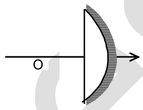
8. Assignment (Subjective Problems)

LEVEL – I

1. A thin converging lens forms a magnified image (magnification :p) of an object. The magnification factor becomes q when the lens is moved a distance 'a' towards the object. Find the focal length of the lens.

2. A parallel beam of light is incident normally onto a solid glass sphere of radius R (μ = 1.5). Find the distance of the image from the outer edge of the glass sphere.

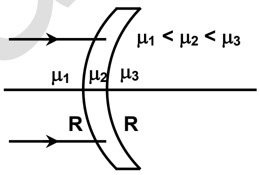
3. A point object is placed in front of a silvered plano-convex lens of refractive index n, radius of curvature R, so that its image is formed on itself. Calculate the object distance.



4. A convex lens focuses a distant object on a screen placed 10 cm away from it. A glass plate (n = 1.5) of thickness 1.5 is inserted between the lens and the screen. Where should the object be placed so that its image is again focused on the screen?

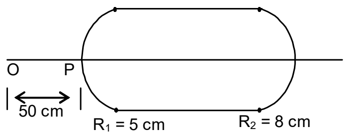
5. A parallel beam of light tavelling in water (refractive index = 4/3) is refracted by a spherical air bubble of radius 2 mm situated in water. Assuming the light rays to be paraxial (i) find the position of image due to refraction at first surface and position of final image. (ii) draw a ray diagram showing the position of both images.

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



7. A converging lens which has a focal length of 20 cm is placed 60 cm to the left of a concave mirror of focal length 30 cm. An object is placed 40 cm to the left of lens. Find the position, nature and magnification of the final image.

8. A cylindrical glass rod has its two coaxial ends of spherical form bulging outward. The front end has a radius of curvature 5 cm and the back end which is silvered has a radius of curvature 8 cm. The thickness of the rod along the axis is 10 cm. Calculate the position of the image of a point object at the axis 50 cm from front face ($_an_g$ = 1.5)



9. A thin bi-convex lens of refractive index 3/2 and radius of curvature 50cm is placed on a reflecting convex surface of radius of curvature 100cm. A point object is placed on the principal axis of the system such that its final image coincides with itself. Now few drops of a transparent liquid is placed between the mirror and lens such that final image of the object is at infinity. Find refractive index of the liquid used. And also find position of the object.

10. An object of height 2.5 cm is placed at a 1.5 f from a concave mirror where f is the magnitude of the focal length of the mirror. The object is placed perpendicular to the principal axis. Find the height of the image. Is the image erect or inverted ?

11. In Young's double slit experiment the fringe width obtained is 0.6 cm, when light of wavelength 4800 A^0 is used. If the distance between the screen and the slit is reduced to half, what should be the wavelength of light used to obtain fringes 0.0045-m width?

12. In a Young's double slit experiment, the slits are 1.5 mm apart. When the slits are illuminated by a monochromatic light source and the screen is kept 1 m apart from the slits, width of 10 fringes is measured as 3.93 mm. Calculate the wavelength of light used. What

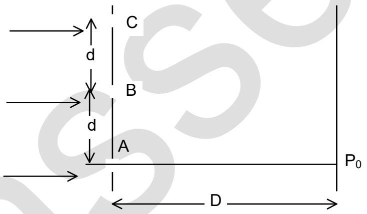
will be the width of 10 fringes when the distance between the slits and the screen is increased by 0.5 m. The source of light used remains the same.

13. A beam of light consisting of two wavelengths 6500A°and 5200A° is used to obtain interference fringes in a Young's double slit experiment. Find the distance of the third fringe on the screen from the central maximum for the wavelength 6500A°.

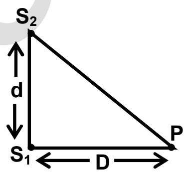
14. In a two-slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} m. If the distance between the slits is 10^{-3} m, calculate the wave length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

15. At a certain point on a screen the path difference for the two interfering rays is $(1/8)^{th}$ of a wavelength. Find the ratio of the intensity at this point to that at the centre of a bright fringe.

16. Figure shows three equidistant slits being illuminated by a monochromatic parallel beam of light. Let $BP_0 - AP_0 = \lambda/3$ and $D >> \lambda$.
(a) Show that in this case $d = \sqrt{2\lambda D/3}$.
(b) Show that the intensity at P_0 is three times the intensity due to any of the three slits individually.



17. Two sources S_1 and S_2 emitting light of wave lengths 600 nm are placed at a distance of 1.0×10^{-2} cm. A detector can be moved on the line S_1P which is perpendicular to S_1S_2. Find out the position of first minimum detected.



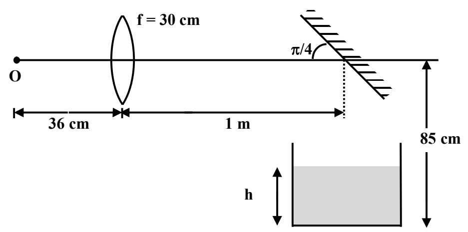
18. White light may be considered to have λ from 4000 A^0 to7500 A^0. If an oil film has thickness 10^{-6} m, deduce the wavelengths in the visible region for which the reflection among the normal direction will be (i) weak, (ii) strong. Take μ of the oil as 1.40.

