PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

INTERFERENCE AND DIFFRACTION

Sample Problem

1. In Fig. , the two light waves that are represented by the rays have wavelength 550.0 nm before entering media 1 and 2. They also have equal amplitudes and are in phase. Medium 1 is now just air, and medium 2 is a transparent plastic layer of index of refraction 1.600 and thickness 2.600 μm.

What is the phase difference of the emerging waves in wavelengths, radians, and degrees? What is their effective phase difference (in wavelengths)?

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2. In Fig. , the two light waves that are represented by the rays have wavelength 550.0

nm before entering media 1 and 2. They also have equal amplitudes and are in phase. Medium 1 is now just air, and medium 2 is a transparent plastic layer of index of refraction 1.600 and thickness 2.600 μm.

If the waves reached the same point on a distant screen, what type of interference would they produce?

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3. What is the distance on screen C in Fig. 35-11a between adjacent maxima near the center of the interference pat- tern? The wavelength λ of the light is 546 nm, the slit separation d is 0.12 mm, and the slit-screen separation D is 55 cm. Assume that θ in Fig. 35-11 is small enough to permit use of the approximations $\sin\theta \approx \tan\theta \approx \theta$, in which θ is expressed in radian measure.

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4. Young's double slit experiment is performed inside water $\left(\mu = \frac{4}{3}\right)$ with light of frequency 6×10^{14} Hz. If the slits are separated by 0.2 mm and the screen kept 1 m from the slits, find the fringe width. Using the same set-up, what will the fringe width be if the experiment is performed in air?

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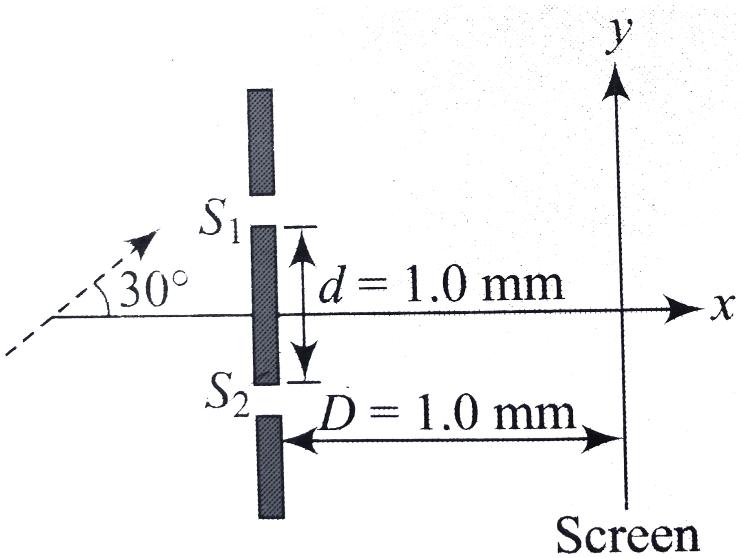
5. A coherent parallel beam of microwaves of wavelength $\lambda = 0.5mm$ falls on aYoung's double-slit apparatus. The separation between the slits is 1.0 mm. The intensity of microwaves is measured on a screen placed parallel to the plane of the slits at a distance of 1.0 m from it as shown in Fig. 2.42.

If the incident beam makes an angle or 30° with the x-axis (as in the dotted arrow shown in the figure), find the y-coordinates of the first minima on either side of the central maximum.



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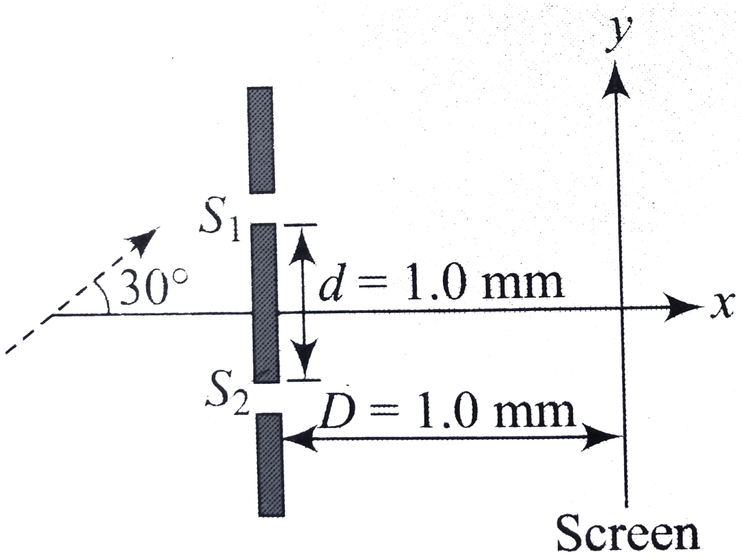

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7. A double slit apparatus is immersed in a liquid of refractive index 1.33. it has slit separation of 1 mm and distance between the plane of the slits and the screen is 1.33 m. the slits are illuminated by a parallel beam of light whose wavelength in air is 6300 Å. what is the fringe width?

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8. A double-slit apparatus is immersed in a liquid of refractive index 1.33. in It has slit separation of 1 mm and distance between the plane of slits and screen is 1.33 m. The slits are illuminated by a parallel beam or light whose wavelength in air is 6300Å.

a. Calculate the fringe width.

b. One of the slits of the apparauts is covered by a thin glass sheet of refractive index 1.53. Find the smallest thickness of the sheet to bring the adjacent minimum on the axix.

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9. Three light waves combine at a certain point where thcir electric field components are

$E_1 = E_0 \sin \omega t,$

$E_2 = E_0 \sin(\omega t + 60^\circ),$

$E_3 = E_0 \sin(\omega t - 30^\circ).$

Find their resultant component E(t) at that point.

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10. The interference pattern is obtained with two coherent light sources of intensity ratio n. In the interference patten, the ratio $\frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$ will be

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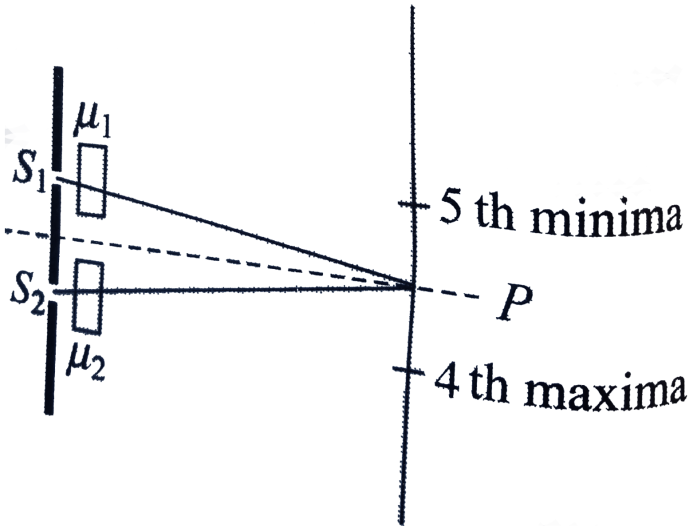
11. In Young's experiment the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate, having the same thickness as the first one but having refractive index 1.7 interference pattern is observed using light of wavelength 5400Å

It is found that point P on the screen where the central maximum $(n = 0)$ fell before the glass plates were inserted now has $3/4$ the original intensity. It is further observed that what used to be the fourth maximum earlier, lies below point P while the fifth minimum lies above P.

Calculate the thickness of glass plate. (Absorption of light by glass plate may be neglected.



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12. Two point sources oscillating in the same phase are on a straight line perpendicular to a screen. The nearest source is at a distance of D »

λ from the screen. What shape will the interference fringes have on the screen? What is the distance on the screen from the perpendicular to the nearest bright fringe if the distance between the sources is $l = n\lambda$ (n is an integer)? Note that λ « l.

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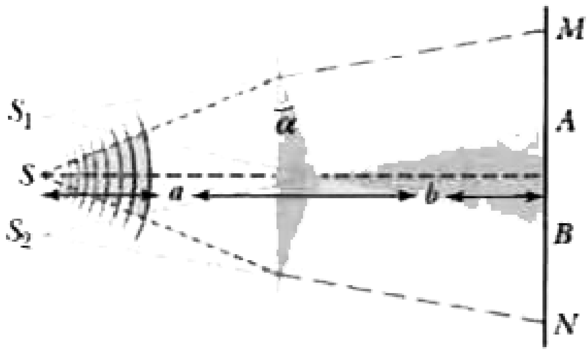
13. Light from source S is incident on the Fresnel biprism shown in Figure. The light beams refracted by the different faces of the prism partly overlap and produce an interference pattern on a screen on its section AB.



Find the distance between adjacent interference fringes if the distance from the source to the prism is a = 1 m and that from the prism to the screen is b = 4 m. The angle of refraction of the prism is $a = 2 \times 10^{-3}$ rad.

The glass of prism has a refractive index of n = 1.5.

The wavelength of the light is $\lambda = 6000 \text{Å}$.

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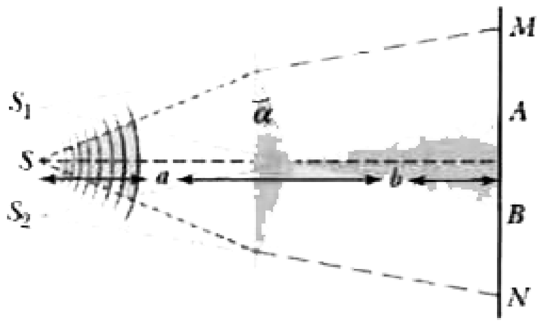
14. Light from source S is incident on the Fresnel biprism shown in Figure. The light beams refracted by the different faces of the prism partly overlap and produce an interference pattern on a screen on its section AB.



How many interference fringes can be observed on a screen?

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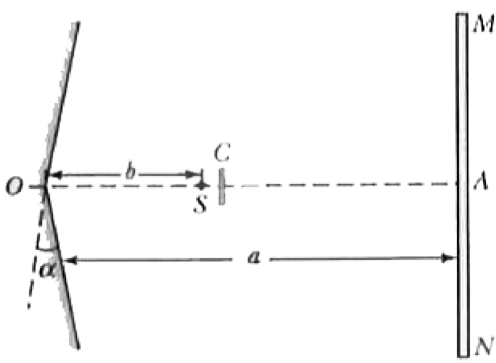
15. Two flat mirrors form an angle close to 180°. A source of light S is placed at an equal distance b from the mirrors. Find the distance between adjacent interference fringes on screen MN at a distance $OA = \alpha$, from the point of intersection of the mirrors. The wavelength of the light is equal to λ. Shield C does not allow the light to pass directly from the source to the screen.



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16. S is a monochromatic point source emitting light of wavelength l = 500 nm. A thin lens of circular shape and of 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. If the third intensity maximum occurs at point A on the screen, find the distance OA.

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17. White light, with a uniform intensity across the visible wavelength range 430 - 690 nm, is perpendicularly incident on a wate film, of index of refraction $\mu = 1.33$ and thickness $d = 320$nm, that is suspended in air. At what wavelength λ is the light reflected by the film brightest to an observer?

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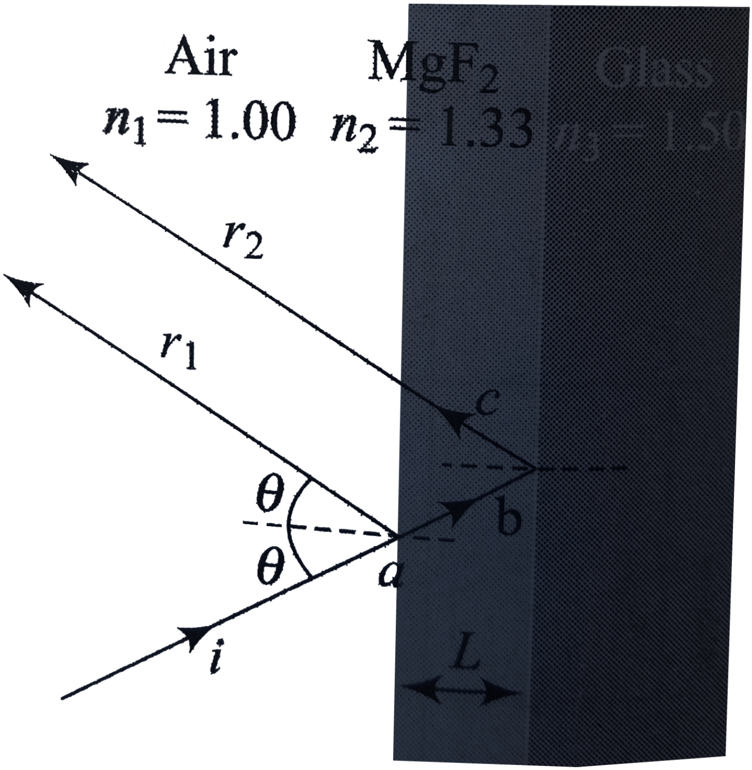
18. A glass lens is coated on one side with a thin film of magnesium fluoride $(MgF_2)$to reduce reflection from the lens surface (Fig. 2.26). The Index of refraction of MgF_2 is 1.38, that of the glass is 1.50. What is the least coating thickness that eliminates (via interference) the reflections at the middle of the visible specturm $(\lambda = 550nm)$? Assume that the light is approxmately perpendicular to the lens surface.



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19. A transparent plastic block with a thin wedge of air at the right. (The wedge thickness is

exaggerated in the figure.) A broad beam of red light, with wavelength $\lambda = 632.8nm$, is directed downward through the top of the block (at an incidence angle of 0°). Some of the light that passes into the plastic is reflected back up from the top and bottom surfaces of the wedge, which acts as a thin film (of air) with a thickness that varies uniformly and gradually from L_L at the left-hand end to L_R at the righthand end. (The plastic layers above and below the wedge of air are too thick to act as thin films.) An observer looking down on the block sees an interference pattern consisting of six dark fringes and five bright red fringes along the wedge. What is the change in thickness $\Delta L (= L_R - L_L)$ along the wedge?

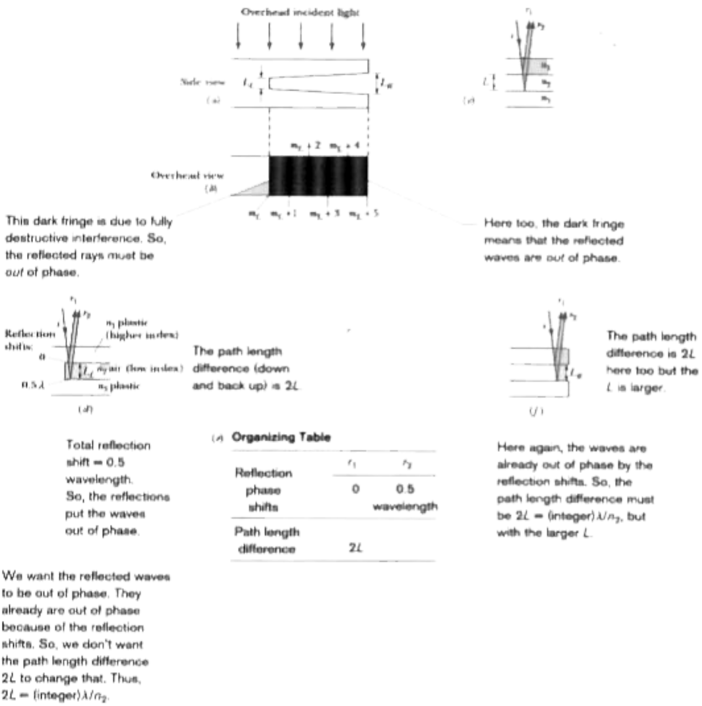

Figure 35-41 (*a*) Red light is incident on a thin, air-filled wedge in the side of a transparent plastic block. The thickness of the wedge is L_L at the left end and L_R at the right end. (*b*) The view from above the block: an interference pattern of six dark fringes and five bright red fringes lies over the region of the wedge. (*c*) A representation of the incident ray i, reflected rays r_1 and r_2, and thickness L of the wedge anywhere along the length of the wedge. The reflection rays at the (*d*) left and (*f*) right ends of the wedge and (*e*) their organizing table.

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20. A slit of width a is illuminated by white light.

(a) For what value of a will the first minimum for red light of wavelength $\lambda = 650nm$ appear at $\theta = 15^\circ$?

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21. A slit of width a is illuminated by white light. What is the wavelength λ of the light whose first side diffraction maximum is at 15°, thus coinciding with the first minimum for the red light?

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22. Find the intensities of the first three secondary maxima in the single-slit diffraction pattern, measured relative to the intensity of the central maximum

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23. A circular converging lens, with diameter d = 32 mm and focal length f = 24 cm, forms images of distant point objects in the focal plane of the lens. The wavelength is $\lambda = 550nm$.

(a) Considering diffraction by the lens, what angular separation must two distant point objects have to satisfy Rayleigh's criterion?

