PHYSICS

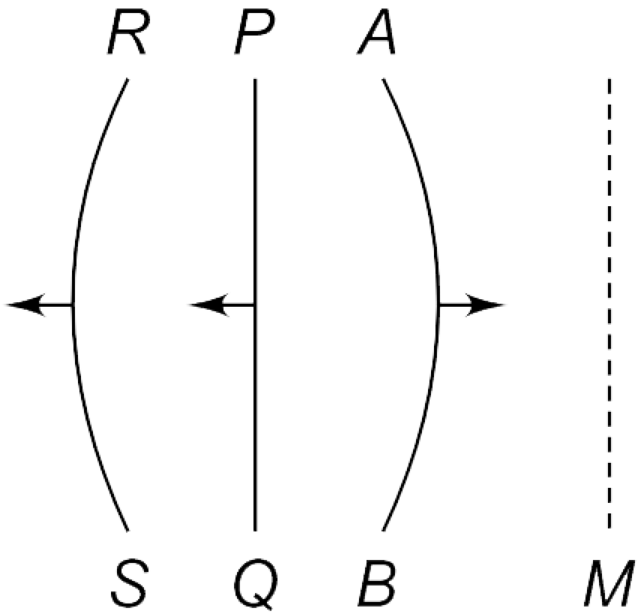
BOOKS - ARIHANT PHYSICS (HINGLISH)

WAVE OPTICS

Others

1. In the figure shown M represents a mirror. AB is an incident wavefront. Which type of

mirror is M if the reflected wave front



(a)PQ (b)RS

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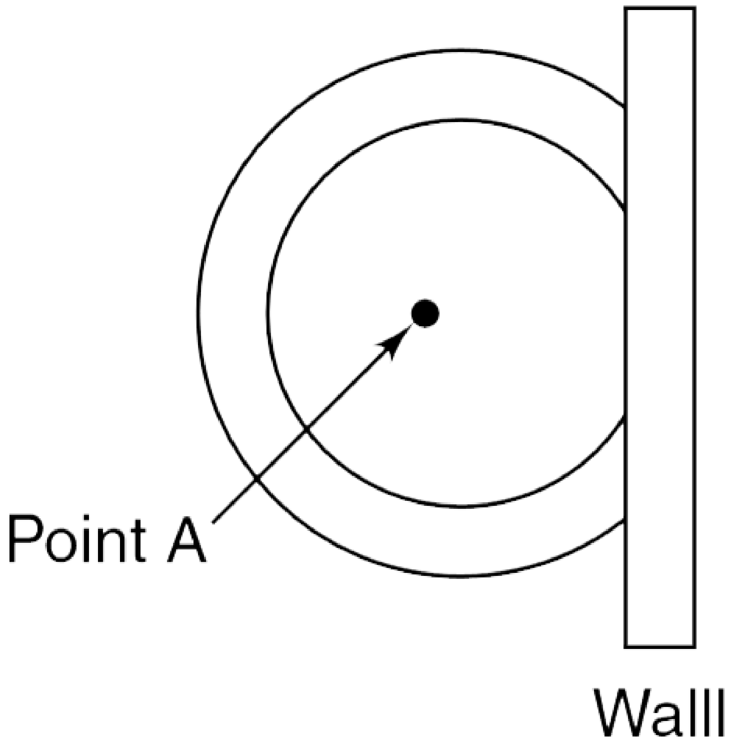
2. On the surface of a calm lake a source at A is causing disturbance. The circular ripples formed get reflected at a wall in the lake. The reflected ripples can be thought to be generated from a virtual source. Indicate the position of virtual source in the diagram



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3. A wavefront expressed by $x + y - z = 4$ is incident on a plane mirror which is lying parallel to xy plane. Write a unit vector in the direction of reflected ray.

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4. A parallel beam of light is travelling along a direction making an angle of 30° with the positive X direction and 60° with positive Y direction. Wavelength is λ. Find the phase difference between points having co-ordinates $(1, \sqrt{3}, 2)$ and $(0, 0, 0)$.

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5. A point source of light is being moved closer to a thin concave lens from a large distance on its principal axis. Is the radius of curvature of the refracted wave front, close to the lens, increasing or decreasing?

