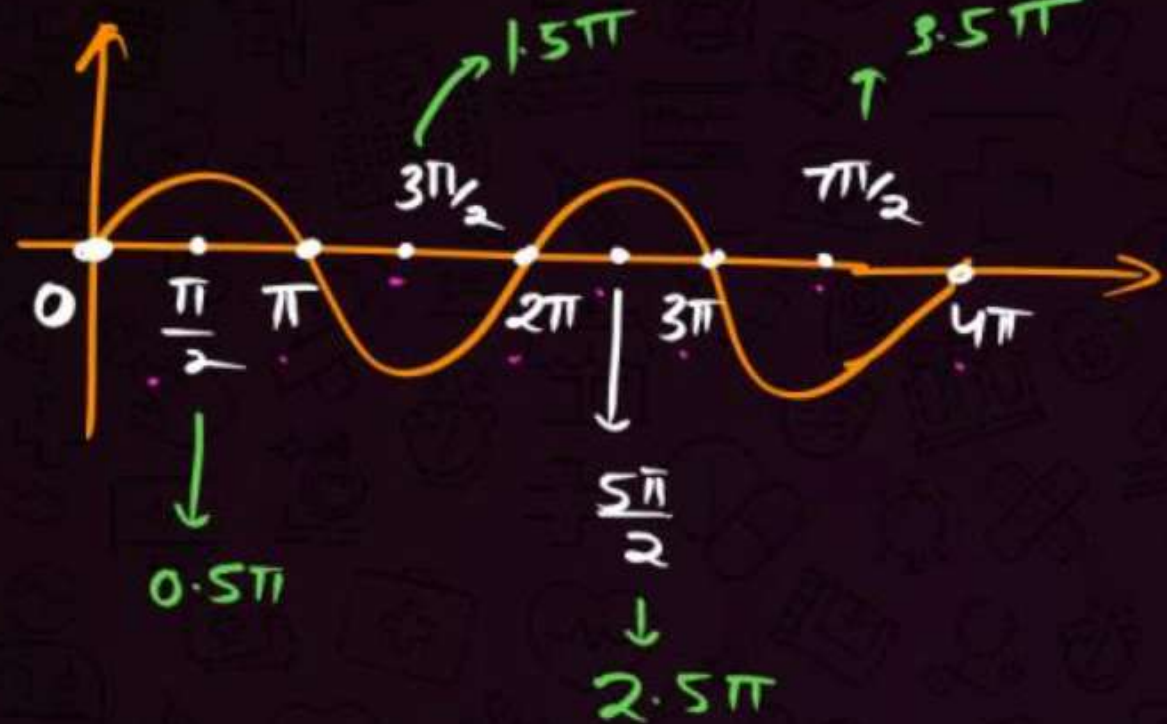
- $\Delta x = \boxed{\frac{\lambda}{2}} \longrightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{2} = \boxed{\pi}$
- $\Delta x = \boxed{\lambda} \longrightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \lambda = \boxed{2\pi}$

- $\Delta x = 2\lambda \longrightarrow \Delta\phi = \frac{2\pi}{\lambda} \times 2\lambda = 4\pi$
- $\Delta x = \frac{3\lambda}{2} \longrightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \frac{3\lambda}{2} = 3\pi$

Pattern

$\lambda \longrightarrow \pi$

2 → Multiply

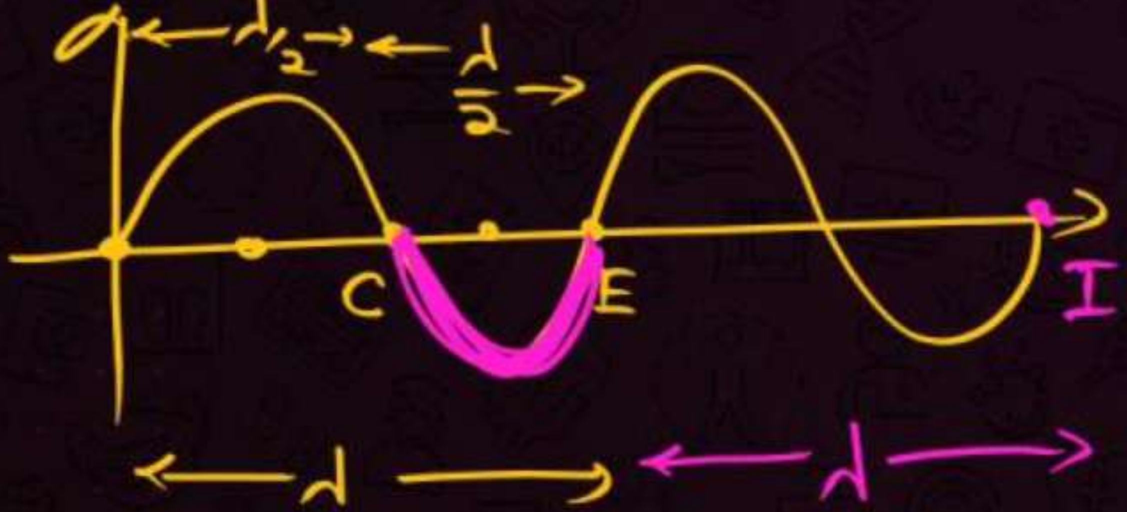


Path diff

$CE \Rightarrow \Delta\phi = 2\pi - \pi = \pi \longrightarrow \lambda/2$

$AD \Rightarrow \Delta\phi = 1.5\pi - 0 = 1.5\pi = \frac{3\pi}{2} \rightarrow \frac{3\lambda}{4}$

$EI \Rightarrow \Delta\phi = 4\pi - 2\pi = 2\pi \longrightarrow \lambda$



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

$$= \frac{\lambda}{2\pi} \times \pi = \frac{\lambda}{2}$$

$$\frac{\lambda}{\cancel{2\pi}} \times \frac{3\cancel{\pi}}{2} = \frac{3\lambda}{4}$$

$$\frac{\lambda}{2\pi} \times 2\pi = \lambda$$

Resultant Amplitude and Intensity

$y_1 = A_1 \sin(\omega t - kx)$

$y_2 = A_2 \sin(\omega t - kx + \phi)$

$$\boxed{A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}}$$

→ Vector addition

↓ Resultant amplitude

→ $A^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$

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

11th class

↓

Wave.

↓

$\boxed{I \propto A^2}$

→ Intensity

$A^2 \propto I$

$A \propto \sqrt{I}$

① Constructive

* $\boxed{\cos\phi = +1} \longrightarrow \max^{m}$
* $\Delta\phi$ or $\phi = 0, \pm 2\pi, \pm 4\pi, \pm 6\pi, \ldots$

$\boxed{\phi = \pm 2n\pi}$

$n = 0, 1, 2, 3, \ldots$

(even multible of π)

* $\boxed{A_{max} = A_1 + A_2}$
* $\boxed{I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2}$
* $\boxed{\Delta x = \pm n\lambda}$ $n = 0, 1, 2, 3, \ldots$

$\Delta x = 0, \pm\lambda, \pm 2\lambda, \pm 3\lambda, \pm 4\lambda \ldots$

↳ multible of λ

② Destructive

* $\boxed{\cos\phi = -1} \longrightarrow \min^{m}$
* $\Delta\phi = \pm\pi, \pm 3\pi, \pm 5\pi, \pm 7\pi, \ldots$

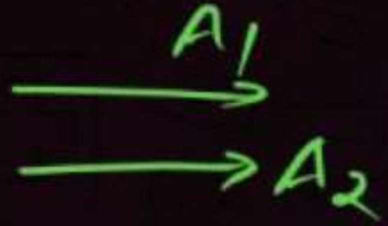
$\boxed{\Delta\phi = \pm(2n-1)\pi}$

$n = 1, 2, 3, 4, \ldots$

(odd multible of π)

* $\boxed{A_{min} = A_1 - A_2}$ or $A_2 - A_1$
* $\boxed{I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2}$
* $\boxed{\Delta x = \pm(2n-1)\frac{\lambda}{2}}$ $n = 1, 2, 3, 4, \ldots$

$\Delta x = \pm\frac{\lambda}{2}, \pm\frac{3\lambda}{2}, \pm\frac{5\lambda}{2}$ ⟷ odd multible of $\frac{\lambda}{2}$.



constructive

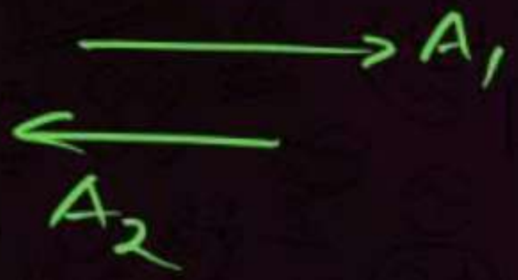
$\cos 0 = 1$

$\cos 2\pi = 1$

$\cos 4\pi = 1$

$\cos 6\pi = 1$

$\cos 8\pi = 1$



Destructive

$(2n-1)\pi$

$n=1 \Rightarrow (2\times1-1)\pi = \pi$

$n=2 \Rightarrow (2\times2-1)\pi = 3\pi$

$n=3 \Rightarrow (2\times3-1)\pi = 5\pi$

$\cos\pi = \cos 180^\circ = -1$

$\cos 3\pi = -1$

$\cos 5\pi = -1$

$\cos 7\pi = -1$

* $\Delta\phi = 2n\pi$

$$\Delta x = \frac{\lambda}{\cancel{2\pi}} \times \cancel{2}n\cancel{\pi}$$

$$\Delta x = n\lambda$$

$0, 2\pi, 4\pi, 6\pi, \text{---}$

$\downarrow$

$0, \lambda, 2\lambda, 3\lambda, \text{----}$

$\Delta\phi = (2n-1)\pi$

$$\Delta x = \frac{\lambda}{2\cancel{\pi}} \times (2n-1)\cancel{\pi}$$

$$\Delta x = (2n-1)\frac{\lambda}{2}$$

$\pi, 3\pi, 5\pi, 7\pi, \text{---}$

$\downarrow$

$\frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \frac{7\lambda}{2} \text{----}$

QUESTION

$\uparrow I_1$ $\uparrow I_2$

Two sources with intensity I_0 and $4I_0$ interfere constructively at a point. The intensity at that point would be

1. $5\,I_0$
2. $3\,I_0$
3. $2\,I_0$
4. [✓ $9\,I_0$]

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

$$= \left(\sqrt{I_0} + \sqrt{4I_0}\right)^2$$

$$= \left(\sqrt{I_0} + 2\sqrt{I_0}\right)^2$$

$$= \left(3\sqrt{I_0}\right)^2 = 9I_0$$

$$I_{max} = \left(\sqrt{1} + \sqrt{4}\right)^2$$

$$= (1+2)^2$$

$$= 3^2 = 9$$

$\downarrow$

TBS

QUESTION

Intensity of two waves are 9I and I respectively. Find out resultant intensity if phase difference between them is π.

↳ Dest.

(1) 3I

[✓ (2) 4I]

(3) 5I

(4) 6I

$$I_{min} = \left(\sqrt{9} - \sqrt{1}\right)^2 = (3-1)^2 = 2^2 = 4$$

$$I_{max} = \left(\sqrt{9} + \sqrt{1}\right)^2 = (3+1)^2 = 4^2 = 16$$

QUESTION

$\overset{1}{\uparrow}$ $\overset{4}{\uparrow}$

In an interference, the intensity of two interfering waves are I and 4I respectively. They produce intensity at two points A and B with phase angle of π/2 and π respectively. Then difference in $\overset{\text{intensity}}{\wedge}$ between them is **[AIIMS 2011]**

① I

② 2I

[✓ ③] 4I

④ 5I

$$I_1 = I$$

$$I_2 = 4I$$

π/2 → cons × dest × (I')

π → Dest. (I'')

$$I' = I + 4I = \boxed{5I}$$

$$I'' = (\sqrt{4} - \sqrt{1})^2$$

$$= (2-1)^2 = 1^2 = 1$$

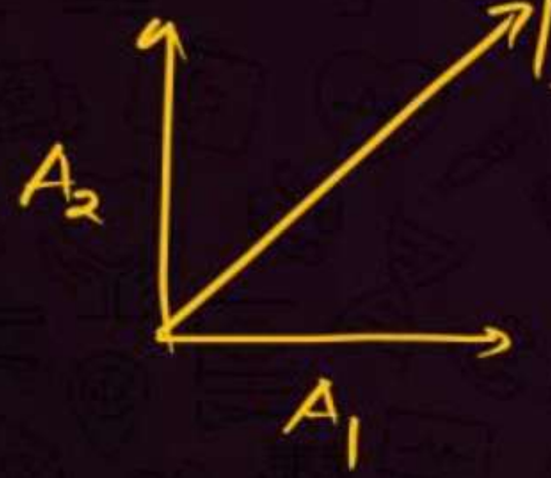
$$\boxed{I'' = \boxed{I}}$$

$$I' - I'' = 5I - I$$

$$= 4I$$

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos 90^\circ$$

✓ $$\boxed{I = I_1 + I_2} \longrightarrow \phi = 90^\circ = \frac{\pi}{2}.$$



$$\boxed{A = \sqrt{A_1^2 + A_2^2}}$$

QUESTION

(single colour)

Two coherent monochromatic light beams of amplitude 3 and 5 units are superposed. The maximum and minimum possible intensities in the resulting beams are in the ratio

[AIIMS 2001]

① 4 : 2

[✓ ② 16 : 1]

③ 8 : 2

④ 4 : 2

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

$$\boxed{\frac{A \propto \sqrt{I}}{A^2 \propto I}}$$

$$\boxed{\frac{I_{max}}{I_{min}} = \left(\frac{A_1+A_2}{A_1-A_2}\right)^2} \longrightarrow \left(\frac{3+5}{3-5}\right)^2 = \frac{8^2}{(-2)^2} = \frac{64}{4} = \frac{16}{1}$$

$$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (A_1 + A_2)^2$$

$$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2 = (A_1 - A_2)^2$$

QUESTION

$A_1 \nearrow A_2$

Two waves having amplitudes in the ratio 5 : 1 produce interference. The ratio of the maximum to the minimum intensity is......

① 25 : 1

② 6 : 4

[✓ ③ 9 : 4]

④ 9 : 2

$$\frac{I_{max}}{I_{min}} = \left(\frac{5+1}{5-1}\right)^2 = \left(\frac{6}{4}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

QUESTION

$\uparrow I_1 \quad \nearrow I_2.$

The ratio of intensities of two waves is 9 : 1. They are producing interference. The ratio of maximum and minimum intensities will be

① 10 : 8

② 9 : 1

[✓ ③ 4 : 1]

④ 2 : 1

$$\frac{I_1}{I_2} = \frac{9}{1}$$

$$\frac{I_{max}}{I_{min}} = ?$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{9}+\sqrt{1}}{\sqrt{9}-\sqrt{1}}\right)^2$$

$$= \left(\frac{3+1}{3-1}\right)^2 = \left(\frac{4}{2}\right)^2 = \left(\frac{2}{1}\right)^2 = \frac{4}{1}$$

QUESTION

The intensity ratio of the maxima and minima in an interference pattern produced by two coherent sources of light is 9 : 1. The intensities of the used light sources are in ratio

[AIIMS 2016]

① 3 : 1

[✓ ② 4 : 1]

③ 9 : 1

④ 10 : 1

$$\frac{I_{max}}{I_{min}} = \frac{9}{1} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$$

$$\frac{I_1}{I_2} = ?$$

$$\hookrightarrow \frac{3}{1} = \frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}$$

$$3\sqrt{I_1} - 3\sqrt{I_2} = \sqrt{I_1}+\sqrt{I_2}$$

$$3\sqrt{I_1} - \sqrt{I_1} = \sqrt{I_2} + 3\sqrt{I_2}$$

$$\cancel{2}\sqrt{I_1} = \overset{2}{\cancel{4}}\sqrt{I_2}$$

$$\frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{2}{1}$$

$$\frac{I_1}{I_2} = \frac{4}{1}$$

$$\begin{tikzcd}
\frac{I_1}{I_2}=\frac{9}{1} \arrow[drr] & & \frac{I_{max}}{I_{min}}=\frac{4}{1} \\
\frac{I_1}{I_2}=\frac{4}{1} \arrow[urr] & & \frac{I_{max}}{I_{min}}=\frac{9}{1}
\end{tikzcd}$$

$\text{Darshak} \rightleftarrows \text{Fielder}$

QUESTION

The intensity ratio of the maxima and minima in an interference pattern produced by two coherent sources of light is 36 : 1. The intensities of the used light sources are in ratio

[AIIMS 2016]

① 7 : 5

[✓ ② 49 : 25]

③ 6 : 1

④ 1 : 6

$$\frac{I_{max}}{I_{min}} = \frac{36}{1}$$

$$\frac{I_1}{I_2} = ?$$

6

$$\frac{49}{25}$$

$$\xrightarrow{\quad} \frac{I_1}{I_2} = \frac{36}{1}$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{36}+\sqrt{1}}{\sqrt{36}-\sqrt{1}}\right)^2 = \left(\frac{6+1}{6-1}\right)^2$$

$$= \left(\frac{7}{5}\right)^2 = \frac{49}{25}.$$

QUESTION

The path length difference between two waves coming from coherent sources for destructive interference should be

1. Zero ×
2. $(2n)\lambda$ ×
3. $(2n-1)\frac{\lambda}{\boxed{3}}$ ×
4. [✓ $\underline{(2n+1)\frac{\lambda}{2}}$]

$$\boxed{\begin{aligned} \Delta x &= (2n-1)\frac{\lambda}{2} \\ \Delta x &= (2n+1)\frac{\lambda}{2} \end{aligned}}$$

$\Delta x = (2n-1)\frac{\lambda}{2} \Rightarrow n = 1, 2, 3, \ldots \quad n = 1 \rightarrow \boxed{\lambda/2}$

$\Delta x = (2n+1)\frac{\lambda}{2} \Rightarrow n = 0, 1, 2, 3, \ldots \quad n = 0 \rightarrow \boxed{\frac{\lambda}{2}}$

→ Dono hi sahi Hain.

Question

$$\frac{I_1}{I_2} = n = \frac{n}{1}$$

The interference pattern is obtained with two coherent light sources of intensity ratio n. In the interference pattern, the ratio $\frac{I_{\max}-I_{\min}}{I_{\max}+I_{\min}}$ will be $\rightarrow$ F.V. **[NEET-2016 (Phase-2)]**

1. $\frac{\sqrt{n}}{n+1}$
2. $\frac{2\sqrt{n}}{n+1}$
3. $\frac{\sqrt{n}}{(n+1)^2}$
4. $\frac{2\sqrt{n}}{(n+1)^2}$

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

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

$$\frac{I_{max}-I_{min}}{I_{max}+I_{min}} = \frac{2\sqrt{I_1 I_2}+2\sqrt{I_1 I_2}}{2(I_1+I_2)} = \frac{\overset{2}{\cancel{4}}\sqrt{I_1 I_2}}{\cancel{2}(I_1+I_2)}$$

$$= \frac{2\sqrt{I_1 I_2}}{I_1+I_2} = \frac{2\sqrt{n\times 1}}{n+1} = \frac{2\sqrt{n}}{n+1}$$

Identical Sources

$A_1 = A_2 = A_0$

$$\boxed{A = \overset{A_{max}}{2A_0}\cos\left(\frac{\phi}{2}\right)}$$

Square

$I_1 = I_2 = I_0$

$$\boxed{I = \underbrace{4I_0}_{I_{max}}\cos^2\left(\frac{\phi}{2}\right)}$$

$$\underline{\underline{I \propto A^2}}$$

$$\boxed{\begin{array}{c} A_{max} = 2A_0 \\ I_{max} = 4I_0 \\ \hline A_{min} = 0 \\ I_{min} = 0 \end{array}}$$

If $A = B$

$R = 2A\cos\left(\frac{\theta}{2}\right)$

Question

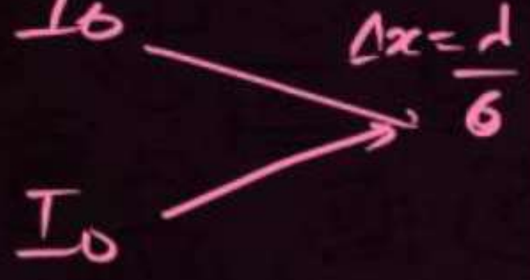
Two sources with each of intensity I_0 interfere at a point where path difference is $\lambda/6$. Find resultant intensity at that point.

[✓ 1] $3\,I_0$

2 $4\,I_0$

3 $2\,I_0$

4 I_0



$$I_1 = I_2 = I_0$$

$$\Delta\phi = \frac{2\pi}{\cancel{\lambda}} \times \frac{\cancel{\lambda}}{6}$$

$$\phi = \frac{2\pi}{6} = \underline{\frac{\pi}{3}}$$

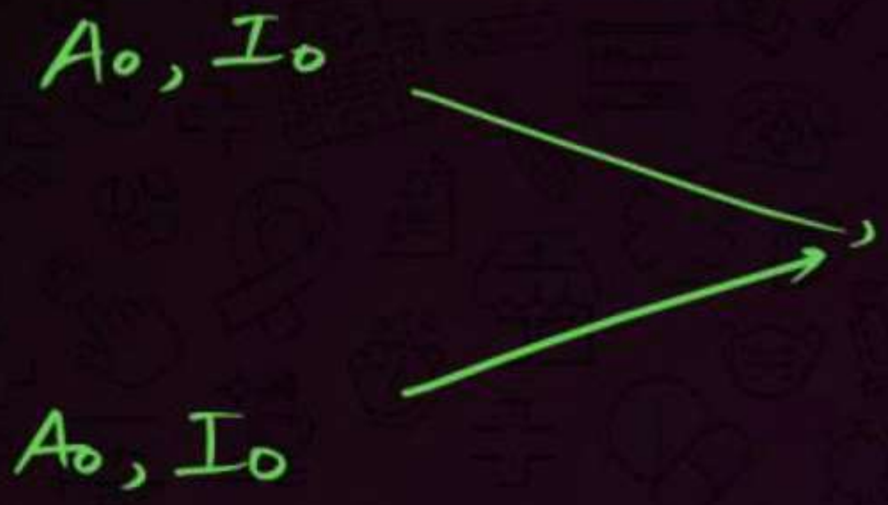
$$\frac{\phi}{2} = \frac{\pi}{6}$$

$$I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$$

$$= 4I_0 \cos^2\left(\frac{\pi}{6}\right)$$

$$= 4I_0 \cos^2 30^\circ$$

$$= 4I_0 \times \left(\frac{\sqrt{3}}{2}\right)^2 = \cancel{4}I_0 \times \frac{3}{\cancel{4}} = \boxed{3I_0}$$



$$I_{max} = \left(\sqrt{I_0} + \sqrt{I_0}\right)^2 = \left(2\sqrt{I_0}\right)^2 = \boxed{4I_0}$$

$$A_{max} = \boxed{2A_0}$$

QUESTION

A_0, A_0

I_0, I_0

Waves of same amplitude and same frequency from two coherent sources overlap at a point. The ratio of the resultant intensity when they arrive in phase to that when they arrive with 90° phase difference is

① 1 : 1

② $\sqrt{2} : 1$

[✓ ③] 2 : 1

④ 4 : 1

$\Delta\phi = 90^\circ$

$I = I_0 + I_0 = 2I_0$

$\Delta\phi = 0 \rightarrow$ const.

$\hookrightarrow \cos\phi = +1$

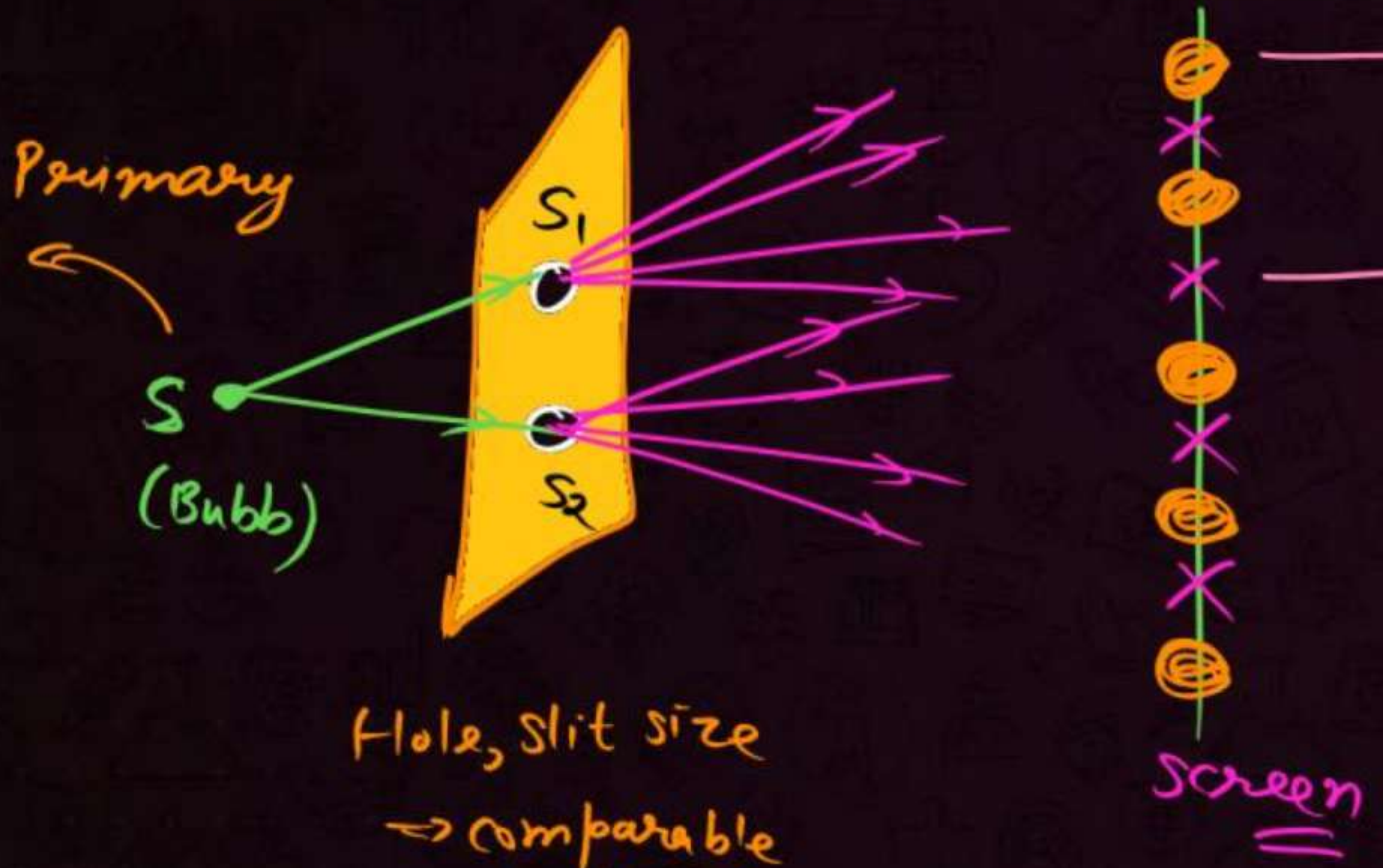
$I_{max} = 4I_0$

$$\frac{4I_0}{2I_0} = \frac{2}{1}$$

$$\boxed{\text{Out of phase} \Rightarrow \Delta\phi = \pi = 180^\circ \\ \downarrow \\ \text{Destructive}}$$

Young's Double Slit Experiment (YDSE)

- Experimentally established wave nature of light.