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24. A circular converging lens, with diameter d = 32 mm and focal length f = 24 cm, forms images of distant point objects in the focal plane of the lens. The wavelength is $\lambda = 550nm$.

What is the separation Ar of the centers of the images in the focal plane? (That is, what is the separation of the central peaks in the two intensity-versus-position curves?)

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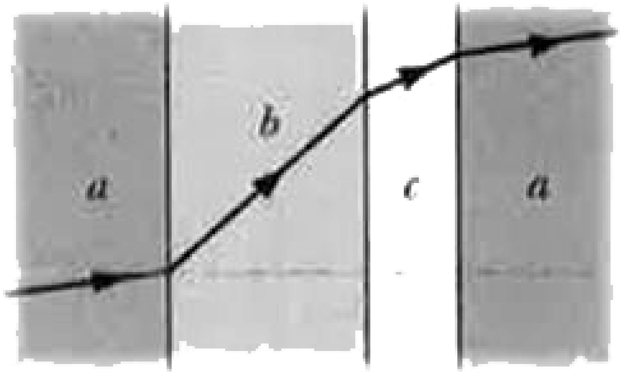
Checkpoint

1. The figure shows a monochromatic ray of light traveling across parallel interfaces, from an original material a, through layers of materials b and c, and then back into material a. Rank the materials according to the speed of light in them, greatest first.



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2. The light waves of the rays have the same wavelength and amplitude and are initially in phase. (a) If 7.60 wavelengths fit within the length of the top material and 5.50 wavelengths fit within that of the bottom material, which material has the greater index of refraction? (b) If the rays are angled slightly so that they meet at the same point on a distant screen, will the interference there result in the brightest possible illumination, bright intermediate illumination, dark intermediate illumination, or darkness?

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3. What are ΔL (as a multiple of the wavelength) and the phase difference in wavelengths) for the two rays if point Pis (a) a third side maximum and (b) a third minimum?

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4. Each of four pairs of light waves arrives at a certain point on a screen. The waves have the same wavelength. At the arrival point, their amplitudes and phase differences are (a) $2E_0, 6E_0$, and π rad, (b) $3E_0, 5E_0$, and π rad, (c) $9E_0, 7E_0$ and 3π rad, (d) $2E_0, 2E_0$ and 0 rad. Rank the four pairs according to the intensity of the light at the arrival point, greatest first. (Hint: Draw phasors.)

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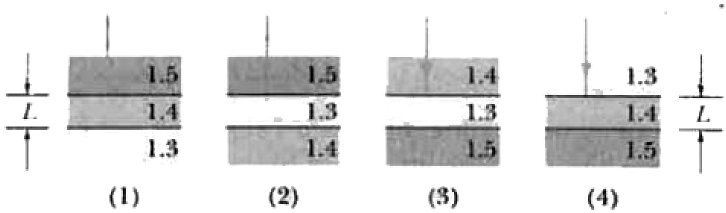
5. The figure shows four situations in which light reflects perpendicularly from a thin film of thickness L, with indexes of refraction as given. (a) For which situations does reflection at the film interfaces cause a zero phase difference for the two reflected rays? (b) For which situations will the film be dark if the path length difference 2L causes a phase difference of 0.5 wavelength?



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6. We produce a diffraction pattern on a viewing screen by means of a long narrow slit illuminated by blue light. Does the pattern expand away from the bright center (the maxima and minima shift away from the center) or contract toward it if we

(a) switch to yellow light or (b) decrease the slit width?

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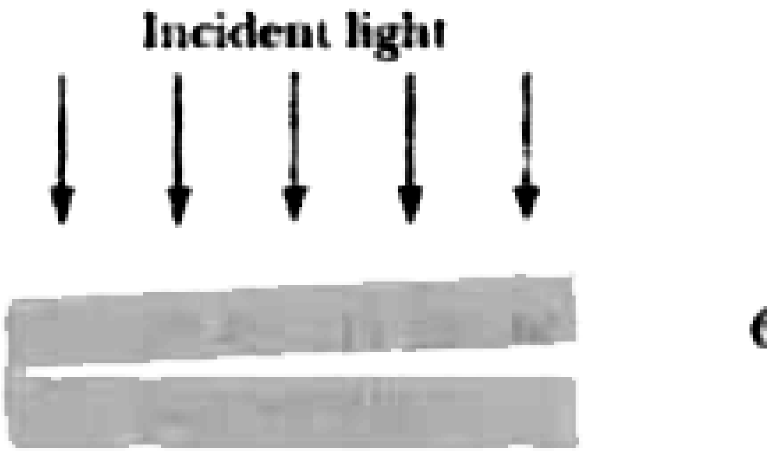
Problems



1.

In Figure, a broad bcam Incident light of light of wavelength 630 nn is sent directly downward through the top plate of a pair of glass plates touching at the left end. The air between the plates acts as a thin film, and an interference pattern can be seen from above the plates. Initially, a dark fringe lies at the left end, a bright fringe lies at the right end, and nine dark fringes lie between those two end fringes. The plates are then very gradually squeezed together at a constant rate to decrease the angle between them. As a result, the fringe at the right side changes between being bright to being dark every 15.0 s. (a) At what rate is the spacing between the plates at the right end being changed? (b) By how inuch has the spacing there changed when both left and right ends have a dark fringe and there are five dark fringes between them?

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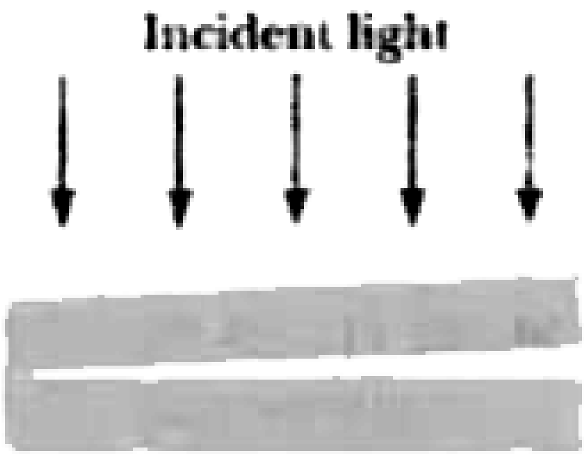

2.

In Figure, two microscope slides touch at one end and are separated at the other end. When light of wavelength 420 nm shines vertically down on the slides, an overhead observer sees an interference pattern on the slides with the dark fringes separated by 1.9 mm. What is the angle between the slides?

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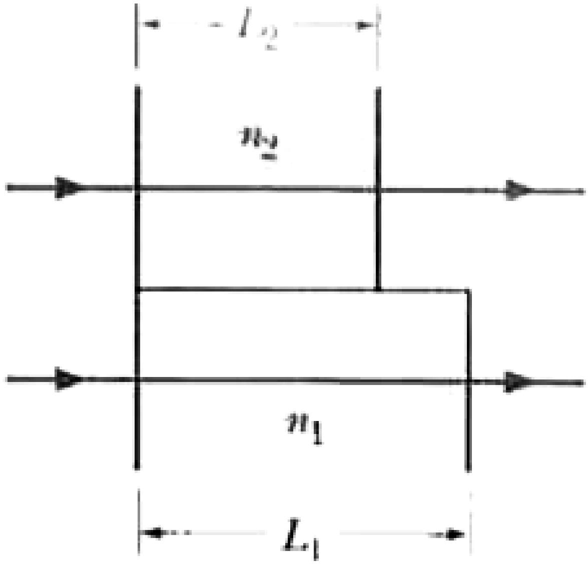

3.

Two waves of light in air, of wavelength $\lambda = 600.0nm$, are initially in phase. They then both travel through a layer of plastic as shown in Figure, with $L_1 = 4.00\mu m,\ \ L_2 = 3.50\mu m, n_1 = 1.42,$ and $n_2 = 1.60.$ (a) What multiple of λ gives their phase difference after they both have emerged from the layers? (b) If the waves later arrive at some common point with the same amplitude, is their interference fully constructive, fully destructive, interme- diate but closer to fully constructive, or intermediate but closer to fully destructive?

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4. The wavelength of yellow sodium light in air is 589 nm. (a) What is its frequency? (b) What is its wavelength in glass whose index of refraction is

1.52? (c) From the results of (a) and (b), find its speed in this glass.

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5. Two waves of the same frequency have amplitudes 1.60 and 2.20. They interfere at a point where their phase difference is 60.0°. What is the resultant amplitude?

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6. A double-slit arrangement produces interference fringes for sodium light ($\lambda = 589nm$) that have an angular separation of 3.50×10^{-3} rad. For what wavelength would the angular separation be 6.0% greater?

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7. White light is sent downward onto a horizontal thin film that is sandwiched between two materials. The indexes of refraction are 1.80 for the top material, 1.65 for the thin film, and 1.50 for the bottom material. The film thickness is 5.00×10^{-7} m. Of the visible wavelengths (400 nm to 700 nm) that result in fully constructive interference at an observer above the film, which is the (a) longer and (b) shorter wavelength? The materials and film are then heated so that the film thickness increases. (c) Does the light resulting in fully constructive interference shift toward longer or shorter wavelengths?

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8. In a double slit experiment, the distance between the slits is 5.0 mm and the slits are 1.0m from the screen. Two interference patterns can be seen on the screen one due to light with wavelength 480nm, and the other due to light with wavelength 600nm. What is the separation on the screen between the third order bright fringes of the two intergerence patterns?

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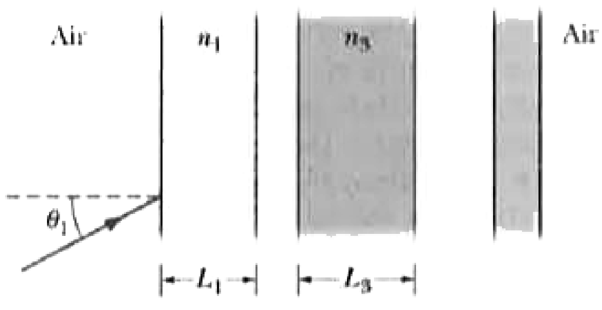
9. In Figure, a light ray is incident at angle $\theta_1 = 55^\circ$ on a series of five transparent layers with parallel boundaries. For layers 1 and 3. $L_1 = 20 \mu m, L_3 = 25 \mu m, n_1 = 1.6,$ and $n_3 = 1.15$. (a) At what angle does the light emerge back into air at the riglit? (b) How much time does the light take to travel through layer 3?



10. Assume that two waves of light in air, of wavelength 585 nm, are initially in phase. One travels through a glass layer of index of refraction $n_1 = 160$ and thickness L. The other travels through an equally thick plastic layer of index of refraction $n_2 = 1.50$. (a) What is the smallest value L should have if the waves are to end up with a phase difference of 5.65 rad? (b) If the waves arrive at some common point with the same amplitude, is their interference fully constructive, fully destructive, intermediate but closer to fully constructive, or intermediate but closer to fully destructive?

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11. The rhinestones in costume jewelry are glass with index of refraction 1.50. To make uliem more reflective, they are often coated with a layer of silicon monoxide of index of refraction 2.00. What is the minimum coating thickness nccded to ensure that light of wavelength 500 nm and of perpendicular incidence will be reflected from the two surfaces of the coating with fully constructive interference?

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12. A disabled tanker leaks kerosene (n = 1.20) into the Persian Gulf, creating a large slick on top of the water (n = 1.30). (a) If you are looking straight down from an airplane, while the Sun is overhead, at a region of the slick where its thickness is 380 nm, for which wavelength(s) of visible light is the reflection brightest because of constructive interference? (b) If you are scuba diving directly under this same region of the slick, for which wavelength(s) of visible light is the transmitted intensity strongest?

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13. A thin film (n = 1.25) coats a thick glass plate (n = 1.50). White light is incident normal to the film. In the reflections, fully destructive interference nccurs at 600 mm and fully constructive interference at 700 nm. Calculate the thickness of the film.

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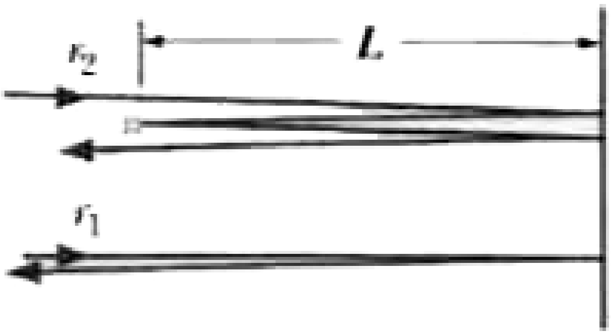
14.



In Figure, a light wave along ray r_1 reflects once from a mirror and a light wave along ray r_2 reflects twice from that same mirror and once from a tiny mirror at distance L from the bigger mirror. (Neglect the slight tilt of the rays.) The waves have wavelength 350 nm and are initially in phase. (a)What is the smallest value of L that puts the final light waves exactly out of phase? (b) With the tiny mirror initially at that value of L, how far must it be moved away from the bigger mirror to again put the final waves out of phase?

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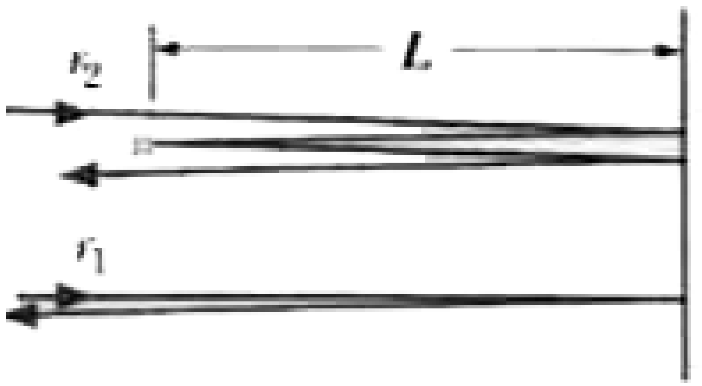
15. 

In Figure, a light wave along ray r_1 reflects once from a mirror and a light wave along ray r_2 reflects twice from that same mirror and once from a tiny mirror at distance L from the bigger mirror. (Neglect the slight tilt of the rays.) The waves have wavelength λ and are initially exactly out of phase. What are the (a) smallest. (b) second smallest, and (c) fourth smallest values of L / λ that result in the final waves being exactly in phase?

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16. In the double-slit experiment, the viewing screen is at distance D = 4.00 m, point P lies at distance y = 20.5 cm from the center of the pattern, the slit separation d is $4.50 \mu m$, and the wavelength λ is 650 nm. (a) Determine where point P is in the interference pattern by giving the maximum or minimum on which it lies, or the maximum and minimum between which it lies. (b) What is the ratio of the intensity I_P at point P to the intensity I_{cen} at the center of the pattern?

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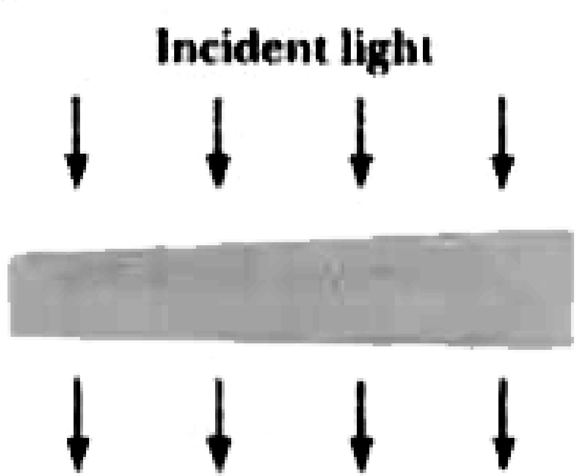
17. In Figure, a broad beam of light of wavelength 420 nm is incident at 90° on a thin, wedge-shaped film with index of refraction 1.70. Transmission gives 10 bright and 9 daik fringes along the film's length. What is the left- to-right change in film thickness?



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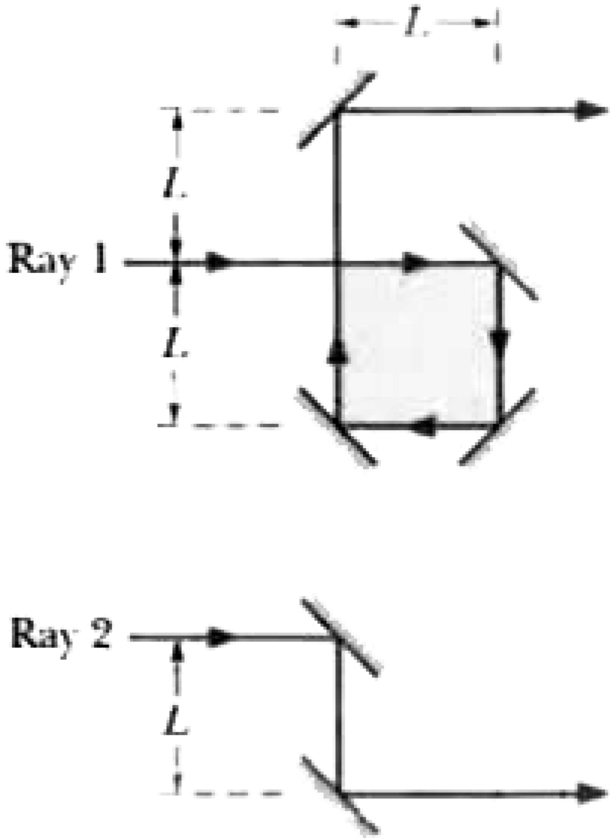
18. In Figure, two light rays go through different paths by reflecting from the various flat surfaces shown. The light waves have a wavelength of 411.0

nm and are initially in phase. What are the (a) smallest and (b) second smallest value of distance L that will put the waves exactly out of phase as they emerge from the region?