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

20. A monochromatic light of λ = 5000 A^0 is incident on two identical slits separated by a distance of 5×10^{-4} m. The interference pattern is seen on a screen placed at a distance of 1m from the plane of slits. A thin glass plate of thickness 1.5×10^{-6} m and refractive index μ = 1.5 is placed between one of the slits and screen. Find the intensity at the centre of the screen if the intensity there is I_0 in the absence of the plate. Also find the lateral shift of the central maxima.

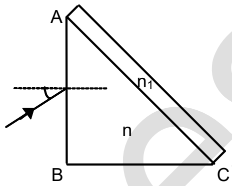
LEVEL – II

1. The image of the object O, shown in the figure is formed at the bottom of the tank filled with water. Using the values given in the figure, calculate the value of h, i.e. the water level in the tank.



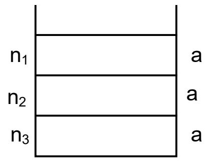
2. (a) The refracting angle of a prism is equal to $\pi/2$. It is given that γ is the angle of minimum deviation and β is the deviation of the ray at grazing incidence. Prove that $\sin\gamma = \sin^2\beta$ and $\cos\gamma = \mu\cos\beta$
(b) A ray of light passes through a prism, deviation equal to the angle of incidence which, again, is equal to 2α. It is given that α is the angle of prism. Show that $\cos^2\alpha = \dfrac{1}{8\left(\mu^2-1\right)}$, where μ is the refractive index of the material of prism.

3. A right angled prism (45^o - 90^o - 45^o) of refractive index n has a plate of refractive index n_1 ($n_1 < n$) cemented to its diagonal face. The assembly is in air. A ray is incident on AB.
(i) Calculate the angle of incidence at AB for which the ray strikes the diagonal face at the critical angle.
(ii) Assuming n = 1.352, calculate the angle of incidence at AB for which the refracted ray passes through the diagonal face undeviated.

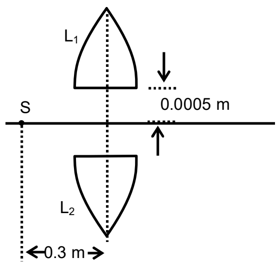


4. Three thin equi-convex lenses each of focal length 'f' are separated by distance 'f' apart. A point object is placed at a distance of 3f in front of the first lens. Find the position of the final image.

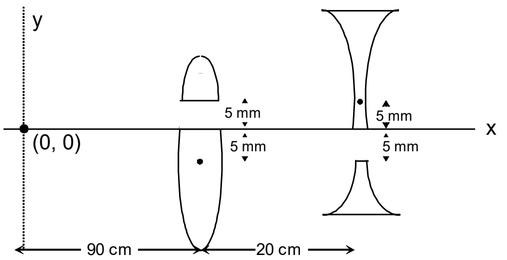
5. A cylindrical vessel of radius R and height 3a is completely filled with three different immiscible liquids each of height a and having refractive indices n_1, n_2 and n_3 (where $n_1>n_2>n_3)>1$. A point object is placed at the centre of the bottom of the vessel. The rays just suffer total internal reflection at the edge of the vessel's mouth. Find the radius of curvature of the vessel.



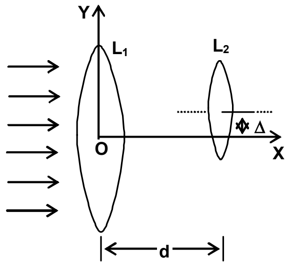
6. A point object is placed at a distance of 0.3 m from a convex lens (focal length 0.2 m) cut into two halves each of which is displaced by 5 $\times$ 10^{-4}m as shown in the figure. Find the position of the image. If more than one image is formed, find their number and the distance between them.



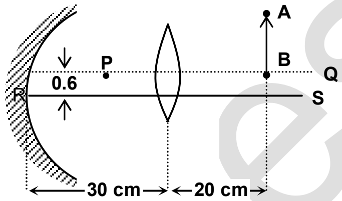
7. A convex lens is divided into two parts at a distance 5 mm from the centre and the two parts are placed at a separation of 5 mm as shown. A concave lens is also divided into two parts but in the opposite sense that of convex lens. The focal lengths of convex and concave lenses are 30 cm and -50 cm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



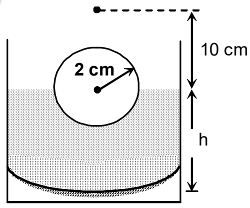
8. Two thin convex lenses of focal lengths f_1 and f_2 are separated by a horizontal distance d (where $d < f_1$, $d < f_2$) and their centres are displaced by a vertical separation Δ as shown in figure. Taking the origin of coordinates O, as the centre of first lens, what would be the x and y coordinates of the focal point of this lens system, for a parallel beam of rays coming from the left ?



9. 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 the 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.

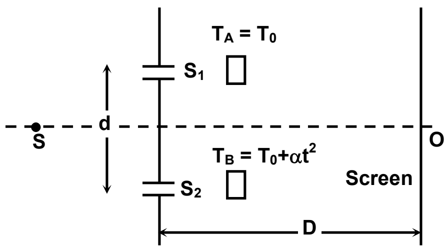


10. A transparent solid sphere of radius 2 cm and density ρ floats in a transparent liquid of density 2ρ kept in a beaker. The bottom of the beaker is spherical in shape with its radius of curvature 8 cm and is silvered to make it a concave mirror as shown in the figure. When an object is placed at a distance of 10 cm directly above the centre of the sphere its final image coincides with it. Find h (as shown in the figure), the height of the liquid surface in the beaker from the apex of the bottom. Consider paraxial rays only. The refractive index of the sphere is (3/2) and that of the liquid is (4/3).

