

**EXERCISE (S-1)**

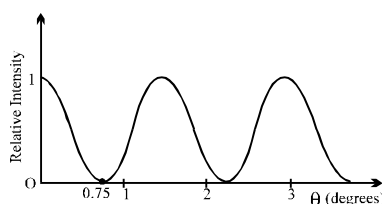
1. In a Young's double slit experiment for interference of light, the slits are 0.2 cm apart and are illuminated by yellow light ( $\lambda = 600$  nm). What would be the fringe width on a screen placed 1 m from the plane of slits if the whole system is immersed in water of index  $4/3$ ?

**WO0001**

2. In Young's double slit experiment the slits are 0.5 mm apart and the interference is observed on a screen at a distance of 100 cm from the slit. It is found that the 9th bright fringe is at a distance of 7.5 mm from the second dark fringe from the centre of the fringe pattern on same side. Find the wavelength of the light used.

**WO0002**

3. Light of wavelength 520 nm passing through a double slit, produces interference pattern of relative intensity versus angular position  $\theta$  as shown in the figure. Find the separation  $d$  between the slits.

**WO0003**

4. In a Young's double slit experiment, two wavelengths of 500 nm and 700 nm were used. What is the minimum distance from the central maximum where their maxima coincide again? (Take  $D/d = 10^3$ . Symbols have their usual meanings.)

**[IIT-JEE 2004]****WO0004**

5. 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.

**WO0005**

6. The distance between two slits in a YDSE apparatus is 3 mm. The distance of the screen from the slits is 1 m. Microwaves of wavelength 1 mm are incident on the plane of the slits normally. Find the distance of the first maxima on the screen from the central maxima. Also find the total number of maxima on the screen.

**WO0006**

7. One slit of a double slit experiment is covered by a thin glass plate of refractive index 1.4 and the other by a thin glass plate of refractive index 1.7. The point on the screen, where central bright fringe was formed before the introduction of the glass sheets, is now occupied by the 5<sup>th</sup> bright fringe. Assuming that both the glass plates have same thickness and wavelength of light used is  $4800 \text{ \AA}$ , find their thickness.

**WO0007**

8. A monochromatic light of  $\lambda = 5000 \text{ \AA}$  is incident on two slits separated by a distance of  $5 \times 10^{-4} \text{ m}$ . The interference pattern is seen on a screen placed at a distance of 1 m from the slits. A thin glass plate of thickness  $1.5 \times 10^{-6} \text{ m}$  & refractive index  $\mu = 1.5$  is placed between one of the slits & the screen. Find the intensity at the centre of the screen, if the intensity there is  $I_0$  in the absence of the plate. Also find the lateral shift of the central maximum.

**WO0008**

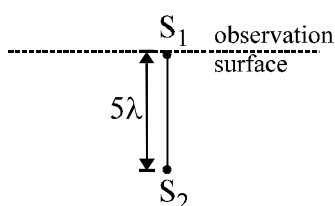
9. In a biprism experiment with sodium light, bands of width 0.0195 cm are observed on screen at 100cm from slit. On introducing a convex lens 30 cm away from the slit between biprism and screen, two images of the slit are seen 0.7 cm apart on screen. Calculate the wavelength of sodium light.

**WO0009**

10. A long narrow horizontal slit lies 1mm above a plane mirror as in Lloyd's mirror. The interference pattern produced by the slit and its image is viewed on a screen distant 1m from the slit. The wavelength of light is 600nm. Find the distance of first maximum above the mirror.

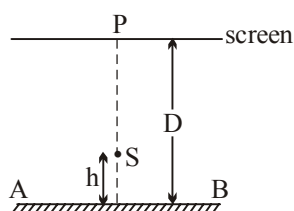
**WO0010**

11. Two microwave coherent point sources emitting waves of wavelength  $\lambda$  are placed at  $5\lambda$  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  $\lambda$  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.

**WO0011**

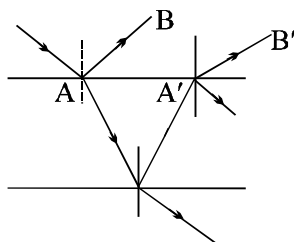
12. A point source  $S$  emitting light of wavelength  $600\text{ nm}$  is placed at a very small height  $h$  above the flat reflecting surface  $AB$  (see figure). The intensity of the reflected light is  $36\%$  of the incident intensity. Interference fringes are observed on a screen placed parallel to the reflecting surface at a very large distance  $D$  from it. [IIT-JEE 2002]

- What is the shape of the interference fringes on the screen?
- Calculate the ratio of the minimum to the maximum intensities in the interference fringes formed near the point  $P$  (shown in the figure).
- If the intensities at point  $P$  corresponds to a maximum, calculate the minimum distance through which the reflecting surface  $AB$  should be shifted so that the intensity at  $P$  again becomes max.



WO0012

13. A ray of light of intensity  $I$  is incident on a parallel glass-slab at a point  $A$  as shown in figure. It undergoes partial reflection and refraction. At each reflection  $20\%$  of incident energy is reflected. The rays  $AB$  and  $A'B'$  undergo interference. Find the ratio  $I_{\max}/I_{\min}$ . [Neglect the absorption of light]



WO0013

**EXERCISE (S-2)**

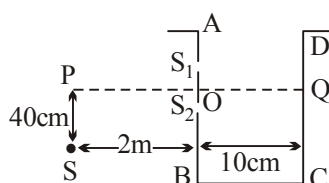
1. A thin glass plate of thickness  $t$  and refractive index  $\mu$  is inserted between screen & one of the slits in a Young's experiment. If the intensity at the centre of the screen is  $I$ , what was the intensity at the same point prior to the introduction of the sheet.

**WO0014**

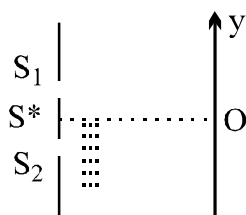
2. In Young's experiment, the source is red light of wavelength  $7 \times 10^{-7} \text{ m}$ . When a thin glass plate of refractive index 1.5 at this wavelength is put in the path of one of the interfering beams, the central bright fringe shifts by  $10^{-3} \text{ m}$  to the position which was previously occupied by the 5<sup>th</sup> bright fringe. Find the thickness of the plate. When the source is now changed to green light of wavelength  $5 \times 10^{-7} \text{ m}$ , the central fringe shifts to a position initially occupied by the 6<sup>th</sup> bright fringe due to red light without the plate. Find the refractive index of glass for the green light. Also estimate the change in fringe width due to the change in wavelength.

**[IIT-JEE 1997 C]****WO0015**

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]****WO0016**

4. The Young's double slit experiment is done in a medium of refractive index  $4/3$ . A light of  $600\text{ nm}$  wavelength is falling on the slits having  $0.45\text{ mm}$  separation. The lower slit  $S_2$  is covered by a thin glass sheet of thickness  $10.4\text{ }\mu\text{m}$  and refractive index  $1.5$ . The interference pattern is observed on a screen placed  $1.5\text{ m}$  from the slits as shown [IIT-JEE'99]
- (i) Find the location of the central maximum (bright fringe with zero path difference) on the  $y$ -axis.
- (ii) Find the light intensity at point  $O$  relative to the maximum fringe intensity.
- (iii) Now, if  $600\text{ nm}$  light is replaced by white light of range  $400$  to  $700\text{ nm}$ , find the wavelengths of the light that form maxima exactly at point  $O$ . [All wavelengths in this problem are for the given medium of refractive index  $4/3$ . Ignore dispersion]

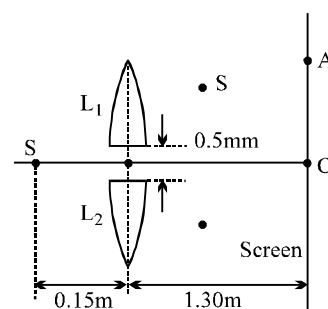


WO0017

5. 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  $5400\text{ }\text{\AA}$ . 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]

WO0018

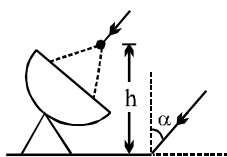
6. In the figure shown  $S$  is a monochromatic point source emitting light of wavelength  $\lambda = 500\text{ nm}$ . A thin lens of circular shape and focal length  $0.10\text{ m}$  is cut into two identical halves  $L_1$  and  $L_2$  by a plane passing through a diameter. The two halves are placed symmetrically about the central axis  $SO$  with a gap of  $0.5\text{ mm}$ . The distance along the axis from  $S$  to  $L_1$  and  $L_2$  is  $0.15\text{ m}$ , while that from  $L_1$  &  $L_2$  to  $O$  is  $1.30\text{ m}$ . 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  $0.5\text{ mm}$ , will the distance  $OA$  increase, decrease or remain the same?

WO0019

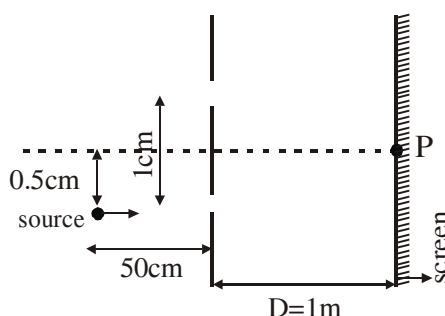
7. Radio waves coming at angle  $\alpha$  to vertical are received by a radar after reflection from a nearby water surface & directly. What should be height of antenna from water surface so that it records a maximum intensity. (wavelength =  $\lambda$ ).

