OPTICS PROBLEMS

Q.1. In young's double slit experiment fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index 4/3 without disturbing the geometrical arrangement, find the new fringe width.

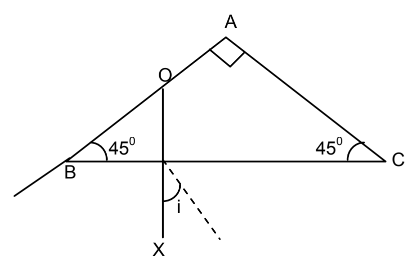
Q.2. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on the screen phase difference between the beams is $\pi/2$ at point A and π at point B. Then find the difference between resultant intensities at A & B.

Q.3. A thin walled glass sphere of radius R is filled with water ($\mu = 4/3$). An object is placed at distance 3R from the surface of the sphere. If the effect of the glass wall is neglected. Find the distance of the final image from the centre of sphere.

Q.4. A parallel beam of light incident on a concave lens of focal length 10cm emerges as a parallel beam from a convex lens placed coaxially, the separation between the lenses being 10 cm. find the focal length of the convex lens in cm.

Q.5. For an equilateral prism, it is observed that when a ray strikes grazingly at one face it emerges grazingly at the other. Calculate its refractive index.

Q.6. ABC is a right angled prism having refractive index $\sqrt{2}$. A ray is incident on face BC (hypotenuse) as shown in the figure. If emergent ray grazes the face AB then calculate angle of incidence i.



Q.7. Two coherent monochromatic light beams of intensities I and 4I are superposed. Find the maximum and minimum possible intensities in the resulting beam.

Q.8. If x and y be the distances of the object and image formed by a concave mirror from its focus and f be the focal length then find the focal length of concave mirror.

Q.9. A double convex lens forms a real image of an object on a screen which is fixed. Now the lens is given a constant velocity $v = 1ms^{-1}$ along its axis and away from the screen. For the purpose of forming the image always on the screen, the object is also required to be given an appropriate velocity. Find the velocity of the object at the instant its size is double the size of the image.

Q.10. A hole of diameter 0.5 m is filled with a glass at the bottom of boat to observer the bottom of river through the hole. Refractive index of glass is 1.5 and water is 1.4.

Q.11. A planoconvex lens has a thickness of = 4 cm. When placed on a horizontal surface (table), with the covered surface in contact with it, the apparent depth of the bottom most point of the lens is found to be t_1= 3 cm. If the lens is inverted such that the plane face is in contact with the table, the apparent depth of the center of the plane surface is found to be t_2 = 25/8 cm. Find the focal length of the lens.

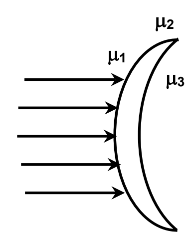
Q.12. The focal length of a convex lens of R.I. 1.5 is f when it is placed in air. When it is immersed in a liquid it behaves as a converging lens its focal length becomes xf (x > 1). Find the refractive index of the liquid

Q.13. A spectral line results from the transition n =2 to n =1, in the atoms/species given below which one of these will produce the shortest wavelength emission H, He^+, Li^{++}.

Q.14. A lens has focal length f in air. What is the power of lens of refractive index μ, when immersed in water (μ_0).

Q.15. In Young's experiment wavelength of red light is 7.8×10^{-8} cm and that of blue light is 5.2×10^{-8} cm. Find the value of n for which $(n + 1)^{th}$ blue bright line concides with nth red fringe.

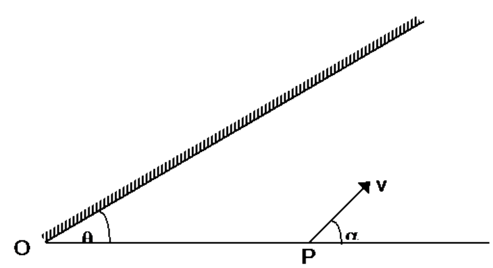
Q.16. A meniscus lens is made of a material of refractive index μ_2. Both its surfaces have radii of curvature R. It has two different media of refractive indices μ_1 and μ_3 respectively, on its two sides (see figure). Calculate its focal length for $\mu_1 < \mu_2 < \mu_3$, when light is incident on it as shown.



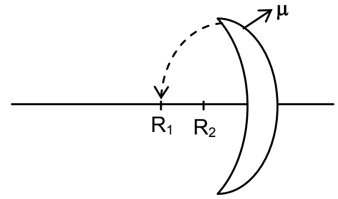
Q.17. Interference fringes are produced by a double slit arrangement and a piece of plane parallel glass of refractive index 1.5 is interposed in one of the interfering beam. If the fringes are displaced through 30 fringe widths for light of wavelength 6×10^{-5} cm, find the thickness of the plate.

Q.18. In a young's double slit experiment, the path difference, of waves for a point p on screen is one third of wavelength of the light. Find the ratio of intensity at P to that at maximum.

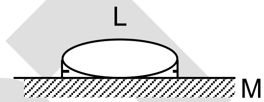
Q.19. A plane mirror is inclined at an angle $\theta = 60^0$ with horizontal surface. A particle is projected from point P (see figure) at t = 0 with a velocity v at an angle α with horizontal. The image of the particle is observed from the frame of the particle projected. Assuming the particle does not collide the mirror. Find the time when image will come momentarily at rest with respect to particle.



Q.20. The figure shows a lens placed in air. $\mu = 1.5$, $R_1 = 20$ cm, $R_2 = 10$ cm. Find the focal length of lens.

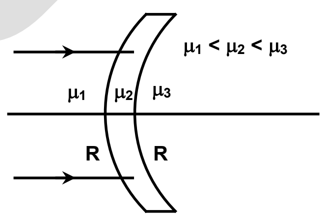


Q.21. A bi-convex lens L having radii of curvature 40 cm and 30 cm rests horizontally with the face of larger radius of curvature in contact with a horizontal plane mirror M. A little water is held by capillary action between L and M, thus forming a water lens. Calculate the focal length of the combination. [$\mu_\omega = 4/3$, $\mu_g = 3/2$]



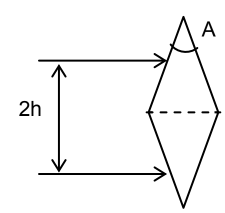
Q.22. In the ideal Young's double-slit experiment, when a glass-plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wave-length λ), the intensity at the position where the central maximum occurred previously remains unchanged. Find the minimum thickness of the glass-plate.

Q.23. Find the focal length of the lens shown in the figure. The radii of curvature of both the surfaces are equal to R.



Q.24. A light source emits light of two wavelengths $\lambda_1 = 4300\ A^0$ and $\lambda_2 = 5100\ A^0$. The source is used in a double slit interference experiment. The distance between the slit is 0.025 mm and between source and screen is 1.5 m. Calculate the separation between the third order bright fringes due to these two wavelengths.

