PHYSICS

The following question given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.
(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).
(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) If (A) is true but (R) is false.
(D) If (A) is false but (R) is true.

Q.1 **Assertion :** Geometrical optics can be regarded as the limiting case of wave optics.

Reason : When size of obstacle or opening is very large compared to the wavelength of light then wave nature can be ignored and light can be assumed to be travelling in straight line. **[A]**

Q.2 **Assertion** : In Young's double slit experiment interference pattern disappears when one of the slits is closed.

Reason : Interference occurs due to superimposition of light wave from two coherent sources. **[A]**

Q.3 **Assertion** : The fringe obtained at the centre of the screen is known as zeroth order fringe, or the central fringe.

Reason : Path difference between the wave from S_1 and S_2, reaching the central fringe (or zero order fringe) is zero. **[D]**

Q.4 **Assertion** : The phase difference between any two points on a wavefront is zero.

Reason : Light from the source reaches every point of the wavefront at the same time. **[A]**

Q.5 **Assertion** : Interference obeys the law of conservation of energy.

Reason : The energy is redistributed in case of interference. **[A]**

Q.6 **Assertion** : Interference pattern is obtained on a screen due to two identical coherent sources of monochromatic light. The intensity at the central part of the screen becomes one-fourth if one of the source is blocked.

Reason : The resultant intensity is the sum of the intensities due to two sources. **[C]**

Q.7 **Assertion** : Newton's rings are formed in the reflected system when the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of glass make and lesser than that of lens. The central spot of the pattern is bright.

Reason : This is because the reflection in these cases will be from a denser to rarer medium and the two interfering rays are reflected under similar conditions. **[A]**

Q.8 **Assertion** : Light from two coherent sources is reaching the screen. If the path difference at a point on the screen for yellow light is $3\lambda/2$, then the fringe at the point will be coloured.

Reason : Two coherent sources always have constant phase relationship. **[D]**

Q.9 **Assertion :** No interference pattern is detected when two coherent sources are infinitely close to each other in simple YDSE.

Reason : The fringe width is inversely proportional to the distance between the two slits in simple YDSE. **[B]**

Q.10 **Assertion :** The maximum intensity in interference pattern is four times the intensity due to each slit.

Reason : Intensity is directly proportional to square of amplitude. **[B]**

Q.11 **Assertion** : In Young's double slit experiment interference pattern disappears when one of the slits is covered by transparent slab.

Reason : Interference occurs due to superimposition of light wave from two coherent sources. **[D]**

Q.12 **Assertion** : Newton's rings are formed in the reflected system when the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of lens and lesser than that of glass plate. The central spot of the pattern is bright.

Reason : This is because the reflection in these cases will be from a denser to rarer medium and the two interfering rays are reflected under similar conditions. **[C]**

Q.13 **Assertion :** No interference pattern is detected when two coherent sources are infinitely close to each other.

Reason : Fringe width is inversely proportional to the distance between two slits. **[B]**

Q. 14 **Assertion :** When a thin transparent sheet is placed in front of both the slits of Young's experiment, the fringe width will increase.

Reason: In Young's experiment the fringe width is proportional to wavelength of the source used. **[D]**

Q. 15 **Assertion :** Colours are seen in thin layers of oil on the surface of water.

Reason : White light is composed of several colours.

Sol. **[B]**

A – True

R – True but not correct explanation

Q.16 **Assertion :** In Young's double slit experiment, we observe an interference pattern on the screen if both the slits are illuminated by two bulbs of same power.

Reason : The interference pattern is observed when source is monochromatic and coherent.

Sol. **[D]**

assertion is false but reason is true.

If both the slits are illuminated by two bulbs of same power, no interference pattern will be observed on the screen. This is because waves reaching at any point on the screen do not have a constant phase difference. as phase difference from two non coherent sources changes randomly. Therefore, maxima and minima would also change their positions randomly and in quick succession. This will result in general illumination of the screen.

Q.17 **Assertion :** Thin film such a soap bubble or a thin layer of oil on water show beautiful colours when illuminated by monochromatic light.

Reason : Colour in film are obtained due to interference between reflected light from the upper & lower layer of film **[D]**

Q.18 **Assertion :** When a thin transparent sheet is placed in front of both the slits of Young's experiment, the fringe width will increase.

Reason : In Young's experiment the fringe width is proportional to wavelength of the source used.

Sol. **[D]**

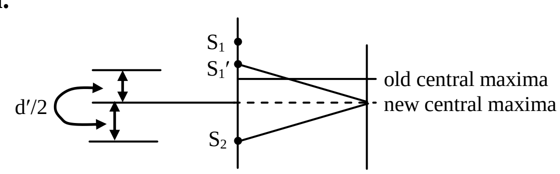
Assertion is false but reason is true.

Fringe width $\beta = \lambda D/d$ shall remain the same as the waves travel in air only, after passing through the thin transparent sheet. Due to introduction of thin sheet, only path difference of the wave is changed due to which there is shift of position of fringes only, which is given as $\Delta x = \frac{D(n-1)t}{d}$, where n is refractive index of thin sheet and t is its thickness.

Q.19 **Assertion :** In standard YDSE experiment if upper slit is slightly moved downward then central maxima shifts downward.

Reason : Fringe width in such case will increase. **[B]**

Sol.

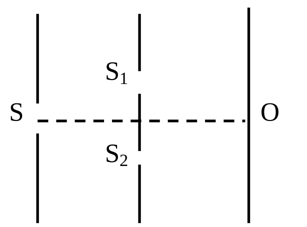


$\beta = \frac{\lambda D}{d}$ as $d\downarrow \Rightarrow \beta\uparrow$

Q.20 **Assertion :** Thin films such as soap bubble or a thin layer of oil spread on water show beautiful colours when illuminated by white light.

Reason : It is due to interference of sun's light reflected from upper and lower surfaces of the film. **[A]**

Q.1 Figure shows a set-up to perform Young's double slit experiment. A monochromatic source of light is placed at S. S_1 and S_2 act as coherent sources and interference pattern is obtained on the screen. Match Column-I with Column-II in regard to interference in Young's double slit experiment.