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19. We wish to coat flat glass (n=1.50) with a transparent material (n = 1.45) so that reflection of light at wavelength 500 nm is eliminated by interference. What minimum thickness can the coating have to do this?

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20. A plane wave of monochromatic light is incident normally on a uniform thin film of oil that covers a glass plate. The wavelength of the source can be varied continuously. Fully destructive interference of the reflected light is observed for wavelengths of 500 nm and 700 nm and for no wavelengths in between. If the index of refraction of the oil is 1.26 and that of the glass is 1.50, find the thickness of the oil film.

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21. Assume that the two light waves, of wavelength 515 nm in air, are initially out of phase by π rad. The indexes of refraction of the media are $n_1 = 1.45$ and $n_2 = 1.75$. What are the (a) smallest and (b) second smallest value of L that will put the waves exactly in phase once they pass through the two media?

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22. In a double-slit experiment, the fourth-order maximum for a wavelength of 450 nm occurs at an angle of $\theta = 90^\circ$. (a) What range of wavelengths in the visiblc range (400 nm to 700 nm) are not present in the third-order maxima? To eliminate all visible light in the fourth-order maximum, (b) should the slit separation be increased or decreased and (c) what least change is needed?

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23. Light of wavelength 424 nm is incident perpendicularly on a soap film (n = 1.33) suspended in air. What are the (a) least and (b) second least thicknesses of the film for which the reflections from the film undergo fully constructive interference?

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24. In the double-slit experiment, the electric fields of the waves arriving at point P are given by

$$E_1 = (2.00\mu V/m)\sin\left[\left(1.26 \times 10^{15}\right)t\right]$$

$$E_2 = (2.00\mu V/m)\sin\left[\left(1.26 = 10^{15}\right)t + 38.6\text{rad}\right]$$

where timer is in seconds. (a) What is the amplitude of the resultant electric field at point P? (b) What is the ratio of the intensity I_P at point P to the intensity I_{cen} at the center of the interference pattern? (C) Describe where point P is in the interference pattern by giving the maximum or minimum on which it lies, or the maximum and minimum between which it lies. In a phasor diagram of the electric fields, (d) at what rate would the phasors rotate around the origin and (e) what is the angle between the phasors?

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25. Three electromagnetic waves travel through a certain point P along an x axis. They are polarized parallel to a y axis, with the following variations in their amplitudes. Find their resultant at P.

$$E_1 = (8.00\mu V/m)\sin\left[(2.0 \times 10^{14}\text{rad}/s)t\right]$$

$$E_2 = (5.00\mu V/m)\sin\left[(2.0 \times 10^{14}\text{rad}/s)t + 55.0^\circ\right]$$

$$E_3 = (5.00\mu V/m)\sin\left[(2.0 \times 10^{14}\text{rad}/s)t - 55.0^\circ\right]$$

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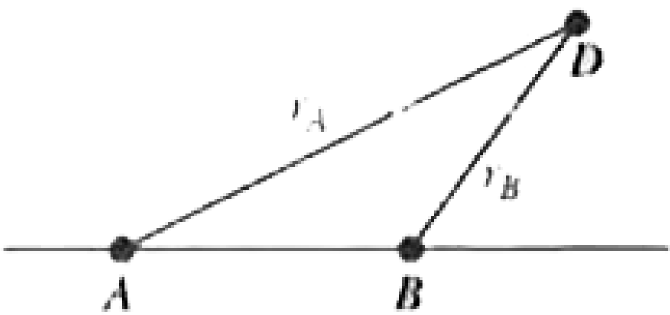
26. In Figure, sources A and B emit long-range radio waves of wavelength 400 m, with the phase of the emission from A ahead of that from source B by 90.0°. The distance r_A from A to detector D is greater than the corresponding distance r_B by 150 m. What is the phase difference of the waves at D?



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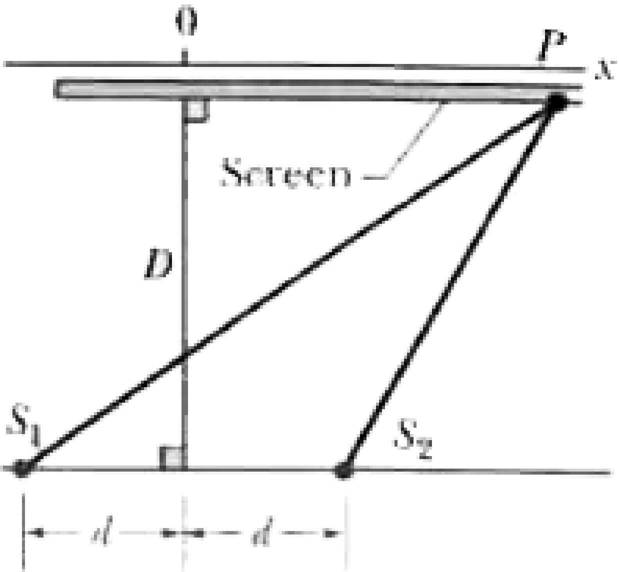
27. In Figure, two isotropic point sources S_1 and S_2 emit light in phase at wavelength λ and at the same amplitude. The sources are separated by distance $2d = 6.00\lambda$. They lie on an axis that is parallel to an x axis, which runs along a viewing screen at distance $D = 20.0\lambda$. The origin lies on the perpendicular bisector between the sources. The figure shows two rays reaching point P on the screen, at position x_P. (a) At what value of x_P do the rays have the minimum possible phase difference? (b) What multiple of λ gives that minimum phase difference? (c) At what value of

x_P do the rays have the maximum possible phase difference? What multiple of λ gives (d) that maximum phase difference and (c) the phase difference when $x_P = 6.00\lambda$? (f) When $x_P = 6.00\lambda$, is the resulting intensity at point P maximum, minimum, intermediate but closer to maximum, or intermediate but closer to minimum?



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28. Suppose that the two waves have wavelength $\lambda = 610nm$ in air. What multiple of λ gives their phase difference when they emerge if (a)

$n_1 = 1.50, n_2 = 1.60,$ and L = 700 um, (b) $n_1 = 1.62, n_2 = 1.72,$ and L = 700 um, and (c) $n_1 = 1.83, n_2 = 1.59,$ and L = 2.16 um? (d) Suppose that in each of these three situations the waves arrive at a common point (with the same amplitude) after emerging, Rank the situations according to the brightness the waves produce at the common point.

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29. Monochromatic green light, of wavelength 550 nm, illuminates two parallel narrow slits $5.60 \mu m$

apart. Calculate the angular deviation of the third-order (m=3) bright fringe (a) in radians and (b) in degrees.

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30. A thin flake of mica (n = 1.58) is used to cover one slit of a double-slit interference arrangement. The central point on the viewing screen is now occupied by what had been the fifth bright side fringe (m = 5). If $\lambda = 550 nm$, what is the thickness of the mica?

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31. In a double-slit arrangement the slits are separated by a distance equal to 100 times the wavelength of the light passing through the slits. (a) What is the angular separation in radians between the central maximum and an adjacent maximum? (b) What is the distance between these maxima on a screen 90.0 cm from the slits?

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32. A double-slit arrangement produces interference fringes for sodium light ($\lambda = 589nm$) that are 0.25° apart. What is the angular separation if the arrangement is immersed in water (n=1.33)?

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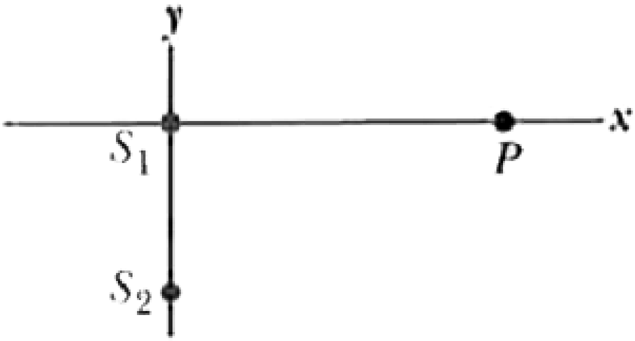
33.



In Figure, two isotropic point sources of light (S_1 and S_2) are separated by distance $2.70 \mu m$ along a y axis and emit in phase at wavelength 900 nm and at the same amplitude. A light detector is located at point P at coordinate x_P on the x axis. What are (a) the greatest value of x_P and (b) the second greatest value at which the detected light is minimum due to destructive interference?

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34.

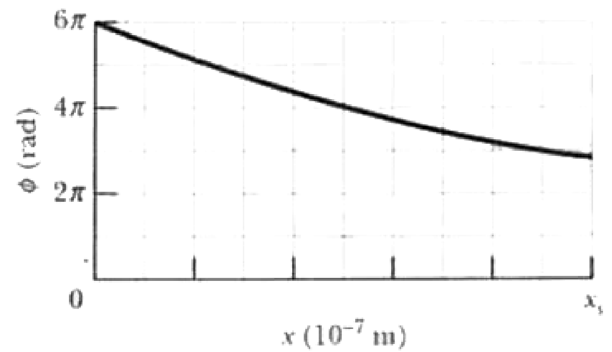

Figure shows two isotropic point sources of light (S_1 and S_2) that emit in phase at wavelength 400 nm and at the same amplitude. A detection point P is shown on an x axis that extends through source S_1. The phase difference ϕ between the light arriving at point P from the two sources is to be measured as P is moved along the x axis from x = 0 out to $x = +\infty$. The results out to

$x_s = 10 \times 10^{-7}$ m. On the way out to $+\infty$, what is the greatest value of x at which the light arriving at P from S_1 is exactly out of phase with the light arriving at P from S_2 ?

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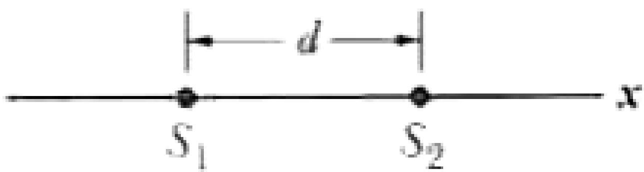

35.

In Figure, two radio- frequency point sources S_1 and S_2 separated by distance d = 1.8 m, are radiating in phase with $\lambda = 0.50m$. A detector moves in a large circular path around the two sources in a plane contain- ing them. How many (a) maxima and (b) minima does it detect?

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36. The ratio of intensitics duc to upper and lower slits on the screen of a Young's double-slit experiment is 16:9. Find the ratio of maximum to average intensity on screen.

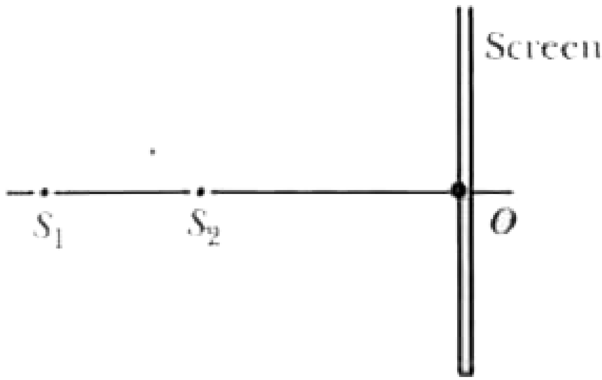
Watch Video Solution

37. In a Young's double-slit experiment apparatus, two identical slits are separated by 1 mm and distance between slits and screen is 1 m. The wavelength of light used is 6000 Å. What is the minimum distance between two points on the screen having 75% intensity of the maximum intensity?

View Text Solution

38. Two coherent point sources S_1 and S_2 are located at a distance 4l from each other.

Perpendicular to the straight line joining S_1 and S_2 there is a large screen at a distance of 1000 λ from S_1 as shown in Figure. Find the radius of the third maxima starting from the point O.



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39. The distance between a slit and a biprism of acute angle 2° is 10 cm. Find (a) the fringe width and (b) the width of the entire fringe pattern when observation is made on screen at a distance of 90 cm from the biprism. The refractive index of the biprism is 1.5 and l = 5890 Å.

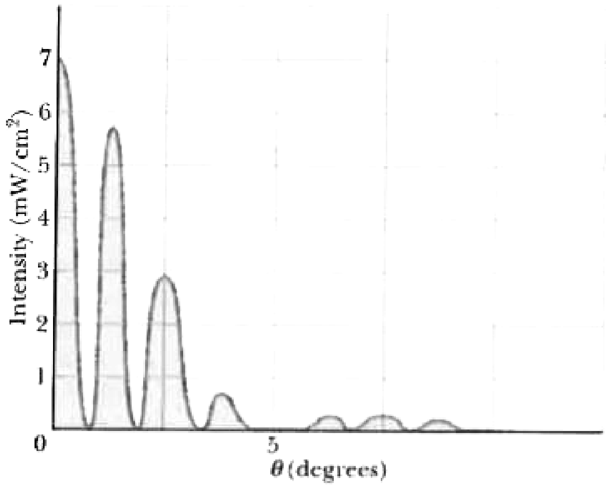
View Text Solution

40. Estimate the linear separation of two objects on Mars that can just be resolved under ideal conditions by an observer on Earth (a) using the naked eye and (b) using the 200 in. (= 5.1 m) Mount Palomar telescope. Use the following data:

distance to $\mathrm{Mars} = 8.0 \times 10^7$ km, diameter of pupil = 5.0 mm, wavelength of light = 550 nm.

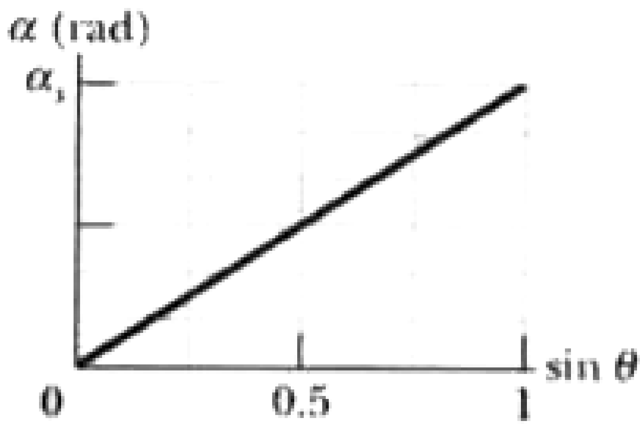
View Text Solution

41. Light of wavelength 620 nm passes through a double slit, yielding a diffraction pattern whose graph of intensity I versus angular position θ is shown in Figure. Calculate (a) the slit width and (b) the slit separation. (c) Verify the displayed intensities of thc m = 1 and m = 2 interference fringes.



View Text Solution

42. Figure gives α versus the sine of the angle θ in a single-slit diffraction experiment using light of wavelength 610 nm. The vertical axis scale is set by $\alpha_s = 12$ rad. What are (a) the slit width, (b) the total number of diffraction minima in the pattern (count them on both sides of the center of the diffraction pattern), (e) the least angle for a minimum, and (d) the greatest angle for a minimum?



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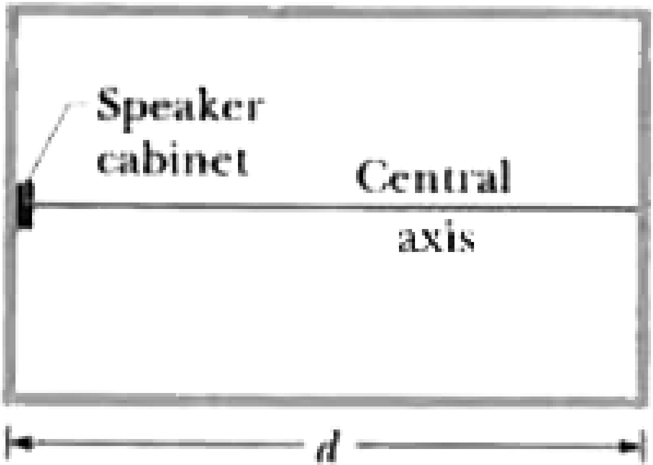
43. Sound waves with frequency 2500 Hz and speed $343m/s$ diffract through the rectangular opening axis of a speaker cabinet and into a large auditorium of length d = 100 m. The opening, which has a horizontal width of 30.0 cm, faces a wall 100 m away. Along that wall, how far from the central axis will a listener be at the first diffraction minimum and thus have difficulty hearing the sound? (Neglect reflections.)



