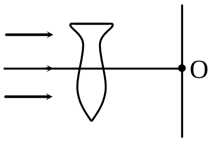
PHYSICS

Q.1 Two monochromatic waves each of intensity I have a constant phase difference of ϕ. If these waves superpose, then the intensity of the resultant wave is -

(A) 4I (B) $4I \cos \phi$

(C) $4I \cos^2 \phi$ (D) $4I \cos^2 (\phi/2)$ **[D]**

Q.2 A thin convex lens & thin concave lens of focal length of magnitude f each are cut into two halves and pasted together. If a coherent parallel beam of light is incident on the combination and intensity of incident light is I & focal length $f = 2.25\ \lambda$ is same for both lens, then –



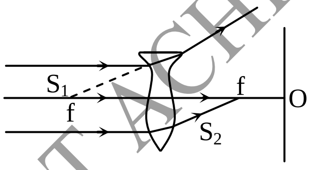
(A) Total number of maxima excluding maxima at infinity is 10

(B) Total number of maxima excluding maxima at infinity is 9

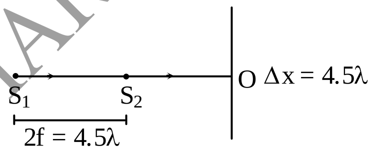
(C) Intensity at point O is 4I

(D) Intensity at point O is zero

Sol. **[D]**



There are two sources S_1 & S_2.



at point O minima will form

at infinity $\Delta x = 0$

Q.3 In Young's double slit experiment $\frac{d}{D} = 10^{-4}$ and wavelength of light is used 6000 Å. At a point P on the screen resulting intensity is equal to the intensity due to individual slit I_0. Then the distance of point P from the central maximum is

(A) 2 mm (B) 1 mm

(C) 0.5 mm (D) 4 mm **[A]**

Q.4 Young's double slit experiment is made in a liquid. The 10th bright fringe in liquid lies where 6th dark fringe lies in vacuum. The refractive index of the liquid is approximately -

(A) 1.8 (B) 1.54

(C) 1.67 (D) 1.2 **[A]**

Q.5 Consider an interference pattern between two coherent sources. If I_1 and I_2 be intensities at points where the phase difference are $\frac{\pi}{3}$ and $\frac{2\pi}{3}$ respectively, then the intensity at maxima is -

(A) $\frac{I_2 - 3I_1}{2}$ (B) $\frac{I_1 - 3I_2}{2}$

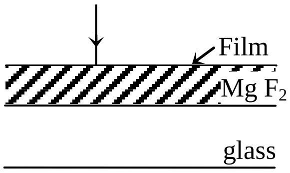
(C) $\frac{3I_1 - I_2}{2}$ (D) $\frac{I_2 - 3I_1}{2}$ **[C]**

Q.6 The interference pattern is obtained with two coherent light sources of intensity ratio η. The value of $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ is -

(A) $\frac{2\sqrt{n}}{n+1}$ (B) $\frac{2\sqrt{n}}{n-1}$

(C) $\frac{2n}{\sqrt{n}+1}$ (D) $\frac{2n}{\sqrt{n}-1}$ **[A]**

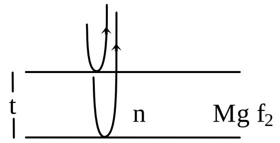
Q.7 White light is incident normally on a glass surface (n = 1.52) that is coated with a film of MgF_2 (n = 1.38). For what minimum thickness of the film will yellow light of wavelength 550 nm (in air) be missing in the reflected light –



(A) 99.6 nm (B) 49.8 nm

(C) 19.6 nm (D) 10.6 nm **[A]**

Sol.



$$2t = \left[\frac{2m+1}{2}\right]\frac{\lambda}{n}$$

⇒ For t_{min} m = 0

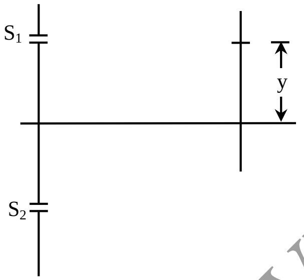
$$t_{min} = \frac{\lambda}{4n} = \frac{5.5\times10^{-7}}{4\times1.38} = 99.6 \text{ nm}$$

Q.8 In a YDSE experiment, I_0 is given to be the intensity of the central bright fringe & β is the fringe width. Then, at a distance y from central bright fringe, the intensity will be -

(A) $I_0 \cos\left(\frac{\pi y}{\beta}\right)$ (B) $I_0 \cos^2\left(\frac{\pi y}{\beta}\right)$

(C) $I_0 \cos\left(\frac{2\pi y}{\beta}\right)$ (D) $I_0 \cos^2\left(\frac{\pi y}{2\beta}\right)$

Sol. **[B]**



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

$I_{net} = I + I + 2I \cos \Delta\phi$

$$= 2I\left(1+\cos\left(\frac{2\pi y}{\beta}\right)\right) = 4I\cos^2\left(\frac{\pi y}{\beta}\right)$$

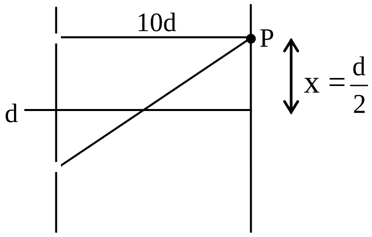
$$= I_0 \cos^2\left(\frac{\pi y}{\beta}\right) \qquad [\because I_0 = 4I]$$

Q.9 The maximum intensity in Young's double-slit experiment is I_0. Distance between the slits is $d=5\lambda$, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance D = 10d?