**WO0020**

8. One radio transmitter  $A$  operating at 60.0 MHz is 10.0 m from another similar transmitter  $B$  that is  $180^\circ$  out of phase with transmitter  $A$ . How far must an observer move from transmitter  $A$  toward transmitter  $B$  along the line connecting  $A$  and  $B$  to reach the nearest point where the two beams are in phase?

**WO0021**

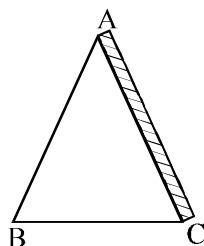
9. In a typical Young's double slit experiment a point source of monochromatic light is kept as shown in the figure. If the source is given an instantaneous velocity  $v = 1$  mm per second towards the screen, then the instantaneous velocity of central maxima is given as  $\alpha \times 10^{-\beta}$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

**WO0022**

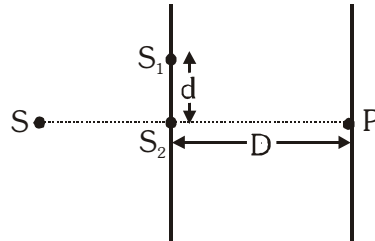
10. A prism ( $\mu_p = \sqrt{3}$ ) has an angle of prism  $A = 30^\circ$ . A thin film ( $\mu_f = 2.2$ ) is coated on face  $AC$  as shown in the figure. Light of wavelength 550 nm is incident on the face  $AB$  at  $60^\circ$  angle of incidence. Find

**[IIT-JEE 2003]**

- (i) the angle of its emergence from the face  $AC$  and  
(ii) the minimum thickness (in nm) of the film for which the emerging light is of maximum possible intensity.

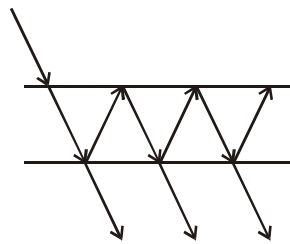
**WO0023**

11. In a YDSE experiment two slits  $S_1$  and  $S_2$  have separation of  $d = 2 \text{ mm}$ . The distance of the screen is  $D = 8/5 \text{ m}$ . 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  $500 \text{ nm}$ . 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  $n$ .



WO0024

12. A narrow beam of light has entered a large thin glass plate. Each refraction is accompanied by reflection of one third of the beam's energy. What percentage of the light energy is transmitted through the plate?

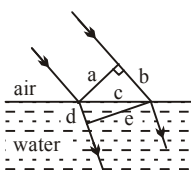


WO0025

## EXERCISE (O-1)

### SINGLE CORRECT TYPE QUESTIONS

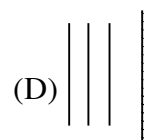
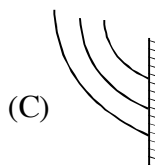
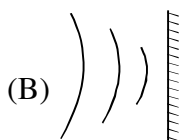
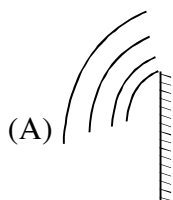
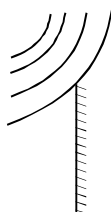
1. Figure shows plane waves refracted from air to water using Huygen's principle (where a, b, c, d, e are lengths on the diagram). The refractive index of water wrt air is the ratio :-



- (A)  $a/e$                       (B)  $b/e$                       (C)  $b/d$                       (D)  $d/b$

WO0026

2. Spherical wavefronts shown in figure, strike a plane mirror. Reflected wavefronts will be as shown in



WO0027

3. Two beams of light having intensities  $I$  and  $4I$  interfere to produce a fringe pattern on a screen. The phase difference between the beams is  $\pi/2$  at point A and  $\pi$  at point B. Then the difference between the resultant intensities at A and B is : [IIT-JEE (Scr.) 2001]

- (A)  $2I$                       (B)  $4I$                       (C)  $5I$                       (D)  $7I$

WO0028

4. In a young 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, number of fringes observed in the same segment of the screen is given by [IIT-JEE (Scr.) 2001]

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

WO0029



5. Two coherent monochromatic light beams of intensities  $I$  and  $4I$  are superposed. The maximum and minimum possible intensities in the resulting beam are :
- (A)  $5I$  and  $I$                       (B)  $5I$  and  $3I$                       (C)  $9I$  and  $I$                       (D)  $9I$  and  $3I$

WO0030

6. When light is refracted into a denser medium,
- (A) its wavelength and frequency both increase  
 (B) its wavelength increases but frequency remains unchanged  
 (C) its wavelength decreases but frequency remains unchanged  
 (D) its wavelength and frequency both decrease.

WO0031

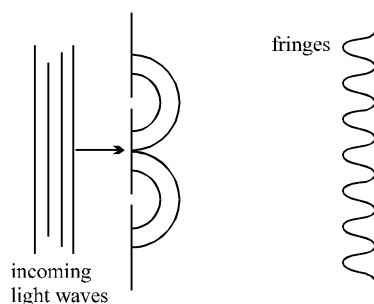
7. In YDSE how many maxima can be obtained on the screen if wavelength of light used is  $200\text{nm}$  and  $d = 700\text{ nm}$ :
- (A) 12                      (B) 7                      (C) 18                      (D) none of these

WO0032

8. In a YDSE, the central bright fringe can be identified :
- (A) as it has greater intensity than the other bright fringes.  
 (B) as it is wider than the other bright fringes.  
 (C) as it is narrower than the other bright fringes.  
 (D) by using white light instead of single wavelength light.

WO0033

9. In a Young's double slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which of the following changes would cause the observed fringes to be more closely spaced?



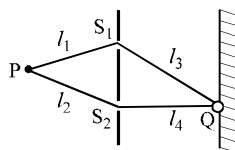
- (A) Reducing the separation between the slits  
 (B) Using blue light instead of green light  
 (C) Used red light instead of green light  
 (D) Moving the light source further away from the slits.

WO0034

10. In Young's double slit experiment, the wavelength of red light is  $7800\text{ \AA}$  and that of blue light is  $5200\text{ \AA}$ . The value of  $n$  for which  $n^{\text{th}}$  bright band due to red light coincides with  $(n + 1)^{\text{th}}$  bright band due to blue light, is :
- (A) 1                      (B) 2                      (C) 3                      (D) 4

WO0035

11. Two identical narrow slits  $S_1$  and  $S_2$  are illuminated by light of wavelength  $\lambda$  from a point source P. If, as shown in the diagram, the light is then allowed to fall on a screen, and if  $n$  is a positive integer, the condition for destructive interference at  $Q$  is :-



- (A)  $(\ell_1 - \ell_2) = (2n + 1)\lambda/2$  (B)  $(\ell_3 - \ell_4) = (2n + 1)\lambda/2$   
 (C)  $(\ell_1 + \ell_2) - (\ell_3 + \ell_4) = n\lambda$  (D)  $(\ell_1 + \ell_3) - (\ell_2 + \ell_4) = (2n + 1)\lambda/2$

WO0036

12. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude  $A$  and wavelength  $\lambda$ . In another experiment with the same setup the two slits are sources of equal amplitude  $A$  and wavelength  $\lambda$  but are incoherent. The ratio of the average intensity of light at the midpoint of the screen in the first case to that in the second case is :-

- (A) 1 : 1 (B) 2 : 1 (C) 4 : 1 (D) none of these

WO0037

13. In a Young's double slit experiment, a small detector measures an intensity of  $I$  units at the centre of the fringe pattern. If one of the two (identical) slits is now covered, the measured intensity will be :-

- (A)  $2I$  (B)  $I$  (C)  $I/4$  (D)  $I/2$

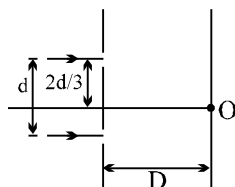
WO0038

14. In a Young's double slit experiment  $D$  equals the distance of screen and  $d$  is the separation between the slit. The distance of the nearest point to the central maximum where the intensity is same as that due to a single slit, is equal to :-

- (A)  $\frac{D\lambda}{d}$  (B)  $\frac{D\lambda}{2d}$  (C)  $\frac{D\lambda}{3d}$  (D)  $\frac{2D\lambda}{d}$

WO0039

15. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the white spot on the screen from  $O$  is [Assume  $d \ll D$ ,  $\lambda \ll d$ ]



- (A) 0 (B)  $d/2$  (C)  $d/3$  (D)  $d/6$

WO0040

16. In the above question if the light incident is monochromatic and point  $O$  is a maxima, then the wavelength of the light incident cannot be :-

(A)  $d^2/3D$  (B)  $d^2/6D$  (C)  $d^2/12D$  (D)  $d^2/18D$

WO0041

17. In a YDSE bi-chromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0.1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is :- [IIT-JEE' 2004 (Scr)]

(A) 4 mm (B) 5.6 mm (C) 14 mm (D) 28 mm

WO0042

18. In Young's double slit arrangement, water is filled in the space between screen and slits. Then :

(A) fringe pattern shifts upwards but fringe width remains unchanged.  
 (B) fringe width decreases and central bright fringe shifts upwards.  
 (C) fringe width increases and central bright fringe does not shift.  
 (D) fringe width decreases and central bright fringe does not shift.