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6. Three coherent sources S_1, S_2 and S_3 can throw light on a screen. With S_1 switched on intensity at a point P on the screen was observed to be I. With only S_2 on, intensity at P was 2I and when all three are switched on the intensity at P becomes zero. Intensity at P is I when S_1 and S_2 are kept on. Find the phase difference between the waves reaching at P from sources S_1 and S_3.

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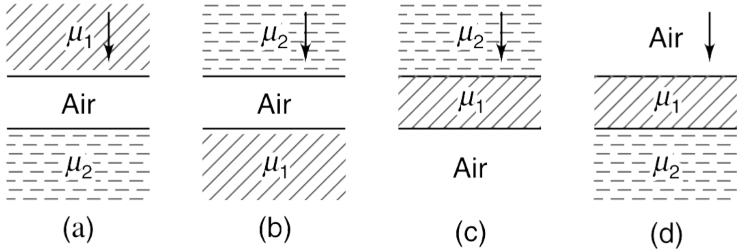
7. Three media are arranged in various ways as shown in figures a, b, c and d. Light of wavelength λ is incident perpendicularly on the boundary of the middle layer and interference between waves reflected at the boundaries of the middle layer is studied. In which of the four cases the reflected light is eliminated by destructive interference when the thickness of middle layer approaches zero.

$\mu_1 = 1.5 \text{ and} \mu_2 = 1.8$



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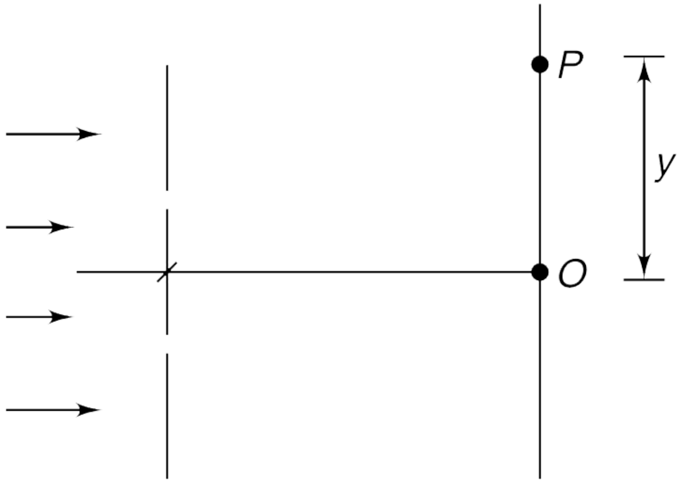
8. In young's double slit experiment, when the slit plane is illuminated with light of wavelengthλ_1, it was observed that point P is closest point from central maximum O, where intensity was 75% the intensity at O. When the light of wavelength λ_2 is used, point P happens to be the nearest point from O where intensity is 50% of that at O. Find the ratio $\frac{\lambda_1}{\lambda_2}$.



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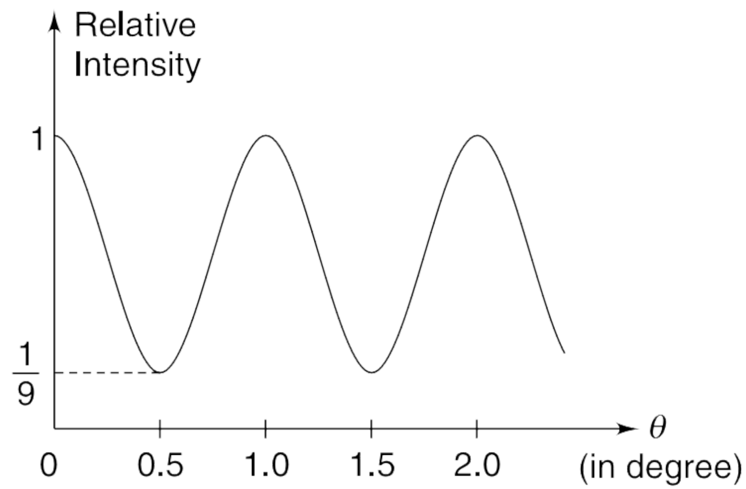
9. In young's double slit experiment relative intensity at a point on the screen may be defined as ratio of intensity at that point to the maximum intensity on the screen. Light of wavelength $7500\mathring{A}$ A passing through a double slit, produces interference pattern of relative intensity variation as shown in Fig. θ on horizontal axis represents the angular position of a point on the screen



(a) Find separation d between the slits.