(A) $\frac{I_0}{2}$ (B) $\frac{3}{4}I_0$

(C) I_0 (D) $\frac{I_0}{4}$ **[A]**

Sol.



$$\Delta x \text{ at P} = \frac{dx}{D} = \frac{d^2}{2D} = \frac{(5\lambda)^2}{2\times10\times d}$$

$$\Delta x = \frac{(5\lambda)^2}{2\times10\times5\lambda} = \frac{\lambda}{4}$$

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

$$I_0 = 4I \Rightarrow I = \frac{I_0}{4}$$

$$I_{net} = I + I + 2\sqrt{I}\sqrt{I}\cos\frac{\pi}{2} = 2I = \frac{I_0}{2}$$

Q.10 In Young's double slit experiment the y-coordinates of central maxima and 10th maxima are 2 cm and 5 cm respectively. When the YDSE apparatus is immersed in a liquid of refractive index 1.5, the corresponding y-coordinates will be -

(A) 2 cm, 7.5 cm (B) 3 cm, 6 cm

(C) 2 cm, 4cm (D) 4/3 cm, 10/3 cm

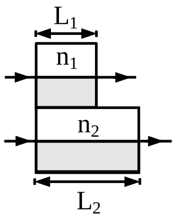
Sol. **[C]**

After immersing, no change in central maxima in air, separation between central maxima & 10th maxima = 5cm –2cm = 3cm = $10\frac{D\lambda}{d}$ in liquid, separation between central maxima & 10th maxima =

$$10\frac{D\lambda'}{d} = 10\frac{D}{d}\frac{\lambda}{\mu} = \left(\frac{10D\lambda}{d}\right)/1.5 = \frac{3\text{cm}}{1.5} = 2\text{cm}.$$

So new co-ordinate of 10th maxima = 2cm + 2cm = 4cm

Q.11 Two waves of light in air have the same wavelength and are initially in phase. They then travel through plastic layers with thickness of L_1 = 3.5 μm and L_2 = 5.0 μm and indices of refraction n_1 = 1.7 and n_2 = 1.25 as shown in figure. The rays later arrive at a common point. The longest wavelength of light for which constructive interference occurs at the point is –



(A) 0.6 μm (B) 1.2 μm

(C) 2.4 μm (D) 0.3 μm **[B]**

Q.12 The wave front of a light beam is given by the equation x + 2y + 3z = C, (where C is arbitrary constant) then the angle made by the direction of light with the y – axis is-

(A) $\cos^{-1}\frac{1}{\sqrt{14}}$ (B) $\sin^{-1}\frac{2}{\sqrt{14}}$

(C) $\cos^{-1}\frac{2}{\sqrt{14}}$ (D) $\sin^{-1}\frac{3}{\sqrt{14}}$ **[C]**

Sol. Here direction of light is given by normal vector

$\hat{n} = \hat{i} + 2\hat{j} + 3\hat{k}$

∴ angle made by the $\hat{n}$ with y– axis is given by

$$\cos\beta = \frac{2}{\sqrt{1^2+2^2+3^2}} = \frac{2}{\sqrt{14}}$$

Q.13 In Young's double slit experiment, 12 fringes are observed by light of λ = 600 nm in a certain segment of the screen. If wavelength is changed to 400 nm then number of fringes in the same segment will be -

(A) 12 (B) 18 (C) 24 (D) 30

Sol.[B] $n_1\lambda_1 = n_2\lambda_2$

$12 \times 600 = n_2 \times 400$

$n_2 = 18$

Q.14 The contrast in the fringes in any interference pattern depends on -

(A) Fringe width

(B) Wavelength

(C) Intensity ratio of the sources

(D) Distance between the sources **[C]**

Sol. Fringe visibility gives the contrast of the fringes given by

$$V = \frac{2\sqrt{I_1/I_2}}{1+I_1/I_2}$$

Q.15 Young's double slit experiment is made in a liquid. The 10th bright fringe in liquid lies where 6th dark fringe lies in vacuum. The refractive index of the liquid is approximately-

(A) 1.8 (B) 1.54

(C) 1.67 (D) 1.2

Sol. **[C]**

$10\,\beta_1 = 10 \times \frac{\lambda D}{\mu d}$

in liquid

$\beta_2 = \frac{\lambda D}{d}$

$6\beta_2 = 10\beta_1$

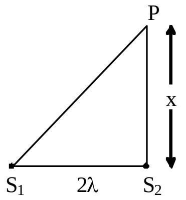
$\frac{6\lambda D}{d} = \frac{10\lambda D}{\mu d}$

$\mu = \frac{10}{6} = 1.67$

Q.16 Two coherent point sources S_1 and S_2 vibrating in phase emit light of wavelength λ. The separation between the sources is 2λ. The smallest distance from S_2 on a line passing through S_2 and perpendicular to S_1S_2 where a minimum intensity occurs is -

(A) $\frac{7\lambda}{12}$ (B) $\frac{15\lambda}{4}$ (C) $\frac{\lambda}{2}$ (D) $\frac{3\lambda}{4}$

