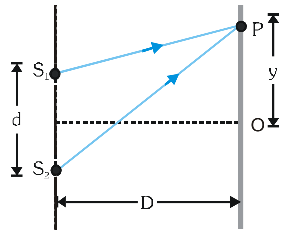
SOLVED EXAMPLES

Ex.1 Young's double slit experiment is carried out using microwaves of wavelength $\lambda = 3$ cm. Distance in between plane of slits and the screen is D = 100 cm. and distance in between the slits is 5 cm. Find

(A) the number of maximas and **(B)** their positions on the screen

Sol. **(A)** The maximum path difference that can be produced = distance between the sources or 5 cm. Thus, in this case we can have only three maximas, one central maxima and two on its either side for a path difference of λ or 3 cm.

(B) For maximum intensity at P, $S_2P - S_1P = \lambda \Rightarrow \sqrt{(y + d/2)^2 + D^2} - \sqrt{(y - d/2)^2 + D^2} = \lambda$



substiuting d = 5 cm, D = 100 cm and λ = 3cm we get y = ± 75 cm

Thus, the three maximas will be at y = 0 and y = ± 75 cm

Ex.2 State two conditions to obtain sustained interference of light. In Young's double slit experiment, using light of wavelength 400 nm, interference fringes of width 'X' are obtained. The wavelength of light is increased to 600 nm and the separation between the slits is halved. If one wants the observed fringe width on the screen to be the same in the two cases, find the ratio of the distance between the screen and the plane of the slits in the two arrangements.

Sol. Conditions for sustained interference of light

(i) Sources should be coherent. **(ii)** There should be point sources

$\because$ fringe width $\beta = \frac{\lambda D}{d}$ Here, $\beta_1 = \frac{\lambda_1 D_1}{d_1}$ and $\beta_2 = \frac{\lambda_2 D_2}{d_2}$

As $\beta_1 = \beta_2 \Rightarrow \frac{\lambda_1 D_1}{d_1} = \frac{\lambda_2 D_2}{d_2} \Rightarrow \frac{D_1}{D_2} = \frac{\lambda_2 d_1}{\lambda_1 d_2} = \frac{600}{400} \times \frac{1}{1/2} = \frac{6}{2} = \frac{3}{1}$

Ex.3 A beam of light consisting of two wavelengths 6500 Å and 5200 Å is used to obtain interference fringes in a young's double slit experiment. The distance between the slits is 2 mm and the distance between the plane of the slits and screen is 120 cm.

(A) Find the distance of the third bright fringe on the screen from the central maxima for the wavelength 6500 Å.

(B) What is the least distance from the central maxima where the bright fringes due to both the wave-lengths coincide?

Sol. **(A)** Distance of third bright fringe from centre of screen

$$x_3 = \frac{nD\lambda}{d} = \frac{3 \times 120 \times 10^{-2} \times 6500 \times 10^{-10}}{2 \times 10^{-3}} = 1.17 \times 10^{-3}\text{ m} = 1.17\text{ mm}$$

(B) When bright fringes coincide to each other then $n_1\lambda_1 = n_2\lambda_2 \Rightarrow \frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{5200Å}{6500Å} = \frac{4}{5}$

for minimum value of n_1 & n_2 $n_1 = 4$, $n_2 = 5$

So $x = \frac{n_1\lambda_1 D}{d} = \frac{4 \times 6500 \times 10^{-10} \times 120 \times 10^{-2}}{2 \times 10^{-3}} = 0.156 \times 10^{-2}\text{ m} = 0.156\text{ cm}$

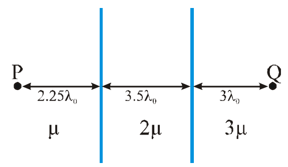
Ex.4 Two slits separated by a distance of 1 mm are illuminated with red light of wavelength 6.5×10^{-7} m. The interference fringes are observed on a screen placed 1m from the slits. The distance between the third dark fringe and the fifth bright fringe is equal to

(A) 0.65 mm **(B)** 1.625 mm **(C)** 3.25 mm **(D)** 0.975 mm

Sol. Distance between third dark fringe and the fifth bright fringe

$$= 2.5\beta = 2.5\frac{\lambda D}{d} = 2.5\frac{6.5\times10^{-7}\times1}{10^{-3}} = 1.625 \text{ mm}$$

Ex.5 An electromagnetic wave of wavelength λ_0 (in vacuum) passes from P towards Q crossing three different media of refractive index μ, 2μ and 3μ respectively as shown in figure. ϕ_P and ϕ_Q be the phase of the wave at points P and Q. Find the phase difference $\phi_Q - \phi_P$. [Take : μ=1]

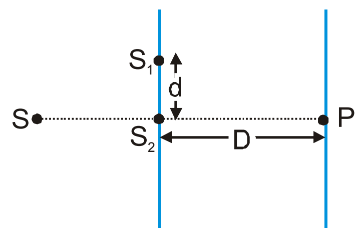


(A) 0 **(B)** $\frac{\pi}{4}$ **(C)** $\frac{\pi}{2}$ **(D)** π

Sol. Optical path difference between (OPD) P & Q

(O.P.D.) $= 2.25\,\lambda_0\times1 + (3.5\,\lambda_0)\times2 + 3\lambda_0\times3 = 18.25\,\lambda_0$ and phase difference $\Delta\phi = \frac{2\pi}{\lambda_0}\times\Delta x = \frac{\pi}{2}$

Ex.6 In a YDSE experiment two slits S_1 and S_2 have separation of $d = 2$ mm. The distance of the screen is $D = \frac{8}{5}$ 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

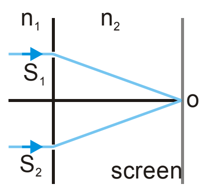


(A) 4001 **(B)** 3999 **(C)** 3998 **(D)** 4000

Sol. $S_1P - S_2P = \frac{d^2}{2D} = \frac{2\times10^{-3}\times2\times0^{-3}}{2\times\frac{8}{5}} = \frac{5}{2}\lambda \;\; (\lambda = 500\text{nm})$

So when S is at ∞ there is I[st] minima and when S is at S_2 there is last minima because d/λ=4000
So the number of minima's will be 4001 and number of maxima's will be 4000.

Ex.7 In a Young's double slit experiment the slits S_1 & S_2 are illuminated by a parallel beam of light of wavelength 4000 Å, from the medium of refractive index $n_1 = 1.2$. A thin film of thickness 1.2μm and refractive index $n = 1.5$ is placed infront of S_1 perpendicular to path of light. The refractive index of medium between plane of slits & screen is $n_2 = 1.4$. If the light coming from the film and S_1 & S_2 have equal intensities I then intensity at geometrical centre of the screen O is



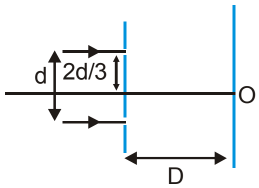
(A) 0 **(B)** 2I **(C)** 4I **(D)** None of these

Sol. Path difference at O : $(\mu_{rel} - 1)\,t = \left(\frac{n}{n_2} - 1\right) t$

$\therefore$ Phase difference at O: $t\left(\frac{n}{n_2} - 1\right)\frac{2\pi}{\lambda_2}$ where $n_1\lambda_1 = n_2\lambda_2$

$\Rightarrow$ Phase difference $= \frac{\pi}{2} \Rightarrow$ Resultant intensity = 2I

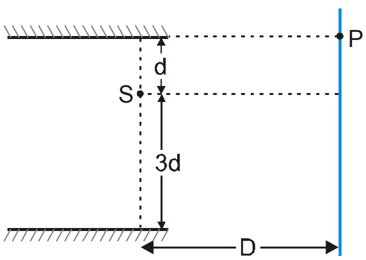
Ex.8 In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the only white spot on the screen from O is :[assume $d \ll D$, $\lambda \ll d$]



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

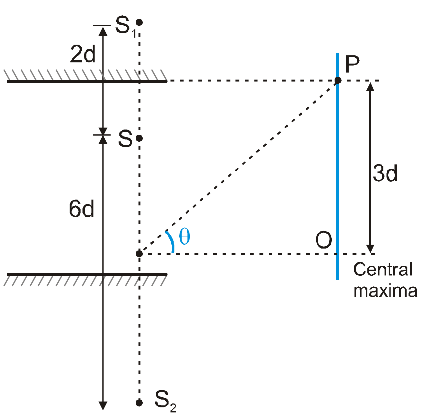
Sol. White spot will be at the symmetrical point w.r.t. slits . Its distance from O will be ,(2d/3) – (d/2) = d/6 .

Ex.9 Consider the optical system shown in figure. The point source of light S is having wavelength equals to λ.The light is reaching screen only after reflection. For point P to be 2nd maxima, the value of λ would be ($D \gg d$ and $d \gg \lambda$)



(A) $\frac{12d^2}{D}$ **(B)** $\frac{6d^2}{D}$ **(C)** $\frac{3d^2}{D}$ **(D)** $\frac{24d^2}{D}$

Sol.

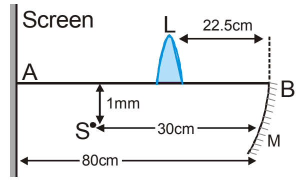


At P, $\Delta x = \frac{(8d) \times 3d}{D}$; For 2nd maxima, $\Delta x = 2\lambda$

$\Rightarrow \frac{24d^2}{D} = 2\lambda \Rightarrow \lambda = \frac{12d^2}{D}$

Ex.10 to12

In the figure shown, S is a point monochromatic light source of frequency 6×10^{14} Hz.M is a concave mirror of radius of curvature 20 cm and L is a thin converging lens of focal length 3.75 cm. AB is the principal axis of M and L.



Light reflected from the mirror and refracted from the lens in succession reaches the screen. An interference pattern is obtained on the screen by this arrangement.

10. If the lens is replaced by another converging lens of focal length $\frac{10}{3}$ cm and the lens is shifted towards right by 2.5 cm then-

(A) Fringe width remains same
(B) Intensity of pattern will remain same
(C) Fringe width will change
(D) No interference pattern will form.

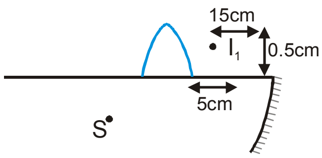
11. Distance between two coherent sources which makes interference pattern on the screen is-

(A) 1 mm **(B)** 0.5 mm **(C)** 1.5 mm **(D)** 0.25 mm

12. Fringe width is-

(A) 1mm **(B)** 0.5 mm **(C)** 1.5 mm **(D)** 0.25 mm

Sol.

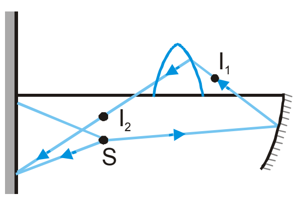


10. Image formed by the combination is I_2 at

$\frac{1}{v} - \frac{1}{-5} = \frac{3}{10} \Rightarrow v = 10$ cm . It will coincide with S●,

so no interference pattern on the screen .

11. **Ans. (B)**



Wave length of light $\lambda = \frac{c}{f} = 5 \times 10^{-7}$ m

Image formed by M : $\frac{1}{v} + \frac{1}{-30} = \frac{1}{-10} \Rightarrow v = -15$ cm also $M = -\frac{v}{u} = -\frac{-15}{-30} = -\frac{1}{2}$.

This will be located at 15 cm left of M and 0.5 mm above the line AB.

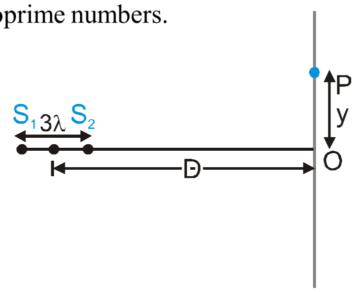
This will act as an object for the lens L.

Now for the lens $u = -7.5$cm and $m = \frac{v}{u} = \frac{7.5}{-7.5} = -1$

So it will be at 7.5 cm to the left of L and 0.5 mm below line AB. See the ray diagram. Second image I_2 and source S will act as two slits (as in YDSE) to produce the interference pattern . Distance between them = 0.5 mm (= d)

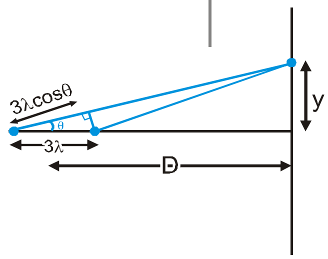
12. $\beta = \frac{5 \times 10^{-7} \times 50 \times 10^{-2}}{0.5 \times 10^{-3}} = 5 \times 10^{-4}$ m = 0.5 mm

Ex.13 Figure shows two coherent microwave source S_1 and S_2 emitting waves of wavelength λ and separated by a distance 3λ. For $\lambda << D$ and $y \neq 0$, the minimum value of y for point P to be an intensity maximum is $\frac{\sqrt{m}\,D}{n}$. Determine the value of m + n, if m and n are coprime numbers.



Sol. Path difference $= 3\lambda\cos\theta = 2\lambda \Rightarrow \cos\theta = \frac{2}{3}$

$y = D\tan\theta = \frac{D\sqrt{5}}{2} \Rightarrow m + n = 5 + 2 = 7$



Ex.14 **Statement–1:** In Young's double slit experiment the two slits are at distance d apart. Interference pattern is observed on a screen at distance D from the slits. At a point on the screen when it is directly opposite to one of the slits, a dark fringe is observed. Then, the wavelength of wave is proportional to square of distance of two slits.

Statement–2 : In Young's double slit experiment, for identical slits, the intensity of a dark fringe is zero.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1

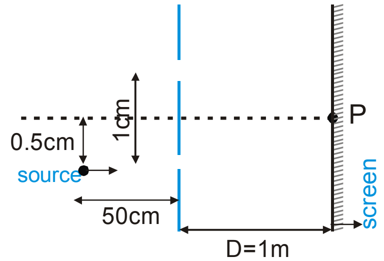
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1

(C) Statement–1 is True, Statement–2 is False.

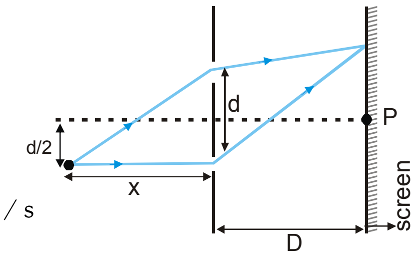
(D) Statement–1 is False, Statement–2 is True.

Sol. **Ans. (B)**

Ex.15 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 $\alpha \times 10^{-\beta}$ cm/s upward in scientific notation. Find the value of $\alpha+\beta$.



