GUIDED REVISION

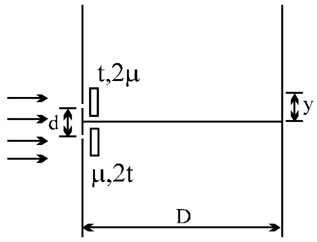
SECTION-I

Single Correct Answer Type **11 Q. [3 M (–1)]**

1. In YDSE how many maxima can be obtained on the screen if wavelength of light used is 200nm and d = 700 nm:

(A) 12 (B) 7 (C) 18 (D) none of these

2. In the YDSE shown the two slits are covered with thin sheets having thickness t & $2t$ and refractive index 2μ and μ. Find the position (y) of central maxima

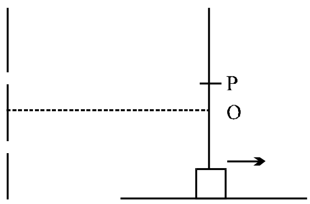


(A) zero (B) $\frac{tD}{d}$ (C) $-\frac{tD}{d}$ (D) None

3. Monochromatic light of wavelength 900 nm is used in a young's double slit experiment. One of the slits is covered by a transparent sheet of thickness 1.8×10^{-5} m made of material of refractive index 1.6. How many fringes will shift due to introduction of the sheet :-

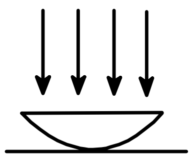
(A) 18 (B) 12 (C) 10 (D) 6

4. In a Young's Double slit experiment, first maxima is observed at a fixed point P on the screen. Now the screen is continuously moved away from the plane of slits. The ratio of intensity at point P to the intensity at point O (centre of the screen)



(A) remains constant
(B) keeps on decreasing
(C) first decreases and then increases
(D) First decreases and then becomes constant

5. A thin slice is cut out of a glass cylinder along a plane parallel to its axis. The slice is placed on a flat glass plate as shown. The observed interference fringes from this combination shall be **[IIT-JEE '99]**



(A) straight
(B) circular
(C) equally spaced
(D) having fringe spacing which increases as we go outwards.

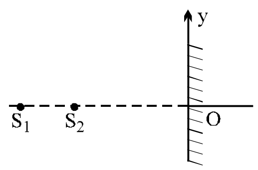
6. Two point monochromatic and coherent sources of light of wavelength λ are placed on the dotted line in front of a large screen. The sources emit waves in phase with each other. The distance between S_1 and S_2 is d while their distance from the screen is much larger.

(1) If $d = 7\lambda/2$, O will be a minima

(2) If $d = 4.3\lambda$, there will be a total of 8 minima on y-axis.

(3) If $d = 7\lambda$, O will be a maxima.

(4) If $d = \lambda$, there will be only one maxima on the screen.



Which is the set of correct statement :

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

7. Direction :

The question has a paragraph followed by two statement, Statement-1 and statement-2. Of the given four alternatives after the statements, choose the one that describes the statements.

A thin air film is formed by putting the convex surface of a plane-convex lens over a plane glass plate. With monochromatic light, this film gives an interference pattern due to light reflected from the top (convex) surface and the bottom (glass plate) surface of the film **[AIEEE-2011]**

Statement-1: When light reflects from the air-glass plate interface, the reflected wave suffers a phase change of π.

Statement-2 : The centre of the interference pattern is dark :-

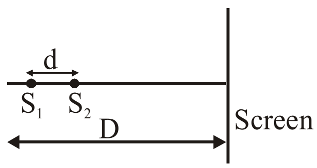
(A) Statement-1 is true, Statement-2 is true and Statement-2 is not the correct explanation of Statement-1.

(B) Statement-1 is false, Statement-2 is true

(C) Statement-1 is true, Statement-2 is false

(D) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of statement-1.

8. Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown. The fringes obtained on the screen will be : **[JEE-Mains 2013]**



(A) points (B) straight lines (C) semicircles (D) concentric circles

9. During the propagation of electromagnetic waves in a medium : **[JEE-Mains 2014]**

(A) Electric energy density is equal to the magnetic energy density

(B) Both electric magnetic energy densities are zero

(C) Electric energy density is double of the magnetic energy density

(D) Electric energy density is half of the magnetic energy density.

10. On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam : **[JEE-Mains 2015]**

(A) bends downwards (B) bends upwards

(C) becomes narrower (D) goes horizontally without any deflection

11. Young's double slit experiment is carried out by using green, red and blue light, one color at a time. The fringe widths recorded are β_G, β_R and β_B, respectively. Then **[IIT-JEE-2012]**

(A) $\beta_G > \beta_B > \beta_R$ (B) $\beta_B > \beta_G > \beta_R$

(C) $\beta_R > \beta_B > \beta_G$ (D) $\beta_R > \beta_G > \beta_B$

Multiple Correct Answer Type 2 Q. [4 M (–1)]

12. In an arrangement to view the interference pattern produced by a wedge of liquid between a microscope slide and a glass block the interference pattern obtained is made of equally spaced parallel fringes. The fringe separation (or fringe width) can not be decreased by which of the following actions.

(A) by increasing the angle of the liquid wedge.

(B) by using a liquid of smaller refractive index.

(C) by using a thicker glass block.