Sol **[A]**



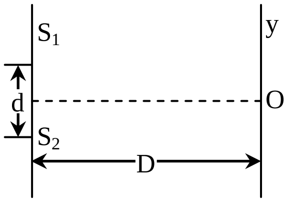
$S_1P - S_2P = \frac{3\lambda}{2}$

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

On solving

$x = \frac{7\lambda}{12}$

Q.17 Consider a usual set-up of Young's double slit experiment with slits of equal intensity as shown in the figure. Take 'O' as origin and the Y axis as indicated. If average intensity between $y_1 = \frac{\lambda D}{4d}$ and $y_2 = \frac{\lambda D}{4d}$ equals n times the intensity of maximum, then n equal is (take average over phase difference) -



(A) $\frac{1}{2}\left(1+\frac{2}{\pi}\right)$ (B) $2\left(1+\frac{2}{\pi}\right)$

(C) $\left(1+\frac{2}{\pi}\right)$ (D) $\frac{1}{2}\left(1-\frac{2}{\pi}\right)$

Sol. **[A]**

Phase difference correspnding to $y_1 = \frac{-\pi}{2}$ and that for $y_2 = +\frac{\pi}{2}$

$\therefore$ Average intensity between y_1 and y_2

$$= \frac{1}{\pi}\int_{-\pi/2}^{\pi/2} I_{max}\cos^2\left(\frac{\phi}{2}\right)d\phi$$

$$= I_{max}\ \frac{(\pi+2)}{2\pi}$$

Hence required ratio = $\frac{1}{2}\left(1+\frac{2}{\pi}\right)$

Q.18 In young double slit experiment $\frac{d}{D} = 10^{-4}$ and wavelength of light is used 6000 Å. At a point P on the screen resulting intensity is equal to the intensity due to individual slit I_0. Then the distance of point P from the central maximum is-

(A) 2 mm (B) 1 mm

(C) 0.5 mm (D) 4 mm

Sol. **[A]**

$I_0 = I_0 + I_0 + 2I_0 \cos\phi$

$\phi = 120°$

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

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

$\Delta x = \frac{dx}{D} = \frac{\lambda}{3}$

$10^{-4}\ x = \frac{6000 \times 10^{-7}}{3}$

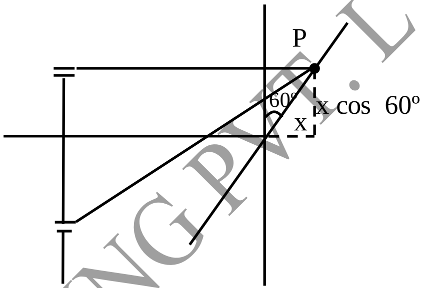
x = 2 mm

Q.19 In a young double slit apparatus the screen is rotated by 60° about an axis parallel to the slits. The slits separation is 3 mm, slit to screen distance (at central fringe) is 4m, & wavelength of light is 450 nm. The separation between the 3rd dark fringe on the either side of central fringe is -

(A) 6 mm (B) 8 mm

(C) $4\sqrt{3}$ mm (D) $2\sqrt{3}$ mm

Sol. **[A]**



Δx at P = $\frac{dx\cos 60}{D}$ = 2.5 λ

$x = \frac{2.5\lambda \times D \times 2}{d} = \frac{5\lambda D}{d}$

distance between two 3rd dark fringe on either side = 2x = $\frac{10\lambda D}{d}$

Q.20 In an interference pattern of a point we observe 16th bright fringe for λ_1 = 6000 Å. What order will be visible if the source is replaced by another bright fringe λ_2 = 4800 Å?

(A) 12 (B) 20 (C) 18 (D) 24

Sol. [B] The distance of a bright fringe from zero order fringe is given by $x_n = \frac{n\lambda D}{2d}$

Then at a given point n λ is constant $n_1\lambda_1 = n_2\lambda_2$

$n_2 = \frac{n_1\lambda_1}{\lambda_2} = \frac{16 \times 6000}{4800} = 20$

Q.21 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 -

(A) 0.30 mm (B) 0.40 mm

(C) 0.53 mm (D) 450 microns **[A]**

Q.22 Monochromatic green light of wavelength 5×10^{-7} m illuminates a pair of slits 1 mm apart. The separation of bright lines in the interference pattern formed on a screen 2 m away is -

(A) 0.25 mm (B) 0.1 mm

(C) 1.0 mm (D) 0.01 mm **[C]**

Q.23 The width of a certain spectral line at 500 nm is 2×10^{-2} nm. Approximately what is the largest path difference for which interference fringes produced by this light are clearly visible?

(A) 10^{-4} cm (B) 2×10^{-4} cm

(C) 3×10^{-4} cm (D) 4×10^{-4} cm **[C]**

Sol. The coherence length l_c is given by

$$\lambda_c = \frac{\lambda^2}{\Delta\lambda} = 1.25 \times 10^{-3} \text{ cm.}$$

If the optical path difference is about a quarter of l_c, 3×10^{-4} cm, we can observe the fringes clearly.

Q.24 If one of the two slits of a Young's double slit experiment is painted over so that it transmits half the light intensity of the other, then –

(A) the fringe system would disappear

(B) the bright fringes will be more bright & dark fringes will be more dark

(C) the dark fringes would be bright and bright fringes would be darker

(D) bright as well as dark fringes would be darker

[C]

Sol. Let $I_1 = a^2$, $I_2 = b^2$

$$\therefore \quad \frac{I_{max}}{I_{min}} = \frac{(a+b)^2}{(a-b)^2} \text{ and } \frac{I'_{max}}{I'_{min}} = \frac{\left(\frac{a+b}{\sqrt{2}}\right)^2}{\left(\frac{a-b}{\sqrt{2}}\right)^2}$$

Comparing them, we get $I'_{max} < I_{max}$; $I'_{min} > I_{min}$

Therefore the answer is (C).