Sol. The central maxima $\frac{dy}{D} = \sqrt{d^2 + x^2} - x = x\left[1 + \frac{d^2}{2x^2}\right] - x = \frac{d^2}{2x}$



$$y = \frac{Dd}{2x} \Rightarrow \frac{dy}{dt} = -\frac{Dd}{2x^2}\left(\frac{dx}{dt}\right) = \left(\frac{1 \times 0.01}{2 \times 0.5 \times 0.5}\right) \times (0.001) = 0.02\text{mm/s}$$

$\Rightarrow y = 2 \times 10^{-3}$ cm/s $\Rightarrow \alpha + \beta = 5$

Exercise # 1 [Single Correct Choice Type Questions]

1. Huygen's principle is applicable to-
(A) Only light waves **(B)** Only sound waves
(C) Only mechanical waves **(D)** For all the above waves

2. Which of the following phenomenon can not be explained by the Huygen's theory-
(A) Refraction **(B)** Reflection **(C)** Diffraction **(D)** Formation of spectrum

3. According to huygen's theory of secondary waves, following can be explained-
(A) Propagation of light in medium **(B)** Reflection of light
(C) Refraction of light **(D)** All of the above

4. The main drawback of huygen's theory was-
(A) Failure in explanation of rectilinear propagation of lignt
(B) Failure of explain the spectrum of white light
(C) Failure to explain the formation of newton's rings
(D) A failure of experimental verification of ether medium

5. Huygen's theory of secondary waves can be used to find-
(A) Velocity of light **(B)** The wavelength of light
(C) Wave front geometrically **(D)** Magnifying power of microscope

6. Two coherent sources of intensities I_1 and I_2 produce an interference pattern. The maximum intensity in the interference pattern will be :–
(A) $I_1 + I_2$ **(B)** $I_1^2 + I_2^2$ **(C)** $(I_1 + I_2)^2$ **(D)** $(\sqrt{I_1} + \sqrt{I_2})^2$

7. The colour are characterized by which of following character of light–
(A) Frequency **(B)** Amplitude **(C)** Wavelength **(D)** Velocity

8. Light has a wave nature, because-
(A) the light travel in a straight line
(B) Light exhibts phenomenon of reflection and refraction
(C) Light exhibits phenomenon interference
(D) Light exhibits phenomenon of photo electric effect

9. Two wave are represented by the equations $y_1 = a \sin \omega t$ and $y_2 = a \cos \omega t$. The first wave :–
(A) leads the second by π **(B)** lags the seconds by π
(C) leads the second by $\frac{\pi}{2}$ **(D)** lags the seconds by $\frac{\pi}{2}$

10. The phase difference corresponding to path difference of x is :–
(A) $\frac{2\pi x}{\lambda}$ **(B)** $\frac{2\pi\lambda}{x}$ **(C)** $\frac{\pi x}{\lambda}$ **(D)** $\frac{\pi\lambda}{x}$

11. The resultant amplitude of a vibrating particle by the superposition of the two waves

$y_1 = a\sin\left[\omega t + \frac{\pi}{3}\right]$ and $y_2 = a \sin \omega t$ is :–

(A) a **(B)** $\sqrt{2}$ a **(C)** 2a **(D)** $\sqrt{3}$ a

12. The energy in the phenomenon of interference :–

(A) is conserved, gets redistributed **(B)** is equal at every point
(C) is destroyed in regions of dark fringes **(D)** is created at the place of bright fringes

13. Phenomenon of interference is observed :–

(A) only for light waves **(B)** only for sound waves
(C) for both sound and light waves **(D)** none of above

14. The resultant amplitude in interference with two coherent sources depends upon :–

(A) only amplitude **(B)** only phase difference
(C) on both the previous option **(D)** none of the above

15. For the sustained interference of light, the necessary condition is that the two sources should :–

(A) have constant phase difference **(B)** be narrow
(C) be close to each other **(D)** of same amplitude

16. Two coherent sources must have the same :–

(A) amplitude **(B)** phase difference **(C)** frequency **(D)** both (B) and (C)

17. If the ratio of the intensity of two coherent sources is 4 then the visibility $[(I_{max} - I_{min})/(I_{max} + I_{min})]$ of the fringes is

(A) 4 **(B)** 4/5 **(C)** 3/5 **(D)** 9

18. If the distance between the first maxima and fifth minima of a double slit pattern is 7 mm and the slits are separated by 0.15 mm with the screen 50 cm from the slits, then wavelength of the light used is

(A) 600 nm **(B)** 525 nm **(C)** 467 nm **(D)** 420 nm

19. 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

20. In Young's double slit experiment using sodium light (λ = 5898Å), 92 fringes are seen. If given colour (λ = 5461Å) is used, how many fringes will be seen

(A) 62 **(B)** 67 **(C)** 85 **(D)** 99

21. In Young's double slit experiment, the separation between the slits is halved and the distance between the slits and the screen is doubled. The fringe width is :–

(A) unchanged **(B)** halved **(C)** doubled **(D)** quadrupled

22. In Young's double slit experiment, a mica sheet of thickness t and refractive index μ is introduced in the path of ray from the first source S_1. By how much distance the fringe pattern will be displaced

(A) $\frac{d}{D}(\mu-1)t$ **(B)** $\frac{D}{d}(\mu-1)t$ **(C)** $\frac{d}{(\mu-1)D}$ **(D)** $\frac{D}{d}(\mu-1)$

23. In Young's experiment, one slit is covered with a blue filter and the other (slit) with a yellow filter. Then the interference pattern :–

(A) will be blue **(B)** will be yellow **(C)** will be green **(D)** will not be formed

24. In the young's double slit experiment the central maxima is observed to be I_0. If one of the slits is covered, then intensity at the central maxima will become :–

(A) $\frac{I_0}{2}$ **(B)** $\frac{I_0}{\sqrt{2}}$ **(C)** $\frac{I_0}{4}$ **(D)** I_0

25. In Young's double slit experiment, if monochromatic light is replaced by white light :–

(A) all bright fringes become white

(B) all bright fringes have coloures between violet and red

(C) only the central fringe is white, all other fringes are coloured

(D) no fringes are observed

26. In Young's double slit experiment, one of the slits is so painted that intensity of light emitted from it is half of that of the light emitted from other slit. Then

(A) fringe system will disappear

(B) bright fringes will become brighter and dark fringes will be darker

(C) both bright and dark fringes will become darker

(D) dark fringes will become less dark and bright fringes will become less bright.

27. In YDSE, the source placed symmetrically with respect to the slit is now moved parallel to the plane of the slits 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.

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

(A) 12 **(B)** 7 **(C)** 18 **(D)** None of these

29. In a double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then in the interference pattern.

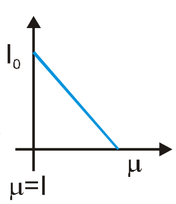
(A) the intensifies of both the maxima and minima increase.

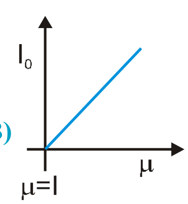
(B) the intensity of the maxima increases and the minima has zero intensity.

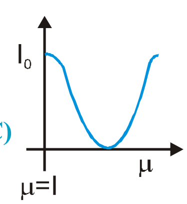
(C) the intensity of the maxima decreases and that of minima increases

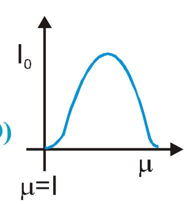
(D) the intensity of the maxima decreases and the minima has zero intensity.

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

(A) 

(B) 

(C) 

(D) 

31. When light is refracted into a denser medium-

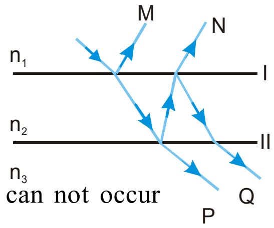
(A) Its wavelength and frequency both increase.

(B) Its wavelength increases but frequency remains unchanged.

(C) Its wavelength decreases but frequency remains unchanged.

(D) its wavelength and frequency both decrease.

32. A ray of light is incident on a thin film. As shown in figure M, N are two reflected rays and P, Q are two transmitted rays, Rays N and Q undergo a phase change of π. Correct ordering of the refracting indices is :



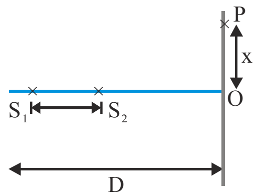
(A) $n_2 > n_3 > n_1$ **(B)** $n_3 > n_2 > n_1$

(C) $n_3 > n_1 > n_2$ **(D)** none of these, the specified changes can not occur

33. Let S_1 and S_2 be the two slits in Young's double slit experiment. If central maxima is observed at P and angle $\angle S_1PS_2 = \theta$, then the fringe width for the light of wavelength λ will be. (Assume θ to be a small angle)

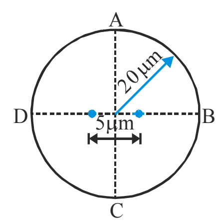
(A) λ/θ **(B)** $\lambda\theta$ **(C)** $2\lambda/\theta$ **(D)** $\lambda/2\theta$

34. Two coherent narrow slits emitting light of wavelength λ in the same phase are placed parallel to each other at a small separation of 3λ. The light is collected on a screen S which is placed at a distance D (>>λ) from the slits. The smallest distance x such that the P is a maxima.



(A) $\sqrt{3}D$ **(B)** $\sqrt{8}D$ **(C)** $\sqrt{5}D$ **(D)** $\sqrt{5}\dfrac{D}{2}$

35. Two point source separated by d = 5 μm emit light of wavelength λ=2 μm in phase. A circular wire of radius 20 μm is placed around the source as shown in figure.



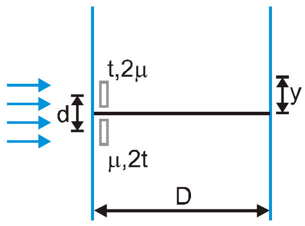
(A) Points A and B are dark and points C and D are bright.

(B) Points A and B are bright and point C and D are dark.

(C) Points A and C are dark and points B and D are bright.

(D) Points A and C are bright and points B and D are dark.

36. 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)** $\dfrac{tD}{d}$ **(C)** $-\dfrac{tD}{d}$ **(D)** None of these

37. Minimum thickness of a mica sheet having $\mu = \dfrac{3}{2}$ which should be placed in front of one of the slits in YDSE is required to reduce the intensity at the centre of screen to half of maximum intensity is-

(A) $\lambda/4$ **(B)** $\lambda/8$ **(C)** $\lambda/2$ **(D)** $\lambda/3$

38. Diffraction and interference of light refers to :–

(A) quantum nature of light **(B)** wave nature of light

(C) transverse nature of light **(D)** electromagnetic nature of light

39. 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 not 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)** $\frac{11\pi}{3}$

40. Sound waves shows more diffraction as compare to light rays :–

(A) wavelength of sound waves is more as compare to light rays

(B) wavelength of light rays is more as compare to sound waves

(C) wavelength of sound waves and light ray is same

(D) none of these

41. The phenomenon of diffraction of light was discovered by :–

(A) Huygens **(B)** Newton **(C)** Fresnel **(D)** Grimaldi

42. Diffraction initiated from obstacle, depends upon the

(A) size of obstacle **(B)** wave length, size of obstacle

(C) wave length and distance of obstacle from screen **(D)** size of obstacle and its distance from screen

43. The conversation going on, in some room, can be heared by the person outside the room. The reason for it is :–

(A) interference of sound **(B)** reflection of sound **(C)** diffraction of sound **(D)** refraction of sound

44. Diffraction of light is observed only, when the obstacle size is :–

(A) very large **(B)** very small

(C) of the same order that of wavelength of light **(D)** any size

45. Phenomenon of diffraction occurs :–

(A) only in case of light and sound waves **(B)** for all kinds of waves

(C) for electro-magnetic waves and not for matter waves **(D)** for light waves only

46. All fringes of diffraction are of :–

(A) the same intensity **(B)** unequal width **(C)** the same width **(D)** full darkness

47. Which of the following ray gives more distinct diffraction :–

(A) X-ray **(B)** light ray **(C)** γ–ray **(D)** Radio wave

48. Direction of the second maximum in the Fraunhofer diffraction pattern at a single slit is given by (a is the width of the slit) :–

(A) $a \sin\theta = \frac{\lambda}{2}$ **(B)** $a \cos\theta = \frac{3\lambda}{2}$ **(C)** $a \sin\theta = \lambda$ **(D)** $a \sin\theta = \frac{3\lambda}{2}$

49. A single slit of width d is placed in the path of beam of wavelength λ. The angular width of the principal maximum obtained is :–

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

50. Red light is generally used to observe diffraction pattern from single slit. If green light is used instead of red light, then diffraction pattern :–

(A) will be more clear **(B)** will be contract **(C)** will be expanded **(D)** will not visualize

51. Angular width (θ) of central maximum of a diffraction pattern of a single slit does not depend upon :–

(A) distance between slit and source **(B)** wavelength of light used

(C) width of the slit **(D)** frequency of light used

52. In single slit Fraunhoffer diffraction which type of wavefront is required :–

(A) cylindrical **(B)** spherical **(C)** elliptical **(D)** plane

54. Central fringe obtained in diffraction pattern due to a single slit :–

(A) is of minimum intensity **(B)** is of maximum intensity

(C) intensity does not depend upon slit width **(D)** none of the above

53. Calculate angular width of central maxima if $\lambda = 6000$ Å, $a = 18 \times 10^{-5}$ cm :–

(A) 20° **(B)** 40° **(C)** 30° **(D)** 260°

55. In the diffraction pattern of a single slit aperture, the width of the central fringe compared to widths of the other fringes, is :–

(A) equal **(B)** less **(C)** little more **(D)** double

56. In the laboratory, diffraction of light by a single slit is being observed. If slit is made slightly narrow, then diffraction pattern will :–

(A) be more spreaded than before **(B)** be less spreaded than before

(C) be spreaded as before **(D)** be disappeared

57. In a single slit diffraction pattern, if the light source is used of less wave length then previous one. Then width of the central fringe will be :–

(A) less **(B)** increase **(C)** unchanged **(D)** none of the above

58. In a Fraunhofer's diffraction by a slit, if slit width is a, wave length λ, focal length of lens is f, linear width of central maxima is :–

(A) $\frac{f\lambda}{a}$ **(B)** $\frac{fa}{\lambda}$ **(C)** $\frac{2f\lambda}{a}$ **(D)** $\frac{f\lambda}{2a}$

59. Find the half angular width of the central bright maximum in the Fraunhofer diffraction pattern of a slit of width 12×10^{-5} cm when the slit is illuminated by monochromatic light of wavelength 6000 Å.

(A) 40° **(B)** 45° **(C)** 30° **(D)** 60°

60. In a Fraunhofer's diffraction obtained by a single slit aperture, the value of path difference for n^{th} order of minima is:–

(A) $n\lambda$ **(B)** $2n\lambda$ **(C)** $\frac{(2n-1)\lambda}{2}$ **(D)** $(2n-1)\lambda$

61. Light waves can be polarised as they are :

(A) Transverse **(B)** Of high frequency **(C)** Longitudinal **(D)** Reflected

62. A polariser is used to :

(A) Reduce intensity of light **(B)** Produce polarised light

(C) Increase intensity of light **(D)** Produce unpolarised light

63. The angle of polarisation for any medium is 60°, what will be critical angle for this :

(A) $\sin^{-1}\sqrt{3}$ **(B)** $\tan^{-1}\sqrt{3}$ **(C)** $\cos^{-1}\sqrt{3}$ **(D)** $\sin^{-1}\frac{1}{\sqrt{3}}$

64. Through which character we can distinguish the light waves from sound waves :

(A) Interference **(B)** Refraction **(C)** Polarisation **(D)** Reflection

65. A polaroid is placed at 45° to an incoming light of intensity I_0. Now the intensity of light passing through polaroid after polarisation would be :

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

66. The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n)

(A) $\sin^{-1}(n)$ **(B)** $\sin^{-1}\left(\frac{1}{n}\right)$ **(C)** $\tan^{-1}\left(\frac{1}{n}\right)$ **(D)** $\tan^{-1}(n)$

67. A ray of light is incident on the surface of a glass plate at an angle of incidence equal to Brewster's angle ϕ. If μ represents the refractive index of glass with respect to air, then the angle between reflected and refracted rays is :

(A) $90+\phi$ **(B)** $\sin^{-1}(\mu\cos\phi)$ **(C)** 90° **(D)** $90° - \sin^{-1}(\sin\phi/\mu)$

68. Plane polarised light is passed through a polaroid. On viewing through the polariod we find that when the polariod is given one complete rotation about the direction of the light, one of the following is observed.