(b) Find the ratio of amplitudes of the two waves producing interference pattern on the screen.

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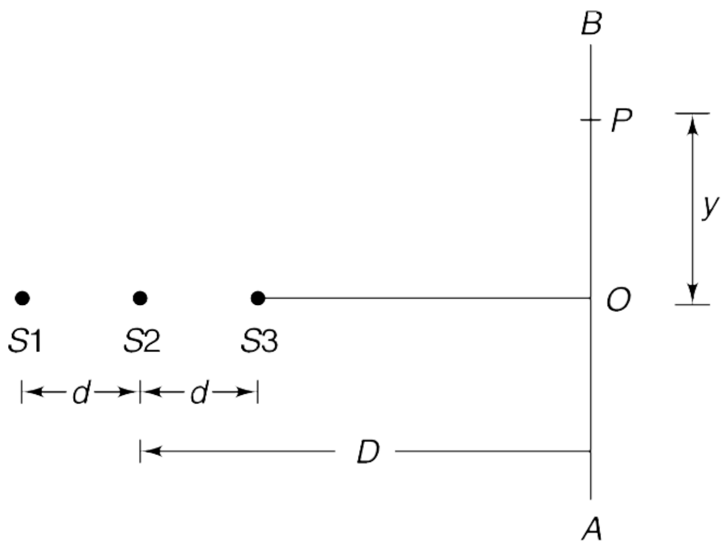
10. A monochromatic point source(S_1) is at a distance d from a screen. Another identical source (S_2) is at a large distance from the screen. The two sources are on a line which is perpendicular to the screen. Sources are coherent. What is the shape of interference fringes on the screen?

(b) Three identical coherent sources are placed on a straight line with two neighbouring ones separated by a distance $\mathrm{d} = 0.06\,\mathrm{mm}$. The sources produce monochromatic light of wavelength $\lambda = 550.4\,\mathrm{nm}$. A line AB is located at a distance D = 2.50 m from the sources and is perpendicular to line joining the three sources. Intensity of light at P with any one of the sources switched on is I_o. Find the intensity when all three sources are switched on. Distance of point P from O is

$y = 1.72$ cm (see figure)



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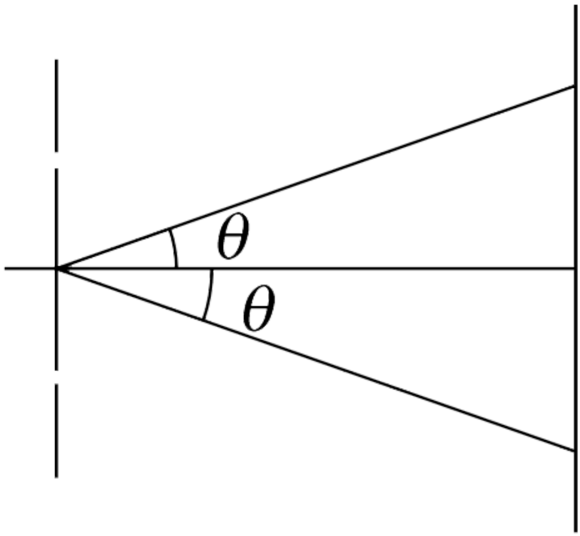
11. In Young's double-slit experiment, the separation between two slits is $d = 0.32$ mm and the wavelength of light

used is$\lambda = 5000\overset{\circ}{A}$. Find the number of maxima in the angular range $-\sin^{-1}(0.6) \le \theta \le \sin^{-1}(0.6)$



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12. In young's double slit experiment (with identical slits) the intensity of a maxima is I. P is a point on the screen where10^{th} maxima is formed with light of wave- length $\lambda = 6000\overset{\circ}{A}$. Find the intensity at point P if the entire experimental set up is submerged in water of refractive index $\mu = \frac{4}{3}$. Assume that intensity due to individual slits remains unchanged after the system is dipped in water.