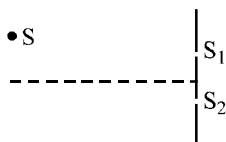
WO0043

19. Light of wavelength  $\lambda$  in air enters a medium of refractive index  $\mu$ . Two points in this medium, lying along the path of this light, are at a distance  $x$  apart. The phase difference between these points is :

(A)  $\frac{2\pi\mu x}{\lambda}$  (B)  $\frac{2\pi x}{\mu\lambda}$  (C)  $\frac{2\pi(\mu-1)x}{\lambda}$  (D)  $\frac{2\pi x}{(\mu-1)\lambda}$

WO0044

20. In YDSE, the source placed symmetrically with respect to the slit is now moved parallel to the plane of the slits so that it is closer to the upper slit, as shown. Then,



(A) the fringe width will increase and fringe pattern will shift down.  
 (B) the fringe width will remain same but fringe pattern will shift up.  
 (C) the fringe width will decrease and fringe pattern will shift down.  
 (D) the fringe width will remain same but fringe pattern will shift down.

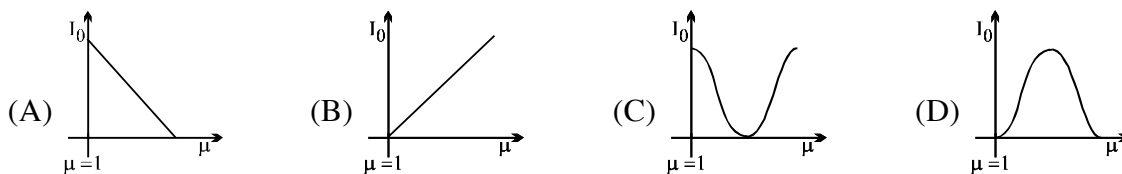
WO0045

21. 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  $\lambda$ ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is :- [IIT-JEE 2002]

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

WO0046

22. 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  $\mu$  ( $\mu \geq 1$ ) will be best represented by [Assume slits of equal width and there is no absorption by slab]

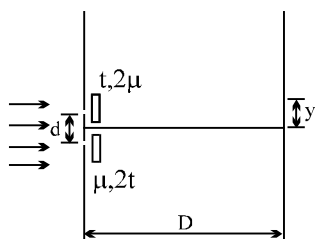
**WO0047**

23. In a Young's double-slit experiment, let A and B be the two slits. Films of thicknesses  $t_A$  and  $t_B$  and refractive indices  $\mu_A$  and  $\mu_B$ , are placed in front of A and B respectively. If  $\mu_A t_A = \mu_B t_B$ , the central maximum will :

- (A) not shift (B) shift towards A  
(C) shift towards B (D) option (B), if  $t_B > t_A$ ; option (C) if  $t_B < t_A$

**WO0048**

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



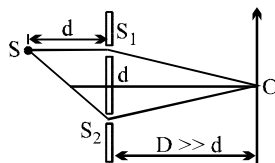
- (A) zero (B)  $\frac{tD}{d}$  (C)  $-\frac{tD}{d}$  (D) None

**WO0049**

25. In a double slit experiment, when the width of one slit is made twice as wide as the other in compared to normal YDSE having slits of equal width. Then, in the interference pattern [IIT-JEE(Scr.) 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.

**WO0050**

26. To make the central fringe at the centre  $O$ , a mica sheet of refractive index 1.5 is introduced. Choose the correct statements (s).



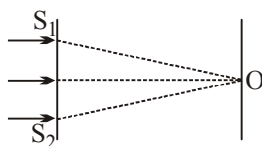
- (A) The thickness of sheet is  $2(\sqrt{2} - 1)d$  in front of  $S_1$ .  
 (B) The thickness of sheet is  $(\sqrt{2} - 1)d$  in front of  $S_2$ .  
 (C) The thickness of sheet is  $2\sqrt{2}d$  in front of  $S_1$ .  
 (D) The thickness of sheet is  $(2\sqrt{2} - 1)d$  in front of  $S_1$ .

WO0051

27. **Statement-1 :** In YDSE, as shown in figure, central bright fringe is formed at  $O$ . If a liquid is filled between plane of slits and screen, the central bright fringe is shifted in upward direction.

and

**Statement-2 :** If path difference at  $O$  increases, y-coordinate of central bright fringe will change.



- (A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.  
 (B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.  
 (C) Statement-1 is true, statement-2 is false.  
 (D) Statement-1 is false, statement-2 is true.

WO0052

28. **Statement-1 :** In glass, red light travels faster than blue light.

and

**Statement-2 :** Red light has a wavelength longer than blue.

- (A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.  
 (B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.  
 (C) Statement-1 is true, statement-2 is false.  
 (D) Statement-1 is false, statement-2 is true.

WO0053

29. **Statement-1** : In standard YDSE set up with visible light, the position on screen where phase difference is zero appears bright.

**and**

**Statement-2** : In YDSE set up magnitude of electromagnetic field at central bright fringe is not varying with time.

- (A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.  
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.  
(C) Statement-1 is true, statement-2 is false.  
(D) Statement-1 is false, statement-2 is true.

**WO0054**

30. **Statement-1** : In YDSE, the spacing between any two successive points having intensity half of the maximum intensity is same.

**and**

**Statement-2** : The intensity on the screen in YDSE varies uniformly with distance from central maximum.

- (A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.  
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.  
(C) Statement-1 is true, statement-2 is false.  
(D) Statement-1 is false, statement-2 is true.

**WO0055**

31. In a double slit experiment, the separation between the slits is  $d = 0.25$  cm and the distance of the screen  $D = 100$  cm from the slits. If the wavelength of light used is  $\lambda = 6000\text{\AA}$  and  $I_0$  is the intensity of the central bright fringe, the intensity at a distance  $x = 4 \times 10^{-5}$  m from the central maxima is :-

- (A)  $I_0$                       (B)  $I_0/2$                       (C)  $3I_0/4$                       (D)  $I_0/3$

**WO0056**

32. Imagine a Young's double slit interference experiment performed with waves associated with fast moving electrons produced from an electron gun. The distance between successive maxima will decrease the most if :-

- (A) the accelerating voltage in the electron gun is decreased  
(B) the accelerating voltage is increased and the distance of the screen from the slits is decreased  
(C) the distance of the screen from the slits is increased.  
(D) the distance between the slits is decreased.

**WO0057**

33. Two monochromatic and coherent point sources of light are placed at a certain distance from each other in the horizontal plane. The locus of all those points in the horizontal plane which have constructive interference will be
- (A) a hyperbola (B) family of hyperbolas  
(C) family of straight lines (D) family of parabolas

WO0058

### MULTIPLE CORRECT TYPE QUESTIONS

34. To observe a sustained interference pattern formed by two light waves, it is not necessary that they must have :
- (A) the same frequency (B) same amplitude  
(C) a constant phase difference (D) the same intensity

WO0059

35. As a wave propagates, [IIT-JEE 1999]
- (A) the wave intensity remains constant for a plane wave  
(B) the wave intensity decreases with distance from source and is proportional to inverse of the distance, for a spherical wave.  
(C) the wave intensity decreases with distance from source and proportional to inverse square of the distance, for a spherical wave.  
(D) total average power of the spherical wave over any spherical surface centered at the source remains same.

WO0060

36. In a YDSE apparatus, if we use white light then :
- (A) the fringe next to the central will be red (B) the central fringe will be white.  
(C) the fringe next to the central will be violet (D) there will not be a completely dark fringe.

WO0061

37. If the source of light used in a Young's Double Slit Experiment is changed from red to blue, then
- (A) the fringes will become brighter  
(B) consecutive fringes will come closer  
(C) the number of maxima formed on the screen increases  
(D) the central bright fringe will become a dark fringe.

WO0062

38. In a Young's double-slit experiment, let  $A$  and  $B$  be the two slits. A thin film of thickness  $t$  and refractive index  $\mu$  is placed in front of  $A$ . Let  $\beta$  = fringe width. The central maximum will shift :
- (A) towards  $A$  (B) towards  $B$  (C) by  $t(\mu - 1) \frac{\beta}{\lambda}$  (D) by  $\mu t \frac{\beta}{\lambda}$

WO0063

39. If one of the slits of a standard YDSE apparatus is covered by a thin parallel sided glass slab so that it transmit only one half of 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 be less bright and the dark ones will be more bright.  
 (D) the fringe width will remain unchanged.

**WO0064**

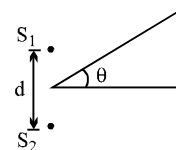
40. In an interference arrangement similar to Young's double-slit experiment, the slits  $S_1$  &  $S_2$  are illuminated with coherent microwave sources, each of frequency  $10^6$  Hz. The sources are synchronized to have zero phase difference. The slits are separated by a distance  $d = 150.0$  m. The intensity  $I(\theta)$  is measured as a function of  $\theta$  at a large distance from  $S_1$  &  $S_2$ , where  $\theta$  is defined as shown. If  $I_0$  is the maximum intensity then  $I(\theta)$  for  $0 \leq \theta \leq 90^\circ$  is given by :

(A)  $I(\theta) = \frac{I_0}{2}$  for  $\theta = 30^\circ$

(B)  $I(\theta) = \frac{I_0}{4}$  for  $\theta = 90^\circ$

(C)  $I(\theta) = I_0$  for  $\theta = 0^\circ$

(D)  $I(\theta)$  is constant for all values of  $\theta$ .