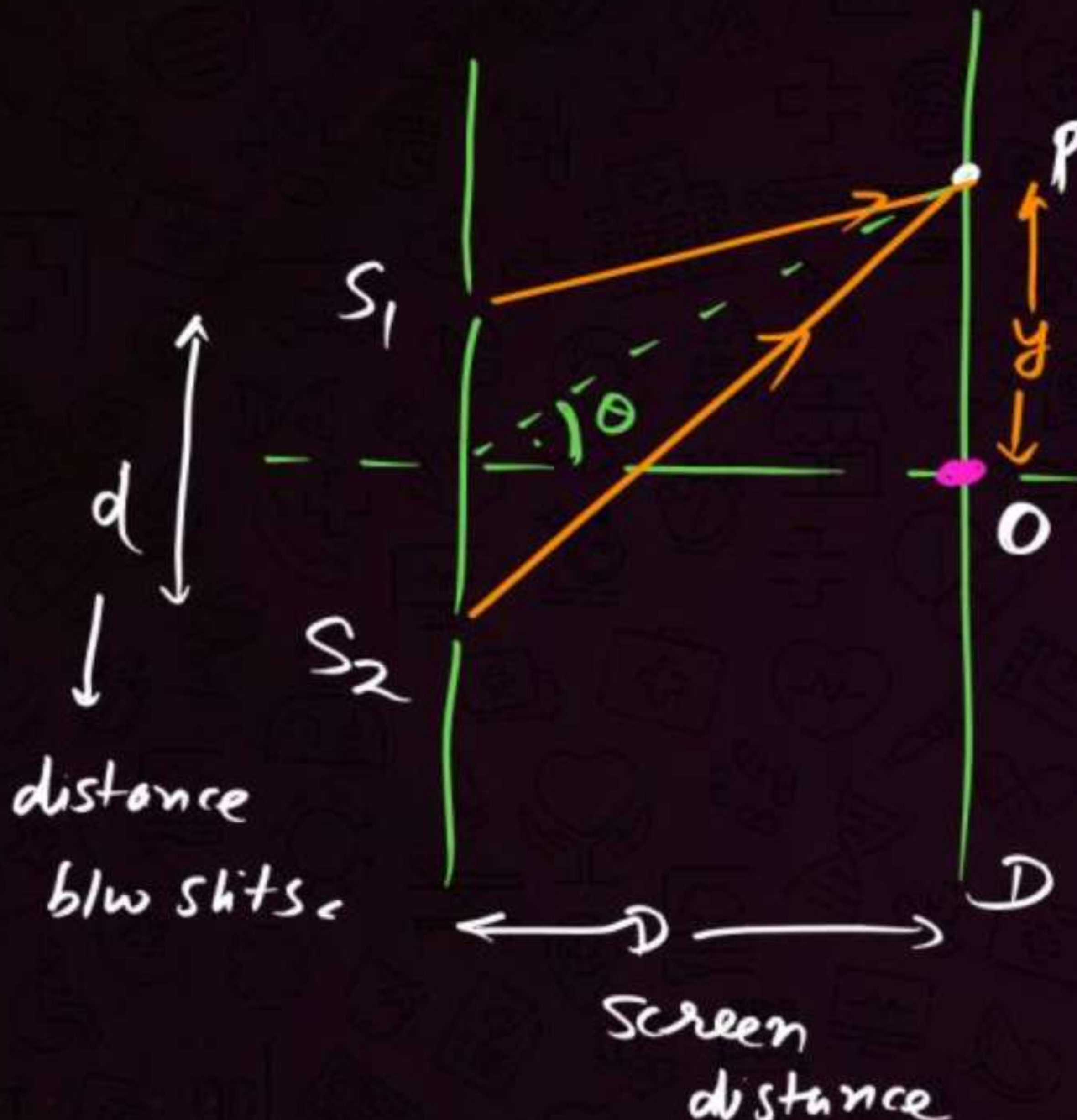


Hole, slit size
⇒ comparable
to λ of light.

S_1, S_2 ⇒ secondary sources

→ constructive int. ⇒ maxima → Bright fringe (band)

→ Destructive int. ⇒ minima → Dark fringe (band)



* $D >> d$

$$\boxed{\Delta x = S_2P - S_1P = d\sin\theta \simeq \frac{yd}{D}}$$

Const.

$$\frac{yd}{D} = n\lambda$$

$$y = n\frac{D\lambda}{d}$$

$n=0 \rightarrow y=0$

$n=1 \rightarrow y=\frac{D\lambda}{d}$

$n=2 \rightarrow y=\frac{2D\lambda}{d}$

$n=3 \rightarrow y=\frac{3D\lambda}{d}$

Dest.

$$\frac{yd}{D} = \frac{(2n-1)\lambda}{2}$$

$$y = (2n-1)\frac{D\lambda}{2d}$$

$n=1 \rightarrow y=\frac{D\lambda}{2d} = 0.5\frac{D\lambda}{d}$

$n=2 \rightarrow y=\frac{3D\lambda}{2d} = 1.5\frac{D\lambda}{d}$

$n=3 \rightarrow y=\frac{5D\lambda}{2d} = 2.5\frac{D\lambda}{d}$

⟶ 3rd max^m → $y = \frac{3D\lambda}{d} = 3\beta$

$2.5\beta = \frac{2.5D\lambda}{d}$ ← 3rd min^m

⟶ 2nd max^m → $y = \frac{2D\lambda}{d} = 2\beta$

$1.5\beta = \frac{1.5D\lambda}{d}$ ← 2nd mini

⟶ Ist max^m → $y = \frac{D\lambda}{d} = \beta$

$0.5\beta = \frac{0.5D\lambda}{d}$ ← Ist min^m ⟵

O → Central max^m → $y = 0$

$-0.5\beta = -\frac{0.5D\lambda}{d}$ ⟵

⟶ $y = -\frac{D\lambda}{d} = -\beta$

$-1.5\beta = -\frac{1.5D\lambda}{d}$ ⟵

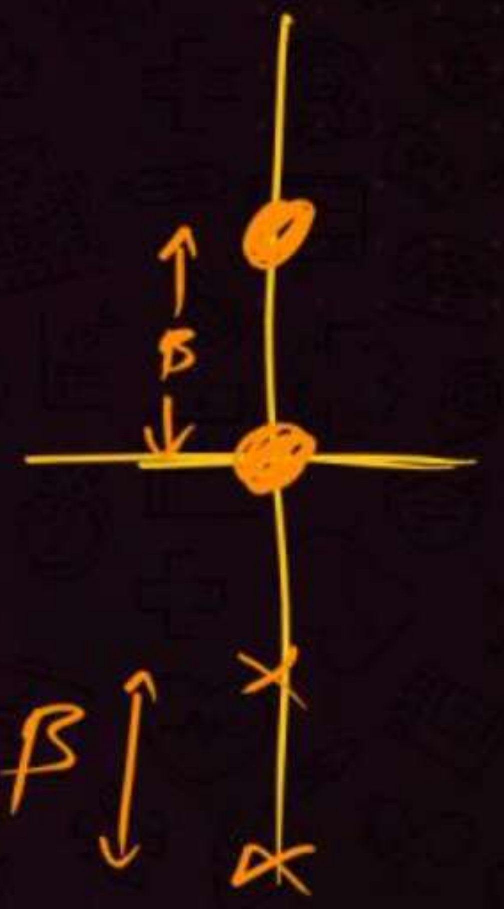
⟶ $y = -\frac{2D\lambda}{d} = -2\beta$

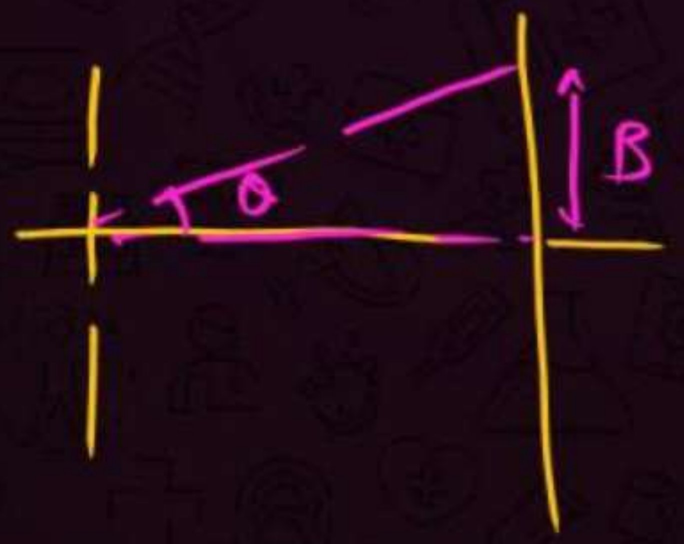
$-2.5\beta = -\frac{2.5D\lambda}{d}$ ⟵

⟶ $y = -\frac{3D\lambda}{d} = -3\beta$

* $\boxed{\frac{D\lambda}{d} = \beta = \text{Fringe width}}$

distance b/w consecutive maxima or minima





$\boxed{\theta = \frac{\lambda}{d}}$ → radian when λ, d put in metres

independent of D.

Angular fringe width

QUESTION

In Young's double slit experiment, if the separation between coherent sources is halved and the distance of the screen from the coherent sources is doubled, then the fringe width becomes:

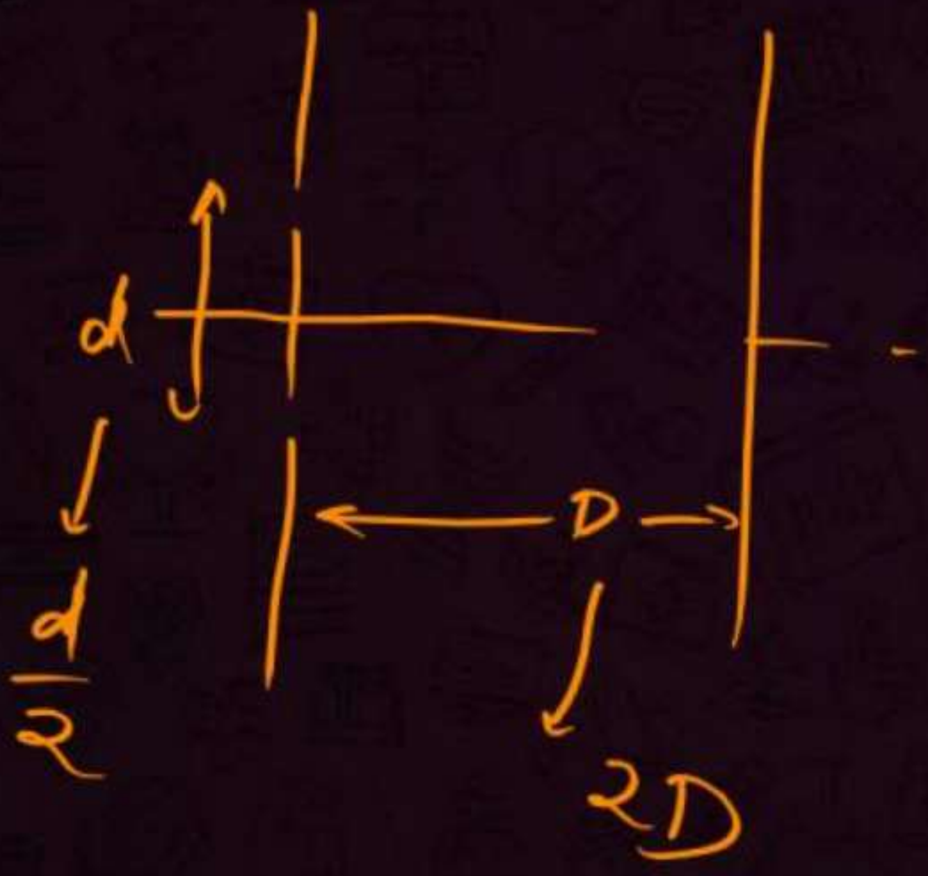
[NEET-2020 (Phase-1)]

① Half

[✓ ②] Four times

③ One-fourth

④ Double



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

$$\beta' = \frac{2D\times\lambda}{d/2}$$

$$= 4\frac{D\lambda}{d} = 4\beta$$

QUESTION

In young's experiment, if yellow light is replaced by blue light without distributing the other arrangements

1. Fringe width will increase
2. [✓ Fringe width will decrease]
3. Fringe width will remain unchanged
4. Fringe width will disappear

VIBGYOR

$\longleftarrow$

λ dec.

Blue $\Rightarrow \lambda \downarrow$

$\lambda \downarrow \Rightarrow \beta \downarrow$

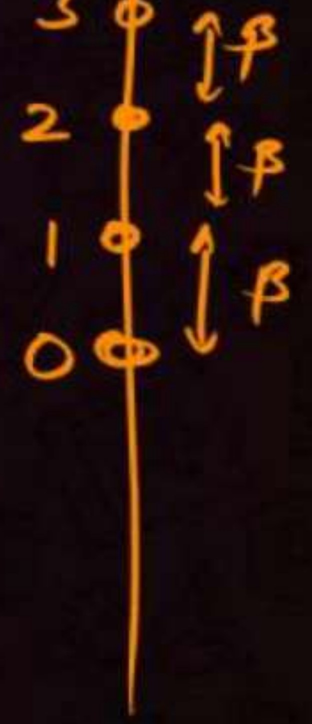
$\beta = \frac{D\lambda}{d}$

$\boxed{\beta \propto \lambda}$

QUESTION

Assertion: In YDSE bright and dark fringe are equally spaced.

Reason: It ~~only~~ depends upon phase difference. $\beta = \frac{D\lambda}{d}$ [AIIMS 2016]



① Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

② Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

[✓ ③] Assertion (A) is True, Reason (R) is False.

④ Assertion (A) is False, Reason (R) is True.

QUESTION

destructive

Assertion: Light added to light can produce darkness.

Reason: The destructive interference of two coherent light sources may give dark fringe.

[✓ ①] Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

② Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

③ Assertion (A) is True, Reason (R) is False.

④ Assertion (A) is False, Reason (R) is True.

QUESTION

Two coherent sources of light interfere and produce fringe pattern on a screen. For central maximum the phase difference between the two waves will be,

[NEET-2020 (Phase-2)]

① π

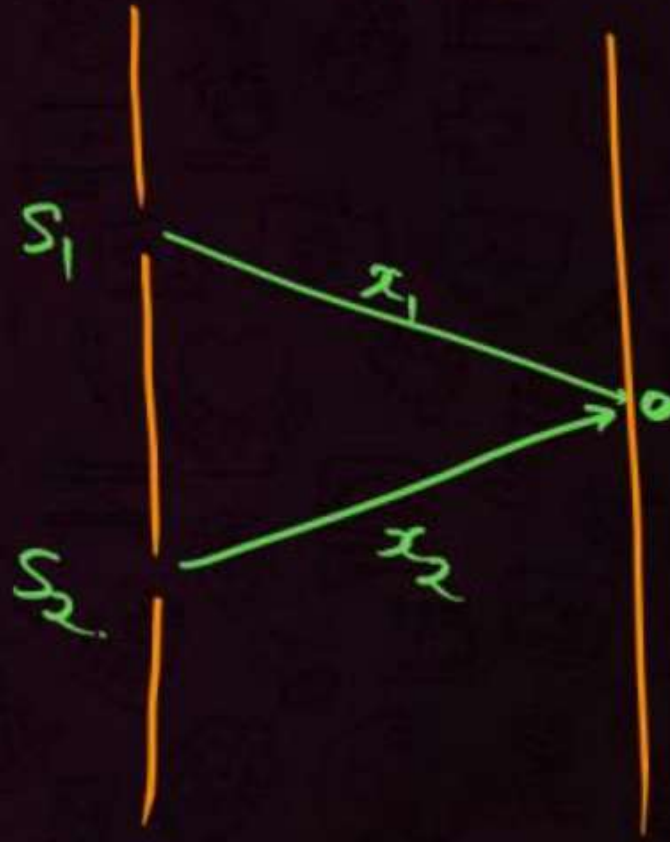
[✓ ② Zero]

③ 2π

④ $3\pi/2$

$\hookrightarrow n = 0 \rightarrow \Delta x = 0$

$\hookrightarrow \Delta\phi = 0$



$x_1 = x_2$.

$\Delta x = 0$

$\Delta\phi = 0$

$n = 0$

QUESTION

The path difference of a 9th Dark Band in an interference pattern is

↳ minima

① $13\lambda/2$

[✓ ② $17\lambda/2$]

③ $19\lambda/2$

④ $15\lambda/2$

$$8.5\lambda = \frac{85}{10}\lambda = \frac{17}{2}\lambda$$

$1 \rightarrow 0.5$

$2 \rightarrow 1.5$

$3 \rightarrow 2-5$

$\vdots$

$9 \rightarrow 8.5$

$$\Delta x = (2n-1)\frac{\lambda}{2} = (2\times 9-1)\frac{\lambda}{2} = 17\frac{\lambda}{2}$$

QUESTION

The path difference of a 10th Dark Band in an interference pattern is

$\hookrightarrow 9.5\lambda.$

$(2\times 10-1)\frac{\lambda}{2}$

$=\frac{19\lambda}{2}$

① 13 λ/2

② 17 λ/2

[✓ ③ 19 λ/2]

④ 15 λ/2

QUESTION

In Young's double slit experiment, distance between the slits is 1 mm. Wavelength of the light used is 600 nm. Fringe width of interference pattern (as shown in figure) is

- ① 0.6 mm
- [✓ ②] 0.3 mm
- ③ 0.4 mm
- ④ 0.2 mm

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

$\lambda = 600 nm = 600 \times 10^{-9} m$

$= 6 \times 10^{-7} m.$

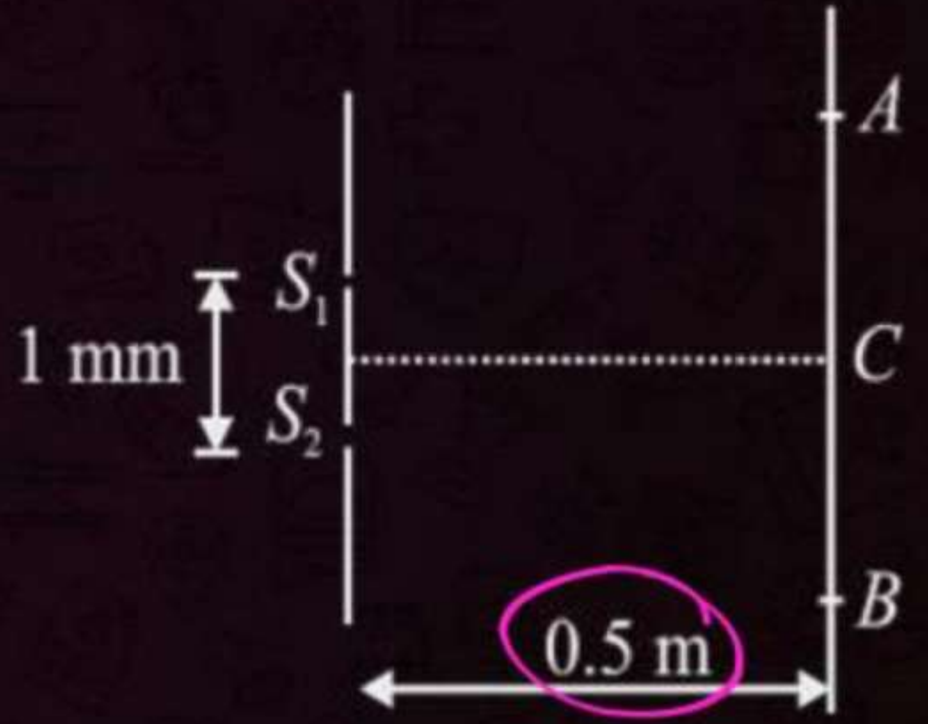
$D = 0.5 m$

$\beta = \frac{D\lambda}{d} = \frac{0.5 \times 6 \times 10^{-7}}{10^{-3}}$

$= 3 \times 10^{-4} m$

$= 3 \times 10^{-1} mm$

$= 0.3 mm.$



QUESTION

In a Young's double slit experiment the spacing between the slits is 0.3 mm and the screen is kept at a distance of 1.5 m. The second bright fringe is found 6 mm from the central fringe. The wavelength of the light used in the experiment is [AIIMS 2013]

2nd maxm

(1) 625 nm

[✓ (2) 600 nm]

(3) 550 nm

(4) 500 nm

$d = 0.3$ mm

$D = 1.5$ m

$2\beta = 6$ mm

$$2\times\frac{D\lambda}{d} = 6\times10^{-3}\text{ m.}$$

$$\frac{10\times\cancel{2}\times\cancel{1.5}\times\lambda}{\cancel{0.3}\times10^{-3}} = \textcircled{6}\times10^{-3}$$

$$\lambda = \frac{6\times10^{-6}}{10} = 6\times10^{-7} = 600\times10^{-9}$$

$= 600$ nm

QUESTION

HW

5β

In Young's double slits experiment, the position of 5th bright fringe from the central maximum is 5 cm. The distance between slits and the screen is 1 m and wavelength of monochromatic light used is 600 nm. The separation between the slits is:

(d) (d)

[25 Jan, 2023 (S-I)]

① 60 µm

② 48 µm

③ 12 µm

④ 36 µm

QUESTION

In Young's double slit experiment the two slits are 0.6 mm distance apart. Interference pattern is observed on a screen at a distance 80 cm from the slits. The first dark fringe is observed on the screen directly opposite to one of the slits. The wavelength of light will be _____ nm.

[27 June, 2022 (S-I)]

① 150

② 300

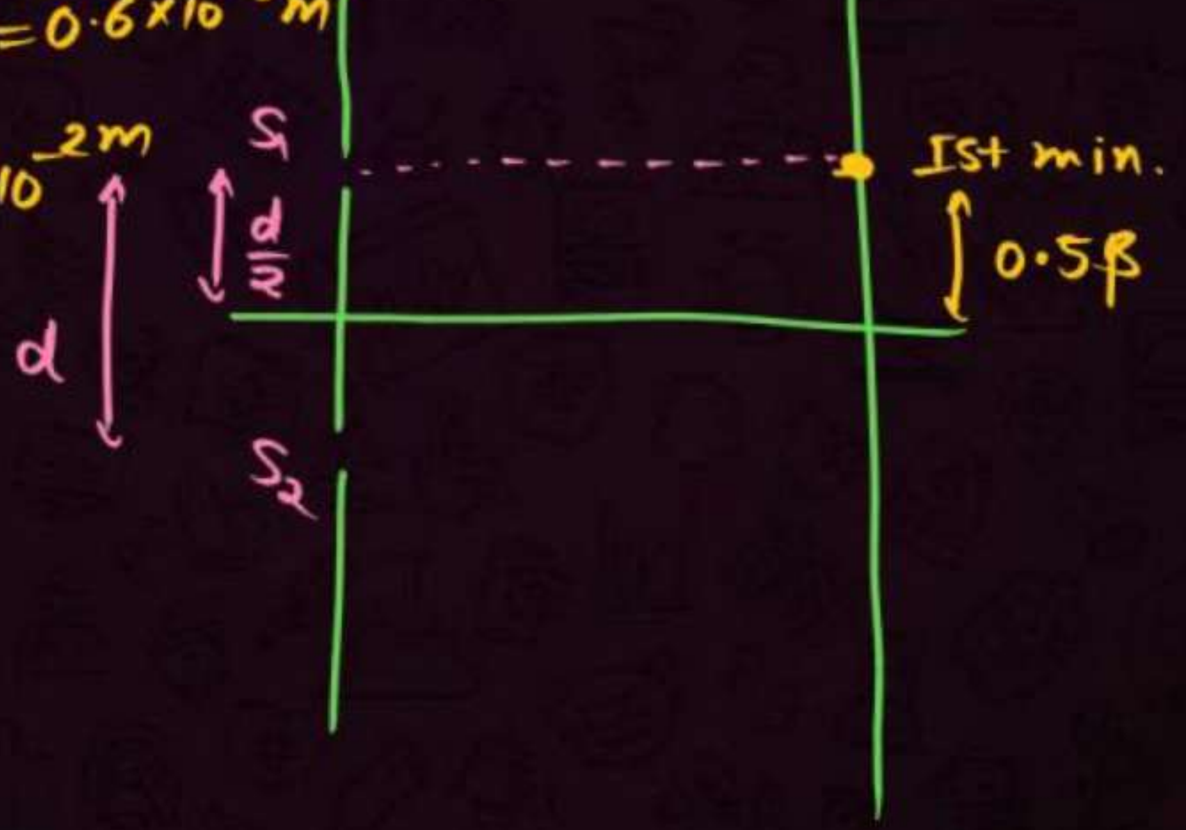
[✓ ③] 450

④ 600

$d = 0.6\ mm = 0.6 \times 10^{-3} m$

$D = 80\ cm = 80 \times 10^{-2} m$

$\rightarrow 0.5\beta$



$$\boxed{0.5\beta = \frac{d}{2}}$$

$$0.5 \times \frac{D\lambda}{d} = \frac{d}{2}$$

$$\frac{1}{\cancel{2}} \frac{D\lambda}{d} = \frac{d}{\cancel{2}}$$

$$\lambda = \frac{d^2}{D}$$

QUESTION

Using Young's double slit experiment, a monochromatic light of wavelength 5000Å produces fringes of fringe width 0.5 mm. If another monochromatic light of wavelength 6000 Å is used and the separation between the slits is doubled, then the new fringe width will be

[29 June, 2022 (S-I)]

1. 0.5 mm
2. 1.0 mm
3. 0.6 mm
4. [✓ 0.3 mm]

$$\beta = \frac{\overset{\text{const.}}{D}\lambda}{d}$$

$\lambda_1 = 5000$

$d_1 = d$

$\lambda_2 = 6000$

$d_2 = 2d$

$$\frac{\beta_2}{\beta_1} = \frac{\lambda_2}{\lambda_1} \times \frac{d_1}{d_2}$$

$$\frac{\beta_2}{0.5} = \frac{\overset{3}{\cancel{6000}}}{\cancel{5000}} \times \frac{\cancel{d}}{\cancel{2d}}$$

$$\beta_2 = 0.5 \times \frac{3}{5}$$

$$= 0.1 \times 3 = 0.3 \text{ mm.}$$

QUESTION

HW

The ratio of intensities at two points P and Q on the screen in a Young's double slit experiment where phase difference between two wave of same amplitude are $\pi/3$ and $\pi/2$, respectively are

[10 April, 2023 (S-II)]

① 1 : 3

② 3 : 1

③ 3 : 2

④ 2 : 3

QUESTION

The width of fringe is 2 mm on the screen in a double slits experiment for the light of wavelength of 400 nm. The width of the fringe for the light of wavelength 600 nm will be:

[08 April, 2023 (SI-I)]

① 4 mm

② 1.33 mm

[✓ ③ 3 mm]

④ 2 mm

$$\beta = \frac{\overset{\nearrow \text{const}}{D}\lambda}{\underset{\searrow \text{const.}}{d}}$$

$$\beta \propto \lambda.$$

$$\frac{\beta_2}{\beta_1} = \frac{\lambda_2}{\lambda_1} = \frac{600}{400} = \frac{3}{2}$$

$$\beta_2 = \frac{3}{\cancel{2}} \times \cancel{2} = 3\,\text{mm}$$

QUESTION

Two sources required

Assertion: In Young's double slit experiment, interference pattern disappears when one of the slits is closed.

Reason: Interference occurs due to superposition of light waves from two coherent sources.

[AIIMS 2018]

[✓ 1] Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

2 Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

3 Assertion (A) is True, Reason (R) is False.

4 Assertion (A) is False, Reason (R) is True.

QUESTION

In a Young's double slit experiment, light of 500 nm is used to produce an interference pattern. When the distance between the slits is 0.05 mm, the angular width (in degree) of the fringes formed on the distance screen is close to:

[03 Sep, 2020 (S-I)]

① 0.17° ×

② 1.7° ×

[✓ ③ 0.57°]

④ 0.07° ×

$$\theta = \frac{\lambda}{d} = \frac{500\times10^{-9}}{0.05\times10^{-3}} = \frac{\cancel{5}\times\overset{10^{-4}}{\cancel{10^{-7}}}\times100}{\cancel{5}\times\cancel{10^{-3}}}$$

$$= 10^{-2} = \frac{1}{100}\text{ rad}$$

$$\frac{\overset{9}{\cancel{180}}}{\pi}\times\frac{1}{\underset{5}{\cancel{100}}} = \left(\frac{9}{5\pi}\right)^{\circ} \simeq \left(\frac{\overset{3}{\cancel{9}}}{5\times\cancel{3}}\right)^{\circ} \simeq \left(\frac{3}{5}\right)^{\circ} \simeq \underline{\underline{0.6^{\circ}}}$$

QUESTION

In normal YDSE experiment maximum intensity is $4I_0$. In Column-I, y-coordinate is given corresponding to centre line. In Column-II resultant intensities are given. Match the two columns.

$$y = \frac{\lambda D}{3d} \Rightarrow \frac{yd}{D} = \frac{\lambda}{3} = \Delta x \Rightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{3} = \boxed{\frac{2\pi}{3}}$$

$$\frac{\phi}{2} = \frac{\pi}{3} = 60^\circ$$

1. ✓ A-(r); B-(s); C-(p); D-(q)
2. A-(p); B-(s); C-(q); D-(r)
3. A-(q); B-(r); C-(p); D-(s)
4. A-(s); B-(r); C-(q); D-(p)

Column-I		Column-II	
A.(r)	$y = \lambda D/d$ $(\beta) \rightarrow$ 1st max^m	p.	$I = I_0$
B.(s)	$y = \lambda D/2d = 0.5\beta$ 1st min^m	q.	$I = 2I_0$
C.(p)	$y = \lambda D/3d$	r.	$I = 4I_0$
D.(q)	$y = \lambda D/4d$	s.	$I = \text{Zero}$

HW

$$I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$$

$$= 4I_0 \cos^2 60^\circ = 4I_0\left(\frac{1}{2}\right)^2 = I_0$$

QUESTION

Two waves from coherent sources meet at a point in a path difference of Δx. Both the waves have same intensities. Match the following two columns.

Column-I		Column-II	
A.	If $\Delta x = \lambda/3$ $I_0, I_0 \to I_0$	p.	Resultant intensity will become three times
B.	If $\Delta x = \lambda/6$ already done	q.	Resultant intensity will remain same
C.	If $\Delta x = \lambda/4$ (HW)	r.	Resultant intensity will become two times
D.	If $\Delta x = \overset{(\text{min}^{m})}{\lambda/2}$	s.	Resultant intensity will become zero

① A-(r); B-(s); C-(p); D-(q)

[✓ ② A-(q); B-(p); C-(r); D-(s)]

③ A-(q); B-(r); C-(p); D-(s)

④ A-(s); B-(r); C-(q); D-(p)

QUESTION

(D) $4.5\beta - 2\beta$
$= 2.5\beta$

In terms of fringe width ω, match the following two columns.