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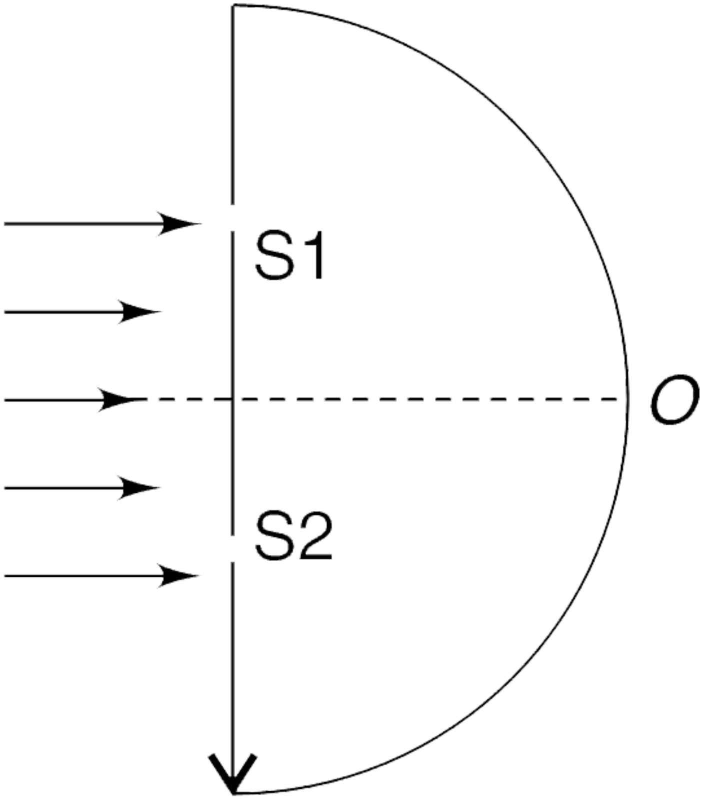
13. Coherent light of wavelength $\lambda = 500\ \mathrm{nm}$ is sent through two narrow parallel slits in a large vertical wall. The two slits are 5 μm apart. In front of the wall there is a semi cylindrical screen with its hori- zontal axis at the line running on the wall parallel to the slits and midway between them. Radius of the cylin- drical screen is $\mathrm{R} = 2.0\ \mathrm{m}$. Find the vertical height of the second order interference maxima from the centre (O) of the screen.



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14. In a Young double slit experiment, the two slits are named as A and B. Two transparent films of thickness $t_1 \text{and} t_2$ having refractive indices μ_1 $\text{and} \mu_2$ placed in front of the slits A and B respectively. It is given that $\mu_1 t_1 = \mu_2 t_2$ $\text{and} t_1 < t_2$

In which direction will the central maximum shift after the two films are placed?

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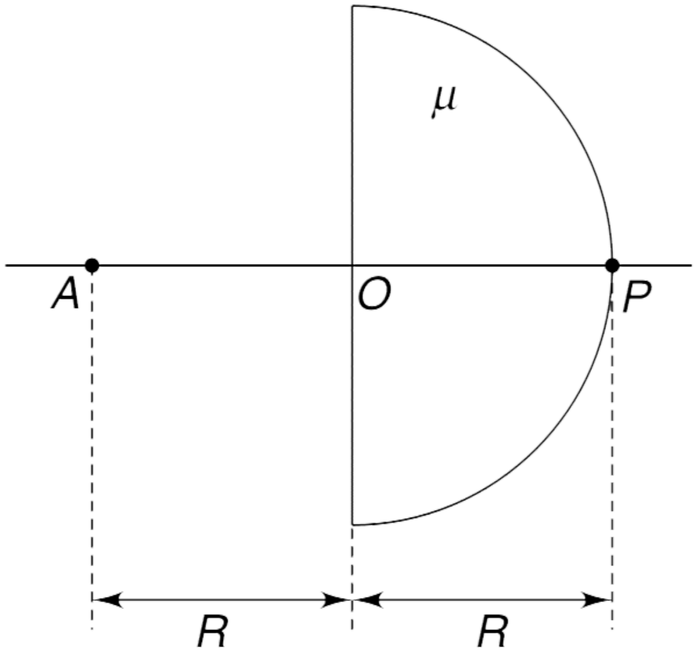
15. A point source (A) is kept on the axis of a hemi- spherical paperweight made of glass of refractive index $\mu = \frac{3}{2}$. The distance of the point source from the centre (O) of the sphere is R where R is radius of the hemisphere. Use paraxial approximations for answering following questions (a) Find the change in radius of curvature of the wave- fronts just after they enter the glass at O. (b) Find the radius of curvature of the wavefronts at point

P just outside the glass.