**WO0065**

41. In a standard YDSE apparatus, a thin film ( $\mu = 1.5$ ,  $t = 2.1 \mu\text{m}$ ) is placed in front of upper slit. How far above or below the centre point of the screen are two nearest maxima located? Take  $D = 1$  m,  $d = 1\text{mm}$ ,  $\lambda = 4500\text{\AA}$ . (Symbols have usual meaning)
- (A) 1.5 mm                      (B) 0.6 mm                      (C) 0.15 mm                      (D) 0.3 mm

**WO0066**

42. In a YDSE with two identical slits, when the upper slit is covered with a thin, perfectly transparent sheet of mica, the intensity at the centre of screen reduces to 75% of the initial value. Second minima is observed to be above this point and third maxima below it. Which of the following can be a possible value of phase difference caused by the mica sheet

(A)  $\frac{\pi}{3}$

(B)  $\frac{13\pi}{3}$

(C)  $\frac{17\pi}{3}$

(D)  $\frac{11\pi}{3}$

**WO0067**

43. A beam of 2000 eV electrons are incident normally on the surface of crystal whose inter atomic separation is 0.11 nm. The mass of the electron can be taken as  $9 \times 10^{-31}$  kg. At what angle to the normal can we observe a diffraction maxima.

(A)  $\sin^{-1}\left(\frac{1}{4}\right)$

(B)  $2 \cos^{-1}\left(\frac{1}{4}\right)$

(C)  $\sin^{-1}\left(\frac{1}{2}\right)$

(D)  $2 \cos^{-1}\left(\frac{1}{2}\right)$

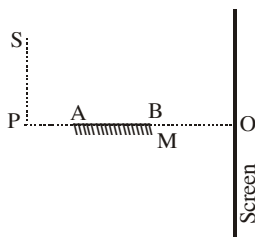
**WO0068**



## COMPREHENSION TYPE QUESTIONS

## Paragraph for Question No. 44 and 45

In an experiment on interference due to single mirror, a light wave emitted directly by the source  $S$  (narrow slit) interferes with the wave reflected from the mirror  $M$  of length 2 mm. Source and screen are separated by distance 90 cm. Source  $S$  is at the height of 3 mm, from the point  $P$  and the middle point of mirror is at distance of 2 mm from point  $P$ . Point  $P$  and mirror are in the same plane of screen is perpendicular to this plane.



44. If fringe width is 0.1 mm then what is the wavelength of light used?  
 (A)  $3.3 \times 10^{-7}$  m      (B)  $6.7 \times 10^{-7}$  m      (C)  $1.0 \times 10^{-7}$  m      (D)  $4 \times 10^{-7}$  m

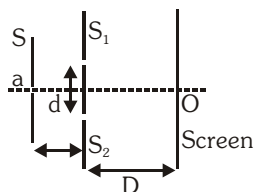
WO0069

45. If the mirror is shifted towards left then how does the fringe pattern on screen change?  
 (A) Fringe width decreases and the region in which interference is formed shifts downward.  
 (B) Fringe width decreases and region in which interference is formed shifts upwards  
 (C) Fringe width does not change and region in which interference is formed shifts upwards  
 (D) Fringe width does not change and region in which interference is formed shifts downwards

WO0069

## Paragraph for Question No. 46 to 48

The figure shows a schematic diagram showing the arrangement of Young's Double Slit Experiment



46. Choose the correct statement(s) related to the wavelength of light used  
 (A) Larger the wavelength of light larger the fringe width  
 (B) The position of central maxima depends on the wavelength of light used  
 (C) If white light is used in YDSE, then the violet colour forms its first maxima closest to the central maxima  
 (D) The central maxima of all the wavelengths coincide

WO0070

47. If the distance  $D$  is varied, then choose the correct statement(s)

- (A) The angular fringe width does not change  
 (B) The fringe width changes in direct proportion  
 (C) The change in fringe width is same for all wavelengths  
 (D) The position of central maxima remains unchanged

**WO0070**

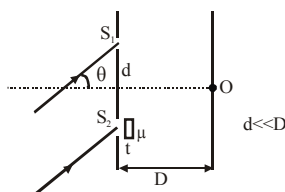
48. If the distance  $d$  is varied, then identify the correct statement(s)

- (A) The angular width does not change  
 (B) The fringe width changes in inverse proportion  
 (C) The positions of all maxima change  
 (D) The positions of all minima change

**WO0070**

**Paragraph for Question No. 49 to 51**

A monochromatic beam of light falls on Young's double slit experiment apparatus as shown in figure. A thin sheet of glass is inserted in front of lower slit  $S_2$ .



49. The central bright fringe can be obtained

- (A) at  $O$  only  
 (B) at  $O$  or below  $O$  only  
 (C) at  $O$  or above  $O$  only  
 (D) Anywhere on the screen

**WO0071**

50. If central bright fringe is obtained on screen at  $O$  :-

- (A)  $(\mu-1)t = d\sin\theta$       (B)  $(\mu-1)t = d\cos\theta$       (C)  $(\mu-1)t + d\sin\theta = 0$       (D)  $\frac{t}{\mu-1} = \frac{d}{\sin\theta}$

**WO0071**

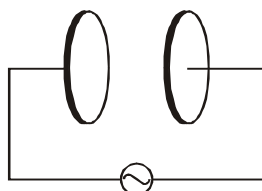
51. The phase difference between the waves interfering at fifth minima is

- (A)  $5\pi$       (B)  $7\pi$       (C)  $9\pi$       (D)  $11\pi$

**WO0071**

## SUPPLEMENT FOR JEE-MAINS

52. A parallel plate capacitor (fig.) made of circular plates each of radius  $R = 6.0$  cm has a capacitance  $C = 100 \mu\text{F}$ . The capacitor is connected to a 230 V ac supply with a (angular) frequency of  $300 \text{ rad s}^{-1}$ .
- What is the rms value of the conduction current?
  - Is the conduction current equal to the displacement current?
  - Determine the amplitude of  $B$  at a point 3.0 cm from the axis between the plates.



WO0072

53. The amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is  $B_0 = 510 \text{ nT}$ . What is the amplitude of the electric field part of the wave?

WO0073

54. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of  $2.0 \times 10^{10} \text{ Hz}$  and amplitude  $48 \text{ V m}^{-1}$ .
- What is the wavelength of the wave?
  - What is the amplitude of the oscillating magnetic field?
  - Show that the average energy density of the  $E$  field equals the average energy density of the  $B$  field. [ $c = 3 \times 10^8 \text{ m s}^{-1}$ ]

WO0074

55. Suppose that the electric field part of an electromagnetic wave in vacuum is

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

- What is the direction of propagation?
- What is the wavelength  $\lambda$ ?
- What is the frequency  $\nu$ ?
- What is the amplitude of the magnetic field part of the wave?
- Write an expression for the magnetic field part of the wave.

WO0075

56. A plane electromagnetic wave traveling in the positive direction of  $x$  axis in vacuum has components  $E_x = E_y = 0$  and  $E_z = (2.0 \text{ V/m}) \cos [(\pi \times 10^{15} \text{ S}^{-1})(t - x/c)]$ . (a) What is the amplitude of the magnetic field component? (b) Parallel to which axis does the magnetic field oscillate? (c) When the electric field component is in the positive direction of the  $z$  axis at a certain point  $P$ , what is the direction of the magnetic field component there?

WO0076

57. An open circuit consists of a  $12\ \mu\text{F}$  parallel plate capacitor charged to  $200\text{V}$  and a  $10\Omega$  resistor. At the instant when a switch closes the circuit (with no battery in it) the displacement current between the plates of the capacitor is

WO0077

58. Two coherent waves are described by the following expressions.

$$E_1 = E_0 \sin \left( \frac{2\pi x_1}{\lambda} - 2\pi ft + \frac{\pi}{6} \right); E_2 = E_0 \sin \left( \frac{2\pi x_2}{\lambda} - 2\pi ft + \frac{\pi}{8} \right)$$

Determine the relationship between  $x_1$  and  $x_2$  that produces constructive interference when the two waves are superposed.

WO0078

59. A nickel crystal is used as a diffraction grating for x-rays. Then the same crystal is used to diffract electrons. If the two diffraction patterns are identical, and the energy of each x-ray photon is  $E = 20.0\text{ keV}$ . What is the kinetic energy of each electron?

WO0079

60. The velocity of electromagnetic waves in a dielectric medium ( $\epsilon_r = 4$ ) is :-  
 (A)  $3 \times 10^8$  metre/second (B)  $1.5 \times 10^8$  metre/second  
 (C)  $6 \times 10^8$  metre/second (D)  $7.5 \times 10^7$  metre/second

WO0080

61. Which of these statements correctly describes the orientation of the electric field ( $\vec{E}$ ), the magnetic field ( $\vec{B}$ ), and the velocity of propagation ( $\vec{v}$ ) of an electromagnetic wave?