Q.25 Two lamps of 2000 and 1000 candle power respectively are suspended 30 ft above the ground and are 100 ft apart. Find the intensity of illumination at a point on the ground in line with the lamps between them and 40 ft from the base of the more powerful lamp –

(A) 0.48 ft-candle

(B) 0.58 m-candle

(C) 0.58 ft-candle

(D) 0.38 ft-candle **[C]**

Sol. $$I = \frac{L_1 \cos\theta_1}{r_1^2} + \frac{L_2 \cos\theta_2}{r_2^2} = \frac{L_1 h}{r_1^3} + \frac{L_2 h}{r_2^3}$$

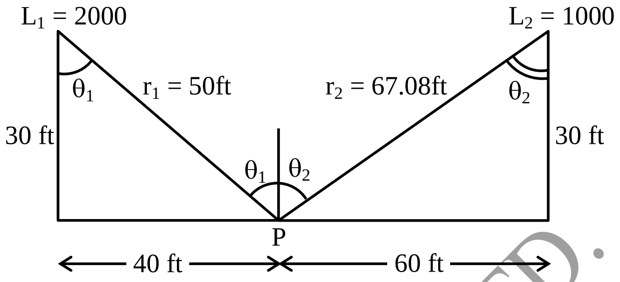


Fig.

$$I = \frac{2000 \times 30}{50^3} + \frac{1000 \times 30}{(67.08)^3} = 0.48 + 0.1 = 0.58 \text{ ft-candle}$$

Therefore the answer is (C).

Q.26 The central fringe of the interference pattern produced by light of wavelength 6000 Å is found to shift to the position of 4th bright fringe after a glass plate of refractive index 1.5 is introduced in path of one of beams. The thickness of the glass plate would be –

(A) 4.8 μm (B) 8.23 μm

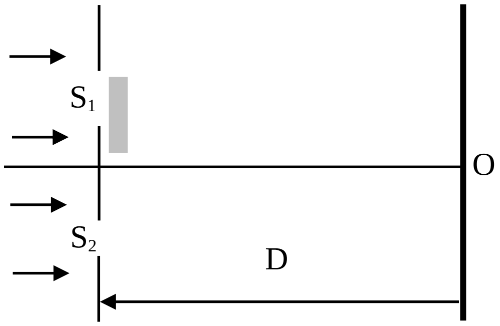
(C) 14.98 μm (D) 3.78 μm **[A]**

Q.27 Young's double slit experiment is made in a liquid. The 10th bright fringe in liquid lies where 6th dark fringe lies in vacuum. The refractive index of the liquid is approximately :

(A) 1.8 (B) 1.54 (C) 1.67 (D) 1.2

[A]

Q.28 In the diagram shown, the separation between the slit is equal to 3λ, where λ is the wavelength of the light incident on the plane of the slits. A thin film of thickness 3λ and refractive index 2 has been placed in the front of the upper slit. The distance of the central maxima on the screen from O is:



(A) D (B) λd/D

(C) λD/d (D) none of these

[A]

Q.29 What happens to the fringe pattern if in the path of one of the slits a glass plate which absorbs 50% energy is introduced -

(A) The bright fringes become bright and dark fringes become darker

(B) No fringes are observed

(C) The fringe width decreases

(D) None of the above **[D]**

Q.30 The Young's double slit experiment is performed with blue and with green light of wavelengths 4360 Å and 5460 Å respectively. If X is the distance of 4th maximum from the central one, then -

(A) X (blue) = X (green)

(B) X (blue) > X (green)

(C) X (blue) < X (green)

(D) $\frac{X(\text{blue})}{X(\text{green})} = \frac{5460}{4360}$ **[C]**

Q.31 In YDSE, we get 60 fringes in field of view for light of wavelength 4000 Å. If we use light of wavelength 6000 Å, the number of fringes obtained in the same field of view are -

(A) 60 (B) 90 (C) 40 (D) 15

Sol. [C] $n_1\lambda_1 = n_2\lambda_2$

$60 \times 4000 = n_2 \times 6000$

$\therefore \quad n_2 = 40$

Q.32 In order that a thin film of oil floating on the surface of water should show colours due to interference, the thickness of the oil film should be of the order of -

(A) 100 Å (B) 10,000 Å

(C) 1 mm (D) 1 cm **[B]**

Q.33 When interference of light takes place -

(A) Energy is created in the region of maximum intensity

(B) Energy is destroyed in the region of maximum intensity

(C) Conservation of energy holds good and energy is redistributed

(D) Conservation of energy does not hold good

[C]

Q.34 A thin transparent sheet is placed in front of a Young's double slit. The fringe-width will -

(A) increase (B) decrease

(C) remain same

(D) become non-uniform **[C]**

Q.35 In an interference experiment monochromatic light is replaced by white light, we will see -

(A) uniform illumination on the screen

(B) uniform darkness on the screen

(C) equally spaced white and dark bands

(D) a few coloured bands and then uniform illumination **[D]**

Q.36 In a two slit experiment with white light, a white fringe is observed on a screen kept behind the slits. When the screen is moved away by 0.05 m, this white fringe -

(A) does not move at all

(B) gets displaced from its earlier position

(C) becomes coloured

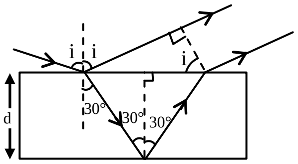
(D) disappears **[A]**

Q.37 light of wavelength 5880Å is incident on a thin glass plate (μ = 1.5) such that the angle of refraction in the plate is 30°. The minimum thickness of the plate, so that it appears dark in the reflected light will be -

(A) 2940 Å (B) 4074 Å

(C) 2263 Å (D) 3394 Å **[C]**

Sol.



