EXERCISE-1

SECTION (A) : PRINCIPLE OF SUPERPOSITION, PATH DIFFERENCE, WAVEFRONTS, AND COHERENCE

A 1. Two sources of intensity I & 4I 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) $\frac{\pi}{2}$ and (c) π.

A 2. What is the geometrical shape of the wavefront in each of the following cases.
(a) Light diverging from a point source.
(b) Light emerging out of a convex lens when a point source is placed at its focus.
(c) The portion of the wavefront of light from a distant star intercepted by the earth.

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

A 4. 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?

A 5. Two light waves are given by, $E_1 = 2\sin(100\pi t - kx + 30^\circ)$ and $E_2 = 3\cos(200\pi t - k'x + 60^\circ)$
What is the ratio of intensity of first wave to that of second wave?

SECTION (B) : YDSE WITH MONOCHROMATIC LIGHT

B 1. What is the effect on the 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 source slit is moved closer to the double-slit plane.
(e) The width of the source slit is increased.
(f) The widths of two slits are increased.
(g) The monochromatic source is replaced by source of white light.
[In each operation, take all parameters, other than the one specified to remain unchanged]

B 2. 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.

B 3. 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?

B 4. In Young's double slit experiment the angular width of a fringe formed on a distant screen is 1 °. The wavelength of light used is 6000 Å. What is the approximate spacing between the slits?

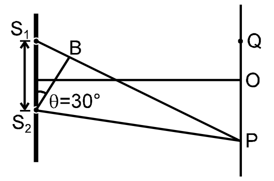
B 5. In a double slit inteference experiment, the separation between the slits is 1.0 mm, the wavelength of light used is 5.0×10^{-7} m and the distance of the screen from theslits is 1.0m. (a) Find the distance of the centre of the first minimum from the centre of the central maximum. (b) How many bright fringes are formed in one centrimeter width on the screen?

B 6. Find the angular separation between the consecutive bright fringes in a Young's double slits experiment with blue-green light of wavelength 50 nm. The separation between the slits is 2.0×10^{-3} m.

B 7. A Young's double slit arrangement produces interference fringes for sodium light (λ = 5890 Å) that are 0.20º apart. What is the angular fringe separation, if the entire arrangement is immersed in water. (R.I. of water = 4/3)

B 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.

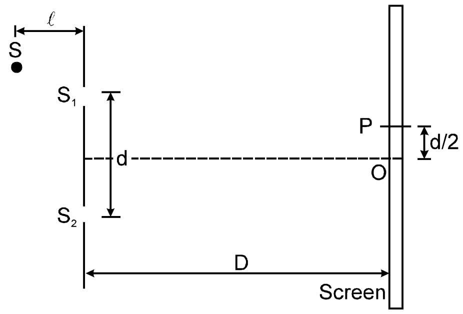
B 9. The double slit experiment of Young has been shown in figure. Q is the position of the first bright fringe on the right side and P is the 11th bright fringe on the other side as measured from Q. If wavelength of the light used is 6000 Å, find the distance S_1 B.



B 10. 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). ($\lambda << d$, $d << D$, $\ell >> d$)

(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.



SECTION (C) : YDSE WITH POLYCHROMATIC LIGHT

C 1. A source emitting light of wavelengths 480 nm and 600 nm is used in a double slit interference experiment. The separation between the slits is 0.25 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 correspoinding to the two wavelengths.

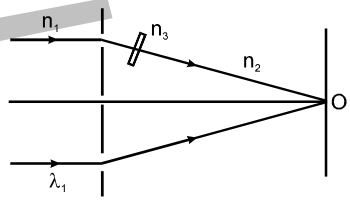
C 2. White light is used in a Young's double slit experiment. Find the minimum non zero order of the violet fringe (λ = 400 nm) which overlaps with a red fringe (λ = 700 nm).

SECTION (D) : YDSE WITH GLASS SLAB, OPTICAL PATH

D 1. A mica strip and a polysterene strip are fitted on the two slits of a double slit apparatus. The thickness of the strips is 0.50 mm and the separation between the slits is 0.12 cm. The refractive index of mica and polysterene are 1.58 and 1.55 respectively for the light of wavelength 590 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 centre will the first maximum be located?

D 2. Find the thickness of a plate which will produce a change in optical path equal to half the wavelength λ of the light passing through it normally. The refractive index of the plate is μ.

D 3. 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 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)



D 4. Two transparent slabs having equal thickness but different refractive indices μ_1 and μ_2 are pasted side by side to form a composite slab. This slab is placed just after the double slit in a Young's experiment so that the light from one slit goes through one material and the light from the other slit goes through the other material. What should be the minimum non zero thickness of the slab so that there is maximum at the point P_0 which is equidistant from the slits ?