- (A)  $\vec{E}$  is perpendicular to  $\vec{B}$ ;  $\vec{v}$  may have any orientation relative to  $\vec{E}$ .  
 (B)  $\vec{E}$  is perpendicular to  $\vec{B}$ ;  $\vec{v}$  may have any orientation perpendicular to  $\vec{E}$   
 (C)  $\vec{E}$  is parallel to  $\vec{B}$ ;  $\vec{v}$  is perpendicular to both  $\vec{B}$  and  $\vec{E}$ .  
 (D) Each of the three vectors is perpendicular to the other two.

WO0081

62. The amplitude of electric field in a parallel light beam of intensity  $4\text{Wm}^{-2}$  is :  
 (A)  $35.5\text{ NC}^{-1}$  (B)  $45.5\text{ NC}^{-1}$  (C)  $49.5\text{ NC}^{-1}$  (D)  $54.8\text{ NC}^{-1}$

WO0082

63. Instantaneous displacement current of  $1.0\text{A}$  in the space between the parallel plates of  $1\mu\text{F}$  capacitor can be established by changing potential difference of:  
 (A)  $10^{-6}\text{ V/s}$  (B)  $10^6\text{ V/s}$  (C)  $10^{-8}\text{ V/s}$  (D)  $10^8\text{ V/s}$

WO0083

64. A plane electromagnetic wave,  
 $E_z = 100 \cos (6 \times 10^8 t + 4x)\text{ V/m}$   
 propagates in a medium of dielectric constant:

- (A) 1.5 (B) 2.0 (C) 2.4 (D) 4.0

WO0084

65. A large parallel plane capacitor, whose plates have an area of  $1 \text{ m}^2$  and are separated from each other by  $1 \text{ mm}$ , is being charged at a rate of  $25.8 \text{ V/s}$ . If the dielectric between the plates has the dielectric constant 10, then the displacement current at this instant is :-

(A)  $251 \mu\text{A}$  (B)  $11 \mu\text{A}$  (C)  $2.2 \mu\text{A}$  (D)  $1.1 \mu\text{A}$

WO0085

66. The rms value of the electric field of the light coming from the sun is  $720 \text{ N/C}$ . The average total energy density of the electromagnetic wave is :

(A)  $4.58 \times 10^{-6} \text{ J/m}^3$  (B)  $6.37 \times 10^{-9} \text{ J/m}^3$  (C)  $81.35 \times 10^{-12} \text{ J/m}^3$  (D)  $3.3 \times 10^{-3} \text{ J/m}^3$

WO0086

67. A beam of light travelling along x-axis is described by the electric field,  $E_y = (600 \text{ Vm}^{-1}) \sin \omega(t - x/c)$  then maximum magnetic force on a charge  $q = 2e$ , moving along y-axis with a speed of  $3.0 \times 10^7 \text{ ms}^{-1}$  is ( $e = 1.6 \times 10^{-19} \text{ C}$ ) :

(A)  $19.2 \times 10^{-17} \text{ N}$  (B)  $1.92 \times 10^{-17} \text{ N}$  (C)  $0.192 \text{ N}$  (D) None of these

WO0087

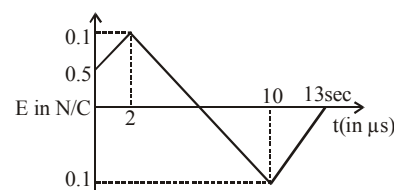
68. A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is  $9.3 \text{ Vm}^{-1}$ . The magnetic induction is:

(A)  $3.1 \times 10^{-8} \text{ T}$  (B)  $3 \times 10^{-5} \text{ T}$  (C)  $3.1 \times 10^{-6} \text{ T}$  (D)  $9.3 \times 10^{-6} \text{ T}$

WO0088

69. The electric field through an area of  $2 \text{ m}^2$  varies with time as shown in the graph. The greatest displacement current through the area is at :-

(A)  $t = 1 \text{ sec}$ .  
(B)  $t = 4 \text{ sec}$ .  
(C)  $t = 8 \text{ sec}$ .  
(D)  $t = 12 \text{ sec}$ .



WO0089

70. A plane electromagnetic wave travelling along the X-direction has a wavelength of  $3 \text{ mm}$ . The variation in the electric field occurs in the Y-direction with an amplitude  $66 \text{ Vm}^{-1}$ . The equation for the electric and magnetic fields as a function of  $x$  and  $t$  are respectively.

(A)  $E_y = 33 \cos \pi \times 10^{11} \left( t - \frac{x}{c} \right)$ ;  $B_z = 1.1 \times 10^{-7} \cos \pi \times 10^{11} \left( t - \frac{x}{c} \right)$

(B)  $E_y = 11 \cos 2\pi \times 10^{11} \left( t - \frac{x}{c} \right)$ ;  $B_y = 1.1 \times 10^{-7} \cos 2\pi \times 10^{11} \left( t - \frac{x}{c} \right)$

(C)  $E_x = 33 \cos \pi \times 10^{11} \left( t - \frac{x}{c} \right)$ ;  $B_x = 1.1 \times 10^{-7} \cos \pi \times 10^{11} \left( t - \frac{x}{c} \right)$

(D)  $E_y = 66 \cos 2\pi \times 10^{11} \left( t - \frac{x}{c} \right)$ ;  $B_z = 2.2 \times 10^{-7} \cos 2\pi \times 10^{11} \left( t - \frac{x}{c} \right)$

WO0090

71. In a stack of three polarizing sheets the first and third are crossed while the middle one has its axis at  $45^\circ$  to the axes of the other two. The fraction of the intensity of an incident unpolarized beam of light that is transmitted by the stack is:

(A)  $1/2$  (B)  $1/3$  (C)  $1/4$  (D)  $1/8$

WO0091

72. A beam of light strikes a piece of glass at an angle of incidence of  $60^\circ$  and the reflected beam is completely plane polarised. The refractive index of the glass is :-

(A) 1.5 (B)  $\sqrt{3}$  (C)  $\sqrt{2}$  (D)  $(3/2)$

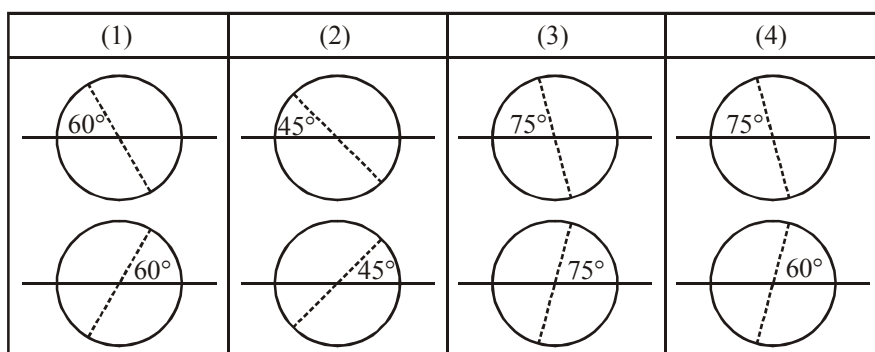
WO0092

73. The Sun is directly overhead and you are facing toward the north. Light coming to your eyes from the sky just above the horizon is :-

(A) Partially polarized north-south (B) Partially polarized east,west  
(C) Partially polarized up-down (D) Randomly polarized

WO0093

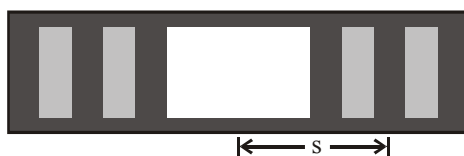
74. The diagrams show four pairs of polarizing sheets, with the polarizing directions indicated by dashed lines. The two 'sheets of each pair are placed one behind the other and the front sheet is illuminated by unpolarized light. The incident intensity is the same for all pairs of sheets. Rank the pairs according to the intensity of the transmitted light, least to greatest.



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

WO0094

75. Light of wavelength 600 nm is incident upon a single slit with width  $4 \times 10^{-4}$  m. The figure shows the pattern observed on a screen positioned 2 m from the slits. Determine the distance  $s$ .



(A) 0.002 m (B) 0.003 m (C) 0.004 m (D) 0.006 m

WO0095

76. The image of a star (effectively a point source) is made by a convergent lens of focal length 1m and diameter of aperture 5.0 cm. If the lens is ideal and the effective wavelength in image formation is taken as  $5 \times 10^{-5}$  cm, the diameter of the image formed will be nearest to:
- (A) zero (B)  $10^{-6}$  cm (C)  $10^{-5}$  cm (D)  $10^{-3}$  cm

WO0096

77. In a single slit diffraction pattern, as the width of the slit is increased,
- (A) the peak intensity of central maxima increases and its width also increases  
 (B) the peak intensity of central maxima increases and its width decreases.  
 (C) the peak intensity of central maxima decreases and its width increases  
 (D) the peak intensity of central maxima decreases and its width also decreases.

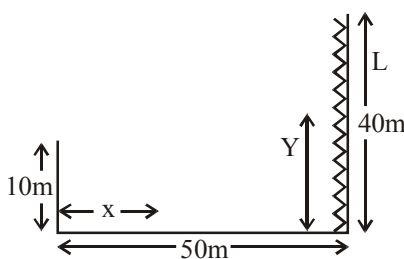
WO0097

78. A beam of electrons with de-broglie wavelength of  $10^{-4}$  m pass through a slit  $10^{-3}$  m wide. Calculate the angular spread introduced because of diffraction by slit.