(D) by using a longer liquid wedge of the same angle

13. 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 $d = \lambda$, the screen will contain only one maximum

(B) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central max.) will be observed on the screen

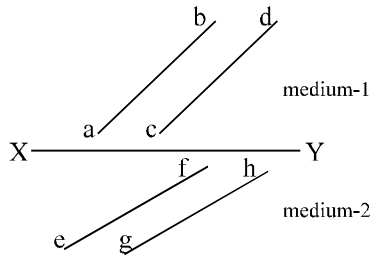
(C) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2, the intensities of the observed dark and bright fringes will increase

(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

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Question Nos. 14 to 16

The figure shows a surface *XY* separating two transparent media, medium-1 and medium-2. The lines *ab* and *cd* represent wavefronts of a light wave traveling in medium-1 and incident on *XY*. The lines *ef* and *gh* represent wavefronts of the light wave in medium-2 after refraction. **[IIT-JEE 2007]**



14. Light travels as a :-
(A) parallel beam in each medium
(B) convergent beam in each medium
(C) divergent beam in each medium
(D) divergent beam in one medium and convergent beam in the other medium

15. The phases of the light wave at *c*, *d*, *e* and *f* are ϕ_c, ϕ_d, ϕ_e and ϕ_f respectively. It is given that $\phi_c \neq \phi_f$.
(A) ϕ_c cannot be equal to ϕ_d
(B) ϕ_d can be equal to ϕ_e
(C) $(\phi_d - \phi_f)$ is equal to $(\phi_c - \phi_e)$
(D) $(\phi_d - \phi_c)$ is not equal to $(\phi_f - \phi_e)$

16. Speed of light is
(A) the same in medium-1 and medium-2
(B) larger in medium-1 than in medium-2
(C) larger in medium-2 than in medium-1
(D) different at *b* and *d*

SECTION-II

Numerical Answer Type Question 3 Q. [3(0)]
(upto second decimal place)

1. A thin film of a specific material can be used to decrease the intensity of reflected light. There is destructive interference of waves reflected from upper and lower surfaces of the film. These films are called anti-reflection coating. Magnesium fluoride (MgF_2) is used as anti-reflecting coating on plane glass surface for light having wavelength 500 nm and normal incidence. The minimum thickness of film required is 100 nm. Find refractive index of magnesium fluoride. It is known that refractive index of glass is more than refractive index of magnesium fluoride.

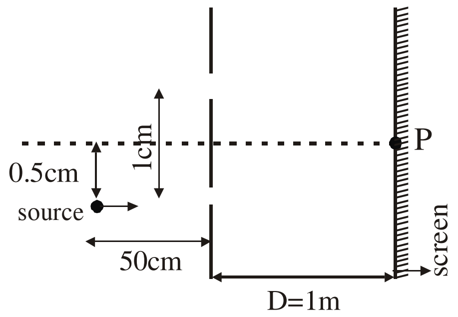
2. In a YDSE apparatus, $d = 1$mm, $\lambda = 600$ nm and $D = 1$m. The slits individually produce same intensity on the screen. Find the minimum distance between two points on the screen having 75% intensity of the maximum intensity.

3. In a Young's experiment, the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate having the same thickness as the first one but having refractive index 1.7. Interference pattern is observed using light of wavelength 5400 Å. It is found that the point P on the screen where the central maximum ($n = 0$) fell before the glass plates were inserted now has 3/4 the original intensity. It is further observed that what used to be the 5th maximum earlier, lies below the point P while the 6th minimum lies above P. Calculate the thickness of the glass plate. (Absorption of light by glass plate may be neglected). **[IIT-JEE 1997]**

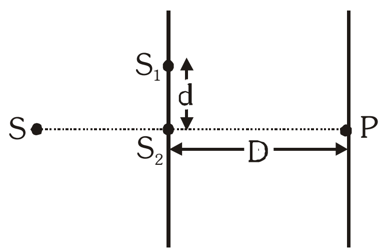
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 2 Q. [4 M (0)]

1. In a typical Young's double slit experiment a point source of monochromatic light is kept as shown in the figure. If the source is given an instantaneous velocity v=1 mm per second towards the screen, then the instantaneous velocity of central maxima is given as $\alpha \times 10^{-\beta}$ m/s upward. Find the value of $\alpha+\beta$.



2. In a YDSE experiment two slits S_1 and S_2 have separation of d = 2 mm. The distance of the screen is D = 8/5 m. Source S starts moving from a very large distance towards S_2 perpendicular to S_1S_2 as shown in figure. The wavelength of monochromatic light is 500 nm. The number of maximas observed on the screen at point P as the source moves towards S_2 is 3995 + n. Find the value of n.

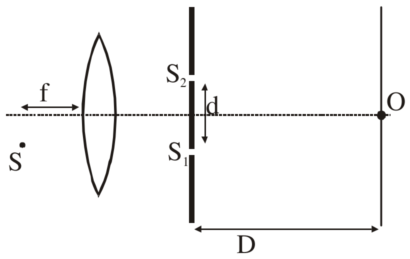


SECTION-IV

Matrix Match Type (4 × 5) **4 Q. [8 M (for each entry +2(0)]**

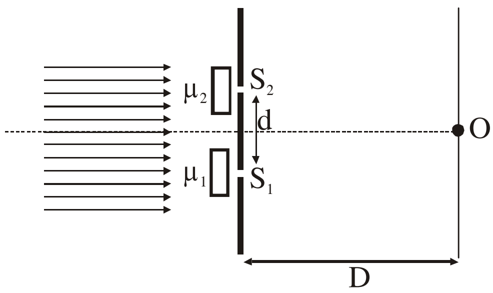
1. Column-I shows some modifications in a standard YDSE setup. Column-II shows the associated characteristics.