SECTION (E) : YDSE WITH OBLIQUE INCIDENCE AND OTHER MODIFICATIONS IN EXPERIMENTAL SETUP OF YDSE

E 1. A parallel beam of monochromatic light 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. If the incident beam makes an angle $\theta = \sin^{-1}\left(\frac{\lambda}{2d}\right)$ with the normal to the plane of the slits, find the intensity at the centre P_0 of the pattern.

E 2. A long narrow horizontal slit is placed 1 mm above a horizontal plane mirror. The interference between the light coming directly from the slit and that after reflection is seen on a screen 1.0 m away from the slit. Find the fringe-width if the light used has a wavelength of 77 nm.

SECTION (F) : THIN FILM INTERFERENCE

F 1. A soap film of thickness 0.0011 mm appears dark when seen by the reflected light of wavelength 580 nm. What is the index of refraction of the soap solution, if it is known to be between 1.2 and 1.5?

F 2. 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 strongly reflects the light?

F 3. A glass surface is coated by an oil film of uniform thickness 1.00×10^{-4} cm. The index of refraction of the oil is 1.25 and that of the glass is 1.50. find the wavelengths of light in the visible region (400nm-750nm) which are weakly transmitted by the oil film under normal incidence.

EXERCISE-2

SECTION (A) : PRINCIPLE OF SUPERPOSITION, PATH DIFFERENCE, WAVEFRONTS, AND COHERENCE

A1. 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

A 2. 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

A 3. For constructive interference to take place between two monochromatic light waves of wavelength λ and having initial phase difference zero the path difference should be :
(A) $(2n - 1)\dfrac{\lambda}{4}$ (B) $(2n - 1)\dfrac{\lambda}{2}$ (C) $n\lambda$ (D) $(2n + 1)\dfrac{\lambda}{2}$

SECTION (B) : YDSE WITH MONOCHROMATIC LIGHT

B 1. 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

B 2. 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.

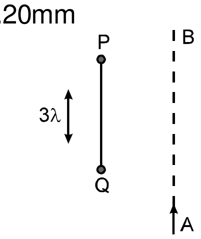
B 3. In a certain double slit experimental arrangement, interference fringes of width 1.0 mm each are observed when light of wavelength 5000 Å is used. Keeping the set-up unaltered if the source is replaced by another of wavelength 6000 Å, the fringe width will be :
(A) 0.5 mm (B) 1.00 mm (C) 1.2 mm (D) 1.5 mm

B 4. The distance between two slits in a Young's double slit experiment is 3 mm. The distance of the screen from the slits is 1 m. Microwaves of wavelength 1 mm are incident on the plane of the slits normally. The distance of the first maxima on the screen from the central maxima will be:
(A) 33.33 cm (B) 35.35 cm (C) 17.7 cm (D) 18 cm

B 5. In a YDSE: D = 1 m, d = 1 mm and λ = 5000 n m. The distance of 1000th maxima from the central maxima is:
(A) 0.5 m (B) 0.577 m (C) 0.495 m (D) does not exist

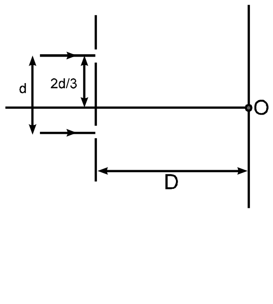
B 6. In a Young's double slit experiment, d = 1 mm, λ = 6000 Å & D = 1 m. The slits produce same intensity on the screen. The minimum distance between two points on the screen having 75% intensity of the maximum intensity is:
(A) 0.45 mm (B) 0.40 mm (C) 0.30 mm (D) 0.20mm

B 7. Two coherent light sources each of wavelength λ are separated by a distance 3λ. The maximum number of minima formed on line AB which runs from $-\infty$ to $+\infty$ is:
(A) 2 (B) 4 (C) 6 (D) 8



SECTION (C) : YDSE WITH POLYCHROMATIC LIGHT

C 1. 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



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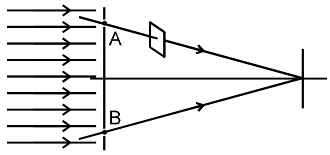
C2. In the above question if the light incident is monochromatic and point O is a maxima, then the wavelength of the light incident cannot be:
(A) $d^2/3D$ (B) $d^2/6D$ (C) $d^2/12D$ (D) $d^2/18D$

C 3. The Young's double slit experiment is performed with blue and with green light of wavelengths 4360 Å and 5460 Å respectively. If X is the distance of 4th maximum from the central one, then :
(A) X(blue) = X(green) (B) X(blue) > X(green)
(C) X(blue) < X(green) (D) $\frac{X(\text{blue})}{X(\text{green})} = \frac{5460}{4360}$