Column I	**Column II**
(A) A thin transparent plate is placed in front of S_1. Assuming negligible absorption by the plate	(P) Interference fringes disappear
(B) S_1 is closed	(Q) There is uniform illumination on a large part of the screen
(C) Width of S_1 is two times the width of S_2	(R) The zero order fringe will not form at O
(D) S is removed and two real sources emitting light of same wavelength are placed at S_1 and S_2	(S) Intensity of a dark fringe, though it is less than the intensity of bright fringe, will be non-zero

(A)→R, (B)→P,Q (C)→S (D)→P,Q

Q.2

Column I	**Column II**
(A) Young's double slit experiment uses	(P) Incoherent sources
(B) Sources of variable phase difference	(Q) Coherent sources
(C) Point on a wavefront behaves as a light source	(R) Superposition principle
(D) Net displacement is the vector sum of individual displacement	(S) Huygens principle

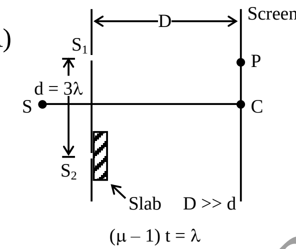
(A)→Q,R, (B)→P, (C)→S (D)→R

Q.3 In each case $S_2P - S_1P = \frac{\lambda}{2}$,

I (P_C) – Intensity of light at C.
I(P_P) – Intensity of light at P.

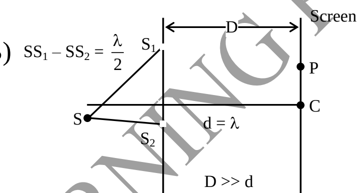
Column-I **Column-II**

(A)



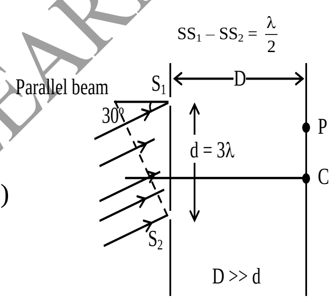
(P) Where μ – R.I. of lass slab t – thickness of slab

(B)



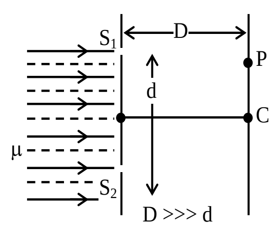
(Q)

(C)



(R) I (P_C) > I (P_P)

(D)



(S) I (P_C) < I (P_P)

(A)→P,R, (B)→S, (C)→P, S (D)→Q,R

Q.4 Match column I with column II in the light of possibility of occurrence of phenomena listed in column I using the systems in column II -

Column-I	**Column-II**
(A) Interference	(P) Non-mechanical waves
(B) Diffraction	(Q) Electro magnetism
(C) Polarisation	(R) Visible light wave
(D) Reflection	(S) Sound waves

A → P, Q, R, S B → P, Q, R, S
C → P, Q, R D → P, Q, R, S

Q.5 Match column I with column II in the light of possibility of occurrence of phenomena listed in column I using the systems in column II –

Column I	Column II
(A) Interference	(P) Non-mechanical waves
(B) Diffraction	(Q) Electromagnetic waves
(C) Polarisation	(R) Visible light waves
(D) Reflection	(S) Sound waves

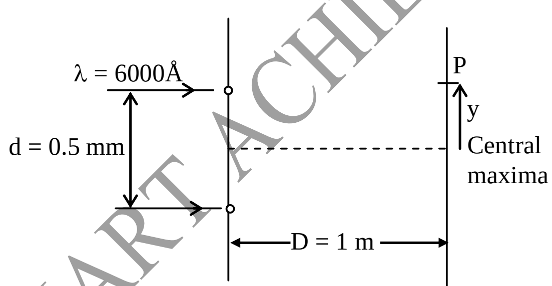
A → P,Q,R,S ; B → P,Q,R,S ;
C → P,Q,R ; D → P,Q,R,S

Q.6

Column-I	Column-II
(A) Phenomena which is not Explained by Huygen's construction of wavelength	(P) interference
(B) Huygen's wave theory of light Cannot explain	(Q) total internal reflection
(C) Light waves projected on oil Surface shows seven colours	(R) origin of spectra
(D) Shining of diamonds	(S) photoelectric effect

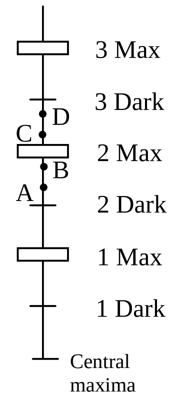
Sol. **(A) → (R) (B) → (S), (C) → (P), (D) → (Q)**

Q.7 In YDSE light of wavelength λ = 6000Å is used screen distance D = 1 m and slit separation d = 0.5 mm. Intensity of light on screen emerging from slits are individually I_0 and $4I_0$. Column I indicates distance of certain point P on screen from central maxima. Match the entries of columns.



Column I	Column II
(A) y = 2 mm	(P) Intensity = $7I_0$ at P
(B) y = 2.2 mm	(Q) Intensity = $3I_0$ at P
(C) y = 2.6 mm	(R) P lies between 2nd minima and 3rd maxima
(D) y = 2.8 mm	(S) P lies between 3rd minima and 2nd maxima

Sol. **A → Q,R; B → P,R ; C → P,R,S ; D → Q,R,S**



$$\beta = \frac{\lambda D}{d} = 1.2 \text{ mm}$$

for $7I_0 = I_0 + 4I_0 + 2\sqrt{I_0}\ \sqrt{4I_0}\cos\phi$

$\Rightarrow \quad \phi = \pi/3 \Rightarrow \Delta x = \dfrac{\lambda}{6}$

$\Rightarrow$ y from any maxima = 0.2 mm

for $3I_0$, $\phi = 120°$, y = 0.4 mm

Q. 8

Column - I **Associated phenomena**	**Column II** **Example/Nature of process**
(A) Interference	(P) Superposition
(B) Diffraction	(Q) Transverse wave
(C) Polarisation	(R) Longitudinal wave
(D) Stationary waves	(S) Colour of thin films

Ans. **A → P,Q,R,S; B → P,Q,R;C → Q;D → P,Q,R**

Q.9 Match the Column :

Column-I	**Column-II**
(a) Interference	(p) Spherical wavefront
(b) Point source of light	(q) Amplitude division
(c) Limit of resolution of telescope	(r) Superposition of waves
(d) Coherent sources	(s) Radius of lens

(A) a → r, b → p, c → s, d → q

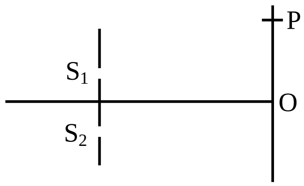
(B) a → p, b → r, c → q, d → s

(C) a → q, b → s, c → p, d → q

(D) a → s, b → q, c → r, d → p **[A]**

Sol. a → r, b → p, c → s, d → q

Q.10 In the YDSE apparatus shown in figure Δx is the path difference between S_2P and S_1P. Now a glass slab is introduced in front of S_2, then match the following -

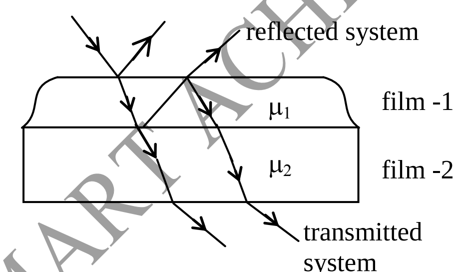


	Column I		**Column II**
(A)	Δx at P will	(P)	increase
(B)	Fringe width will	(Q)	decrease
(C)	Fringe pattern will	(R)	remain same
(D)	Number of fringes between O and P will	(S)	shift upward
		(T)	shift downward

Sol. **A → P ; B → R ; C→ T ; D → R**

If glass slab is introduced across S_2 this effective path increases so central maxima will be shifted downward but fringe width remains same.