(A) The intensity of light gradually decreases to zero and remains at zero

(B) The intensity of light gradually increases to a maximum and remains at maximum

(C) There is no change in intensity

(D) The intensity of light is twice maximum and twice zero

69. Polarised glass is used in sun glasses because :

(A) It reduces the light intensity to half an account of polarisation

(B) It is fashionable

(C) It has good colour

(D) It is cheaper

70. A beam of light strikes a glass plate at an angle of incident 60° and reflected light is completely polarised than the refractive index of the plate is:-

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

71. When the angle of incidence on a material is 60°, the reflected light is completely polarized. The velocity of the refracted ray inside the material is (in ms^{-1}) :

(A) 3×10^8 **(B)** $\left(\frac{3}{\sqrt{2}}\right)\times10^8$ **(C)** $\sqrt{3}\times10^8$ **(D)** 0.5×10^8

72. When unpolarized light beam is incident from air onto glass (n=1.5) at the polarizing angle :

(A) Reflected beam is polarized 100 percent

(B) Reflected and refracted beams are partially polarized

(C) The reason for (A) is that almost all the light is reflected

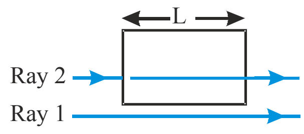
(D) All of the above

73. The path difference between two interfering waves at a point on the screen is $\lambda/6$. The ratio of intensity at this point and that at the central bright fringe will be : (Assume that intensity due to each slit is same)

(A) 0.853 **(B)** 8.53 **(C)** 0.75 **(D)** 7.5

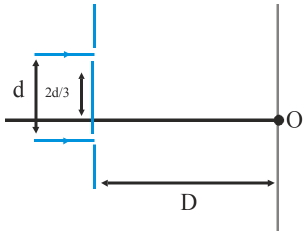
74. As shown in arrangement waves with identical wavelengths and amplitudes and that are initially in phase travel through different media, Ray 1 travels through air and Ray 2 through a transparent medium for equal length L, in four different situations. In each situation the two rays reach a common point on the screen. The number of wavelengths in length L is N_2 for Ray 2 and N_1 for Ray 1. In the following table, values of N_1 and N_2 are given for all four situations, The order of the situations according to the intensity of the light at the common point in descending order is :

Situations	1	2	3	4
N_1	2.25	1.80	3.00	3.25
N_2	2.75	2.80	3.25	4.00



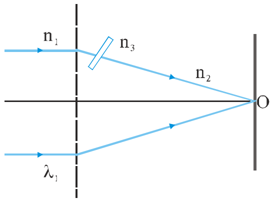
(A) $I_3 = I_4 > I_2 > I_1$ **(B)** $I_1 > I_3 = I_4 > I_2$ **(C)** $I_1 > I_2 > I_3 > I_4$ **(D)** $I_2 > I_3 = I_4 > I_1$

75. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the nearest white spot on the screen from O is : [assume d << D, λ << d]



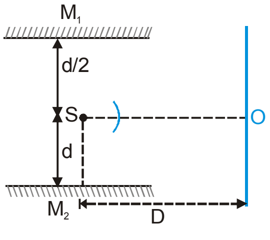
(A) 0 **(B)** d/2 **(C)** d/3 **(D)** d/6

76. In the figure shown in a YDSE, a parallel beam of light is incident on the slits from a medium of refractive index n_1. The wavelength of light in this medium is λ_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)** $\frac{2\pi n_1}{\lambda_1}(n_3 - n_2)\,t$

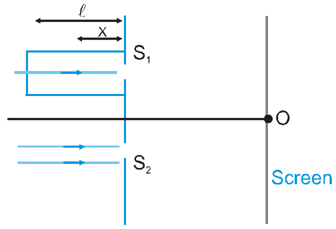
77. M_1 and M_2 are plane mirrors and kept parallel to each other. At point O there will be a maxima for wavelength λ. Light from monochromatic source S of wavelength λ is not reaching directly on the screen. Then λ is : [D >> d >> λ]



(A) $\frac{3d^2}{D}$ **(B)** $\frac{3d^2}{2D}$

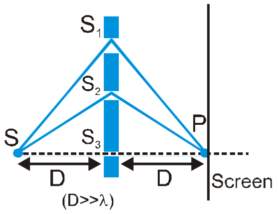
(C) $\frac{d^2}{D}$ **(D)** $\frac{2d^2}{D}$

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



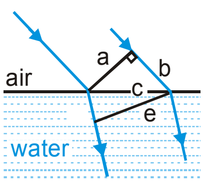
(A) $\frac{\lambda}{\ell}$ **(B)** $\frac{\lambda}{\ell^2}$ **(C)** $\frac{\ell^2}{\lambda}$ **(D)** none of these

79. A monochromatic light source of wavelength λ is placed at S. Three slits S_1, S_2 and S_3 are equidistant from the source S and the point P on the screen. $S_1P - S_2P = \lambda/6$ and $S_1P - S_3P = 2\lambda/3$. If I be the intensity at P when only one slit is open, the intensity at P when all the three slits are open is–



(A) 3 I **(B)** 5 I **(C)** 8 I **(D)** zero

80. Figure shows plane waves refracted from air to water using Huygen's principle a,b,c,d,e are lengths on the diagram. The refractive index of water w.r.t air is the ratio.

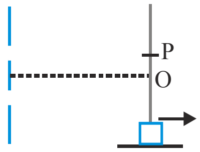


(A) a/e **(B)** b/e **(C)** b/d **(D)** d/b

81. Two monochromatic (wavelength = a/5) and coherent sources of electromagnetic waves are placed on the x-axis at the points (2a,0) and (–a,0). A detector moves in a circle of radius R(>>2a) whose centre is at the origin. The number of maximas detected during one circular revolution by the detector are-

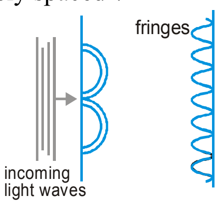
(A) 60 **(B)** 15 **(C)** 64 **(D)** None

82. 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

83. 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.

84. 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 with the curved surface downwards. Monochromatic light is incident normally from the top. The observed interference fringes from the combination do not follow on of the following statements.

(A) The fringes are straight and parallel to the length of the piece.

(B) The line of contact of the cylindrical glass piece and the glass plate appears dark.

(C) The fringe spacing increases as we go outwards.

(D) The fringes are formed due to the interference of light rays reflected from the curved surface of the cylindrical piece and the top surface of the glass plate.

85. A circular planar wire loop is dipped in a soap solution and after taking it out, held with its plane vertical in air. Assuming thickness of film at the very small, as sunlight falls on the soap film, & observer receive reflected light.

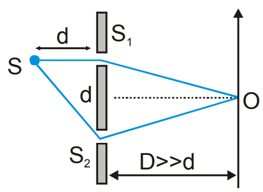
(A) The top portion appears dark while the first colour to be observed as one moves down is red.

(B) The top portion appears violet while the first colour to be observed as one moves down in indigo.

(C) The top potion appears dark while the first colour to be observed as one move down in violet.

(D) The top portion appears dark while the first colour to be observed as one move down depends on the refractive index of the soap solution.

86. 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 infront of S_1.

(B) The thickness of sheet is $(\sqrt{2}-1)$ d infront of S_2.

(C) The thickness of sheet is $2\sqrt{2}d$ infront of S_1.

(D) The thickness of sheet is $(2\sqrt{2}-1)$ d infront of S_1.

87. A parallel coherent beam of light falls on fresnel biprism of refractive index μ and angle α. The fringe width on a screen at a distance D from biprism will be (wavelength = λ)

(A) $\frac{\lambda}{2(\mu-1)\alpha}$ **(B)** $\frac{\lambda D}{2(\mu-1)\alpha}$ **(C)** $\frac{D}{2(\mu-1)\alpha}$ **(D)** None of these

88. Ratio of intensities of two light waves is given by 4 : 1. The ratio of the amplitudes of the waves is :

(A) 2 : 1 **(B)** 1 : 2 **(C)** 4 : 1 **(D)** 1 : 4

89. Soap bubble appears coloured due to the phenomenon of :–

(A) interference **(B)** diffraction **(C)** dispersion **(D)** reflection

90. The contrast in the fringes in any interference pattern depends on :

(A) Fringe width **(B)** Wavelength

(C) Intensity ratio of the sources **(D)** Distance between the sources

91. 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

92. In a YDSE: D = 1 m, d = 1 mm and λ = 500 nm. The distance of 1000^{th} maxima from the central maxima is:

(A) 0.5 m **(B)** 0.577 m **(C)** 0.495 m **(D)** does not exist

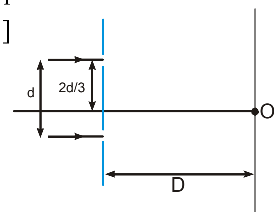
93. In a Young's double slit experiment, d = 1 mm, λ = 6000 Å & D = 1 m. The slits produce same intensity on the screen. The minimum distance between two points on the screen having 75 % intensity of the maximum intensity is:

(A) 0.45 mm **(B)** 0.40 mm **(C)** 0.30 mm **(D)** 0.20mm

94. Yellow light emitted by sodium lamp in Young's double slit experiment is replaced by monochromatic blue light of the same intensity :

(A) fringe width will decrease.
(B) fringe width will increase.
(C) fringe width will remain unchanged.
(D) fringes will become less intense.

95. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the nearest white spot on the screen from O is: [assume d << D, λ << d]

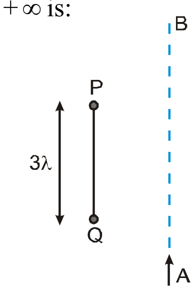


(A) 0
(B) d/2
(C) d/3
(D) d/6

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

(A) X(blue) = X(green) **(B)** X(blue) > X(green) **(C)** X(blue) < X(green) **(D)** $\frac{X(\text{blue})}{X(\text{green})} = \frac{5460}{4360}$

97. Two coherent light sources each of wavelength λ are separated by a distance 3 λ. The total number of minima formed on line AB which runs from - ∞ to + ∞ is:



(A) 2 **(B)** 4 **(C)** 6 **(D)** 8

98. A two slit Young's interference experiment is done with monochromatic light of wavelength 6000 Å. The slits are 2 mm apart. The fringes are observed on a screen placed 10 cm away from the slits. Now a transparent plate of thickness 0.5 mm is placed in front of one of the slits and it is found that the interference pattern shifts by 5 mm. The refractive index of the transparent plate is :

(A) 1.2 **(B)** 0.6 **(C)** 2.4 **(D)** 1.5

99. In a YDSE both slits produce equal intensities on the screen. A 100 % transparent thin film is placed in front of one of the slits. Now the intensity of the geometrical centre of system on the screen becomes 75 % of the previous intensity. The wavelength of the light is 6000Å and μ_{glass} = 1.5. The thickness of the film cannot be:

(A) 0.2 μm **(B)** 1.0 μm **(C)** 1.4 μm **(D)** 1.6 μm

100. A slit of size 0.15 cm is placed at 2.1 m from a screen. On illuminated it by a light of wavelength 5 x 10^{-5} cm. The width of diffraction pattern will be:-

(A) 70 mm **(B)** 0.14 mm **(C)** 1.4 cm **(D)** 0.14 cm

101. White light is incident normally on a glass plate (in air) of thickness 500 nm and refractive index of 1.5. The wavelength (in nm) in the visible region (400 nm - 700nm) that is strongly reflected by the plate is:

(A) 450 **(B)** 600 **(C)** 400 **(D)** 500

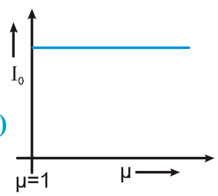
102. If the ratio of the intensity of two coherent sources is 4 then the visibility $[(I_{max} - I_{min})/(I_{max} + I_{min})]$ of the fringes is

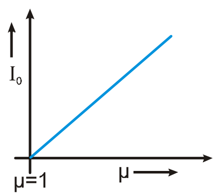
(A) 4 **(B)** 4/5 **(C)** 3/5 **(D)** 9

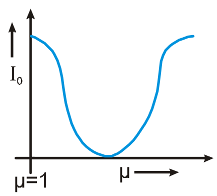
103. In a Young's double slit experiment the slit is illuminated by a source having two wavelengths of 400 nm and 600 nm. If distance between slits, d = 1mm, and distance between the plane of the slit and screen, D = 10 m then the smallest distance from the central maximum where there is complete darkness is :

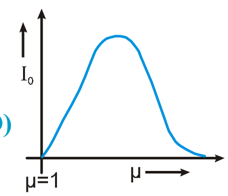
(A) 2mm **(B)** 3mm **(C)** 12 mm **(D)** there is no such point

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

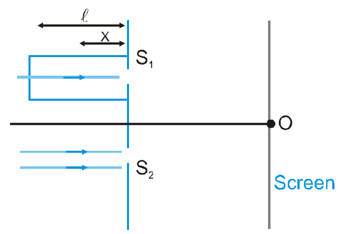
(A) 

(B) 

(C) 

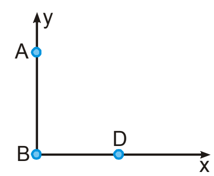
(D) 

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



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

106. An interference is observed due to two coherent sources 'A' & 'B' having phase constant zero separated by a distance 4 λ along the y – axis where λ is the wavelength of the source. A detector D is moved on the positive x – axis. The number of points on the x – axis excluding the points x = 0 & x = ∞ at which maximum will be observed is

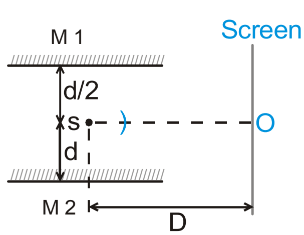


(A) three **(B)** four **(C)** two **(D)** infinite

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

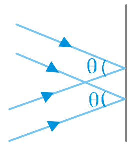
(A) 2 cm only **(B)** 4 cm only **(C)** 2m, $\frac{2}{3}$ cm, $\frac{2}{5}$ cm **(D)** 4cm, $\frac{4}{3}$ cm, $\frac{4}{5}$ cm

108. M1 and M2 are two plane mirrors which are kept parallel to each other as shown. There is a point 'O' on perpendicular screen just infront of 'S'. What should be the wavelength of light coming from monchromatic source 'S'. So that a maxima is formed at 'O' due to interference of reflected light from both the mirrors. [Consider only 1st reflection]. [D >> d, d >> λ]



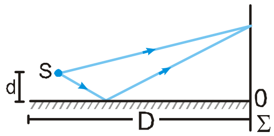
(A) $\frac{3d^2}{D}$ **(B)** $\frac{3d^2}{2D}$ **(C)** $\frac{d^2}{D}$ **(D)** $\frac{2d^2}{D}$

109. Two parallel beams of light of wavelength λ inclined to each other at angle θ (<<1) are incident on a plane at near normal incidence. The fringe width will be :



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

110. A long narrow horizontal slit lies 1 mm above a plane mirror. The interference pattern produced by the slit and its image is viewed on a screen Σ distant 1m from the slit. The wavelength of light is 600 nm. Then the distance of the first maxima above the mirror is equal to (d << D):



(A) 0.30 mm (B) 0.15 mm

(C) 60 mm (D) 7.5 mm

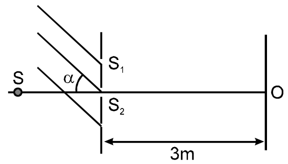
111. A parallel monochromatic beam of light is incident normally on a narrow slit. A diffraction pattern is formed on a screen placed perpendicular to the direction of the incident beam. At the first minimum of the diffraction pattern, the phase difference between the rays coming from the two edges of the slit is:

(A) 0 (B) $\pi/2$ (C) π (D) 2π

Exercise # 2

Part # I [Multiple Correct Choice Type Questions]

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



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

(B) the intensity at O is zero

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

(D) the intensity at a point on the screen 4m from O is zero

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

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

(B) the intensities at the screen due to the two slits are 4 and 1 units

(C) the amplitude ratio of the individual waves is 3

(D) the amplitude ratio of the individual waves is 2

3. A Young's double slit experiment is performed with white light:

(A) The maxima next to the central will be red.

(B) The central maxima will be white

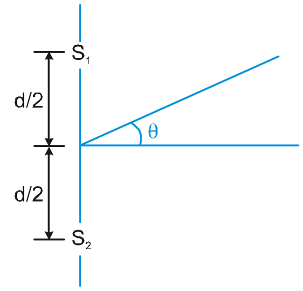
(C) The maxima next to the central will be violet

(D) There will not be a completely dark fringe.

4. If the first minima in a Young's slit experiment occurs directly in front of one of the slits, (distance between slit & screen D = 12 cm and distance between slits d = 5 cm) then the wavelength of the radiation used can be :

(A) 2 cm **(B)** 4 cm **(C)** $\frac{2}{3}$ cm **(D)** $\frac{4}{3}$ cm

5. In an interfrence 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 and screen is at very large distance from slits. The intensity $I(\theta)$ is measured as a function of θ, where θ is defined as shown. Screen is at a large distance. If I_0 is the maximum intensity then $I(\theta)$ for $0 \le \theta \le 90°$ is given by:



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

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

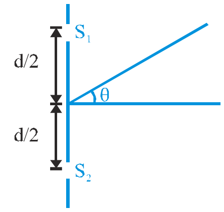
(C) $I(\theta) = I_0$ for $\theta = 0°$

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

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

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

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



(A) $I(\theta) = I_0/2$ for $\theta = 30°$ **(B)** $I(\theta) = I_0/4$ for $\theta = 90°$

(C) $I(\theta) = I_0$ for $\theta = 0°$ **(D)** $I(\theta)$ is constant for all values of θ

8. In young's double slit experiment, slits are arranged in such a way that besides central bright fringe, there is only one bright fringe on either side of it. Slit separation d for the given condition cannot be (if λ is wavelength of the light used) :

(A) λ **(B)** $\lambda/2$ **(C)** 2λ **(D)** $3\lambda/2$

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

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

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

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

(D) The fringe width will remain unchanged

Part # II [Assertion & Reason Type Questions]

In each of the following questions, a Assertion of Statement -1 and Statement - 2 of Reason.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1

(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1

(C) Statement–1 is True, Statement–2 is False.

(D) Statement–1 is False, Statement–2 is True.

(E) Statement–1 is False, Statement–2 is False.