C 4. White light is used to illuminate the two silts 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) $\lambda = \frac{b^2}{d}$ (B) $\lambda = \frac{2b^2}{d}$ (C) $\lambda = \frac{b^2}{3d}$ (D) $\lambda = \frac{2b^2}{3d}$

SECTION (D) : YDSE WITH GLASS SLAB, OPTICAL PATH

D 1. In Young's experiment, monochromatic parallel beam of light is used to illuminate the two slits A and B. Interference fringes are observed on a screen placed in front of the slits. Now if a thin glass plate is placed normally in the path of the beam coming from the slit A, then
(A) the fringe will disappear
(B) the fringe width will increase
(C) the fringe width will decrease
(D) there will be no change in fringe width



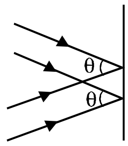
D 2. A two slit Young's interference experiment is done with monochromatic light of wavelength 6000 Å. The slits are 2 mm apart. The fringes are observed on a screen placed 10 cm away from the slits. Now a transparent plate of thickness 0.5 mm is placed in front of one of the slits and it is found that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

D 3. 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

D 4. In Young's double slit experiment using monochromatic light the fringe pattern shifts by a certain distance on the screen when a mica sheet of refractive index 1.6 and thickness 1.964 microns is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the plane of slits and the screen is doubled. It is found that the distance between successive maxima (or minima) now is the same as the observed fringe shift upon the introduction of the mica sheet. The wavelength of the light will be :
(A) 3000 Å (B) 4850 Å (C) 5892 Å (D) None of these इनमें से कोई नहीं

SECTION (E) : YDSE WITH OBLIQUE INCIDENCE AND OTHER MODIFICATIONS IN EXPERIMENTAL SETUP OF YDSE

E 1. 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) $2\lambda \sin\theta$



SECTION (F) : THIN FILM INTERFERENCE

F 1. A thin film of air between a plane glass plate and a convex lens is irradiated with a parallel beam of monochromatic light and is observed under a microscope. You will see :
(A) Uniform brightness
(B) Complete darkness
(C) Film crossed over by concentric bright and dark rings
(D) Film crossed over by parallel bright and dark bands

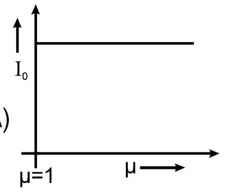
F 2. White light is incident normally on a glass plate (in air) of thickness 500 nm and refractive index of 1.5. The wavelength (in nm) in the visible region (400 nm - 700nm) that is strongly reflected by the plate is:
(A) 450 (B) 600 (C) 400 (D) 500

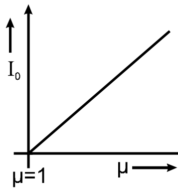
EXERCISE-3

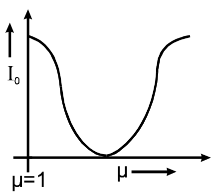
1. If the ratio of the intensity of two coherent sources is 4 then the visibility $[(I_{max} - I_{min})/(I_{max} + I_{min})]$ of the fringes is
(A) 4 (B) 4/5 (C) 3/5 (D) 9

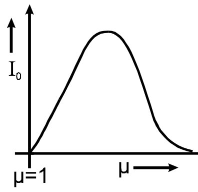
2. In Young's double slit experiment, the interference pattern is found to have an intensity ratio between bright and dark fringes as 9. This implies :
(A) the intensities at the screen due to the two slits are 5 and 4 units
(B) the intensities at the screen due to the two slits are 4 and 1 units
(C) the amplitude ratio of the individual waves is 3
(D) the amplitude ratio of the individual waves is 2

3. 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) 

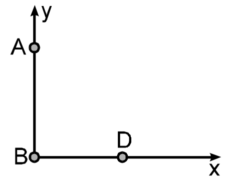
(C) 

(D) 

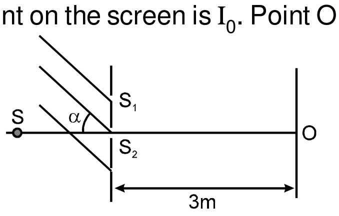
4. In a Young's double slit experiment the slit is illuminated by a source having two wavelengths of 400 nm and 600 nm. If distance between slits, d = 1mm, and distance between the plane of the slit and screen, D = 10 m then the smallest distance from the central maximum where there is complete darkness is :
(A) 2mm (B) 3mm (C) 12 mm (D) there is no such point

5. 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

6. An interference is observed due to two coherent sources 'A' & 'B' having face 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



7. A parallel beam of light ($\lambda = 5000$ Å) is incident at an angle $\alpha = 30°$ with the normal to the slit planein 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



8. 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.