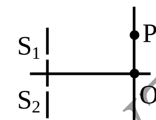
Q.11 For the situation shown in the figure below, match the entries of column-I with column-II



	Column - I		**Column - II**
(A)	$\mu_1 = \mu_2$	(P)	Film 1 appears shiny from the reflected system
(B)	$\mu_1 > \mu_2$	(Q)	Film 1 appears dark from the reflected system
(C)	$\mu_1 < \mu_2$	(R)	Film 1 appears shiny from the transmitted system
(D)	$\mu_1 \neq \mu_2$	(S)	Film 1 appears dark from the transmitted system

Sol. A→ Q,R B→ Q, S C→ P,S D→ P,Q,R,S

Q.12 In the YDSE apparatus shown Δx is path difference between S_2P and S_1P. Now a glass slab is introduced in front of S_2 then match the following.



Column-I	**Column-II**
(A) Δx at P will	(P) increase
(B) Fringe width will	(Q) decrease
(C) Fringe pattern will	(R) remains same
(D) Number of fringes between O and P will	(S) shift upwards
	(T) shift downwards

Sol. A → P ; B → R ; C → T ; D → R

Q.13 Match column I with column II in the light of possibility of occurrence of phenomena listed in column I using the systems in column II -

	Column-I		**Column-II**
(A)	Interference	(P)	Non-mechanical waves
(B)	Diffraction	(Q)	Electromagnetism
(C)	Polarisation	(R)	Visible light wave
(D)	Reflection	(S)	Sound waves

Sol. **A → P, Q, R, S ; B → P, Q, R, S;**
C → P, Q, R ; D → P, Q, R, S

Q.14 In column-I the effect on fringe pattern in YDSE in mentioned when the changes mentioned in column-II are made. Match the entries of column-I with the entries of column-II.

	Column-I		**Column-II**
(A)	Angular fringe width change	(P)	Screen is moved away from the plane of the slits
(B)	Fringe width (linear	(Q)	Wavelength of light

	separation between two consecutive fringes) changes		used is decreased
(C)	Angular fringe width remain same	(R)	The separation between the slits is increased
(D)	The fringe pattern may disappear	(S)	The width of the source slit is increased

Sol. **A $\rightarrow$ Q,R ; B $\rightarrow$ P,Q,R ; C $\rightarrow$ P,S ; D $\rightarrow$ Q,R,S**

PHYSICS

Q.1 Two coherent waves represented by $Y_1 = A \sin\left(\frac{2\pi x_1}{\lambda} - \omega t + \frac{\pi}{4}\right)$ and $Y_2 = A \sin\left(\frac{2\pi x_2}{\lambda} - \omega t + \frac{\pi}{6}\right)$ are superposed. The two waves will produce -

(A) constructive interference at $x_1 - x_2 = \frac{11\lambda}{24}$

(B) constructive interference at $x_1 - x_2 = \frac{23\lambda}{24}$

(C) destructive interference at $x_1 - x_2 = \frac{23\lambda}{24}$

(D) destructive interference at $x_1 - x_2 = \frac{11\lambda}{24}$

[B,D]

Q.2 If one of the slits of a standard young's double slit experiment is covered by a thin parallel slit glass so that it transmits only one half the light intensity of the other, then:

(A) The fringe pattern will get shifted towards the covered slit

(B) The fringe pattern will get shifted away from the covered slit

(C) The bright fringes will become less bright and the dark ones will become more bright

(D) The fringe width will remain unchanged

[A,C,D]

Sol. $I_1 = I_2 = I$

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

$$I_{min} = \left(\sqrt{I} - \sqrt{\frac{I}{2}}\right)^2 > 0$$

Q.3 To observe a stationary interference pattern formed by two light waves, it is not necessary that they must have -

(A) the same frequency

(B) the same amplitude

(C) a constant phase difference

(D) the same intensity **[B,D]**

Q.4 Four coherent light waves are represented by :

(i) $y = a_1 \sin \omega t$

(ii) $y = a_2 \sin (\omega t + \varepsilon)$

(iii) $y = a_1 \sin 2\omega t$

(iv) $y = a_2 \sin 2(\omega t + \varepsilon)$

Interference fringes may be observed due to superposition of -

(A) (i) and (ii) (B) (i) and (iii)

(C) (ii) and (iv) (D) (iii) and (iv) **[A,B]**

Q.5 If white light is used in a Young's double-slit experiment -

(A) bright white fringe is formed at the centre of the screen

(B) fringes of different colours are observed clearly only in the first order

(C) the first-order violet fringes are closer to the centre of the screen than the first order red fringes

(D) the first-order red fringes are closer to the centre of the screen than the first order violet fringes **[A,B,C]**

Q.6 In Young's double slit experiment the two slits are covered by slabs of same thickness but refractive index 1.4 and 1.7. If slit to screen separation is 1 m and slits are at 1 mm separation using a coherent source of wavelength 4000 Å and the central fringe shifts to the 3^{rd} bright fringe position, then -

(A) shift will be towards slab of index 1.7 by 1.2 mm

(B) shift will be towards slab of index 1.4 by 1.2 mm

(C) slabs are of thickness 4 μm

(D) slabs are of thickness 4 Å **[A,C]**

Q.7 A thin film of index 1.6 is placed in air and white light reflected from it is viewed. The wavelengths 432 nm, 540 nm and 120 nm are missing. Then -

(A) the thickness of film is 675 nm

(B) only 617 nm will be maximum reflected wavelength lying in visible region

(C) if the order of 432 nm is 5, the order of 540 nm is 4

(D) order cannot be found from the given information **[A,B,C]**

Q.8 White light is used to illuminate the two slits in a Young's double slit experiment. The separation between slits is b and the screen is at a distance d (>> b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are -

(A) $\lambda = b^2/d$ (B) $\lambda = 2b^2/d$

(C) $\lambda = b^2/3d$ (D) $\lambda = 2b^2/3d$ **[A,C]**

Q.9 Light waves travel in vacuum along the X-axis. Which of the following may represent the wavefronts -

(A) x = c (B) y = c

(C) z = c (D) x + y + z = c **[A]**

Q.10 In the Young's double slit experiment, the interference pattern is found to have an intensity ratio between bright and dark fringes as 9. This implies that -