Column-I **Column-II**

(A) 

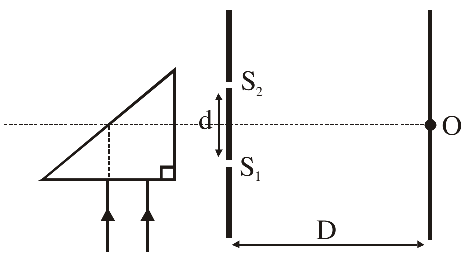
monochromatic point source S placed in focal plane.

(P) Zero order maxima lies above O.

(B) 

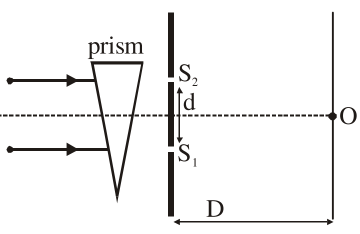
monochromatic parallel beam incident on S_1S_2 through transparent slabs of same thickness but $\mu_1 > \mu_2$

(Q) If a transparent mica sheet is introduced infront of S_2 central bright fringe can be obtained at O.

(C) 

monochromatic parallel beam incident on a right angled isosceles prism of refractive index 1.50

(R) Fringe width $\beta = \frac{\lambda D}{d}$

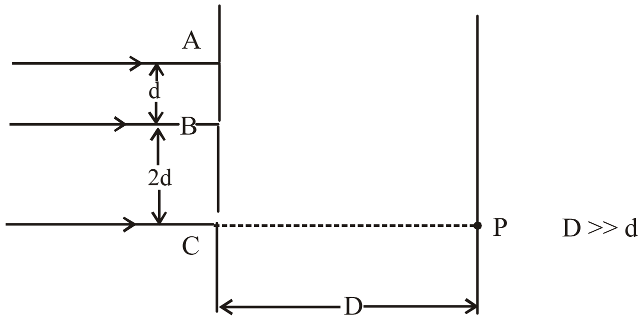
(D) 

monochromatic parallel beam incident on thin prism

(S) Point O can be a minima

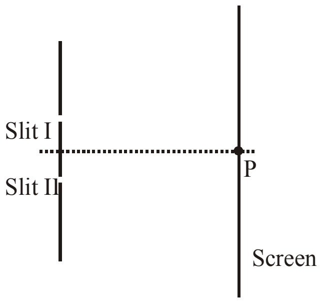
(T) Point O can be a least order minima.

2. In the figure A, B and C are three slits. Intensity of light from each slit is I_0 at point P. Wavelength of light is λ. Match the conditions of column-I to resultant intensity at point P given in column-II.



Column - I	Column-II
(A) If $\frac{d^2}{D} = \lambda$	(P) $I_p = I_o$
(B) If $\frac{d^2}{D} = \frac{\lambda}{2}$	(Q) $I_p = 4I_o$
(C) If $\frac{d^2}{D} = \frac{\lambda}{4}$	(R) $I_p = 5I_o$
(D) If $\frac{d^2}{D} = 2\lambda$	(S) $I_p = 9I_o$
	(T) $I_p = 3I_o$

3. A double slit interference pattern is produced on a screen, as shown in the figure, using monochromatic light of wavelength 500nm. Point P is the location of the central bright fringe, that is produced when light waves arrive in phase without any path difference. A choice of three strips *A*, *B* and *C* of transparent materials with different thicknesses and refractive indices is available, as shown in the table. These are placed over one or both of the slits, singularly or in conjunction, causing the interference pattern to be shifted across the screen from the original pattern. In the column–I, how the strips have been placed, is mentioned whereas in the column–II, order of the fringe at point *P* on the screen that will be produced due to the placement of the strips(s), is shown. Correctly match both the column.

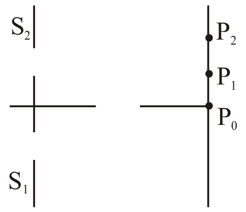


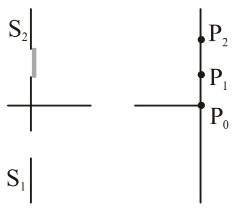
Film	A	B	C
Thickness (in μm)	5	1.5	0.25
Refractive index	1.5	2.5	2

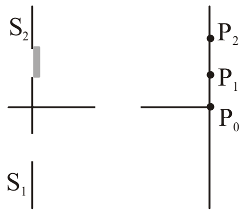
Column I	Column II
(A) Only strip B is placed over slit–I	(P) First Bright
(B) Strip A is placed over slit–I and strip C is placed over slit–II	(Q) Fourth Dark
(C) Strip A is placed over the slit–I and strip B and strip C are placed over the slit–II in conjunction	(R) Fifth Dark
(D) Strip A and strip C are placed over slit–I (in conjuction) and strip B is placed over Slit–II	(S) Central Bright

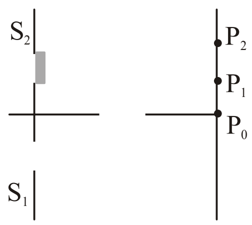
4. **Column I** shows four situations of standard Young's double slit arrangement with the screen placed far away from the slits S_1 and S_2. In each of these cases $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda/4$ and $S_1P_2 - S_2P_2 = \lambda/3$,, where λ is the wavelength of the light used. In the cases *B*, *C* and *D*, a transparent sheet of refractive index μ and thickness t is pasted on slit S_2. The thicknesses of the sheets are different in different cases. The phase difference between the light waves reaching a point *P* on the screen from the two slits is denoted by $\delta(P)$ and the intensity by $I(P)$. Match each situation given in **Column I** with the statement(s) in **Column II** valid for that situation. **[IIT-JEE-2009]**