For destructive interference

$\mu\,(2d \sec 30°) - 2d \tan 30° \sin i = n\lambda$

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

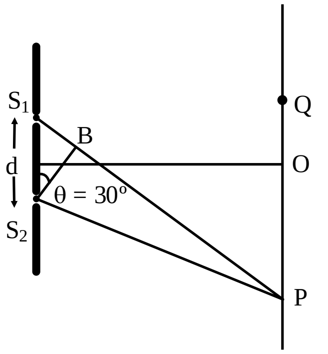
By snell's law $1 \sin i = \frac{3}{2}\sin 30° = \frac{3}{4}$

$\therefore \quad d = \frac{2n\lambda}{3\sqrt{3}}$

$d_{\min} = \frac{2\lambda}{3\sqrt{3}} \simeq 2263$ Å

Altier : $2\mu d \cos r = n\lambda$ for destructive interference.

Q.38 The double slit experiment of Young has been shown in figure. Q is the position of the first bright fringe on the right side and P is the 11th fringe on the other side as measured from Q. If wavelength of the light used is 6000 Å, S_1B, will be equal to –



(A) 6×10^{-6} m (B) 6.6×10^{-6} m

(C) 3.138×10^{-7} m (D) 3.144×10^{-7} m

[A]

Q.39 In a Biprism experiment, if the wavelength of red light used is 6.5×10^{-7} m and that of green is 5.2×10^{-7} m, the value of n for which (n + 1)th green bright band coincides with the nth red bright band for the same setting is given by -

(A) 2 (B) 3 (C) 4 (D) 1

[C]

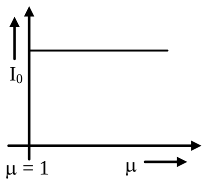
Q.40 The slits in a Young's double slit experiment have equal width and the source is placed symmetrically with respect to the slits. The intensity at the central fringe is I_0. If one of the slits is closed, the intensity at this point will be -

(A) I_0 (B) $I_0/4$ (C) $I_0/2$ (D) $4I_0$

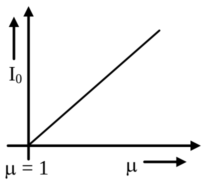
[B]

Q.41 In a YDSE experiment if a slab whose refractive index can be varied is placed in front of one of the slits then the variation of resultant intensity at mid-point of screen with 'μ' will be best represented by (μ ≥1). [Assume slits of equal width and there is no absorption by slab]

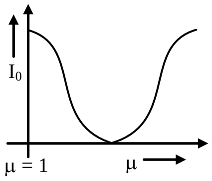
(A)



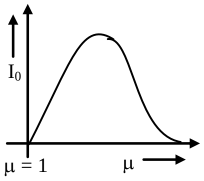
(B)



(C)



(D)



[C]

Q.42 If the first minima in a Young's slit experiment occurs directly infront of one of the slits. (distance between slit & screen D = 12 cm and distance between slits d = 5 cm) then the wavelength of the radiation used is:

(A) 2 cm only (B) 4 cm only

(C) 2m, $\frac{2}{3}$ cm, $\frac{2}{5}$ cm (D) 4 cm, $\frac{4}{3}$ cm, $\frac{4}{5}$ cm

[C]

Q.43 A plane monochromatic light falls on a diaphragm normally on two slits separated by a distance of 2.5 mm. The fringe pattern formed on a screen at 1 m distance displaces due to glass plate (μ = 3/2) of thickness 10 μm placed in front of one slit. Then value of displacement is -

(A) 1 mm (B) 2 mm

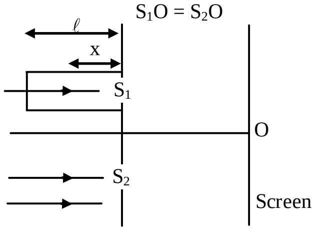
(C) 3 mm (D) 4 mm **[B]**

Sol. Shift = $(\mu - 1)\, t \,.\, \frac{D}{d}$

$$= \left(\frac{3}{2} - 1\right) \times \frac{10 \times 10^{-6} \times 1}{2.5 \times 10^{-3}}$$

= 2 mm

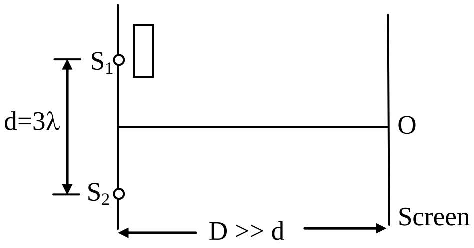
Q.44 In the figure shown, a parallel beam of light is incident on the plane of the slits of a Young's double slit experiment. Light incident on the slit, S_1 passes through a medium of variable refractive index μ = 1 + ax (where 'x' is the distance from the plane of slits as shown), up to a distance'ℓ' before falling on S_1. Rest of the space is filled with air. If at 'O' a minima is formed, then the minimum value of the positive constant a (in terms of ℓ and wavelength 'λ' in air) is:



(A) $\frac{\lambda}{\ell}$ (B) $\frac{\lambda}{\ell^2}$

(C) $\frac{\ell^2}{\lambda}$ (D) None of these **[B]**

Q.45 In YDSE experiment, the separation between the slits is equal to 3λ where λ is the wavelength of the light incident on the plane of the slits. A thin film of thickness 2λ and refractive index 2 has been placed in front of the upper slit. Location of central maxima on the screen is –



(A) D/3 (B) D/2 (C) 2D/3 (D) D

Sol. [C] $\frac{yd}{D} = \Delta x = (\mu - 1)t$

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

$$= \frac{D}{3\lambda}(2 - 1)\,2\lambda = \frac{2}{3}D$$

Q.46 In a double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then, in the interference pattern –
[IIT – JEE 2000]

(A) the intensities of both the maxima and the minima increase

(B) the intensity of the maxima increases and the minima has zero intensity

(C) the intensity of the maxima decreases and that of the minima increases

(D) the intensity of the maxima decreases and the minima has zero intensity **[A]**

Q.47 Two beams of light having intensities I and 4 I interfere to produce a fringe pattern on a screen. The phase difference between the beams is π/2 at point A and π at point B. Then the difference between the resultant intensities at A and B is –

[IIT-JEE 2001]

(A) 2 I (B) 4 I
(C) 5 I (D) 7 I **[B]**

Q.48 In the ideal double-slit experiment, when a glass-plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is –
[IIT - 2002]

(A) 2λ (B) 2λ/3
(C) λ/3 (D) λ **[A]**

Q.49 When a thin transparent sheet of refractive index $\mu = \frac{3}{2}$ is placed near one of the slits in young double slit experiment, the intensity at the centre of the screen reduces to half of the maximum intensity. The minimum thickness of the sheet should be -

(A) $\frac{\lambda}{4}$ (B) $\frac{\lambda}{8}$ (C) $\frac{\lambda}{2}$ (D) $\frac{\lambda}{3}$

Sol.[C] $I_{new} = 2I$

$I + I + 2I\cos\phi = 2I$

$\cos\phi = 0$

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

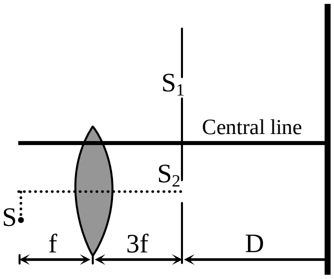
$\Delta x = \frac{\lambda}{4}$

Δx at screen centre $= (\mu - 1)t$

$\left(\frac{3}{2} - 1\right)t = \frac{\lambda}{4}$

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

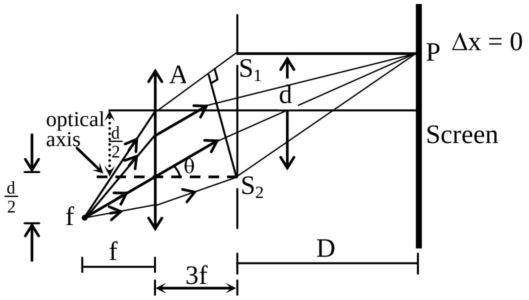
Q.50 Consider the set up shown in the figure. The source S is d/2 distance below the optical axis and the optical axis is equal distance below the central line. The separation between slits is d. The position of the central maxima on the screen is- (D >>> d)



(A) Dd/2f (B) Dd/f

(C) Dd/3f (D) None of these

Sol. **[A]**



$$\Delta x = AS_1 + S_1P - S_2P$$

$$= d\sin\theta - \frac{dx}{D} = 0$$

$$\Delta x = \frac{d \times d}{2f} - \frac{dx}{D} = 0 \qquad d <<< D$$

$$x = \frac{dD}{2f}$$

(D) No interference.

Q.1 In Young's double slit experiment set-up with light of wavelength $\lambda = 6000$ Å, distance between the two slits is 2 mm and distance between the plane of slits and the screen is 2 m. The slits are of equal intensity. When a sheet of glass of refractive index 1.5 (which permits only a fraction η of the incident light to pass through) and thickness 8000 Å is placed in front of the lower slit, it is observed that intensity at a point, P, 0.15 mm above the central maxima does not change. Find the value of η.

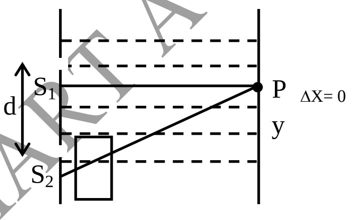
[0.21]

Q. 2 In Young's double slit experiment mixture of two light wave having wavelengths $\lambda_1 = 500$ nm and $\lambda_2 = 700$ nm are being used. Find the position next to central maxima, where maximas due to both waves coincides.

(Given $\frac{D}{d} = 1000$) **[0003]**

Q.3 In a modified YDSE the region between screen and slits is immersed in a liquid whose refractive index varies with time as $\mu_\ell = \frac{5}{2} - \frac{T}{4}$ until it reaches a steady state value $\frac{5}{4}$. A glass plate of thickness 36 μm and refractive index $\frac{3}{2}$ is introduced infront of one the slits. The speed of the central maxima when it is at O is …….. × 10^{-3} m/s **[0003]**

Sol.