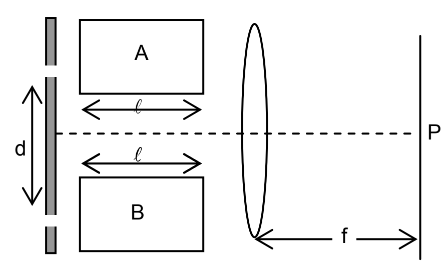
Q.25. Two identical thin isosceles prism of refracting angle A and refractive index μ are placed with their bases touching each other and this system can collectively acts as a crude converging lens. A parallel beam of light is incident on this system as shown. Find the focal length of this converging lens.



Q.26. The two slits are illuminated by monochromatic plane waves from the left. To the right of the slits are two identical glass containers A and B, each of inside thickness $\ell = 5 \times 10^{-4}$ m. With both containers evacuated, a bright fringe appears at P on the screen opposite to the centre of the slits. A gas is then admitted to A resulting in a shift of 20 fringes as observed at P for light of wavelength $\lambda = 0.5\ \mu$m

(a) Which way did the fringes move.

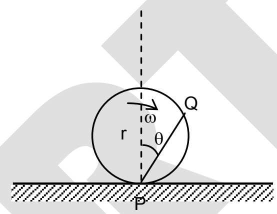
(b) What is the refractive index of the gas.



Q.27. A point square of light is placed at depth h below the surface of a large deep lake. What is the percentage of light energy that escapes directly from the water surface ($\mu_w = 4/3$)

Q.28. In Young's double slit experiment the slits are 0.5 mm apart and interference is observed on a screen placed at a distance of 100 cm from the slits. It is found that the 9^{th} bright fringe is at a distance of 8.835 mm from the 2^{nd} dark fringe from the centre of fringe pattern. Find the wavelength of light used.

Q.29. A disc of radius r is rolling on a plane horizontal mirror with constant angular velocity ω as shown in the figure. Calculate velocity of image of point Q w.r.t. Q itself. P is contact point and line PQ makes an angle θ with vertical at given instant.



Q.30. A ray of light incident normally on one of the faces of a right angled isoceles glass prism is found to be totally reflecting. What is the minimum value of the refractive index of the material of prism ?

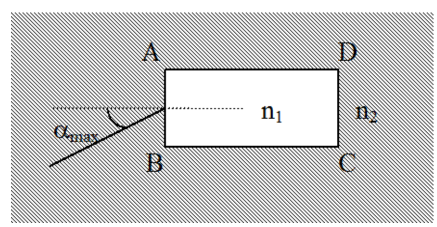
Q.31. A prism can produce a minimum deviation δ in a light beam. It three such prisms are combined, find the minimum deviation that can be produced in this beam.

Q.32. In Young's double slit experiment interference is produced due to slits distance d metre apart. The fringe pattern is observed on a screen distant D metre from the slits. If λ in metre, denotes, the wavelengths of light, find the number of fringes per metre of the screen.

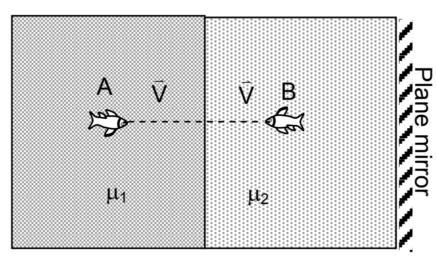
Q.33. In Young's experiment wavelength of red light is 7.8×10^{-7} m and that of blue light is 5.2×10^{-7} m. Find the value of n for which (n + 1)th blue bright line concides with nth red fringe.

Q.34. What is the fractional change in wavelength of light when it passes through water from glass. (n_w = 4/3 and n_g = 3/2)

Q.35. A rectangular slab ABCD, of refractive index n_1, is immersed in water of refractive index n_2 ($n_1 > n_2$). A ray of light is incident at the surface AB of the slab is shown. Find the maximum value of the angle of incidence α_{max}, such that the ray comes out only from the other surface.

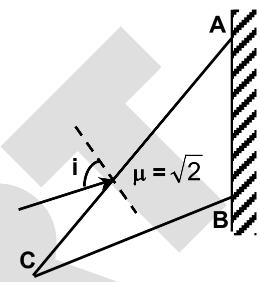


Q.36. An aquarium is bifurcated by a thin sheet of transparent material as shown in the figure. Each of the two portions contains different kinds of liquid (refractive indices'μ_1' and 'μ_2' respectively), two fish A and B swim along each other with their line of approach perpendicular to the interface. One of the side walls is a plane mirror. Find the velocity of separation of the two images of the fish B that are being observed by the fish 'A'.
Given that $\mu_1 < \mu_2$.



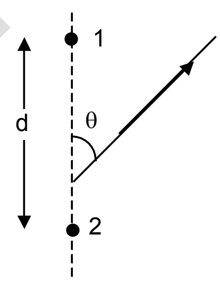
Q.37. A beam of light consisting of two wavelength 6500 A° and 5200 A° is used to obtain interference fringes in a Young's double slit experiment what is the least distance from the centre maximum where the bright fringes due to both the wave lengths coincide?
The distance between the slit is 2mm and the distance between the plane of the slits and the screen is 120 cm.

Q.38. One face of a prism ABC of $\mu = \sqrt{2}$ is silvered and the ray incident at angle 45° retraces its initial path. Find the angle $\angle$CAB.



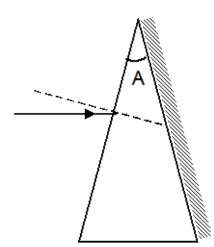
Q.39. The principal section of glass prism is an isosceles ΔPQR with PQ = PR. The face PR is silvered. A ray is incident perpendicularly on face PQ and after two reflections it emerges from base QR, normal to it. Find the angle of the prism.

Q.40. A system consists of two coherent point sources 1 and 2 located in a certain plane. The sources are separated by a distance d and the wavelength of radiation is λ. Taking into account that the oscillations of source 2 lag in phase behind the oscillations of source 1 by ϕ ($\phi < \pi$), find the angle θ at which the radiation intensity is maximum

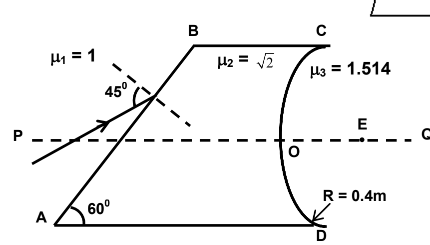


Q.41. In a modified young's double slit experiment (λ = 6000 A^0) the zero order maxima and tenth order maxima fall at 12.34 mm and 14.73 mm on a screen from a particular reference point. If λ is changed to 5000 A^0, find the new positions of the zero-order maxima and 10^{th} order maxima if other arrangements remaining unchanged.

Q.42. A thin prism is placed in the position of minimum deviation. If A be its refracting angle and μ the refractive index of the material of the prism, find the net deviation suffered by the ray on emergence from the prism, if the opposite refracting surface is silvered.



Q.43. A light ray is incident on an irregular shaped slab of refractive index $\sqrt{2}$ at an angle of 45° with the normal on the incline face as shown in the figure. The ray finally emerges from the curved surface in the medium of the refractive index μ = 1.514 and passes through point E. If the radius of curved surface is equal to 0.4 m, find the distance OE correct upto two decimal places.



Q.44. A ray of light incident normally on one of the faces of a right angled isoceles glass prism is found to be totally reflecting. What is the minimum value of the refractive index of the material of prism ?