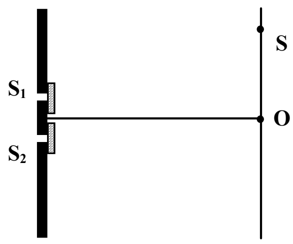


11. Sodium light has two wavelengths λ_1 = 589 nm and λ_2 = 589.6 nm. As the path difference increases, when is the visibility of the fringes minimum ?

12. In Young's double slit experimental setup as shown in the figure, the two glass plates A and B each of thickness $T_A = T_0$ and $T_B = T_0 + \alpha t^2$ (where α is constant, t is time in sec) are placed in the paths of rays of light coming from S_1 and S_2. Find out the minimum time after which the central maxima position O will again appear bright in the presence of light of wavelength λ. [Take μ = refractive index of glass]

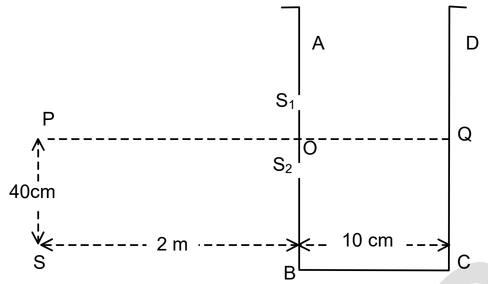


13. Two transparent slabs having equal thickness 0.45 mm and refractive indices 1.40 & 1.42 are pasted on the two slits of a double slit aparatus. The separation of slits equals 1 mm. Wavelength of light used equals 600 nm. The screen S is placed at a distance 1 m from the plane of the slits. Find the position(s) of first



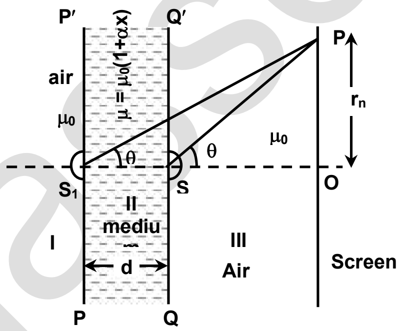
maxima from the centre ‘O’ of the screen.

14. A vessel ABCD of 10cm width has two small slits S_1 and S_2 sealed with identical glass plates of equal thickness. The distance between the slits is 0.8 mm. POQ is the line perpendicular to the plane AB and passing through O, the middle point of S_1 and S_2. A monochromatic light source is kept at S, 40cm below P and 2m from the vessel, to illuminate the slits as shown in the figure below.

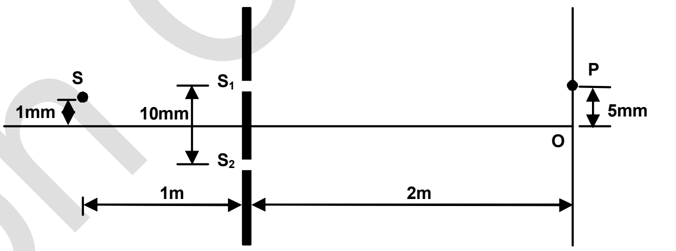


Calculate the position of the central bright fringe on the other wall CD with respect to the line OQ. Now, a liquid is poured into the vessel and filled up to OQ. The central bright fringe is found to be at Q. Calculate the refractive index of the liquid.

15. Consider the situation of the interference experiment set up as shown in the figure. The S_1S_2 part of the set up is put in a medium whose refractive index varies as $\mu = \mu_0(1 + \alpha x)$ where x is the displacement from the line PP′. [Take (D>>d, D>>r) and α =constant].
(a) Find the nature of fringes obtained on the screen.
(b) Find the distance of nth bright fringe from the central fringe on the screen. [take θ to be small]. Taking μ_0 as refractive index in medium I and III and also of S_1 and S_2 sources.

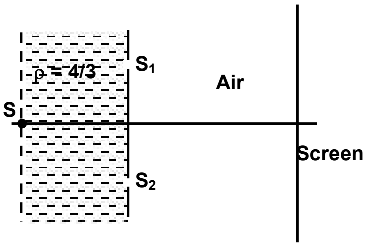


16. In the Young’s Double Slit experiment the point source is placed slightly off the central axis as shown in the figure.
(a) Find the nature and order of the interference at the point P.
(b) Find the nature and order of the interference at O.
(c) Where should we place a film of refractive index μ = 1.5 and what should be its thickness so that a maxima of zero order is placed at O?



17. In a modified Young’s double-slit experiment, a monochromatic, uniform and parallel beam of light of wavelength 6000 Å 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 perfect transparent film of thickness 2000 Å and refractive index 1.5 for the wavelength of 6000 Å is placed in front of aperture A (figure). Calculate the power (in watt) received at the focal spot F of the lens. The lens is symmetrically placed with respect to the apertures. Assume that 10% of the power received by each aperture goes in the original direction and is brought to the focal spot.