(A) the intensities at the screen due to the two slits are 5 units and 4 units respectively

(B) the intensities at the screen due to the two slits can be 4 units and 1 unit respectively

(C) the amplitude ratio is 3

(D) the amplitude ratio is 2 **[B,D]**

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

$$\frac{I_1}{I_2} = \left(\frac{A_1}{A_2}\right)^2$$

we can find $\frac{I_1}{I_2}$ from equation (1)

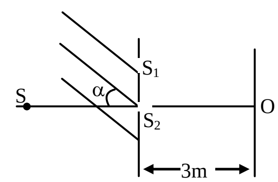
and $\frac{A_1}{A_2}$ from equation (2)

Q.11 While light is incident normally on a glass plate of thickness 5000 Å and refractive index 1.5. The wavelength in the visible region (4000 Å to 7000 Å) that are strongly reflected by the plate is -

(A) 4290 Å (B) 6000Å

(C) 4000Å (D) 5000Å **[A,B]**

Q.12 A parallel beam of light (λ = 5000 Å) is incident at an angle $\alpha = 30°$ with the normal to the slit plane in a young's double slit experiment. Assume that the intensity due to each slit at any point on the screen is I_0. Point O is equidistant from S_1 & S_2. The distance between slits is 1mm.



(A) the intensity at O is $4I_0$

(B) the intensity at O is zero

(C) the intensity at a point on the screen 4m from O is $4I_0$

(D) the intensity at a point on the screen 4m from O is zero **[A,C]**

Q.13 Two monochromatic coherent point sources S_1 and S_2 are separated by a distance L. Each source emits light of wavelength λ, where L >> λ. The line $S_1 S_2$ when extended meets a screen perpendicular to it at a point A. **[IIT-JEE 93]**

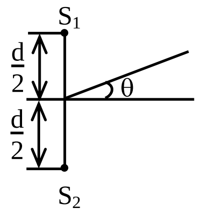
(A) The interference fringes on the screen are circular in shape

(B) The interference fringes on the screen are straight lines perpendicular to the line $S_1 S_2$ A

(C) The point A is an intensity maxima if $L = n\lambda$

(D) The point A is always an intensity maxima for any separation L **[A,C]**

Q.14 In an interference arrangement, similar to Young's double slit experiment, the slits S_1 and S_2 are illuminated with coherent microwave sources, each of frequency 10^6 Hz. The sources are synchronized to have zero phase difference. The slits are separated by distance d = 150.0 m. The intensity $I_{(\theta)}$ is measured as a function of θ, where θ is defined as shown in Fig. If I_0 is maximum intensity, then $I_{(\theta)}$ for $0 \le \theta \le 90^\circ$ is given by – **[IIT -JEE 95]**



(A) $I_{(\theta)} = (I_0)$ for $\theta = 0^\circ$

(B) $I_{(\theta)} = (I_0/2)$ for $\theta = 30^\circ$

(C) $I_{(\theta)} = (I_0/4)$ for $\theta = 90^\circ$

(D) $I_{(\theta)}$ is constant for all values of θ

[A,B]

Q.15 Three simple harmonic motions in the same direction having the same amplitude a and same period are superposed. If each differs from the next by 45º, then – **[IIT-JEE 99]**

(A) the resultant amplitude is $(1 + \sqrt{2})$ a

(B) the phase of the resultant motion relative to the first is 90º

(C) the energy associated with the resulting motion is $(3 + 2\sqrt{2})$ times the energy associated with any single motion

(D) the resulting motion is not simple harmonic

[A,C]

Q.16 In a Young's double slit experiment, the separation between the two slits is d and the wavelength of the light is λ. The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Choose the correct choice(s). **[IIT-JEE 2008]**

(A) If d = λ, the screen will contain only one maximum

(B) If λ < d < 2λ, at least one more maximum (besides the central maximum) will be observed on the
screen

(C) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2, the intensities of the observed dark and bright fringes will increase

(D) If the intensity of light falling on slit 2 is increased so that it becomes equal to that of slit 1, the intensities of the observed dark and bright fringes will increase **[A,B]**

Q.17 A Young's double-slit apparatus is immersed in oil of refractive index 5/3. The wavelength of light used in 500 nm (in oil), slit separation 2 mm, and distance to screen is 3 m. A glass slab of thickness 10 μm & refractive index 3/2 is placed before one slit. The fringe pattern will shift -

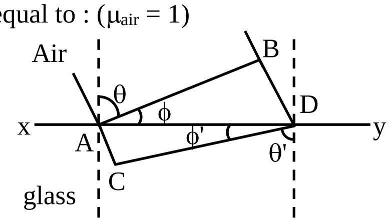
(A) 2 mm towards the other slit

(B) 2 mm away from the other slit

(C) 2.5 mm towards the other slit

(D) 2.5 mm away from the other slit **[C]**

Q.18 In the given diagram a wavefront AB moving in air is incident on a plane glass surface xy. Its position CD after refraction through the glass slab is shown also along with normals drawn at A and D. The refractive index of glass will be equal to : ($\mu_{air} = 1$)



(A) (BD/AC) (B) (AB/CD)

(C) (sin φ/sin φ') (D) (cos θ/cos θ')

[A,C,D]

Q.19 In Young's double slit experiment, the two slits are covered by slabs of same thickness but refractive index 1.4 and 1.7. If slit to screen separation is 1 m and slits are at 1 mm separation, using a coherent source of wavelength 4000 Å and the central fringe shift to the 3^{rd} bright fringe position, then -

(A) shift will be towards slab of index 1.7 by 1.2 mm

(B) shift will be towards slab of index 1.4 by 1.2 mm

(C) slabs are of thickness 4 μm

(D) slabs are of thickness 4 Å **[A,C]**

Q.20 White light is used to illuminate the two slits in a Young's double slit experiment. The separation between slits is b and the screen is at a distance 2d (>> b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are -

(A) $\lambda = b^2/d$ (B) $\lambda = b^2/2d$

(C) $\lambda = b^2/6d$ (D) $\lambda = 2b^2/3d$ **[B,C]**

Q.1 In Young's double slit experiment set-up with light of wavelength λ = 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.

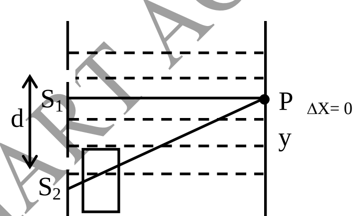
[0.21]

Q. 2 In Young's double slit experiment mixture of two light wave having wavelengths λ_1 = 500 nm and
λ_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.