- (A)  $\frac{9^\circ}{\pi}$  (B)  $\frac{18^\circ}{\pi}$  (C)  $\frac{36^\circ}{\pi}$  (D)  $\frac{4.5^\circ}{\pi}$

WO0098

79. A person lives in a high-rise building on the bank of a river 50m wide. Across the river is a well lit tower of height 40 m. When the person, who is at a height of 10m, looks through a polarizer at an appropriate angle at light of the tower reflecting from the river surface, he notes that intensity of light coming from distance X from his building is the least and this corresponds to the light coming from light bulbs at height 'Y' on the tower. The values of X and Y are respectively close to (refractive index of water  $\simeq 4/3$ )



- (A) 13 m, 27 m (B) 22 m, 13 m (C) 25 m, 10 m (D) 17 m, 29 m

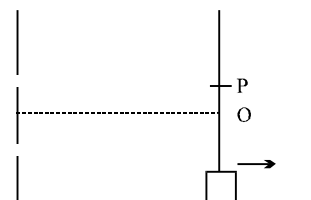
WO0099

## EXERCISE (O-2)

## SINGLE CORRECT TYPE QUESTIONS

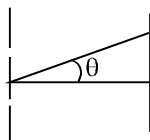
1. In a Young's Double slit experiment, first maxima is observed at a fixed point  $P$  on the screen. Now the screen is continuously moved away from the plane of slits. The ratio of intensity at point  $P$  to the intensity at point  $O$  (centre of the screen)

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



WO0100

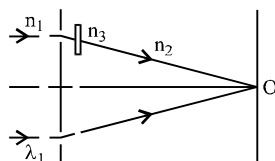
2. Two slits are separated by 0.3 mm. A beam of 500 nm light strikes the slits producing an interference pattern. The number of maxima observed in the angular range  $-30^\circ < \theta < 30^\circ$ .



- (A) 300 (B) 150 (C) 599 (D) 601

WO0101

3. In the figure shown in YDSE, a parallel beam of light is incident on the slit from a medium of refractive index  $n_1$ . The wavelength of light in this medium is  $\lambda_1$ . A transparent slab of thickness  $t$  and refractive index  $n_3$  is put in front of one slit. The medium between the screen and the plane of the slits is  $n_2$ . The phase difference between the light waves reaching point ' $O$ ' (symmetrical, relative to the slits) is :

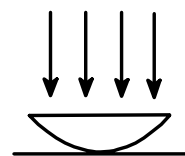


- (A)  $\frac{2\pi}{n_1\lambda_1} (n_3 - n_2) t$  (B)  $\frac{2\pi}{\lambda_1} (n_3 - n_2) t$  (C)  $\frac{2\pi n_1}{n_2 \lambda_1} \left( \frac{n_3}{n_2} - 1 \right) t$  (D)  $\frac{2\pi n_1}{\lambda_1} (n_3 - n_1) t$

WO0102

4. 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.

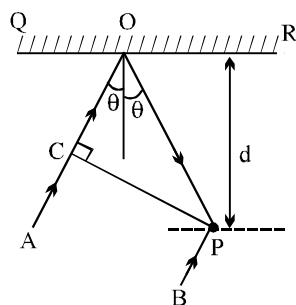


WO0103



5. In the adjacent diagram,  $CP$  represents a wavefront and  $AO$  and  $BP$ , the corresponding two rays. Find the condition on  $\theta$  for constructive interference at  $P$  between the ray  $BP$  and reflected ray  $OP$ .

[JEE (Scr.) 2003]



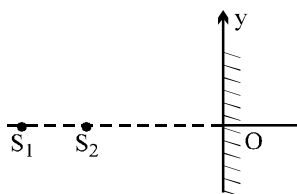
- (A)  $\cos\theta = \frac{3\lambda}{2d}$       (B)  $\cos\theta = \frac{\lambda}{4d}$       (C)  $\sec\theta - \cos\theta = \frac{\lambda}{d}$       (D)  $\sec\theta - \cos\theta = \frac{4\lambda}{d}$

WO0104

6. Two point monochromatic and coherent sources of light of wavelength  $\lambda$  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

WO0105

7. A parallel coherent beam of light falls on Fresnel biprism of refractive index  $\mu$  and angle  $\alpha$ . The fringe width on a screen at a distance  $D$  from biprism will be (wavelength =  $\lambda$ )

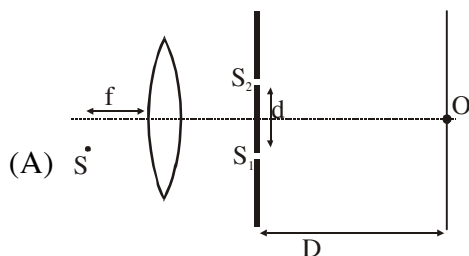
- (A)  $\frac{\lambda}{2(\mu-1)\alpha}$       (B)  $\frac{\lambda D}{2(\mu-1)\alpha}$       (C)  $\frac{D}{2(\mu-1)\alpha}$       (D) none

WO0106

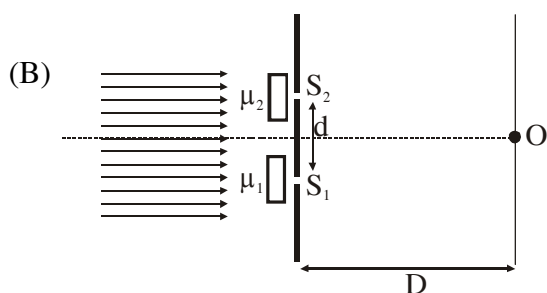
## MATRIX MATCH TYPE QUESTIONS

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

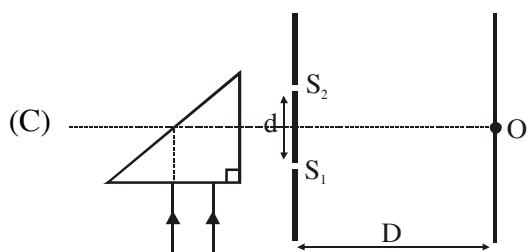
## Column-I



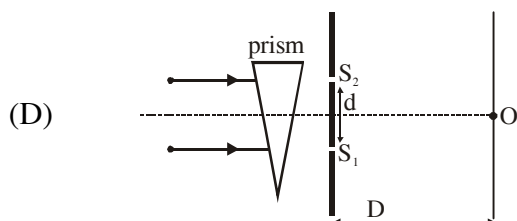
monochromatic point source  
S placed in focal plane.



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



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



monochromatic parallel beam  
incident on thin prism

## Column-II

(P) Zero order maxima lies above O.

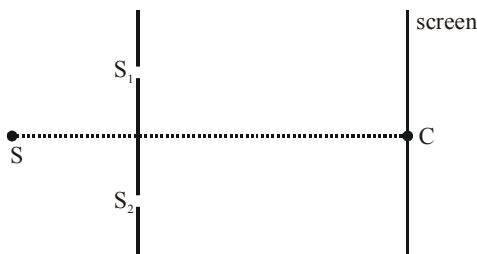
(Q) If a transparent mica sheet is introduced  
infront of  $S_2$  central bright fringe can be  
obtained at O.

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

(S) Point O can be a minima

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

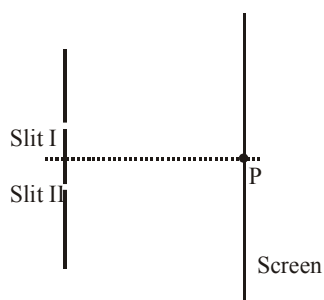
9. In a YDSE setup, light of wavelength  $4000 \text{ \AA}$  is used. Distance of screen from the slits is  $2\text{m}$  and distance between slits is  $1\text{mm}$ . There are three slabs slab 1 (thickness  $2\text{mm}$ ,  $\mu = 2$ ), slab 2 (thickness  $1\text{mm}$ ,  $\mu = 3$ ), slab 3 (thickness  $4\text{mm}$   $\mu = \frac{3}{2}$ )



- (A) If slab 1 is placed in front of slit  $S_1$  (P) Central maxima at C  
 (B) If the slab 2 is placed in front of slit  $S_2$  along with condition (A) (Q) Central maxima above C  
 (C) If slab 3 is placed in front of slab 1 along with condition (B) (R) Fringe width is equal to  $0.8 \text{ mm}$   
 (S) No. of fringes crossing central maxima as a result of slab placing is 5000

WO0108

10. A double slit interference pattern is produced on a screen, as shown in the figure, using monochromatic light of wavelength  $500\text{nm}$ . 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 strip(s), is shown. Correctly match both the column.



Film	A	B	C
Thickness (in $\mu\text{m}$ )	5	1.5	0.25
Refractive index	1.5	2.5	2

**Column I**

- (A) Only strip B is placed over slit-I  
 (B) Strip A is placed over slit-I and strip C is placed over slit-II  
 (C) Strip A is placed over the slit-I and strip B and strip C are placed over the slit-II in conjunction  
 (D) Strip A and strip C are placed over slit-I (in conjunction) and strip B is placed over Slit-II

**Column II**

- (P) First Bright  
 (Q) Fourth Dark  
 (R) Fifth Dark  
 (S) Central Bright

WO0109

## EXERCISE-(J-M)

1. A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is :- [AIEEE-2009]

(1) 442.5 nm                      (2) 776.8 nm                      (3) 393.4 nm                      (4) 885.0 nm

WO0110

2. If a source of power 4kW produces  $10^{20}$  photons/second, the radiation belongs to a part of the spectrum called [AIEEE 2010]

(1) microwaves                      (2) y-rays                      (3) X-rays                      (4) ultraviolet rays

WO0111

**Direction : Questions number 3 to 5 are based on the following paragraph.**

An initially parallel cylindrical beam travels in a medium of refractive index  $\mu(I) = \mu_0 + \mu_2 I$ , where  $\mu_0$  and  $\mu_2$  are positive constants and  $I$  is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius.