Column-I

(A) 

(B) $(\mu - 1)\, t = \lambda/4$ 

(C) $(\mu - 1)\, t = \lambda/2$ 

(D) $(\mu - 1)\, t = 3\lambda/4$ 

Column-II

(P) $\delta(P_0) = 0$

(Q) $\delta(P_1) = 0$

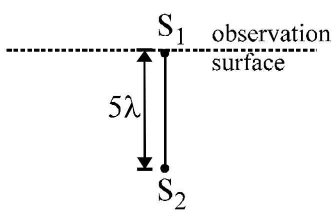
(R) $I(P_1) = 0$

(S) $I(P_0) > I(P_1)$

(T) $I(P_2) > I(P_1)$

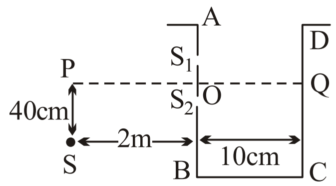
Subjective Type **5 Q. [4 M (0)]**

1. Two microwave coherent point sources emitting waves of wavelength λ are placed at 5λ distance apart. The interference is being observed on a flat non-reflecting surface along a line passing through one source, in a direction perpendicular to the line joining the two sources (refer figure). Considering λ as 4 mm, calculate the positions of maxima and draw shape of interference pattern. Take initial phase difference between the two sources to be zero.



2. A thin glass plate of thickness t and refractive index μ is inserted between screen & one of the slits in a Young's experiment. If the intensity at the centre of the screen is I, what was the intensity at the same point prior to the introduction of the sheet.

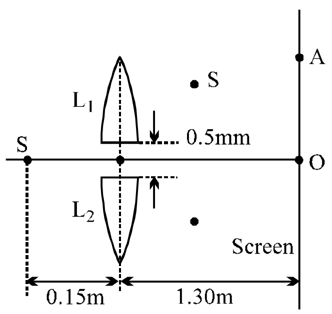
3. A vessel $ABCD$ of 10 cm width has two small slits S_1 and S_2 sealed with identical glass plates of equal thickness. The distance between the slits is 0.8 mm. POQ is the line perpendicular to the plane AB and passing through O, the middle point of S_1 and S_2. A monochromatic light source is kept at S, 40cm below P and 2 m from the vessel, to illuminate the slits as shown in the figure below. Calculate the position of the central bright fringe on the other wall CD with respect to the line OQ. Now, a liquid is poured into the vessel and filled up to OQ. The central bright fringe is found to be at Q. Calculate the refractive index of the liquid. **[IIT-JEE 2001]**



4. In the figure shown S is a monochromatic point source emitting light of wavelength $\lambda = 500$ nm. A thin lens of circular shape and focal length 0.10 m is cut into two identical halves L_1 and L_2 by a plane passing through a diameter. The two halves are placed symmetrically about the central axis SO with a gap of 0.5 mm. The distance along the axis from S to L_1 and L_2 is 0.15 m, while that from L_1 & L_2 to O is 1.30 m. The screen at O is normal to SO. **[IIT-JEE 1993]**

(i) If the third intensity maximum occurs at the point A on the screen, find the distance OA.

(ii) If the gap between L_1 & L_2 is reduced from its original value of 0.5 mm, will the distance OA increase, decrease or remain the same ?



5. Suppose that the electric field part of an electromagnetic wave in vaccum is

$E = \{(3.1 \text{ N/C}) \cos [(1.8 \text{ rad/m})\, y + (5.4 \times 10^8 \text{ rad/s})t]\ \hat{i}$.

(a) What is the direction of propagation?

(b) What is the wavelength λ?

(c) What is the frequency v?

(d) What is the amplitude of the magnetic field part of the wave?

(e) Write an expression for the magnetic field part of the wave.

SECTION-I

Single Correct Answer Type — 11 Q. [3 M (–1)]

1. Ans. (B) **2. Ans. (B)** **3. Ans. (B)** **4. Ans. (C)**
5. Ans. (A) **6. Ans. (C)** **7. Ans. (A)** **8. Ans. (D)**
9. Ans. (A) **10. Ans. (B)** **11. Ans. (D)**

Multiple Correct Answer Type — 2 Q. [4 M (–1)]

12. Ans. (B,C,D) **13. Ans. (A,B)**

Linked Comprehension Type — (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

14. Ans. (A) **15. Ans. (C)** **16. Ans. (B)**

SECTION-II

Numerical Answer Type Question — 3 Q. [3(0)]
(upto second decimal place)

1. Ans. 1.25 **2. Ans. 0.2 mm** **3. Ans. 9.3 μm**

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) — 2 Q. [4 M (0)]

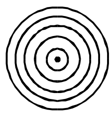
1. Ans. 7 **2. Ans. 5**

SECTION-IV

Matrix Match Type (4 × 5) — 4 Q. [8 M (for each entry +2(0)]

1. Ans. (A) (PRST); (B) (QRST); (C) (R); (D) (PRST)
2. Ans. (A) - (P); (B) - (R); (C) - (P); (D) - (S)
3. Ans. (A) (R) ; (B) (R) ; (C) (S) ; (D) (P)
4. Ans. (A) P, S ; (B) Q ; (C) T ; (D) R,S,T

Subjective Type — 5 Q. [4 M (0)]