(C) $4\beta - 0.5\beta = 3.5\beta$

$\beta = \omega$

① A-(r); B-(s); C-(p); D-(q)

② A-(p); B-(s); C-(q); D-(r)

[✓ ③ A-(q); B-(p); C-(r); D-(p)]

④ A-(s); B-(r); C-(q); D-(p)

Column-I		Column-II	
A.	Distance between central maxima and third order maxima $(3\beta) = 3\omega$ $\rightarrow q$	p.	2.5 ω
B.	Distance between central maxima and third order minima $(2.5\beta = 2.5\omega)$ (p)	q.	3.0 ω
C.	Distance between first minima and fourth order maxima (r)	r.	3.5 ω
D.	Distance between second order maxima and fifth order minima (p)	s.	None of these

QUESTION

(Famous type)

In Young's double slit experiment, the slits are 2 mm apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000$ Å and $\lambda_2 = 10000$ Å. At what minimum distance from the common central bright fringe on the screen 2 m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other?

→ d

→ D.

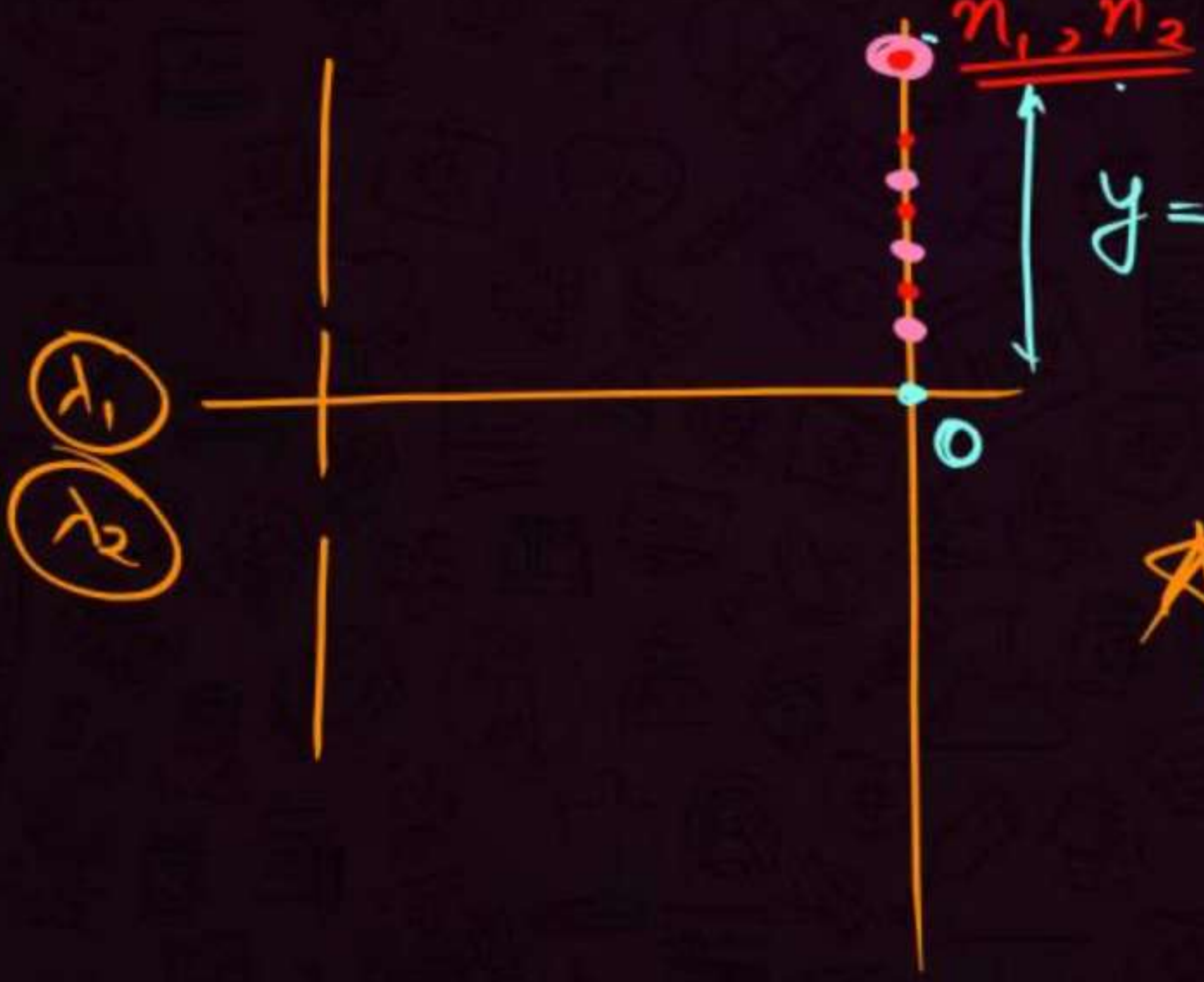
[NEET-2013]

[✓ ① 6 mm]

② 4 mm

③ 3 mm

④ 8 mm



$$y = n_1\beta_1 = n_2\beta_2$$

$$n_1 \frac{\cancel{D}\lambda_1}{\cancel{d}} = n_2 \frac{\cancel{D}\lambda_2}{\cancel{d}}$$

$$\star \ \boxed{n_1\lambda_1 = n_2\lambda_2}$$

λ → diff.

β → diff

$$n_1 \times \overset{6}{\cancel{12000}} = n_2 \times \overset{5}{\cancel{10,000}}$$

$$\frac{n_1}{n_2} = \frac{5}{6}$$

5th max^m.

$$\frac{n_1}{n_2} = \boxed{\frac{5}{6}} = \underbrace{\frac{10}{12} = \frac{15}{18} = \frac{20}{24}}$$

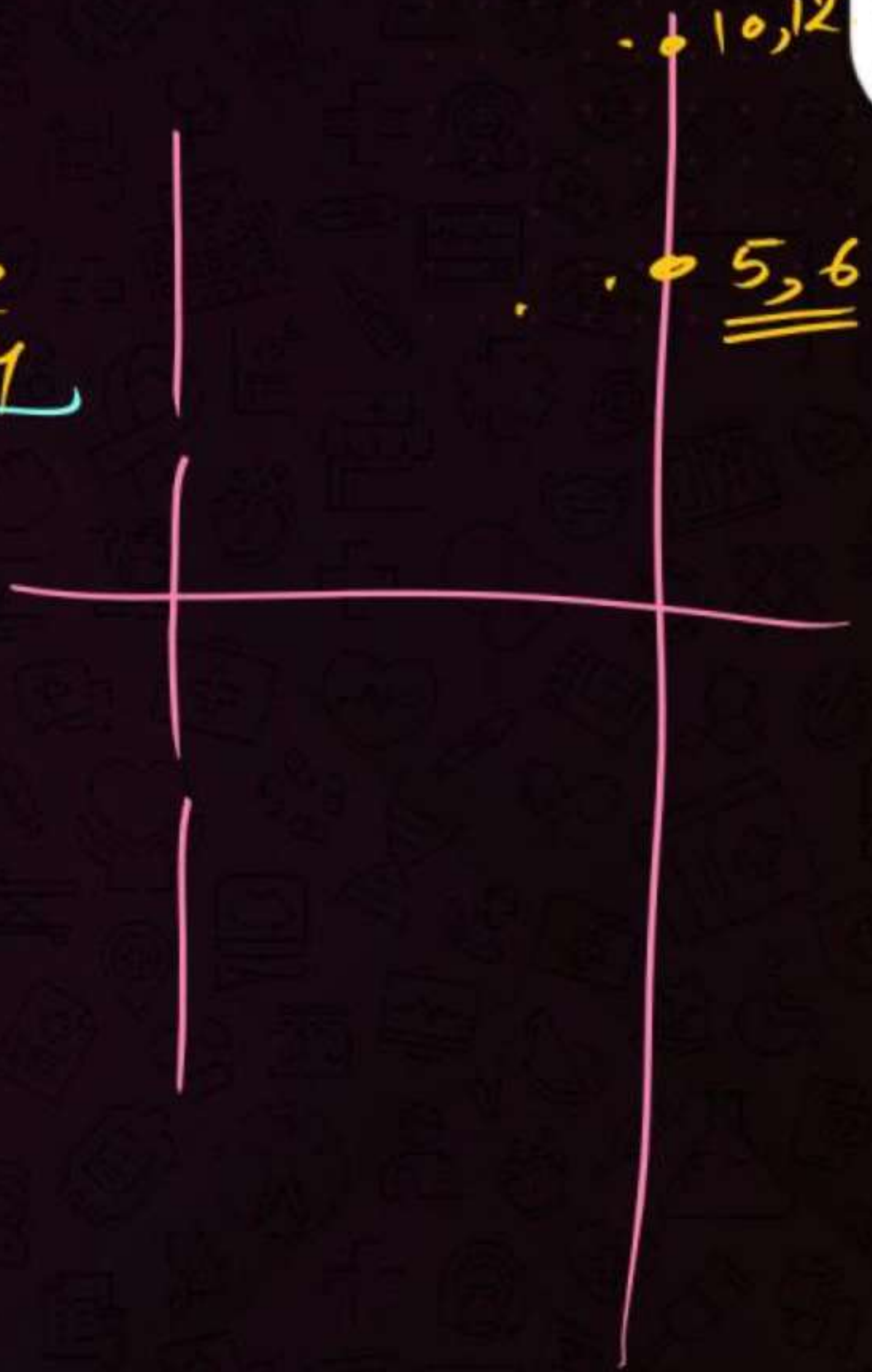
6th max^m

$$\therefore n_1 = 5$$

$$n_2 = 6$$

$$y_1 = \underbrace{n_1 \frac{D\lambda_1}{d}} = \underbrace{n_2 \frac{D\lambda_2}{d}}$$

OR



QUESTION

If 5th order maxima of wavelength 4000 Å in Young's double slit experiment, coincides with nth order maxima of wavelength 5000 Å, then n is equal to

① 5

② 8

③ [✓ 4]

④ 10

$$n_1 \lambda_1 = n_2 \lambda_2.$$

$$\cancel{5} \times 4\cancel{000} = n \times \cancel{5000}$$

$$\boxed{4 = n}$$

QUESTION

HW # $n_1\lambda_1 = n_2\lambda_2$ → TBS

In a Young's double slit experiment, 16 fringes are observed in a certain segment of the screen when light of a wavelength 700 mm is used. If the wavelength of light is changed to 400 nm, the number of fringes observed in the same segment of the screen would be

[2 Sep, 2020 (S-II)]

① 28

② 24

③ 30

④ 18

QUESTION

$\frac{I_1}{I_2} = \frac{\beta}{1}$

The two coherent sources with intensity ratio β produce interference. The fringe visibility will be

[AIIMS 2016]

[✓ 1] $\frac{2\sqrt{\beta}}{1+\beta}$

2 2β

3 $\frac{2}{(1+\beta)}$

4 $\frac{\sqrt{\beta}}{1+\beta}$

$$\boxed{F.V. = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}} = \frac{2\sqrt{\beta}}{\beta + 1}$$

(calculation already done)

contrast

$$= \frac{\overset{2}{\cancel{4}}\sqrt{I_1 I_2}}{\cancel{2}(I_1 + I_2)}$$

$4I_0$

0

$4I_0$

0

$4I_0$

0

QUESTION

Learn

During interference of light....... → Energy is conserved, only redistribution

① Energy is destroyed at the dark bands

×

② Energy is created at the bright bands

×

③ ✓ Energy is conserved but distributed among bright and dark bands

④ All the above are true

QUESTION

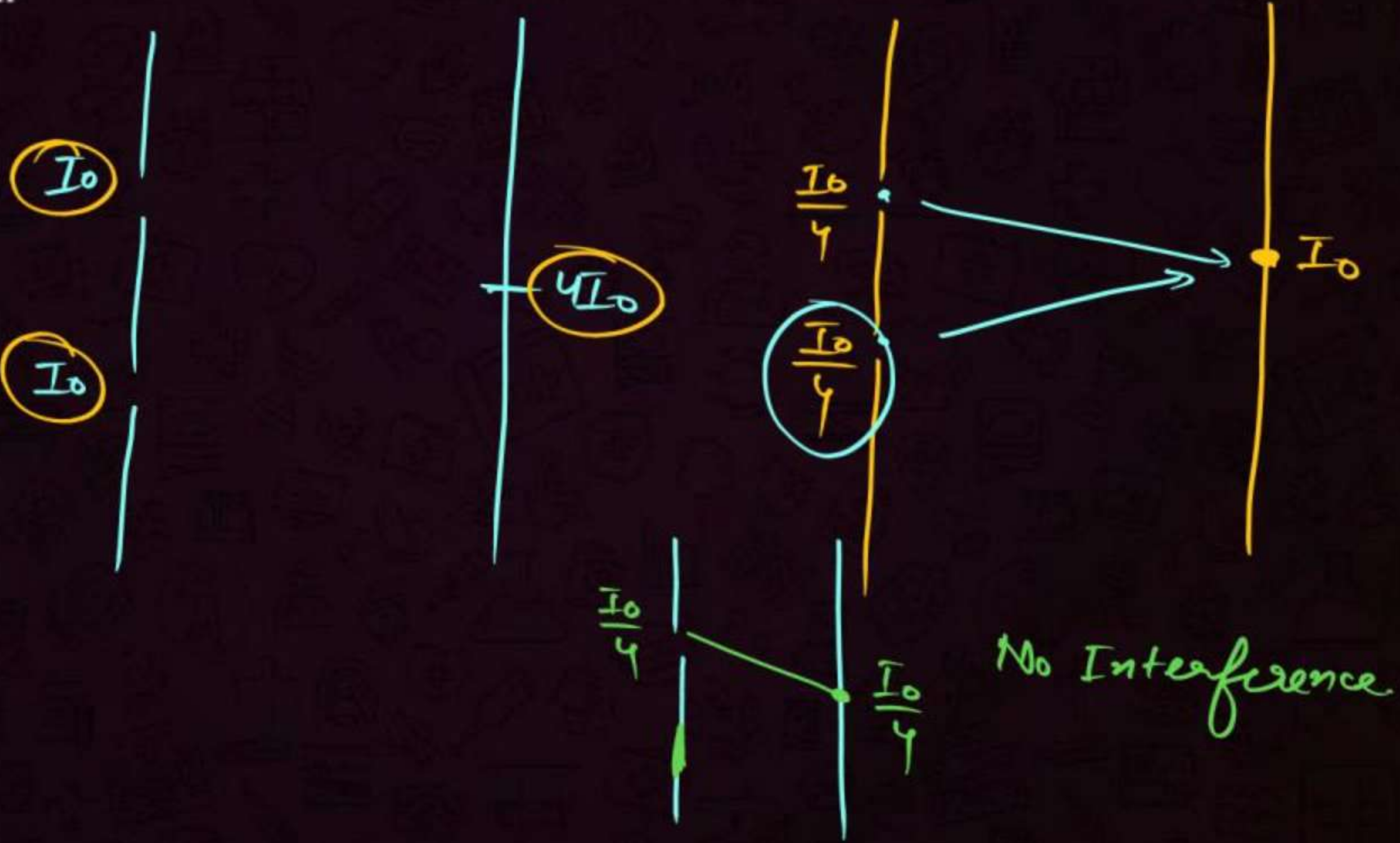
The intensity of the central bright fringe is I_0. If one of the slit is covered, the intensity at the same point is....

① $2I_0$

② I_0

③ $I_0/2$

④ [✓ $I_0/4$]



QUESTION

Assertion: YDSE, the intensity at the maxima is observed to be I_0. If one of the slits is closed, then the intensity at the location of the maxima reduces to $I_0/4$.

Previos ones

Reason: In YDSE, fringes with blue light are wider than those for red light

narrower

① Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

② Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

[✓ ③] Assertion (A) is True, Reason (R) is False.

④ Assertion (A) is False, Reason (R) is True.

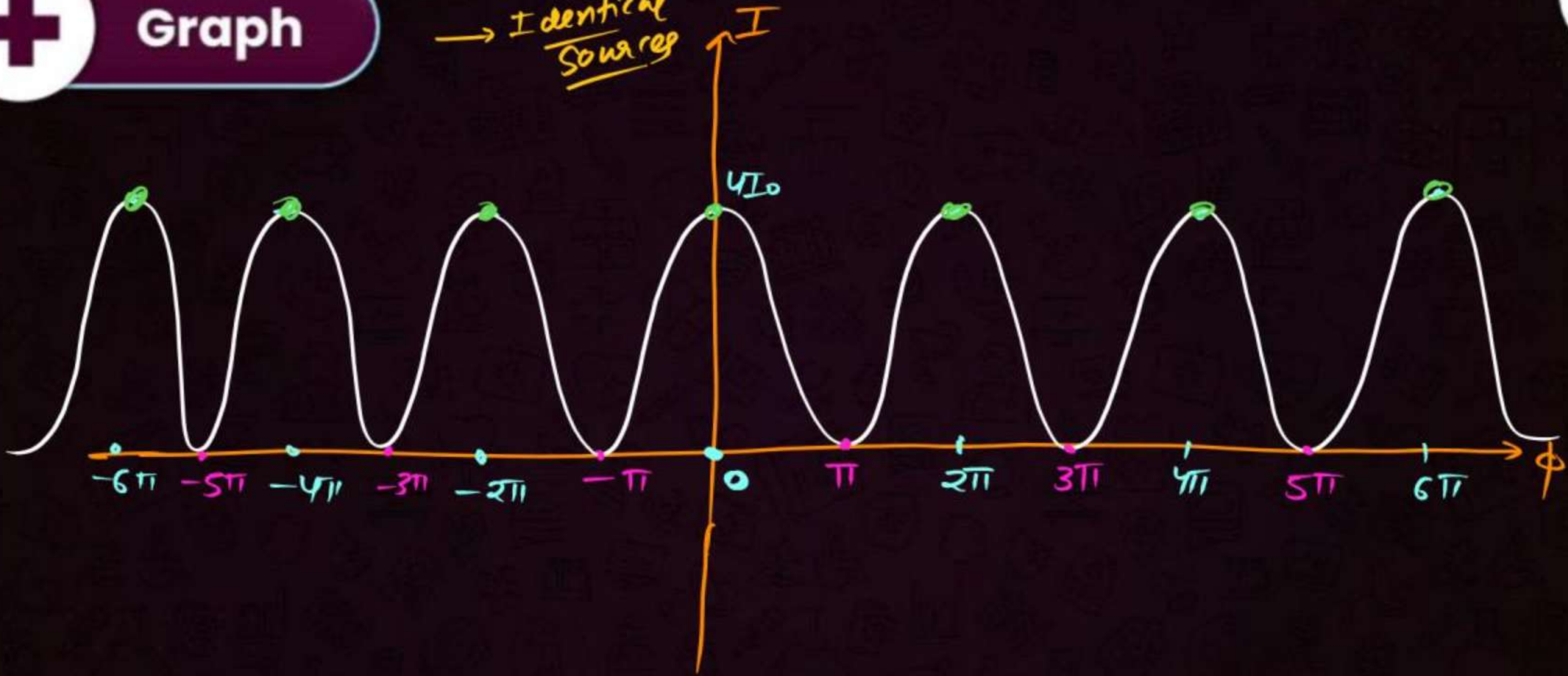
VIBGYOR

$\xleftarrow{\lambda \text{ dec.}}$

$\xleftarrow{\beta \text{ dec}}$

Graph

→ Identical Sources



Effect of slit width on intensity

→ $\boxed{I \propto \text{Area of slit}}$

A → equal

I → equal

$$\boxed{I \propto lw}$$

If l → same

$$I \propto w$$

$$\boxed{\frac{I_1}{I_2} = \frac{w_1}{w_2}}$$

QUESTION

Two slits in Young's experiment have widths in the ratio 1:25. The ratio of intensity at the maxima and minima in the interference pattern, I_{max}/I_{min} is [Re-AIPMT-2015]

① 4/9

[✓ ② 9/4]

③ 121/49

④ 49/121

$$\frac{w_1}{w_2} = \frac{1}{25} = \frac{I_1}{I_2}$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{25}+\sqrt{1}}{\sqrt{25}-\sqrt{1}}\right)^2$$

$$= \left(\frac{5+1}{5-1}\right)^2 = \left(\frac{6}{4}\right)^2 = \left(\frac{3}{2}\right)^2$$

$$= \frac{9}{4}$$

QUESTION

In a Young's double slit experiment, the width of the one of the slit is three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.

[24 Feb, 2021 (S-I)]

(JEE Main)

1. 1 : 4
2. [✓ 4 : 1]
3. 3 : 1
4. 2 : 1

$$\frac{w_1}{w_2} = \frac{3}{1}$$

Twist $\longrightarrow$ $\boxed{A \propto w}$

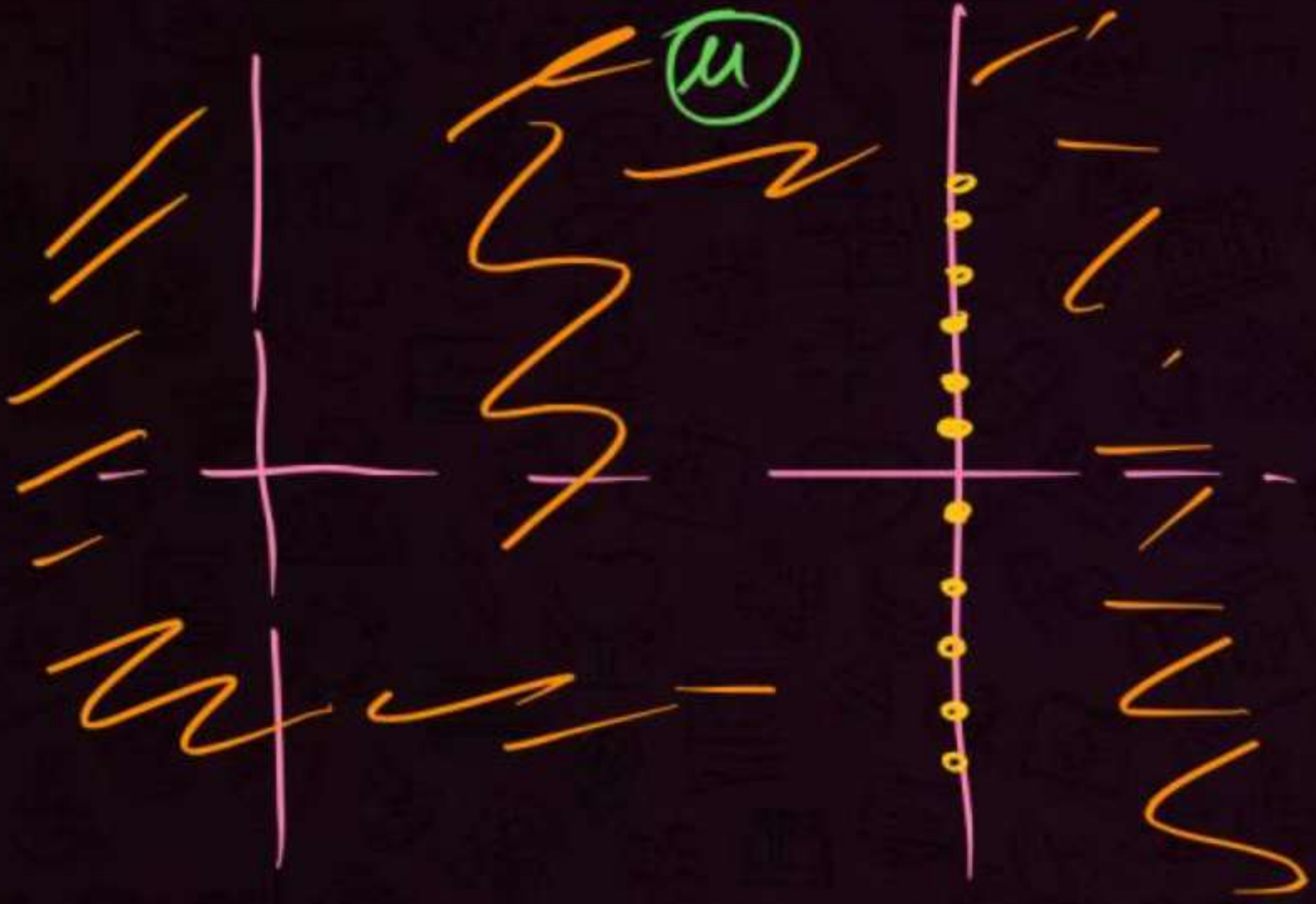
$$\frac{A_1}{A_2} = \frac{3}{1}$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$$

$$= \left(\frac{3+1}{3-1}\right)^2 = \left(\frac{4}{2}\right)^2 = \frac{2^2}{1^2} = \frac{4}{1}$$

Medium change in YDSE

Pani Mein Gaya → Chhapak



Ray optics → air → medium

$$\boxed{\lambda \rightarrow \frac{\lambda}{\mu}} \rightarrow \text{dec}$$

$$\beta = \frac{D\lambda}{d} \Rightarrow \beta \propto \lambda.$$

$$\boxed{\beta' = \frac{\beta}{\mu}} \rightarrow \text{decreases}$$

↓

Pattern Contract.

QUESTION

Assertion: In YDSE, the fringe width (β) depends on the medium in which the experiment is carried out

Reason: Because $\beta = \lambda D/d$ and λ depends on the medium

[✓ 1] Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

2. Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

3. Assertion (A) is True, Reason (R) is False.

4. Assertion (A) is False, Reason (R) is True.

QUESTION

In Young's double slit experiment, the fringe width is 12 mm. If the entire arrangement is placed in water of refractive index 4/3, then the fringe width becomes (in mm):

[26 July, 2022 (S-I)]

$$\beta' = \frac{\beta}{\mu} = \frac{\cancel{12}^{\,3}}{\cancel{4}/3} = 3 \times 3 = 9 \text{ mm.}$$

① 16

[✓ ② 9]

③ 48

④ 12

QUESTION

Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8th bright fringe in the medium lies where 5th dark fringe lies in air. The refractive index of the medium is nearly

[NEET-2017]

① 1.25

② 1.59

③ 1.69

[✓ ④ 1.78]

air	medium
β	β'
4.5β	$8\beta'$

$$4.5\beta = 8\beta'$$

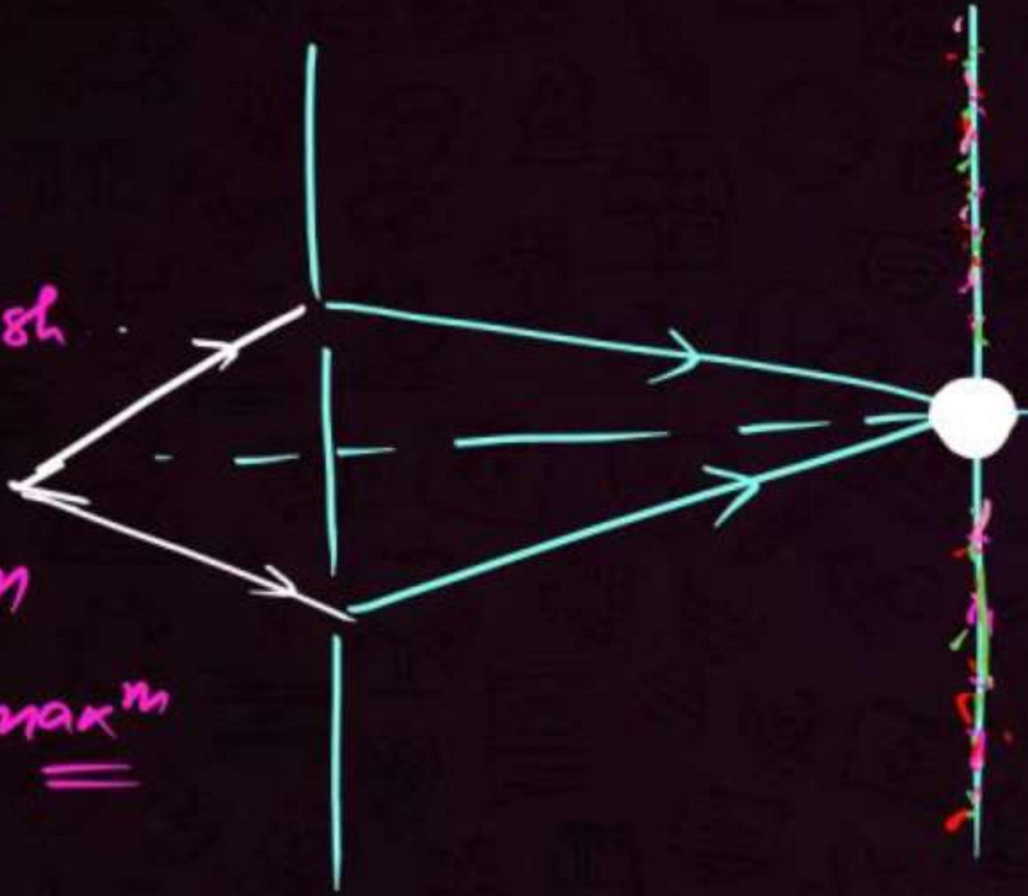
$$\frac{\cancelto{9}{45}}{\cancelto{2}{10}}\cancel{\beta} = \frac{8\cancel{\beta}}{\mu}$$

$$\mu = \frac{2\times 8}{9} = \frac{16}{9} = 1.777\ldots$$

YDSE with white light

Technique.

to distinguish central max^m from all other max^m



→ colour pattern.