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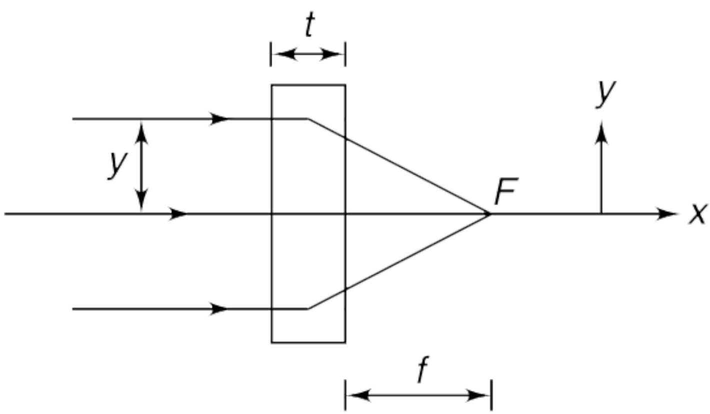
16. A parallel beam of light travelling in x direction is incident on a glass slab of

thickness t. The refractive index of the slab changes with y as $\mu = \mu_0\left(1 - \frac{y2}{y_2^0}\right)$ where μ_0 is the refractive index along x axis and y_0 is a constant. The light beam gets focused at a point F on the x axis. By using the concept of optical path length calculate the focal length f. Assume $f > > t$ and consider y to be small.



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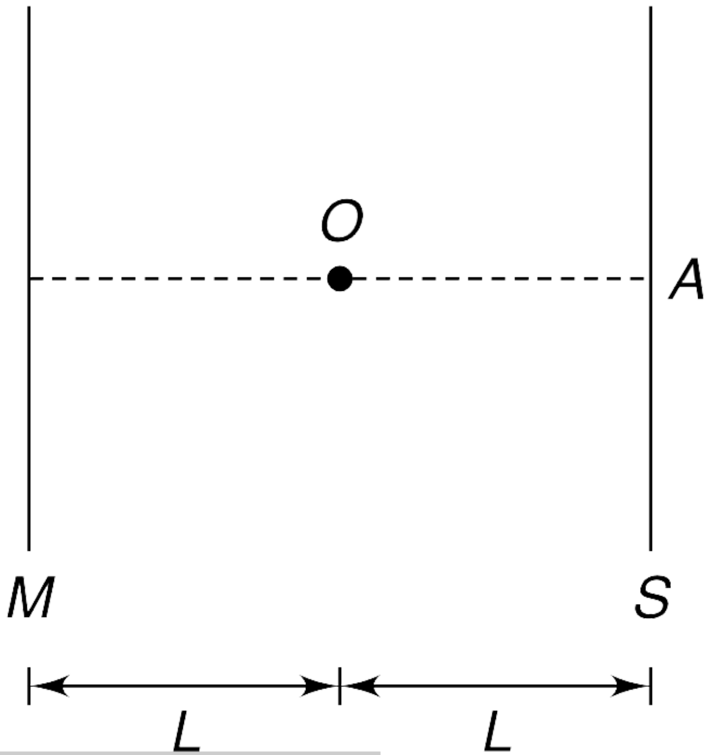
17. In the figure shown, O is a point source of light and S is a screen placed at a distance L from the source. Intensity of light at point A on the screen due to the source is 81 I where I is some unit. Now a large mirror (M) is placed behind the source at a distance L from it. The mirror reflects 100% of the light energy incident on it. Calculate the inten- sity at point



A. ,brgt

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18. In a routine Young's double slit experiment the paral- lel beam of light incident on the slit plane is a mixture of wavelength distributed between$\lambda + \Delta\lambda$ and$\lambda - \Delta\lambda$. Because of this the interference fringes are poorly defined compared to the ideal case of monochromatic light. It is understood that the central maxima and the first order maxima will be well resolved if there is no overlapping in the first order minima and the first order maxima. Write the values of $\Delta\lambda$ so that the first order maxima is well resolved from the central fringe.