1. Ans. 48, 21, $\frac{32}{3}$, $\frac{9}{2}$, 0 m.m.; 

2. Ans. $I_0 = I\sec^2\left[\frac{\pi(\mu-1)t}{\lambda}\right]$

3. Ans. (i) y = 2 cm, (ii) m = 1.0016

4. Ans. (i) 1 mm (ii) increase

5. Ans. (a) $-\hat{j}$ (b) 3.5 m (b) 86 MHz (c) 10.3 nT (e) {(10.3 nT) cos [(1.8 rad/m) y + (5.4 × 10^8 rad/s)t]} $\hat{k}$

SOLUTIONS
SECTION-I

Single Correct Answer Type **11 Q. [3 M (–1)]**

1. **Ans. (B)**

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

$-1 < \sin\theta = \frac{n\lambda}{d} < 1$

$-1 < \frac{n\lambda}{d} < 1$

$-\frac{d}{\lambda} < n < \frac{d}{\lambda}$

$-\frac{7}{2} < n < \frac{7}{2}$

$n = 0, \pm1, \pm2, \pm3$

2. **Ans. (B)**

Sol. $[S_2P + (\mu_2 - 1)t_2] - (S_1P + (\mu_1 - 1)t_1) = n\lambda = 0$

$(S_2P - S_1P) = (\mu_1 - 1)t_1 - (\mu_2 - 1)t_2$

$= (2\mu - 1)t - (\mu - 1)2t$

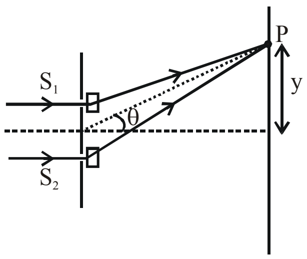
$= -t + 2t = t$

$d \sin\theta = t$

$d \tan\theta = t$

$\frac{dy}{D} = t$

$y = \frac{Dt}{d}$

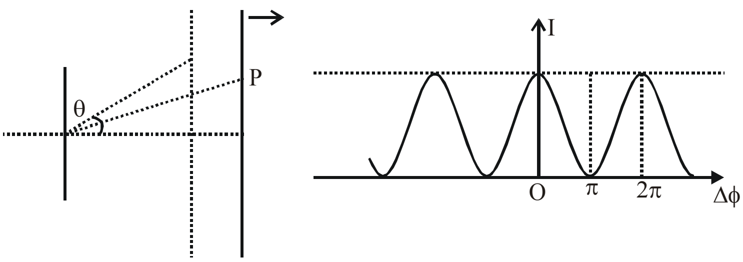


3. **Ans. (B)**

Sol. No. of fringes shift (N) $= \frac{t}{\lambda}(\mu - 1) = \frac{(1.6-1)\times1.8\times10^{-5}}{900\times10^{-9}} = 12$

4. **Ans. (C)**

Sol.

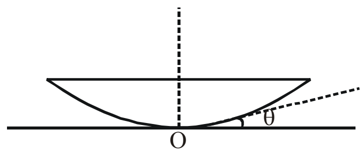


$I = I_{max}\cos^2\left(\frac{\pi}{\lambda} d \sin\theta\right)$

θ decreases & hence I increases.

5. **Ans. (A)**

Sol. $\beta = \dfrac{\lambda}{2\mu\theta}$



$\beta = \dfrac{\lambda}{2\theta}$

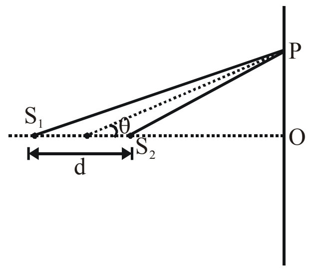
θ increases as we move from point O. Hence β decreases.

6. **Ans. (C)**

Sol. $\Delta x = S_1P - S_2P = d\cos\theta$

$d\cos\theta = n\lambda$ (maxima)

$d\cos\theta = \left(n + \dfrac{1}{2}\right)\lambda$ (minima)



$\cos\theta = \dfrac{\left(n + \dfrac{1}{2}\right)\lambda}{d}$

For d = 4.3 l

$\cos\theta = \dfrac{\left(n + \dfrac{1}{2}\right)\lambda}{4.3\lambda} = \dfrac{\left(n + \dfrac{1}{2}\right)}{4.3}$

n = 0, 1, 2, 3

4 minimas above 0 & 4 minimas below 0

∴ Total no. of minimas is 8

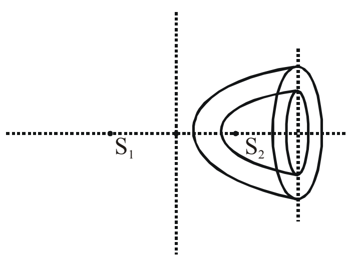
At 0, θ = 0°, d = nλ (maxima)

At 0, θ = 0°, d = $\left(n + \dfrac{1}{2}\right)\lambda\left(\min ima\right)$

7. **Ans. (A)**

8. **Ans. (D)**

Sol.

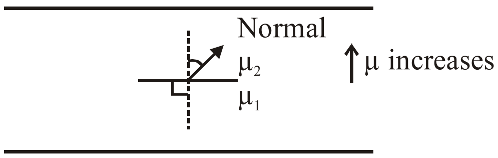


9. **Ans. (A)**

Sol. Factual question

10. **Ans. (B)**

Sol.