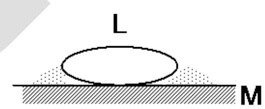
When the prism is immersed in water, trace the path of emergent ray for the same incident ray taking the refractive index of the material of the prism to be equal to the minimum value of the refractive index as calculated in this problem earlier, indicating the values of all angles (μ = 4/3).

Q.45. A plano - convex lens has a thickness of 4 cm, when placed on a horizontal table, with the curved surface in contact with it, the apparent depth of the bottom most point of the lens is found to be 3 cm. If the lens is inverted such that the plane face is in contact with the table , the apparent depth of the centre of the plane face of the lens is found to be 25/8 cm. Find the focal length of the lens.

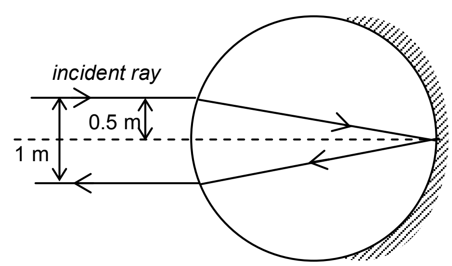
Q.46. Interference fringes are produced by a double slit arrangement and a piece of plane parallel glass of refractive index 1.5 is interposed in one of the interfering beam. If the fringes are displaced through 30 fringe widths for light of wavelength 6×10^{-5} cm, find the thickness of the plate.

Q.47. In Young's double slit experiment the slits are 0.5 mm apart and interference is observed on a screen placed at a distance of 100 cm from the slits. It is found that the 9th bright fringe is at a distance of 8.835 mm from the 2nd dark fringe from the centre of fringe pattern. Find the wavelength of light used.

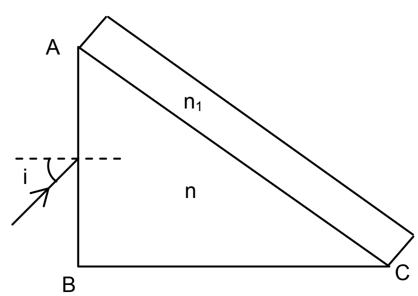
Q.48. A bi-convex lens L having radii of curvature 40 cm and 30 cm rests horizontally with the face of larger radius of curvature in contact with a horizontal polished metal plate M. A little water is held by capillary action between L and M, thus forming a water lens. Calculate the focal length of the combination. [μ_ω = 4/3, μ_g = 3/2]



Q.49. A transparent cylinder of radius 1m has a mirrored surface on its right half as shown. A ray of light travelling in air is incident on the left side of the cylinder. The ray coming out from the cylinder is parallel to incident ray and at a distance d = 1.00 m from the incident ray. Find the refractive index of the material.



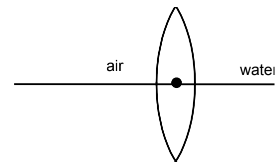
Q.50. A right angle prism ($45^0 - 90^0 - 45^0$) of refractive index 'n' has a plane of refractive index n_1 ($n_1 < n$) cemented to its diagonal face. The assembly is in air. The ray is incident on AB as shown in figure. Calculate the angle of incidence at AB for which the ray strikes the diagonal face at the critical angle.



Q.51. A pin is placed 10cm in front of a convex lens of focal length 20cm and refractive index 1.5. The surface of the lens further away from the pin is silvered and has a radius of curvature 25cm. Find the position of the image.

Q.52. Find the focal length of the glass (μ = 3/2) lens (bi convex lens) of radius of curvature 20 cm, with air as medium on one of its side and water on the other.

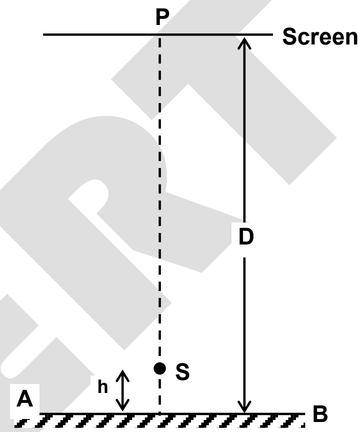
$(\mu_{air} = 1 \quad \mu_{water} = 1.3)$



Q.53. A point source *S* emitting light of wavelength 600 nm is placed at a very small height *h* above a flat reflecting surface *AB* (see figure). The intensity of the reflected light is 36% of the incident intensity. Interference fringes are observed on a screen placed parallel to the reflecting surface at a very large distance *D* from it.

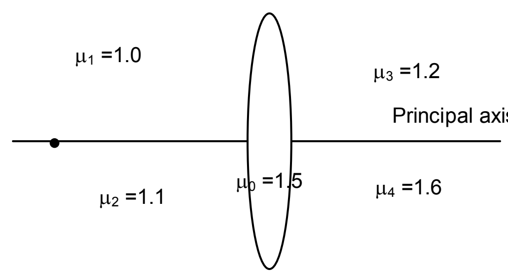
(a) What is the shape of the interference fringes on the screen?

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



(c) If the intensity at point P corresponds to a maximum, calculate the minimum distance through which the reflecting surface *AB* should be shifted so that the intensity at *P* again becomes maximum.

Q.54. A convex lens of focal length f_0 = 24 cm in air is surrounded by four different mediums as shown in the figure. A point object O is placed along the principal axis at a distance u = 30 cm from the lens. Find the number and position of the images formed.



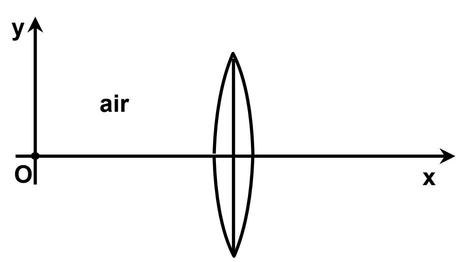
Q.55. A thin equi-convex spherical glass lens (μ = 3/2) of focal length 30 cm is placed on the x-axis with its optical centre at x = 40 cm and its principal axis coinciding with the x-axis. A light ray, given by the equation :

39 y = – x + 1 (x, y in cm)

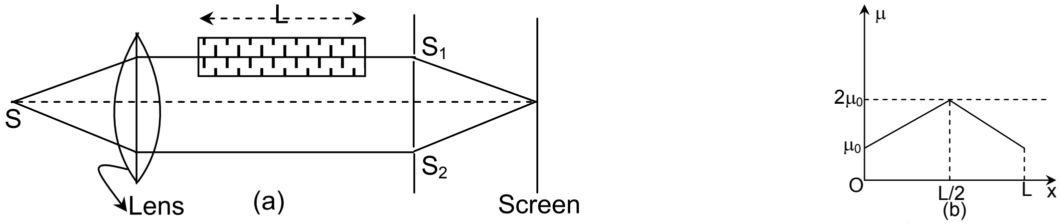
is incident onto the lens, towards the positive x-axis.

(a) Find the equation of the refracted ray.

(b) If the space on the right side of the lens (x > 40 cm) is filled with a liquid of refractive index 4/3, find the new equation of the refracted ray.