9. 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 distant 1m from the slit. The wavelength of light is 6oo nm. Then the distance of the first maxima above the mirror is equal to:
(A) 30 mm (B) 15 mm (C) 60 mm (D) 7.5 mm

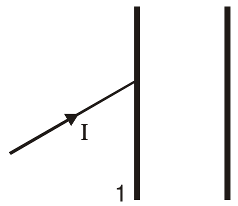
EXERCISE-4

SECTION (A) : PRINCIPLE OF SUPERPOSITION, PATH DIFFERENCE, WAVEFRONTS, AND COHERENCE

A 1. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude 'A' and wavelength 'λ'. In another experiment with the same set-up the two slits are sources of equal amplitude 'A' and wavelength 'λ', but are incoherent. Find the ratio of the intensity of light at the midpoint of the screen in the first case to that in the second case.

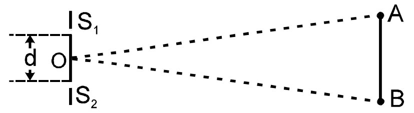
A 2. Find the maximum intensity in case of interference of n identical waves each of intensity I_0 if the interference is (a) coherent (b) incoherent.

A 3. 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.



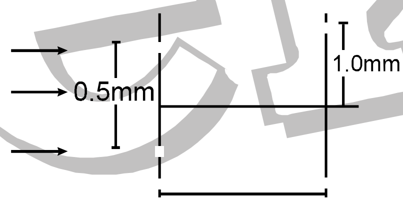
SECTION (B) : YDSE WITH MONOCHROMATIC LIGHT

B 1. 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.



SECTION (C) : YDSE WITH POLYCHROMATIC LIGHT

C 1. White coherent light (400 nm-700) is sent through the slits of a Young's double slit experiment (as shown in the figure). The separation betweem the slits is 0.5 mm and the screen is 50 cm away from the slits. There is a hole in the screen at a point 1.0 mm away (along the width of the fringes) from the central line. (a) Which wavelength(s) will be absent in the light coming from the hole ? (b) which wavelength(s) will have a strong intensity?



C 2. 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?

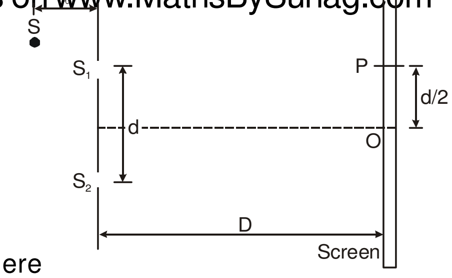
SECTION (D) : YDSE WITH GLASS SLAB, OPTICAL PATH

D 1. 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 Δd = 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.

SECTION (E) : YDSE WITH OBLIQUE INCIDENCE AND OTHER MODIFICATIONS IN EXPERIMENTAL SETUP OF YDSE

E 1. Two coherent point sources S_1 and S_2 vibrating in phase emit light of wavelength λ. The separation between the sources is 2λ. Consider a line passing through S_2 and perpendicular to the line S_1 S_2. What is the smallest distance from S_2 where a minimum of intensity occurs?

E 2. 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).

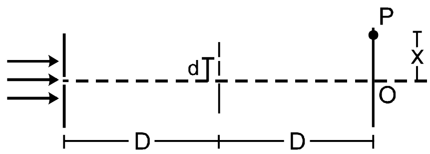


($\lambda << d$, $d << D$, $\ell >> d$)

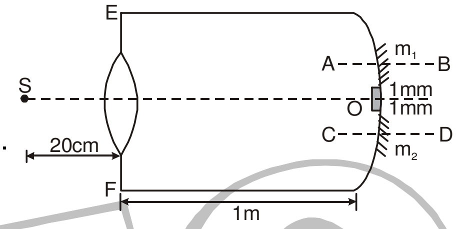
(a) between the screen and the slits.

(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.

E 3. Consider the arrangement show in figure. The distance D is large compared to the separation d between the slits. (a) Find the minimum value of d so that there is a dark fringe at O. (b) Suppose d has this value. Find the distance x at which the next bright fringe is formed. (c) Find the fringe-width.



E 4. An equi 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 axes AB and CD respectively are separated by 1 mm each from the principle axes 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 :

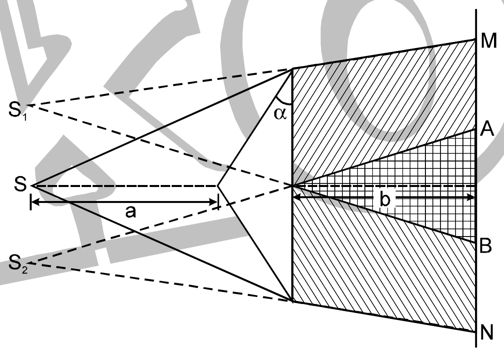


(a) the position of the image formed by lens water combination.