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44. (a) How many bright fringes appear between the first diffraction-envelope minima to either side of the central maximum in a double-slit pattern if $\lambda 550 nm$, d = 0.180 mm, and

$a = 30.0 \mu m$? (b) What is the ratio of the intensity of the third bright fringe to the intensity of the central fringe?

View Text Solution

45. A single slit is illuminated by light of wavelengths λ_a and λ_b chosen so that the first diffraction minimum of the λ_a component coincides with the second minimum of the λ_b component. (a) If $\lambda_b = 420 nm$, what is λ_a? For what order number m_b (if any) does a minimum of the λ_b component coincide with the minimum of the λ_a component in the order number (b) $m_a = 2$ and (c) $m_a = 3$?

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46. A slit 1.00 mm wide is illuminated by light of wavelength 650 nm. We see a diffraction pattern on a screen 3.00 m away. What is the distance between the first and third diffraction minima on the same side of the central diffraction maximum?

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47. The two headlights of an approaching automobile are 1.4 m apart. At what (a) angular separation and (b) maximum distance will the eye resolve them? Assume that the pupil diameter is 4.5 mm, and use a wavelength of 550 nm for the light. Also assume that diffraction effects alone limit the resolution so that Rayleigh's criterion can be applied.

View Text Solution

48. A 0.20 mm wide slit is illuminated by light of wave- length 420 nm. Consider a point P on a viewing screen on which the diffraction pattern of the slit is viewed, the point is at 30° from the central axis of the slit. What is thc phase difference between the Huygens wavelets arriving at point P from the top and midpoint of the slit?

View Text Solution

49. In conventional television, signals are broadcast from towers to home receivers. Even when a receiver is not in direct view of a tower because of a hill or building, it can still intercept a signal if the signal diffracts enough around the obstacle, into the obstacle's "shadow region." Previously, television signals had a wavelength of about 50 cm, but digital television signals that are transmitted from towers have a wavelength of about 10 mm. (a) Did this change in wavelength increase or decrease the diffraction of the signals into the shadow regions of obstacles? Assume that a signal passes through an opening of 6.0 m width between two adjacent buildings. What is the angular spread of the central diffraction maximum out to the first minima) for wavelengths of (b) 50 cm and (c) 10 mm?

View Text Solution

50. Entoptic halos. If someone looks at a bright outdoor lamp in otherwise dark surroundings, the lamp appears to be surrounded by bright and dark rings (hence halos) that are actually a circular diffraction pattern, with the central maximum overlapping the direct light from the lamp. The diffraction is produced by structures within the cornea or lens of the eye (hence entoptic). If the lamp is monochromatic at wavelength 550 nm and the first dark ring subtends angular diameter 2.0° in the observer's view, what is the linear) diameter of the structure producing the diffraction?

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51. In the single-slit diffraction experiment, let the wavelength of the light be 500 nm, the slit width be 6.00 μm, and the viewing screen be at distance D=4.00 m. Let a y axis extend upward along the viewing screen, with its origin at the center of the diffraction pattern. Also let I_P represent the intensity of the diffracted light at point P at y = 15.0 cm (a) What is the ratio of I_P to the intensity I_m at the center of the pattern? (b) Determine where point P is in the diffraction pattern by giving the maximum and minimum between which it lies, or the two minima between which it lies.

View Text Solution

52. A plane wave of wavelength 420 nm is incident on a slit with a width of a=0.60 mm. A thin converging lens of focal length +70 cm is placed between the slit and a viewing screen and focuses the light on the screen. (a) How far is the screen from the lens? (b) What is the distance on the screen from the center of the diffraction pattern to the first minimum?

View Text Solution

53. Assume that Rayleigh's criterion gives the limit of resolution of an astronaut's eye looking down on Earth's surface from a typical space shuttle altitude of 420 km. (a) Under that idealized assumption, estimate the smallest linear width on Earth's surface that the astronaut can resolve. Take the astronaut's pupil diameter to be 5 mm and the wavelength of visible light to be 550 nm. (b) Can the astronaut resolve the Great Wall of China, which is more than 3000 km long, 5 to 10 m thick at its base, 4 m thick at its top, and 8 min height? (c) Would the astronaut be able to resolve any unmistakable sign of intelligent life on Earth's surface?

View Text Solution

54. (a) Show that the values of a at which intensity maxima for single-slit diffraction occur can be found exactly by differentiating Eq. 35-56 with respect to α and equating the result to zero, obtaining the condition $\tan \alpha = \alpha$. To find values of a satisfying this relation, plot the curve $y = \tan a \ lpha$ and the straight line $y = \alpha$ and then find their intersections, or use a calculator to find an appropriate value of α by trial and error. Next, from $\alpha = (m + 1/2)\pi$, determine the values of m associated with the maxima in the single-slit pattern. (These m values are not integers because secondary maxima do not lie exactly halfway between minima.) What are the (b) smallest α and (c) associated m, the (d) second smallest α and (e) associated m, and the (f) third smallest α and (g) associated m?

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55. The telescopes on some commercial surveillance satellites can resolve objects on the ground as small as 85 cm across (see Google Earth), and the telescopes on military surveillance satellites reportedly can resolve objects as small as 10 cm across. Assume first that object resolution is determined entirely by Rayleigh's criterion and is not degraded by turbulence in the atmosphere. Also assume that the satellites are at a typical altitude of 420 km and that the wavelength of visible light is 550 nm. What would be the required diameter of the telescope aperture for (a) 85 cm resolution and (b) 10 cm resolution? (c) Now, considering that turbulence is certain to degrade resolution and that the aperture diameter of the Hubble Space Telescope is 2.4 m, what can you say about the answer to (b) and about how the military surveillance resolutions are accomplished?

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56. Light of wavelength 420 nm is incident on a narrow slit. The angle between the first diffraction minimum on one side of the central maximum and the first minimum on the other side is 2.00°. What is the width of the slit?

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57. (a) A circular diaphragm 50 cm in diameter oscillates at a frequency of 25 kHz as an underwater source of sound used for submarine detection, Far from the source, the sound intensity is distributed as the diffraction pattern of a circular hole whose diameter equals that of the diaphragm. Take the speed of sound in water to be $1450 m/s$ and find the angle between the normal to the diaphragm and a line from the diaphragm to the first minimum. (b) Is there such a minimum for a source having an (audible) frequency of 1.0 kHz?

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58. Monochromatic light of wavelength 441 nm is incident on a narrow slit. On a screen 2.00 m away, the distance between the second diffraction minimum and the central maximum is 1.80 cm.(a)

Calculate the angle of diffraction θ of the second minimum. (b) Find the width of the slit.

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59. Monochromatic light with wavelength 420 nm is incident on a slit with width 0.050 mm. The distance from the slit to a screen is 3.5 m. Consider a point on the screen 2.2 cm from the central maximum. Calculate (a) θ for that point, (b) α, and (c) the ratio of the intensity at that point to the intensity at the central maximum.

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60. Two slits of width a and separation d are illuminated by a coherent beam of light of wavelength λ. What is the linear separation of the bright interference fringes observed on a screen that is at a distance D away?

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61. (a) In a double-slit experiment, what ratio of d to a causes diffraction to eliminate the fourth bright side fringe? (b) what other bright fringes are also eliminated?

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Practice Questions Single Correct Choice Type

1. The intensity ratio of the two interfering beams of light is m. What is the value of $I_{\max} - I_{\min} / I_{\max} + I_{\min}$?

A. $2\sqrt{m}$

B. $\frac{2\sqrt{m}}{1+m}$

C. $\dfrac{2}{1+m}$

D. $\dfrac{1+m}{2\sqrt{m}}$

Answer: B

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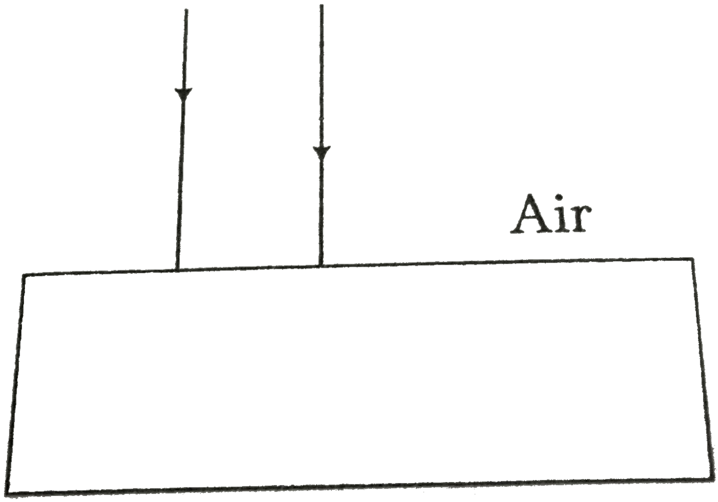
2. A parallel beam of light of intensity I is incident on a glass plate. 25% of light is reflected in any reflection by upper surface and 50% of light is reflected by any reflection from lower surface. Rest is refracted The ratio of maximum to minimum intensity in interference region of reflected rays is



A. $\left[\frac{(1/2)+\left(\sqrt{3}/\sqrt{8}\right)}{(1/2)-\left(\sqrt{3}/\sqrt{8}\right)}\right]^2$

B. $\left[\frac{(1/4)+\left(\sqrt{3}/\sqrt{8}\right)}{(1/2)-\left(\sqrt{3}/\sqrt{8}\right)}\right]^2$

C. $\frac{5}{8}$

D. $\frac{8}{5}$

Answer: A

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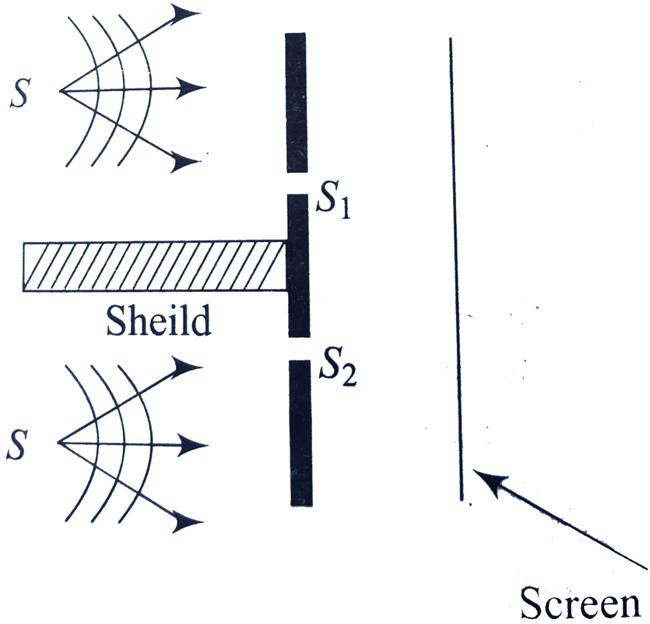
3. What happens to the interference pattern if the two slits in Young's experiment are illuminated by two independent sources such as two sodium lamps S and S' as shown in figure



A. Two sets of interference fringes overlap

B. No fringes are observed

C. The intensity of the bright fringes is doubled

D. The intensity of the bright fringes becomes four times

Answer: B

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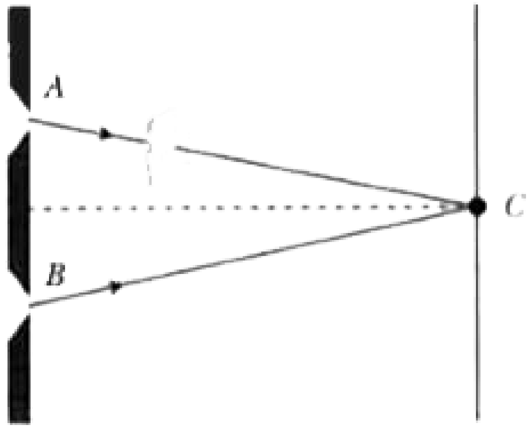
4. In Young's experiment, monochromatic light is used to illuminate the two slits A and B. Interference fringes are observed on a screen placed in front of the slits. Now, if a thin glass plate is placed normally in the path of the beam coming from the slit, then



A. The fringes will disappear

B. The fringe width will increase

C. The fringe width will decrease

D. There will be no change in the fringe width, but the pattern shifts

Answer: D

Watch Video Solution

5. In Young's double slit experiment, the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ is the wavelength of light) is I. if I_0 denotes the maximum intensities, then I / I_0 is equal to

A. $3/4$

B. $1/\sqrt{2}$

C. $\sqrt{3}/2$

D. $1/2$

Answer: A

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6. 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. $\dfrac{\sin^{-1}(1)}{\sqrt{3}}$

Answer: D

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7. White light is used to illuminate the two slits in Young's experiment. The separation between the slits is d and the screen is at a distance D(»d) from the slits. At a point directly in front of one of the slits, certain wavelength is missing. The missing wavelength

A. $\lambda = d^2 / D$

B. $\lambda = d^2 / 5D$

C. $\lambda = d^2 / 3D$

D. All of these

Answer: D

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8. Light passes successively through two polarimeters tubes each of length $0.29m$. The first tube contains dextro rotatory solution of concentration $60kgm^{-3}$ and specific rotation $0.01radm^2kg^{-1}$. The second tube contains laevo rotatory solution of concentration $30kg/m^3$ and specific rotation $0.02 rad m^2 kg^{-1}$. The net rotation produced is

A. 15°

B. 0°

C. 20°

D. 10°

Answer: B

Watch Video Solution

9. Two Nicols are oriented with their principal planes making an angle of 60°. The percentage of incident unpolarised light which passes through the system is

A. 50°

B. 100°

C. 12.5°

D. 37.5°

Answer: C

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10. In the visible region of the spectrum the rotation of the place of polarization is given by $\theta = a + \frac{b}{\lambda^2}$. The optical rotation produced by a particular material is found to be 30° per mm at $\lambda = 5000 \text{Å}$ and 50° per mm at $\lambda = 4000 \text{Å}$. The value of constant a will be

A. $+\frac{50^\circ}{9}$ per mm

B. $-\frac{50^\circ}{9}$ per mm

C. $+\frac{9}{50^\circ}$ per mm

D. $-\frac{9}{50^\circ}$ per mm

Answer: B

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11. When a ray of light of frequency 6×10^{14} Hz travels from water of refractive index $4/3$ to glass of refractive index $8/5$, its

A. Frequency becomes five-sixth $(5/6)$ of its initial value

B. Speed becomes five-sixth $(5/6)$ of its initial value

C. Wavelength becomes six-fifth $(6/5)$ of its initial value

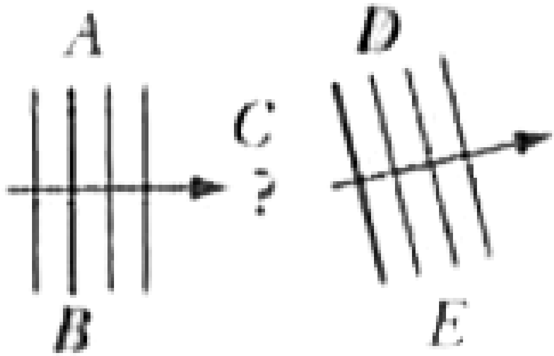
D. Speed becomes six-fifth $(6/5)$ of its initial value

Answer: B

Watch Video Solution

12. A wavefront AB passing through a system C emerges as DE (As shown in the following figure).

The system C could be



A. A slit

B. A prism

C. A biprism

D. A glass slab

Answer: C

View Text Solution

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

A. $\frac{\cos^{-1}(1)}{\sqrt{14}}$

B. $\frac{\sin^{-1}(2)}{\sqrt{14}}$

C. $\frac{\cos^{-1}(2)}{\sqrt{14}}$

D. $\frac{\sin^{-1}(3)}{\sqrt{14}}$

Answer: C

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14. In Young's double-slit interference experiment a first screen with a single narrow slit is used in addition to the double-slit screen. An interference pattern is observed on the screen. What happens if the first screen is removed and light from an extended but monochromatic source, e.g.,yellow light from large sodium vapor lamp, is allowed to illuminate the double-slit screen directly?

A. The interference pattern disappears

B. The intensity of light on the viewing screen is reduced

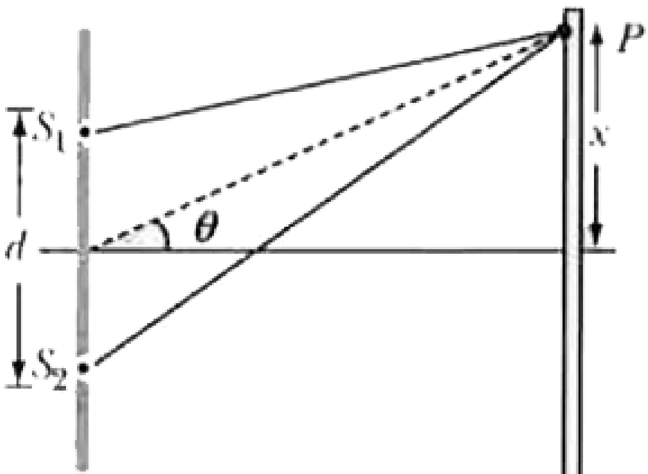
C. The width of the dark fringes reduces noticeably

D. The width of the bright fringes reduces noticeably

Answer: A

Watch Video Solution

15. Two sources, in phase and a distance d apart, each emit a wave of wavelength l (as shown in the following figure). Which of the choices for the path difference $\Delta L = \Delta P = \quad S_2P - S_1P\Delta L = L_1 - L_2$ will always produce constructive interference at point P?