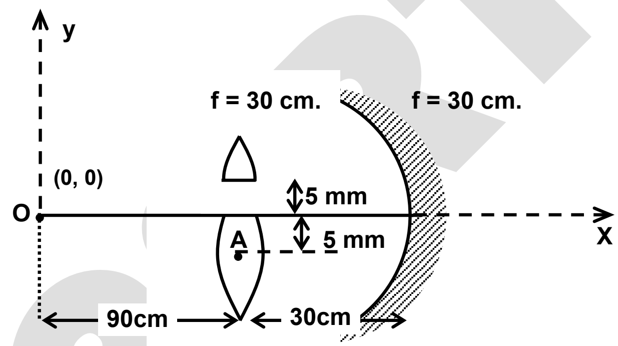


Q.56. The figure (a) shows a narrow slit S illuminated by a monochromatic light of wavelength λ in a double slit experiment. In the path of the rays reaching the upper slit S_1 a tube of length L is interposed in which the index of refraction of the medium varies linearly as shown in the figure (b).



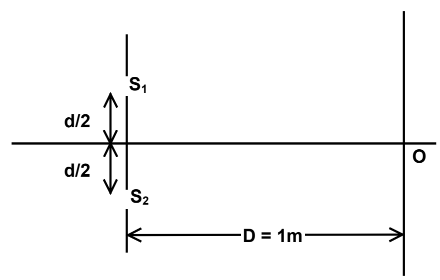
The position of the central maximum in the interference pattern on the screen was displaced by N fringes. Find the value of N in terms of μ_0, L and λ.

Q.57. A lens having focal length 30 cm. is cut along a plane parallel to the principal axis of the lens at a distance 5 mm above optical centre 'A' and upper part of lens is shifted by 5 mm from the x-axis as shown in the figure. A point object is placed on the principal axis of the mirror at origin O (0, 0). Find the number of images formed just after the reflection from the mirror and write their co-ordinates.



Q.58. In a young's double slit experiment, the path difference, of waves for a point p on screen is one third of wavelength of the light. Find the ratio of intensity at P to that at maximum.

Q.59. In a double slit experiment the separation between the slits is 1mm. Light rays fall normally on the plane of the slits and the interference pattern is observed on a screen placed at a distance of 1m from the plane of the slits. The arrangement is shown in the figure. When one of the slits is covered by a transparent strip of thickness 4μm, the central maximum is formed at a distance of 2mm from the point O. When the entire apparatus (one of the slits remaining covered) is immersed in a liquid, the distance between the central maximum and the point O is reduced to 0.5mm.



(a) Find the refractive index of the material of the strip and the liquid.

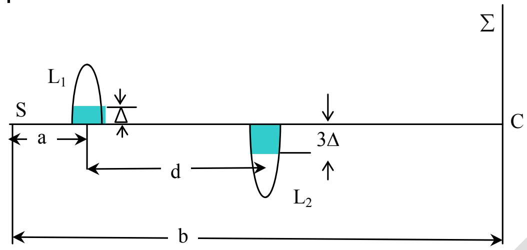
(b) If the wavelength of light used is 500nm and the experiment is performed in the liquid find distance of the nearest maximum from the point O.

Q.60. Fringes are produced using light of wavelength λ = 4800 A^0 in a double – slit experiment. One of the slit is covered by a thin plate of glass of refractive index 1.4 and other slit by another plate of glass of double thickness and of refractive index 1.7.

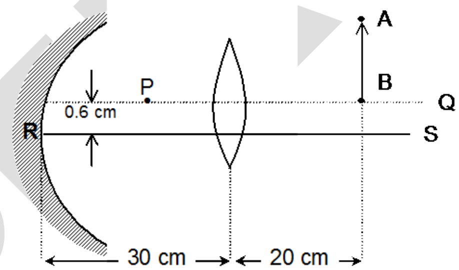
During this process the central bright fringe shifts to a position originally occupied by the fifth bright fringe from the centre. Find the thickness of each glass plate.

Q.61. In the figure S is a monochromatic point source emitting light of wavelength λ = 500 nm is placed at a distance b = 2m from a screen Σ. A thin lense of focal length f = 16 cm is cut into two identical half. They are placed at a distance 20 cm and 80 cm from S. The part L_1 is shifted Δ = 0.40 mm

while L_2 is shifted 3Δ transverse to the line SC. The gaps between the line SC and the lens parts are filled by an opaque material as shown in figure. Calculate
(i) Where the image of S will form.
(ii) The refractive index μ of a transparent sheet of thickness t = 1 mm to be placed in path of rays emerging from one of the parts so that the central maxima is formed at point C.

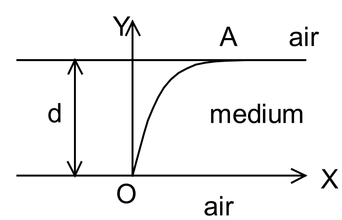


Q.62. A convex lens of focal length 15 cm and a concave mirror of focal length 30cm are kept with their optic axes PQ and RS parallel but separated in vertical direction by 0.6 cm as shown. The distance between the lens and mirror is 30 cm. An upright object AB of height 1.2 cm is placed on the optic axis PQ of the lens at a distance of 20 cm from the lens. If A′ B′ is the image after refraction from the lens and reflection from the mirror, find the distance of A′B′ from the pole of the mirror and obtain its magnification. Also locate positions of A′ and B′ with respect to the optic axis RS.



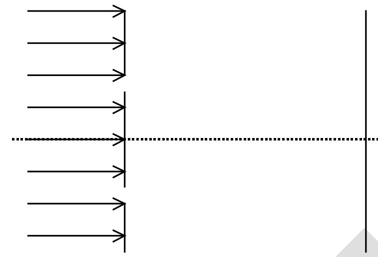
Q.63. A glass plate of refractive index 1.5 is coated with a thin layer of thickness t and refractive Index 1.8. Light of wavelength λ traveling in air is incident normally on the layer . It is partly reflected at the upper and the lower surfaces of the layer and the two reflected rays interfere. Write the condition for their constructively interference. If λ = 648 nm, obtain the least value of t for which the rays interfere constructively.

Q.64. A long rectangular slab of transparent medium of thickness d is placed on a table with its length parallel to the X-axis and width parallel to Y-axis. A ray of light travelling in air makes a near normal incidence on the slab as shown.
Take the point of incidence as origin (0, 0, 0)
and $\mu = \dfrac{\mu_0}{1-(x/r)}$



where μ_0 and r(> d) are constants. $\mu_{air} = 1$
Determine the X-coordinate of the point A, where the ray intersects the upper surface of slab - air boundary.

Q.65. A parallel beam of light consisting of two wavelengths 14000 A^0 and 26000 A^0 coherent in themselves falls on a double slit apparatus. The separation between the two slits is 2 cm and that of between plane of the slits and screen is 1 meter find out



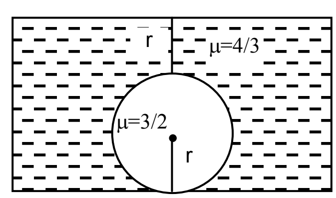
(a) The location of central maximas for both the wavelengths.
(b) The location of a point on the screen when the maxima's of two waves coincide for the first time after central maxima.
(c) The location where the minimas of the two waves coincide for the first time after central maxima.