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

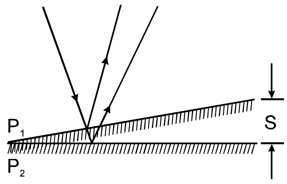
(c) width of the fringes on EF.

E 5. Light from source S is incident on the Fresnel biprism as shown in the fig. The light beam refracted by the different faces of the prism partly overlap and produce an interference pattern on a screen on its section AB. Find the fringe width, if the distance from the source to the prism is a = 1 m and from the prism to the screen b = 4 m. The angle of refraction of the prism is $\alpha = 2 \times 10^{-3}$ rad. The glass which the prism is made of has a refractive index of n = 1.5. The wavelength of the light wave λ = 6000 Å. How many interference fringes can be observed on the screen MN.



SECTION (F) : THIN FILM INTERFERENCE

F 1. Figure shows two flat glass plates P_1 and P_2 placed nearly (but not exactly) parallel forming an air wedge. The plates are illuminated normally by monochromatic light and viewed from above. Light waves reflected from the upper and lower surfaces of the air wedge give rise to an interference pattern.



(a) Show that the separation between two successive bright (or dark) fringes is given by $\frac{\lambda \ell}{2S}$ where 'ℓ' is the length of each plate and S is the separation between the plates at the open end of the wedge.

(b) In the experiment, a dark fringe is observed along the line joining the two plates. Why?

(c) If the space between the glass plates is filled with water, what changes in the fringe pattern do you expect to see, if at all.

(d) Suggest a way of obtaining a bright fringe along the line of contact of the two plates in the experiment.

F 2. In order that a thin film of oil floating on the surface of water should show colours due to interference, the thickness of the oil film should be of the order of :

(A) 100 Å (B) 10,000 Å (C) 1 mm (D) 1 cm

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EXERCISE-5

1. In YDSE the separation between slits is 2×10^{-3} m where as the distance of screen from the plane of slits is 2.5 m. A light of wavelengths in the range 2000 – 8000 Å is allowed to fall on the slits. **[REE '96, 5]**

(i) The wavelength in the visible region that will be present on the screen at 10^{-3} m from the central maxima will be

(A) $\frac{8000}{3}$ Å, 2000 Å (B) 2000 Å, 4000 Å (C) 3000 Å, 6000 Å (D) 4000 Å, 8000 Å

(ii) Wavelengths that will be present at that point of screen in infra – red as well in ultra violet region will be

(A) $\frac{8000}{3}$ Å, 2000 Å (B) 2000 Å, 4000 Å (C) 3000 Å, 6000 Å (D) 4000 Å, 8000 Å

2. A double – slit apparatus is immersed in a liquid of refractive index 1.33. It has slit separation of 1 mm & distance between the plane of the slits & screen is 1.33 m. The slits are illuminated by a parallel beam of light whose wavelength in air is 6300 Å : **[JEE '96, 2+3]**

(i) the fringe width will be -
(A) 0.63 mm (B) 0.315 mm (C) 1.32 mm (D) None of these

(ii) One of the slits of the apparatus is now covered by a thin glass sheet of refractive index 1.53. The smallest thickness of the sheet to bring the adjacent minima on the axis will be :
(A) 1.8 μm (B) 1.575 μm (C) 1 μm (D) 2.5 μm

3. In Young's experiment, the source is red light of wavelength 7×10^{-7} m. When a thin glass plate of refractive index 1.5 is put in the path of one of the interfering beams, the central bright fringe shifts by 10^{-3} m to the position previously occupied by the 5th bright fringe.

(i) The thickness of the plate :
(A) 7 μm (B) 14 μm (C) 3.5 μm (D) None of these

(ii) When the source is changed to green light of wavelength 5×10^{-7} m, the central fringe shifts to a position initially occupied by the 6th bright fringe due to red light. The refractive index of glass for the green light will be :
(A) 1.5 (B) 1.2 (C) 1.6 (D) 2

(iii) The change in fringe width due to the above change in wavelength will be

(A) $\frac{400}{7}$ μm (increase) (B) 400 μm (decrease)

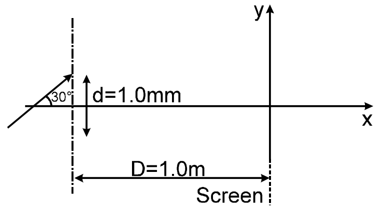
(C) 400μm (increase) (D) $\frac{400}{7}$ μm (decrease)