A. $d \sin \theta$

B. λ

C. $(x / \lambda)d$

D. $\lambda / 2$

Answer: B

Watch Video Solution

16. In a double-slit interference pattern, the first maxima for infrared light would be

A. At the same place as the first maxima for green light

B. Closer to the center than the first maxima for green light

C. Farther from the center than the first maxima for green light

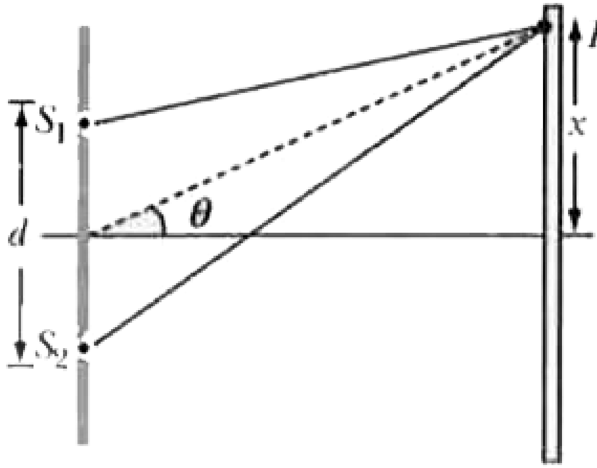
D. Infrared light does not produce an interference pattern

Answer: C

Watch Video Solution

17. Light shining through two very narrow slits produces an interference maximum at point P when the entire apparatus is in air as shown in the following figure. For the interference maximum represented, light through the bottom slit travels one wavelength further than light through the top slit before reaching point P. If the entire apparatus is immersed in water, the angle θ

to the interference maximum



A. Is unchanged

B. Decreascs bccausc the frequency decreases

C. Decreases because the wavelength decreases

D. Increases because the frequency increases

Answer: C

View Text Solution

18. In Young's double-slit experiment, the slit separation is 0.5 mm and the screen is 0.5 m away from the slit. For a monochromatic light of wavelength 500 nm, the distance of 3rd maxima from the 2nd minima on the other side of central maxima is

A. 2.75 mm

B. 2.5 mm

C. 22.5 mm

D. 2.25 mm

Answer: B

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19. Two different color beams (yellow and blue) from a point source are incident on both slits of a Young's double-slit experiment setup

A. There will be no interference pattern seen on the screen

B. There will be interference pattern and where there is constructive interference the spot will be green

C. There will be alternate bands of yellow, blue, and dark regions with equal separation between them

D. There will be yellow and blue light interference patterns which are slightly separated from each otherbecause the angles at which the maxima and minima occur for the two wavelengths are different

Answer: D

Watch Video Solution

20. Two wavelength of light λ_1 and λ_2 are sent through Young's double-slit apparatus simultaneously. What must be true about λ_1 and λ_2 if the third-order bright fringe of λ_1 coincides with fifth-order dark fringe of λ_2

A. $3\lambda_1 = 2\lambda_2$

B. $2\lambda_1 = 3\lambda_2$

C. $3\lambda_1 = 5\lambda_2$

D. $5\lambda_1 = 3\lambda_2$

Answer: B

Watch Video Solution

21. In a Young's double-slit experiment, if the incident light consists of two wavelengths λ_1 and λ_2, the slit separation is d, and the distance between the slit and the screen is D, the maxima due to each wavelength will coincide at a distance from the central maxima, given by

A. $\frac{\lambda_1 + \lambda_2}{2Dd}$

B. LCM of $\frac{\lambda_1}{d}$ and $\frac{\lambda_2 D}{d}$

C. $(\lambda_1 - \lambda_2)\frac{2D}{d}$

D. HCF of $\frac{\lambda_1 D_2}{d}$ and $\frac{\lambda_2 D}{d}$

Answer: B

Watch Video Solution

22. Two plane monochromatic coherent waves produce inter- ference pattern (of alternately bright and dark bands) on a screen. When the angle between the two beams is decreased the fringe width

A. Increases

B. is unaffected

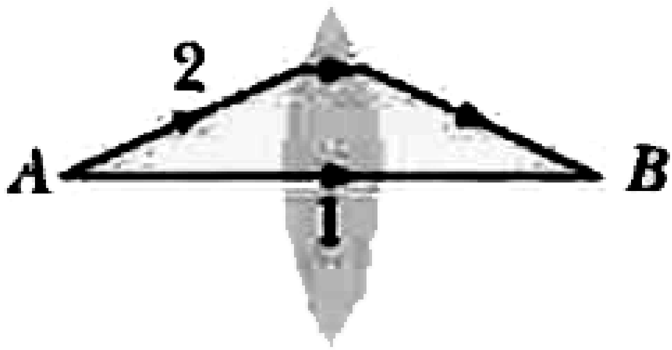
C. Decreases

D. Increases and then decreases

Answer: A

Watch Video Solution

23. Path followed by two rays through a thin lens in air is shown in the following figure. (Assume value of μ of lens same for both rays.) Optical path followed for two rays from A to B is



A. Greater in case 2 than 1

B. Greater in case 1 than 2

C. Equal in both the cases

D. Value of μ is needed to compare

Answer: C

Watch Video Solution

24. An interference pattern is formed on a screen by shining a planar wave on a double-slit arrangement. If we cover one slit with a glass plate, the phases of the two emerging waves will be different because the wavelength is shorter in glass than in air. If the phase difference is 180°, how is the interference pattern altered?

A. The pattern vanishes

B. The bright spots lie closer together

C. The bright spots are farther apart

D. The pattern gets shifted in such a way that center of the screen is a dark band

Answer: D

View Text Solution

25. A glass slab of thickness $4cm$ contains the same number of waves as $5cm$ of water, when both are traversed by the same monochromatic light. If the refractive index of water is $4/3$, then refractive index of glass is

A. $\frac{5}{3}$

B. $\frac{5}{4}$

C. $\frac{16}{15}$

D. $\frac{3}{2}$

Answer: A

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26. On introducing a thin sheet of mica (thickness 12×10^{-7} cm) in path of one of the interfering beams ($\lambda_{\text{vacuum}} = 600 nm$) in Young's double-slit experiment, the central fringe is shifted through a distance equal to the spacing between successive bright fringes. Calculate the refractive index of mica.

A. 1.33

B. 1.4

C. 1.5

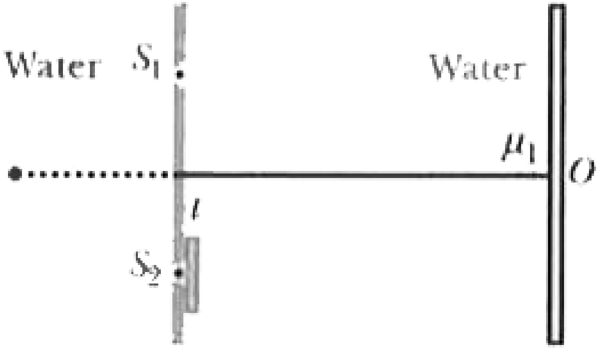
D. 2.5

Answer: C

Watch Video Solution

27. A Young's double-slit experiment is conducted in water (n_1) as shown in the following figure, and a glass plate of thickness t and refractive index n_2 is placed in the path of S_2. Wavelength of light in water is λ. Find the magnitude of the phase difference between waves coming from S_1

and S_2 at O.



A. $\left|\left(\frac{n_2}{n_1}-1\right)t\right|\frac{2\pi}{\lambda}$

B. $\left|\left(\frac{n_2}{n_1}-1\right)t\right|\frac{2\pi}{\lambda}$

C. $|(n_2-n_1)t|\frac{2\pi}{\lambda}$

D. $|(n_2-1)t|\frac{2\pi}{\lambda}$

Answer: A

Watch Video Solution

28. In a Young's double-slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which one 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. Using red light instead of green light

D. Moving the light source further away from the slits

Answer: B

Watch Video Solution

29. Why isn't the interference pattern like the one from Young's double-slit experiment produced from the two headlights of a car?

A. The lights are too far apart

B. The lights are not bright enough

C. The lights are not rectangular slit in shape

D. The light from one lamp is not coherent with the other

Answer: D

Watch Video Solution

30. Coherent light is incident on two fine parallel slits S_1 and S_2 as show in fig. If a dark fringe occurs at P, which of the following gives possible phase difference for the light waves arriving at P from S_1 and S_2 ?

A. $m\pi$ rad

B. $(m + 1/2)\pi$ rad

C. $(2m - 1)\pi$ rad

D. $(2m + 1/2)\pi$ rad

Answer: C

Watch Video Solution

31. Three coherent, equal intensity light rays arrive at a point Pon a screen to produce an interference minimum of zero intensity. If any two of the rays are blocked, the intensity of the light at P is I_1. What is the intensity of the light at P if only one of the rays is blocked?

A. 0

B. $I_1 / 2$

C. I_1

D. $2I_1$

Answer: C

Watch Video Solution

32. In a Young's double slit experiment, if the slits are of unequal width

A. Fringes will not be formed

B. The positions of minimum intensity will not be completely dark

C. Bright fringe will not be formed at the center of the screen

D. Distance between two consecutive bright fringes will not be equal to the distance between two consecutive dark fringes

Answer: B

Watch Video Solution

33. Intensities of light due to the two slits of Young's double-slit experiment are I and 4I. How far from the centre maxima will the intensity be equal to the average intensity on the screen? (β is the fringe width.)

A. $\frac{\beta}{2}$

B. $\frac{\beta}{3}$

C. $\frac{\beta}{6}$

D. $\frac{\beta}{4}$

Answer: D

Watch Video Solution

34. In a Young's double-slit interference pattern, the intensity of the central fringe at $P = I_0$. When one slit width is reduced to half, the intensity at P will be

A. $I_0 / 2$

B. $I_0 / 4$

C. $\frac{I_0}{8}(3+2\sqrt{2})$

D. $\frac{9}{4}I_0$

Answer: D

Watch Video Solution

35. In a Young's double-slit experiment, the central bright fringe can be identified

A. As it has greater intensity than the other bright fringes

B. As it is wider than the other bright fringes

C. As it is narrower than the other bright fringes

D. By using white light instead of monochromatic light

Answer: D

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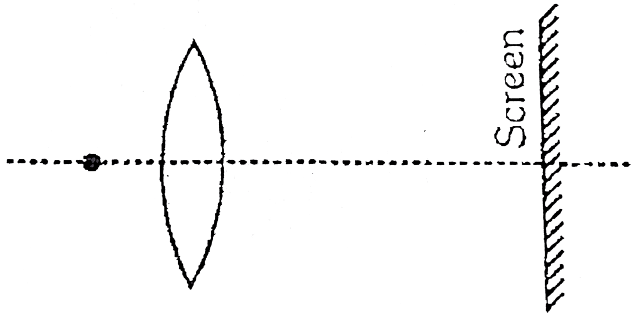
36. 

As shown in the right figure, a point light source is placed at distance 2f from a lens with focus length f. and a screen is placed at 4f from the lens. The lens is then cut at the middle into two equal portions: upper half and lower half. the upper half is moved upwards by a small distance d comparable to the light wavelength and the lower half is moved downwards by the same distance d. What is the light pattern on the screen?

A. Bright and dark strips similar to the pattern seen in Young's double-slit experiment

B. Bright and dark concentric rings

C. Two large, bright, and partly overlapping patches

D. Two separate bright spots

Answer: A

Watch Video Solution

37. A fresnel biprism is used to form the inerference fringes. The distance between the source and the biprisim is 20 cm and that between the biprism and the screen is 80 cm. If A= 6563 A and the separation between the virtual sources is 3.6 mm, then the fringes width (in mm) is.

A. 1.82 cm

B. 0.182 cm

C. 0.0182 cm

D. 0.00182 cm

Answer: C

Watch Video Solution

38. In a biprism experiment, the biprism is made of glass (n = 1.5). When the setup is shifted from air to the inside of a still, clear lake water $(n = 4/3)$ then

A. The fringe pattern gets enlarged

B. The fringe pattern gets shrunk

C. The fringe pattern gets shifted

D. The fringe pattern remains unchanged

Answer: A

Watch Video Solution

39. Two radio station that are 250 m apart emit radio waveslength 100m. Point A is 400m from both station.Point B is 450m from both station. Point C is 400m from one station and 450 m from the other.The radio station emit radio waves in phase. Which of the following statement is true ?

A. There will be constructive interference at A and B and destructive interference at C

B. There will be destructive interference at A and B and constructive interference at C

C. There will be constructive interference at A and destructive interference at B and C

D. There will be constructive interference at B and C and destructive interference at A

Answer: A

Watch Video Solution

40. A soap film of thickness is surrounded by air. It is illuminated at near normal incidence by monochromatic light which has wavelength λ in the film. What will be the film thickness that will produce maximum brightness of the reflected light?

A. $(1/4)\lambda$

B. $(1/2)\lambda$

C. λ

D. 2λ

Answer: A

Watch Video Solution

41. A thin oil film of refracting index 1.2 floats on the surface of water $\left(\mu = \frac{4}{3}\right)$. When a light of wavelength $\lambda = 9.6 \times 10^{-7} m$ falls normally on the film air, then it appears dark when seen normally. The minimum change in its thickness for which it will appear bright in normally reflected light by the same light is $Z \times 10^{-7} m$. Then find Z

.

A. 10^{-7} m

B. $2 \times 10^{-7} m$

C. $3 \times 10^{-7} m$

D. $5 \times 10^{-7} m$

Answer: A

Watch Video Solution

42. White light is normally incident on a soap bubble in air, and the reflected light is viewed. As the wall thickness of the bubble approaches zero (just before it breaks) the reflected light

A. Becomes dim for all wavelengths

B. Becomes unusually bright for all wavelengths

C. Becomes bright only for certain wavelengths, dependent on the index of refraction of the bubble

D. None of the above occurs

Answer: A

Watch Video Solution

43. Light is reflecting off a wedge-shaped thin piece of glass producing bright and dark interference fringes. If a certain location has a bright fringe, a nearby point will have a dark fringe if the thickness of the glass increases by

A. $1/8$ of a wavelength of the light in glass

B. $1/4$ of a wavelength of the light in glass

C. $1/2$ of a wavelength of the light in glass

D. 1 wavelength of the light in glass

Answer: B

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44. Consider two identical inicroscope slides in air illumi- nated with monochromatic light. The bottom slide is rotated (counterclockwise about the point of contact in the side view) so that the wedge angle gets a bit smaller. What happens to the fringes?

A. They are spaced farther apart

B. They are spaced closer together

C. They do not change

D. Bright and dark spots are interchanged

Answer: A

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45. Radio waves are readily diffracted around buildings whereas light waves are negligibly diffracted around buildings. This is because radio waves

A. Are plane polarized

B. Have much longer wavelengths than light waves

C. Have much shorter wavelengths than light waves

D. Are nearly monochromatic (single frequency)

Answer: B

Watch Video Solution

46. The shimmering or wavy lines that can often be seen near the ground on a hot day are due to

A. Brownian movement

B. Reflection

C. Refraction

D. Diffraction

Answer: C

Watch Video Solution

47. If the Huygen's principle applies to any point anywhere in a beam path, why does not a laser beam without any slit spread out in all directions?

A. Because all waves that spread interfere destructively

B. It does spread, but the spread is so small that we normally do not notice it

C. We cannot apply the Huygen's principle anywhere but in slits and apertures

D.

Answer: A

Watch Video Solution

48. No fringes are seen in a single-slit diffraction pattern if

A. The screen is far away

B. The wavelength is less than the slit width

C. The wavelength is greater than the slit width

D. The distance to the screen is greater than the slit width

Answer: C

Watch Video Solution

49. Monochromatic plane waves of light are incident normally on a single slit. Which option correctly shows the diffraction pattern observed on a distant screen?

A. 

B. 