Q.66. In a YDSE a source of wavelength 6000 A^0 issued the screen is placed 1m from the slits. Fringes formed on the screen are observed by a student sitting close to the slits. The student's eye can distinguish two night boring fringes if they subtend an angle more than minute arc. Find the maximum distance between the slits so that the fringes are clearly visible using this information also find the position of 3^{rd} bright and 5^{th} dark fringe from the centre of the screen.

Q.67. In a Young's experiment the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate, having the same thickness as the first one but having refractive index 1.7. Interference pattern is observed using light of wavelength 5400Å. It is found that the point P on the screen where the central maximum (n = 0) fell before the glass plates were inserted now has 3/4 the original intensity. It is further observed that what used to be the fourth maximum earlier, lies below the point P while the fifth minimum lies above P. Calculate the thickness of the glass plate. (Absorption of light by glass plate may be neglected).

Q.68. Two convex lenses of focal length 20 cm each are placed coaxially with a separation of 60 cm between them. Find the image of a distant object formed by the combination by
(a) Using thin lens formula separately for the two lenses and
(b) Using the equivalent lens. Note that although the combination forms a real image of a distant object on the other side, it is equivalent to a diverging lens as far as the location of the final image is concerned.

Q.69. A glass sphere having refractive index (3/2) is having a small irregularity at its centre. It is placed in a liquid of refractive index $\frac{4}{3}$ such that surface of liquid is r high above sphere where r is radius of sphere. If irregularity is viewed from above normally, calculate distance from centre where eye will observe the irregularity.

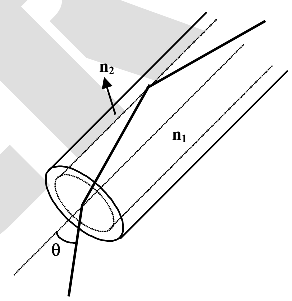


Q.70. An x-rays tube with a copper target is found to be emitting lines other than those due to copper. The k_α line of copper is known to have a wavelength 1.5405 A^0 and the other two k_α lines observed have wavelengths 0.7092 A^0 and 1.6578^{0}A. Identify the impurities.

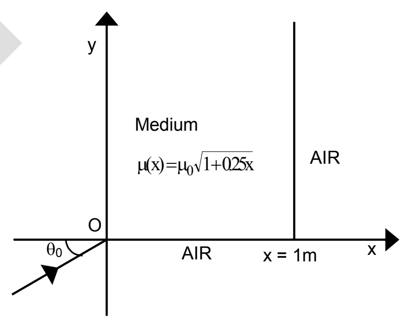
Q.71. Fringes are produced using light of wavelength λ = 4800 A^0 in a double-slit experiment. One of the slits is covered by a thin plate of glass of refractive index 1.4 and other slit by another plate of glass of double the thickness and of refractive index 1.7. During this process, the central bright fringe shifts to a position originally occupied by the fifth bright fringe from the centre. Find the thickness of each glass plate.

Q.72. A double convex lens forms a real image of an object on a screen which is fixed. Now the lens is given a constant velocity v = $1ms^{-1}$ along its axis and away from the screen. For the purpose of forming the image always on the screen, the object is also required to be given an appropriate velocity. Find the velocity of the object at the instant its size is double the size of the image.

Q.73. An optical fiber consists of a glass core (index of refraction n_1) surrounded by a coating (index of refraction $n_2 < n_1$). Suppose a beam of light enters with the fiber axis as shown in the figure.□the fiber from air at an angle □Show that the greatest possible value of = sin□□for which a ray can travel down the fiber core is given by $^{-1}\sqrt{n_1^2 - n_2^2}$.

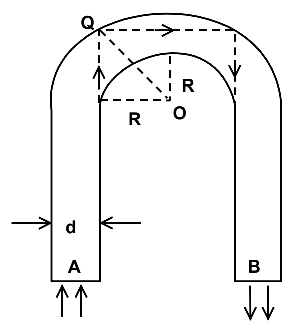


Q.74. A light ray enters into a medium whose refractive index varies along the x - axis as $\mu(x) = \mu_0\sqrt{1+0.25x}$ where μ_0 = 1. The medium is bounded by the planes x = 0, x = 1m and y = 0. The ray enters at the origin at an angle $\theta_0 = 30°$ with the horizontal.
(a) Determine the trajectory of the light ray.
(b) Find the position at which it comes out of the medium.



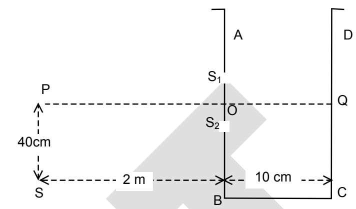
$$y = 2\left[\sqrt{3+1} - \sqrt{3}\right] = 0.54m$$

Q.75. A rod made of glass (μ = 1.5) and of square cross-section is bent into the shape shown in the figure. A parallel beam of light falls perpendicularly on the plane flat surface A. Referring to the diagram, d is the width of a side and R the radius of inner semi-circle. Find the maximum value of d/R so that all light entering the glass through surface A emerge from the glass through B.

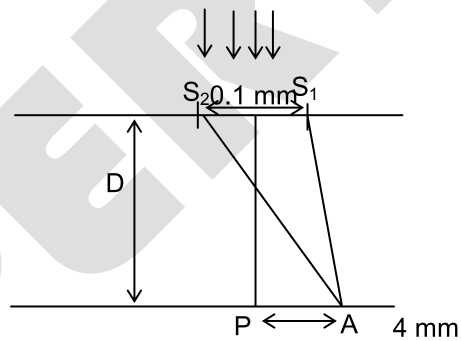


Q.76. Two thin similar convex glass pieces are joined together, front to front, with its rear portion slivered such that a sharp image is formed at 0.2m for an object at infinity. When the air between the glass pieces is replaced by water (μ = 4/3), find the position of image.

Q.77. A vessel ABCD of 10cm width has two small slits S_1 and S_2 2m from the vessel, to illuminate the slits as shown in the figure below. Calculate the position of the central bright fringe on the other wall CD with respect to the line OQ. Now, a liquid is poured into the vessel and filled up to OQ. The central bright fringe is found to be at Q. Calculate the refractive index of the liquid.

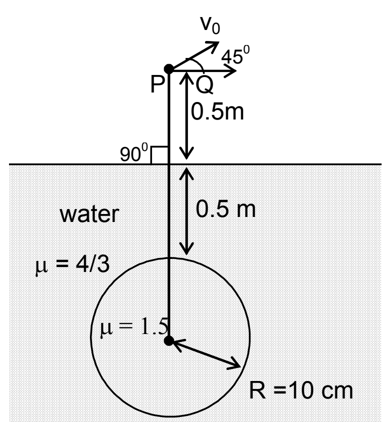


Q.78. Light of two different wavelengths 6000 A^0 and 8000 A^0 is incident on two identical slits, the slit separation being 0.2 mm. A screen is kept at a distance of 1m (see figure).