$\Delta x_{\text{at p}} = (S_2P - t)_{\text{liquid}} + t_{\text{glass}} - S_1P_{\text{liquid}}$

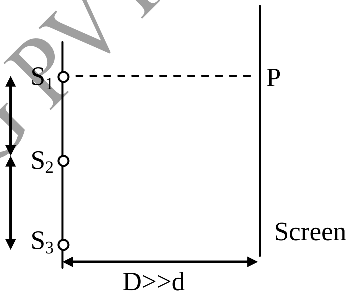
$$\Delta x = \frac{yd}{D} + \left(\frac{t \times \mu_g}{\mu_\ell} - t\right)_{\text{liquid}}$$

$\because \Delta x = 0$

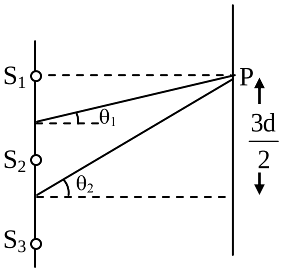
$$\therefore y = \frac{-Dt}{d}\left[\frac{\mu_g - \mu_\ell}{\mu_\ell}\right] = \frac{-tD}{d}\left[\frac{4-T}{10-T}\right]$$

central maxima will be at 0 when y = 0 i.e. at T = 4. Find $\frac{dy}{dT}$ at T = 4 sec

Q.4 Consider the interference at P between waves emanating from three coherent sources in same phase located at S_1, S_2 and S_3. If intensity due to each source is $I_0 = 12$ W/m^2 at P and $\frac{d^2}{2D} = \frac{\lambda}{3}$ then resultant intensity at P will be (in W/m^2). **[0036]**

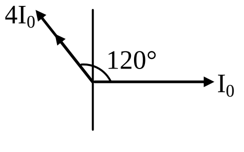


Sol.



$$S_2P - S_1P = d\sin\theta_1 = d.\frac{d/2}{D} = \frac{d^2}{2D} = \frac{\lambda}{3}$$

$$S_3P - S_2P = d\sin\theta_2 = d\frac{3d/2}{D} = \frac{3d^2}{2D} = \lambda$$



$$I_{\text{Resultant}} = I_0 + 4I_0 + 2\sqrt{I_0}\sqrt{4I_0}\cos 120°$$
$$= 3I_0$$

Q.5 In a YDSE (young double slit experiment) screen is placed 1 m from the slits wavelength of light used is 6000 Å. Fringes formed on the screen are observed by a student sitting close to the slits. The student's eye can distinguish two neighboring fringes, if they subtend an angle more than 1 minutes of arc. Calculate the maximum distance between the slits, so that fringes are clearly visible. (give are in mm).

[0002]

Sol. Angular fringe width $\theta_\beta = \frac{\beta}{D} = \frac{\lambda}{d}$

According to the given condition

$$\frac{\lambda}{d} \geq \frac{\pi}{180\times 60}$$

$$d < \frac{6\times 10^{-7}\times 180\times 60}{\pi}$$

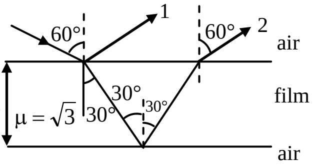
$$d_{max} = 2.06\times 10^{-3}\ \text{m}$$

$$d_{max} = 2.06\ \text{mm}$$

Q.6 A parallel beam of white light falls from air on a thin film in air whose refractive index is equal to $\sqrt{3}$. The angle of incidence i = 60°, what must be the minimum film thickness (in nanometer) if the reflected light is most intense for $\lambda = 6000$ Å ?

Sol. $1\sin 30° = \sqrt{3}\ \sin r$

$\Rightarrow r = 30°$



Optical path diff. = $2\mu t \sec r - 2t\tan r \sin i$

$$= 2\sqrt{3}\, t \sec 30° - 2t\tan 30° \sin 60°$$

$$= 4t - 2t\ \frac{1}{\sqrt{3}}\cdot\frac{\sqrt{3}}{2}$$

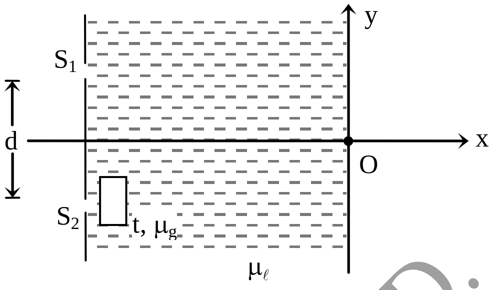
$$= 3t$$

Phase diff. = π due to reflection of ray 1

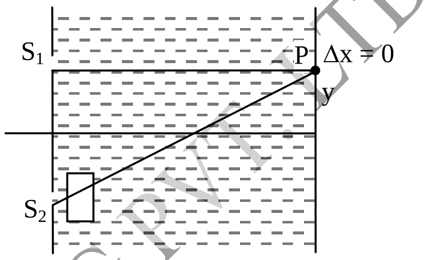
$\therefore$ for constructive interference, $3t = \frac{\lambda}{2}$

$$t = \frac{\lambda}{6} = 1000\ \text{Å} = 100\ \text{nm}$$

Q.7 In a modified YDSE the region between screen and slits is immersed in a liquid whose refractive index varies with time as $\mu_\ell = \frac{5}{2} - \frac{T}{4}$ until it reaches a steady state value $\frac{5}{4}$. A glass plate of thickness 36 μm and refractive index $\frac{3}{2}$ is introduced in front of one of the slits. The speed of the central maxima when it is at O is………… × 10^{-3} m/s. **[0003]**



Sol.