$\mu_2 > \mu_1$

$\therefore$ light bends towards normal

$\therefore$ light beam bends upwards (as $\mu\uparrow$ with height)

11. **Ans. (D)**

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

$\lambda_R > \lambda_a > \lambda_B$

Multiple Correct Answer Type 2 Q. [4 M (–1)]

12. **Ans. (B,C,D)**

Sol. $\beta = \frac{\lambda}{2\mu\theta}$

13. **Ans. (A,B)**

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

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

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

$n = 0$ only one maxima

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

$\lambda < d < 2\lambda$

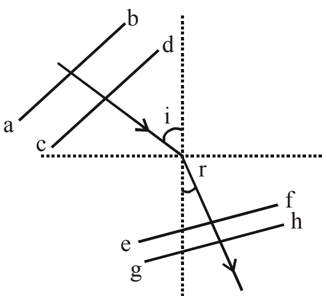
$n = 0, 1$

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

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

14. **Ans. (A)**

Sol.



15. Ans. (C)

Sol. $\phi_a = \phi_b$

$\phi_c = \phi_d$

$\phi_e = \phi_f$

$\phi_g = \phi_h$

$\phi_c - \phi_e = \phi_d - \phi_f$

16. Ans. (B)

Sol. $\mu = \frac{C}{v}$

SECTION-II

Numerical Answer Type Question **3 Q. [3(0)]**

(upto second decimal place)

1. Ans. 1.25

Sol. $\Delta X = 2\ \mu t$

For destructive interference

$2\mu t = \lambda/2$

$\mu = \frac{\lambda}{4t} = 1.25$

2. Ans. 0.2 mm

Sol. $0.75\ I_{max} = I = I_{max}\cos^2\frac{\Delta\phi}{2}$

$\cos\frac{\Delta\phi}{2} = \frac{\sqrt{3}}{2}$

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

$\frac{2\pi}{\lambda} d\sin\theta = \frac{\pi}{3}$

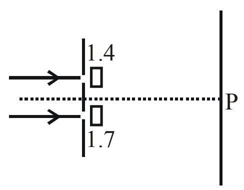
$\frac{d(\Delta y)}{D} = \frac{1}{6}(\lambda)$

$\Delta y = \frac{D\lambda}{6d}$

3. Ans. 9.3 μm

Sol. $\frac{3}{4} = \cos^2\frac{\Delta\phi}{2}$

$\Delta\phi = 2n\pi + \frac{\pi}{3}$ $\left(n + \frac{1}{2}\right)\lambda$



5^{th} max & 6^{th} min

phase diff : 10π & 11π

$\frac{2\pi}{\lambda}(\mu_2 - \mu_1)t = \Delta\phi = 10\pi + \frac{\pi}{3}$ is acceptable

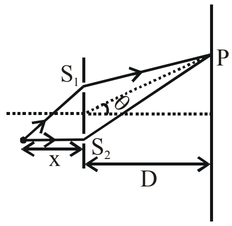
$t = \frac{31\pi}{3}\frac{x\lambda}{x2\pi\times(\mu - \mu_1)} = \frac{31}{3}\times 5400\times 10^{-10}$

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **2 Q. [4 M (0)]**

1. Ans. 7

Sol. $S_2P + x - (S_1P + \sqrt{(0.01)^2 + x^2}) = 0$



$(d\sin\theta + x)^2 = (0.01)^2 + x^2$

$(d\sin\theta)^2 + 2dx\sin\theta = 10^{-4} \times 1$

$$2 \times 1 \times 10^{-2} \times x \times \frac{y}{D} = 10^{-4}$$

$$y = \frac{10^{-2}}{2} \times \frac{1}{x}$$

$$y = 5 \times 10^{-3} \times \frac{1}{x}$$

$$\frac{dy}{dt} = -\frac{5 \times 10^{-3}}{x^2}\frac{dx}{dt}$$

$$\frac{dy}{dt} = -\frac{5}{(0.5)^2} \times 10^{-3} \times 1 \times 10^{-3}$$

$$= -\frac{1}{5} \times 10^2 \times 10^{-6} = -0.2 \times 10^{-4}$$

$$\frac{dy}{dt} = -2 \times 10^{-5}$$

$\alpha = 2, \beta = 5$

$\alpha + \beta = 7$

2. Ans. 5

Sol. When source is at infinite

Path difference = $S_1P - S_2P$

$$\sqrt{D^2 + d^2} - D = \frac{1}{2}\frac{d^2}{D}$$

For maxima $\frac{1}{2}\frac{d^2}{D} = n_1\lambda$

$$\frac{1}{2} \times \frac{4 \times 10^{-6}}{\frac{8}{5}m} = n_1 \times 5 \times 10^{-7}$$

$\Rightarrow n_1 = 2.5$

$$\left(S_2S_1 + \sqrt{D^2 + d^2}\right) - S_2P$$

$$\Rightarrow 2 \times 10^{-3} + \frac{1}{2}\frac{d^2}{D}$$

For max $2 \times 10^{-3} + \frac{1}{2}\frac{d^2}{D} = n_2 \times 5 \times 10^{-7}$

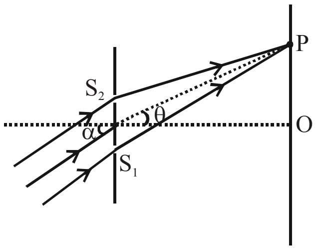
$\Rightarrow n_2 = 4002.5$
i.e. number of miximas = $n_2 - n_1$
$= 4000 = 3995 + n$
$n = 5$

SECTION-IV

Matrix Match Type (4 × 5) 4 Q. [8 M (for each entry +2(0)]

1. Ans. (A) (PRST); (B) (QRST); (C) (R); (D) (PRST)

Sol. (A)



$S_1P - (S_2P + d \sin \alpha) = n\lambda$
$d\sin\theta - d \sin \theta = 0$
$\theta = \alpha$
After introduction of sheet
$-(\mu - 1)t + d \sin \theta - d \sin \alpha = 0$
when $\theta = 0, -(\mu - 1)t = d \sin \alpha$
not possible