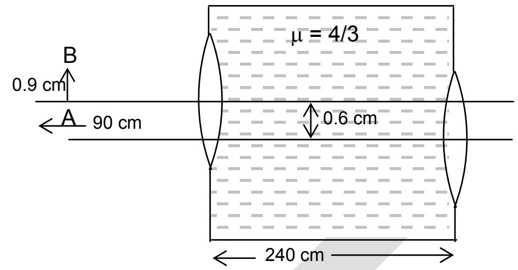
(a) Find the fringe width of the interference pattern formed on the screen due to each wavelength.
(b) Find the path difference and the corresponding phase difference for light of both wavelengths (6000 A^0 and 4000 A^0) arriving at a point A, which is at a distance of 5mm from the central point P.
(c) If the ratio of the intensities I_A (at the point A) and I_P (at the point P) is $I_A : I_P = 4 : 9$, find the ratio of the intensities of the light of 6000 A^0 to that of 8000 A^0 incident on the slits.

Q.79. A small object PQ (of size = 3cm) moves with a velocity v_0 ($v_0 = 5\sqrt{2}$ m/s) as shown in the figure, above a tank containing water (μ = 4/3) in which a partially reflecting glass sphere (μ = 1.5) is immersed.



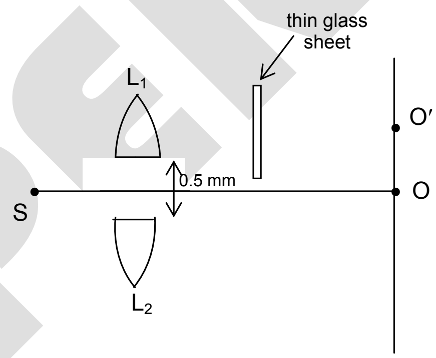
(a) Find the position, size and the velocity of the image after the first refraction on the surface of water.
(b) Find the position and size of the image formed by reflection of the incident rays on the glass sphere.
(c) Lastly, find the position and size of the image formed by single refraction of the incident rays on the glass sphere.

Q.80. Two thin equi convex lenses of glass of refractive index $\mu = \frac{3}{2}$ and of focal length 0.3 m in air each are sealed into separate openings at opposite faces of a tank filled will water $\left(\mu = \frac{4}{3}\right)$ as shown in the figure. The separation between the two lenses is 240 cm whereas the principal axes of both the lenses are shifted by 0.6 cm.



If an object AB of height 0.9 cm is placed outside the tank and 90 cm away from one lens along its axis, then find,
(a) the position of the final image
(b) the lengths of the final image above and below the axis of the second lens.

Q.81. A thin equi convex lens of focal length 10 cm is cut into two identical halves L_1 and L_2 by a plane passing through it's principal axis. The two halves are placed symmetrically about the central axis SO with a gap of 0.5 mm. A monochromatic point source 'S' which emits light of wavelength $\lambda = 600$ nm is placed on the central axis such that its distance from L_1 and L_2 along the axis is 15 cm. A screen perpendicular to SO is placed 180 cm away from L_1 and L_2 to receive the interference pattern. A thin transparent glass sheet ($\mu = 1.5$) is inserted between L_1 and the screen at a distance slightly greater than 30 cm.The central bright fringe is found on the screen at a point O′ 5 mm above O. Find,



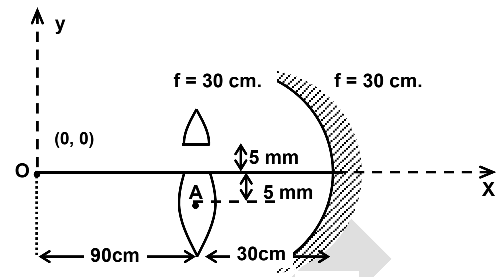
(a) The fringe width of the pattern
(b) The thickness of the glass sheet

Q.82. A Plano - convex lens has a thickness of 4 cm, when placed on a horizontal table, with the curved surface in contact with it, the apparent depth of the bottom most point of the lens is found to be 3 cm. If the lens is inverted such that the plane face is in contact with the table , the apparent depth of the centre of the plane face of the lens is found to be 25/8 cm. Find the focal length of the lens.

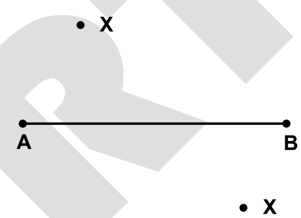
Q.83. Fringes are produced using light of wavelength $\lambda = 4800\ A^0$ in a double-slit experiment. One of the slits is covered by a thin plate of glass of refractive index 1.4 and other slit by another plate of glass of double the thickness and of refractive index 1.7.
During this process, the central bright fringe shifts to a position originally occupied by the fifth bright fringe from the centre. Find the thickness of each glass plate.

Q.84. A glass plate of refractive index 1.5 is coated with a thin layer of thickness t and refractive Index 1.8. Light of wavelength λ travelling in air is incident normally on the layer . It is partly reflected at the upper and the lower surfaces of the layer and the two reflected rays interfere. Write the condition for their constructively interference. If λ = 648 nm, obtain the least value of t for which the rays interfere constructively.

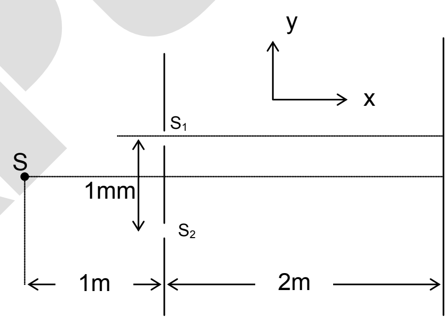
Q.85. A lens having focal length 30 cm. is cut along a plane parallel to the principal axis of the lens at a distance 5 mm above optical centre 'A' and upper part of lens is shifted by 5 mm from the x-axis as shown in the figure. A point object is placed on the principal axis of the mirror at origin O (0, 0). Find the number of images formed just after the reflection from the mirror and write their co-ordinates.



Q.86. An image Y is formed of point object X by a lens whose optic axis is AB as shown in the figure. Draw a ray diagram to locate the lens and its focus. If the image Y of the object X is formed by a concave mirror (having the same optic axis as AB) instead of lens, draw another ray diagram to locate the mirror and its focus.
Write down the steps of construction of the ray diagrams.

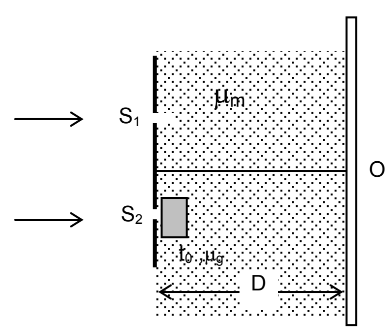


Q.87. In a Young's double slit experiment set-up, source S of wavelength 5000 A^0 illuminates two slits S_1 and S_2, which act as two coherent sources. The source S oscillates about its shown position according to the equation along y-axis, y = 0.5 sin πt, where y is in millimeters and t in seconds. Find



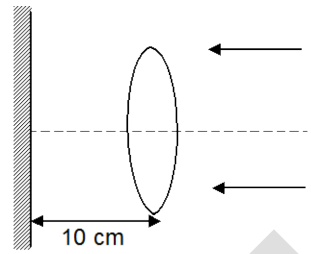
(a) Position of the central maxima as a function of time,
(b) minimum value of t for which the intensity at point P on the screen exactly in front of the upper slit becomes maximum.