1. **Statement–1 :** In YDSE, if a thin film is introduced in front of the upper slit, then the fringe pattern shifts in the downward direction.

Statement–2 : In YDSE if the slit widths are unequal, the minima will be completely dark

2. **Statement–1 :** If white light is used in YDSE, then the central bright fringe will be white

Statement–2 : In case of white light used in YDSE, all the wavelengths produce their zero order maxima at the same position

3. **Statement–1:** In YDSE, interference pattern disappears when one of the slits is closed.

Statement–2 : In YDSE, interference occurs due to super–imposition of light wave from two coherent sources.

4. **Statement–1:** The phase difference between any two points on a wave front is zero.

Statement–2 : Light from the source reaches every point of the wave front at the same time.

5. **Statement–1 :** In YDSE central maxima means the maxima formed with zero optical path difference. It may be formed anywhere on the screen.

Statement–2 : In an interference pattern, whatever energy disappears at the minimum, appears at the maximum.

6. **Statement–1:** Two coherent point sources of light having nonzero phase difference are seperated by small distance. Then on the perpendicular bisector of line segment joining both the point sources, constructive interference cannot be obtained.

Statement–2: For two waves from coherent point sources to interfere constructively at a point, the magnitude of their phase difference at that point must be $2m\pi$ (where m is a nonnegative integer) .

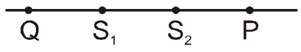
7. **Statement–1:** No interference pattern is detected when two coherent sources are infinitely close to each other.

Statement–2 : The fringe width is inversely proportional to the distance between the two slits.

8. **Statement–1 :** As light travels from one medium to another, the frequency of light doesn't change.

Statement–2 : Frequency is the characteristic of source.

9. **Statement–1:** Two point coherent sources of light S_1 and S_2 are placed on a line as shown. P and Q are two points on that line. If at point P maximum intensity is observed then maximum intensity should also be observed at Q.



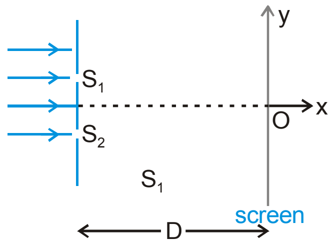
Statement–2: In the figure of statment 1, the distance $|S_1P - S_2P|$ is equal to distance $|S_2Q - S_1Q|$.

10. **Statement–1:** Thin films such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.

Statement–2: It happens due to the interference of light reflected from the upper surface of the thin film.

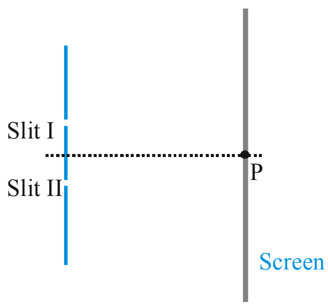
Exercise # 3 Part # I [Matrix Match Type Questions]

1. A monochromatic parallel beam of light of wavelength λ is incident normally on the plane containing slits S_1 and S_2. The slits are of unequal width such that intensity only due to one slit on screen is four times that only due to the other slit. The screen is placed perpendicular to x-axis as shown. The distance between slits is d and that between screen and slit is D. Match the statements in column-I with results in column-II. ($S_1S_2 << D$ and $\lambda << S_1S_2$)



Column-I	Column-II
(A) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{1}{9}$ th of maximum intensity.	**(P)** $\frac{D\lambda}{3d}$
(B) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{3}{9}$ th of maximum intensity.	**(Q)** $\frac{D\lambda}{d}$
(C) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{5}{9}$ th of maximum intensity.	**(R)** $\frac{2D\lambda}{d}$
(D) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{7}{9}$ th of maximum intensity.	**(S)** $\frac{3D\lambda}{d}$

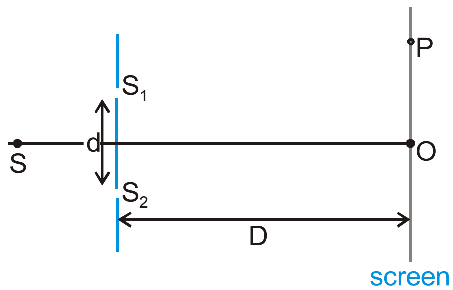
2. A double slit interference pattern is produced on a screen, as shown in the figure, using monochromatic light of wavelength 500nm. Point P is the location of the central bright fringe, that is produced when light waves arrive in phase without any path difference. A choice of three strips A, B and 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
		(T)	Fifth bright

3. In a typical Young's double slit experiment, S_1 and S_2 are identical slits and equidistant from a point monochromatic source S of light having wavelength λ. The distance between slits is represented by d and that between slits and screen is represented by D. P is a fixed point on the screen at a distance $y = \frac{\lambda D_o}{2d_o}$ from central order bright on the screen: where D_o, d_o are initial values of D and d respectively. In each statement of column-I some changes are made to above mentioned situation. The distance between the slits and the source is very large. The effect of corresponding changes is given in column-II. Match the statements in column-I with resulting changes in column-II.



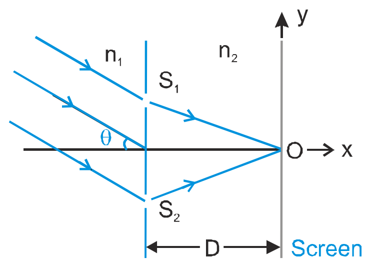
	Column-I		Column-II
(A)	The distance d between the slits is doubled keeping distance between slits and screen fixed	(P)	fringe width increases .
(B)	The distance D between slit and screen is doubled by shifting screen to right	(Q)	Magnitude of optical path difference between interfering waves at P will decrease.
(C)	The width of slit S_1 is decreased (such that intensity of light due to slit S_1 on screen decreases) and the distance D between slit and screen is doubled by shifting screen to right	(R)	Magnitude of optical path difference between interfering waves at P will increase.
(D)	The whole setup is submerged in water of refractive index $\frac{4}{3}$. (neglecting absorption in medium)	(S)	The intensity at P will increase

Part # II [Comprehension Type Questions]

Comprehension # 1

In the figure an arrangement of young's double slit experiment is shown. A parallel beam of light of wavelength 'λ' (in medium n_1) is incident at an angle 'θ' as shown. Distance $S_1O = S_2O$. Point 'O' is the origin of the coordinate system. The medium on the left and right side of the plane of slits has refractive index n_1 and n_2 respectively. Distance between the slits is d. The distance between the screen and the plane of slits is D.

Using D = 1m, d = 1mm, $\theta = 30°$, $\lambda = 0.3$mm, $n_1 = \frac{4}{3}$, $n_2 = \frac{10}{9}$, answer the following



1. The y-coordinate of the point where the total phase difference between the interefering waves is zero, is

(A) y = 0 **(B)** $y = +\frac{3}{4}$ m **(C)** $y = -\frac{3}{4}$ m **(D)** $-\frac{1}{\sqrt{3}}$ m

2. If the intensity due to each light wave at point 'O' is I_0 then the resultant intensity at point 'O' will be -

(A) Zero **(B)** $2I_0\left(1+\cos\frac{40\pi}{9}\right)$ **(C)** $3I_0$ **(D)** I_0

3. y-coordinate of the nearest maxima above 'O' will be -

(A) $\frac{150}{\sqrt{154}}$ cm **(B)** 24 cm **(C)** $\frac{100}{\sqrt{99}}$ cm **(D)** None of these

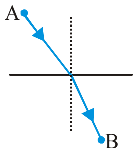
Comprehension # 2

The lens governing the behavior of the rays namely rectilinear propagation, laws of reflection and refraction can be summarised in one fundamental law known as Fermat's principle. According to this principle a ray of light travels from one point to another such that the time taken is at a stationary value (maximum or minimum). If c is the velocity of light in a vacuum, the velocity in a medium of refractive index μ is $\frac{c}{\mu}$, hence time taken to travel a distance ℓ is $\frac{\mu\ell}{c}$. If the light passes through a number of media, the total time taken is $\left(\frac{1}{c}\right)\sum\mu\ell$ or $\frac{1}{c}\int\mu d\ell$ if refractive index varies continuously. Now, $\sum\mu\ell$ is the total optical path, so that Fermat's principle states that the path of a ray is such that the optical path in at a stationary value. This principle is obviously in agreement with the fact that the ray are straight lines in a homogenous isotropic medium. It is found that it also agrees with the classical laws of reflection and refraction.

1. If refractive index of a slab varies as $\mu = 1 + x^2$ where x is measured from one end, then optical path length of a slab of thickness 1 m is :

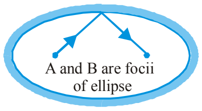
(A) $\frac{4}{3}$m (B) $\frac{3}{4}$m (C) 1 m (D) None

2. The optical path length followed by ray from point A to B given that laws of refraction are obeyed as shown in figure.



(A) Maximum (B) Minimum (C) Constant (D) None

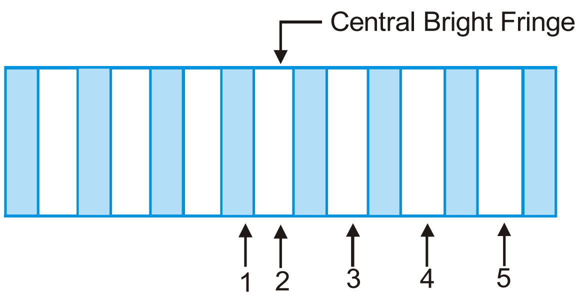
3. The optical path length followed by ray from point A to B given that laws of reflection are obeyed as shown in figure is



(A) Maximum (B) Minimum (C) Constant (D) None

Comprehension # 3

The figure shows the interference pattern obtained in a double–slit experiment using light of wavelength 600nm.



1. The third order bright fringe is

(A) 2 (B) 3 (C) 4 (D) 5

2. Which fringe results from a phase difference of 4π between the light waves incidenting from two slits?

(A) 2 (B) 3 (C) 4 (D) 5

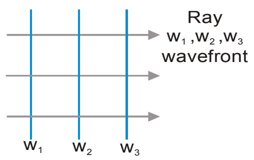
3. Let ΔX_A and ΔX_C represent path differences between waves interfering at 1 and 3 respectively then $(|\Delta X_C| - (|\Delta X_A|)$ is equal to

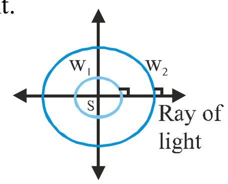
(A) 0 (B) 300 mn (C) 600 nm (D) 900 nm

Comprehension # 4

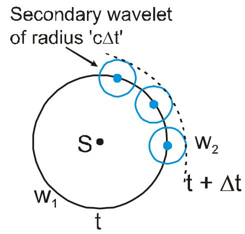
Huygen was the first scientist who proposed the idea of wave theory of light. He said that the light propagates in form of wavefronts. A wavefront is an imaginary surface of every point of which waves are in the same phase.

For example the wavefronts for a point source of light is collection of concentric spheres which have centre at the origin. w_1 is a wavefront. w_2 is another wavefront.





The radius of the wavefront at time 't' is 'ct' in this case where 'c' is the speed of light. The direction of propagation of light is perpendicular to the surface of the wavefront. The wavefronts are plane wavefronts in case of a parallel beam of light.



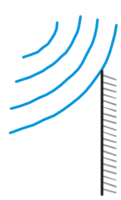
Huygen also said that every point of the wavefront acts as the source of secondary wavelets. The tangent drawn to all secondary wavelets at a time is the new wavefront at that time. The wavelets are to be considered only in the forward direction (i.e. the direction of propagation of light) and not in the reverse direction. If a wavefront w_1 at time t is given, then to draw the wavefront at time $t + \Delta t$ take some points on the wavefront w_1 and draw spheres of radius'$c\Delta t$'. They are called secondary wavelets.

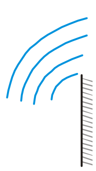
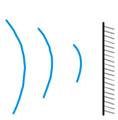
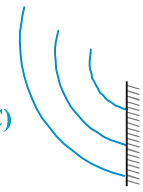
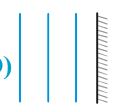
Draw a surface w_2 which is tangential to all these secondary wavelets. w_2 is the wavefront at time '$t + \Delta t$'. Huygen proved the laws of reflection and laws of refraction using concept of wavefronts.

1. A point source of light is placed at origin, in air. The equation of wavefront of the wave at time t, emitted by source at t = 0, is (Take refractive index of air as 1)

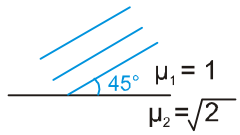
(A) $x + y + z = ct$ **(B)** $x^2 + y^2 + z^2 = t^2$ **(C)** $xy + yz + zx = c^2t^2$ **(D)** $x^2 + y^2 + z^2 = c^2 t^2$

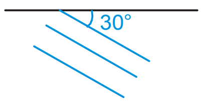
2. Spherical wavefronts shown in figure, strike a plane mirror. Reflected wavefront will be as shown in

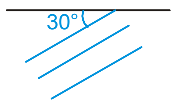


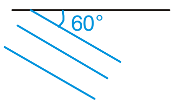
(A)  **(B)**  **(C)**  **(D)** 

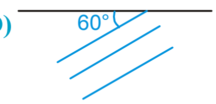
3. Wavefronts incident on an interface between the media are shown in the figure. The refracted wavefront will be as shown in



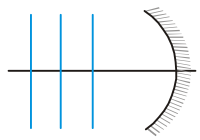
(A) 

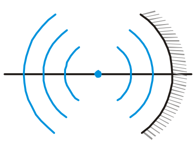
(B) 

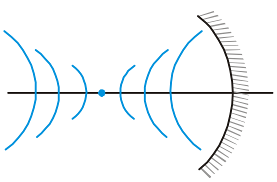
(C) 

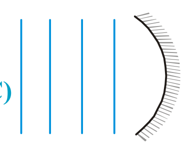
(D) 

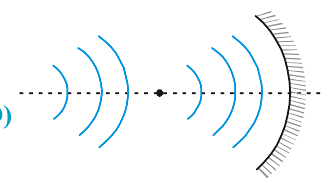
4. Plane wavefronts are incident on a spherical mirror as shown in the figure. The reflected wavefronts will be



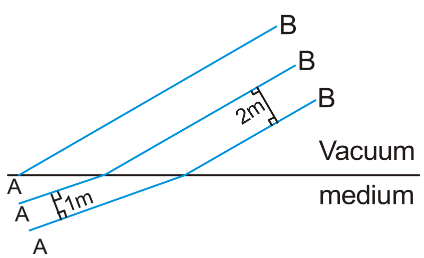
(A) 

(B) 

(C) 

(D) 

5. Certain plane wavefronts are shown in figure. The refractive index of medium is



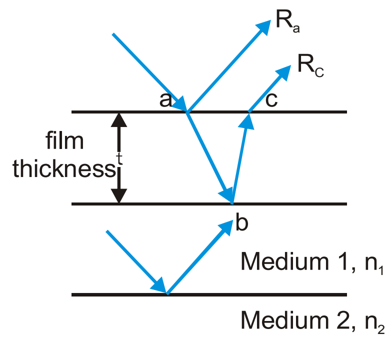
(A) 2 **(B)** 4 **(C)** 1.5 **(D)** Cannot be determined

6. The wavefront of a light beam is given by the equation x + 2y + 3z = c, (where c is arbitrary constant) then the angle made by the direction of light with the y–axis is:

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

Comprehension # 5

Thin films, including soap bubbles and oil slicks, show patterns of alternating dark and bright regions resulting from interference among the reflected light waves. If two waves are in phase their crest and troughs will coincide. The interference will be constructive and the amplitude of the resultant wave will be greater than the amplitude of either constituent wave. If the two waves are out of phase, the crests of one wave will coincide with the troughs of the other wave. The interference will be destructive and the amplitude of the resultant wave will be less than that of either constituent wave. At the interface between two transparent media, some light is reflected and some light is refracted.



- When incident light, reaches the surface at point a, some of the light is reflected as ray R_a and some is refracted following the path ab to the back of the film.
- At point b some of the light is refracted out of the film and part is reflected back through the film along path bc. At point c some of the light is reflected back into the film and part is refracted out of the film as ray R_c.

  R_a and R_c are parallel. However, R_c has travelled the extra distance within the film of abc. If the angle of incidence is small, then abc is approximately twice the film's thickness. If R_a and R_c are in phase, they will undergo constructive interference and the region ac will be bright. If R_a and R_c are out of phase, they will undergo destructive interference.
- Refraction at an interface never changes the phase of the wave.
- For reflection at the interface between two media 1 and 2, if $n_1 < n_2$ the reflected wave will change phase by π. If $n_1 > n_2$ the reflected wave will not undergo a phase change. For reference $n_{air} = 1.00$.
- If the waves are in phase after reflection at all interfaces, then the effects of path length in the film are:

  Constructive interference occur when : (n = refractive index) $2t = m\lambda/n$ $m = 0, 1, 2, 3$.........