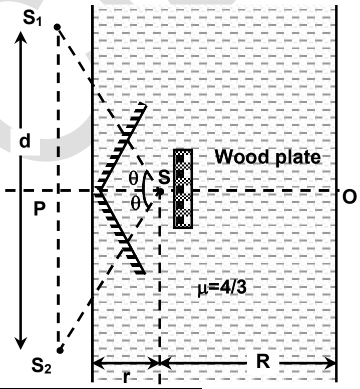
18. In the Young's double slit experiment the space between the light source and the two slits is filled with a liquid of refractive index 4/3. Whereas the medium between the slits and screen is air. Find the position of the first bright fringe from the central maxima?
D = 2 m and d = 0.25 mm and λ_{medium} = 5000A°.



19. The Young's double slit experiment is done in a medium of refractive index 4/3. A light of 600 nm wavelength is falling on the slits having 0.45 mm separation. The lower slit S_2 is covered by a thin glass sheet of thickness 10.4 μm and refractive index 1.5. the interference pattern is observed on a screen placed 1.5 m from the slits as shown in figure.

(a) Find the location of the central maximum (bright fringe with zero path difference) on the y-axis.
(b) Find the light intensity at point O relative to the maximum fringe intensity.
(c) Now, if 600 nm light is replaced by white light of range 400 to 700 nm, find the wavelengths of the light that from maxima exactly at point O.
[All wavelengths in this problem are for the given medium of refractive index 4/3. Ignore dispersion.]

20. Two plane mirrors, a source of light S (emitting monochromatic light of wavelength λ) and screen are placed as shown in the figure. Now whole of the setup is kept in a liquid of medium μ = 4/3. If the angle θ is very small, find out the position of third minima on the screen in terms of λ, r, R and θ.

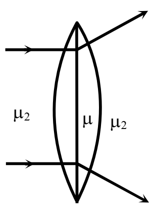


9. Assignment (Objective Problems)

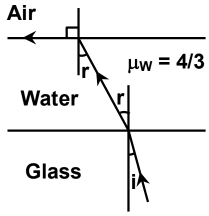
LEVEL – I

1. If the behavior of light rays through a convex lens is as shown in the adjoining figure, then;

(A) $\mu = \mu_2$ (B) $\mu < \mu_2$
(C) $\mu > \mu_2$ (D) $\mu \le \mu_2$



2. A ray of light is incident at the glass-water interface at an angle i, it emerges finally parallel to the surface of water, then the value of μ_g would be
(A) (4/3)sin(i)
(B) [1/sin(i)]
(C) 4/3
(D) 1



3. A converging lens is used to form an image on a screen. When the upper half of the lens is covered by an opaque screen :
(A) half of the image will disappear
(B) image will not form on the screen.
(C) intensity of image will increase
(D) intensity of image will decrease

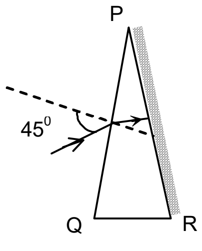
4. A spherical convex surface separates object and image space of refractive index 1 and 4/3 respectively. If radius of curvature of the surface is 0.1 m, its power is :
(A) 2.5 D
(B) –2.5 D
(C) 3.3 D
(D) –3.3 D

5. A ray of light passes through an equilateral prism such that the angle of incidence is equal to the angle of emergence and latter is equal to 3/4th the angle of prism. The angle of deviation is :
(A) 45°
(B) 39°
(C) 20°
(D) 30°

6. A liquid is placed in a hollow prism of angle 60°. If angle of the minimum deviation is 30°, what is the refractive index of the liquid?
(A) 1.41
(B) 1.50
(C) 1.65
(D) 1.95

7. A prism can produce a minimum deviation δ in a light beam. If three such prisms are combined, the minimum deviation that can be produced in this beam is:
(A) 0
(B) δ
(C) 2δ
(D) 3δ

8. The face PR of a prism QPR of angle 30° is silvered. A ray is incident on face PQ at an angle of 45° as shown in figure. The refracted ray undergoes reflection on face PR and retraces its path. The refractive index of the prism is :
(A) $\sqrt{2}$
(B) $3/\sqrt{2}$
(C) 1.5
(D) 1.33



9. A particle moves towards a concave mirror of focal length 30 cm along its axis and with a constant speed of 4 cm/ sec. What is the speed of its image when the particle is at 90 cm from the mirror?
(A) 2 cm/ sec.
(B) 8 cm/sec.
(C) 1 cm/sec.
(D) 4 cm/sec.

10. A thin prism of glass is placed in air and water successively. If ${}_a\mu_g$ = 3/2 and ${}_a\mu_w$ = 4/3, then the ratio of deviations produced by the prism for a small angle of incidence when placed in air and water is :
(A) 9 : 8
(B) 4 : 3
(C) 3 : 4
(D) 4 : 1

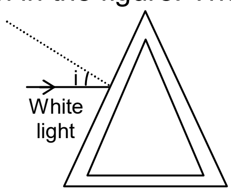
11. A thin prism P_1 with angle 4^o and made from glass of refractive index 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 to produce dispersion without deviation. The angle of the prism P_2 is :
(A) 5.33^o (B) 4^o
(C) 3^o (D) 2.6^o

12. Focal lengths of two lenses are f and f' and dispersive powers of their materials are ω and ω'. To form achromatic combination from these, which relation is correct?
(A) $\omega = \omega_0$, $\omega' = 2\omega_0$, f' = 2f (B) $\omega = \omega_0$, $\omega' = 2\omega_0$, f' = –2f
(C) $\omega = \omega_0$, $\omega' = 2\omega_0$, f' =f/2 (D) $\omega = \omega_0$, $\omega' = 2\omega_0$, f' = –f/2.