3. The initial shape of the wavefront of the beam is :- [AIEEE-2010]

(1) planar  
(2) convex  
(3) concave  
(4) convex near the axis and concave near the periphery

WO0112

4. The speed of the light in the medium is :- [AIEEE-2010]

(1) maximum on the axis of the beam                      (2) minimum on the axis of the beam  
(3) the same everywhere in the beam                      (4) directly proportional to the intensity  $I$

WO0112

5. As the beam enters the medium, it will :- [AIEEE-2010]

(1) travel as a cylindrical beam  
(2) diverge  
(3) converge  
(4) diverge near the axis and converge near the periphery

WO0112

6. At two points P and Q on screen in Young's double slit experiment, waves from slits  $S_1$  and  $S_2$  have a path difference of 0 and  $\frac{\lambda}{4}$  respectively. the ratio of intensities at P and Q will be : [AIEEE-2011]

(1) 3 : 2                      (2) 2 : 1                      (3)  $\sqrt{2} : 1$                       (4) 4 : 1

WO0113

7. **Statement-1:** On viewing the clear blue portion of the sky through a Calcite Crystal, the intensity of transmitted light varies as the crystal is rotated.

**Statement-1:** The light coming from the sky is polarized due to scattering of sun light by particles in the atmosphere. The scattering is largest for blue light. [AIEEE-2011]

- (1) Statement-1 is false, statement-2 is true  
 (2) Statement-1 is true, statement-2 is false  
 (3) Statement-1 is true, statement-2 true; statement-2 is the correct explanation of statement-1  
 (4) Statement-1 is true, statement-2 is true; statement -2 is not correct explanation of statement-1.

WO0114

8. In a Young's double slit experiment, the two slits act as coherent sources of waves of equal amplitude  $A$  and wavelength  $\lambda$ . In another experiment with the same arrangement the two slits are made to act as incoherent sources of waves of same amplitude and wavelength. If the intensity at the middle point

of the screen in the first case is  $I_1$  and in the second case  $I_2$ , then the ratio  $\frac{I_1}{I_2}$  is :- [AIEEE-2011]

- (1) 4 (2) 2 (3) 1 (4) 0.5

WO0115

9. 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  $\pi$ .

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

- (1) Statement-1 is true, Statement-2 is true and Statement-2 is not the correct explanation of Statement-1.  
 (2) Statement-1 is false, Statement-2 is true  
 (3) Statement-1 is true, Statement-2 is false  
 (4) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of statement-1.

WO0116

10. In Young's double slit experiment, one of the slit is wider than other, so that the amplitude of the light from one slit is double of that from other slit. If  $I_m$  be the maximum intensity, the resultant intensity  $I$  when they interfere at phase difference  $\phi$  is given by : [AIEEE-2012]

- (1)  $\frac{I_m}{9} (1 + 8\cos^2 \frac{\phi}{2})$  (2)  $\frac{I_m}{9} (4 + 5\cos\phi)$  (3)  $\frac{I_m}{3} (1 + 2\cos^2 \frac{\phi}{2})$  (4)  $\frac{I_m}{5} (1 + 4\cos^2 \frac{\phi}{2})$

WO0117

11. An electromagnetic wave in vacuum has the electric and magnetic fields  $\vec{E}$  and  $\vec{B}$ , which are always perpendicular to each other. The direction of polarization is given by  $\vec{X}$  and that of wave propagation by  $\vec{k}$ . Then [AIEEE-2012]

- (1)  $\vec{X} \parallel \vec{B}$  and  $\vec{k} \parallel \vec{E} \times \vec{B}$  (2)  $\vec{X} \parallel \vec{E}$  and  $\vec{k} \parallel \vec{B} \times \vec{E}$   
 (3)  $\vec{X} \parallel \vec{B}$  and  $\vec{k} \parallel \vec{B} \times \vec{E}$  (4)  $\vec{X} \parallel \vec{E}$  and  $\vec{k} \parallel \vec{E} \times \vec{B}$

WO0118

12. This question has Statement-1 and statement-2. Of the four choices given after the Statements, choose the one that best describes the two statements. [AIEEE - 2012]

**Statement-1 :** Davisson - Germer experiment established the wave nature of electrons.

**Statement-2:** If electrons have wave nature, they can interfere and show diffraction.

- (1) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation for Statement-1.  
 (2) Statement-1 is true, Statement-2 is true and Statement-2 is not the correct explanation of Statement-I  
 (3) Statement-1 is false, Statement-2 is true.  
 (4) Statement-1 is true, Statement-2 is false

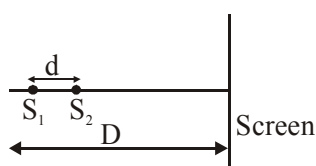
WO0119

13. A beam of unpolarised light of intensity  $I_0$  is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of  $45^\circ$  relative to that of A. The intensity of the emergent light is :- [JEE-Mains 2013]

- (1)  $I_0$  (2)  $I_0/2$  (3)  $I_0/4$  (4)  $I_0/8$

WO0120

14. 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]



- (1) points (2) straight lines (3) semicircles (4) concentric circles

WO0121

15. Match **List-I** (Electromagnetic wave type) with **List-II** (Its association/application) and select the correct option from the choices given below the lists : **[JEE-Mains 2014]**

List-I		List-II	
(a)	Infrared waves	(i)	To treat muscular strain
(b)	Radio waves	(ii)	For broadcasting
(c)	X-rays	(iii)	To detect fracture of bones
(d)	Ultraviolet rays	(iv)	Absorbed by the ozone layer of the atmosphere

- |     |       |       |       |       |
|-----|-------|-------|-------|-------|
|     | (a)   | (b)   | (c)   | (d)   |
| (1) | (iii) | (ii)  | (i)   | (iv)  |
| (2) | (i)   | (ii)  | (iii) | (iv)  |
| (3) | (iv)  | (iii) | (ii)  | (i)   |
| (4) | (i)   | (ii)  | (iv)  | (iii) |

WO0122

16. During the propagation of electromagnetic waves in a medium :

**[JEE-Mains 2014]**

- (1) Electric energy density is equal to the magnetic energy density  
 (2) Both electric magnetic energy densities are zero  
 (3) Electric energy density is double of the magnetic energy density  
 (4) Electric energy density is half of the magnetic energy density.

WO0123

17. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through  $30^\circ$  makes the two beams appear equally bright. If

the initial intensities of the two beams are  $I_A$  and  $I_B$  respectively, then  $\frac{I_A}{I_B}$  equals : **[JEE-Mains 2014]**

- (1) 1                      (2)  $\frac{1}{3}$                       (3) 3                      (4)  $\frac{3}{2}$

WO0124

18. A red LED emits light at 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is:- **[JEE-Mains 2015]**

- (1) 5.48 V/m              (2) 7.75 V/m              (3) 1.73 V/m              (4) 2.45 V/m

WO0125

19. Assuming human pupil to have a radius of 0.25cm and a comfortable viewing distance of 25cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is :-

**[JEE-Mains 2015]**

- (1) 100  $\mu\text{m}$               (2) 300  $\mu\text{m}$               (3) 1  $\mu\text{m}$               (4) 30  $\mu\text{m}$

WO0126

20. 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]**

(1) bends downwards (2) bends upwards  
(3) becomes narrower (4) goes horizontally without any deflection

**WO0127**

21. The box of a pin hole camera, of length  $L$ , has a hole of radius  $a$ . It is assumed that when the hole is illuminated by a parallel beam of light of wavelength  $\lambda$  the spread of the spot (obtained on the opposite wall of the camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would then have its minimum size (say  $b_{\min}$ ) when :- **[JEE-Mains 2016]**

(1)  $a = \frac{\lambda^2}{L}$  and  $b_{\min} = \sqrt{4\lambda L}$  (2)  $a = \frac{\lambda^2}{L}$  and  $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$   
(3)  $a = \sqrt{\lambda L}$  and  $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$  (4)  $a = \sqrt{\lambda L}$  and  $b_{\min} = \sqrt{4\lambda L}$

**WO0128**

22. Arrange the following electromagnetic radiations per quantum in the order of increasing energy :-

A : Blue light      B : Yellow light      C : X-ray      D : Radiowave

**[JEE-Mains 2016]**

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

**WO0129**

23. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is :- **[JEE-Main 2017]**

(1) 9.75 mm      (2) 15.6 mm      (3) 1.56 mm      (4) 7.8 mm

**WO0130**

24. The angular width of the central maximum in a single slit diffraction pattern is  $60^\circ$ . The width of the slit is  $1 \mu\text{m}$ . The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance 50 cm from the slits. If the observed fringe width is 1 cm, what is slit separation distance? (i.e. distance between the centres of each slit.) **[JEE-Main 2018]**

(1)  $50 \mu\text{m}$       (2)  $75 \mu\text{m}$       (3)  $100 \mu\text{m}$       (4)  $25 \mu\text{m}$