4. 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 P while the 6th minimum lies above P. The thickness of the glass plate will be :
(Absorption of light by glass plate may be neglected)
(A) 9.3 μm (B) 4 μm (C) 16μm (D) None of these

5. A slit of width d is placed in front of a lens of focal length 0.5 m & is illuminated normally with light of wavelength 5.89×10^{-7} m. The first diffraction minima on either side of the central diffraction maximum are separated by 2×10^{-3} m. The width d of the slit is _______ m. **[JEE '97 (I), 2]**

6. 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 **[JEE '98, 2]**

7. A coherent parallel beam of microwaves of wavelength λ = 0.5 mm falls on a Young's double slit apparatus. The separation between the slits is 1.0 mm. The intensity of microwaves is measured on screen placed parallel to the plane of the slits at a distance of 1.0 m from it, as shown in the figure.



(i) If the incident beam falls normally on the double slit apparatus, the y – coordinates of all the interference minima on the screen will be :

(A) $\frac{1}{\sqrt{15}}$, $\frac{3}{\sqrt{7}}$ (B) $\pm\frac{1}{\sqrt{15}}$, $\pm\frac{3}{\sqrt{7}}$ (C) $-\frac{1}{\sqrt{15}}$, $-\frac{3}{\sqrt{7}}$ (D) $\frac{1}{\sqrt{15}}$, $-\frac{3}{\sqrt{7}}$

(ii) If the incident beam makes an angle of 30º with the x – axis (as in the dotted arrow shown in the figure), the y – coordinates of the first minima on either side of the central maximum will be :

(A) $\frac{1}{\sqrt{15}}$, $\frac{3}{\sqrt{7}}$ (B) $\pm\frac{1}{\sqrt{15}}$, $\pm\frac{3}{\sqrt{7}}$ (C) $-\frac{1}{\sqrt{15}}$, $-\frac{3}{\sqrt{7}}$ (D) $\frac{1}{\sqrt{15}}$, $-\frac{3}{\sqrt{7}}$

[JEE '98, 5 + 3]

8. In a Young's double slit arrangement, a source of wavelength 6000 Å is used. The screen is placed 1 m from the slits. Fringes formed on the screen, are observed by a student sitting close to the slits. The student's eye can distinguish two neighbouring fringes if they subtend an angle more than 1 minute of arc. **[REE '98, 5]**

(i) The maximum distance between the slits so that the fringes are clearly visible will be :

(A) $\frac{3}{\pi}$ mm (B) $\frac{6}{\pi}$ mm (C) $\frac{4.5}{\pi}$ mm (D) $\frac{6.48}{\pi}$ mm

(ii) The position of the 3rd bright fringe from the centre of the screen will be :

(A) $\frac{\pi}{0.036}$ mm (B) $\frac{\pi}{36}$ mm (C) $\frac{\pi}{3.6}$ mm (D) $\frac{\pi}{0.06}$ mm

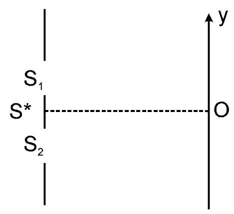
(iii) The position of the 5th dark fringe from the centre of the screen will be :

(A) $\frac{\pi}{24}$ mm (B) $\frac{\pi}{0.024}$ mm (C) $\frac{\pi}{2.4}$ mm (D) $\frac{\pi}{0.06}$ mm

9. A young's double slit experiment is performed using light of wavelength λ = 5000Å, which emerges in phase from two slits a distance d = 3×10^{-7}m apart. A transparent sheet of thickness t = 1.5×10^{-7}m is placed over one of the slits. The refractive index of the material of this sheet is μ = 1.17. The central maximum of the interference pattern now appear at :
(D = distance between screen and slits) **[REE '99,5]**

(A) 0.085 D (B) D (C) 1.2 D (D) 0.5 D

10. The Young's double slit experiment is done in a medium of refractive index 4/3. A light of 600 nm wavelength is falling on the slits having 0.45 mm separation. The lower slit S_2 is covered by a thin glass sheet of thickness 10.4 μm and refractive index 1.5. The interference pattern is observed on a screen placed 1.5 m from the slits as shown. [All wavelengths in this problem are for the given medium of refractive index 4/3. Ignore dispersion]



(i) The location of the central maximum (bright fringe with zero path difference) on the y-axis will be :
(A) – 13/3 mm (B) 2 mm (C) –2/3 mm (D) 2/3 mm

(ii) The light intensity at point O relative to the maximum fringe intensity will be :
(A) I_{max} (B) 0.25 I_{max} (C) 0.5 I_{max} (D) 0.75 I_{max}

(iii) Now, if 600 nm light is replaced by white light of range 400 to 700 nm, the wavelengths of the light that form maxima exactly at point O will be : **[JEE '99, 5+3+2]**
(A) 650 nm, 433.33 nm (B) 300 nm, 200 nm
(C) 650 nm, 300 nm (D) 600 nm, 433.33 nm

11. In a wave motion y = a sin(kx-ωt), y can represent **[JEE '99, 3]**

(A) electric field (B) magnetic field (C) displacement (D) pressure

12. 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 **[JEE '2000 (Scr.)]**

(A) the intensities of both the maxima and the minima increase
(B) the intensity of the maxima increases and the minima has zero intensity
(C) the intensity of the maxima decreases and that of the minima increases
(D) the intensity of the maxima decreases and the minima has zero intensity.