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

* $d \sin \theta - d \sin \alpha = (n + \frac{1}{2}) \lambda$: Minima

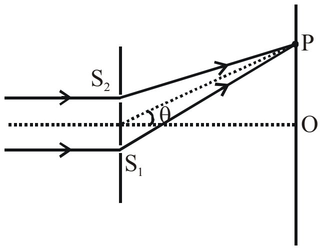
* Put n = 0 in above equation

$d \sin \theta - d \sin \alpha = \frac{\lambda}{2}$: Least order minima

(B) * $S_1P + (\mu_1 - 1)t - [S_2P + (\mu_2 - 1)t] = n\lambda$
$d\sin \theta + (\mu_1 - \mu_2)t = n\lambda$
$n = 0$
$d\sin\theta = -(\mu_1 - \mu_2)t$
zero order max. lies below O
* $d \sin \theta + (\mu' - 1)t' - (\mu_2 - \mu_1) t = 0$
for $\theta = 0°$
$(\mu' - 1)t' = (\mu_2 - \mu_1)t$

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

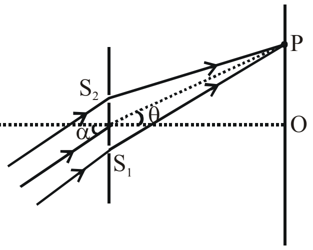
* Point O can be minima
* Point O can be least order minima

(C) 

* $S_1P - [S_2P + (\mu - 1)t] = n\lambda$
$d\sin\theta - (\mu - 1)t = 0$: CBF

$\sin\theta = \frac{(\mu-1)t}{d}$: CBF

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

(D) 

2. **Ans. (A) - (P); (B) - (R); (C) - (P); (D) - (S)**

Sol. Path difference for

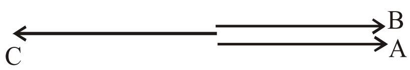
$\Delta x_{AB} \frac{2d^2}{D}$ $\Delta x_{AC} \frac{9d^2}{2D}$

(A)If $\frac{d^2}{D} = \lambda$ then

$\Delta x_{AB} = 2\lambda$ $\Delta x_{AC} = \frac{9}{2}\lambda$

$\Delta\phi_{AB} = \frac{2\pi}{\lambda} \times 2\lambda$ $\Delta\phi_{AC} = \frac{2\pi}{\lambda} \times \frac{9}{2}\lambda = 9\pi$

$= 4\pi$

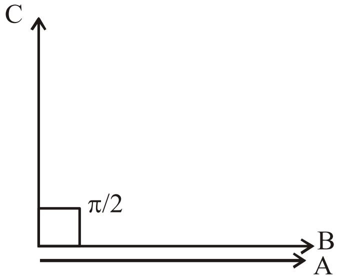


$\boxed{I_R = I_0}$

(B)If $\frac{d^2}{D} = \frac{\lambda}{2}$

$\Delta x_{AB} = 2 \times \frac{\lambda}{2} = \lambda$ $\Delta x_{AC} = \frac{9}{2} \times \frac{\lambda}{2} = \frac{9\lambda}{4}$

$\Delta\phi_{AB} = \frac{2\pi}{\lambda} \times \lambda = 2\pi$ $\Delta\phi_{AC} = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda} \times \frac{9\lambda}{4} = \frac{9\pi}{2}$

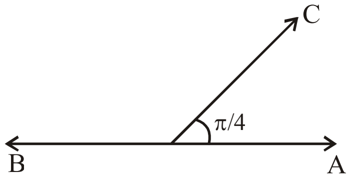


$\boxed{I_R = 5I_0}$

(C) If $\dfrac{d^2}{D} = \dfrac{\lambda}{4}$

$\Delta x_{AB} = 2 \times \dfrac{\lambda}{4} = \dfrac{\lambda}{2}$ $\quad$ $\Delta x_{AC} = \dfrac{9}{2} \times \dfrac{\lambda}{4} = \dfrac{9\lambda}{8}$

$\Delta\phi_{AB} = \dfrac{2\pi}{\lambda} \times \dfrac{\lambda}{2} = \pi$ $\quad$ $\Delta\phi_{AC} = \dfrac{2\pi}{\lambda} \times \dfrac{9\lambda}{8} = \dfrac{9\pi}{4}$

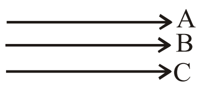


$\boxed{I_R = I_O}$

(D) If $\dfrac{d^2}{D} = 2\lambda$

$\Delta x_{AB} = 2 \times 2\lambda = 4\lambda$ $\quad$ $\Delta x_{AC} = \dfrac{9}{2} \times 2\lambda = 9\lambda$

$\Delta\phi = \dfrac{2\pi}{\lambda} \times 4\lambda = 8\lambda$ $\quad$ $\Delta\phi_{AC} = \dfrac{2\pi}{\lambda} 9\lambda = 18\pi$



$\boxed{I_R = 9I_O}$

3. Ans. (A) (R) ; (B) (R) ; (C) (S) ; (D) (P)

Sol. (A) $\Delta x = (\mu_B - 1)t$

$= (2.5 - 1) \times 1.5 \times 10^{-6}$

$\Delta x = 1.5 \times 1.5 \times 10^{-6}$

$\Delta x = 2.25 \times 10^{-6} = \left(n + \dfrac{1}{2}\right) \times 5 \times 10^{-7}$