  Destructive interference occurs when : $2t = (m + 1/2)\lambda/n$ $m = 0, 1, 2, 3$.........

  If the waves are 180° out of phase after reflection at all interfaces then the effects of path length on the film are :

  Constructive interference occurs when : $2t = (m + 1/2)\lambda/n$ $m = 0, 1, 2, 3$..........

  Destructive interference occurs when : $2t = m\lambda/n$ $m = 0, 1, 2, 3$.........

1. A thin film with index of refraction 1.50 coats a glass lens with index of refraction 1.80. What is the minimum thickness of the thin film that will strongly reflect light with wavelength 600 nm ?

(A) 150 nm **(B)** 200 nm **(C)** 300 nm **(D)** 450 nm

2. A thin film with index of refraction 1.33 coats a glass lens with index of refraction 1.50. Which of the following choices is the smallest film thicknesses that will not reflect light with wavelength 640 nm ?

(A) 160 nm **(B)** 240 nm **(C)** 360 nm **(D)** 480 nm

3. A soap film of thickness t is surrounded by air and is illuminated at near normal incidence by monochromatic light with wavelength λ in the film. With respect to the wavelength of the monochromatic light in the film, what film thickness will produce maximum constructive interference in the reflected light

(A) $\frac{\lambda}{4\mu}$ **(B)** $\frac{\lambda}{2\mu}$ **(C)** $\mu\lambda$ **(D)** $2\mu\lambda$

4. The average human eye sees colors with wavelengths between 430 nm to 680 nm. For what visible wavelength will a 350 nm thick n = 1.35 soap film produce maximum destructive interference ?

(A) 560 nm **(B)** 473 nm **(C)** 610 nm **(D)** none of these

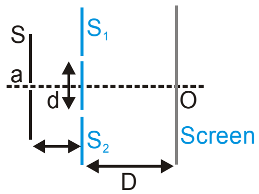
5. A 600 nm light is perpendicularly incident on a soap film suspended in air. The film is 1.00 µm thick with n = 1.35. Which statement most accurately describes the interference of the light reflected by the two surfaces of the film ?

(A) The waves are close to destructive interference **(B)** The waves are close to constructive interference

(C) The waves show complete destructive interference **(D)** The waves show complete constructive interference

Comprehension # 6

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



1. 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 wavelength coincide

2. 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

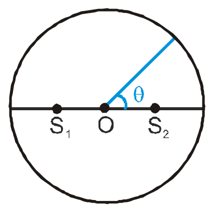
3. If the distance d is varied, then identify the correct statement–

(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

Exercise # 4 [Subjective Type Questions]

1. Two coherent sources S_1 and S_2 separated by distance 2λ emit light of wavelength λ in phase as shown in the figure. A circular wire of radius 100 λ is placed in such a way that S_1 S_2 lies in its plane and the mid–point of S_1S_2 is at the centre of wire.

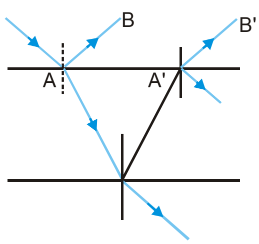


(i) Find the angular positions θ on the wire for which constructive interference takes place. Hence or otherwise find the number of maxima.

(ii) Find the angular positions θ on the wire for which intensity reduces to half of its maximum value.

2. Consider interference between two sources of intensity I and 4I. Find out resultant intensity where phase difference is **(i)** $\pi/4$ **(ii)** π **(iii)** 4π

3. 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 refracted. The rays AB and A'B' undergo interference. Find the ratio $I_{max}/I_{min.}$



4. In a double–slit experiment, fringes are produced using light of wavelength 4800 A°. One slit is covered by a thin plate of glass of refractive index 1.4 and the other slit by another plate of glass of double thickness and of refractive index 1.7. On doing so, the central bright fringe shifts to a position originally occupied by the fifth bright fringe from the centre. Find the thickness of the glass plates.

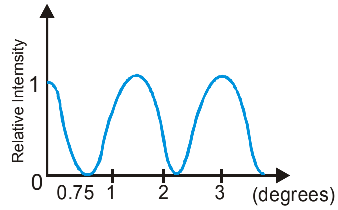
5. In Young's experiment for interference of light the slits 0.2 cm apart are illuminated by yellow light (λ = 5896 A°). What would be the fringe width on a screen placed 1m from the plane of slits ? What will be the fringe width if the system is immersed in water. (Refractive index = 4/3)

6. A thin glass plate of thickness t and refractive index μ is inserted between screen and 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.

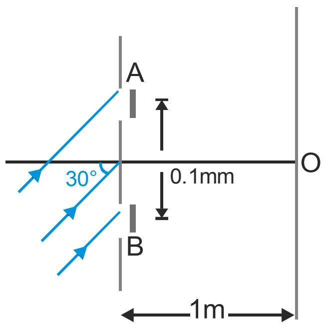
7. Young's double slit experiment is carried out using microwaves of wavelength λ = 3 cm. Distance in between plane of slits and the screen is D = 100 cm and distance in between the slits is 5 cm. Find :**(i)** The number of maximas and **(ii)** Their positions on the screen

8. In a two–slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5}. If the distance between the slits is 10^{-3} m, calculate the wavelength of the light used.

9. Light of wavelength 520nm passing through a double slit, produces interference pattern of relative intensity versus deflection angle θ as shown in the figure. Find the separation d between the slits.



10. In a YDSE a parallel beam of light of wavelength 6000Å is incident on slits at angle of incidence 30°. A and B are two thin transparent films each of refractive index 1.5. Thickness of A is 20.4 μm. Light coming through A and B have intensities I and 4I respectively on the screen. Intensity at point O which is symmetric relative to the slits is 3I. The central maxima is above O.



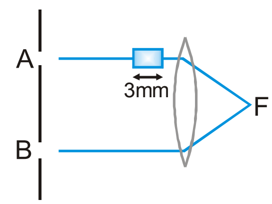
(i) What is the maximum thickness of B to do so. Assuming thickness of B to be that found in part **(i)** answer the following parts.

(ii) Find fringe width, maximum intensity and minimum intensity on screen.

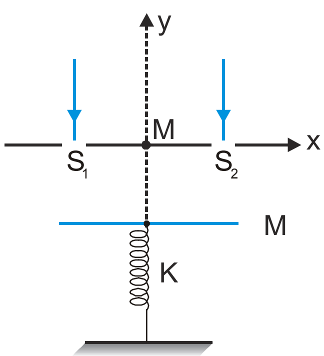
(iii) Distance of nearest minima from O.

(iv) Intensity at 5 cm on either side of O.

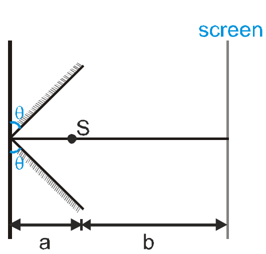
11. Two identical monochromatic light sources A & B intensity 10^{-15}W/m² produce wavelength of light $4000\sqrt{3}$Å. A glass of thickness 3mm is placed in the path of the ray as shown in figure. The glass has a variable refractive index $n = 1+\sqrt{x}$ where x (in mm) is distance of plate from left to right. Calculate total intensity at focal point F of the lens.



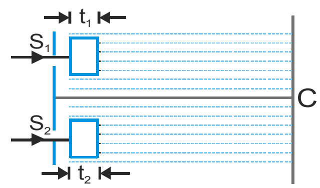
12. Two slits S_1 and S_2 on the x–axis and symmetric with respect to y–axis are illuminated by a parallel monochromatic light beam of wavelength λ. The distance between the slits is d (>> λ). Point M is the mid point of the line S_1S_2 and this point is considered as the origin. The slits are in horizontal plane. The interference pattern is observed on a horizontal plate (acting as screen) of mass M, which is attached to one end of a vertical spring of spring constant K. The other end of the spring is fixed to ground. At t=0 the plate is at a distance D(>>d) below the plane of slits and the spring is in its natural length. The plate is left from rest from its initial position. Find the x and y co–ordinates of the n^{th} maxima on the plate as a function of time. Assume that spring is light and plate always remains horizontal.



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

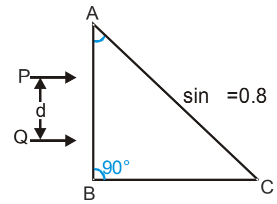


14. A screen is at a distance D=80 cm from a diaphragm having two narrow slits S_1 and S_2 which are d=2 mm apart. Slit S_1 is covered by a transparent sheet of thickness t_1=2.5 μm and S_2 by another sheet of thickness t_2 = 1.25 μm as shown in figure. Both sheets are made of same material having refractive index μ=1.40.



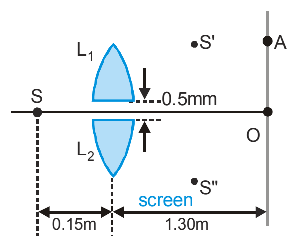
Water is filled in space between diaphragm and screen. A monochromatic light beam of wavelength λ=5000Å is incident normally on the diaphragm. Assuming intensity of beam to be uniform and slits of equal width, calculate ratio of intensity at C to maximum intensity of interference pattern obtained on the screen, where C is foot of perpendicular bisector of S_1S_2. (Refractive index of water, $\mu_w = \frac{4}{3}$)

15. Two parallel beams of light P and Q (separation d) containing radiations of wavelengths 4000Å and 5000Å (which are mutually coherent in each wavelength separately) are incident normally on a prism as shown in figure The refractive index of the prism as a function of wavelength is given by the relation, $\mu(\lambda) = 1.20 + \frac{b}{\lambda^2}$, where λ is in Å and b is a positive constant.



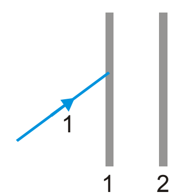
The value of b is such that the condition for total reflection at the face AC is just satisfied for one wavelength and is not satisfied for the other. A convergent lens is used to bring these transmitted beams into focus. If the intensities of the upper and the lower beams immediately after transmission from the face AC, are 4I and I respectively, find the resultant intensity at the focus.

16. In the figure shown S is a monochromatic point source emitting light of wavelength = 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 and L_2 to O is 1.30 m.



The screen at O is normal to SO. **(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 and L_2 is reduced from its original value of 0.5 mm, will the distance OA increase decrease or remain the same?

17. A narrow monochromatic beam of light of intensity I is incident on a glass plate as shown in figure. Another identical glass plate is kept close to the first one & parallel to it. Each glass plate reflects 25% of the light incident on it & transmits the remaining. Find the ratio of the minimum & the maximum intensities in the interference pattern formed by the two beams obtained after one reflection at each plate.



18. An electromagnetic wave travelling through a transparent medium is given by

$E_x(y,t) = E_{ox} \sin 2\pi\left[\frac{y}{5\times10^{-7}} - 3\times10^{14}t\right]$ in SI units. Then what is the refractive index of the medium?

19. Two sources of intensity I & 4 I are used in an interference experiment. Find the intensity at points where the waves from the two sources superimpose with a phase difference of

(a) zero **(b)** $\frac{\pi}{2}$ & **(c)** They meet at phase difference of π.

20. Two slits separated by a distance of 1 mm, are illuminated with red light of wavelength 6.5×10^{-7} m. The interference fringes are observed on a screen placed 1 m from the slits. Find the distance between the third dark fringe and the fifth bright fringe on the same side of the central maxima.

21. What is the effect on the the fringe width of interference fringes in a Young's double slit experiment due to each of the following operations.

(a) The screen is moved away from the plane of the slits.

(b) the (monochromatic) source is replaced by another (monochromatic) source of shorter wavelength.

(c) The separation between the two slits is increased.

(d) The width of two slits are slightly increased.

[In each operation, take all parameters, other than the one specified to remain unchanged]

22. Find the angular fringe width in a Young's double slits experiment with blue-green light of wavelength 6000 Å. The separation between the slits is 3.0×10^{-3} m.

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

24. A flint glass and a crown glass are fitted on the two slits of a double slit apparatus. The thickness of the strips is 0.40 mm and the separation between the slits is 0.12 cm. The refractive index of flint glass and crown glass are 1.62 and 1.52 respectively for the light of wavelength 480 nm which is used in the experiment. The interference is observed on a screen a distance one meter away. **(a)** What would be the fringe-width? **(b)** At what distance from the geometrical centre will the nearest maximum be located?

25. A source emitting two light waves of wavelengths 580 nm and 700 nm is used in a young's double slit interference experiment. The separation between the slits is 0.20 mm and the interference is observed on a screen placed at 150 cm from the slits. Find the linear separation between the first maximum (next to the central maximum) corresponding to the two wavelengths.

26. Find the thickness of a plate which will produce a change in optical path equal to one fourth of the wavelength λ of the light passing through it normally. The refractive index of the plate is μ.

27. A soap film of thickness 0.3 μm appears dark when seen by the refracted light of wavelength 580 nm. What is the index of refraction of the soap solution, if it is known to be between 1.3 and 1.5?

28. A parallel beam of monochromatic light of wavelength λ is used in a Young's double slit experiment. The siits are separated by a distance d and the screen is placed parallel to the plane of the slits. The incident beam makes an angle $\theta = \sin^{-1}\left(\frac{\lambda}{2d}\right)$ with the normal to the plane of the slits. A transparent sheet of refractive index. 'μ' and thickness t $= \frac{\lambda}{2(\mu - 1)}$ is introduced infront of one of the slit. find the intensity at the geometrical centre .

29. A slit of width 'a' is illuminated by light of wavelength 6000 A^0 FOR What value of 'a will the :-

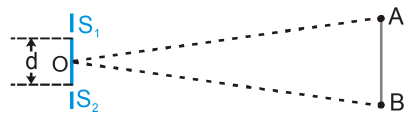
(i) First maximum fall at an angle of diffraction of 30^0?

(ii) First minimum fall at an angle of diffraction 30^0?

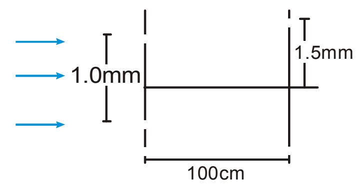
30. A parallel beam of light of wavelength 560 nm falls on a thin film of oil (refractive index = 1.4). What should be the minimum thickness of the film so that it weakly transmits the light?

31. A beam of light consisting of two wavelengths, 6500 Å and 5200 Å is used to obtain slit experiment (1 Å = 10^{-10} m). The distance between the slits is 2.0 mm and the distance between the plane of the slits and the screen is 120 cm. **(a)** Find the distance of the third bright fringe on the screen from the central maximum for the wavelength 6500 Å. **(b)** What is the least distance from the central maximum where the bright fringes due to both the wavelengths coincide?

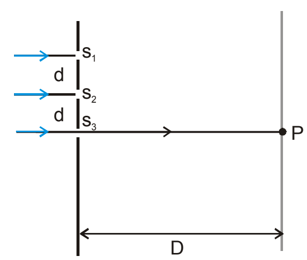
32. Figure shows two coherent sources S_1-S_2 vibrating in same phase. AB is a straight wire lying at a far distance from the sources S_1 and S_2. Let $\frac{\lambda}{d} = 10^{-3}$. ∠ BOA = 0.12°. How many bright spots will be seen on the wire, including points A and B.



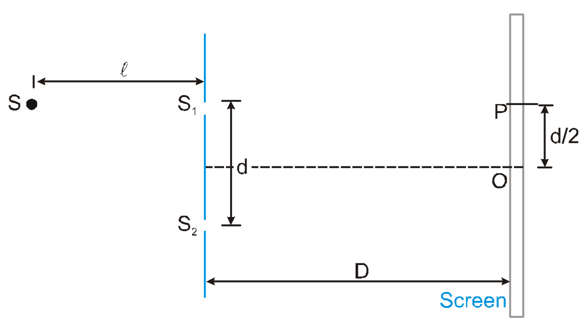
33. White coherent light (400 nm-700 nm) is sent through the slits of a Young's double slit experiment (as shown in the figure). The separation between the slits is 1 mm and the screen is 100 cm away from the slits. There is a hole in the screen at a point 1.5 mm away (along the width of the fringes) from the central line. **(a)** For which wavelength(s) there will be minima at that point ? **(b)** which wavelength(s) will have a maximum intensity?