→ central maximum
↓
pure white

$\Delta x = 0 \rightarrow$ independent of λ.

↳ for all colours

$\beta = \frac{D\lambda}{d}$ $\Delta x = n\lambda$.

Interference for incoherent sources

↓ $\Delta\phi \rightarrow$ variable.

↓

Interference not sustainable

$\rightarrow$ min^m $\rightarrow$ max^m $\rightarrow$ min^n $\rightarrow$ max^m

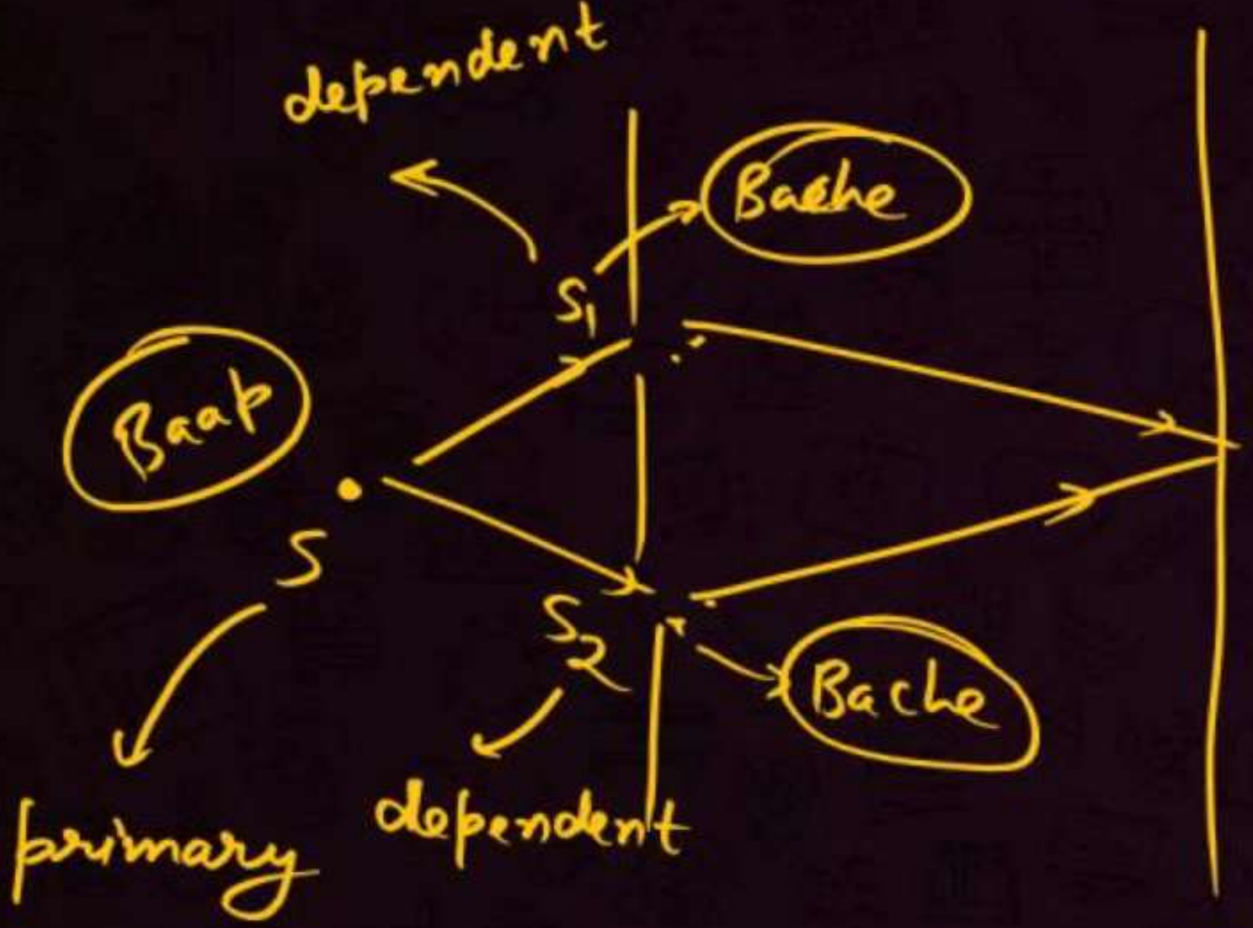
$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

avg. value = 0

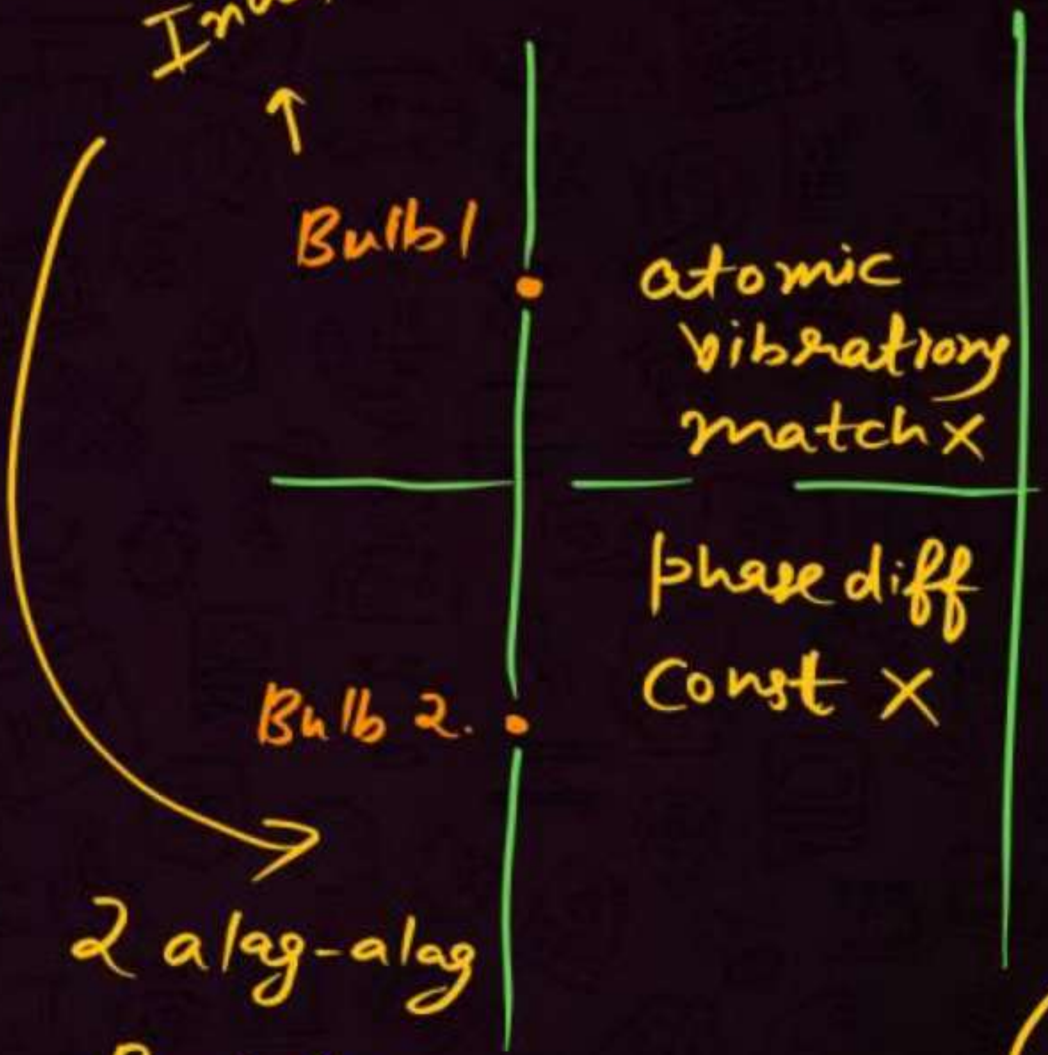
$$I_{av} = I_1 + I_2 + 0$$

$$\boxed{I_{av} = I_1 + I_2.}$$

Independent Sources



Independent



atomic vibration match ×

phase diff const ×

2 alag-alag Baap ki Aulaad

Interference ×

QUESTION

Assertion: If white light is used in YDSE, then the central bright fringe will be white

Reason: Because all the wavelengths produce their zero order maxima at the same position

$n=0, \Delta\phi=0 \hookrightarrow \Delta x=0$

[✓ ①] Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

② Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

③ Assertion (A) is True, Reason (R) is False.

④ Assertion (A) is False, Reason (R) is True.

QUESTION

$I \rightarrow$ same

In Young's double slit experiment, the two slits act as coherent sources of equal amplitude *a* and of wavelength λ. In another experiment with the same set up, the two slits are sources of equal amplitude *a* and wavelength λ, but are incoherent. The ratio of intensities of light at the mid point of the screen in the first case to that in the second case is

↓ center

[AIIMS 2009]

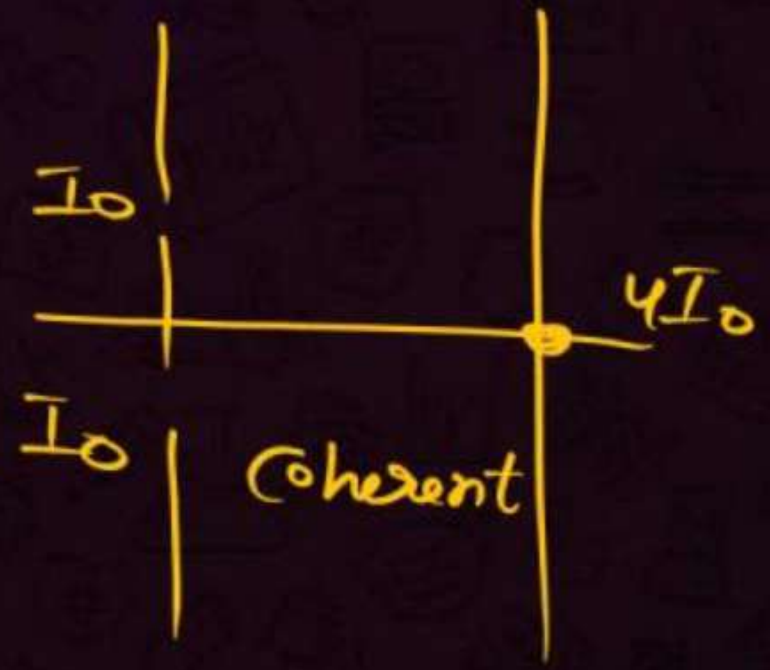
[✓ ① 2 : 1]

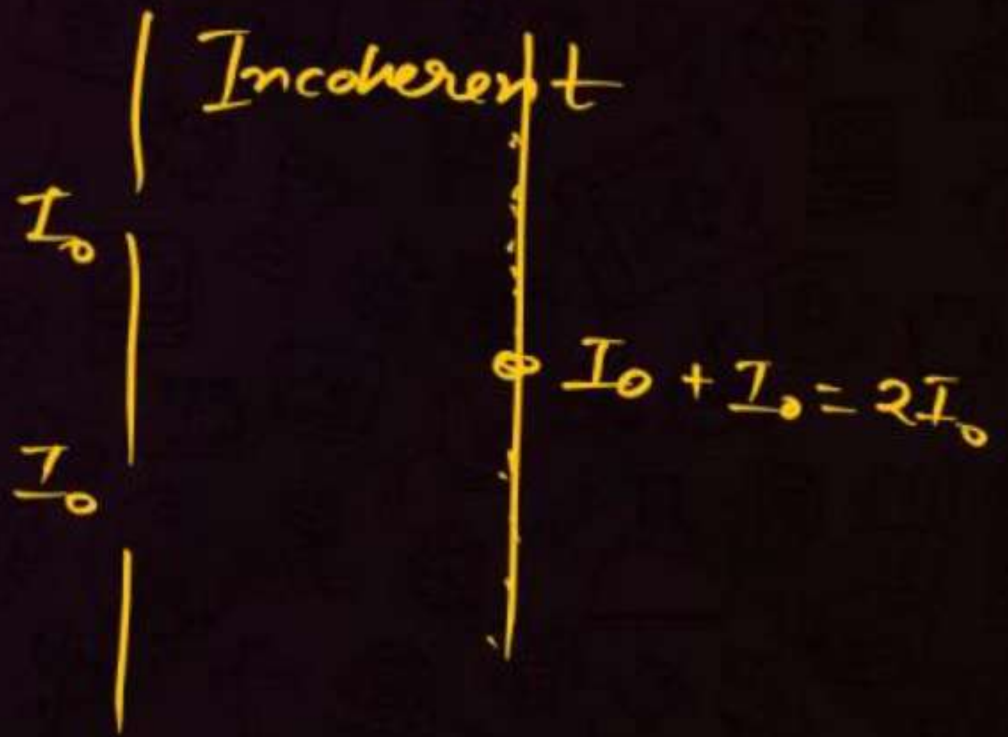
② 1 : 2

③ 3 : 4

④ 4 : 3

$$\frac{4I_0}{2I_0} = \frac{2}{1}$$





Question

Which statements is true for interference?

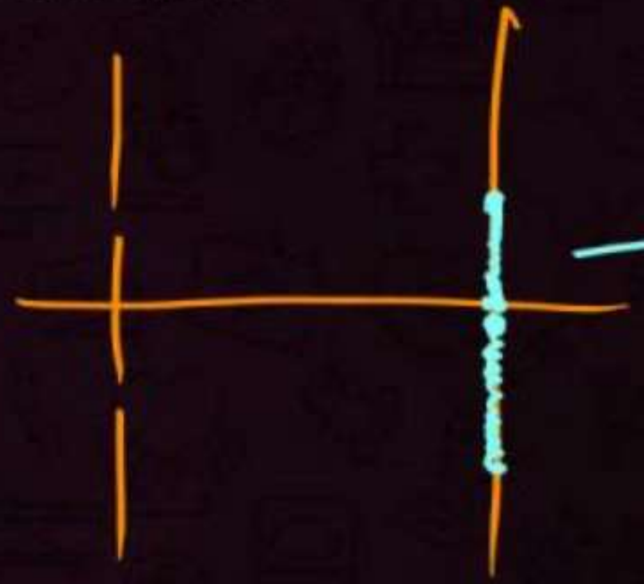
a. Two independent source of light can produce interference

×

b. ✓ There is no violation of conservation of energy

c. White light cannot produce interference

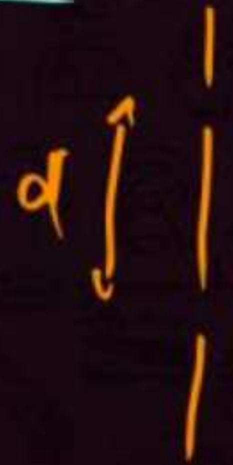
×



→ max/min can't be Identified

d. Interference pattern can be obtained even if coherent sources are widely apart

×

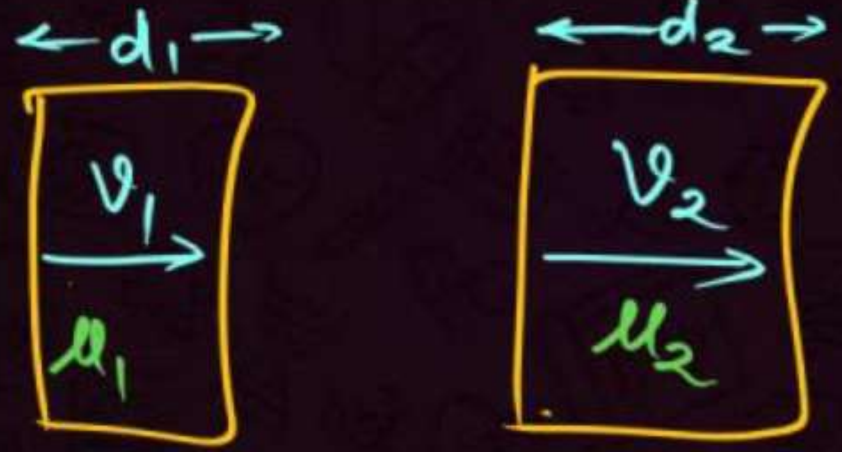


d↑ very high

$\beta \propto \frac{1}{d} \Rightarrow \beta \rightarrow$ very low.

Equivalent Path Concept

→ Two paths are equivalent for a light if it takes same time to cover the distance



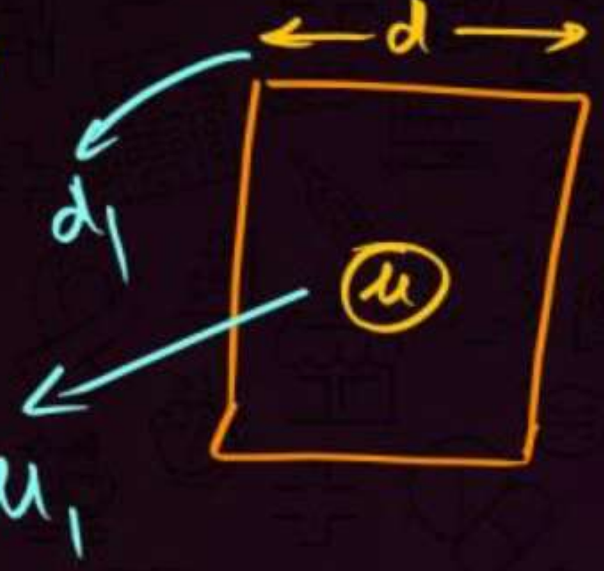
$$t_1 = t_2$$

$$\frac{d_1}{v_1} = \frac{d_2}{v_2}$$

$$c \times \frac{d_1}{v_1} = \frac{d_2}{v_2} \times c$$

$$\star\ \boxed{\mu_1 d_1 = \mu_2 d_2}$$

ques



d distance in glass is equivalent to what distance in air?

$\mu_2 = 1$

$$\mu_1 d_1 = \mu_2 d_2$$

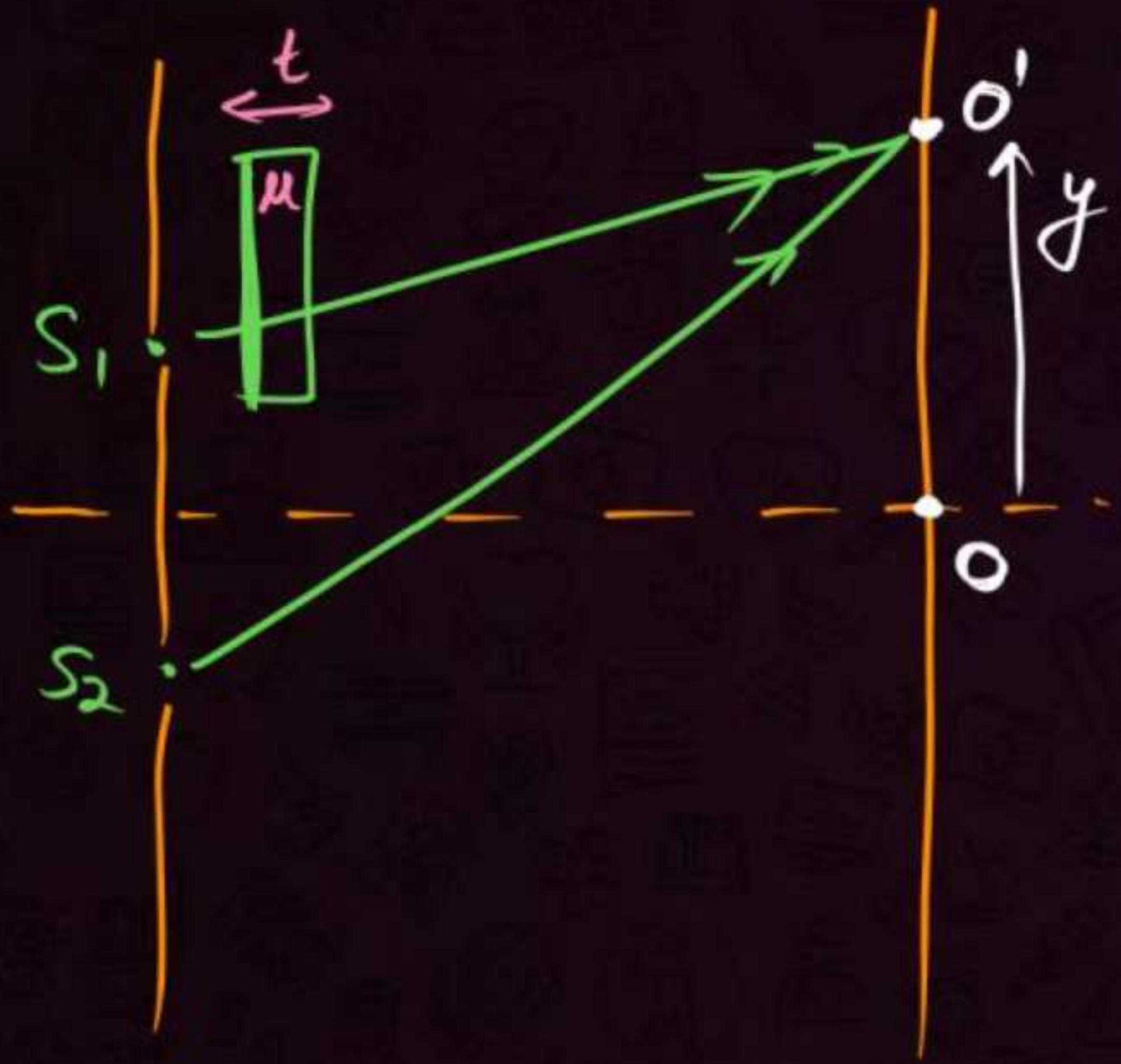
$$\mu d = 1 \times d_2$$

$$\boxed{d_2 = \mu d}$$

eg: 2km

3km

Introduction of glass slab near one slit



$\Delta x \rightarrow$ due to glass slab.

$$\Delta x = (\mu - 1) t$$

Pattern will shift by distance y

$$\boxed{\Delta x = (\mu-1)t = \frac{yd}{D}}$$

QUESTION

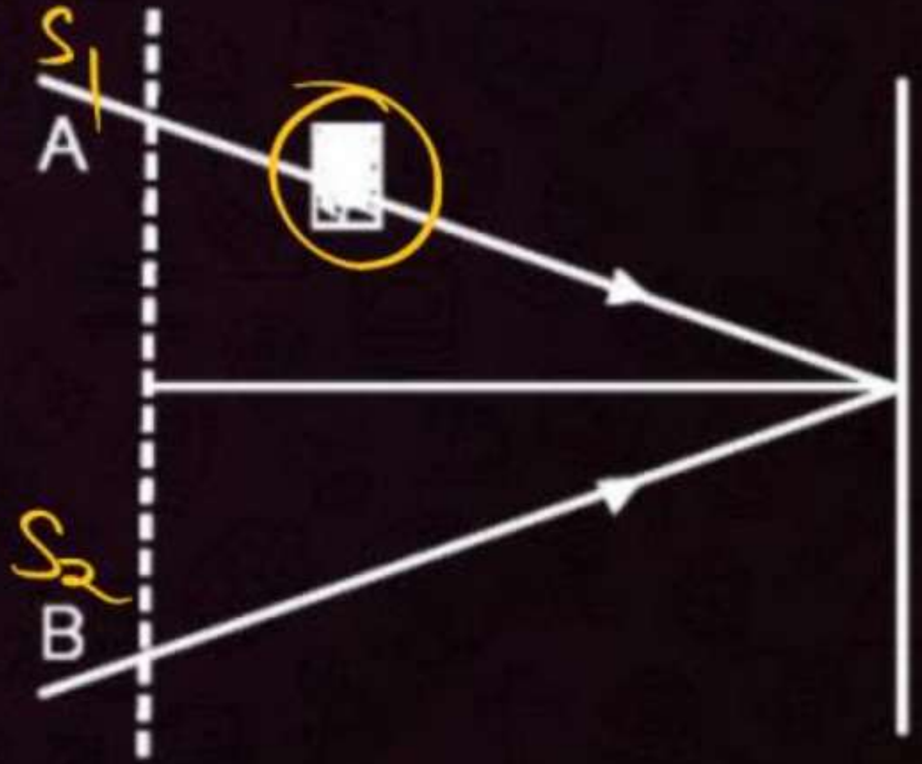
In Young's experiment, the monochromatic light is used to illuminate two slits S_1 and S_2 as shown. Interference fringes are observed on a screen placed in front of the slits. Now if a thin glass plate is placed normally in the path of beam coming from the slit S_1, then

[AIIMS 1999]

no change in $\beta \rightarrow \frac{D\lambda}{d}$

Pattern shift upwards ↑

1. × fringe width will decrease
2. × fringes will disappear
3. × fringe width will increase
4. [✓ there will be no change in fringe width.]



QUESTION

Assertion: In YDSE, if a thin film is introduced in front of the upper slit, then the fringe pattern shifts in the downward direction

Reason: In YDSE if the slit widths are unequal, the minima will be completely dark

① Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

② Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

③ Assertion (A) is True, Reason (R) is False.