13. A glass plate of refractive index 1.5 is coated with a thin layer of thickness t and refractive index 1.8. Light of wavelength λ travelling in air is incident normally on the layer. It is partly reflected at the upper and the lower surfaces of the layer and the two reflected rays interfere.

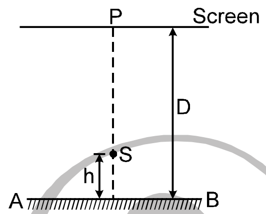
(i) The condition for their constructive interference.

(A) $t = \frac{\lambda}{7.2}, \frac{3\lambda}{7.2}, ...$ (B) $t = \frac{3\lambda}{7.2}, \frac{7\lambda}{7.2}, ...$ (C) $t = \frac{\lambda}{7.2}, \frac{7\lambda}{7.2}, ...$ (D) $t = \frac{3\lambda}{7.2}, \frac{9\lambda}{7.2}, ...$

(ii) If λ = 648 nm, obtain the least value of t for which the rays interfere constructively :

(A) 190 nm (B) 50 nm
(C) 90 nm (D) None of these **[JEE '2000 Mains, 4]**

14. A point source B 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.



(i) The shape of the interference fringes on the screen will be :

(A) Straight line (B) Ellipse (C) Circular (D) Parabolic

(ii) The ratio of the maximum to the minimum intensities in the interference fringes formed near the point P will be :

(A) 4 (B) 8 (C) 16 (D) None of these

(iii) If the intensity at point P corresponds to a maximum, then the minimum distance through which the reflecting surface AB should be shifted so that the intensity at P again becomes maximum is : **[JEE 2002 Mains, 1 + 3 + 1]**

(A) 300 nm (B) 600 nm (C) 150 nm (D) 450 nm

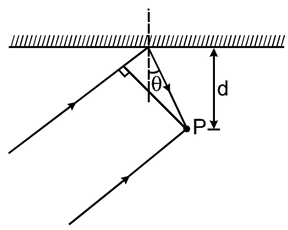
15. In the ideal double-slit experiment, when a glass-plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wavelength λ) the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is: **[JEE 2002 Screening, 3]**

(A) 2 λ (B) 2λ/3 (C) λ/3 (D) λ

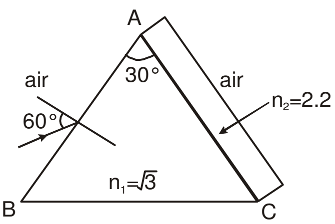
16. A parallel beam of light of wavelength λ is incident on a plane mirror at an angle θ as shown in the figure. With maximum intensity at point P, which of the following relation is correct. **[JEE 2003 Screening, 3]**

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

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



17. A prism has an angle of prism A = 30°. A thin film (μ_f = 2.2) is coated on face AC as shown in the figure. Light of wavelength 550 nm is incident on the face AB at 60° angle of incidence. **[JEE 2003 Mains, 4]**



(i) the angle of its emergence from the face AC will be :

(A) 0º (B) 90° (C) 60° (D) 30°

(ii) the minimum thickness (in nm) of the film for which the emerging light is of maximum possible intensity will be :

(A) 100 (B) 125 nm (C) 150 nm (D) 200 nm

18. 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 Scr.]**

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

19. Two light rays of λ = 500 nm and 700 nn are passed through a young's double slit apparatus. The minimum distance where the maximums of both light rays occur will be : (given D/d = 10^{-3}) **[JEE 2004 Mains, 4]**

(A) 3.5 mm (B) 7 mm (C) 14 mm (D) 10 mm

20. 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 Scr.]**

(A) increase (B) decrease

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

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

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

ANSWER

EXERCISE # 1

A 1. (a) 9 I (b) 5 I (c) I

A 2. (a) sphere (b) plane, (c) plane

A 3. $\cos^{-1}\frac{2}{\sqrt{14}}$ **A4.** 2 **A 5.** $\frac{4}{9}$

B2. 1.63 mm **B 3.** 0.30 mm

B 4. 0.03 mm **B5.** (a) 0.25mm (b) 20

B 6. 0.014 degree **B7.** 0.15º

B 8. λ = 600 nm **B 9.** 6×10^{-6} m

B 10. $\frac{\pi d^2}{\lambda \ell}$ **(a)** $\Delta\phi = \left(\frac{1}{\ell} + \frac{\mu}{D}\right)\frac{\pi d^2}{\lambda}$