34. In the figure shown three slits s_1, s_2 and s_3 are illuminated with light of wavelength λ. $\lambda << d$ and $D >> d$. Each slit produces same intensity I on the screen. If intensity at the point on screen directly infront of s_2 is 3I then find **(a)** maximum value of λ in terms of d and D **(b)** For the above value of λ find the intensity at point P on screen which is directly infront of slit s_3.



35. A source S is kept directly behind the slit S_1 in a double–slit apparatus. Find the phase difference at a point O which is equidistant from S_1 & S_2. What will be the phase difference at P if a liquid of refraction index μ is filled; (wavelength of light in air is λ due to the source). Assume same intensity due to S_1 and S_2 on screen and position at liquid. ($\lambda << d$, $d << D$, $\ell >> d$)



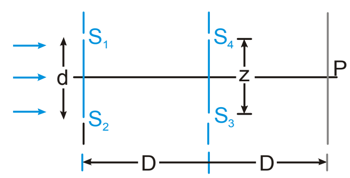
(a) between the screen and the slits.

(b) between the slits & the source S. In this case find the minimum distance between the points on the screen where the intensity is half the maximum intensity on the screen.

36. In a YDSE experiment, the distance between the slits & the screen is 100 cm. For a certain distance between the slits, an interference pattern is observed on the screen with the fringe width 0.25 mm. When the distance between the slits is increased by $\Delta d = 1.2$ mm, the fringe width decreased to $n = 2/3$ of the original value. In the final position, a thin glass plate of refractive index 1.5 is kept in front of one of the slits & the shift of central maximum is observed to be 20 fringe width. Find the thickness of the plate & wavelength of the incident light.

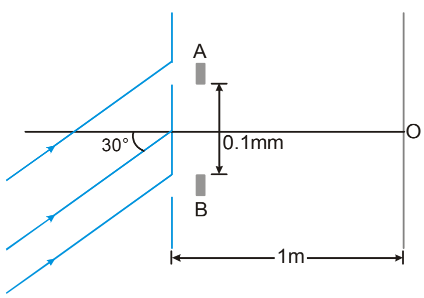
37. A monochromatic light of $\lambda = 5000$ Å is incident on two slits separated by a distance of 5×10^{-4} m. The interference pattern is seen on a screen placed at a distance of 1 m from the slits. A thin glass plate of thickness 1.5×10^{-6} m & refractive index $\mu = 1.5$ is placed between one 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.

38. Parallel monochromatic beam is falling normally on two slits S_1 and S_2 separated by d as shown in figure. By some mechanism, the separation between the slits S_3 and S_4 can be changed. The intensity is measured at the point P which is at the common perpendicular bisector of S_1S_2 and S_3S_4. When $z = \frac{D\lambda}{2d}$, the intensity measured at P is I. Find this intensity when z is equal to



(a) $\frac{3D\lambda}{d}$ **(b)** $\frac{D\lambda}{3d}$ and **(c)** $\frac{4D\lambda}{d}$

39. In a YDSE a parallel beam of light of wavelength 6000 Å is incident on slits at angle of incidence 30º. A & B are two thin transparent films each of R.I. 1.5 . Thickness of A is 20.4 µm. Light coming through A & B have intensities I and 4I respectively on the screen. Intensity at point O which is symmetric relative to the slits is 3 I. The central maxima is above O.



(a) What is the maximum thickness of B to do so.

Assuming thickness of B to be that found in part (a) answer the following parts.

(b) Find fringe width, maximum intensity & minimum intensity on screen.

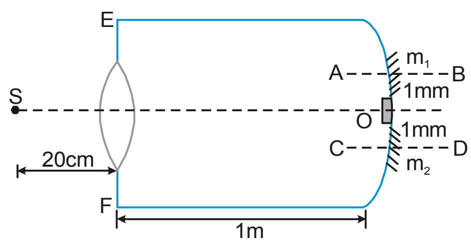
(c) Distance of nearest minima from O.

(d) Intensity at 5 cm on either side of O.

40. 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 $(3/4)^{th}$ the original intensity. It is further observed that what used to be the 5th maximum earlier, lies below the point O while the 6th minimum lies above O. Find the thickness of the glass plate.

(Absorption of light by glass plate may be neglected)

41. An equil convex lens of focal length 10 cm (in air) and R.I. 3/2 is put at a small opening on a tube of length 1 m fully filled with liquid of R.I. 4/3. A concave mirror of radius of curvature 20 cm is cut into two halves m_1 and m_2 and placed at the end of the tube. m_1 & m_2 are placed such that their principal axis AB and CD respectively are separated by 1 mm each from the principal axis of the lens. A slit S placed in air illuminates the lens with light of frequency 7.5×10^{14} Hz. The light reflected from m_1 and m_2 forms interference pattern on the left end EF of the tube. O is an opaque substance to cover the hole left by m_1 & m_2. Find :



(a) the position of the image formed by lens water combination.

(b) the distance between the images formed by m_1 & m_2.

(c) width of the fringes on EF.

Exercise # 5

Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

1. Wavelength of light used in an optical instrument are λ_1= 4000 Å and λ_2= 5000 Å, then ratio of their respective resolving powers (corresponding to λ_1 and λ_2) is - **[AIEEE - 2002]**

(1) 16 : 25 **(2)** 9 : 1 **(3)** 4 : 5 **(4)** 5 : 4

2. Electromagnetic waves are transverse in nature is evident by **[AIEEE-2002]**

(1) polarization **(2)** interference **(3)** reflection **(4)** diffraction

3. To demonstrate the phenomenon of interference we require two sources which emit radiation of **[AIEEE-2003]**

(1) nearly the same frequency
(2) the same frequency
(3) different wavelength
(4) the same frequency and having a definite phase relationship

4. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is **[AIEEE- 2004]**

(1) infinite **(2)** five **(3)** three **(4)** zero

5. A young's double slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen is **[AIEEE - 2005]**

(1) Straight line **(2)** Parabola **(3)** Hyperbola **(4)** Circle

6. If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled ? **[AIEEE - 2005]**

(1) $I_0\pi/\omega$ **(2)** $I_0/2$ **(3)** $2I_0$ **(4)** $4I_0$

7. When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is **[AIEEE - 2005]**

(1) zero **(2)** I_0 **(3)** $\frac{1}{2}I_0$ **(4)** $\frac{1}{4}I_0$

8. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of the light used) is I. If I_0 denotes the maximum intensity, I/I_0 is equal to: **[AIEEE - 2007]**

(1) $\frac{1}{\sqrt{2}}$ **(2)** $\frac{\sqrt{3}}{2}$ **(3)** $\frac{1}{2}$ **(4)** $\frac{3}{4}$

Direction : Questions number 56 – 58 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 μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius. **[AIEEE-2010]**

9. As the beam enters the medium, it will

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

10. The initial shape of the wavefront of the beam is :

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

11. The speed of light in the medium is

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

12. At two points P and Q on a 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) 2 : 1 **(2)** $\sqrt{2}$: 1 **(3)** 4 : 1 **(4)** 3 : 2

13. In a Young's double slit experiment, the two slits act as coherent sources of waves of equal amplitude A and wavelength λ. 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 is I_2 , then the ratio $\frac{I_1}{I_2}$ is : **[AIEEE 2011]**

(1) 2 **(2)** 1 **(3)** 0.5 **(4)** 4

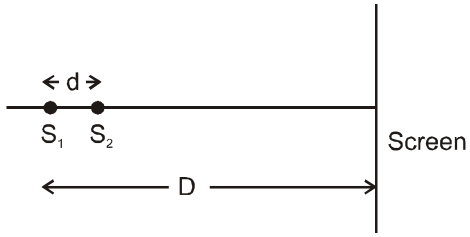
14. **Statement - 1 :**
On viewing the clear blue portion of the sky through a Calcite Crystal, the intensity of transmitted light varies as the crystal is rotated.
Statement - 2:
The light coming from the sky is polarized due to scattering of sun light by particles in the atmosphere. The scattering is largest for blue light **[AIEEE 2011]**

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

15. **Direction :**
The question has a paragraph followed by two statements, Statement –1 and Statement –2. Of the given four alternatives after the statements, choose the one that describes the statements. [Geometrical Optics]
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.
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.

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

16. 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)** semi-circles **(4)** concentric circles

17. A green light is incident from the water to the air – water interface at the critical angle (θ). Select the correct statement **[JEE-Mains 2014]**

(1) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium.

(2) The entire spectrum of visible light will come out of the water at various angles to the normal.

(3) The entire spectrum of visible light will come out of the water at an angle of 90$_0$ to the normal.

(4) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium.

18. 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° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then I_A/I_B equals : **[JEE-Mains 2014]**

(1) 1 **(2)** 1/3 **(3)** 3 **(4)** 3/2

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

(1) 100 μm **(2)** 300 μm **(3)** 1 μm **(4)** 30 μm

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]**

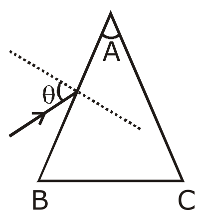
(1) bends downwards

(2) bends upwards

(3) becomes narrower

(4) goes horizontally without any deflection

21. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a rav, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided : **[JEE-Mains 2015]**



(1) $\theta > \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$ **(2)** $\theta < \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

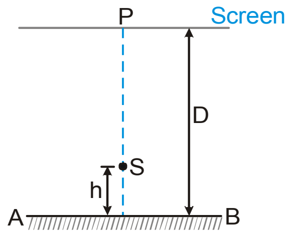
(3) $\theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$ **(4)** $\theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

22. An observer looks at a distant tree of height 10m with a telescope of magnifying power of 20. To the observer the tree appears : **[JEE-Mains 2016]**

(1) 10 times nearer. **(2)** 20 times taller. **(3)** 20 times nearer **(4)** 10 times taller.

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

1. A point source S emitting light of wavelength 600 nm is placed at a very small height h above a flat reflecting surface AB as shown in 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.



(a) What is the shape of the interference fringes on the screen?

(b) Calculate the ratio of the minimum to the maximum intensities in the interference fringes formed near the point P. (Shown in the figure)

(c) If the intensity 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 maximum. :

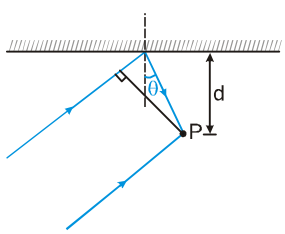
[JEE 2002 Mains]

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

[JEE 2002 Screening]

(A) 2λ **(B)** $2\lambda/3$ **(C)** $\lambda/3$ **(D)** λ

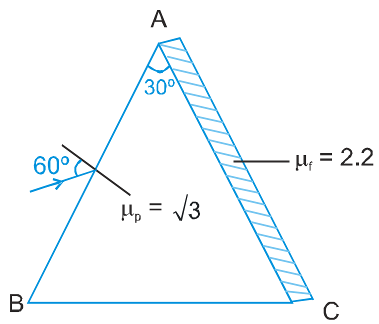
3. A parallel beam of light of wavelength λ is incident on a plane mirror at an angle θ as shown in the figure. With maximum intensity at point P, which of the following relation is correct. **[JEE 2003 Screening]**



(A) $\cos\theta - \sec\theta = \dfrac{\lambda}{4d}$ **(B)** $\cos\theta = \dfrac{\lambda}{4d}$

(C) $\cos\theta - \sin\theta = \dfrac{\lambda}{d}$ **(D)** $\cos\theta = \dfrac{\lambda}{2d}$

4. A prism of refracting angle 30º is coated with a thin film of transparent material of refractive index 2.2 on face AC of the prism. A light of wavelength 6600 Å is incident on face AB such that angle of incidence is 60º, find



(A) the angle of emergence, and **(B)** the minimum value of thickness of the coated film on the face AC for which the light emerging from the face has maximum intensity. [Given refractive index of the material of the prism is $\sqrt{3}$]

[JEE 2003 (Main)]

5. In a YDSE arrangement composite lights of different wavelengths λ_1 = 560 nm and λ_2 = 400 nm are used.If D = 1m, d = 0.1 mm. Then the distance between two completely dark regions is

[JEE 2004 Screening]

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

6. In a Young's double slit experiment, two wavelength of 500 nm and 700 nm are used. What is the minimum distance from the central maximum where their maximas coincide again ? Take D/d = 10^3. Symbols have their usual meanings.

[JEE 2004 Mains]

7. In Young's double slit experiment an electron beam is used to form a fringe pattern instead of light. If speed of the electrons is increased then the fringe width will : **[JEE 2005 Screening]**

(A) increase **(B)** decrease

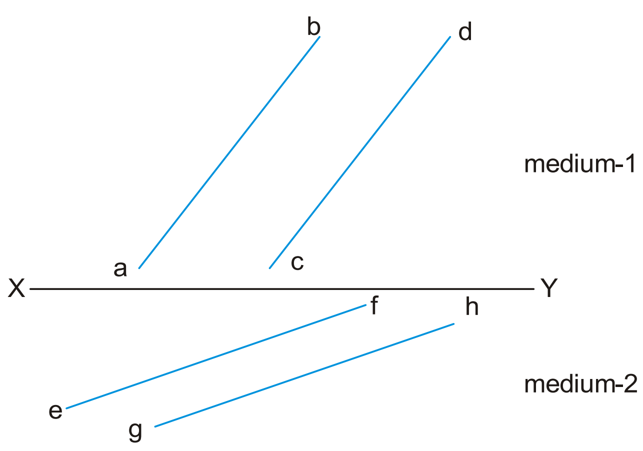
(C) remains same **(D)** no fringe pattern will be formed

8. In Young's double slit experiment maximum intensity is I than the angular position where the intensity becomes $\frac{I}{4}$ is : **[JEE 2005 Screening]**

(A) $\sin^{-1}\left(\frac{\lambda}{d}\right)$ **(B)** $\sin^{-1}\left(\frac{\lambda}{3d}\right)$ **(C)** $\sin^{-1}\left(\frac{\lambda}{2d}\right)$ **(D)** $\sin^{-1}\left(\frac{\lambda}{4d}\right)$

Paragraph :

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



9. 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

10. 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 $\phi_c = \phi_f$:

(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 $(\phi_f - \phi_e)$

11. Speed of light is

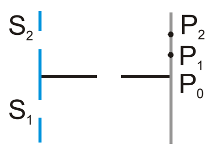
(A) the same in medium–1 and medium–2
(B) larger in medium–1 than in medium–2
(C) larger in medium–2 than in medium–1
(D) different at b and d

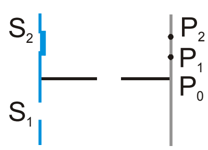
12. In a Young's double slit experiment, the separation between the two slits is d and the wavelength of the light is λ. The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Choose the correct choice(s). **[JEE 2008]**

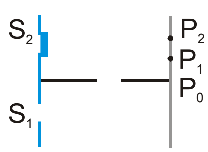
(A) If $d = \lambda$, the screen will contain only one maximum
(B) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central maximum) will be observed on the screen
(C) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2, the intensities of the observed dark and bright fringes will increase
(D) If the intensity of light falling on slit 2 is increased so that it becomes equal to that of slit 1, the intensities of the observed dark and bright fringes will increase

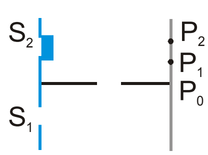
13. **Column I** shows four situations of standard Young's double slit arrangement with the screen placed far away from the slits S_1 and S_2. In each of these cases $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda/4$ and $S_1P_2 - S_2P_2 = \lambda/3$, where λ is the wavelength of the light used. In the 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. **[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) $I(P_2) > I(P_1)$

14. Young's double slit experiment is carried out by using green, red and blue light, one color at 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)** $\beta_R > \beta_G > \beta_B$

15. In the Young's double slit experiment using a monochromatic light of wavelength λ, 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)** $(2n+1)\frac{\lambda}{16}$

16. Using the expression $2d \sin\theta = \lambda$, one calculates the values of d by measuring the corresponding angles θ in the range 0 to 90º. The wavelength λ is exactly knowns and the error in θ is constant for all values of θ. As θ increases from 0º : **[JEE Advanced_2013]**

(A) the absolute error in d remains constant.
(B) the absolute error in d increases.
(C) the fractional error in d remains constant.
(D) the fractional error in d decreases

MOCK TEST

SECTION - I : STRAIGHT OBJECTIVE TYPE

1. Two light waves are given by, $E_1 = 2\sin(100\pi t - kx + 30^\circ)$ and $E_2 = 3\cos(200\pi t - k'x + 60^\circ)$
The ratio of intensity of first wave to that of second wave is :