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

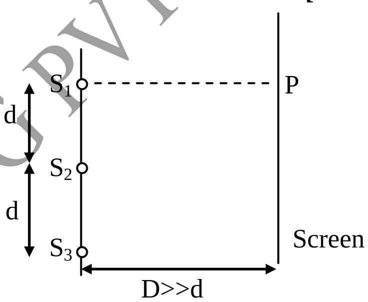
$$\Delta x = \frac{yd}{D} + \left(\frac{t \times \mu_g}{\mu_\ell} - t\right)_{liquid}$$

$\because$ $\Delta x = 0$

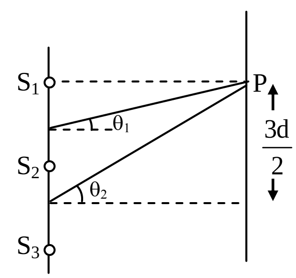
$$\therefore\ y = \frac{-Dt}{d}\left[\frac{\mu_g - \mu_\ell}{\mu_\ell}\right] = \frac{-tD}{d}\left[\frac{4-T}{10-T}\right]$$

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]**

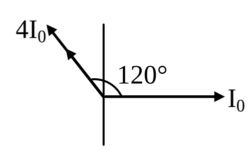


Sol.



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

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



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

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

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

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

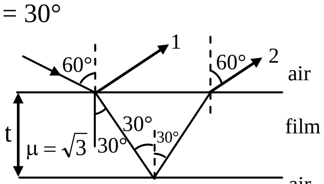
$d_{max} = 2.06 \times 10^{-3}$ m

$d_{max} = 2.06$ 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 λ = 6000 Å ?

Sol. $1 \sin 30° = \sqrt{3} \sin r$

$\Rightarrow r = 30°$



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

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

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

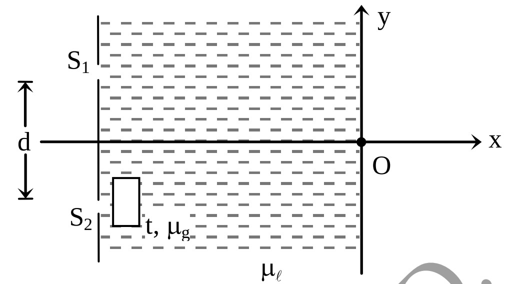
$= 3t$

Phase diff. = π due to reflection of ray 1

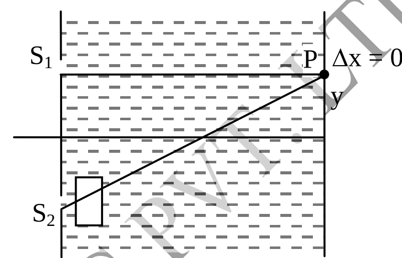
$\therefore$ for constructive interference, $3t = \frac{\lambda}{2}$

$t = \frac{\lambda}{6} = 1000$ Å = 100 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………… $\times 10^{-3}$ m/s. **[0003]**



Sol.



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

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

$\therefore \Delta x = 0$

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

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 10^{th} fringe be observed by reflected light is ….. $\times 10^{-1}$ cm.

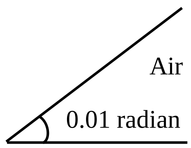
Sol. **[3]**

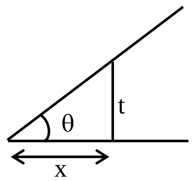
$\theta = 0.01$ radian

$n = 10$

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

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





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

$t = \theta x$

$2\theta x = n\lambda$

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

$= 3 \times 10^{-1}$ 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 $= \dfrac{I_{net}}{I'_{net}} = \dfrac{2}{1} = 2$

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 $\beta_\theta = \dfrac{\beta}{D} = \dfrac{\lambda}{d}$.

According to the given condition

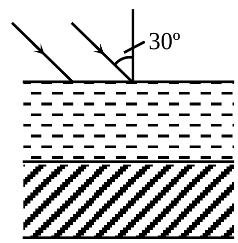
$\dfrac{\lambda}{d} \geq \dfrac{\pi}{180 \times 60}$

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

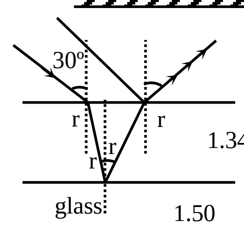
$d_{max} = 2.06 \times 10^{-3}$ m

$d_{max} = 2.06$ 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]

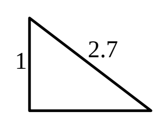


Condition for constructive interference

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

$\sin 30º = 1.34 \sin r$

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



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

$2\mu t \cos r = n\lambda$ …… (1)

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

equation (1) – equation (2)

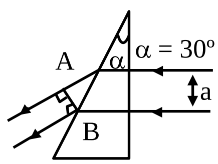
$2\mu \Delta t \cos r = \lambda$

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

Rate of decrease = $\frac{\Delta t}{\text{time}}$ = 1.01 μm/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

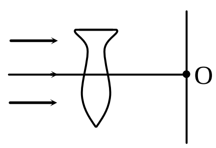
PHYSICS

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 –



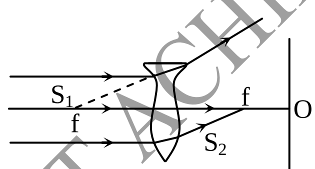
(A) Total number of maxima excluding maxima at infinity is 10

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

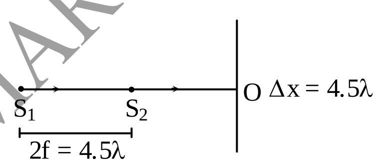
(C) Intensity at point O is 4I

(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 10^{th} bright fringe in liquid lies where 6^{th} 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) $\frac{I_1 - 3I_2}{2}$

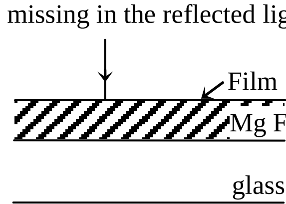
(C) $\frac{3I_1 - I_2}{2}$ (D) $\frac{I_2 - 3I_1}{2}$ **[C]**

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]**

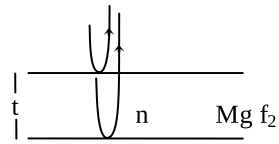
Q.7 White light is incident normally on a glass surface (n = 1.52) that is coated with a film of MgF_2 (n = 1.38). For what minimum thickness of the film will yellow light of wavelength 550 nm (in air) be missing in the reflected light –



(A) 99.6 nm (B) 49.8 nm

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

Sol.