[✓ ④] Assertion (A) is False, Reason (R) is ~~True~~ False.

width unequal $w_1 \neq w_2$

$I_1 \neq I_2$

$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2 \neq 0$

QUESTION

In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used)

[12 April, 2019 (S-I)]

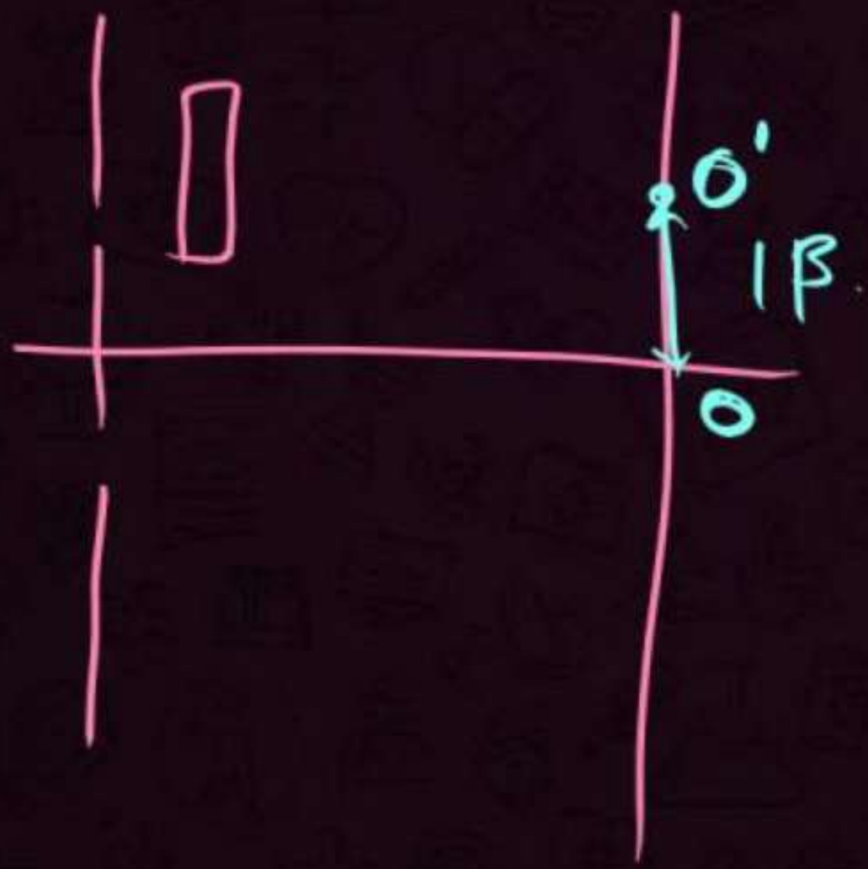
(JEE Mains)

① $\frac{\lambda}{2(\mu-1)}$

② $\frac{\lambda}{(2\mu-1)}$

③ $\frac{2\lambda}{(\mu-1)}$

[✓ ④ $\frac{\lambda}{(\mu-1)}$]



Best Method

$$\boxed{\begin{array}{c} \Delta x = (\mu-1)t = n\lambda. \\ n = 1 \\ (\mu-1)t = \lambda. \\ t = \frac{\lambda}{\mu-1} \end{array}} \rightarrow \text{Direct}$$

M-2

$$(\mu-1)t = \frac{yd}{D}$$

$$(\mu-1)t = \frac{\beta d}{D}$$

$$(\mu-1)t = \frac{\cancel{D}\lambda}{\cancel{d}} \times \frac{\cancel{d}}{\cancel{D}}$$

$$(\mu-1)t = \lambda$$

QUESTION

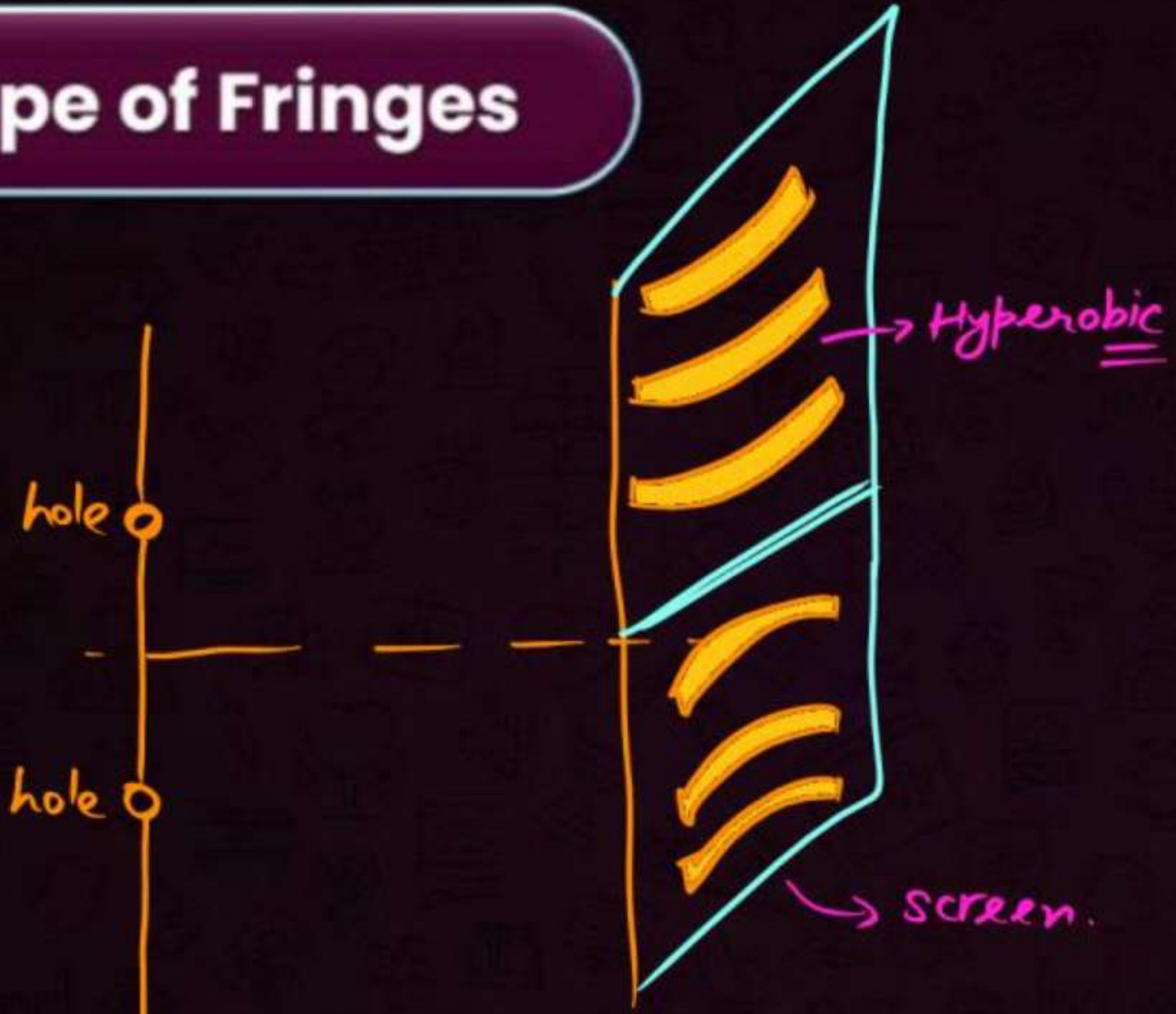
HW

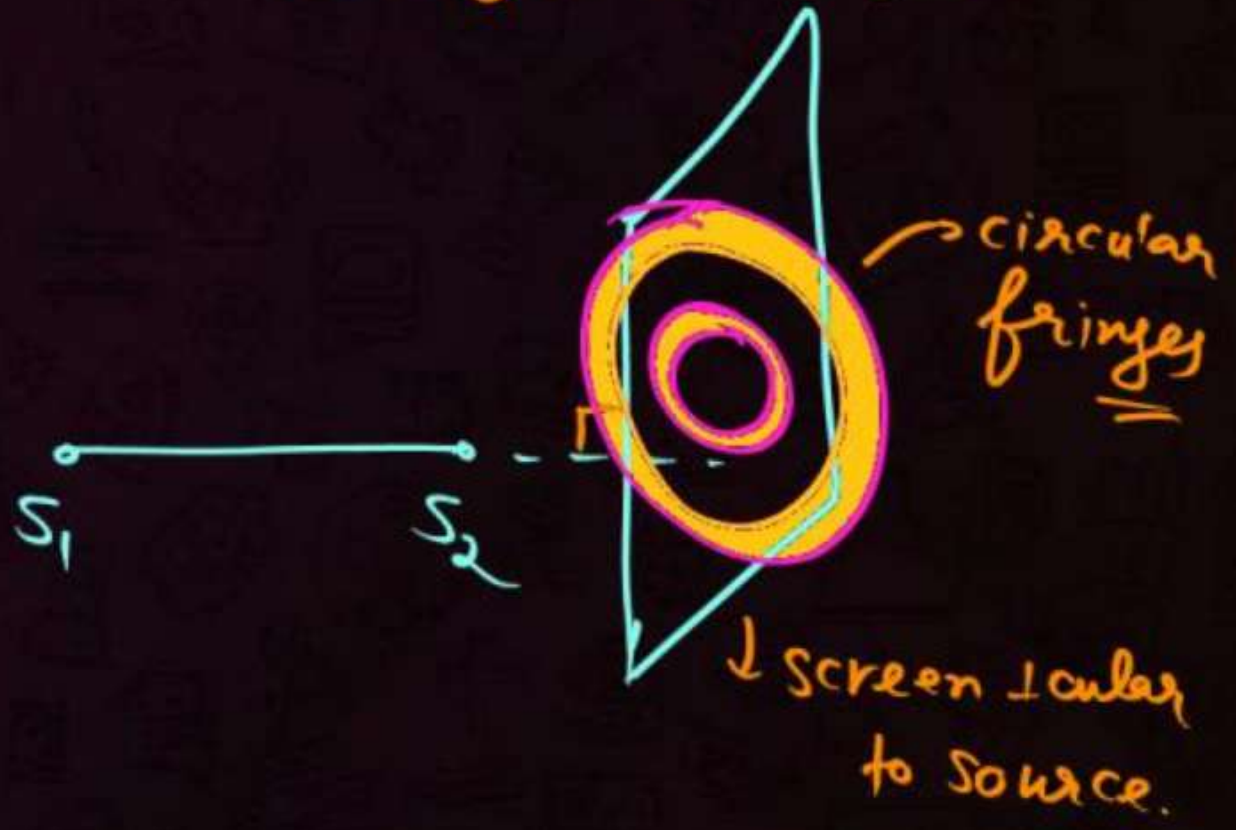
A double slit experiment is performed with light of wavelength 500 nm. A thin film of thickness 2 μm and refractive index 1.5 is introduced in the path of the upper beam. The location of the central maximum will:

$$(\mu-1)t = \underline{\underline{n\lambda}} = \frac{yd}{D}$$

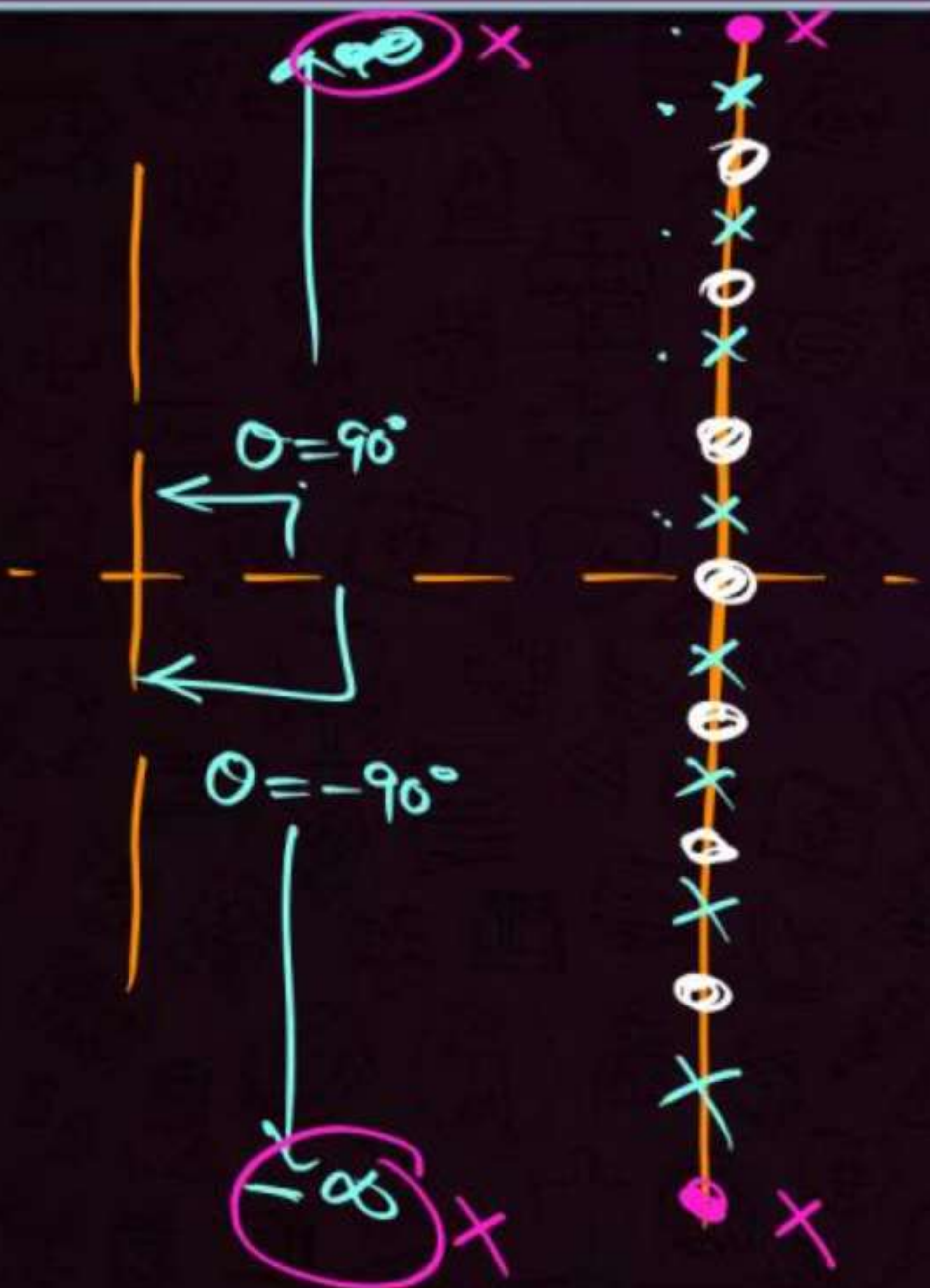
1. Remain unshifted
2. Shift downward by nearly two fringes
3. Shift upward by nearly two fringes
4. Shift downward by 10 fringes

Shape of Fringes





No. of Maxima / Minima



Ques $d = 4\lambda \longrightarrow$ No. of maxm = ? = 7

$\longrightarrow$ No. minm = ? = 8

Soln : $\Delta x = d\sin\theta = n\lambda$

$$4\cancel{\lambda}\sin\theta = n\cancel{\lambda}$$

$$\sin\theta = \frac{n}{4}$$

$$-1 < \frac{n}{4} < 1$$

$$-4 < n < 4 \longrightarrow$$

3
2
1
0
−1
−2
−3

Ques $d = 5\lambda$. $\longrightarrow$ $-5 < n < +5$

No. of max^m = ? $\longrightarrow$ 9

No. of min^m = ? $\longrightarrow$ 10

4

3

2

1

0

-1

-2

-3

-4

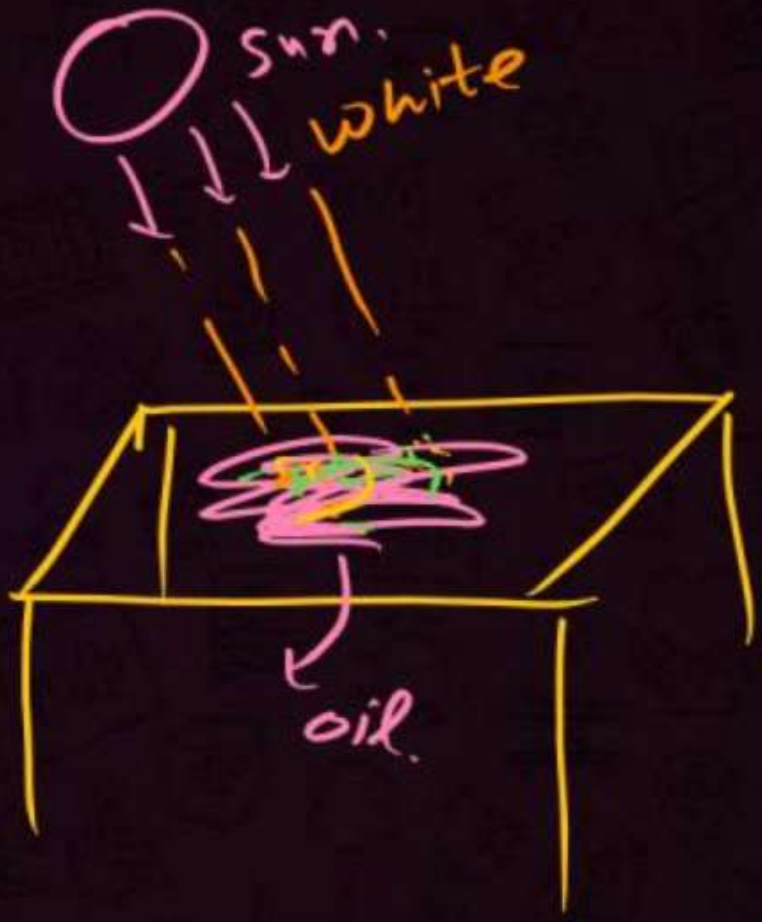
QUESTION

When exposed to sunlight, thin films of oil on water often exhibit brilliant colours due to the phenomenon of

[AIIMS 2005]

1. interference ✓
2. diffraction
3. dispersion
4. polarisation.

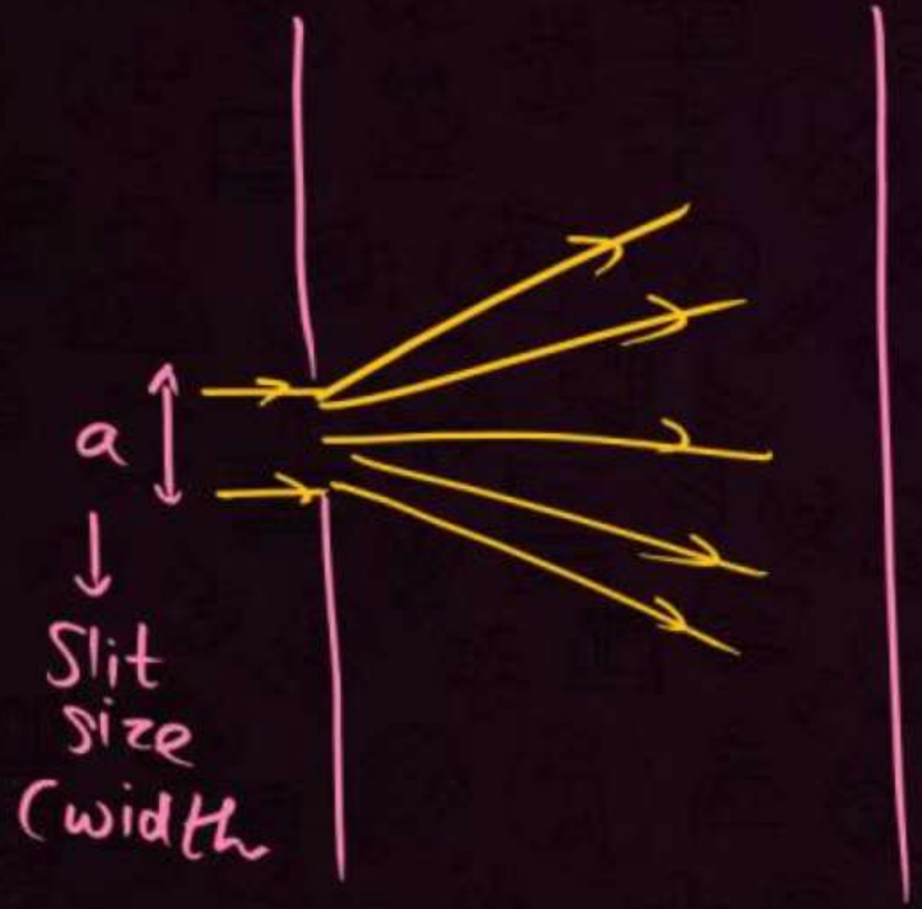
→ Thin film interference



Soap bubble

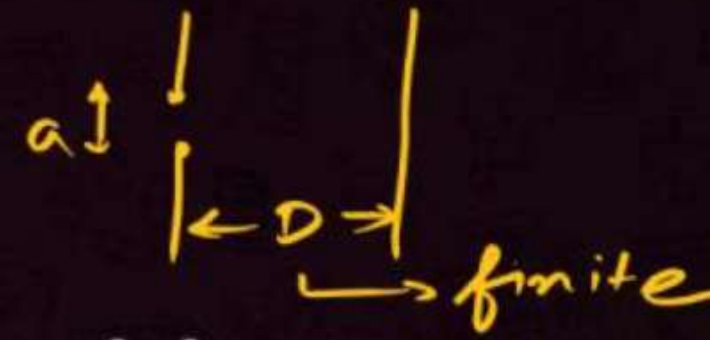
Diffraction

The bending of light rays around the sharp edges/corners.



* $a \sim \lambda$ → for diffraction effects to be visible, slit size must be comparable to λ

Types of Diffraction



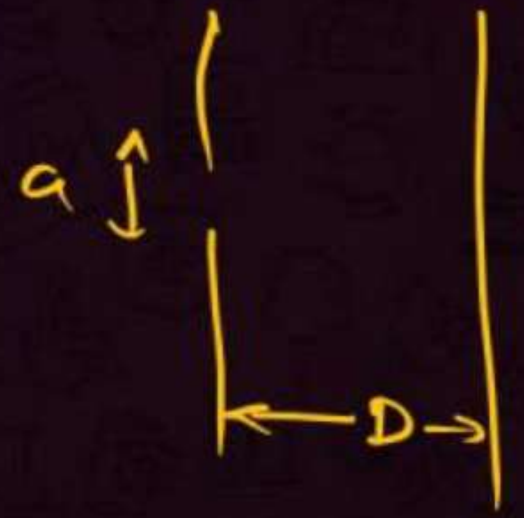
1. Fresnel Diffraction (1788-1827) - The screen and the source are at finite distance from each other.

39 yrs

2. Fraunhofer Diffraction (1787 - 1826) - The screen and the source are at infinite distance from each other.

39 yrs

We study only Fraunhofer diffraction.



$D >> a$

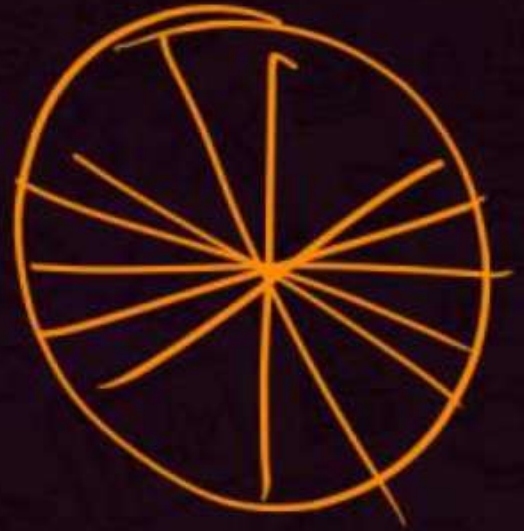
→ syllabus ✓

QUESTION

When a compact disc is illuminated by a source of white light, coloured lines are observed. This is due to → CD, DVD

[AIIMS 2004]

1. dispersion
2. [✓ diffraction]
3. interference
4. refraction



QUESTION

$\lambda\uparrow \rightarrow \lambda \simeq 1m$

$\lambda\downarrow \rightarrow$ a very low $\rightarrow 10^{-6}, 10^{-7}$

Assertion: Diffraction is common in sound but not common in light waves.

Reason: Wavelength of light is more than the wavelength of sound. [AIIMS 2019]

$\lambda\downarrow$ $\lambda\uparrow$

1. Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

2. Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

[✓ 3.] Assertion (A) is True, Reason (R) is False.

4. Assertion (A) is False, Reason (R) is True.

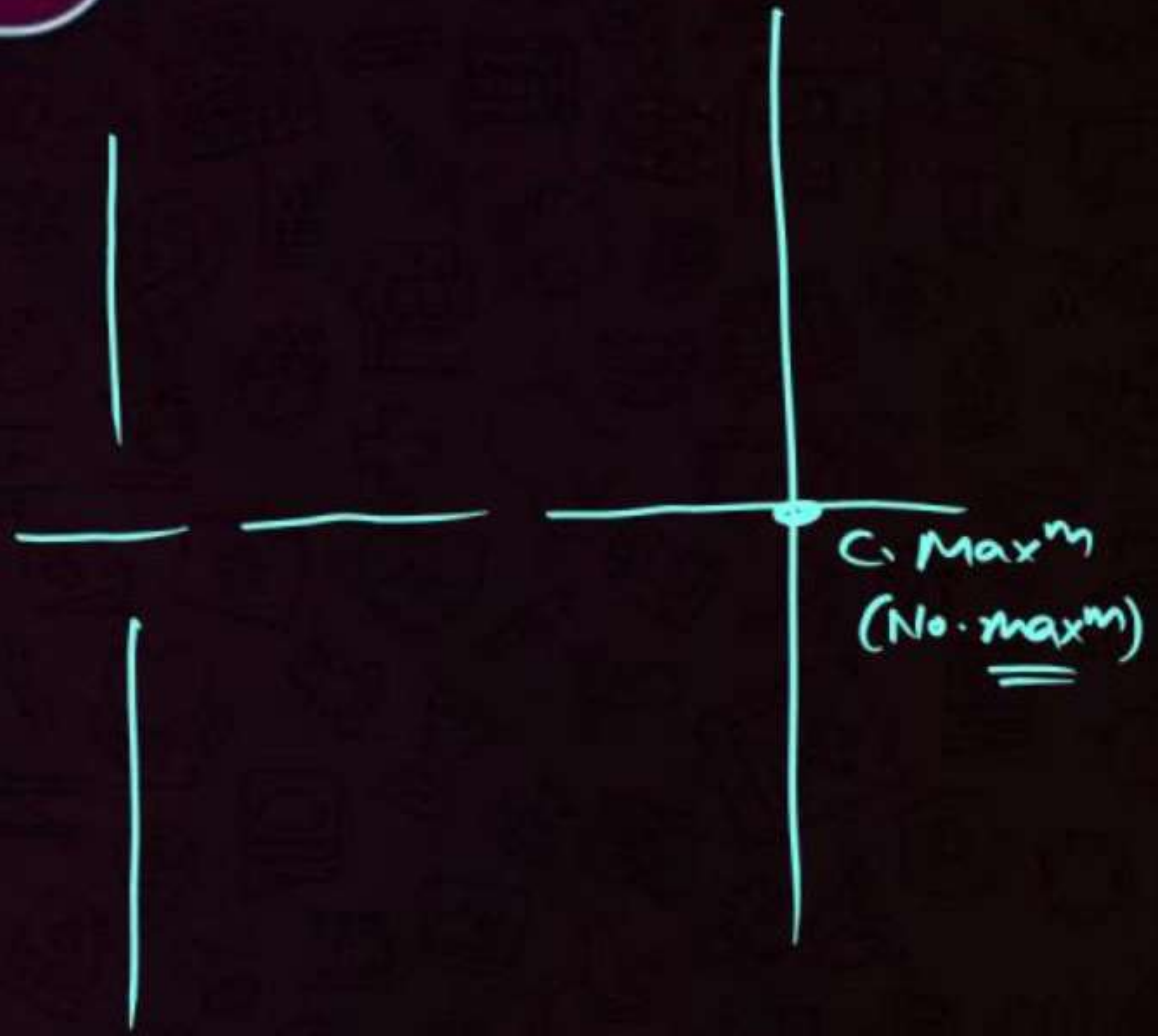
Maxima and Minima in Diffraction

↓

$\Delta x = a \sin\theta \simeq a\theta$

Minima $\boxed{a\theta = \pm n\lambda}$

Maxima $\boxed{a\theta = \pm \frac{(2n+1)\lambda}{2}}$



Minima $a\theta = n\lambda$

$\theta = \frac{n\lambda}{a}$

$n=1 \Rightarrow \theta = \frac{\lambda}{a}.$

$n=2 \Rightarrow \theta = \frac{2\lambda}{a}.$

$n=3 \Rightarrow \theta = \frac{3\lambda}{a}.$

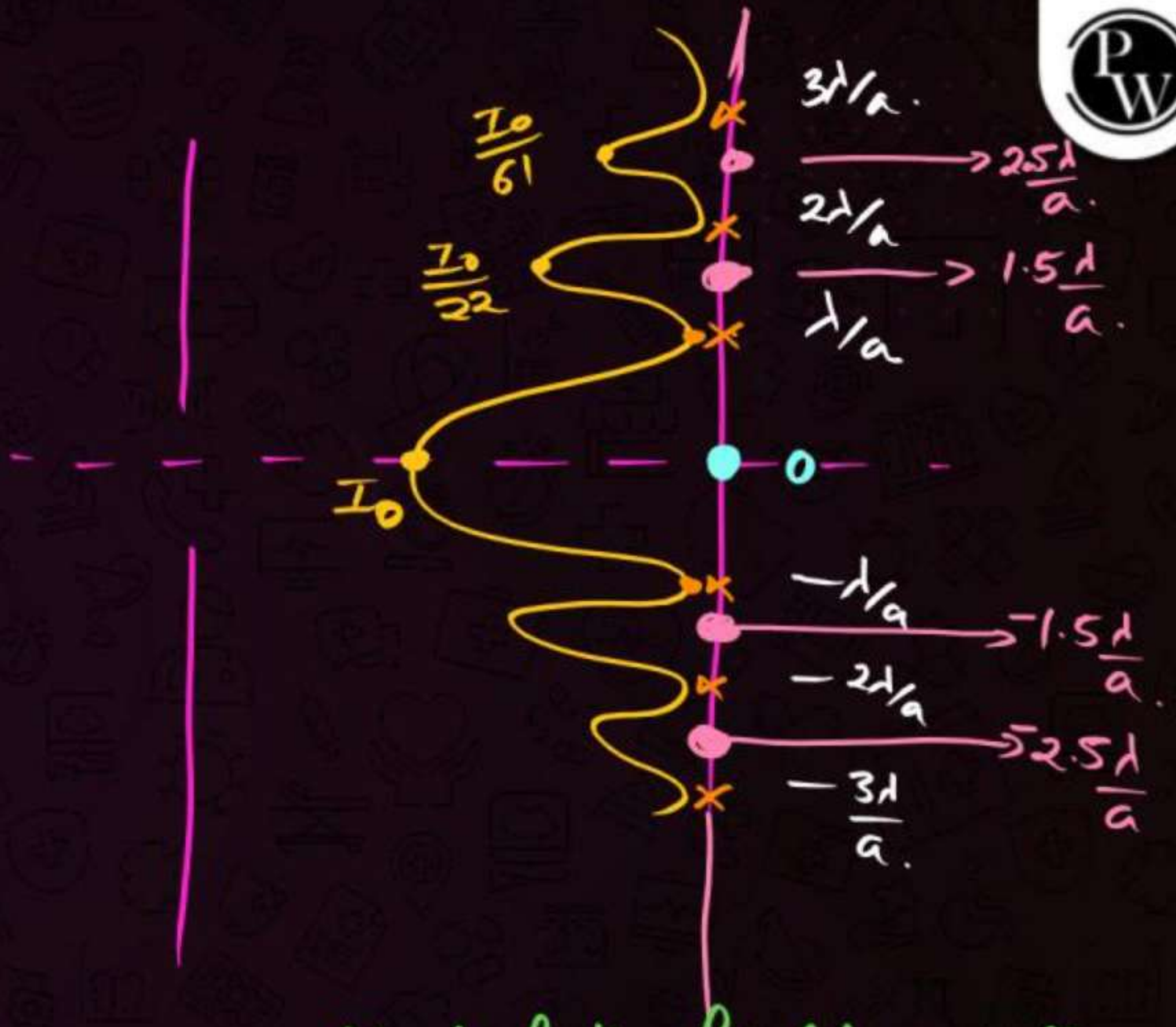
Max^m $a\theta = (2n+1)\frac{\lambda}{2}$