13. A lens of refractive index μ is put in a liquid of refractive index μ'. If the focal length of the lens in air is f, its focal length in liquid will be
(A) $\frac{-f\mu'(\mu-1)}{\mu'-\mu}$ (B) $\frac{f(\mu'-\mu)}{\mu'(\mu-1)}$
(C) $\frac{\mu'(\mu-1)}{f(\mu'-\mu)}$ (D) $\frac{f\mu'\mu}{(\mu-\mu')}$

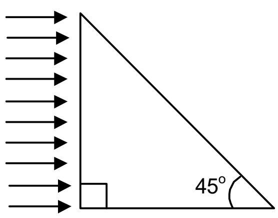
14. A convex lens, a glass slab, a glass prism and a spherical solid ball have been prepared from the same optically transparent material. Dispersive power will be possessed by:
(A) the prism only (B) the convex lens and the prism
(C) all except glass slab. (D) all the four

15. A beam of white light is incident on a hollow prism of glass as shown in the figure. Then



(A) The light emerging from prism gives no spectrum
(B) The light emerging from prism gives spectrum but the bending of all colours is away from base.
(C) The light emerging from prism gives spectrum, all the colours bend towards base, the violet most and red the least.
(D) The light emerging from prism gives spectrum, all the colours bend towards base, the violet the least and red the most.

16. A beam of light consisting of red, green and blue colours is incident on a right-angled prism. The refractive indices of the material of prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The prism will:

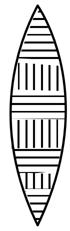


(A) separate part of the red colour from the green and blue colours
(B) separate part of the blue colour from the red and green colours
(C) separate all the three colours from one another
(D) not separate even partially any colour from the other two colours.

17. A convex lens A of focal length 20 cm and a concave lens B of focal length 5 cm are kept along the same axis with a distance d between them. If a parallel beam of light falling on A leaves B as a parallel beam, then the distance d in cm will be:
(A) 25 (B) 15
(C) 10 (D) 30

18. When the distance between the object and the screen is more than 4f, we can obtain the image of the object on the screen for the two different positions of a convex lens of focal length f. If I_1 and I_2 be the sizes of the two images, then the size of the object is:
(A) $(I_1 + I_2)/2$ (B) $I_1 - I_2$
(C) $\sqrt{(I_1 I_2)}$ (D) $\sqrt{(I_1/I_2)}$

19. A layered lens as shown in the figure is made of two types of transparent materials indicated by different shades. A point object is placed on its axis. The object will form:



(A) 1 image (B) 2 images
(C) 3 images (D) 7 images

20. In the displacement method, a convex lens is placed in between an object and a screen. If the magnification in the two positions be m_1 and m_2 and the displacement of the lens between the two positions is X, then the focal length of the lens is :
(A) $X/(m_1 \times m_2)$ (B) $X/|m_1 - m_2|$
(C) $X/|m_1 + m_2|$ (D) $X/(m_1 - m_2)^2$

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

22. In Young's double slit experiment, the fringe width is β. If the entire arrangement is now placed inside a liquid of refractive index μ, the fringe width will become
(A) $\mu\beta$ (B) β/μ
(C) $\frac{\beta}{\mu+1}$ (D) $\frac{\beta}{\mu-1}$

23. In a Young's double slit experiment, let S_1 and S_2 be the two slits, and C be the centre of the screen. If $\angle S_1CS_2=\theta$ and λ is the wavelength, the fringe width will be
(A) $\frac{\lambda}{\theta}$ (B) $\lambda\,\theta$
(C) $2\lambda/\theta$ (D) $\lambda/2\theta$

24. The speed of light in air is 3×10^8 m/s. If the refractive index of glass is 1.5, find the time taken by light to travel a distance 50 cm in glass.
(A) 2.5×10^{-9} sec. (B) 0.5×10^{-9} sec.
(C) 0.16×10^{-9} sec. (D) 3×10^{-9} sec.

25. In the Young's double slit experiment, films of thickness t_A and t_B and refractive indices μ_A and μ_B are placed in front of A and B respectively. If $\mu_A t_A = \mu_B t_B$, the central maximum will
(A) not shift
(B) shift towards A
(C) shift towards B
(D) option (B), if $t_B > t_A$ and option (C) if $t_B < t_A$

26. In the Young's double slit experiment both the slits are similar. If the length of one of the slits is halved, which of the following is true?

(A) Bright fringes becomes narrower. (B) Bright fringes become wider.
(C) Dark fringes become darker. (D) Dark fringes become brighter.

27. Waves from two different sources overlap near a particular point. The amplitude and the frequency of the two waves are same. The ratio of the intensity when the two waves arrive in phase to that when they arrive 90^0 out phase is

(A) 1 : 1
(B) $\sqrt{2}$: 1
(C) 2 : 1
(D) 4 : 1

28. Instead of using two slits as in Young's experiment, if we use two separate but identical sodium lamps, which of the following occur ?