**WO0131**

25. An EM wave from air enters a medium. The electric fields are  $\vec{E}_1 = E_0 \hat{x} \cos\left[2\pi\nu\left(\frac{z}{c} - t\right)\right]$  in air and  $\vec{E}_2 = E_0 \hat{x} \cos[k(2z - ct)]$  in medium, where the wave number  $k$  and frequency  $\nu$  refer to their values in air. The medium is non-magnetic. If  $\epsilon_1$  and  $\epsilon_2$  refer to relative permittivity of air and medium respectively, which of the following options is correct ? **[JEE-Main 2018]**

(1)  $\frac{\epsilon_1}{\epsilon_2} = 2$       (2)  $\frac{\epsilon_1}{\epsilon_2} = \frac{1}{4}$       (3)  $\frac{\epsilon_1}{\epsilon_2} = \frac{1}{2}$       (4)  $\frac{\epsilon_1}{\epsilon_2} = 4$

**WO0132**

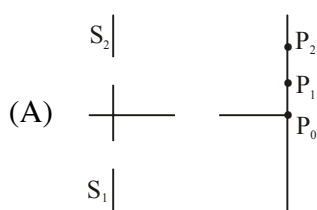


## EXERCISE-(J-A)

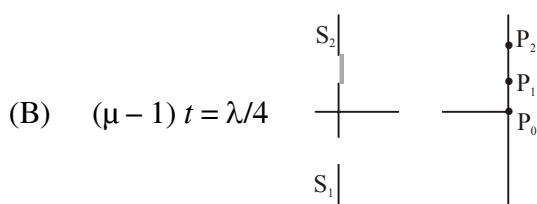
1. **Column I** shows four situations of standard Young's double slit arrangement with the screen placed far away from the slits  $S_1$  and  $S_2$ . In each of these cases  $S_1P_0 = S_2P_0$ ,  $S_1P_1 - S_2P_1 = \lambda/4$  and  $S_1P_2 - S_2P_2 = \lambda/3$ , where  $\lambda$  is the wavelength of the light used. In the cases  $B$ ,  $C$  and  $D$ , a transparent sheet of refractive index  $\mu$  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

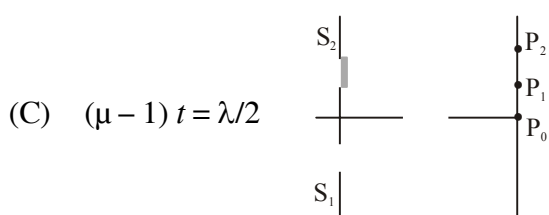
## Column-II



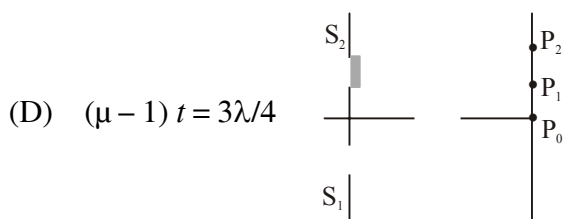
(p)  $\delta(P_0) = 0$



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



(r)  $I(P_1) = 0$



(s)  $I(P_0) > I(P_1)$

(t)  $I(P_2) > I(P_1)$

2. 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  $\beta_G$ ,  $\beta_R$  and  $\beta_B$ , 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)  $\beta_R > \beta_G > \beta_B$

WO0134

3. In the Young's double slit experiment using a monochromatic light of wavelength  $\lambda$ , the path difference (in terms of an integer  $n$ ) corresponding to any point having half the peak intensity is :- [JEE Advanced 2013]

- (A)  $(2n+1)\frac{\lambda}{2}$  (B)  $(2n+1)\frac{\lambda}{4}$   
 (C)  $(2n+1)\frac{\lambda}{8}$  (D)  $(2n+1)\frac{\lambda}{16}$

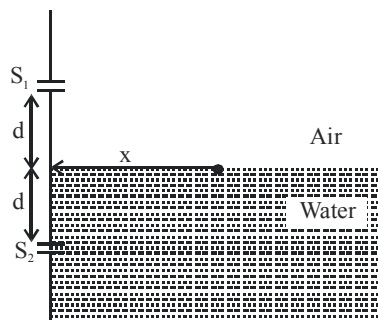
WO0135

4. A light source, which emits two wavelengths  $\lambda_1 = 400$  nm and  $\lambda_2 = 600$  nm, is used in a Young's double slit experiment. If recorded fringe widths for  $\lambda_1$  and  $\lambda_2$  are  $\beta_1$  and  $\beta_2$  and the number of fringes for them within a distance  $y$  on one side of the central maximum are  $m_1$  and  $m_2$ , respectively, then :- [JEE Advanced 2014]

- (A)  $\beta_2 > \beta_1$   
 (B)  $m_1 > m_2$   
 (C) From the central maximum, 3<sup>rd</sup> maximum of  $\lambda_2$  overlaps with 5<sup>th</sup> minimum of  $\lambda_1$   
 (D) The angular separation of fringes of  $\lambda_1$  is greater than  $\lambda_2$

WO0136

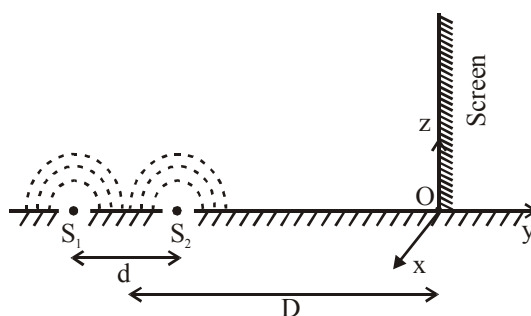
5. A Young's double slit interference arrangement with slits  $S_1$  and  $S_2$  is immersed in water (refractive index =  $4/3$ ) as shown in the figure. The positions of maxima on the surface of water are given by  $x^2 = p^2 m^2 \lambda^2 - d^2$ , where  $\lambda$  is the wavelength of light in air (refractive index = 1),  $2d$  is the separation between the slits and  $m$  is an integer. The value of  $p$  is. [JEE Advanced 2015]



WO0137

6. While conducting the Young's double slit experiment, a student replaced the two slits with a large opaque plate in the  $x$ - $y$  plane containing two small holes that act as two coherent point sources ( $S_1, S_2$ ) emitting light of wavelength 600 nm. The student mistakenly placed the screen parallel to the  $x$ - $z$  plane (for  $z > 0$ ) at a distance  $D = 3\text{m}$  from the mid-point of  $S_1S_2$ , as shown schematically in the figure. The distance between the sources  $d = 0.6003\text{ mm}$ . The origin  $O$  is at the intersection of the screen and the line joining  $S_1S_2$ . Which of the following is (are) true of the intensity pattern on the screen ?

[JEE Advanced 2016]



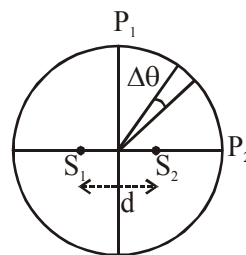
- (A) Hyperbolic bright and dark bands with foci symmetrically placed about  $O$  in the  $x$ -direction  
 (B) Semi circular bright and dark bands centered at point  $O$   
 (C) The region very close to the point  $O$  will be dark  
 (D) Straight bright and dark bands parallel to the  $x$ -axis

WO0138

7. Two coherent monochromatic point sources  $S_1$  and  $S_2$  of wavelength  $\lambda = 600\text{ nm}$  are placed symmetrically on either side of the center of the circle as shown. The sources are separated by a distance  $d = 1.8\text{mm}$ . This arrangement produces interference fringes visible as alternate bright and dark spots on the circumference of the circle. The angular separation between two consecutive bright spots is  $\Delta\theta$ . Which of the following options is/are correct ?

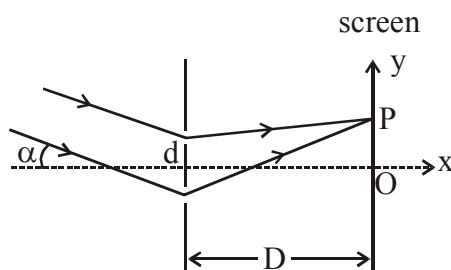
[JEE Advanced 2017]

- (A) A dark spot will be formed at the point  $P_2$   
 (B) The angular separation between two consecutive bright spots decreases as we move from  $P_1$  to  $P_2$  along the first quadrant  
 (C) At  $P_2$  the order of the fringe will be maximum  
 (D) The total number of fringes produced between  $P_1$  and  $P_2$  in the first quadrant is close to 3000



WO0139

8. In a Young's double slit experiment, the slit separation  $d$  is 0.3 mm and the screen distance  $D$  is 1m. A parallel beam of light of wavelength 600nm is incident on the slits at angle  $\alpha$  as shown in figure. On the screen, the point O is equidistant from the slits and distance PO is 11.0 mm. Which of the following statement(s) is/are correct ? **[JEE Advanced 2019]**



- (1) For  $\alpha = \frac{0.36}{\pi}$  degree, there will be destructive interference at point O.
- (2) Fringe spacing depends on  $\alpha$
- (3) For  $\alpha = \frac{0.36}{\pi}$  degree, there will be destructive interference at point P
- (4) For  $\alpha = 0$ , there will be constructive interference at point P.

**WO0140**