$\theta = \frac{(2n+1)\lambda}{2a}$

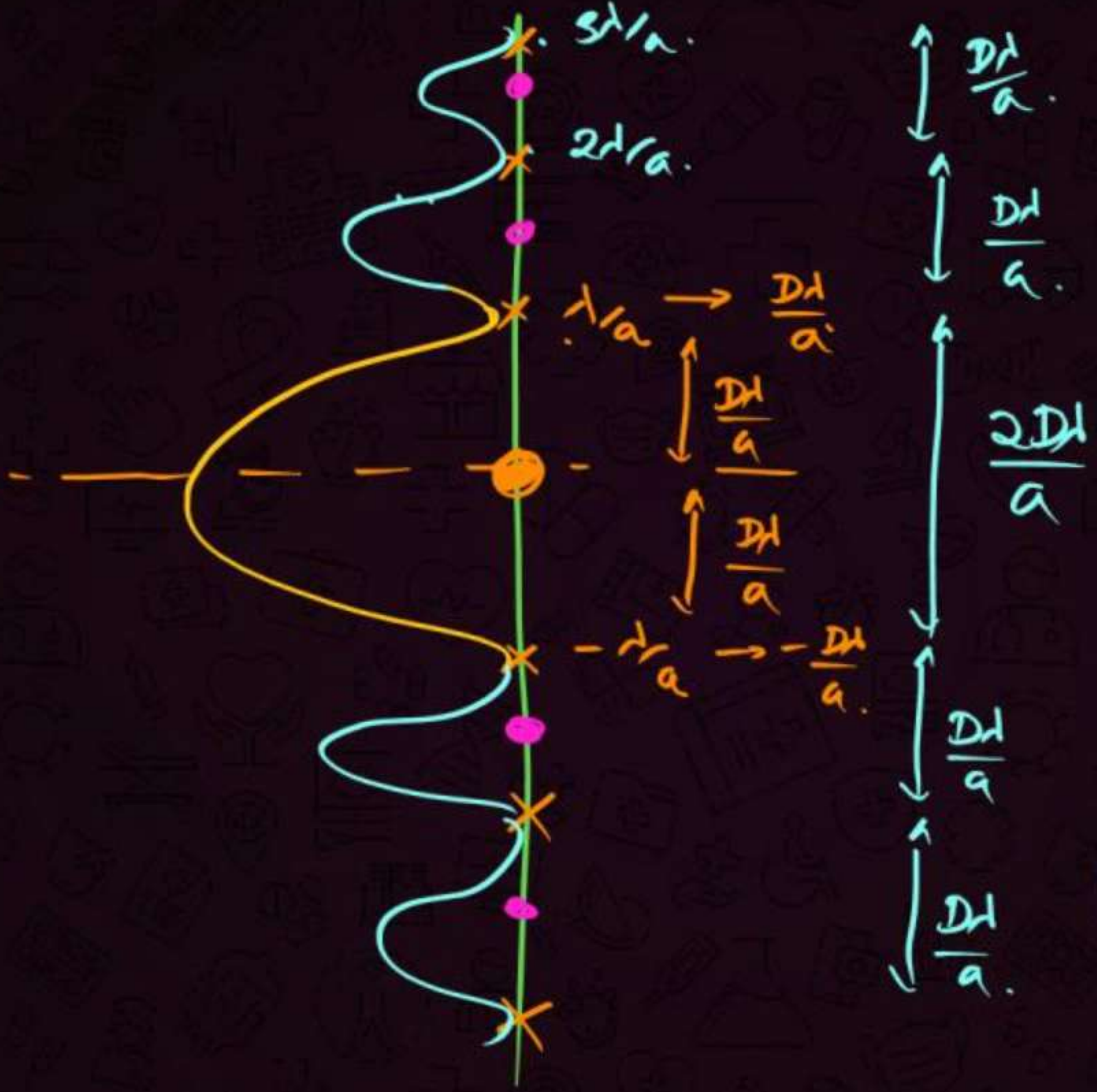
$n=1 \Rightarrow \theta = \frac{3\lambda}{2a} = 1.5.$

$n=2 \Rightarrow \theta = \frac{5\lambda}{2a} \longrightarrow 2.5$

$n=3 \Rightarrow \theta \longrightarrow \frac{7\lambda}{2a} \longrightarrow 3.5.$



Most of the light is diffracted In central max^m



width of central maxm $= \frac{2D\lambda}{a}$

width of other maxm $= \frac{D\lambda}{a}$

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

$\theta = \frac{\lambda}{d}$

ang. width of central maxm $= \frac{2\lambda}{a}$

ang width of other maxm $= \frac{\lambda}{a}$

Differency

Interference	Diffraction
① max^{m} → width → same	① central max^{m} → double width.
② max^{m} → all → same intensity	② central max^{m} → max^{m} intensity
③ Generally two sources (slits)	③ Many sources (family of sources) from a single slit

QUESTION

If red light is replaced by white light then width of diffraction pattern will **[AIIMS 2001]**

① increases

Baki colourful pattern

② decreases

[✓ ③ a central white band is obtained]

④ no effect.

QUESTION

A beam of light of λ = 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern in observed on a screen 2 m away. The distance between first dark fringes on either side of the central bright fringe is **[2014]**

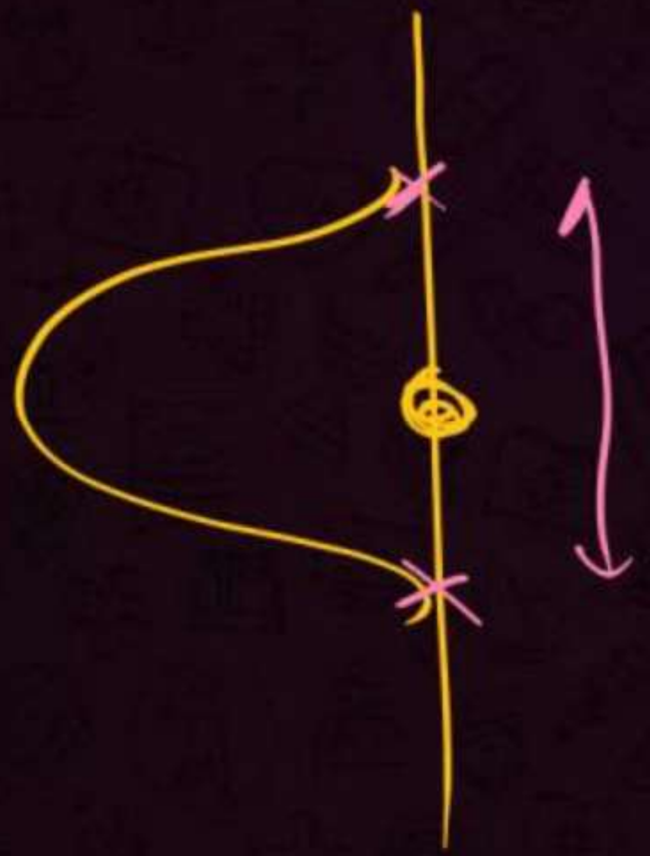
(min^m)

(1) 1.2 cm

(2) 1.2 mm

(3) 2.4 cm

[✓ (4) 2.4 mm]



$$\frac{2D\lambda}{a} = \frac{2\times 2\times 600\times10^{-9}}{1\times10^{-3}}$$

QUESTION

* (Famous Type)

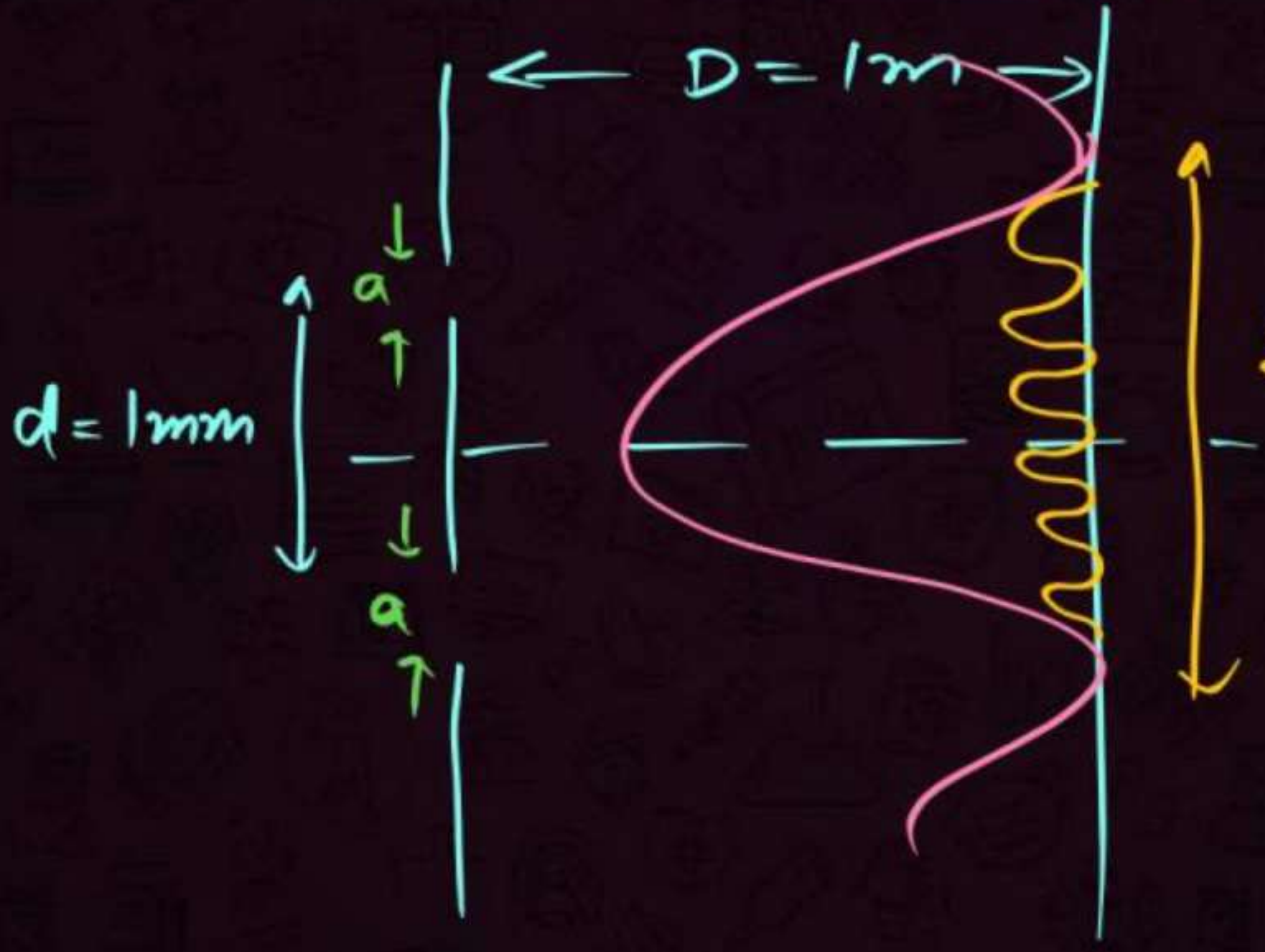
In a double slit experiment, the two slits are 1 mm apart and the screen is placed 1 m away. A monochromatic light of wavelength 500 nm is used. What will be the width of each slit for obtaining twenty maxima of double slit within the central maxima of single slit pattern?

(1) 0.5 mm

(2) 0.02 mm

(3) 0.2 mm

[✓ (4) 0.1 mm]



$$\frac{2D\lambda}{a} = 20\beta$$

$$\frac{\cancel{2D\lambda}}{a} = \overset{10}{\cancel{20}} \times \frac{\cancel{D\lambda}}{d}$$

$$\frac{1}{a} = \frac{10}{d} \Rightarrow a = \frac{d}{10} = \frac{1\,mm}{10}$$

$$= 0.1\,mm.$$

QUESTION

HW

In a Fraunhofer diffraction at single slit of width d with incident light of wavelength 5500 Å, the first minimum is observed at angle 30°. The first secondary maximum is observed at an angle θ= ?

[AIIMS 2016]

$d \sin\theta = n\lambda$

1. $\sin^{-1}\frac{1}{\sqrt{2}}$
2. $\sin^{-1}\frac{1}{4}$
3. $\sin^{-1}\frac{3}{4}$
4. $\sin^{-1}\frac{\sqrt{3}}{2}$

Fresnel Distance

If $D > Z_F \Rightarrow$ wave character dominate.

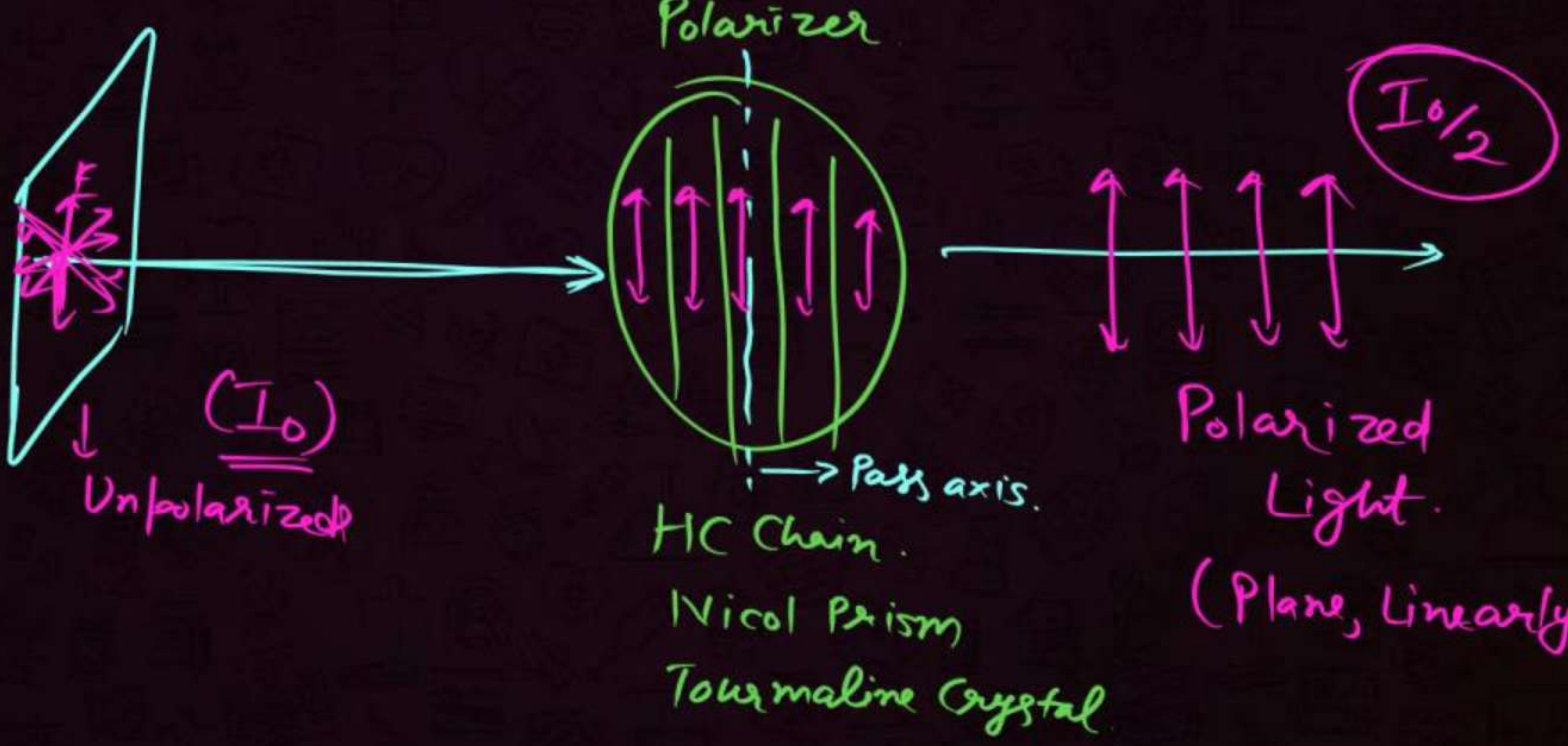
If $D < Z_F$ $\Rightarrow$ ray character dominate

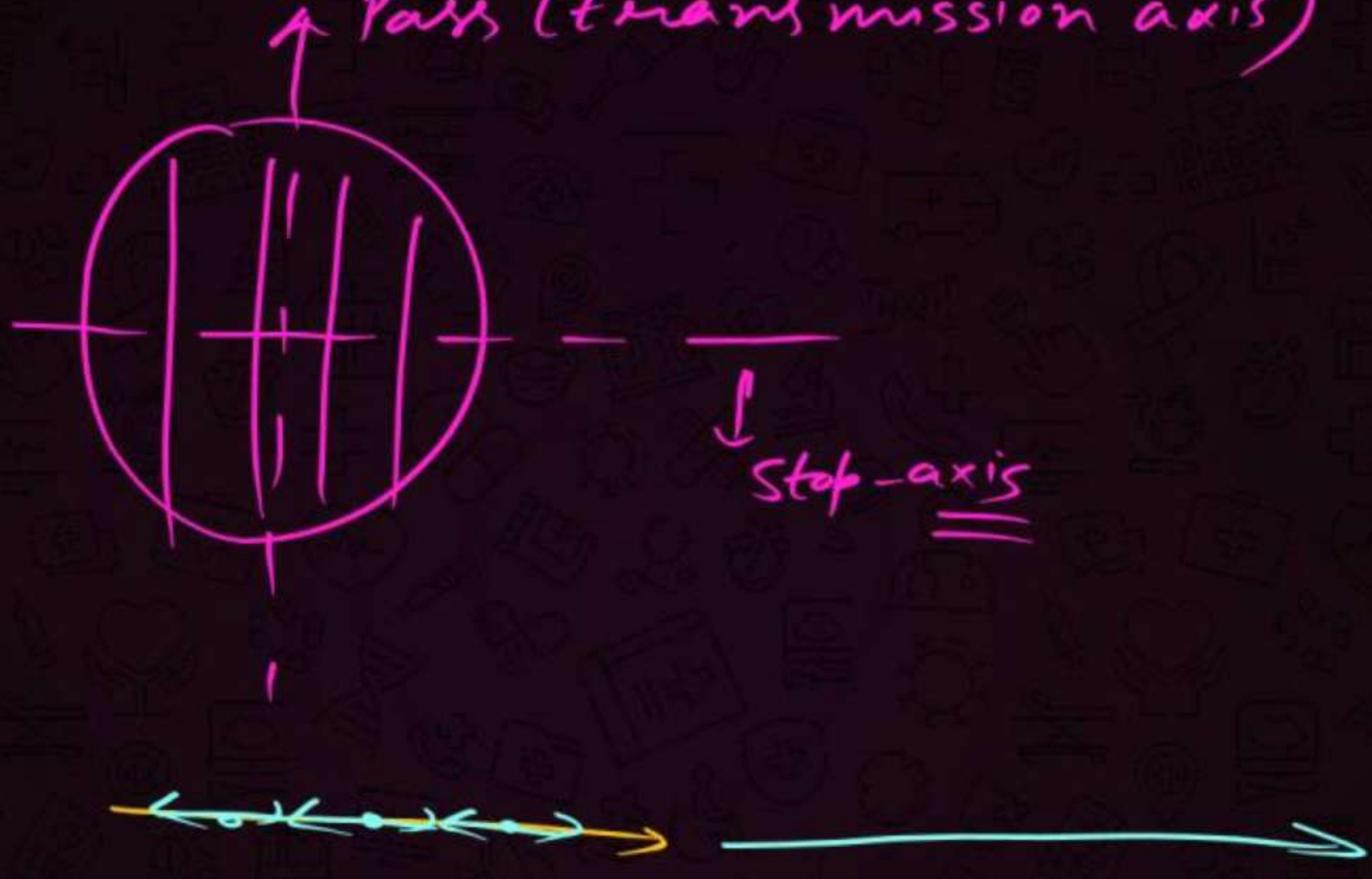
☆ $$\boxed{Z_F = \frac{a^2}{\lambda}}$$

Polarization

optical vector

The phenomenon of restricting the vibration of light (electric vector) in a particular direction perpendicular to the direction of propagation of wave is called polarization of light.




Pass (transmission axis)
Stop-axis

QUESTION

Transverse.

Assertion: Radio waves can be polarised.

Reason: Sound waves in air are longitudinal in nature. **[AIIMS 1998]**

① Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

② Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

③ Assertion (A) is True, Reason (R) is False.

④ Assertion (A) is False, Reason (R) is True.

* Sound waves can't be polarized

QUESTION

Polaroid glass is used in sun glasses because [AIIMS 2013]

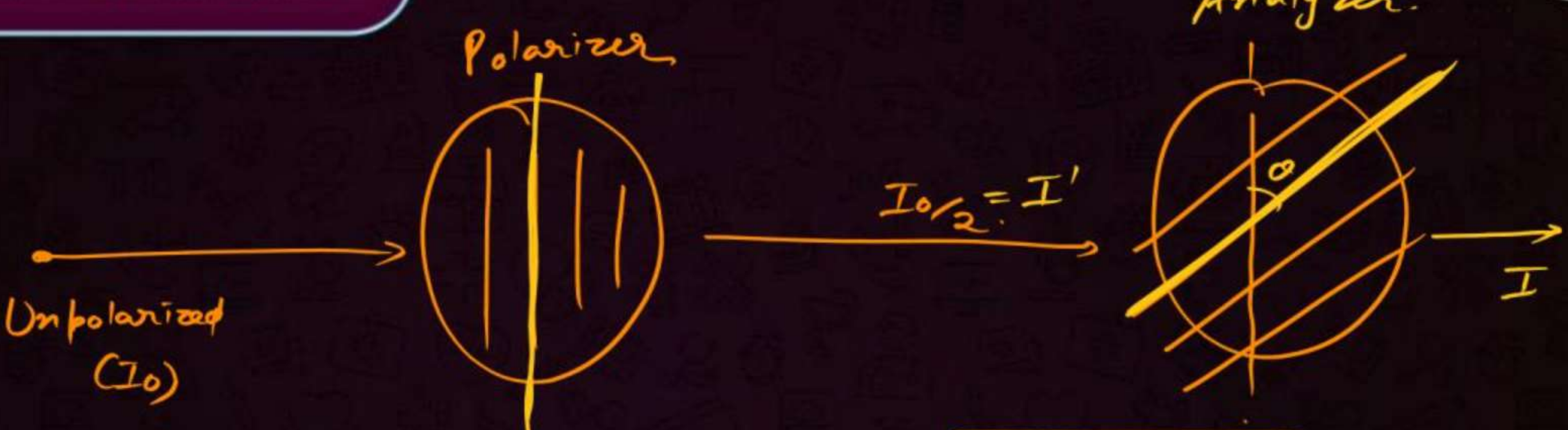
① [✓ it reduces the light intensity to half on account of polarisation]

② ✗ it is fashionable

③ ✗ it has good colour

④ ✗ it is cheaper.

Law of Malus



$$\boxed{I = I'\cos^2\theta.}$$

QUESTION

↗ $\perp$cular

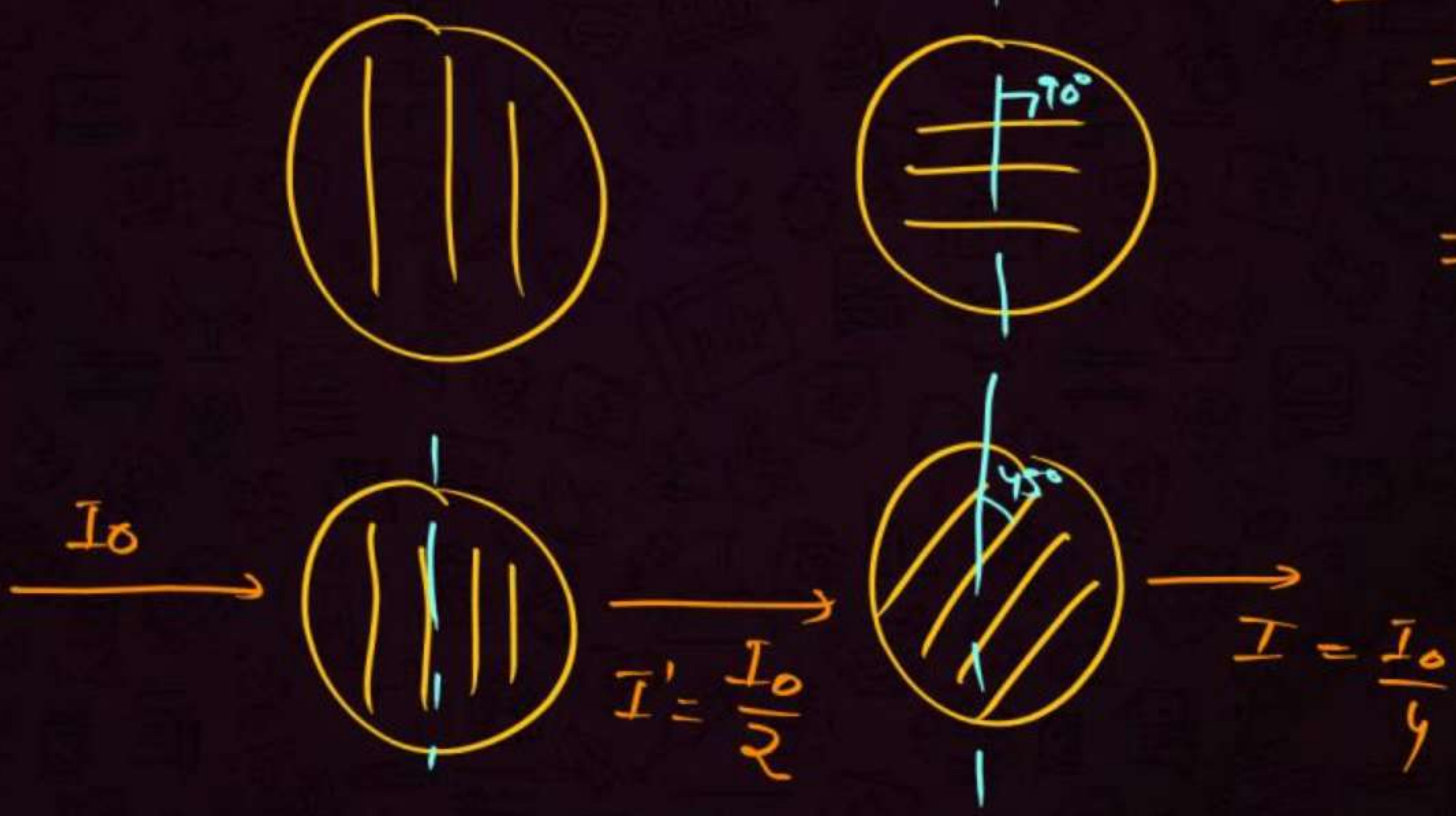
Two polaroids are kept crossed to each other. Now one of them is rotated through an angle of 45°. The percentage of incident light now transmitted through the system is

① 15%

[✓ ② 25%]

③ 50%

④ 75%



$$I = I' \cos^2 45^\circ$$

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

$$= \frac{I_0}{4} \rightarrow \boxed{25\%}$$

QUESTION

HW

Two polaroids A and B are placed in such a way that the pass-axis of polaroids are perpendicular to each other. Now, another polaroid C is placed between A and B bisecting the angle between them. If intensity of unpolarised light is I, then intensity of transmitted light after passing through polaroid B will be: **[31 Jan, 2023 (S-I)]**

① $I_0/4$

② $I_0/2$

③ $I_0/8$

④ Zero

QUESTION

'n' polarizing sheets are arranged such that each makes an angle 45° with the preceding sheet. An unpolarized light of intensity I is incident into this arrangement. The output intensity is found to be I/64. The value of n will be: **[01 Feb, 2023 (S-I)]**

(JEE Mains)

① 3

[✓ ② 6]

③ 5

④ 4

$$\frac{I}{4} \xrightarrow{45^\circ} \frac{I}{8}$$

$$\xrightarrow{45^\circ} \frac{I}{16} \xrightarrow{45^\circ} \frac{I}{32}$$

$$\xrightarrow{45^\circ} \frac{I}{64}$$

$$\frac{I}{2^6} = \frac{I}{64}$$

QUESTION

HW

A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is cross with respect to that of P_1. The pass axis of P_2 is inclined at 60° to the pass axis of P_3. When a beam of unpolarized light of intensity I_0 is incident on P_1, the intensity of light transmitted by the three polarizers is I. The ratio (I_0/I) equals (nearly)

[12 April, 2019 (S-II)]