(A) general illumination
(B) widely separate interference
(C) very bright maximum
(D) very dark minimum

29. For best contrast between maxima and minima in the interference pattern of Young's double slit experiment, the intensity of light emerging out of the two slits should be

(A) equal
(B) double
(C) small
(D) large

30. The path difference between two interfering waves at a point on a screen is 11.5 times the wavelength. The point is

(A) dark
(B) bright
(C) neither dark nor bright
(D) data is inadequate

31. In an interference pattern produced by two identical slits, the intensity at the site of maxima is I. When one of the slit is closed, the intensity at the same spot is I_0. What is the relation between I and I_0

(A) $I = 2I_0$
(B) $I = 4I_0$
(C) $I = 16I_0$
(D) $I = I_0$

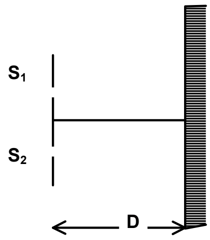
32. In a Young's double slit experiment, the position of first bright fringe coincides with S_1 and S_2 respectively on the either side of central maxima. What is the wavelength of the light used? [Take D = 1m and d = 1.2 mm]

(A) 3600A°
(B) 5400A°
(C) 7200A°
(D) none of these.

33. 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 centre of the screen
(D) distance between two consecutive bright fringes will not be equal to the distance between two consecurive dark fringes.

34. Two identical coherent sources of light S_1 and S_2 separated by a distance 'a' produce an interference pattern on the screen. The wave length of the monochromatic light emitted by the sources is λ. The maximum number of interference fringes that can be observed on the screen is nearly equal to



(A) $\frac{2a}{\lambda}+1$ (B) $\frac{a-\lambda}{\lambda}$

(C) $\frac{a+\lambda}{\lambda}$ (D) $\frac{\lambda}{a}+1$

35. In Young's double slit experiment, we get 60 fringes in the field of view of monochromatic light of wavelength 4000 A^0. If we use monochromatic light of wavelength 6000 A^0, then the number of fringes obtained in the same field of view is

(A) 60 (B) 90

(C) 40 (D) 1.5

36. In Young's double slit experiment, the 7^{th} maximum with wavelength λ_1 is at a distance d_1 and that with wavelength λ_2 is at a distance d_2 . Then d_1/d_2 is

(A) λ_1/λ_2 (B) λ_2 / λ_1

(C) λ_1^2/λ_2^2 (D) λ_2^2/λ_1^2

37. In a two slit experiment with white light, a white fringe is observed on a screen kept behind the slits. When the screen is moved away by 0.05 m, this white fringe

(A) does not move at all

(B) gets displaced from its earlier position

(C) becomes coloured

(D) disappears

38. A source emits electromagnetic waves of wavelength 3m. One beam reaches the observer directly and other after reflection from a water surface, travelling 1.5m extra distance and with intensity reduced to 1/4 as compared to intensity due to the direct beam alone. The resultant intensity will be

(A) (1/4) fold (B) (3/4) fold

(C) (5/4) fold (D) (9/4) fold

39. Ratio of intensities of two waves are given by 4 :1. Then the ratio of the amplitudes of the two waves is

(A) 2 :1 (B) 1 : 2

(C) 4 : 1 (D) 1 : 4

40. In the Young's experiment with sodium light, the slits are 0.589 m apart. What is the angular width of the fourth maximum ? Given that λ = 589 nm.

(A) $\sin^{-1} (3 \times 10^{-6})$ (B) $\sin^{-1} (3 \times 10^{-8})$

(C) $\sin^{-1} (0.33 \times 10^{-6})$ (D) $\sin^{-1} (0.33 \times 10^{-8})$

LEVEL – II

1. An image of a bright square is obtained on a screen with the aid of a convergent lens. The distance between the square and the lens is 40 cm. The area of the image is nine time larger than that of the square. Select the correct statement(s) :
(A) Image is formed at a distance 120 cm from lens.
(B) Image is formed at a distance 360 cm from lens.
(C) Focal length of lens is 30 cm.
(D) Focal length of lens is 36 cm.

2. In a prism of angle A and refractive index μ, the maximum deviation occurs when
(A) the angle of incidence is 90°
(B) the angle of incidence may be is $\sin^{-1}\left[\sqrt{\mu^2-1}\sin A-\cos A\right]$
(C) the angle of emergence is $\sin^{-1}\left[\left(\mu\sin\left(A-\theta_C\right)\right)\right]$
(D) the angle of emergence is equal to the angle of incidence

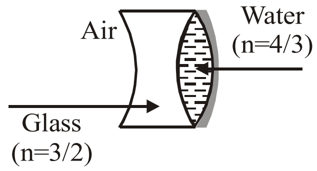
3. A lens of focal length 'f' is placed in between an object and screen at a distance 'D'. The lens forms two real images of object on the screen for two of its different positions, a distance 'x' apart. The two real images have magnifications m_1 and m_2 respectively ($m_1 > m_2$).
(A) $f=\frac{x}{m_1-m_2}$ (B) $m_1m_2 = 1$
(C) $f=\frac{D^2-x^2}{4D}$ (D) $D \geq 4f$.

4. 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 $\frac{\lambda}{2}$, where λ is the wavelength of light

5. A thin paper of thickness 0.02 mm having refractive index 1.45 is pasted across one of the slit in a Young's double slit experiment. The paper transmits 4/9 of light falling on it.
(λ_{light} = 600 nm).
(A) Amplitude of light wave transmitted through the paper will be 2/3 time of incident wave.
(B) The ratio of maximum and minimum intensity in the fringe pattern will be 25.
(C) The total number of fringe crossing the centre if an identical paper is pasted on the other slit is 15.
(D) The ratio of maximum and minimum intensity in the pattern will be 5.