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

$\Rightarrow$ For t_{min} $m = 0$

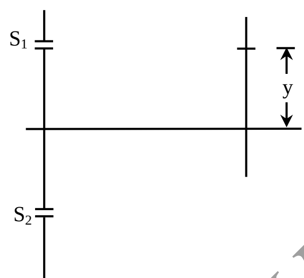
$$t_{min} = \frac{\lambda}{4n} = \frac{5.5\times10^{-7}}{4\times1.38} = 99.6 \text{ nm}$$

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]**



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

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

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

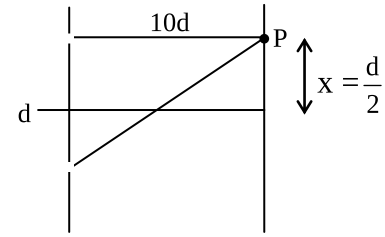
$$= I_0 \cos^2\left(\frac{\pi y}{\beta}\right) \qquad [\because I_0 = 4I]$$

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 10^{th} 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

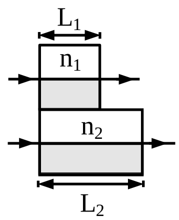
Sol. **[C]**

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

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

So new co-ordinate of 10^{th} 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

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

$\therefore$ 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) $\frac{3\lambda}{4}$

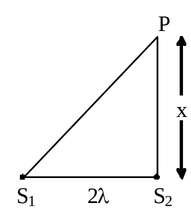
Sol **[A]**

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

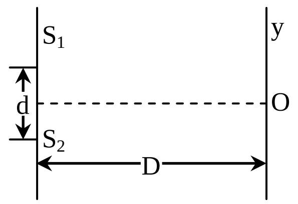
or $\sqrt{4\lambda^2 + x^2} - x = \frac{3\lambda}{2}$

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]**

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

$\phi = 120^o$

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

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

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

$10^{-4}\ x = \frac{6000\times10^{-7}}{3}$

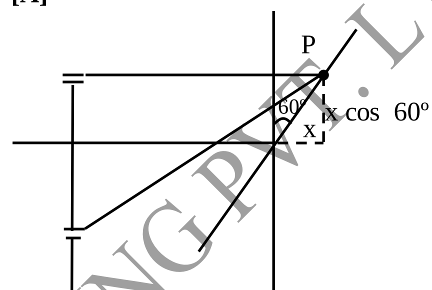
x = 2 mm

Q.19 In a young double slit apparatus the screen is rotated by 60º 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 = $\frac{dx\cos 60}{D} = 2.5\ \lambda$

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

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 $n_1\lambda_1 = n_2\lambda_2$

$n_2 = \frac{n_1\lambda_1}{\lambda_2} = \frac{16\times6000}{4800} = 20$

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

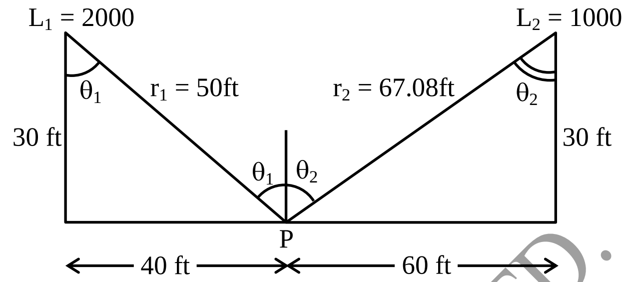


Fig.

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

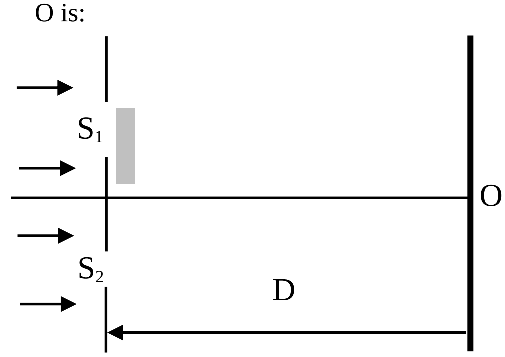
(C) 14.98 μm (D) 3.78 μm **[A]**

Q.27 Young's double slit experiment is made in a liquid. The 10^{th} bright fringe in liquid lies where 6^{th} 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) $\lambda d/D$

(C) $\lambda D/d$ (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 4^{th} 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

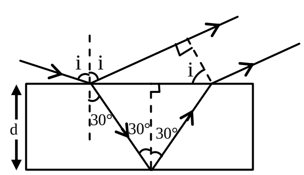
(D) disappears **[A]**

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

μ (2d sec 30°) – 2d tan 30° sin i = nλ

n = 1, 2, 3 ……

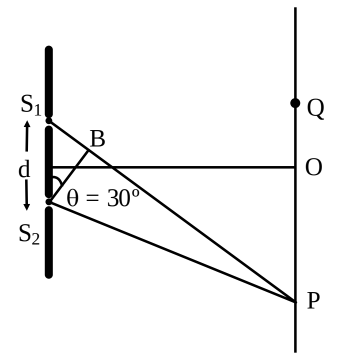
By snell's law 1 sin i = $\frac{3}{2}$ sin30° = $\frac{3}{4}$

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

$d_{min} = \frac{2\lambda}{3\sqrt{3}} \simeq 2263$ 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 11^{th} 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 n^{th} red bright band for the same setting is given by -

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

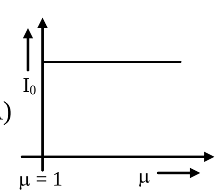
[C]

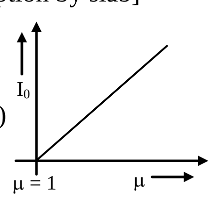
Q.40 The slits in a Young's double slit experiment have equal width and the source is placed symmetrically with respect to the slits. The intensity at the central fringe is I_0. If one of the slits is closed, the intensity at this point will be -

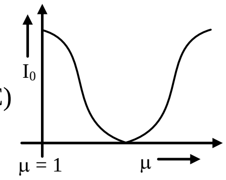
(A) I_0 (B) $I_0/4$ (C) $I_0/2$ (D) $4I_0$

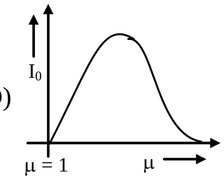
[B]

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 -

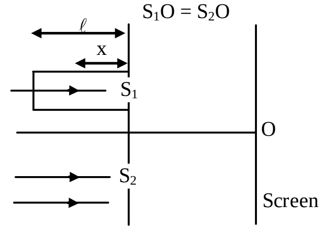
(A) 1 mm (B) 2 mm
(C) 3 mm (D) 4 mm **[B]**

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

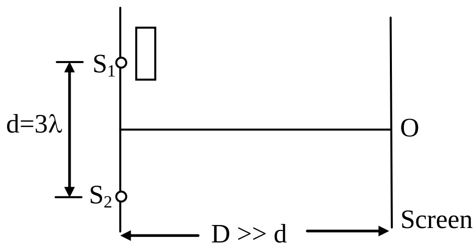
Q.44 In the figure shown, a parallel beam of light is incident on the plane of the slits of a Young's double slit experiment. Light incident on the slit, S_1 passes through a medium of variable refractive index μ = 1 + ax (where 'x' is the distance from the plane of slits as shown), up to a distance '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 $\pi/2$ 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) $2\lambda/3$