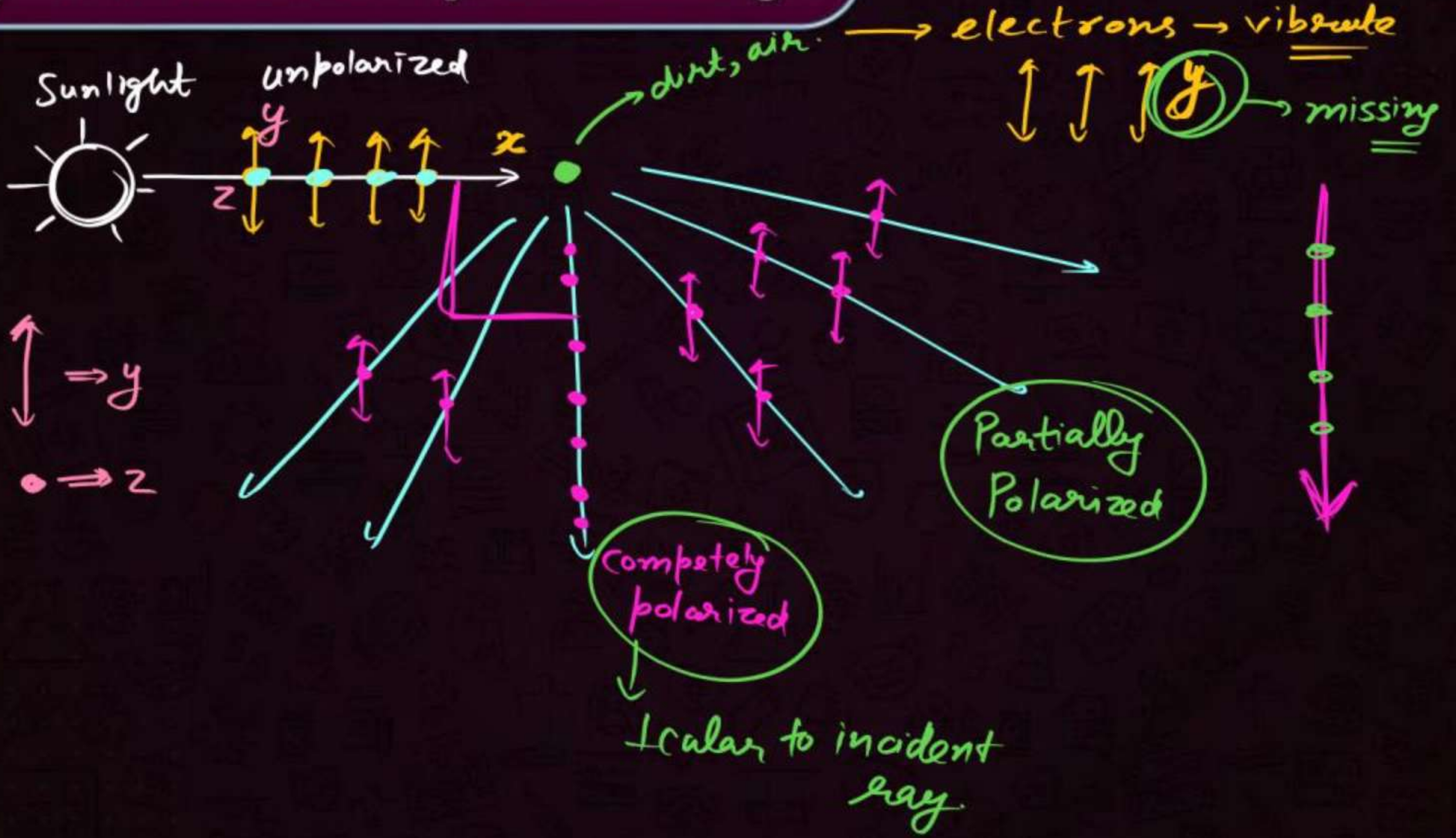
(1) 16.00

(2) 1.80

(3) 5.33

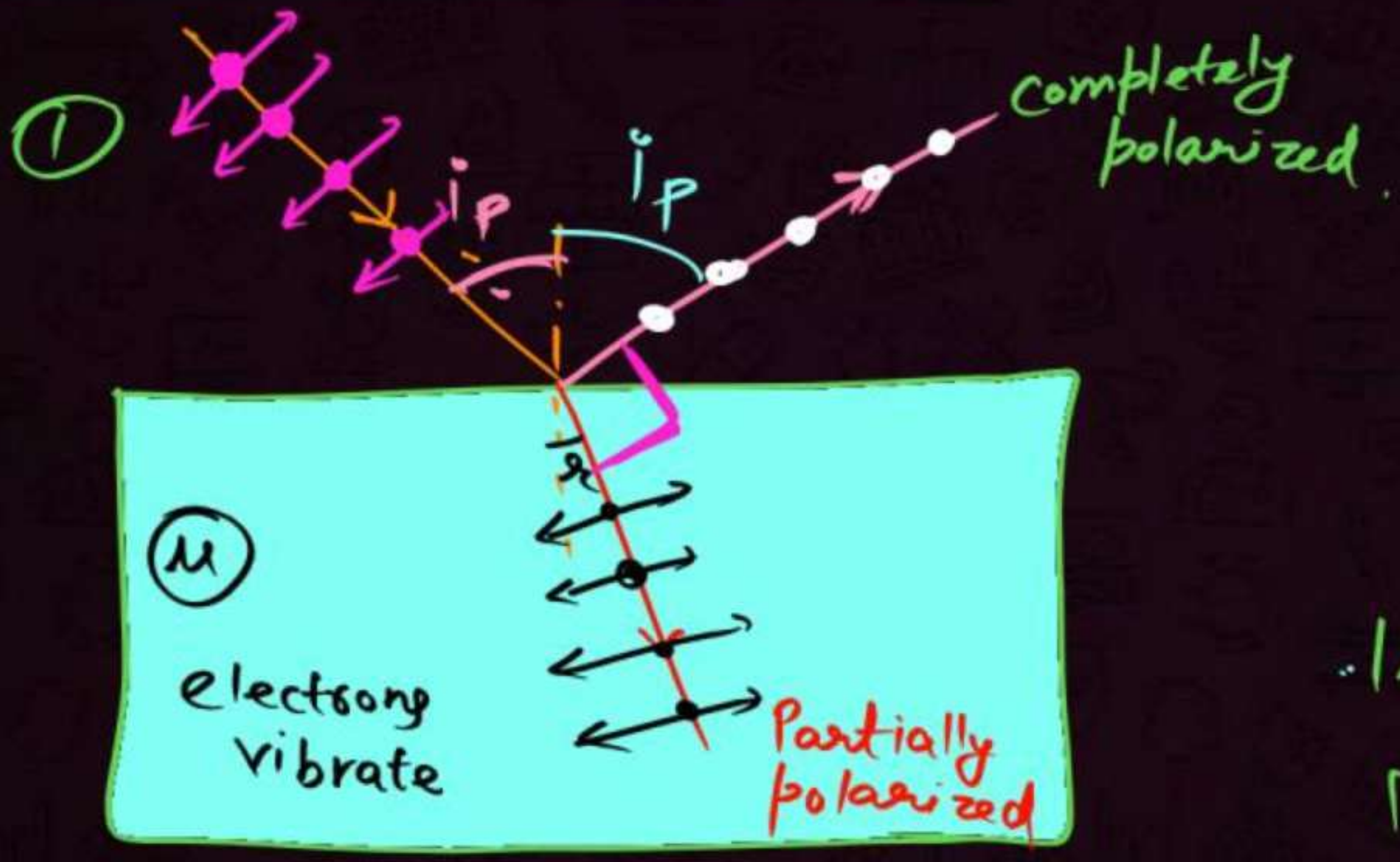
(4) 10.67

Polarization by Scattering



- When light is incident on the small particles of atmosphere such as dust, air molecules it is absorbed by the electrons in the molecules, hence electrons start vibrating.
- These vibrating electrons emit radiations in all directions except in its own line of vibration.
- The emitted radiations (light) scattered in a direction perpendicular to direction of incident light is plane polarised.

Polarization by Reflection



$$r + 90 + i_p = 180^\circ$$

$$r = 90 - i_p$$

$$1 \times \sin i_p = \mu \times \sin r$$

$$1 \times \sin i_p = \mu \times \sin(90 - i_p)$$

$$\sin i_p = \mu \cos i_p.$$

$$\boxed{i_p = \tan^{-1}\mu}$$

Brewster angle

$$\boxed{\tan i_p = \mu.}$$

→ Brewster law (2024 PYQ)

- When unpolarized light is incident on the boundary between two transparent medium, for an angle of incidence in which reflected wave travels at right angle to the refracted wave, the reflected light is completely polarized while the refracted light is partially polarized.

QUESTION

At what angle of incidence will the light reflected from glass (μ = 1.5) be completely polarized?

[AIIMS 1994]

[✓ ① 56.3°]

② 40.3°

③ 72.8°

④ 51.6°

$\mu = \tan i$

$\boxed{1.5} = \tan i$

$\tan 45° = 1$

$\tan 53° = \frac{4}{3} = 1.33$

$\updownarrow \qquad \updownarrow 1.5.$

$\tan 60° = \sqrt{3} = 1.73$

QUESTION

The angle of polarization for any medium is 60°. What will be critical angle for this?

① $\sin^{-1}\sqrt{3}$

② $\tan^{-1}\sqrt{3}$

③ $\cos^{-1}\sqrt{3}$

[✓ ④ $\sin^{-1}\frac{1}{\sqrt{3}}$]

$$\tan 60^\circ = \mu$$

$$\boxed{\sqrt{3} = \mu}$$

$$\sin\theta_c = \frac{1}{\mu}$$

$$\sin\theta_c = \frac{1}{\sqrt{3}}$$

$$\theta_c = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

QUESTION

Last ones

Statement-I: If the Brewster's angle for the light propagating from air to glass is θ_B, then Brewster's angle for the light propagating from glass to air is $\pi/2 - \theta_B$.

Statement-II: The Brewster's angle for the light propagating from glass to air is $\tan^{-1}(\mu_g)$ where μ_g is the refractive index of glass.

$1/\mu_g$

In the light of the above statements, choose the correct answer from the options given below :

[24 Jan, 2023 (S-I)]

(JEE Mains)

① Both Statements-I and Statement-II are true.

[✓ ②] Statement-I is true but Statement-II is false.

③ Both Statement-I and Statement-II are false

④ Statement-I is false but Statement-II is true.

air to glass

$\Rightarrow \theta_B.$

glass to air $\Rightarrow 90^\circ - \theta_B$

$\tan\theta_B = \mu$

$\tan\theta_B' = \frac{1}{\mu}$

$\tan\theta_B' = \frac{1}{\tan\theta_B}$

$$\tan\theta_B' = \frac{1}{\tan\theta_B}$$

$$\tan\theta_B' = \cot\theta_B$$

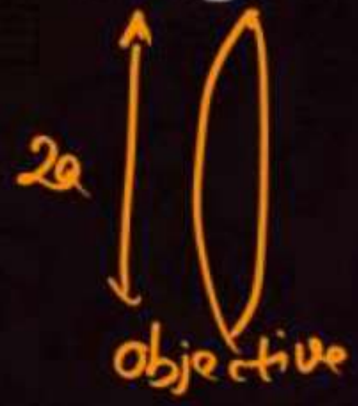
$$\cancel{\tan}\,\underline{\theta_B'} = \cancel{\tan}(\underline{90-\theta_B})$$

$$\boxed{\theta_B' = 90-\theta_B}$$

Resolving Power

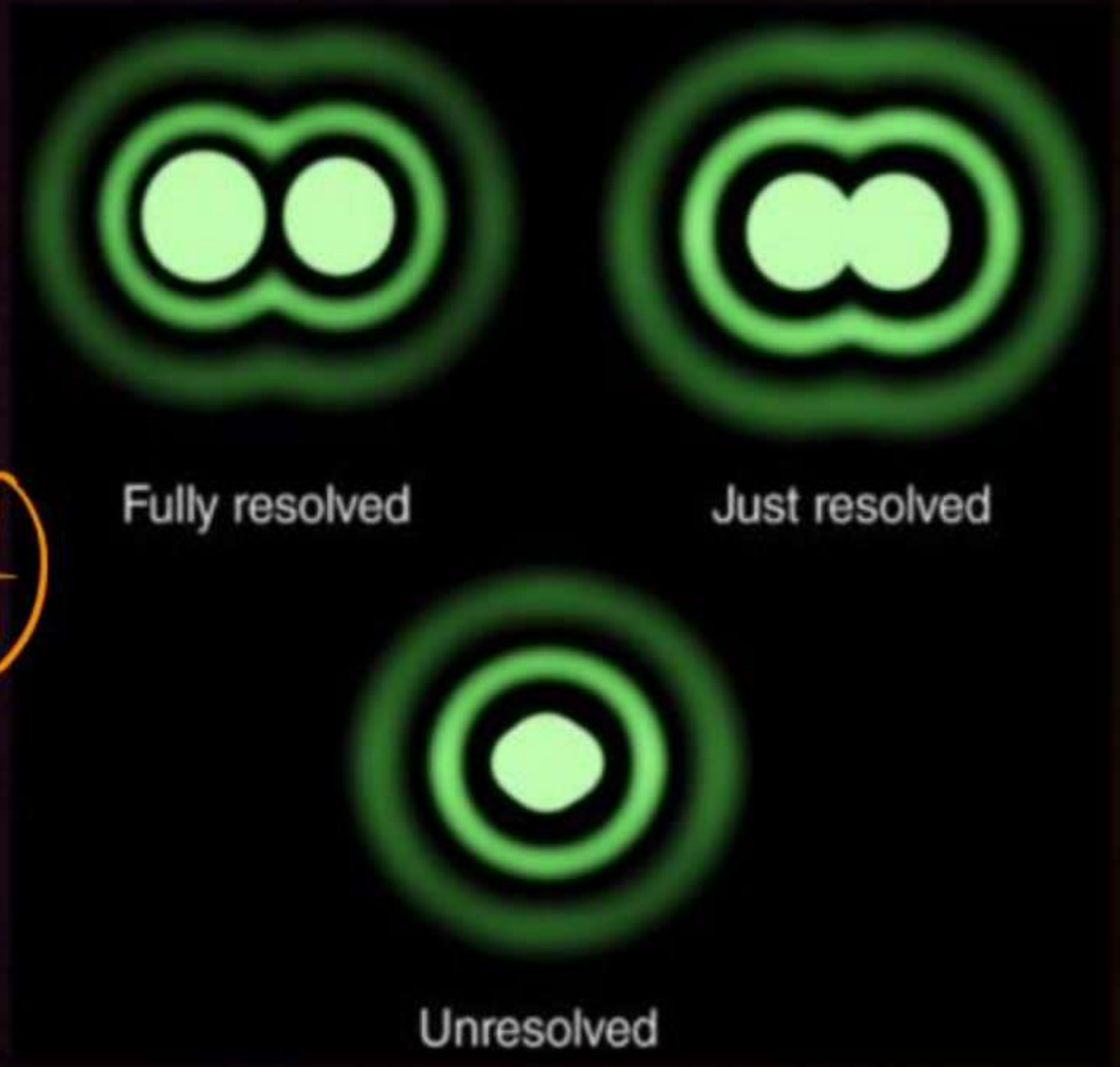
→ Syllabus ✗

The resolving power of an instrument is the ability to distinguish between two neighbouring points.



Telescope → $\boxed{R.P = \frac{2a}{1.22\lambda}}$ → $R.P \propto \frac{1}{\lambda}$

Microscope ⇒ $\boxed{R.P = \frac{2\mu \sin\theta}{1.22\lambda}} \propto \frac{1}{\lambda}$



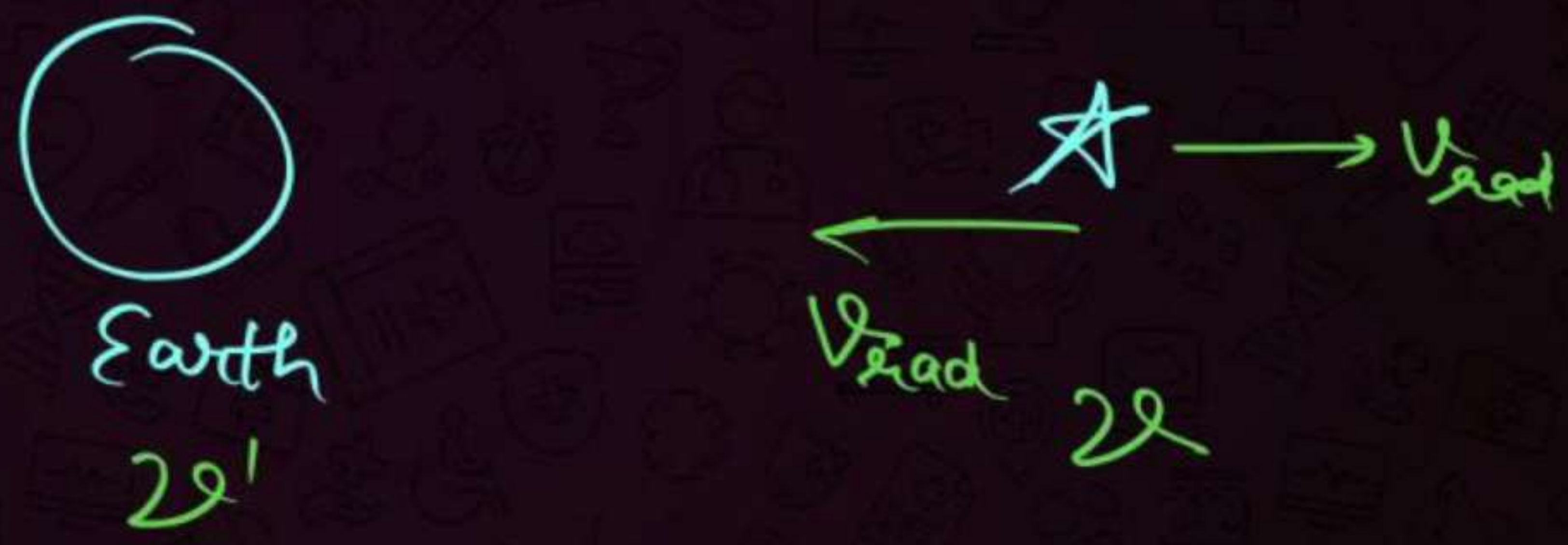
Doppler Effect in Light *

$$\boxed{\frac{\Delta\nu}{\nu} = \frac{\Delta\lambda}{\lambda} = \frac{|v_{radial}|}{c}}$$

Syllabus X

$\Delta\nu = \nu' - \nu$

New NCERT X



QUESTION

In a Young's double slits experiment, the ratio of amplitude of light coming from slits is 2 : 1. The ratio of the maximum to minimum intensity in the interference pattern is

[13 April, 2023 (S-II)]

(1) 9 : 4

(2) 9 : 1

(3) 2 : 1

(4) 25 : 9

QUESTION

If the source of light used in a Young's double slit experiment is changed from red to violet: [24 Feb, 2021 (S-II)]

① The fringes will become brighter.

② Consecutive fringe lines will come closer

③ The central bright fringe will become a dark fringe

④ The intensity of minima will increase

QUESTION

In a Young's double slit experiment two slits are separated by 2 mm and the screen is placed one meter away. When a light of wavelength 500nm used, the fringe separation will be:

[26 Feb, 2021 (S-I)]

(1) 1 mm

(2) 0.75 mm

(3) 0.25 mm

(4) 0.50 mm

QUESTION

In a certain double slit experimental arrangement, interference fringes of width 1 mm each are observed when light of wavelength 5000 Å is used. Keeping the set up unaltered, if the source is replaced by another of wavelength 6000 Å, the fringe width will be [AIIMS 2015]

① 1.2 mm

② 0.5 mm

③ 1 mm

④ 1.5 mm

QUESTION

In and YDSE, the fringes are formed at a distance 1 m from double slits of separation 0.12 mm. Calculate the wave-length of light used, if distance of 3rd bright band from the centre of screen is 1.5 cm.

(1) 6000 Å

(2) 5000 Å

(3) 4000 Å

(4) 8000 Å

QUESTION

In a Young's double slit experiment, the fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index 4/3 without disturbing the geometrical arrangement, the new fringe width will be

(1) 0.30 mm

(2) 0.40 mm

(3) 0.53 mm

(4) 450 micron

TBS Capsule ①

* Theories of Light

a) Newton corpuscle Theory

↓

particle

↓

- Light travel's in straight line
- Explained → Reflection ✓
  - Refraction ✓
  - Interference ×
  - Diffraction ×
  - Polarization ×

b) Huygen's Wave Theory

- Light is a longitudinal wave

longitudinal ↓ ×

wave ↓ ✓

Reflection ✓

Refraction ✓

Interference ✓

Diffraction ✓

Polarization ×

c) Maxwell EM Theory

Light is an EM & transverse wave.

Polarization ✓

Photo-Elec. Effect ×

d) Einstein's quantum Theory

↓

- energy packets → called quanta or photon
- Each photon energy

$$E = h\nu = \frac{hc}{\lambda}$$

- Photoelectric effect ✓

Interference ×

Diffraction ×

Polarization ×

e) De-broglie's Theory :-

- Dual Nature → Particle & Wave
- Depending upon situation, one nature dominates over other

TBS Capsule ②

* Wave-front·

- Locus of all points vibrating in same phase
- ⊥cular to wave propagation

* Huygen's Theory:-

→ We can find W-Front at later time t.

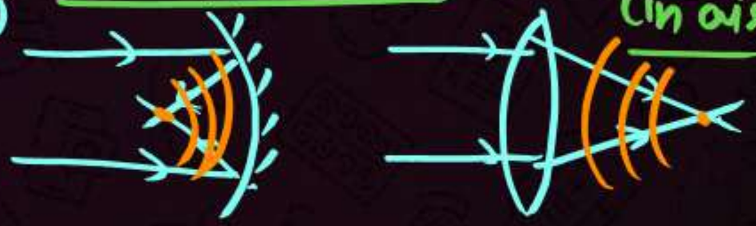
- Each point on wavefront acts as a source of secondary wavelet.
- The common tangent to these wavelets in forward direction is called secondary wavefront.

* Shape

Source	Shape
Point	Spherical
Line	Cylindrical
At infinity	Planar

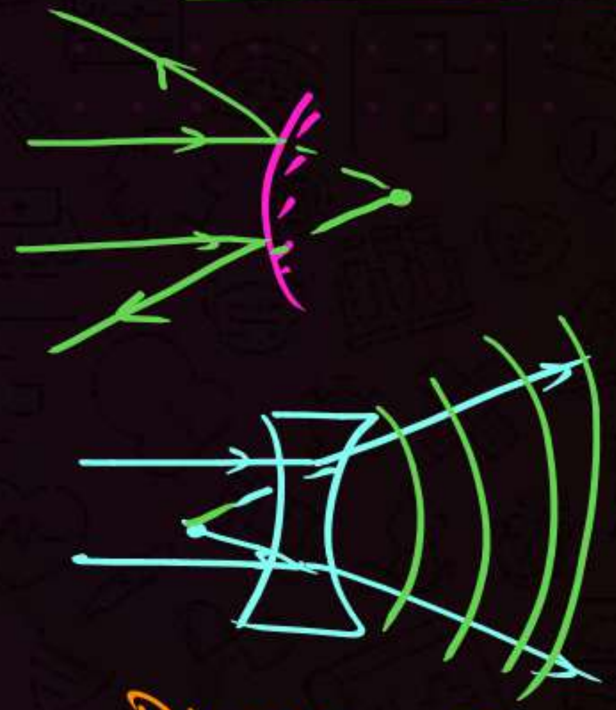
- Reflection / Refraction of ||el rays from optical devices

① Concave mirror & Convex Lens (in air)



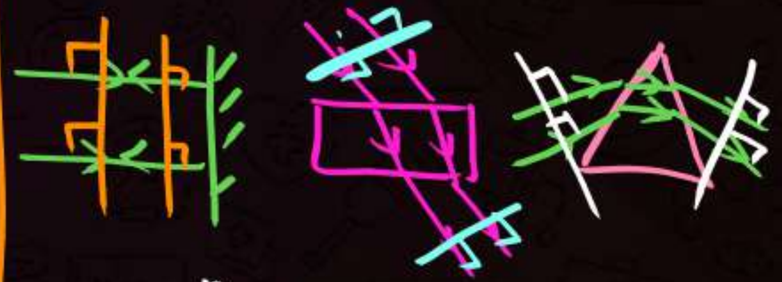
Converging Spherical

② Convex mirror & concave Lens (in air)



Diverging Spherical

③ Plane Mirror, Prism, Glass slab



Planar

TBS capsule ③

- **Super-position of waves**

$\downarrow$

resultant displacement is vector addition of individual waves displacement.

$$\boxed{\vec{y} = \vec{y_1} + \vec{y_2}}$$

- **coherent sources**

$\downarrow$

$$\boxed{\Delta\phi = \phi = 0 \text{ or const.}}$$

- **Interference** → Type of Super-position

$\Downarrow$ same f, Same ω

$\Downarrow$ Same λ, Same k

- $$\boxed{\Delta\phi = \frac{2\pi}{\lambda}\Delta x}$$

$$\boxed{\Delta x = \frac{2\pi}{\lambda}\Delta x}$$

- **Values to Learn**

$\Delta x = \frac{\lambda}{2}$, $\Delta\phi = \pi$

$\Delta x = \lambda$, $\Delta\phi = 2\pi$

- $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$I = I_1 + I_2 + 2\sqrt{I_1I_2}\cos\phi$

- $\boxed{I \propto A^2} \Rightarrow \boxed{\sqrt{I} \propto A}$

① Constructive

- $\boxed{\cos\phi = +1} \longrightarrow \text{max}^m$
- $\Delta\phi$ or $\phi = 0, \pm 2\pi, \pm 4\pi, \pm 6\pi, \dots$

$$\boxed{\phi = \pm 2n\pi}$$

$n = 0, 1, 2, 3, \dots$

(even multiple of π)

- $\boxed{A_{max} = A_1 + A_2}$
- $\boxed{I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2}$
- $\boxed{\Delta x = \pm n\lambda}$ $n = 0, 1, 2, 3, \dots$

$\Delta x = 0, \pm\lambda, \pm 2\lambda, \pm 3\lambda, \pm 4\lambda \dots$

↳ multiple of λ

② Destructive

- $\boxed{\cos\phi = -1} \longrightarrow \text{min}^m$
- $\Delta\phi = \pm\pi, \pm 3\pi, \pm 5\pi, \pm 7\pi, \dots$

$$\boxed{\Delta\phi = \pm(2n-1)\pi}$$

$n = 1, 2, 3, 4, \dots$

(odd multiple of π)

- $\boxed{A_{min} = A_1 - A_2}$ or $A_2 - A_1$
- $\boxed{I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2}$
- $\boxed{\Delta x = \pm(2n-1)\frac{\lambda}{2}}$ $n = 1, 2, 3, 4, \dots$

$\Delta x = \pm\frac{\lambda}{2}, \pm\frac{3\lambda}{2}, \pm\frac{5\lambda}{2}$ ⇔ odd multiple of $\frac{\lambda}{2}$.

* $$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2 = \left(\frac{A_1+A_2}{A_1-A_2}\right)^2$$

* If $\Delta\phi = \phi = \frac{\pi}{2} = 90^\circ$

  & $\Delta x = \lambda/4$

$$\Downarrow$$

$$I = I_1 + I_2, \quad A = \sqrt{A_1^2 + A_2^2}$$

* Identical sourcey

If $A_1 = A_2 = A_0$ & $I_1 = I_2 = I_0$

then
$$\boxed{A = 2A_0 \cos\left(\frac{\phi}{2}\right)}$$
$$\boxed{I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)}$$

$A_{max} = 2A_0$, $A_{min} = 0$

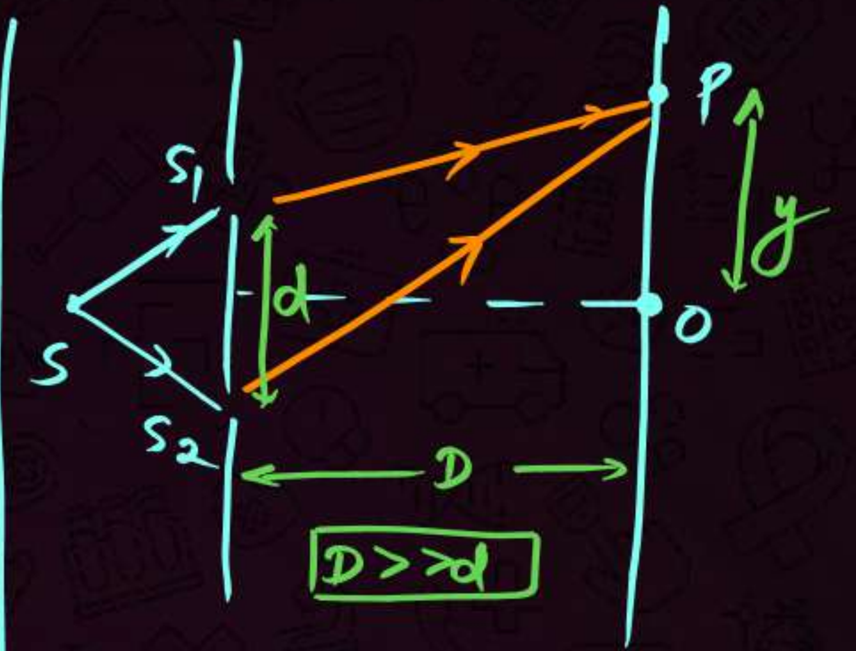
$I_{max} = 4I_0$, $I_{min} = 0$

TBS Capsule ④

* YDSE

Experimentally verfied wave nature of light

• Constructive Interference	• Destructive Interference
↓	↓
maxima	minima
↓	↓
Bright Fringe (Band)	Dark Fringe (Band)



$$\boxed{S_2P - S_1P = \Delta x = d\sin\theta \simeq \frac{yd}{D}}$$

* $\boxed{\beta = \frac{D\lambda}{d}}$ → Fringe width

* $\boxed{\theta = \frac{\lambda}{d}}$ → angular fringe width

↳ if λ & d in metres then θ in radian.