6. For refraction through a small angled prism, the angle of minimum deviation :
(A) increases with the increases in R.I. of the prism
(B) will be 2D for a ray of R.I. 2.4, if it is D for a ray of R.I. 1.2
(C) is directly proportional to the angle of the prism
(D) will decrease with the increase in R.I. of the prism

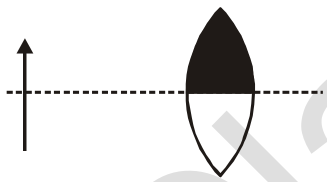
7. The radius of curvature of the left and right surface of the concave lens are 10 cm and 15 cm respectively. The radius of curvature of the mirror is 15 cm :



(A) equivalent focal length of the combination is – 18 cm
(B) equivalent focal length of the combination is + 36 cm
(C) the system behaves like a concave mirror
(D) the system behaves like a convex mirror

8. A point object is placed at 30 cm from a convex glass lens $\left(\mu_g = \frac{3}{2}\right)$ of focal length 20 cm. The final image of object will be formed at infinity if :
(A) another concave lens of focal length 60 cm is placed in contact with the previous lens
(B) another convex lens of focal length 60 cm is placed at a distance of 30 cm from the first lens
(C) the whole system is immersed in a liquid of refractive index 4/3
(D) the whole system is immersed in a liquid of refractive index 9/8

9. The upper portion of lens is painted black in situation as shown in figure. Which of the following statement(s) is/are correct :

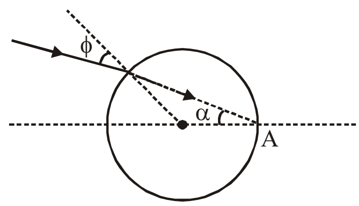


(A) the intensity of image will reduce by a factor of 2
(B) the distribution of brightness of image will not be symmetric
(C) the lower half of image will be brighter than upper half
(D) the upper half of image will be brighter than lower half

10. In a Young's double-slit interference experiment the fringe pattern is observed on a screen placed at a distance D. The slits are separated by d and are illuminated by light of wavelength λ. The distance from the central point where the intensity falls to half the maximum is :
(A) $\frac{\lambda D}{3d}$ (B) $\frac{\lambda D}{2d}$
(C) $\frac{\lambda D}{d}$ (D) $\frac{\lambda D}{4d}$

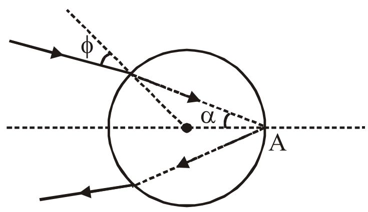
COMPREHENSION

I. A ray of light enters a spherical drop of water of refractive index μ as shown in the figure.



1. Select the correct statement :
(A) Incident rays are partially reflected at point A.
(B) Incident rays are totally reflected at point A.
(C) Incident rays are totally transmitted through A.
(D) None of these.

2. An expression of the angle between incidence ray and emergent ray (angle of deviation) as shown in the figure is
(A) 0º (B) ϕ
(C) $\alpha - \phi$ (D) $\pi - 4\alpha + 2\phi$.

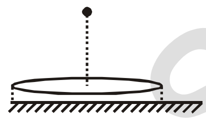


3. Consider the figure of question 8, the angle ϕ for which minimum deviation is produced will be given by

(A) $\cos^2\phi = \frac{\mu^2+1}{3}$ (B) $\cos^2\phi = \frac{\mu^2-1}{3}$

(C) $\sin^2\phi = \frac{\mu^2+1}{3}$ (D) $\sin^2\phi = \frac{\mu^2-1}{3}$.

II. A thin biconvex lens of refractive index 3/2 is placed on a horizontal plane mirror as shown in the figure. The space between lens and the mirror is then filled with water of refractive index 4/3. It is found that when a point object is placed 15 cm above the lens on the principal axis the object coincides with its own image.



4. At what distance object should be placed before water is filled so that image coincides with object if R is radius of curvature of lens

(A) 1.5 R (B) R
(C) 2R (D) R/2

5. In the above experiment when water is present, and parallel rays are incident then it will converge at a distance

(A) 2.25 cm (B) 15 cm
(C) 10 cm (D) 7.5 cm

6. On repeating the above experiment in which water is replaced by a liquid of refractive index μ image again coincide at a distance 25 cm from the lens then refraction index of liquid is

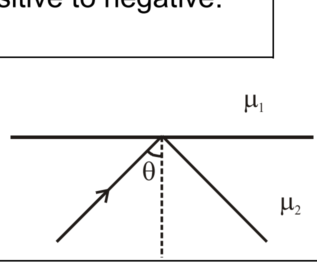
(A) 1.5 (B) 1.4
(C) 1.8 (D) 1.6

MATCH THE FOLLOWING

1. An object located between the focus and the pole of a concave mirror moves towards the pole with a constant velocity along its principal axis. Consider the image formed by paraxial rays. Let θ_0 and θ_I represent the magnitudes (absolute values) of the angles subtended by the object and its image at the pole of the mirror respectively; and let m be defined as $\frac{\theta_I}{\theta_0}$. Use the New Cartesan Sign Convention.

Column I		Column II	
(A)	Velocity of image	(p)	Positive.
(B)	Acceleration of image	(q)	Negative.
(C)	$\frac{d\theta_0}{dt}$, i.e., the rate at which θ_0 changes with time	(r)	Zero.
(D)	$\frac{dm}{dt}$	(s)	Changes from positive to negative.