$$\Delta x_{\text{at P}} = (S_2P - t)_{\text{liquid}} + t_{\text{glass}} - S_1P_{\text{liquid}}$$

$$\Delta x = \frac{yd}{D} + \left(\frac{t\times\mu_g}{\mu_\ell} - t\right)_{\text{liquid}}$$

$$\therefore\ \Delta x = 0$$

$$\therefore\ y = -\frac{Dt}{d}\left[\frac{\mu_g - \mu_\ell}{\mu_\ell}\right] = -\frac{tD}{d}\left[\frac{4-T}{10-T}\right]$$

Central maxima will be at O when y = 0 is at T = 4 sec

find $\frac{dy}{dT}$ at T = 4 sec

Q.8 In a Young's double slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 nm is used. If the wavelength of light is changed to 400 nm, what will be number of fringes observed in the same segment of screen.

Sol. **[0018]**

Fringe width, $w = \frac{\lambda D}{d} \propto \lambda$ wavelength is decreasing from 600 nm to 400 nm so fringe width is also decreasing by a factor of $\frac{4}{6}$ or $\frac{2}{3}$.

So no. of fringes will increase by a factor of $\frac{3}{2}$.

Q.9 A glass wedge of angle 0.01 radian is illuminated by monochromatic light of wavelength 6000 Å falling normally on it. At what distance from the edge of wedge will the 10th fringe be observed by reflected light is ….. × 10^{-1} cm.

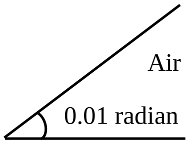
Sol. **[3]**

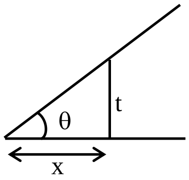
$\theta = 0.01$ radian

$n = 10$

$\lambda = 6000 \times 10^{-8}$ cm

$\Delta x = 2t = n\lambda$





$\theta = \frac{t}{x}$

$t = \theta x$

$2\theta x = n\lambda$

$x = \frac{n\lambda}{2\theta}$

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

Q.10 In Young's double slit experiment the two slits act as coherent sources of equal amplitude A & wavelength λ. In another experiment with the same set up the two slits are source of equal amplitude A & wavelength λ but are incoherent. The ratio of intensity of light at the mid point of the screen into the first case to that in second case.

Sol.[2] When coherent then Δx at centre = 0

$\therefore I_{net} = 4I$

when Incoherent

$I'_{net} = I + I = 2I$

Ratio $= \frac{I_{net}}{I'_{net}} = \frac{2}{1} = 2$

Q.11 In a YDSE (Young's double slit experiment) screen is placed 1m from the slits, wavelength of light used is 6000Å. Fringes formed on the screen are observed by a student sitting close to the slits. The student's eye can distinguish two neighbouring fringes, if they subtend an angle more than 1 minute of arc. Calculate the maximum distance between the slits so that fringes are clearly visible (give ans in mm) –

Sol. **[2]**

Angular fringe width $\beta_\theta = \frac{\beta}{D} = \frac{\lambda}{d}$.

According to the given condition

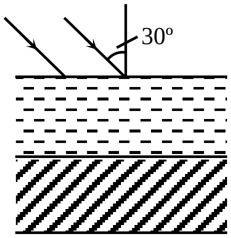
$\frac{\lambda}{d} \geq \frac{\pi}{180 \times 60}$

$d < \frac{6 \times 10^{-7} \times 180 \times 60}{\pi}$

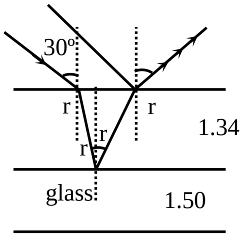
$d_{max} = 2.06 \times 10^{-3}$ m

$d_{max} = 2.06$ mm

Q.12 A surface of a glass plate is covered with a thin layer of water. A light with wavelength = 0.680 μm incident at an angle 30º. Due to evaporation of the water layer, the intensity of the reflected light change periodically, time interval between the appearances of maximum intensity is equal to 15.0 min. Find the rate of decrease of the water layer thickness in μm/hr ($\mu_g = 1.50$, $\mu_w = 1.34$)



Sol.[1]

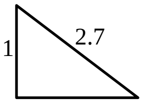


Condition for constructive interference

$2\mu t \cos r = n\lambda$

$\sin 30º = 1.34 \sin r$

$\sin r = \frac{1}{2.68}$ or $\frac{1}{3}$



$\cos r = \sqrt{1 - \sin^2 r}$

$2\mu t \cos r = n\lambda$ …… (1)

$2\mu (t - \Delta t) \cos r = (n - 1)\lambda$ …….(2)

equation (1) – equation (2)

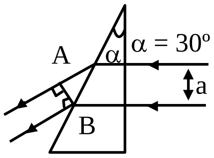
$2\mu \Delta t \cos r = \lambda$

$$\Delta t = \frac{\lambda}{2\mu\cos r}$$

$$\text{Rate of decrease} = \frac{\Delta t}{\text{time}} = 1.01\ \mu\text{m/hr}$$

$$\left[\text{time} = 15\text{min} = \frac{15}{60}\text{hr}\right]$$

Q.13 A plane wavefront of monochromatic wave (λ = 500 nm) is falling on a glass Prism (n = $\sqrt{2}$) and emerge as shown. The distance between incident rays a = 2 cm. what is the difference of phase between the light wave at point A and B after exit from the prism.



Sol. Zero