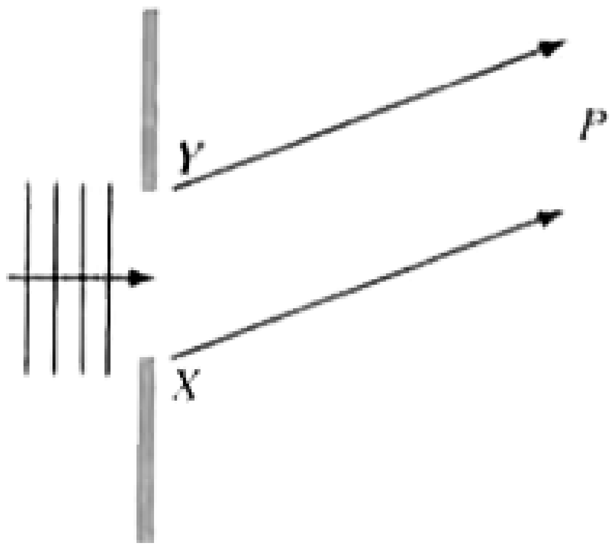
C. 

D. 

Answer: B

View Text Solution

50. A single slit with the direction to a point P on a distant screen as shown in the following figure. At P, the pattern has its second minimum (from its central maximum). If X and Y are the edge of the slit, what is the path length difference (PX) - (PY)?



A. $\lambda/2$

B. λ

C. $3\lambda/2$

D. 2λ

Answer: D

Watch Video Solution

51. At the first minimum adjacent to the central maximum of a single-slit diffraction pattern the phase difference between the Huygens wavelet from the edge of the slit and the wavelet from the mid-point of the slit is

A. $\pi / 8$ rad

B. $\pi / 4$ rad

C. $\pi / 2$ rad

D. π rad

Answer: D

Watch Video Solution

52. A diffraction-limited laser of length l and aperture diameter d generates light of wavelength λ. If the beam is directed at the surface of the Moon a distance D away, the radius of the illuminated area on the Moon is approximately

A. dD/l

B. dD/λ

C. $D\lambda/l$

D. D

Answer: D

Watch Video Solution

53. Two stars that are close together are photographed through a telescope. The black and white film is equally sensitive to all colors. Which situation would result in the most clearly separated images of the stars?

A. Small lens, red stars

B. Small lens, blue stars

C. Large lens, red stars

D. Large lens, blue stars

Answer: D

View Text Solution

54. Resolving power of a telescope can be increased by

A. Increasing the objective focal length and decreasing the eyepiece focal length

B. Increasing the lens diameters

C. Decreasing the lens diameters

D. Inserting a correction lens between objective and eyepiece

Answer: B

Watch Video Solution

55. In a double-slit diffraction experiment, the number of interference fringes within the central diffraction maximum can be increased by

A. Increasing the wavelength

B. Decreasing the wavelength

C. Decreasing the slit separation

D. Decreasing the slit width

Answer: D

Watch Video Solution

56. A double slit is illuminated with monochromatic light of wavelength 6.00×10^2 nm. The m = 0 and m = 1 bright fringes are separated by 3.0cm on a screen which is located 4.0 m from the slits. What is the separation between the slits?

A. 4.0×10^{-5} m

B. 1.2×10^{-4} m

C. 8.0×10^{-5} m

D. 1.6×10^{-4} m

Answer: C

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57. Two slits are separated by 2.00×10^{-5} m. They are illuminated by light of wavelength 5.60×10^{-7} m. If the distance from the slits to the screen is 6.00 m, what is the separation between the central bright fringe and the third dark fringe?

A. 0.421 m

B. 0.168 m

C. 0.224 m

D. 0.084 m

Answer: A

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58. A 4.0×10^2 nm thick film of kerosene (n = 1.2) is floating on water. White light is normally incident on the film. What is the visible wavelength in air that has a maximum intensity after the light is reflected?

Note: The visible wavelength range is 380 nm to 750 nm.

A. 380 nm

B. 480 nm

C. 430 nm

D. 530 nm

Answer: B

Watch Video Solution

59. A portion of a soap bubble appears green ($\lambda = 500.0nm$ in vacuum) when viewed at normal incidence in white light, Determine the two smallest, non-zero thicknesses for the soap film if its index of refraction is 1.40.

A. 89 nm and 179 nm

B. 125 nm and 250 nm

C. 89 nm and 268 nm

D. 125 nm and 375 nm.

Answer: C

Watch Video Solution

60. Light of wavelength λ in vacuum strikes a lens that is made of glass with index of refraction 1.6. The lens has been coated with a film of thickness t and index of refraction 1.3. For which one of the following conditions will there be no reflection?

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

B. $2t = \frac{1}{2}\left(\frac{\lambda}{1.3}\right)$

C. $2t = \frac{\lambda}{1.33}$

D. $2t = \frac{1}{2}\left(\frac{\lambda}{1.6}\right)$

Answer: B

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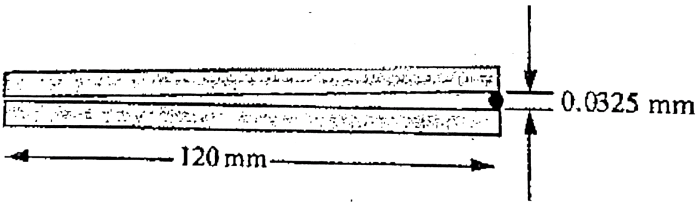
61. 

Light wavelength 650 nm is incident normally upon a glass plate the glass plate rests on top of second plate so that hey touch at one end and are separated by 0.0325 mm at the other end as shown in the figure. Which range of values contains the horizontal separation between adjacent bright fringes?

A. 1.1 mm to 1.4 mm

B. 2.8 mm to 4.2 mm

C. 1.4 mm to 2.8 mm

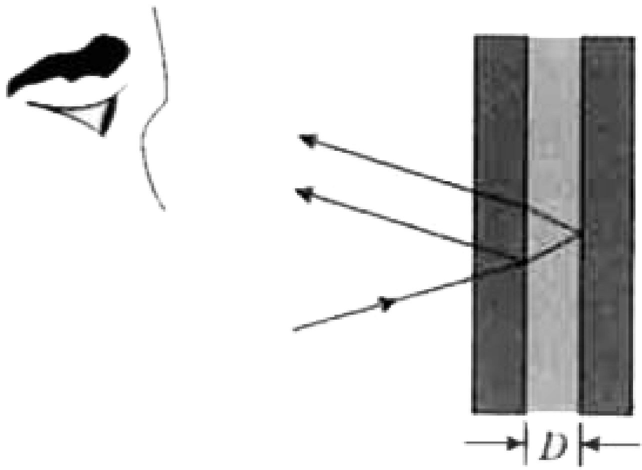
D. 4.2 mm to 5.6 mm

Answer: A

Watch Video Solution

62. Two glass plates, each with an index of refraction of 1.55, are separated by a small distance D. The space between the plates is filled with water (n = 1.33) as shown. For which one of the following conditions will the reflected light appear green?

Note: The wavelength of green light is 460 nm in vacuum.



A. $D = \left(\frac{460nm}{2}\right)$

B. $2D = \frac{1}{2}\left(\frac{460nm}{1.33}\right)$

C. $2D = \left(\frac{460nm}{1.33}\right)$

D. $2D = \frac{1}{2}\left(\frac{460nm}{1.55}\right)$

Answer: B

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63. Light of 600.0 nm is incident upon a single slit. The resulting diffraction pattern is observed on a screen that is 0.50 m from the slit. The distance between the first and third minima of the diffraction pattern is 0.80 mm. Which range of values listed below contains the width of the slit?

A. 0.1 mm to 0.4 mm

B. 0.8 mm to 1.2 mm

C. 0.4 mm to 0.8 mm

D. 1.2 mm to 1.6 mm

Answer: C

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64. A spy satellite is in orbit at a distance of 1.0×10^6 m above the ground. It carries a telescope that can resolve the two rails of a railroad track that are 1.4 m apart using light of wavelength 600 nm. Which one of the following statements best describes the diameter of the lens in the telescope?

A. It is less than 0.14 m.

B. It is greater than 0.14 m and less than 0.23 m.

C. It is greater than 0.23 m and less than 0.35 m.

D. It is greater than 0.52 m.

Answer: D

Watch Video Solution

65. Light from two sources, $\lambda_1 = 623nm$ and $\lambda_2 = 488nm$, is incident on a diffraction grating that has $5550\text{lines}/cm$. What is the angular separation, $\lambda_1 - \lambda_2$ of the second order maxima of the two waves?

A. 11.0°

B. 25.0°

C. 15.0°

D. 32.8°

Answer: A

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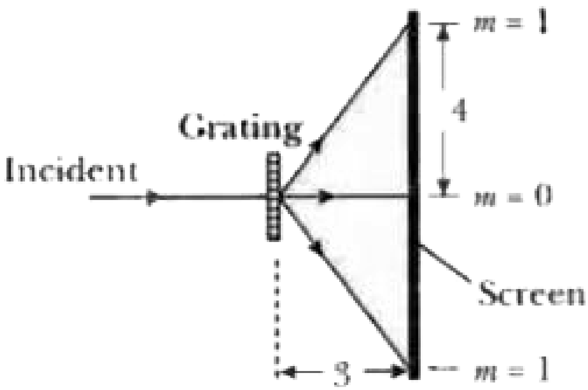
66. Light from a laser $(\lambda = 640 nm)$ passes through a diffraction grating and spreads out into three beams as shown in the figure. Determine the spacing between the slits of the grating



A. 240 nm

B. 680 nm

C. 410 nm

D. 800 nm

Answer: D

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Practice Questions More Than One Correct Choice Type

1. If white light is used in a Young's double-slit experiment, the

A. Bright white fringe is formed at the center of the screen

B. Fringes of different colors are observed clearly only in the first order

C. The first-order violet fringes are closer to the center of the screen than the first-order red fringes

D. The first-order red fringes are closer to the center of the screen than the first-order violet fringes

Answer: A::B::C

Watch Video Solution

2. In a Young's double slit experiment let A and B be the two slits. A thin plate of thickness t and refractive index μ is placed in front of A. Let β be the fringe width. The central maximum will shift

A. Toward A

B. Toward B

C. By $t(n-1)\frac{\beta}{\lambda}$

D. By $nt\frac{\beta}{\lambda}$

Answer: A::C

Watch Video Solution

3. In Young's double slit experiment the ratio of intensities of bright and dark fringes is 9. This means

A. The intensities of individual sources are 5 units and 4 units, respectively

B. The intensities of individual sources are 4 units and 1 unit, respectively

C. The ratio of their amplitudes is 3

D. The ratio of their amplitudes is 2

Answer: B::D

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4. 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).

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 failing 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.

Answer: A::B

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5. 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`(gtb) from the slits. At a point on the screen directly in front of one of the slits, certain wavelength are missing. Some of these missing wavelength are

A. $\lambda = \frac{d^2}{D}$

B. $\lambda = \frac{2d^2}{D}$

C. $\lambda = \frac{d^2}{3D}$

D. $\lambda = \frac{2d^2}{3D}$

Answer: A::C

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6. In Young's double-slit experiment, white light is used. The separation between the slits is d. The screen is at a distance D (D » d) from the slits. Some wavelengths are missing exactly in front of one slit. These wavelengths are

A. $\lambda = \frac{d^2}{D}$

B. $\lambda = \frac{2d^2}{D}$

C. $\lambda = \frac{d^2}{3D}$

D. $\lambda = \frac{2d^2}{3D}$

Answer: A::C

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

A. 2 cm

B. 4 cm

C. $2/3$ cm

D. $4/3$ cm

Answer: A::C

Watch Video Solution

8. An interference pattern is formed on the screen, when light from two different monochromatic sources are allowed to interfere. Then, it is true that

A. Frequencies of light from the two sources are equal to each other

B. The sources are coherent

C. The sources should be located in the same medium

D. The path difference should either be an even or an odd multiple of $\lambda/2$, where λ is the wavelength of light

Answer: A::B

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9. The intensity of a progressing plane wave in loss-free medium is

A. Directly proportional to the square of amplitude of the wave

B. Directly proportional to the velocity of the wave

C. Directly proportional to the square of frequency of the wave

D. Inversely proportional to the density of the medium

Answer: A::B::C

Watch Video Solution

10. If one of the slits of a standard Young's double-slit exper- iment 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 paliern will get shifted toward 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

Answer: A::C::D

Watch Video Solution

11. If instead of monochromatic light, white light is used in Young's double-slit experiment, then

A. A bright white fringe is formed at the center of the screen

B. Fringes of different colors are clearly observed only in the first-order place

C. The first-order red fringes are relatively close to the screen than the first-order violet fringes

D. The first-order violet fringes are relatively close to the center of the screen than the first-order red fringes

Answer: A::B::D

Watch Video Solution

12. Huygen's priciple of secondary wavelets may be used to

A. Find the velocity of light in vacuum

B. Explain the particle behavior of light

C. Find the new position of a wavefront

D. Explain Snell's law

Answer: C::D

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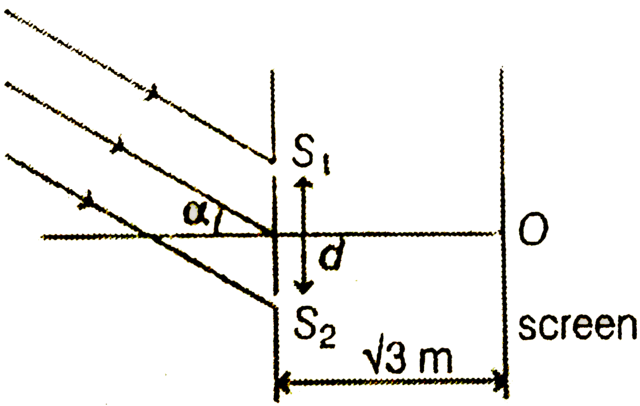
13. A parrallel beam of light $(\lambda = 5000 Å)$ is incident at an angle $\alpha = 30^{\circ}$ as shown in YDSE experiment. Intensity due to each slit at any point on screen in I_0. The distance between slits is 1mm. The intensity at central point O on the screen is KI_0. Find the value of K.



A. The intensity at O is $4I_0$

B. The intensity at O is zero

C. The intensity at a point on the screen 1 m below O is $4I_0$

D. The intensity at a point on the screen 1 m below O is zero

Answer: A::C

Watch Video Solution

14. Which of the following can give sustained interference?

A. Two independent laser sources

B. Two independent light bulbs

C. Two independent sound sources

D. Two independent microwave sources

Answer: A::C::D

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15. A Young's double-slit experiment is performed with white light. Then

A. The central fringe will be white

B. There will not be a completely dark fringe

C. The fringe next to the central will be red

D. The fringe next to the central will be violet

Answer: A::B::D

Watch Video Solution

16. Fraunhoffer diffraction can be observed with

A. One wide slit

B. One narrow slit

C. Two narrow slits

D. Large number of narrow slits

Answer: B::C::D

Watch Video Solution

17. A person views the interference pattern, produced by two slits illuminated by white light, on placing a green filter in front of his eyes. Then

A. He will see sharply distinguishable dark and bright fringes

B. The fringes will not be sharp but are differentiable

C. On replacing the green filter by a blue filter, the fringes will be again sharp bul closer than those by the green filter

D. On using both the filters simultaneously, the central bands will be maximum bright

Answer: A::C

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18. In a Young's double-slit experiment apparatus, we use white light. Then

A. The fringe next to the central will be red

B. The central fringe will be white

C. The fringe next to the central will be violet

D. There will not be a completely dark fringe

Answer: B::C::D

Watch Video Solution

19. Two sources are called coherent if they produce waves

A. Of equal wavelength

B. Of equal velocity

C. Having same shape of wavefront

D. Having a constant phase difference

Answer: A::B::C::D

Watch Video Solution

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

A. The same frequency

B. Same amplitude

C. A constant phase difference

D. The same intensity

Answer: B::D

Watch Video Solution

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

A. The fringe pattern will get shifted toward the covered slit

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

C. The bright fringes will be less bright, and the dark ones will be more bright

D. The fringe width will remain unchanged

Answer: A::C::D

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22. Mark the correct statements(s):

A. Direction of wave propagation is along the normal to wavefront

B. For a point source of light, the shape of wavefronts can be considered to be plane at very large distance from the source

C. A point source of light is placed at the focus of a thin spherical lens, then the shape of the wavefront for emerged light can be plane

D. The shape of the wavefront for the light incident on a thin spherical lens is plane, the shape of the wavefront corresponding to emergent light would always be spherical

Answer: A::B::C::D

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23. The fringes produced on a screen by blue monochromatic light falling upon a double-slit arrangement were found to be too close together for measurements to be taken on them. The fringe separation could be increased by

A. Increasing the distance between the slits and the screen

B. Replacing the light with monochromatic red light

C. Increasing the separation of the slits

D. Decreasing the wavelength of the incident light

Answer: A::B

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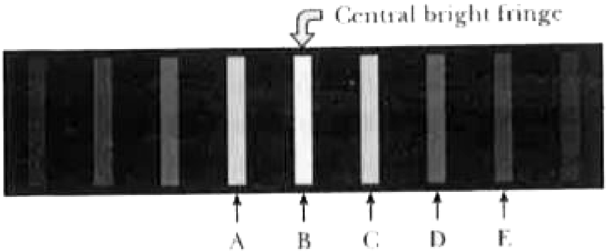
Practice Questions Linked Comprehension

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



Which fringe is the same distance from both slits?