(b) $\Delta\phi = \left(\frac{\mu}{\ell} + \frac{1}{D}\right)\frac{\pi d^2}{\lambda}$; $D_{min} = \frac{\beta}{2} = \frac{\lambda D}{2d}$

C 1. 0.72 mm **C 2.** 7

D 1. (a) 4.9×10^{-4} m (b) 0.021 cm on one side and 0.028 cm on the other side

D 2. $\frac{\lambda}{2(u-1)}$ **D3.** $\frac{2\pi}{n_1\lambda_1}(n_3 - n_2)\,t$

D4. $\frac{\lambda}{|\mu_1 - \mu_2|}$ **E1.** zero

E 2. 0.35 mm **F 1.** 1.32 **F2.** 100 nm

F 3. 625 μm , 500 μm, $\frac{1250}{3}$ μm

EXERCISE # 2

A1. (A) **A 2.** (C) **A 3.** (C)

B 1. (C) **B 2.** (A) **B3.** (C)

B 4. (B) **B 5.** (B) **B6.** (D)

B 7. (C) **C 1.** (D) **C2.** (A)

C 3. (C) **C 4.** AC **D1.** (D)

D 2. (A) **D 3.** (D) **D4.** (C)

E 1. (C) **F 1.** (C) **F 2.** (B)

EXERCISE # 3

1. (B) **2.** B,D **3.** (C)

4. (D) **5.** (A) **6.** (A)

7. (A, C) **8.** (B,C,D) **9.** (B, D)

EXERCISE # 4

A 1. 2 **A 2.** (a) $n^2 I_0$ (b) $n\,I_0$

A 3. 1 : 49 **B 1.** 3

C 1. (a) 400 nm, 667 nm, (b) 500 nm

C 2. (a) 0.12 cm. (b) 0.16 cm

D 1. μ = 600 nm , t = 24 μm

E 1. $7\lambda/12$

E 2. $\frac{\pi d^2}{\lambda \ell}$ (a) $\Delta\phi = \left(\frac{1}{\ell} + \frac{\mu}{D}\right)\frac{\pi d^2}{\lambda}$

(b) $\Delta\phi = \left(\frac{\mu}{\ell} + \frac{1}{D}\right)\frac{\pi d^2}{\lambda}$; $D_{min} = \frac{\beta}{2} = \frac{\lambda D}{2d}$

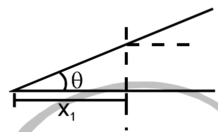
E 3. (a) $\sqrt{\frac{D\lambda}{2}}$ (b) d (c) 2d

E 4. (i) 80 cm behind the lens (ii) 4 mm (iii) β = 60 μm

E 5. β = 0.15 cm , n = ...

F 1. (a) Let a bright fringe is formed at distance x_1 from common line of two mirror. Than at this distance the path difference = $2x_1\theta$ where θ is the angle between mirrors.

Let the next bright fringe be at x_2 from common line, then path difference = $2x_2\theta$



Now, $2(x_2\theta - x_1\theta) = \lambda$

giving $(x_2 - x_1)$ = fringe width = $\frac{\lambda}{2\theta}$, we have $\theta = \left(\frac{S}{\ell}\right)$

so, fringe width = $\beta = \frac{\lambda\ell}{2S}$

(b) As along line joining the two mirrors path diffrence = 0, but as light is getting reflected at upper surface from rarer medium so no phase change of π takes place but for ray reflected at lower surface a phase change of π occurs. Hence along line joining mirrors net path difference = $\lambda/2$ so a dark fringe is observed.

(c) fringe pattern will shrink in water.

(d) to obtain a bright fringe net path difference should be made equal to zero which can be done by filling the space between mirror by water and by using lower glass having refractive index greater than water while upper glass having refrective index less than that of water.

F 2. (B)

EXERCISE # 5

1. (i) D (ii) A **2.** (i) A (ii) B **3.** (i) A (ii) C (iii) D

4. (A) **5.** 0.29 mm **6.** D **7.** (i) B (ii) A

8. (i) D (ii) C (iii) C **9.** A **10.** (i) A (ii) D (iii) A

11. A, B, C **12.** A **13.** (i) A (ii) C

14. (i) C (ii) C (iii) A **15.** A **16.** B

17. (i) A (ii) B **18.** D **19.** A

20. B **21.** B