Q.88. In a Young's double slit experiment the region between the slits and the screen is filled with a liquid whose concentration starts changing at t = 0 and because of that its refractive index also changes with time as $\mu_m = \frac{5}{2} - \frac{t}{4}$. The final value of refractive index is found to be $\frac{5}{4}$. The separation between the slits is d = 2 mm and between the slit and screen is D = 1m. The thickness of glass plate shown in the figure is 36 μm and its refractive index is 1.5.

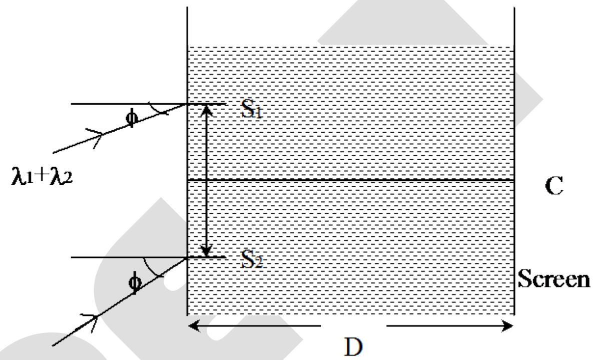


(a) Find the position of central maxima as a function of time and the time when it is at O.
(b) Find the speed of central maxima when it is at O.

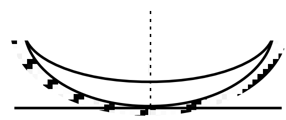
Q.89. A thin equiconvex lens of glass (μ = 1.5) having radius of curvature 30 cm is placed at a distance of 10 cm from a plane mirror which is placed with its plane perpendicular to the optic axis of the lens. Water (μ = 4/3) fills the place between the lens and the mirror. A parallel beam of light is incident on the lens as shown in the figure. Find the position of the final image with respect to the optical center of the lens.



Q.90. In a young's double slit experiment a parallel beam containing wavelengths λ_1 = 4000 A^0 and λ_2 = 5600 A^0 incident at an angle ϕ = 30^0 on a diaphram having narrow slits at a separation d = 2mm. The screen is place at a distance D = 40cm from slits. A mica slab of thickness t =5 mm is placed in front of one of the slits and whole the apparatus is submerged in water. If the central bright fringe is observed at C, calculate (a) the refractive index of the slab. (b) the distance of the first black line from C.



Q.91. The convex surface of a thin concavo-convex lens of refractive index μ = 1.5 has a radius of curvature 20 cm. The concavo surface has radius of curvature 60 cm. The convex side is silvered as shown in the figure.



(i) Where should a pin be placed on the optics axis such that its image is formed at the same place?

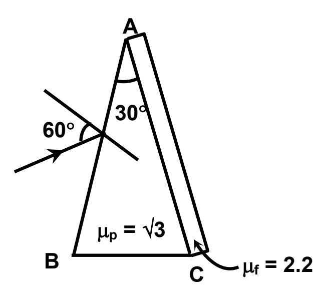
(ii) If the concave part is filled with water of refractive index $\frac{4}{3}$, find the distance through which the pin should be moved so that the image of the pin again coincides with the pin ?

Q.92. A Plano - convex lens has a thickness of 4 cm, when placed on a horizontal table, with the curved surface in contact with it, the apparent depth of the bottom most point of the lens is found to be 3 cm. If the lens is inverted such that the plane face is in contact with the table , the apparent depth of the centre of the plane face of the lens is found to be 25/8 cm. Find the focal length of the lens.

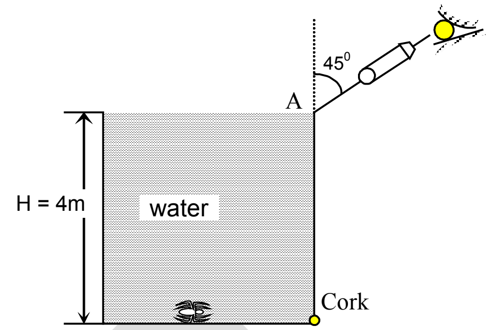
Q.93. Shown in the figure is a prism of an angle 30° and refractive index $\mu_p = \sqrt{3}$. Face AC of the prism is covered with a thin film of refractive index μ_f = 2.2. A monochromatic light of wavelength λ = 550 nm fall on the face AB at an angle of incidence of 60°. Calculate

(a) Angle of emergence.

(b) Minimum value of thickness t so that intensity of emergent ray is maximum.



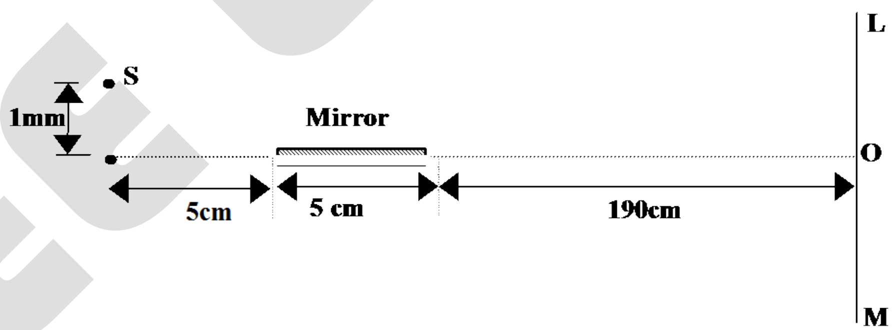
Q.94. A fixed cylinder tank of height H = 4m and radius R = 3m is filled up with a liquid. An observer observes through a telescope fitted at the top of the wall of the tank and inclined at $\theta = 45^0$ with the vertical. When the tank is completely filled with liquid, he notice an insect, which is at the centre of the bottom of the tank. At t = 0, he opens a cork of radius r = 3cm at the bottom of tank. The insect moves in such a way that it is visible for a certain time t. Determine
(a) The refractive index of the liquid.
(b) The velocity of insect as a function of time.



Q.95. A point object is moving with velocity 0.01 m/s on principal axis towards a convex lens of focal length 0.3 m. When object is at a distance of 0.4 m from the lens, find
(a) rate of change of position of the image, and
(b) rate of change of lateral magnification of image.

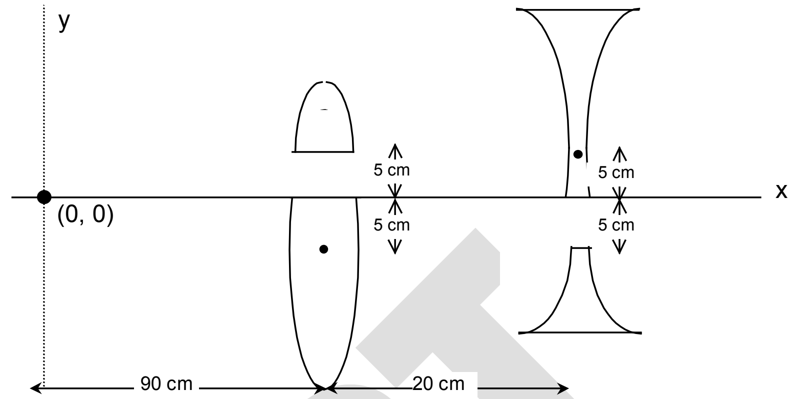
Q.96. An thin equi-biconvex lens of refractive index 3/2 is placed on a horizontal plane mirror as shown in the figure. The space between the lens and the mirror is then filled with water of refractive index 4/3. It is found that when a point object is placed 15cm above the lens on its principle axis, the object coincides with its own image. On repeating with another liquid, the object and the image again coincide at a distance 25 cm from the lens. Calculate the refractive index of the liquid.