A. A

B. C

C. B

D. D

Answer: C

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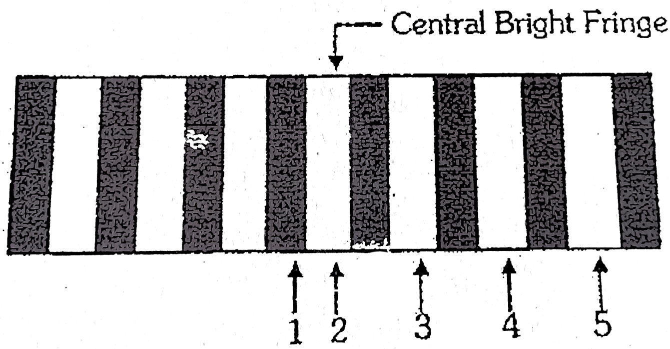
2.



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

Q. The third order bright fringe is

A. A

B. E

C. B

D. D

Answer: B

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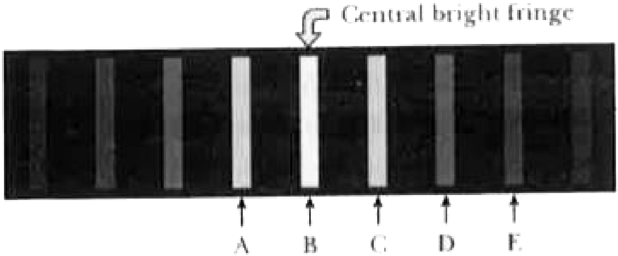
3. The figure shows the interference pattern obtained in a double-slit experiment using light of wavelength 600 nm.



Which fringe is 300 nm closer to one slit than to the other?

A. A

B. C

C. B

D. D

Answer: A

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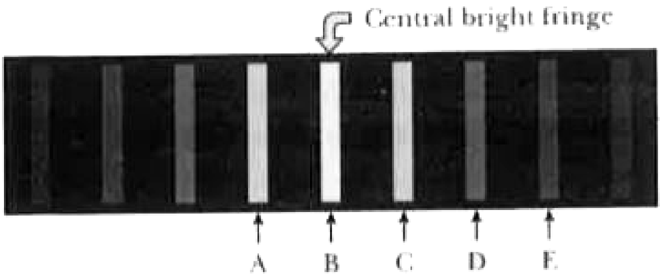
4. The figure shows the interference pattern obtained in a double-slit experiment using light of wavelength 600 nm.



Which fringe results from a phase difference of 4π?

A. A

B. C

C. B

D. D

Answer: D

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5. Angular width of central maxima in the Fraunhofer diffraction pattern of a slit is measured. The slit is illuminated by light of wavelength 6000Å. When the slit is illuminated by light of another wavelength, the angular width decreases by 30%. The wavelength of this light will be

A. 4200 nm

B. 420 nm

C. 800 nm

D. 320 nm

Answer: B

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6. Angular width of central maximum in the Fraunhoffer diffraction pattern of a slit is measured. The slit is illuminated by light of wavelength 6000Å. When the slit is illuminated by light of another wavelength, the angular width decreases by $30\,\%$. Calculate the wavelength of this light. The same decrease in the angular width of central maximum is obtained when the original apparatus is immersed in a liquid. Find the refractive index of the liquid.

A. $\frac{4}{3}$

B. 1.5

C. 1.43

D. 1.86

Answer: C

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7. 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.

31. The initial shape of the wavefront of the beam is

A. Convex

B. Concave

C. Convex near the axis and concave near the periphery

D. Planar

Answer: D

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8. An intially parallel cyclindrical 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 intensity of light beam. The intensity of the beam is decreasing with increasing radius.

Answer the following questions :

The speed of light in the medium is

A. Maximum on the axis of the beam

B. Minimum on the axis of the beam

C. The same everywhere in the beam

D. Directly proportional to the intensity I

Answer: B

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9. 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.

30 . At the beam enters the medium, it will

A. Diverge

B. Converge

C. Diverge near the axis and converge near the periphery

D. Travel as a cylindrical beam

Answer: B

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10. When waves from two herent sources, having amplitudes a and b superimpose, the amplitude R of the resultant wave is given by $R=\sqrt{a^2+b^2+2ab\cos\phi}$ where ϕ is the constant phase angle between the two waves. The resultant intensity I is directly proportional to the square of the amplitude of the resultant wave, i.e., $I \propto R^2$,

i.e., $I \propto \left(a^2+b^2+2ab\cos\phi\right)$

For constructive interference, $\phi = 2n\pi$,

$I_{\max} = (a+b)^2$

For destructive interference, $\phi = (2n-1)\pi$

$I_{\min} = (a-b)^2$

If I_1, I_2 are intensities of light from two slits of widths ω_1 and ω_2, then $\frac{I_1}{I_2} = \frac{\omega_1}{\omega_2} = \frac{a^2}{b^2}$

Light waves from two coherent sources of intensity ratio $81:1$ produce interference. With the help of the passsage given above, choose the most appropriate alternative for each of the following questions :

The ratio of amplitude of two sources is

A. 9 : 1

B. 81 : 1

C. 1 : 9

D. 1 : 81

Answer: A

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11. When waves from two herent sources, having amplitudes a and b superimpose, the amplitude R of the resultant wave is given by $R=\sqrt{a^2+b^2+2ab\cos\phi}$ where ϕ is the constant phase angle between the two waves. The resultant intensity I is directly proportional to the square of the amplitude of the resultant wave, i.e., $I \propto R^2$,

i.e., $I \propto \left(a^2 + b^2 + 2ab\cos\phi\right)$

For constructive interference, $\phi = 2n\pi$,

$I_{\text{max}} = (a + b)^2$

For destructive interference, $\phi = (2n - 1)\pi$

$I_{\text{min}} = (a - b)^2$

If I_1, I_2 are intensities of light from two slits of widths ω_1 and ω_2, then $\frac{I_1}{I_2} = \frac{\omega_1}{\omega_2} = \frac{a^2}{b^2}$

Light waves from two coherent sources of intensity ratio $81:1$ produce interference. With the help of the passsage given above, choose the most appropriate alternative for each of the following questions :

The ratio of slit widths of the two sources is

A. 9 : 1

B. 81 : 1

C. 1 : 9

D. 1 : 81

Answer: B

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12. When waves from two herent sources, having amplitudes a and b superimpose, the amplitude R of the resultant wave is given by $R = \sqrt{a^2 + b^2 + 2ab\cos\phi}$ where ϕ is the constant phase angle between the two waves. The resultant intensity I is directly proportional to the square of the amplitude of the resultant wave, i.e., $I \propto R^2$,

i.e., $I \propto \left(a^2 + b^2 + 2ab\cos\phi\right)$

For constructive interference, $\phi = 2n\pi$,

$I_{\max} = (a+b)^2$

For destructive interference, $\phi = (2n-1)\pi$

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If I_1, I_2 are intensities of light from two slits of widths ω_1 and ω_2, then $\frac{I_1}{I_2} = \frac{\omega_1}{\omega_2} = \frac{a^2}{b^2}$

Light waves from two coherent sources of intensity ratio $81:1$ produce interference. With the help of the passsage given above, choose the most appropriate alternative for each of the following questions :

The ratio of amplitude of two sources is

A. 9 : 1

B. 81 : 1

C. 25 : 16

D. 16 : 25

Answer: C

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13. When waves from two coherent source of amplitudes a and b superimpose , the amplitude R of the resultant wave is given by R = $\sqrt{a^2 + b^2 + 2ab\cos\phi}$.

where ϕ is the constant phase angle between the two waves. The resultant intensity I is directly proportional to the square of the amplitude of the resultant wave i.e $I \propto R^2$ i.e,

$I \propto (a^2 + b^2 + 2ab\cos\phi)$

For constructive interference ,

$$\phi = 2n\pi \quad \text{and} \quad I_{\max} = (a+b)^2$$

For destructive interference ,

$$\phi = (2n-1)\pi \text{and} I_{\min} = (a-b)^2$$

If $I_1 I_2$ are intensities from two slits of width

$w_1 \text{and} w_2$ then

$$\frac{I_1}{I_2} = \frac{w_1}{w_2} = \frac{a^2}{b^2}$$

Light waves from two coherent sources of intensity ratio 81 : 1 produce interference. With the help of the passage choose the most appropriate alternative for each of the following questions

If two slits in Young's experiment have width ratio

1:4 the ratio of maximum and minimum intensity in the interference pattern would be

A. 1 : 4

B. 1 : 16

C. 9 : 1

D. 9 : 16

Answer: A

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14. When waves from two herent sources, having amplitudes a and b superimpose, the amplitude R of the resultant wave is given by $R = \sqrt{a^2 + b^2 + 2ab\cos\phi}$ where ϕ is the constant phase angle between the two waves. The resultant intensity I is directly proportional to the square of the amplitude of the resultant wave, i.e., $I \propto R^2$,

i.e., $I \propto \left(a^2 + b^2 + 2ab\cos\phi\right)$

For constructive interference, $\phi = 2n\pi$,

$I_{\text{max}} = (a+b)^2$

For destructive interference, $\phi = (2n-1)\pi$

$I_{\text{min}} = (a-b)^2$

If I_1, I_2 are intensities of light from two slits of widths ω_1 and ω_2, then $\frac{I_1}{I_2} = \frac{\omega_1}{\omega_2} = \frac{a^2}{b^2}$

Light waves from two coherent sources of intensity ratio $81:1$ produce interference. With the help of the passsage given above, choose the most appropriate alternative for each of the following questions :

The ratio of amplitude of two sources is

A. 1 : 4

B. 4 : 1

C. 2 : 1

D. 1 : 2..

Answer: D

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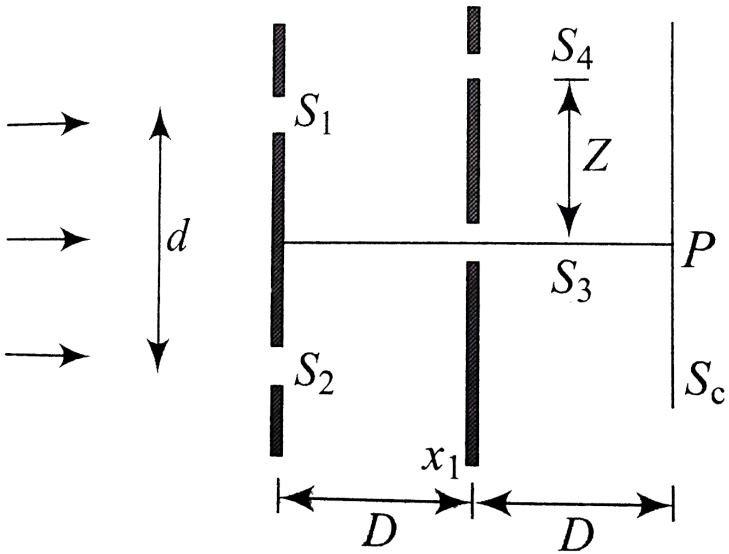
15. Consider the situation shown in fig. The two slits S_1 and S_2 placed symmetrically around the central line are illuminated by monochromatic light of wavelength λ. The separation between the slit is d. The ligth transmitted by the slits falls on a screen S_0 placed at a distance D form the slits. The slit S_3 is at the central line and the slit S_4 is at a distance z from S_3 Another screen S_c is placed a further distance D away from S_c Find the

ratio of the maximum to minimum intensity observed on S_c



If $z = \dfrac{\lambda D}{2d}$

A. 1

B. $1/2$

C. $3/2$

D. 2

Answer: A

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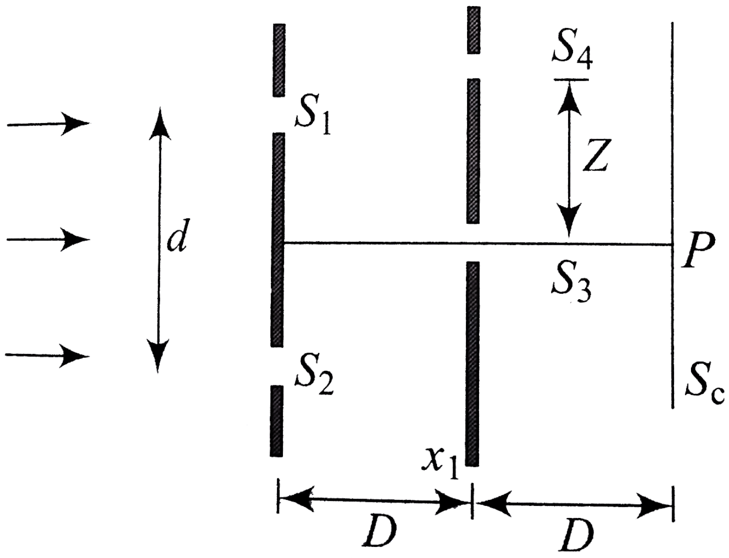
16. Consider the situation shown in fig. The two slits S_1 and S_2 placed symmetrically around the central line are illuminated by monochromatic light of wavelength λ. The separation between the slit is d. The ligth transmitted by the slits falls on a screen S_0 placed at a distance D form the slits. The slit S_3 is at the central line and the slit S_4 is at a distance z from S_3 Another screen S_c is placed a further distance D away from S_c Find the

ratio of the maximum to minimum intensity observed on S_c



If $z = \dfrac{\lambda D}{d}$

A. 4

B. 2

C. ∞

D. 1

Answer: C

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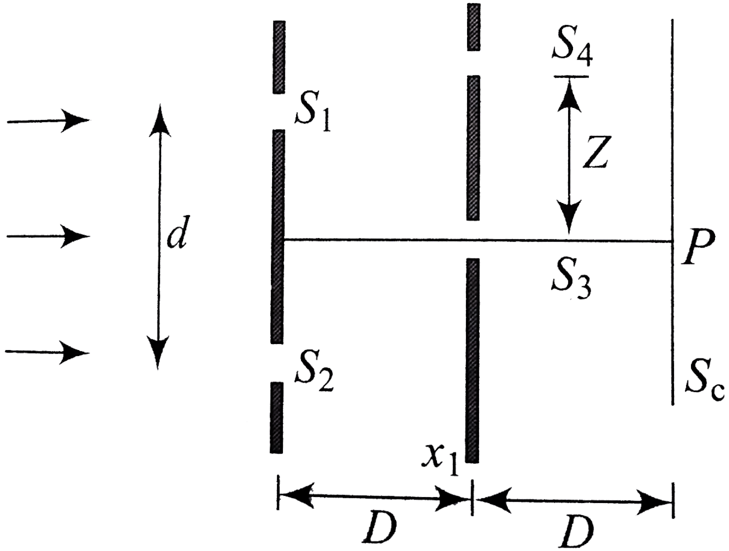
17. Consider the situation shown in fig. The two slits S_1 and S_2 placed symmetrically around the central line are illuminated by monochromatic light of wavelength λ. The separation between the slit is d. The ligth transmitted by the slits falls on a screen S_0 placed at a distance D form the slits. The slit S_3 is at the central line and the slit S_4 is at a distance z from S_3 Another screen S_c is placed a further distance D away from S_c Find the

ratio of the maximum to minimum intensity observed on S_c



If $z = \frac{\lambda D}{4d}$

A. $\left[3 - 2\sqrt{2}\right]^2$

B. $\left[3 + 2\sqrt{2}\right]^2$

C. $\left[3 - \sqrt{2}\right]^2$

D. $\left[3 + 2\sqrt{2}\right]^2$

Answer: D

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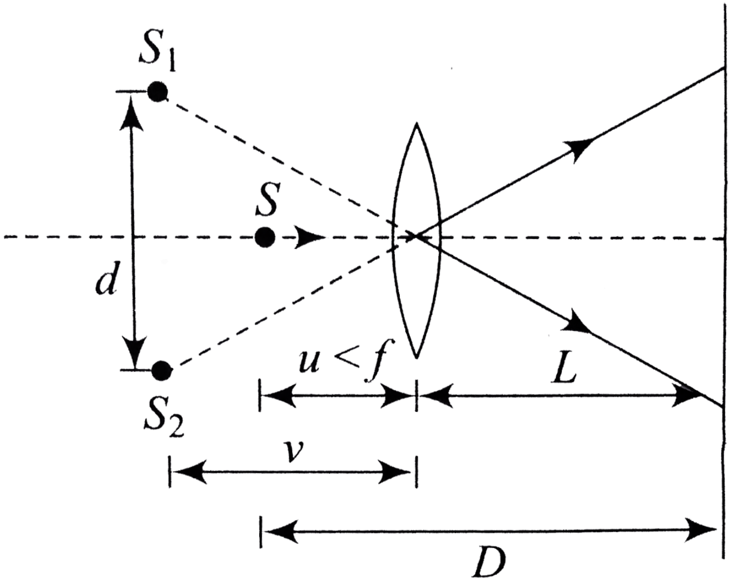
18. A lens of focal length f is cut along the diameter into two identical halevs. In this process, a layer of the lens t in thickness is lost, then the halves are put together to form a composite lens. In between the focal plane and the composite lens, a narrow slit is placed near the focal plane. The slit is emitting monochromatic λ. Behind the lens, a screen is located at a distance L front it.