* Constructive

$$\Delta x = \frac{yd}{D} = \pm n\lambda$$

* Destructive

$$\Delta x = \frac{yd}{D} = \pm\frac{(2n-1)\lambda}{2}$$

* y is the distance from center of screen.

→ 3rd max^m → $y = \frac{3D\lambda}{d} = 3\beta$

$2.5\beta = \frac{2.5 D\lambda}{d}$ ← 3rd min^m

→ 2nd max^m → $y = \frac{2D\lambda}{d} = 2\beta$

$1.5\beta = \frac{1.5 D\lambda}{d}$ ← 2nd mini

→ Ist max^m → $y = \frac{D\lambda}{d} = \beta$

$0.5\beta = \frac{0.5 D\lambda}{d}$ ← Ist min^m ←

→ Central max^m → $y = 0$

$-0.5\beta = -\frac{0.5 D\lambda}{d}$ ←

→ $y = -\frac{D\lambda}{d} = -\beta$

$-1.5\beta = -\frac{1.5 D\lambda}{d}$ ←

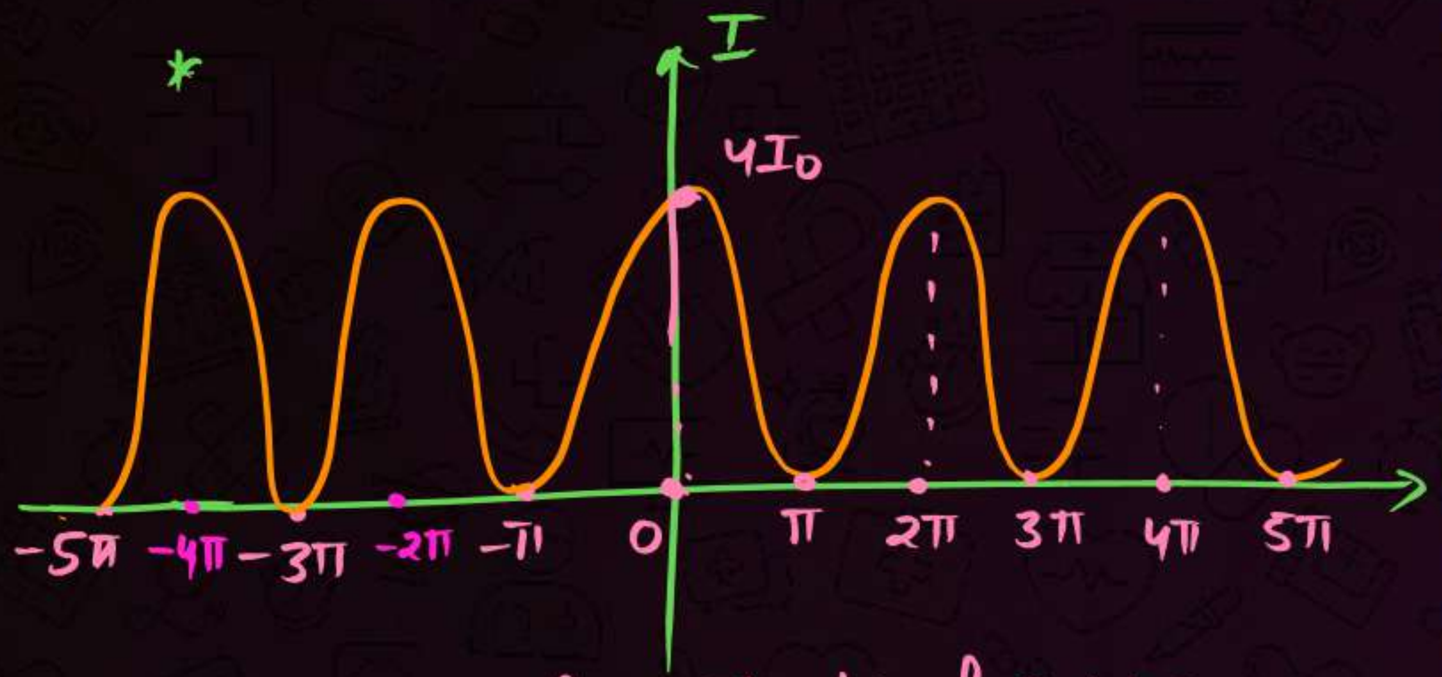
→ $y = -\frac{2D\lambda}{d} = -2\beta$

$-2.5\beta = -\frac{2.5 D\lambda}{d}$ ←

→ $y = -\frac{3D\lambda}{d} = -3\beta$

TBS Capsule ⑤

*



Graph for Identical sources

* Intensity ∝ Area of Slit / Circular Hole

$I \propto lw \rightarrow$ rectangular slit.

If $l_1 = l_2 \longrightarrow$ same

then $\frac{I_1}{I_2} = \frac{w_1}{w_2}$

* Medium change

$\boxed{\lambda' = \frac{\lambda}{\mu}}$ $\boxed{\beta' = \frac{\beta}{\mu}}$

Decreases

* If white light used instead of monochromatic light

⇓

central max^m white bcoz $\Delta x = 0$

- Rest is colourful pattern

* Incoherent Source

↓

Interference not sustainable

$\boxed{I_{av} = I_1 + I_2}$

↓

everywhere on screen.

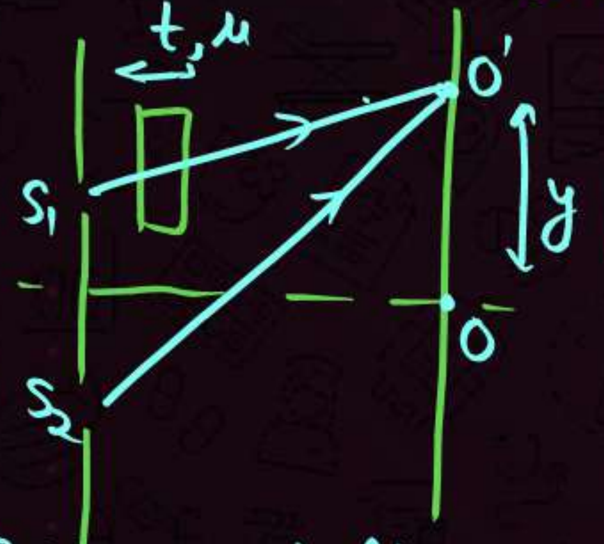
* Two independent sources can't show inteference bcoz their phase diff. not remain constant. (i.e. Incoherent Sources)

* oil film & soap bubble Show colours due to interference.

* Equivalent optical path

$$\boxed{\mu_1 d_1 = \mu_2 d_2}$$ → If light takes same time to cover these distance.

*



$$\boxed{\frac{yd}{D} = (\mu-1)t}$$

For no. of fringes shift

$$\boxed{(\mu-1)t = n\lambda}$$

Patterns shifts in the direction of Slit introduced.

* Two maximas matching

$$\boxed{n_1\lambda_1 = n_2\lambda_2} \longrightarrow \text{TBS}$$

* No. of max^m/min^m : $d\sin\theta = n\lambda$

eg : $d = 4\lambda \Rightarrow -1 < \sin\theta < 1$

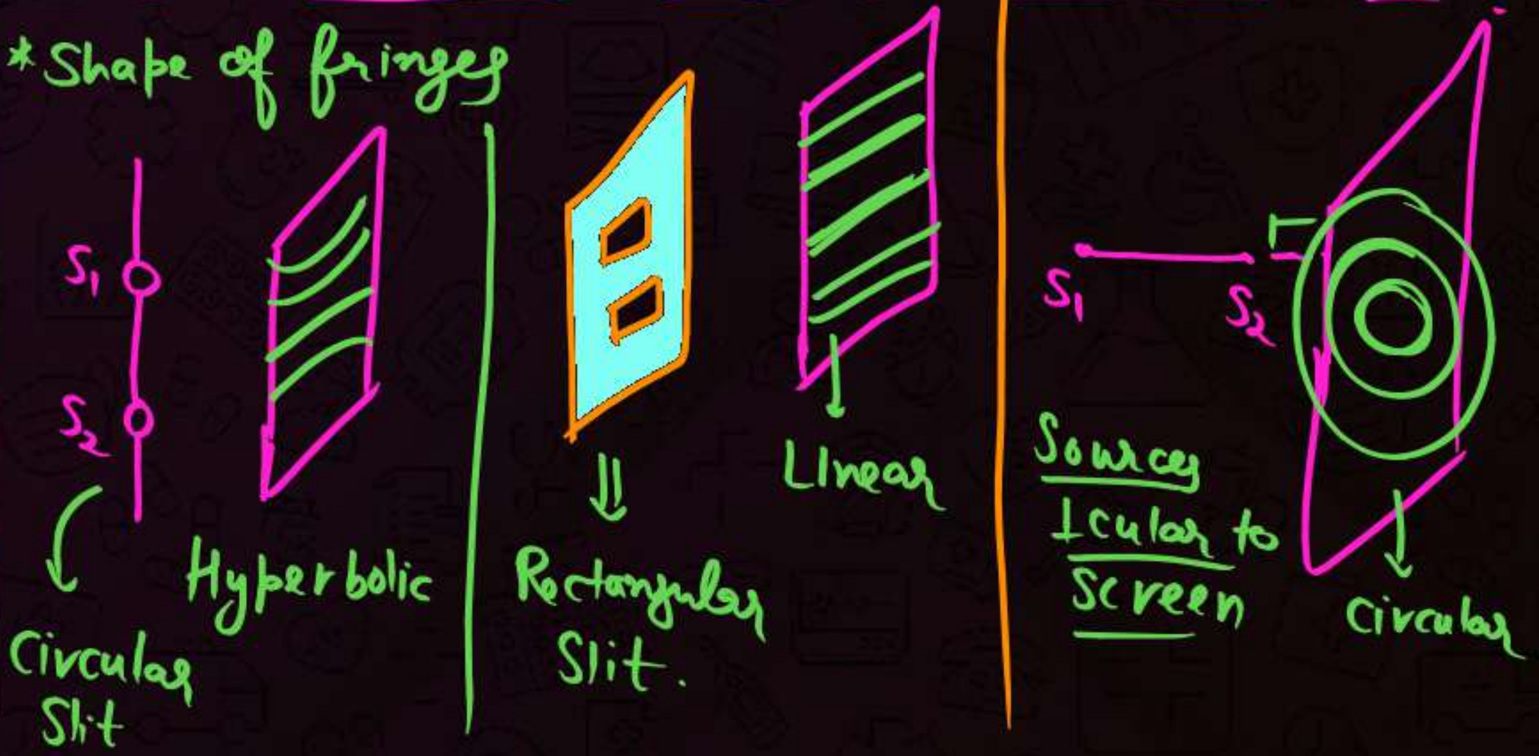
$-4 < n < 4$

Max^m = 7

Min^m = 8

$-4, 4$ not considered bcoz they form at ∞.

*Shape of fringes



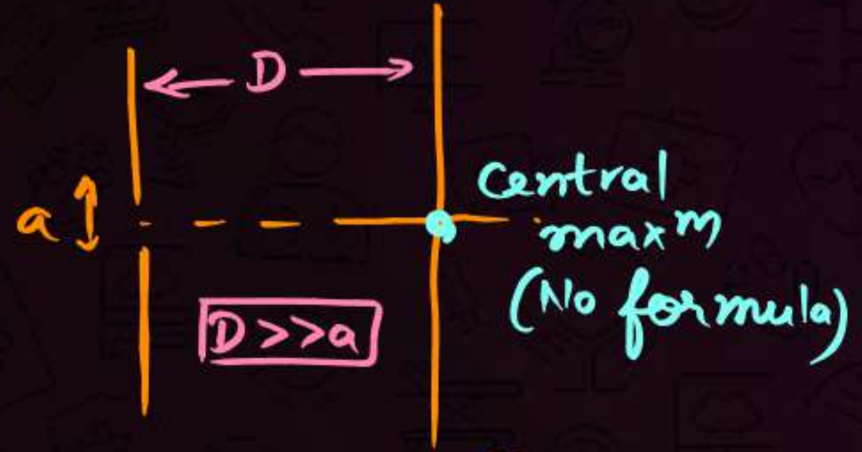
TBS Capsule ⑥

* **Diffraction**

↓

Bending of light rays around obstacle

*



For visible diffraction effects $\boxed{a \sim \lambda}$

↓

comparable.

* CD, DVD colours due to diffraction.

* **Min^m**

$$\boxed{a\theta = \pm n\lambda} \rightarrow n = 1, 2, 3, ----$$

* **Max^m**

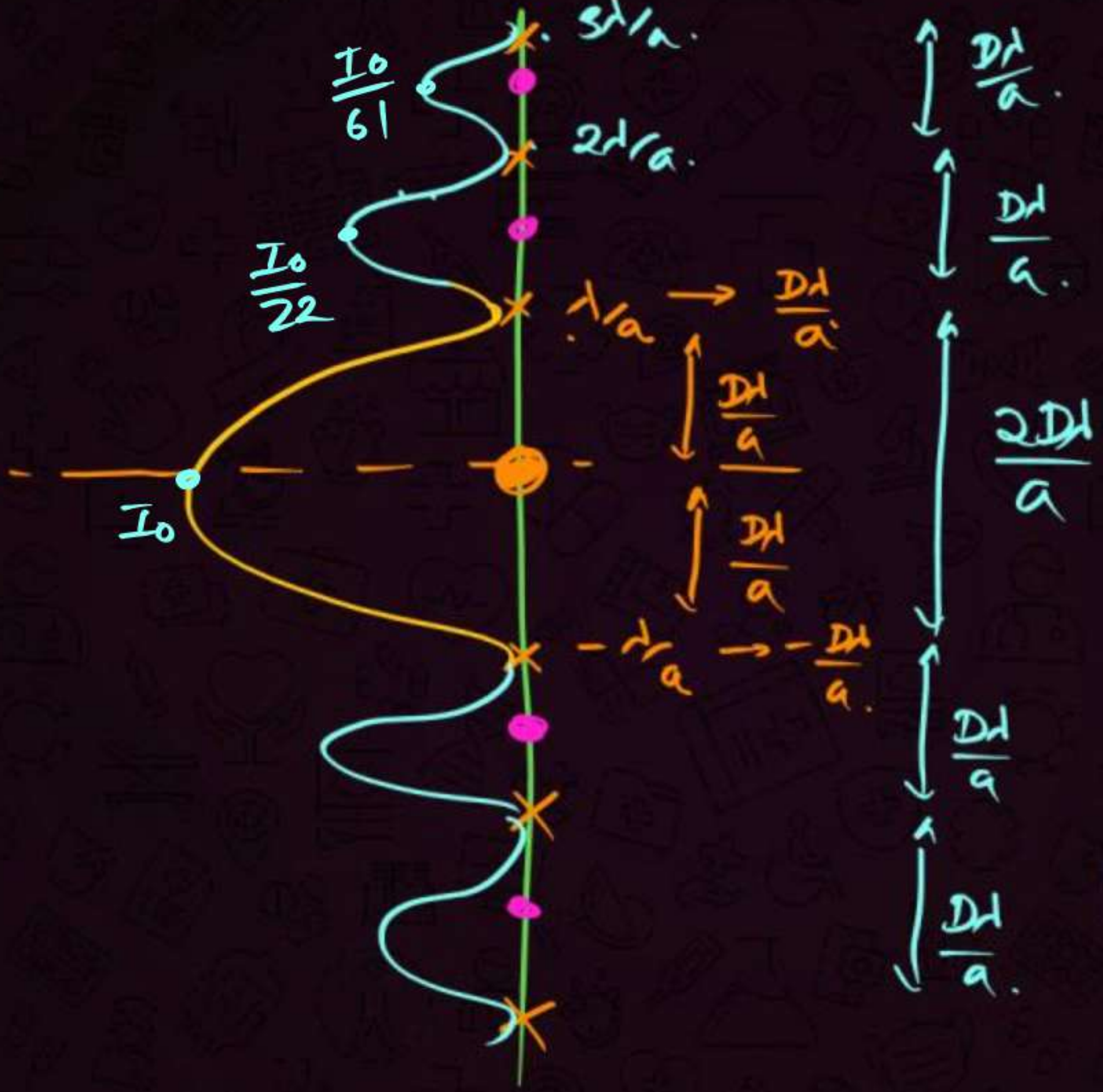
$$\boxed{a\theta = \pm \frac{(2n+1)\lambda}{2}} \rightarrow n = 1, 2, 3, ----$$

* Most of the light gets diffracted in central max^m.

* Fresnel :- Slit & screen at finite distance

Fraunhoffer :- Slit & source at infinite distance.

↳ We study Fraunhoffer



width of central max^m $= \frac{2D\lambda}{a}$

width of other max^m $= \frac{D\lambda}{a}$.

$$\boxed{\begin{array}{c} \beta = \frac{D\lambda}{d} \\ \theta = \frac{\lambda}{d} \\ \text{Interference} \end{array}}$$

ang. width of central max^m $= \frac{2\lambda}{a}$

ang width of other max^m $= \frac{\lambda}{a}$

Differency

Interference	Diffraction
① $\text{max}^m \rightarrow$ width → same	① central $\text{max}^m \rightarrow$ double width.
② $\text{max}^m \rightarrow$ all → same intensity	② central $\text{max}^m \rightarrow \text{max}^m$ intensity
③ Generally two sources (slits)	③ Many sources (family of sources) from a single slit

* **Fresnel distance** : $\boxed{Z_F = \frac{a^2}{\lambda}}$

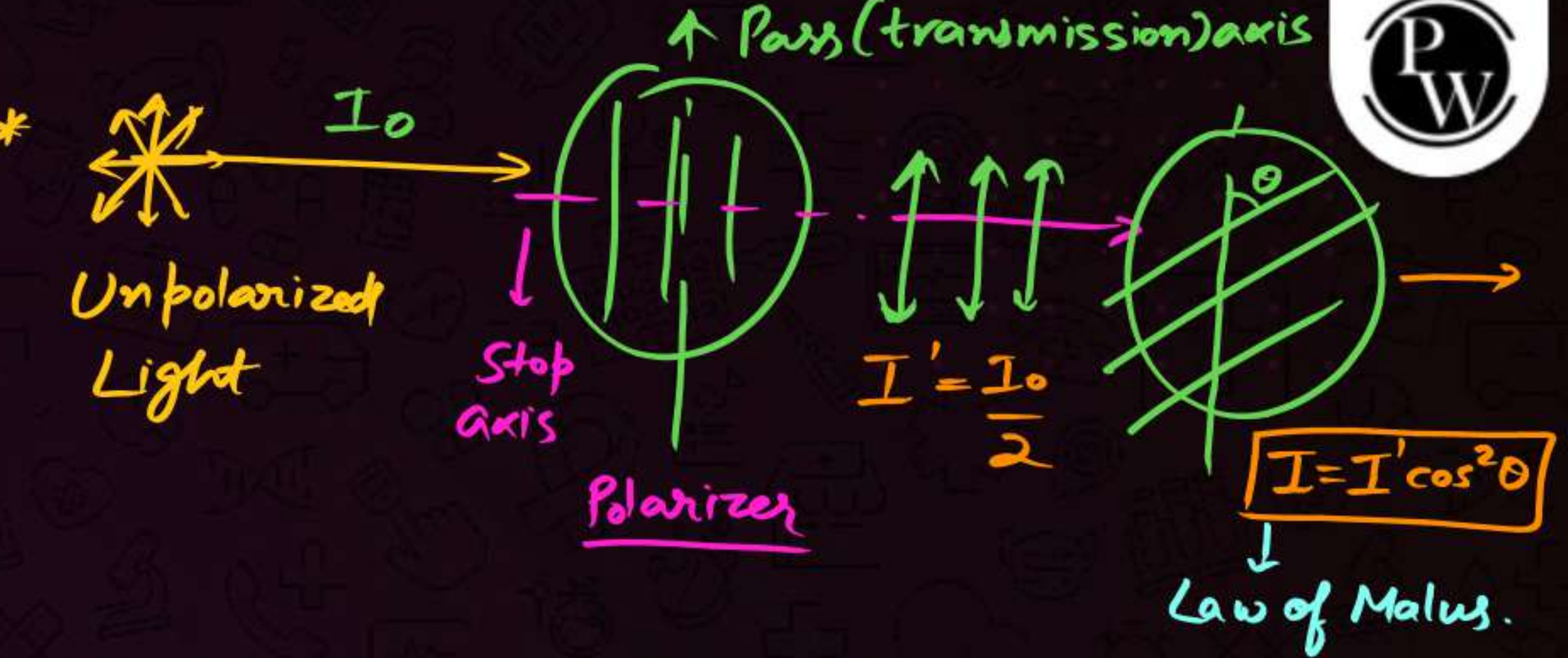
If $D > Z_F \rightarrow$ wave optics dominate

If $D < Z_F \Rightarrow$ Ray Optics dominate

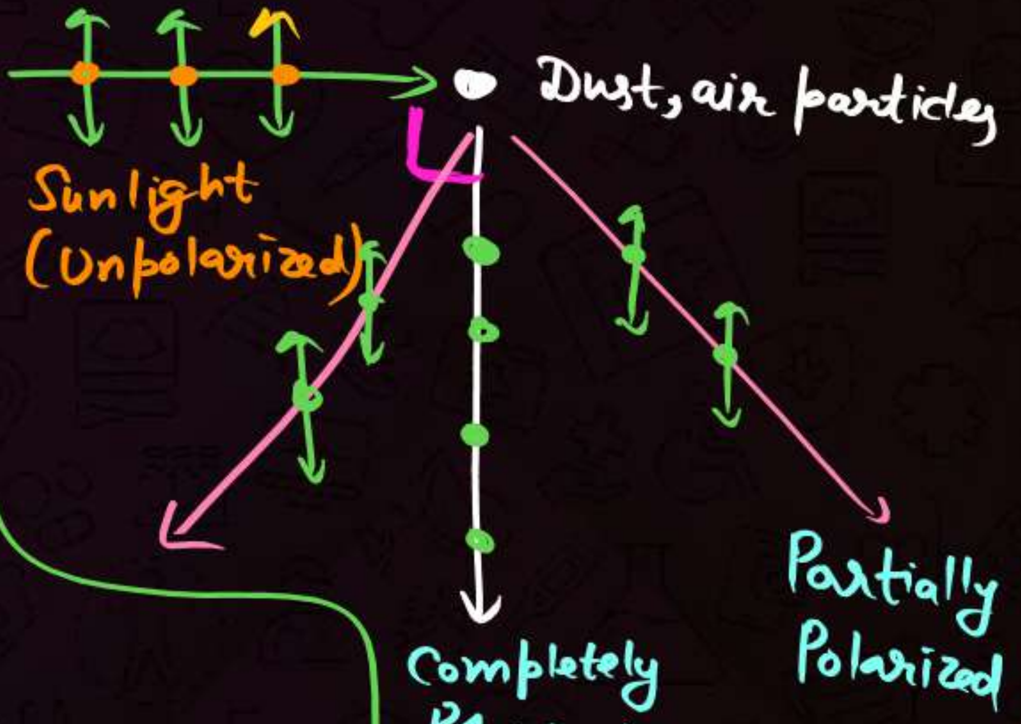
TBS capsule ⑦

- * Polarization
  ↓
  restricting electric field in a particular direction
- * called plane or linearly polarized light after passing through polarizer
- * Polarization reduces intensity
- * Longitudinal waves can't be polarized.

*



* Polarization by scattering →



* Polarization by Reflection

If $\boxed{\tan i_p = \mu}$ → reflected & refracted rays are ⊥cular

Refracted → Partially Polarized

Reflected → Completely polarized

Homework

- ~~Kal~~ Subah DPP Battle – Ground
- Next lecture most probably on 30th January → Subah → 10 am
  "Dual Nature of Radiation and Matter" ✓

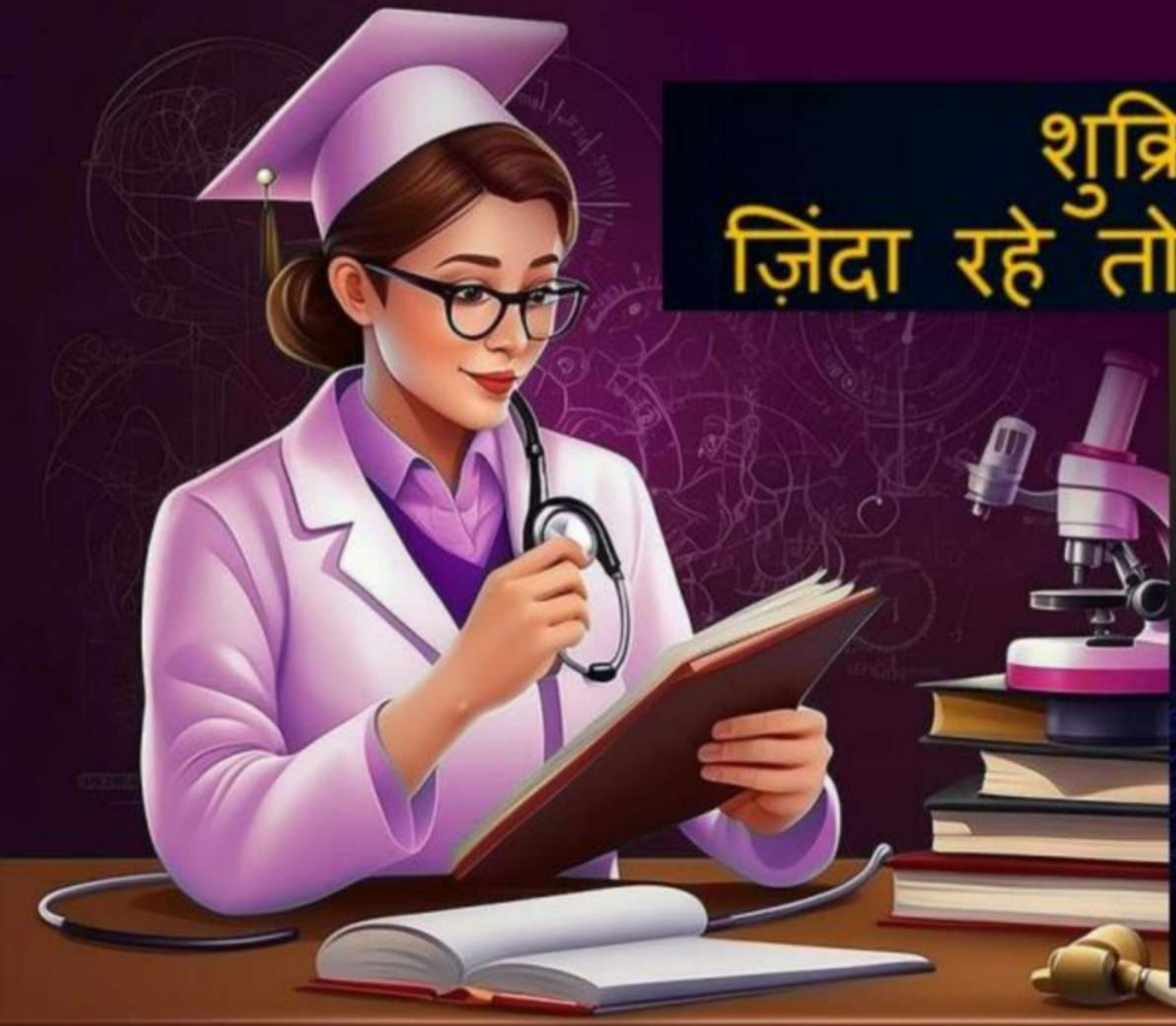
Next ⇒ Atoms & Nuclei

Next ⇒ Semi-conductors

Slide No.	Option
63	1
66	3
76	1
102	3
126	3
128	4
139	2
140	2
141	3
142	1
143	1
144	1

FOR NOTES & DPP CHECK DESCRIPTION

शुक्रिया !
ज़िंदा रहे तो फिर मिलेंगे



@PHYSICSBY_TANUJSIR