Q.97. The arrangement of the Lloyd's mirror experiment is shown in the figure. 'S' is a point source of frequency 6×10^{14} Hz. A and B represent the two ends of a mirror placed horizontally, and LOM represents the screen.



Determine the position of the region where the fringes will be visible and calculate the number of fringes.

Q.98. A convex lens is divided into two parts at a distance 5 cm from the centre and the two parts are placed at a separation of 5 cm as shown. A concave lens is also divided into two parts but in the opposite sense that of convex lens. The focal lengths of convex and concave lenses are 30 cm and -50 cm respectively. Find the co-ordinate(s) of real images when an object is placed at a distance of 90 cm from convex lens plane.

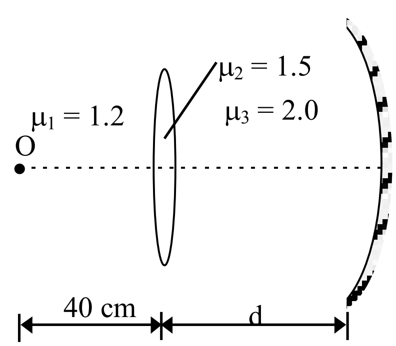


Q.99. An equi convex lens μ = 1.5 with radii 4 cm is located at a distance of 4 cm from an equiconvex lens of μ = 1.6 with radii 8 cm. The lenses are thin and medium between them is water of μ = 4/3, while both sides of lenses the medium is air. Find the equivalent focal length of the system.

Q.100. Two thin similar convex glass pieces are joined together front to front, with rear portion silvered and combination of glass pieces is placed at a distance a = 60 cm from a screen. A small object is placed on optical axis of the combination such that its m=2 times the magnified image formed on the screen. If the air between the glass pieces is replaced by water (μ = 4/3), calculate the distance through which the object must be displaced so that a sharp image is again formed on the screen.

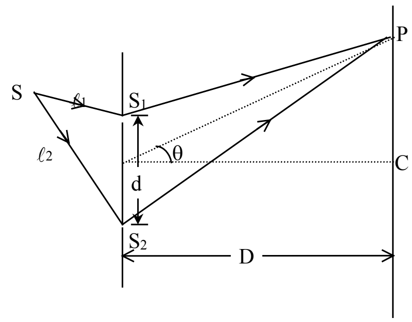
Q.101. In a Young's experiment the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate, having the same thickness as the first one but having refractive index 1.7. Interference pattern is observed using light of wavelength 5400Å. It is found that the point P on the screen where the central maximum (n = 0) fell before the glass plates were inserted now has 3/4 the original intensity. It is further observed that what used to be the fourth maximum earlier, lies below the point P while the fifth minimum lies above P. Calculate the thickness of the glass plate. (Absorption of light by glass plate may be neglected.

Q.102. The figure shows an arrangement of a convex lens and a concave mirror. A point object O is placed on the principal axis at a distance 40 cm from the lens such that the final image is also formed at the position of the object. If the radius of curvature of the concave mirror is 80 cm, find the distance d. Also draw the ray diagram. The focal length of the lens in air is 20 cm.



Q.103. In a Young's experiment the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate, having the same thickness as the first one but having refractive index 1.7. Interference pattern is observed using light of wavelength 5400Å. It is found that the point P on the screen where the central maximum (n = 0) fell before the glass plates were inserted now has 3/4 the original intensity. It is further observed that what used to be the fourth maximum earlier, lies below the point P while the fifth minimum lies above P. Calculate the thickness of the glass plate. (Absorption of light by glass plate may be neglected).

Q.104. In a young experiment the light source is at distance ℓ_1 = 20 μm and ℓ_2 = 40 μm from the slits. The light of wavelength λ = 500 nm incident on slits separated at a distance 10 μm. A screen is placed at a distance D = 2m away from the slits as shown in figure. Find
(a) the angular positions relative to the central line do maxima appear on the screen ?
(b) How many maxima will appear on the screen?
(c) What should be minimum thickness of a slab of refractive index 1.5 be placed on the path of one of the ray so that minima occur at C ?



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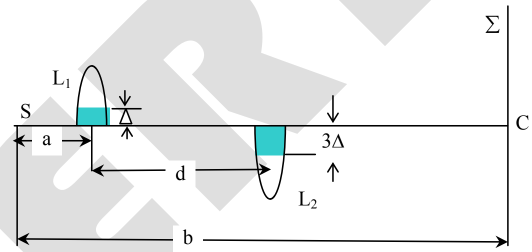
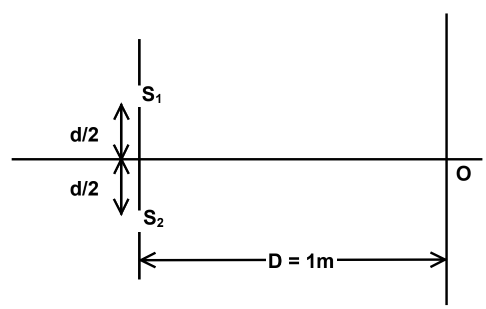


Question - 105

Q.105. In the figure S is a monochromatic point source emitting light of wavelength λ = 500 nm is placed at a distance b = 2m from a screen Σ. A thin lens of focal length f = 16 cm is cut into two identical half. They are placed at a distance 20 cm and 80 cm from S. The part L_1 is shifted Δ = 0.40 mm while L_2 is shifted 3Δ transverse to the line SC. The gaps between the line SC and the lens parts are filled by an opaque material as shown in figure. Calculate
(i) where the image of S will form.
(ii) the refractive index μ of a transparent sheet of thickness t = 1 mm to be placed in path of rays emerging from one of the parts so that a bright spot is formed at point C.

Q.106. In a double slit experiment the separation between the slits is 1mm. Light rays fall normally on the plane of the slits and the interference pattern is observed on a screen placed at a distance of 1m from the plane of the slits. The arrangement is shown in the figure. When one of the slits is covered by a transparent strip of thickness 4μm, the central maximum is formed at a distance of 2mm from the point O. When the entire apparatus (one of the slits remaining covered) is immersed in a liquid, the distance between the central maximum and the point O is reduced to 0.5mm.



(a) Find the refractive index of the material of the strip and the liquid.
(b) If the wavelength of light used is 500nm and the experiment is performed in the liquid find distance of the nearest maximum from the point O.

Q.107. In a Young's experiment the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate, having the same thickness as the first one but having refractive index 1.7. Interference pattern is observed using light of wavelength 5400Å. It is found that the point P on the screen where the central maximum (n = 0) fell before the glass plates were inserted now has 3/4 the original intensity. It is further observed that what used to be the fourth maximum earlier, lies below the point P while the fifth minimum lies above P. Calculate the thickness of the glass plate. (Absorption of light by glass plate may be neglected.