Find the fringe width for the pattern obtained under given arrangement on the screen.

A. 0.19 m

B. 0.24 m

C. 0.3 m

D. 0.43 m

Answer: C

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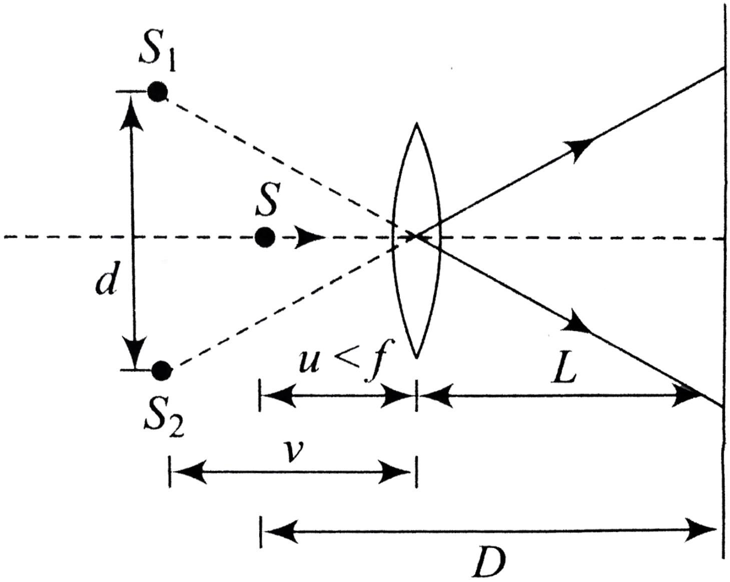
19. A lens of focal length f is cut along the diameter into two identical halevs. In this process, a layer of the lens t in thickness is lost, then the halves are put together to form a composite lens. In between the focal plane and the composite lens, a narrow slit is placed near the focal plane. The slit is emitting monochromatic λ. Behind the lens, a screen is located at a distance L front it.



The expression for the number of visible maxima which are obtained through above said arrangement will turn out to be

A. $\dfrac{Lt^2}{\lambda f^2}$

B. $\dfrac{2Lt^2}{\lambda f^2}$

C. $\dfrac{Lt}{2\lambda f^2}$

D. $\frac{Lt^2}{2\lambda f^2}$

Answer: C

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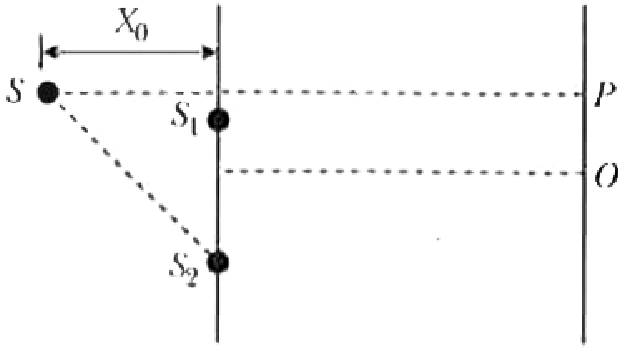
20. In a modified Young's double-slit experiment, source S is kept in front of slit S_1 as shown in the following figure. Find the phase difference at a point that is equidistant from slits S_1 and S_2 and point P that is in front of slit S_1 in the following situations:



If a liquid of refractive index n is filled between the screen and slits, what is the phase difference?

A. $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2+x_0^2}+x_0\right]+\frac{nd^2}{2D}\right]$

B. $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2+x_0^2}-x_0\right]+\frac{nd^2}{2D}\right]$

C. $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2-x_0^2}+x_0\right]+\frac{nd^2}{2D}\right]$

D. $\frac{2\pi}{\lambda}\left[\left[\sqrt{d^2-x_0^2}-x_0\right]+\frac{nd^2}{2D}\right]$

Answer: B

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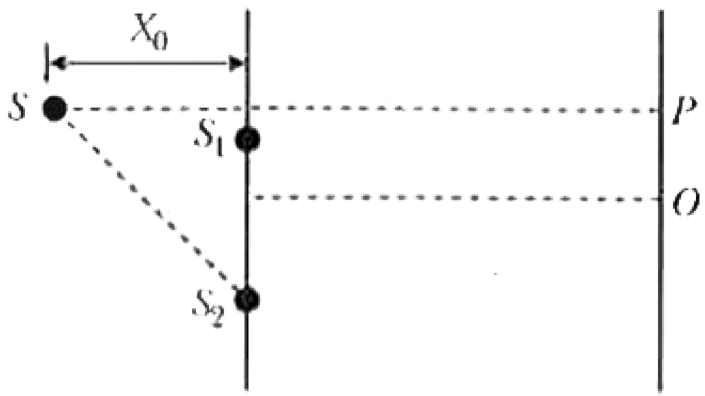
21. In a modified Young's double-slit experiment, source S is kept in front of slit S_1 as shown in the following figure. Find the phase difference at a point that is equidistant from slits S_1 and S_2 and point P that is in front of slit S_1 in the following situations:



If a liquid is filled between the slit and the source S, what is the phase difference?

A. $\frac{2\pi}{\lambda}\left[n\sqrt{d^2 + x_0^2} - x_0 - \frac{d^2}{2D}\right]$

B. $\frac{2\pi}{\lambda}\left[n\sqrt{d^2 + x_0^2} - x_0 + \frac{d^2}{2D}\right]$

C. $\frac{2\pi}{\lambda}\left[n\sqrt{d^2 + x_0^2} + x_0 + \frac{d^2}{2D}\right]$

D. $\frac{2\pi}{\lambda}\left[n\sqrt{d^2 - x_0^2} - x_0 - \frac{d^2}{2D}\right]$

Answer: A

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Practice Questions Matrix Match

1. Match the statements in Column I labeled as (a), (b), (c), and (d) with those in Column II labeled as (p), (q). (c), and (s). Any given statement in Column I can have correct matching with one or more statements in Column II.

Match the property with the concept it is based on.

Column I	Column II
(a) Interference	(p) Corpuscular theory
(b) Compton effect	(q) Longitudinal waves
(c) Diffraction	(r) Transverse waves
(d) Polarization	(s) Dual theory

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Practice Questions

1. Match the statements in Column I labeled as (a), (b), (c), and (d) with those in Column II labeled as (p), (q). (c), and (s). Any given statement in Column I can have correct matching with one or more statements in Column II.

Match the observation given in Column I with the experiments given in Column II.

Column I	Column II
(a) Central fringes is bright and all fringes are equally spaced	(p) Interference in wedge-shaped thin
(b) Central fringes is dark and all fringes are equally spaced	(q) Young's double-slit experiment
(c) Central fringes is bright and fringes are not equally spaced	(r) Fraunhoffer single-slit diffraction experiment
(d) All fringes are equally spaced	(s) Lloyd's mirror experiment

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2. Interference is an important property of light. In the given table, Column I shows the properties of interfering waves, Column II shows the phase difference, and Column III shows the path difference between two interfering waves

Column I	Column II	Column III
(I) Produced by systematic fluctuations.	(i) Phase difference $= 2n\pi$	(J) Path difference will vary continuously
(II) Points of maximum intensity	(ii) Phase difference $= (2n-1)\pi$	(K) Path difference $= n\lambda$
(III) Not very short-lived (produced by random fluctuations)	(iii) Phase difference $= 2\pi/\lambda(xd/D)$	(L) Path difference $= xd/D$
(IV) Points of minimum intensity	(iv) Phase difference will vary continuously	(M) Path difference $= (2n-1)\lambda/2$

What are the conditions for constructive interference?

A. (I) (iv) (M)

B. (IV) (ii) (L)

C. (II) (i) (K)

D. (II) (i) (K)

Answer: D

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3. Interference is an important property of light. In the given table, Column I shows the properties of interfering waves, Column II shows the phase difference, and Column III shows the path difference between two interfering waves

Column I	Column II	Column III
(I) Produced by systematic fluctuations.	**(i)** Phase difference $= 2n\pi$	**(J)** Path difference will vary continuously
(II) Points of maximum intensity	**(ii)** Phase difference $= (2n-1)\pi$	**(K)** Path difference $= n\lambda$
(III) Not very short-lived (produced by random fluctuations)	**(iii)** Phase difference $= 2\pi/\lambda(xd/D)$	**(L)** Path difference $= xd/D$
(IV) Points of minimum intensity	**(iv)** Phase difference will vary continuously	**(M)** Path difference $= (2n-1)\lambda/2$

What are the conditions for destructive interference?

A. (I) (ii) (J)

B. (IV) (ii) (M)

C. (II) (iii) (L)

D. (I) (i) (M)

Answer: B

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4. Interference is an important property of light. In the given table, Column I shows the properties of interfering waves, Column II shows the phase difference, and Column III shows the path difference between two interfering waves

Column I	Column II	Column III
(I) Produced by systematic fluctuations.	(i) Phase difference $= 2n\pi$	(J) Path difference will vary continuously
(II) Points of maximum intensity	(ii) Phase difference $= (2n-1)\pi$	(K) Path difference $= n\lambda$
(III) Not very short-lived (produced by random fluctuations)	(iii) Phase difference $= 2\pi/\lambda(xd/D)$	(L) Path difference $= xd/D$
(IV) Points of minimum intensity	(iv) Phase difference will vary continuously	(M) Path difference $= (2n-1)\lambda/2$

What are the conditions for sustained interference?

A. (II) (ii) (J)

B. (III) (iii) (L)

C. (IV) (i) (L)

D. (II) (iii) (M)

Answer: B

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5. The amplitudes of two coherent waves are vector quanti- ties. In the given table, Column I shows the phase differ ence between two coherent waves, Column II shows the path difference between them and Column III shows their resultant amplitudes.

Column I	Column II	Column III
(I) $\phi = 0$	(i) $\delta = 0$	(J) $E_R = 2E_0$
(II) $\phi = 120$	(ii) $\delta = \lambda/6$	(K) $E_R = 0$
(III) $\phi = 60(2\pi)$	(iii) $\delta = \lambda/3$	(L) $E_R = 3E_0$
(IV) $\phi = 180$	(iv) $\delta = \lambda/2$	(M) $E_R = E_0$

When is the phasor diagram at primary maxima?

A. (I) (iii) (M)

B. (III) (ii) (K)

C. (I) (i) (L)

D. (I) (iii) (J)

Answer: C

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6. The amplitudes of two coherent waves are vector quanti- ties. In the given table, Column I shows the phase differ ence between two coherent waves, Column II shows the path difference between them and Column III shows their resultant amplitudes.

Column I	Column II	Column III
(I) $\phi = 0$	(i) $\delta = 0$	(J) $E_R = 2E_0$
(II) $\phi = 120$	(ii) $\delta = \lambda/6$	(K) $E_R = 0$
(III) $\phi = 60(2\pi)$	(iii) $\delta = \lambda/3$	(L) $E_R = 3E_0$
(IV) $\phi = 180$	(iv) $\delta = \lambda/2$	(M) $E_R = E_0$

When is E_R maximum?

A. (I) (ii) (M)

B. (III) (ii) (J)

C. (II) (ii) (K)

D. (II) (iv) (M)

Answer: B

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7. The amplitudes of two coherent waves are vector quanti- ties. In the given table, Column I shows the phase differ ence between two coherent waves, Column II shows the path difference between them and Column III shows their resultant amplitudes.

Column I	Column II	Column III
(I) $\phi = 0$	(i) $\delta = 0$	(J) $E_R = 2E_0$
(II) $\phi = 120$	(ii) $\delta = \lambda/6$	(K) $E_R = 0$
(III) $\phi = 60(2\pi)$	(iii) $\delta = \lambda/3$	(L) $E_R = 3E_0$
(IV) $\phi = 180$	(iv) $\delta = \lambda/2$	(M) $E_R = E_0$

When is the phasor diagram at secondary maxima?

A. (III) (i) (L)

B. (IV) (i) (J)

C. (III) (iv) (J)

D. (IV) (iv) (M)

Answer: D

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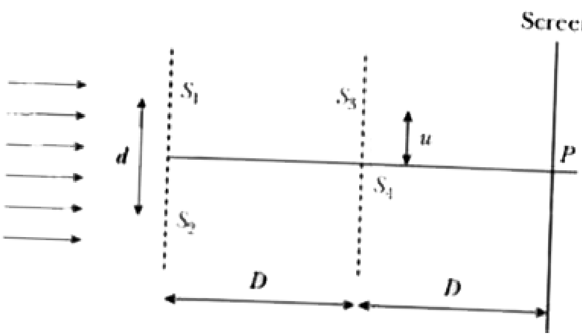
Practice Questions Integer Type

1. In the arrangement shown in the following figure, the wavelength of light used is λ. The distance between slits S_1 and S_2 is d (« D). The distance between S_3 and S_4 is $u = \lambda D / 3d$. If the ratio of maximum to minimum intensity observed on screen is k. Find k.



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2. Light used in a Young's double-slit experiment consists of two wavelengths 450 nm and 720 nm. In the interference pattern, eighth maximum of the first coincides with the mth maximum of the second. What is m?

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3. In YDSE, $d = 2mm, D = 2m,$ and $\lambda = 500nm.$ If intensities of two slits are I_0 and $9I_0$, then find intensity at $y = \frac{1}{6}mm.$

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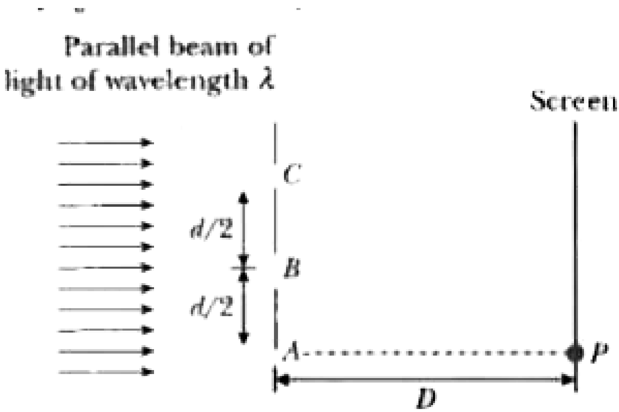
4. For the situation depicted in the following figure, $BP - AP = \lambda/3$ and D » d. The slits are of equal widths, having intensity I_0. If the intensity of Pis kI_0, find k.



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5. A thin glass plate of thickness t and refractive index μ is between screen &one of the slits in young's experiment.if the intensity at the center of the screen is I ,was the intensity at the same point prior to the introduction of the sheet.

(b) One slit of a young's experiment is covered by a glass plate $(\mu_1 = 1.4)$ and the other by another glass plate $(\mu_2 = 1.7)$ of the same thickness. The point of central maxima of the screen,before the plates were introduced is now occupied by the third bright fringe.Find the thicknes of the thickness of the plates.the wavelength of light used in 4000Å.

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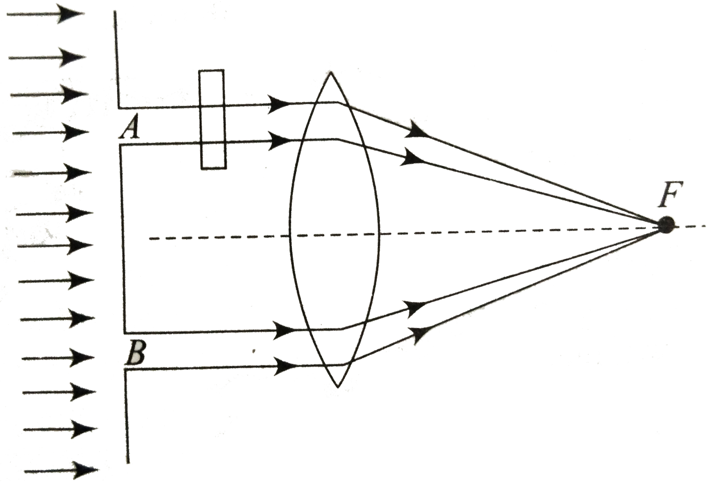
6. In a modified Young's double-slit experiment, a monochromatic uniform and parallel beam of light of wavelength 6000Å and intensity $(10/\pi)$ W m^{-2} is incident normally on two circular apertures A and B of radii 0.001 m and 0.002 m, respectively. A perfectly transparent film of thickness 2000Å and refractive index 1.5 for the wavelength of 6000Å is placed in front of aperture A (see the figure). Calculate the power (in mW) received at the focal spot F of the lens. Then lens is symmetrically placed with respect to the aperture. Assume that 10% of the power received by each aperture goes in the original direction and is brought to the focal spot.



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