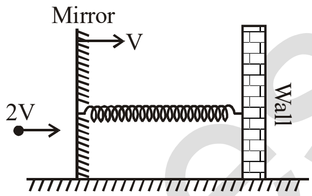
2. A ray of light strikes at the boundary separating two media at angle θ. μ_1 and μ_2 are refractive indices of media with ($\mu_2 > \mu_1$).



Column I		Column II	
(A)	When $\theta < \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$ then deviation in the path of ray is	(p)	$\frac{\pi}{2} - \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$

(B)	Maximum deviation in the path of ray for refraction at boundary	(q)	$\pi - 2\sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$
(C)	Maximum deviation in the path of ray for reflection at the boundary	(r)	Zero
(D)	Deviation in the path at grazing angle of incidence	(s)	$\sin^{-1}\left(\frac{\mu_1}{\mu_2}\sin\theta\right) - \theta$

3. A plane mirror is tied to the free end of an ideal spring. The other end of the spring is attached to a wall. The spring with mirror is held vertically to the floor, can slide along it smoothly. When the spring is at its natural length, the mirror is found to be moving at a speed of V with respect to ground frame. An object is moving towards the mirror with speed 2V with respect to ground frame. Then, Match the following :



Column I		Column II	
(A)	Speed of image with respect to ground frame when spring is at natural length	(p)	V
(B)	Speed of image with respect to mirror when spring is at natural length	(q)	O
(C)	Speed of image with respect to object when spring is at natural length	(r)	2V
(D)	Speed of image with respect to ground frame when spring is at maximum compressed state	(s)	3V

10. Answers to the Subjective Assignment

LEVEL – I

1. $\frac{apq}{q-p}$ **2.** $\frac{R\,(2-n)}{2\,(n-1)}$

3. R/n **4.** 190cm, right of the lens

5. – 5 mm from left of 2nd surface **6.** $\frac{\mu_3 R}{\mu_3 - \mu_1}$

7. 60 cm behind the mirror, virtual & inverted, 3

8. 9.365cm **9.** 7/6 and 100 cm

10. 5 cm and inverted **11.** 72×10^{-7} m

12. 5.9×10^{-7}m, 5.9×10^{-3} m **13.** 0.117 cm

14. $6000A^0$ **15.** 0.853

17. 1.7 cm

18. For weak reflection : 7000, 4667 & 4000 A^0

For strong reflection 6222, 5091, 4308 A^0

19. n^2I_0 , nI_0 **20.** Zero, 1.5 mm

LEVEL – II

1. h = 20 cm.

3. (i) $\sin^{-1}\{n \sin (45^0 - n_1/n)\}$ (ii) $i = 72.9^0$

4. -2f from third lens

5. $R = a\left[\frac{1}{\sqrt{n_1^2-1}}+\frac{1}{\sqrt{n_2^2-1}}+\frac{1}{\sqrt{n_{31}^2-1}}\right]$

6. 0.6m from lens, 0.003m

7. (160, -0.5), (135, -0.75), (160, -0.15)

8. $\frac{f_1f_2+d(f_1-d)}{f_1+f_2-d}, \frac{(f_1-d)\Delta}{f_1+f_2-d}$

9. 15cm, -1.5, 1.5cm below RS, 0.3cm above RS

10. 15 cm

11. 0.29 mm

12. $t = \sqrt{\frac{\lambda}{\alpha(\mu-1)}}$

13. 0.6 mm

14. 2 cm, 1.0016

15. (a) circular (b) $d' = \mu_0\left(d+\frac{\alpha d^2}{2}\right)$

16. (a) Max, 70 (b) Max, 20 (c) In front of S_1, 20 μm

17. 7×10^{-6}watt

18. 0.53 cm

19. (a) $y_0 = 4.33 \times 10^{-3}$m (below X axis) (b) 0.75 I_{max}
(c) 650 nm, 433.34 nm

20. $\frac{15}{32}\lambda\left(\frac{2r+R}{r\theta}\right)$

11. Answers to the Objective Assignment

LEVEL – I

1.	(B)	2.	(B)
3.	(D)	4.	(A)
5.	(D)	6.	(A)
7.	(B)	8.	(A)
9.	(C)	10.	(D)
11.	(C)	12.	(B)
13.	(A)	14.	(C)
15.	(A)	16.	(A)
17.	(B)	18.	(C)
19.	(B)	20.	(B)
21.	(C)	22.	(B)
23.	(A)	24.	(A)
25.	(D)	26.	(D)

27. (C)
28. (A)
29. (A)
30. (A)
31. (B)
32. (C)
33. (B)
34. (A)
35. (C)
36. (A)
37. (A)
38. (D)
39. (A)
40. (A)

LEVEL – II

1. (A), (C)
2. (A), (B), (C)
3. (A), (B), (C), (D)
4. (A), (B)
5. (A), (B), (C)
6. (A), (C)
7. (D)
8. (A), (D)
9. (A), (B), (C)
10. (D)

COMPREHENSION

1. (A)
2. (D)
3. (B)
4. (B)
5. (D)
6. (D)

MATCH THE FOLLOWING

1. (A) – (q); (B) – (p); (C) – (p); (D) – (r)
2. (A) – (s); (B) – (p); (C) – (q); (D) – (r)
3. (A) – (q); (B) – (p); (C) – (r); (D) – (r)