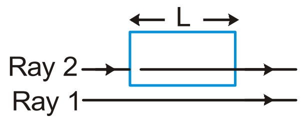
(A) $\frac{2}{3}$ **(B)** $\frac{4}{9}$ **(C)** $\frac{1}{9}$ **(D)** $\frac{1}{3}$

2. The wavefront of a light beam is given by the equation $x + 2y + 3z = c$, (where c is arbitrary constant) then the angle made by the direction of light with the y-axis is :

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

3. If the ratio of the intensity of two coherent sources is 4 then the visibility $[(I_{max} - I_{min})/(I_{max} + I_{min})]$ of the fringes is
(A) 4 **(B)** 4/5 **(C)** 3/5 **(D)** 9

4. As shown in arrangement waves with identical wavelengths and amplitudes and that are initially in phase travel through different media, Ray 1 travels through air and Ray 2 through a transparent medium for equal length L, in four different situations. In each situation the two rays reach a common point on the screen. The number of wavelengths in length L is N_2 for Ray 2 and N_1 for Ray 1. In the following table, values of N_1 and N_2 are given for all four situations, The order of the situations according to the intensity of the light at the common point in descending order is :



Situations	1	2	3	4
N_1	2.25	1.8	3	3.25
N_2	2.75	2.8	2.25	4

(A) $I_3 = I_4 > I_2 > I_1$ **(B)** $I_1 > I_3 = I_4 > I_2$ **(C)** $I_1 > I_2 > I_3 > I_4$ **(D)** $I_2 > I_3 = I_4 > I_1$

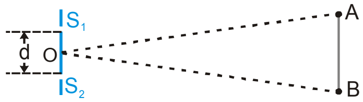
5. If the distance between the first maxima and fifth minima of a double slit pattern is 7mm and the slits are separated by 0.15 mm with the screen 50 cm from the slits, then wavelength of the light used is :
(A) 600 nm **(B)** 525 nm **(C)** 467 nm **(D)** 420 nm

6. In a YDSE: D = 1 m, d = 1 mm and λ = 5000 nm. The distance of 100^{th} maxima from the central maxima is:

(A) $\frac{1}{2}$ m **(B)** $\frac{\sqrt{3}}{2}$ m **(C)** $\frac{1}{\sqrt{3}}$ m **(D)** does not exist

7. Let S_1 and S_2 be the two slits in Young's double slit experiment. If central maxima is observed at P and angle $\angle S_1PS_2 = \theta$, then the fringe width for the light of wavelength λ will be. (Assume θ to be a small angle)
(A) λ/θ **(B)** $\lambda\theta$ **(C)** $2\lambda/\theta$ **(D)** $\lambda/2\theta$

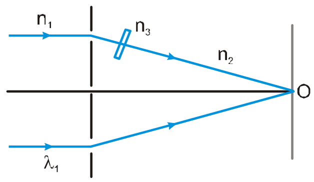
8. Figure shows two coherent sources S_1, S_2 vibrating in same phase. AB is an irregular wire lying at a far distance from the sources S_1 and S_2. Let $\frac{\lambda}{d} = 10^{-3}$. $\angle BOA = 0.12°$. How many bright spots will be seen on the wire, including points A and B.



(A) 2 **(B)** 3 **(C)** 4 **(D)** more than 4

9. The path difference between two interfering waves at a point on the screen is $\lambda/6$. The ratio of intensity at this point and that at the central bright fringe will be : (Assume that intensity due to each slit in same)
(A) 0.853 **(B)** 8.53 **(C)** 0.75 **(D)** 7.5

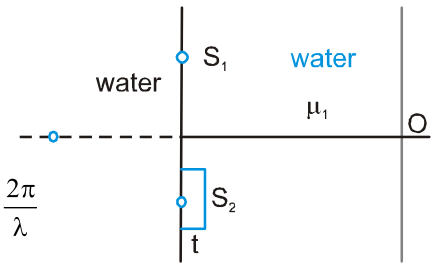
10. In the figure shown in a YDSE, a parallel beam of light is incident on the slits from a medium of refractive index n_1. The wavelength of light in this medium is λ_1. A transparent slab of thickness 't' and refractive index n_3 is put infront of one slit. The medium between the screen and the plane of the slits is n_2. Find the phase difference between the light waves reaching point 'O' (symmetrical, relative to the slits)



(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)** $\frac{2\pi n_1}{\lambda_1}(n_3 - n_2)t$

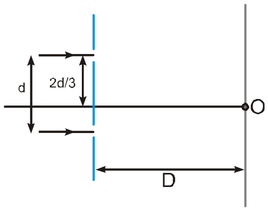
11. A Young's double slit experiment is conducted in water (μ_1) as shown in the figure, and a glass plate of thickness t and refractive index μ_2 is placed in the path of S_2. The magnitude of the phase difference at O is : (Assume that 'λ' is the wavelength of light in air)



(A) $\left|\left(\frac{\mu_2}{\mu_1} - 1\right)t\right|\frac{2\pi}{\lambda}$ **(B)** $\left|\left(\frac{\mu_1}{\mu_2} - 1\right)t\right|\frac{2\pi}{\lambda}$

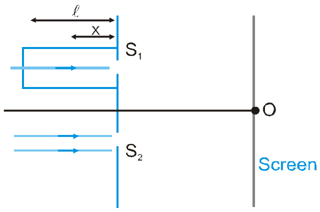
(C) $|(\mu_2 - \mu_1)t|\frac{2\pi}{\lambda}$ **(D)** $|(\mu_2 - 1)t|\frac{2\pi}{\lambda}$

12. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the nearest white spot on the screen from O is: [assume $d << D$, $\lambda << d$]



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

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



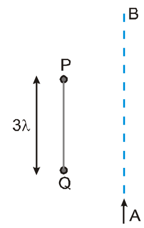
(A) $\frac{\lambda}{\ell}$ **(B)** $\frac{\lambda}{\ell^2}$

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

14. Interference fringes were produced using white light in a double slit arrangement. When a mica sheet of uniform thickness of refractive index 1.6 (relative to air) is placed in the path of light from one of the slits, the central fringe moves through some a distance. This distance is equal to the width of 30 interference bands if light of wavelength 4800 Å is used. The thickness (in 1μm) of mica is:

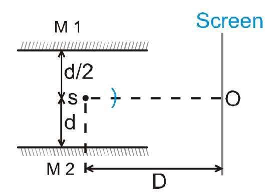
(A) 90 **(B)** 12 **(C)** 14 **(D)** 24

15. Two coherent light sources each of wavelength λ are separated by a distance 3λ. The total number of minima formed on line AB which runs from $-\infty$ to $+\infty$ is:



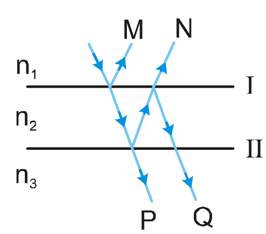
(A) 2 **(B)** 4 **(C)** 6 **(D)** 8

16. M1 and M2 are two plane mirrors which are kept parallel to each other as shown. There is a point 'O' on perpendicular screen just infront of 'S'. What should be the wavelength of light coming from monchromatic source 'S'. So that a maxima is formed at 'O' due to interference of reflected light from both the mirrors. [Consider only 1st reflection].



(A) $\frac{3d^2}{D}$ **(B)** $\frac{3d^2}{2D}$ **(C)** $\frac{d^2}{D}$ **(D)** $\frac{2d^2}{D}$

17. A ray of light is incident on a thin film. As shown in figure M,N are two reflected rays and P,Q are two transmitted rays. Rays N and Q undergo a phase change of π. Correct order of the refracting indices is:



(A) $n_2 > n_3 > n_1$

(B) $n_3 > n_2 > n_1$

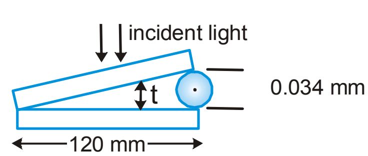
(C) $n_3 > n_1 > n_2$

(D) None of these, the specified changes can not occur

18. From a medium of index of refraction n_1, monochromatic light of wavelength λ is incident normally on a thin film of uniform thickness L (where $L > 0.1\,\lambda$) and index of refraction n_2. The light transmitted by the film travels into a medium with refractive index n_3. The value of minimum film thickness when maximum light is transmitted if ($n_1 < n_2 < n_3$) is :

(A) $\frac{n_1\lambda}{2n_2}$ **(B)** $\frac{n_1\lambda}{4n_2}$ **(C)** $\frac{\lambda}{4n_2}$ **(D)** $\frac{\lambda}{2n_2}$

19. A broad source of light ($l = 680$ nm) illuminates normally two glass plates 120 mm long that touch at one end and are separated by a wire 0.034 mm in diameter at the other end. The total number of bright fringes that appear over the 120 mm distance is :



(A) 50 **(B)** 100 **(C)** 200 **(D)** 400

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

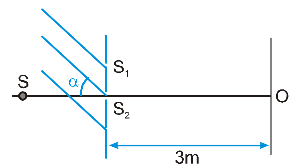
20. If the first minima in a Young's slit experiment occurs directly in front of one of the slits, (distance between slit & screen D = 12 cm and distance between slits d = 5 cm) then the wavelength of the radiation used can be :

(A) 2 cm **(B)** 4 cm **(C)** $\frac{2}{3}$ cm **(D)** $\frac{4}{3}$ cm

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

(A) The fringe pattern will get shifted towards the covered slit
(B) The fringe pattern will get shifted away from the covered slit
(C) The bright fringes will become less bright and the dark ones will become more bright
(D) The fringe width will remain unchanged

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



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

SECTION - III : ASSERTION AND REASON TYPE

23. **Statement-1 :** Two point coherent sources of light S_1 and S_2 are placed on a line as shown. P and Q are two points on that line. If at point P maximum intensity is observed then maximum intensity should also be observed at Q.

Statement-2 : In the figure of statment 1, the distance $|S_1P - S_2P|$ is equal to distance $|S_2Q - S_1Q|$.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

24. **Statement-1 :** Two coherent point sources of light having nonzero phase difference are seperated by small distance. Then on the perpendicular bisector of line segment joining both the point sources, constructive interference cannot be obtained.

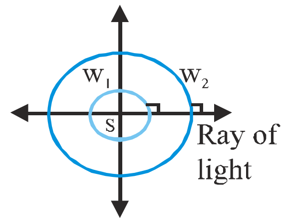
Statement-2 : For two waves from coherent point sources to interfere constructively at a point, the magnitude of their phase difference at that point must be $2m\pi$ (where m is a nonnegative integer) .

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

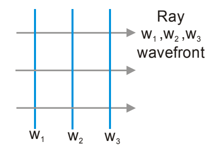
SECTION - IV : COMPREHENSION TYPE

Read the following comprehensions carefully and answer the questions.

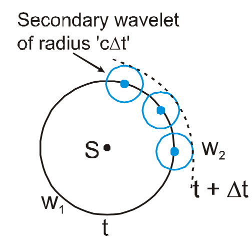
Comprehension # 1



Huygen was the first scientist who proposed the idea of wave theory of light. He said that the light propagates in form of wavefronts. A wavefront is an imaginary surface at every point of which waves are in the same phase. For example the wavefronts for a point source of light is collection of concentric spheres which have centre at the origin, w_1 is a wavefront, w_2 is another wavefront.



The radius of the wavefront at time 't' is 'ct' in this case where 'c' is the speed of light. The direction of propagation of light is perpendicular to the surface of the wavefront. The wavefronts are plane wavefronts in case of a parallel beam of light.



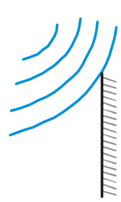
Huygen also said that every point of the wavefront acts as the source of secondary wavelets. The tangent drawn to all secondary wavelets at a time is the new wavefront at that time. The wavelets are to be considered only in the forward direction (i.e. the direction of propagation of light) and not in the reverse direction. If a wavefront w_1 at time t is given, then to draw the wavefront at time $t + \Delta t$ take some points on the wavefront w_1 and draw spheres of radius '$c\Delta t$'. They are called secondary wavelets.

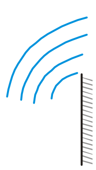
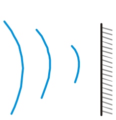
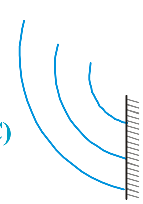
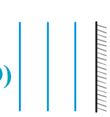
Draw a surface w_2 which is tangential to all these secondary wavelets. w_2 is the wavefront at time '$t + \Delta t$'.
Huygen proved the laws of reflection and laws of refraction using concept of wavefronts.

25. A point source of light is placed at origin, in air. The equation of wave front of the wave at time t, emitted by source at $t = 0$, is (take refractive index of air as 1)

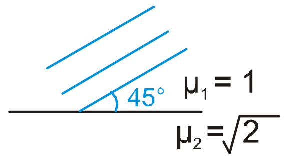
(A) $x + y + z = ct$ **(B)** $x^2 + y^2 + z^2 = t^2$
(C) $xy + yz + zx = c^2t^2$ **(D)** $x^2 + y^2 + z^2 = c^2t^2$

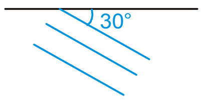
26. Spherical wave fronts shown in figure, strike a plane mirror. Reflected wave fronts will be as shown in

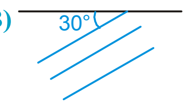


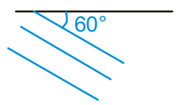
(A)  **(B)**  **(C)**  **(D)** 

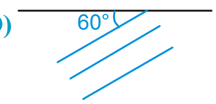
27. Wavefronts incident on an interface between the media are shown in the figure. The refracted wavefronts will be as shown in



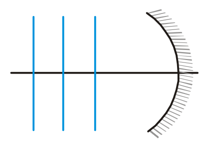
(A) 

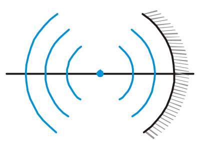
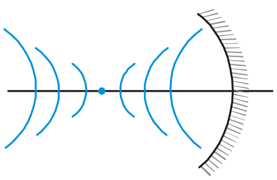
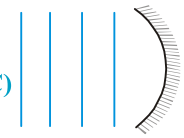
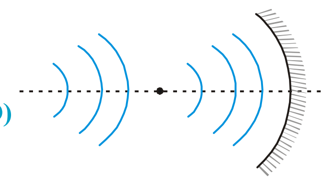
(B) 

(C) 

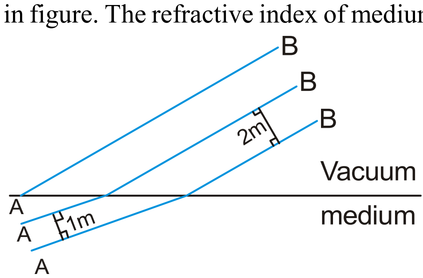
(D) 

28. Plane wavefronts are incident on a spherical mirror as shown. The reflected wavefronts will be in the figure



(A) 
(B) 
(C) 
(D) 

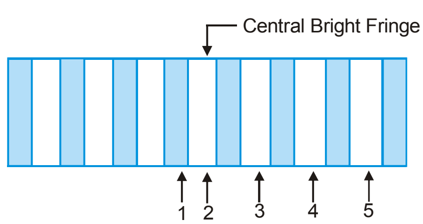
29. Certain plane wavefronts are shown in figure. The refractive index of medium is



(A) 2 **(B)** 4 **(C)** 1.5 **(D)** Cannot be determined

Comprehension # 2

The figure shows the interference patttern obtained in a double-slit experiment using light of wavelength 600 nm. 1, 2, 3, 4 and 5 are marked on five fringes .



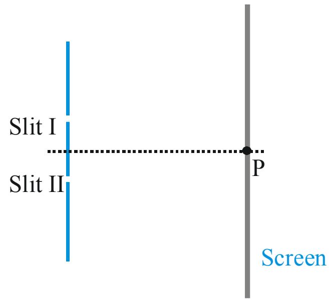
30. The third order bright fringe is
(A) 2 **(B)** 3 **(C)** 4 **(D)** 5

31. Which fringe results from a phase difference of 4π between the light waves incidenting from two slits?
(A) 2 **(B)** 3 **(C)** 4 **(D)** 5

32. Let ΔX_A and ΔX_C represent path differences between waves interfering at 1 and 3 respectively then $(|\Delta X_C| - |\Delta X_A|)$ is equal to
(A) 0 **(B)** 300mn **(C)** 600 nm **(D)** 900nm.