(C) $\lambda/3$ (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] $I_{new} = 2I$

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

$\cos\phi = 0$

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

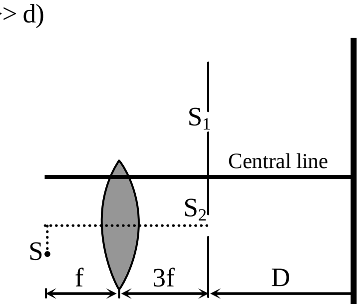
$\Delta x = \frac{\lambda}{4}$

Δx at screen centre $= (\mu - 1)t$

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

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

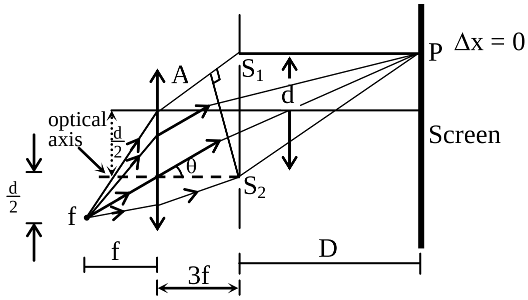
Q.50 Consider the set up shown in the figure. The source S is d/2 distance below the optical axis and the optical axis is equal distance below the central line. The separation between slits is d. The position of the central maxima on the screen is- (D >>> d)



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

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

Sol. **[A]**



$\Delta x = AS_1 + S_1P - S_2P$

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

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

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

(D) No interference.

PHYSICS

Q.1 The optical path of a monochromatic light is the same if it goes through 2.00 cm of glass or 2.25 cm of water. If the refractive index of water is 1.33, what is the refractive index of glass ? **[1.50]**

Q.2 Find the maximum intensity in case of interference of n identical waves each of intensity I_0 if the interference is (a) coherent (b) incoherent. **[(a) $n^2 I_0$ (b) nI_0]**

Q.3 Two coherent monochromatic light beams of intensities I and 4I are superposed. What is the maximum and minimum possible intensities in the resulting beam ? **[I_{max} = 9 I & I_{min} = I]**

Q.4 A double slit arrangement produces interference fringes for sodium light (λ = 589 nm) that are 0.2º apart. For what wavelength would the angular separation be 10% greater ? **[647.9 nm]**

Q.5 White light is used in a Young's double slit experiment. Find the minimum order of the violet fringe (λ = 400 nm) which overlaps with a red fringe (λ = 700 nm). **[7]**

Q.6 In a Young's double slit experiment a parallel light beam containing wavelength λ_1 = 4000 Å and

λ_2 = 5600 Å is incident on a diaphragm having two narrow slits. Separation between the slits is d = 2 mm. If distance between diaphragm and screen is D = 40 cm, calculate :

(i) distance of first black line from central bright fringe and

(ii) distance between two consecutive black lines on either side of central fringe.

[280 μ m (ii) 560 μ m]

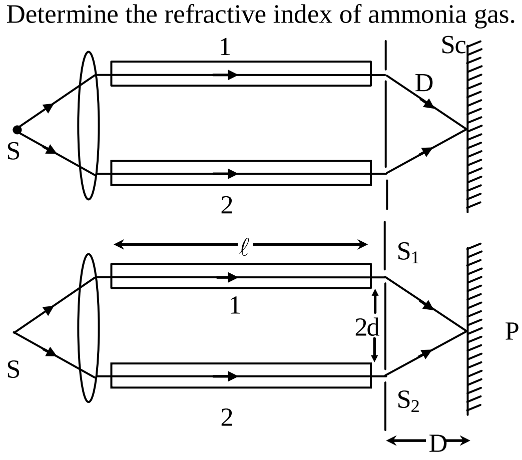
Q.7 A thin paper of thickness 0.02 mm having a refractive index 1.45 is pasted across one of the slits in a Young's double slit experiment. The paper transmits 4/9 of the light energy falling on it. (a) Find the ratio of the maximum intensity to the minimum intensity in the fringe pattern. (b) How many fringes will cross through the centre if an identical paper piece is pasted on the other slit also ? The wavelength of the light used is 600 nm.

[(a) 25 , (b) 15]

Q.8 In a Young's double slit experiment using monochromatic light, the fringe pattern shifts by a certain distance on the screen when a mica sheet of refractive index 1.6 and thickness 1.964 micron (1 micron = 10^{-6} m) is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the screen and the slits is doubled. It is found that the distance between the successive maxima now is the same as the observed fringe-shift upon the introduction of the mica sheet. Calculate the wavelength of the monochromatic light used in the experiment.

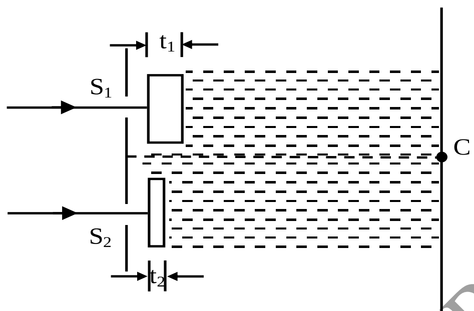
[590 nm]

Q.9 Figure illustrates an interferometer used in measurements of refractive indices of transparent substances. Here S is a narrow slit illuminated by monochromatic light with wavelength λ = 589 nm, 1 and 2 are identical tubes with air of length ℓ = 10.0 cm each, D is a diaphragm with two slits. After the air in tube 1 was replaced with ammonia gas, the interference pattern on the screen Sc was displaced upward by N = 17 fringes. The refractive index of air is equal to n = 1.000277. Determine the refractive index of ammonia gas.