$22.5 = (n + 0.5)5$

$4.5 = n + 0.5$

$n = 4$

(B) $\Delta x = (\mu_A - 1)t_A - (\mu_C - 1)t_C$

$= [(1.5 - 1) \times 5 - (2 - 1) \times 0.25] \times 10^{-6}$

$\Delta x = (0.5 \times 5 - 0.25] \times 10^{-6} = 0$

CBF is obtained at P

(C) $\Delta x = (\mu_A - 1)t_A - \{(\mu_B - 1)t_B + (\mu_C - 1)t_C\}$

(D) $\Delta x = [(\mu_A - 1)t_A + (\mu_C - 1)t_C] - (\mu_B - 1)t_B$

4. Ans. (A) p, s ; (B) q ; (C) t ; (D) r,s,t

Sol. (A) $\Delta x = S_2P - S_1P = 0$

$$\delta(P_0) = \frac{2\pi}{\lambda}\Delta x = 0$$

$$\Delta x = S_1P_1 - S_2P_1 = \frac{\lambda}{4}$$

$$\delta(P_1) = \frac{2\pi}{\lambda}\times\frac{\lambda}{4} = \frac{\pi}{2}$$

$$I = I_{max}\cos^2\left(\frac{\Delta\phi}{2}\right)$$

$$I(P_1) = I_1 = I_{max}\cos^2\frac{\delta}{2} = \frac{I_{max}}{2}$$

$$\delta(P_2) = \frac{2\pi}{\lambda}\times\frac{\lambda}{3} = \frac{2\pi}{3}$$

$$I(P_2) = I_2 = I_{max}\cos^2\frac{\pi}{3} = \frac{I_{max}}{4}$$

$I(P_0) > I(P_1)$

(B) $\Delta x = S_1P - [S_2P + (\mu - 1)t]$

$\Delta x_1 = S_1P_1 - S_2P_1 - (\mu - 1)t$

$$\Delta x_1 = \frac{\lambda}{4} - \frac{\lambda}{4} = 0$$

$8(P_1) = 0$; $I(P_1) = I_{max}$

$$8(P_0) = \frac{\pi}{2}\ \delta(P_0) \neq 0$$

$I(P_0) = I_{max}/2$

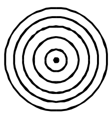
$\Delta x = S_1P_2 - S_1P_2 - (\mu - 1)t$

$$= \frac{\lambda}{3} - \frac{\lambda}{4} = \frac{\lambda}{12}$$

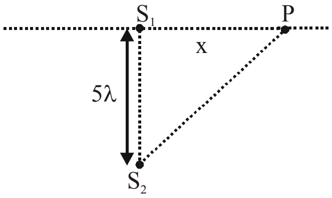
$$8(P_2) = \frac{2\pi}{\lambda}\times\frac{\lambda}{12} = \frac{\pi}{6}$$

$$I(P_2) = I_{max}\cos^2\left(\frac{\pi}{12}\right)$$

Subjective Type 5 Q. [4 M (0)]

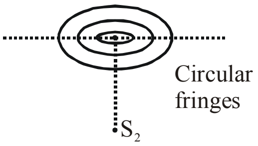
1. Ans. 48, 21, $\frac{32}{3}$, $\frac{9}{2}$, 0 m.m.; 

Sol.



$S_2P - S_1P = n\lambda$

$\sqrt{(5\lambda)^2 + x^2} - x = n\lambda$



2. **Ans.** $I_0 = I\sec^2\left[\frac{\pi(\mu-1)t}{\lambda}\right]$

Sol. $I_R = I_{max}\cos^2\left(\frac{\Delta\phi}{2}\right)$

$I_R = I_{max}$

$I = I_{R'} = I_{max}\cos^2\frac{(\mu-1)t}{2}$

$I_{max} = I\sec^2\frac{(\mu-1)t}{2}$

3. **Ans.** (i) y = 2 cm, (ii) m = 1.0016

Sol. $d\sin\theta - d\sin\alpha = 0$

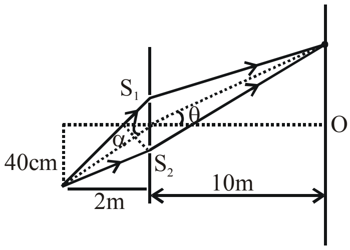
$\theta = \alpha$

$\tan\theta = \tan\alpha = \frac{40}{200} = \frac{1}{5}$

$y = \frac{1}{5}\times 10 = 2cm$

$(\mu - 1)t = d\sin\alpha$

$\mu = \frac{d\sin\alpha}{t} + 1$



4. **Ans.** (i) 1 mm (ii) increase

Sol. $OA = y = \frac{3D\lambda}{d}$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} - \frac{1}{15} = \frac{1}{30}$

v = 30 cm

D = 1.30 – 0.30

D = 1.00 m

$d_0 = m = \frac{v}{u} = \frac{30}{15} = 2$

$d_0 = 2 \times 0.5 \text{ mm} = 0.5 \text{ mm}$

$d = 0.5 + 2d_0 = 1.5 \text{ mm}$

$OA = \frac{3 \times 1 \times 5 \times 10^{-7}}{1.5 \times 10^{-3}}$

$OA = 10 \times 10^{-4}$

$OA = 1\text{mm}$

5. **Ans.** (a) $-\hat{j}$ (b) 3.5 m (b) 86 MHz (c) 10.3 nT (e) $\{(10.3 \text{ nT}) \cos [(1.8 \text{ rad/m}) y + (5.4 \times 10^8 \text{ rad/s})t]\} \hat{k}$