SECTION - V : MATRIX - MATCH TYPE

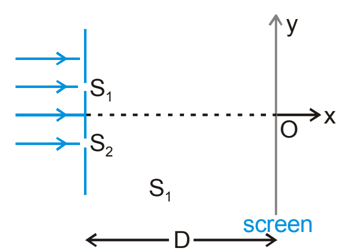
33. A double slit interference pattern is produced on a screen, as shown in the figure, using monochromatic light of wavelength 500 nm. Point P is the location of the central bright fringe, that is produced when light waves arrive in phase without any path difference. A choice of three strips A, B and 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 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

34. A monochromatic parallel beam of light of wavelength λ is incident normally on the plane containing slits S_1 and S_2. The slits are of unequal width such that intensity only due to one slit on screen is four times that only due to the other slit. The screen is placed perpendicular to x-axis as shown. The distance between slits is d and that between screen and slit is D. Match the statements in column-I with results in column-II.



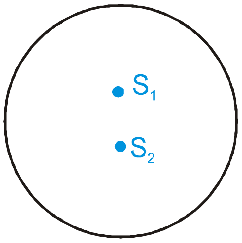
Column-I	Column-II
(A) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{1}{9}$ th of maximum intensity.	**(P)** $\frac{D\lambda}{3d}$
(B) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{3}{9}$ th of maximum intensity.	**(Q)** $\frac{D\lambda}{d}$

(C) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{5}{9}$ th of maximum intensity. **(R)** $\frac{2D\lambda}{d}$

(D) The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{7}{9}$ th of maximum intensity. **(S)** $\frac{3D\lambda}{d}$

(T) $\frac{2D\lambda}{3d}$

35. Two coherent point sources of light having wavelength λ are seperated by a distance d. A circle is drawn in space surrounding both the point sources as shown. The plane of circle contains both the point sources. The distance d between both the sources is given in column-I and the total number of corresponding points of maximum intensity and minimum intensity on the periphery of the shown circle are given in column-II. Match each situation of column-I with the results in column-II.

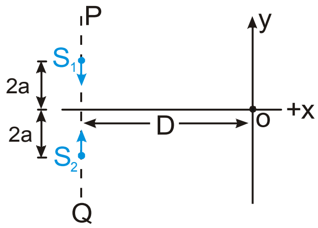


Column-I	Column-II
(A) $d = 99.4\ \lambda$	**(P)** 398 points of maximum intensity
(B) $d = 99.6\ \lambda$	**(Q)** 400 points of maximum intensity
(C) $d = 100\ \lambda$	**(R)** 396 points of minimum intensity
(D) $d = 100.4\,\lambda$	**(S)** 400 points of minimum intensity
	(T) 402 points of maximum intensity

SECTION - VI : INTEGER TYPE

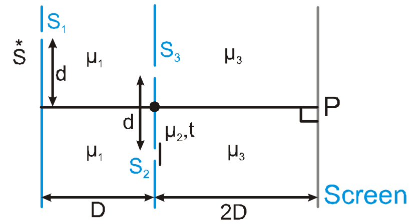
36. An interference pattern is obtained by using a Fresnel's biprism. If the fringe width is 4 mm when air is the surrounding medium, then find the fringe width(in mm.) if water is the surrounding medium. Keeping the same source. Assume $n_{glass} = 1.5$, $n_{water} = 4/3$, $n_{air} = 1$.

37. In the figure shown S_1 and S_2 are two coherent sources emitting light of wave length 'λ' and having no initial phase difference. S_1 and S_2 oscillate simple harmonically with amplitude 'a' each and frequency 'f' each on the line PQ which is perpendicular to the x-axis. The initial position and initial direction of motion of 'S_1' and 'S_2' are shown in the figure. S_1 and S_2 are at their mean position at t = 0 sec. if the y-coordinates of 3[rd] maxima at time



't'.is $\frac{x\lambda D}{2a(2-\sin\omega t)}$ then x is Assume that $\lambda << a$ and $a << D$.

38. In the figure shown 'S' is a monochromatic source of light emitting light of wavelength λ (in air). Light falls on slit 'S_1' from 'S' and then reach the slits 'S_2' and 'S_3' through a medium of refractive index 'μ_1'. Light from slits S_2 and S_3 reach the screen through medium of refractive index μ_3. A thin transparent film of refractive index μ_2 and thickness 't' is placed infront of 'S_2'. point 'P' is symmetrical w.r.t. 'S_2' and 'S_3'. Using the values d = 1 mm, D = 1 m, $\mu_1 = 4/3$,

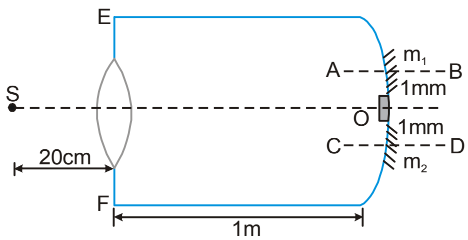


$\mu_2 = 3/2$, $\mu_3 = 9/5$ and $t = \frac{4}{9} \times 10^{-5}$ m. Find the

(i) Distance of central maxima from P.(in mm.)

(ii) If the film in front of S_2 is removed, then x/27 mm. distance and central maxima shift then x is

39. An equil convex lens of focal length 10 cm (in air) and R.I. 3/2 is put at a small opening on a tube of length 1 m fully filled with liquid of R.I. 4/3. A concave mirror of radius of curvature 20 cm is cut into two halves m_1 and m_2 and placed at the end of the tube. m_1 & m_2 are placed such that their principal axis AB and CD respectively are separated by 1 mm each from the principal axis of the lens. A slit S placed in air illuminates the lens with light of frequency 7.5×10^{14} Hz. The light reflected from m_1 and m_2 forms interference pattern on the left end EF of the tube. O is an opaque substance to cover the hole left by m_1 & m_2. Find :

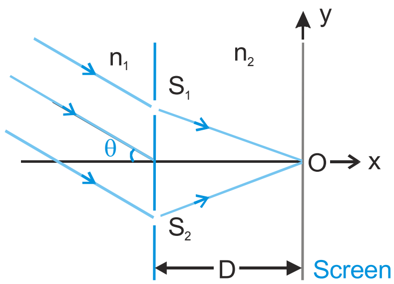


(A) distance of the image formed by lens water combination.in cm.

(B) the distance between the images formed by m_1 & m_2.in(mm.)

(C) width of the fringes on EF.in μm.

40. In the figure an arrangement of young's double slit experiment is shown. A parallel beam of light of wavelength 'λ' (in medium n_1) is incident at an angle 'θ' as shown. Distance $S_1O = S_2O$. Point 'O' is the origin of the coordinate system. The medium on the left and right side of the plane of slits has refractive index n_1 and n_2 respectively. Distance between the slits is d. The distance between the screen and the plane of slits is D. Using D = 1m, d = 1mm, θ = 30°, λ = 0.3mm, $n_1 = \frac{4}{3}$, $n_2 = \frac{10}{9}$,



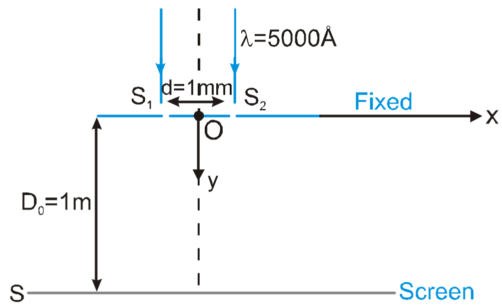
answer the following

(i) if y-coordinate of the point where the total phase difference between the interefering waves is zero, is $y = -x_0$ cm.then x_0 is

(ii) y-coordinate of the nearest maxima above 'O' is $\frac{x}{\sqrt{154}}$ cm. then x is

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

42. In the figure shown light of wave length $\lambda = 5000$ Å is incident on the slits (in a horizontal fixed plane) S_1 and S_2 separated by distance d = 1 mm. A horizontal screen 'S' is released from rest from initial distance $D_0 = 1$ m from the plane of the slits. Taking origin at O and positive x and y axis as shown, find at t = 2 seconds; (Use g = 10 m/s^2)



(i) velocity in ms^{-1}

(ii) acceleration in ms^{-2}

(iii) if relative acceleration of second maxima w.r.t. first minima on same side is x x 10^{-4} ms^{-2} then x is

ANSWER KEY

EXERCISE - 1

1. D	**2.** D	**3.** D	**4.** D	**5.** C	**6.** D	**7.** A	**8.** C	**9.** D	**10.** A	**11.** D	**12.** A	**13.** C
14. C	**15.** A	**16.** D	**17.** B	**18.** A	**19.** B	**20.** D	**21.** D	**22.** B	**23.** D	**24.** C	**25.** C	**26.** D
27. D	**28.** B	**29.** A	**30.** C	**31.** C	**32.** B	**33.** A	**34.** B	**35.** D	**36.** B	**37.** C	**38.** B	**39.** A
40. A	**41.** D	**42.** B	**43.** C	**44.** C	**45.** B	**46.** B	**47.** D	**48.** D	**49.** C	**50.** B	**51.** A	**52.** D
53. B	**54.** B	**55.** D	**56.** A	**57.** A	**58.** C	**59.** C	**60.** A	**61.** A	**62.** B	**63.** D	**64.** C	**65.** B
66. D	**67.** C	**68.** D	**69.** A	**70.** B	**71.** C	**72.** A	**73.** C	**74.** D	**75.** D	**76.** A	**77.** B	**78.** B
79. A	**80.** C	**81.** A	**82.** C	**83.** B	**84.** C	**85.** C	**86.** A	**87.** A	**88.** A	**89.** A	**90.** C	**91.** C
92. B	**93.** D	**94.** A	**95.** D	**96.** C	**97.** C	**98.** A	**99.** D	**100.** D	**101.** B	**102.** B	**103.** D	**104.** C
105. B	**106.** A	**107.** A	**108.** B	**109.** C	**110.** B	**111.** D						

EXERCISE - 2 : PART # I

1. A, C **2.** B, D **3.** B, C,D **4.** A,C **5.** A, C **6.** A,C **7.** A,C **8.** A,B **9.** A,C,D

PART # II

1. E **2.** A **3.** B **4.** A **5.** B **6.** D **7.** A **8.** A **9.** D **10.** C

EXERCISE - 3 : PART # I

1. $A \to Q,R,S$; $B \to P,Q,R,S$; $C \to Q,R,S$; $D \to P,Q,R,S$ **2.** $A \to T$; $B \to R$; C ; $S \to D \to P$

3. $A \to R,S$; $B \to P,Q,S$; $C \to P,Q,S$; $D \to R,S$

PART # II

Comp. # 1 **1.** C **2.** D **3.** A

Comp. # 2: **1.** A **2.** B **3.** C

Comp. # 3 : **1.** D **2.** C **3.** B

Comp. # 4 : **1.** D **2.** C **3.** B **4.** A **5.** A **6.** C

Comp. # 5 : **1.** B **2.** C **3.** A **4.** B **5.** D

Comp. # 6 : **1.** A,C,D **2.** A,B,D **3.** B,D

EXERCISE - 4

1. (i) 0°, 60°, 90°, 120°, 180°, 240°, 270°, 300°, 8 **(ii)** $\cos q = \pm\frac{1}{8}, \pm\frac{3}{8}, \pm\frac{5}{8}, \pm\frac{7}{8}$ **2. (i)** 7.8 I **(ii)** I **(iii)** 9I

3. 81 :1 **4.** 2.4 mm and 4.8mm **5.** 0.3 mm, 0.225 mm **6. (i)** $I_0 = I\cos^2\left[\frac{\pi(\mu-1)t}{\lambda}\right]$ **7. (i)** 3 (ii) y=0 and y = ± 75 cm

8. 6000Å **9.** 1.98×10^{-2} mm

10. (i) $t_B = 120$ mm (ii) b = 6mm, I_{max} =9I, I_{min} = I (iii) $\frac{\beta}{6}$ = 1mm (iv) 9I, 3I **11.** 4×10^{-15} W/m^2

12. $\frac{n\lambda D'}{d}$, –D' where $D' = D + \frac{Mg}{K}(1-\cos\omega t)$ **13.** $\frac{2(a+b)\lambda}{4a\theta}$ **14.** 3:4 **15.** 9I **16.** (i) 1mm (ii) increases **17.** 1:49

18. 2 **19.** (a) 9 I (b) 5 I (c) I **20.** 1.625 mm

21. (a) Angular separation of the fringes remains constant (= λ / d).The actual separation of the fringe increases in proportion to the distance of the screen from the plane of the two slits.

(b) The separation of the fringes (and also angular separation) decrease.

(c) The separation of the fringe (and also angular separation) decreases.
(d) By slightly increasing the width of the slits ,we are only increasing the intensity of incident beam.Again no change in λ, D, d. so β unchanged but sharpness of the fringe increase.

22. $\frac{180}{\pi} \times 2 \times 10^{-4}$ degree $= 0.011^{o}$ **23.** 0.30 mm **24.** (a) $\beta = 4.0 \times 10^{-4}$ m (b) $\frac{\beta}{3}$ and $\frac{2\beta}{3}$ **25.** 0.9 mm

26. $\frac{\lambda}{4(\mu - 1)}$ **27.** 1.45 **28.** maximum **29. (i)** $a = \frac{3\lambda}{2\sin\theta_1} = \frac{3 \times 6 \times 10^{-7}}{2 \times \sin 30^{o}}$ **(ii)** $A = 1.2 \times 10^{-6}$ m **30.** 100 nm

31. (a) 1.17 mm. **(b)** 1.56 mm **32.** 3 **33. (a)** 428 nm, 600 nm, **(b)** 500 nm **34. (a)** $\lambda = \frac{3d^2}{2D}$ (b) 3I

35. (a) $\Delta\phi = \left(\frac{1}{\ell} + \frac{\mu}{D}\right)\frac{\pi d^2}{\lambda}$ **(b)** $\Delta\phi = \left(\frac{\mu}{\ell} + \frac{1}{D}\right)\frac{\pi d^2}{\lambda}$; $D_{min} = \frac{\beta}{2} = \frac{\lambda D}{2d}$ **36.** $\mu = 600$ nm , $t = 24$ µm **37.** 0 , 1.5 mm

38. (a) zero (b) $\frac{3I}{2}$ (c) 2I **39. (a)** $t_B = 120$ µm **(b)** $\beta = 6$ mm ; $I_{max} = 9I$, $I_{min} = I$ **(c)** $\beta/6 = 1$ mm
(d) I (at 5 cm above O), I (at 5 cm below O) = 3 I **40.** 9.3 µm **41.** (a) 80 cm behind the lens (b) 4 mm (c) $\beta = 60$ µm

EXERCISE - 5 : PART # I

1. 4 **2.** 1 **3.** 4 **4.** 3 **5.** 3 **6.** 3 **7.** 3 **8.** 4 **9.** 4 **10.** 4 **11.** 1 **12.** 1 **13.** 1
14. 2 **15.** 1 **16.** 4 **17.** 4 **18.** **19.** 4 **20.** 2 **21.** 3 **22.** 2

PART # II

1. (a) circular **(b)** $\frac{I_{min}}{I_{max}} = \frac{1}{16}$ **(c)** 300 nm **2.** A **3.** B **4. (a)** 0^{o} **(b)** $t_{min} = \frac{\lambda}{2\mu_f} = 150$ nm **5.** (D)
6. 3.5 mm. **7.** B **8.** B **9.** A **10.** C **11.** B **12.** A, B **13.** A→ P, S; B → Q; C →T ; D → R, S, T
14. D **15.** B **16.** D

MOCK TEST

1. B **2.** B **3.** B **4.** $0, I_0, \frac{I_0}{2}, \frac{I_0}{2}$ respetively. **5.** A **6.** B **7.** A **9.** C **10.** A **11.** C **12.** D
13. B **14.** D **15.** C **16.** B **17.** B **18.** B **19.** B **20.** A,C **21.** A,C,,D **22.** A,C **23.** D **24.** D
25. D **26.** C **27.** B **28.** A **29.** A **30.** D **31.** C **32.** B **33.** A → R, B →R, C →S, D → P
34. A → Q,R,S ; B → P,Q,R,S, T ; C → Q,R,S ; D → P,Q,R,S **35.** A → P,R ; B → P,S ; C → Q,S ; D → S,T
36. 3 $\beta = 12$ mm. **37.** (3) 38 **(i)** 0 **(ii)** $\frac{40}{27}$ mm downwards **39. (a)** 80 cm behind the lens **(b)** 4 mm
(c) $\beta = 60$ µm **40.** (75) **41.** (13) **42.** **(i)** 100 **(ii)** 10 **(iii)** 75