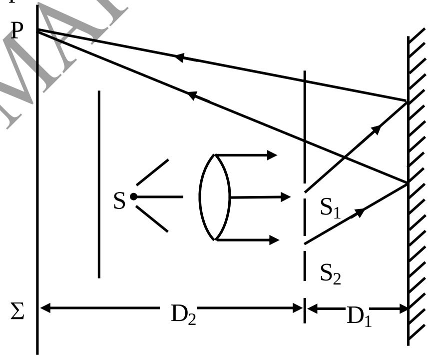
[n + Nλ / ℓ, 1.000377]

Q.10 A screen is at a distance D = 80 cm from a diaphragm having two narrow slits S_1 and S_2 which are d = 2 mm apart. Slit S_1 is covered by a transparent sheet of thickness t_1 = 2.5 μm and S_2 by another sheet of thickness t_2 = 1.25 μm as shown in figure. Both sheets are made of same material having refractive index μ = 1.40. Water is filled in space between diaphragm and screen. A monodichromatic light beam of wavelength λ = 5000 Å is incident normally on the diaphragm. Assuming intensity of beam to be uniform and slits of equal width, calculate ratio of intensity at C to maximum intensity of interference pattern obtained on the screen, where C is foot of perpendicular bisector of S_1S_2. (Refractive index of water, $\mu_w = 4/3$)



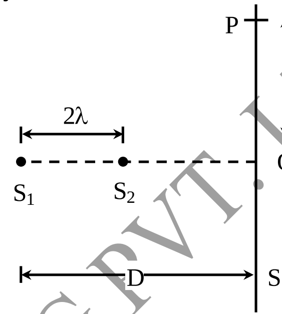
$\left[\frac{3}{4}\right]$

Q.11 A double slit $S_1 - S_2$ is illuminated by a coherent light of wavelength λ. The slits are separated by a distance d. A plane mirror is placed in front of the double slit at a distance D_1 from it and a screen Σ is placed behind the double slit at a distance D_2 from it (Figure). The screen Σ receives only the light reflected by the mirror. Find the fringe-width of the interference pattern on the screen.



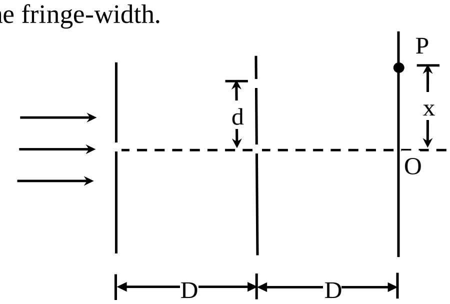
[$\lambda (2D_1 + D_2) / d$]

Q.12 Two coherent narrow slits emitting light of wavelength λ in the same phase are placed parallel to each other at a small separation of 2λ. The light is collected on a screen S which is placed at a distance D (>> λ) from the slit S_1 and shown in figure. Find the distance x such that the intensity at point P is equal to the intensity at O.



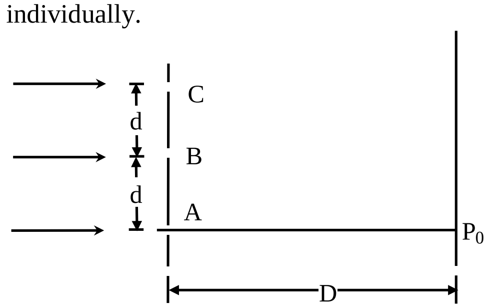
[$\sqrt{3}D$]

Q.13 Consider the arrangement shown in figure. The distance D is large compared to the separation d between the slits. (a) Find the minimum value of d so that there is a dark fringe at O. (b) Suppose d has this value. Find the distance x at which the next bright fringe is formed. (c) Find the fringe-width.



[(a) $\sqrt{\frac{\lambda D}{2}}$ (b) d (c) 2d]

Q.14 Figure shows three equidistant slits being illuminated by a monochromatic parallel beam of light. Let $BP_0 - AP_0 = \lambda/3$ and D >> λ. (a) Show that in this case $d = \sqrt{2\lambda D/3}$. (b) Show that the intensity at P_0 is three times the intensity due to any of the three slits individually.

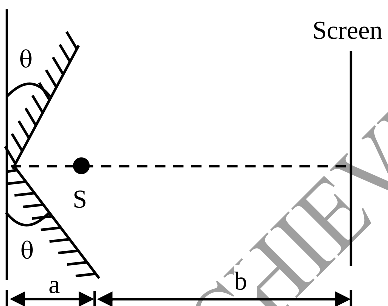


Q.15 A soap film of thickness 0.0011 mm appears dark when seen by the reflected light of wavelength 580 nm. What is the index of refraction of the soap solution, if it is known to be between 1.2 and 1.5 ? Consider normal incidence. **[1.32]**

Q.16 A glass surface is coated by an oil film of uniform thickness 1.00×10^{-4} cm. The index of refraction of the oil is 1.25 and that of the glass is 1.50. Find the wavelengths of light in the visible region (400 nm-750 nm) which are completely transmitted by the oil film under normal incidence.

[455nm, 556nm, 714nm]

Q.17 Two plane mirrors, a source S of light, emitting monochromatic rays of wavelength λ and a screen are arranged as shown in figure. If angle θ is very small, calculate fringe width of interference pattern formed on screen by reflected rays.



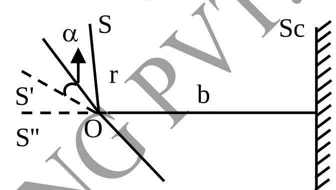
Q.18 A lens of diameter 5.0 cm and focal length f = 25.0 cm was cut along the diameter into two identical halves. In the process, the layer of the lens a = 1.00 mm in thickness was lost. Then the halves were put together to form a composite lens. In this focal plane a narrow slit was placed, emitting monochromatic light with wavelength λ = 0.60 μm. Behind the lens a screen was located at a distance b = 50 cm from it. Find the width of a fringe on the screen and the number of possible maxima.

[Δx = 0.15 mm, N = 13]

Q.19 Figure illustrates the interference experiment with Fresnel mirrors. The angle between the mirrors is α α = 12´, the distances from the mirrors intersection line to the narrow slit S and the screen Sc are equal to r = 10.0 cm and b = 130 cm respectively. The wavelength of light is λ = 0.55 μm. Find :

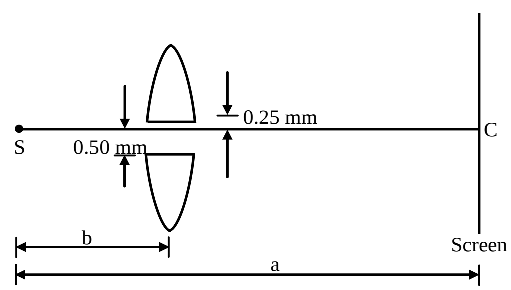
(a) the width of a fringe on the screen and the number of possible maxima :

(b) the shift of the interference pattern on the screen when the slit is displaced by Δt = 1.0 mm along the arc of radius r with centre at the point O;



Q.20 A luminous point object S is placed in front of a screen at a distance a = 225 cm from the screen. A convex lens of focal length f = 20 cm is broken along a diameter into two equal parts. These two parts are placed between source and screen at a distance b = 30 cm from the source. One of these parts is displaced by d_1 = 0.25 mm from line SC which is normal to the screen and the other part is displaced by d_2 = 0.50 mm as shown in figure. The gap between two parts of the lens is filled by an opaque material.

Calculate refractive index μ of a transparent sheet of thickness t = 1.25 μm to be placed in path of rays emerging from one of the parts so that a white spot is formed at point C.



[1.5]