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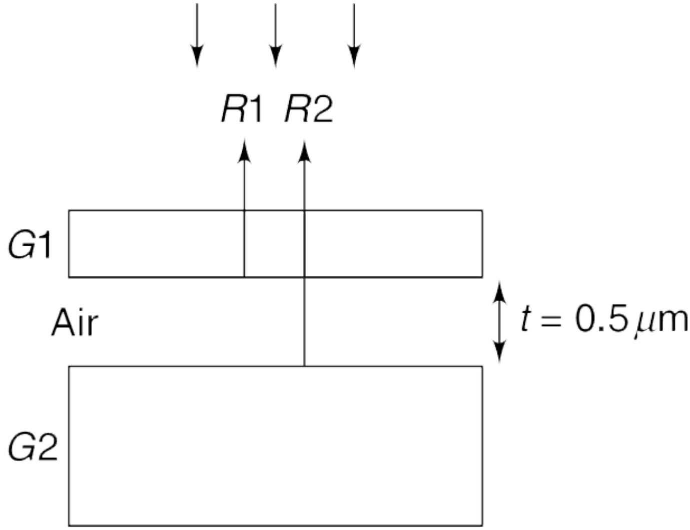
19. A thin glass slab G1 is held over a large glass slab G2, creating an air gap of uniform thickness $t = 0.5 \mu m$ between them. Electromagnetic wave having wavelengths



ranging from $0.4 \mu m to 1.15 \mu m$ is incident normally on the slab G1. When interference between waves reflected from boundaries of air gap (the two reflected waves are shown in fig as R1 and R2) was studied, it was found that only two wavelengths interfered constructively. One of these two wavelengths is $\lambda_1 = 0.04 \mu m$.

Find the other wavelength (λ_2) that interferes constructively.

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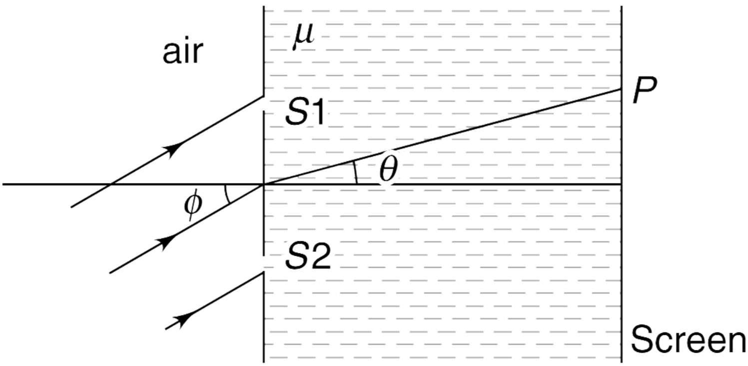
20. Light is incident at an angle $\phi$with the normal to a vertical plane containing two narrow slits (S1 and S2) at separation d. The medium to the left of slit plane is air and wavelength of the incident light is λ. The medium to the right of the slit plane has refractive index μ. Find all values of angular position $(\theta)$of a point P where we will observe constructive interference. Wavelength of incident light is λ.



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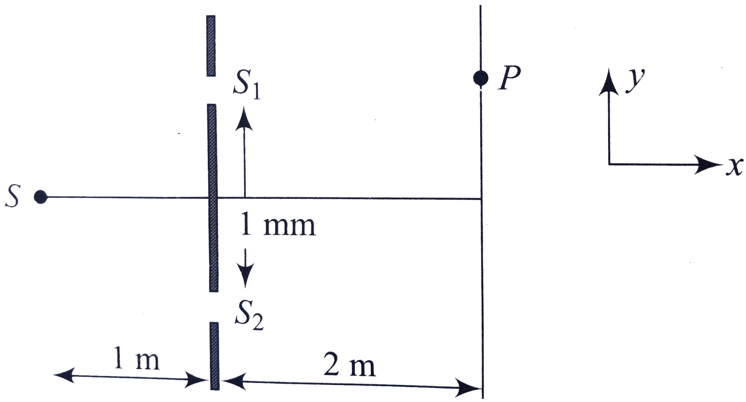
21. In young's double-slit experiment set up, sources S of wavelength 50 nm illumiantes two slits S_1 and S_2 which act as two coherent sources. The sources S oscillates about its own position according to the equation $y = 0.5 \sin \pi t$, where y is in nm and t in seconds. The minimum value of time t for which the intensity at point P on the screen exaclty in front of the upper slit becomes minimum is



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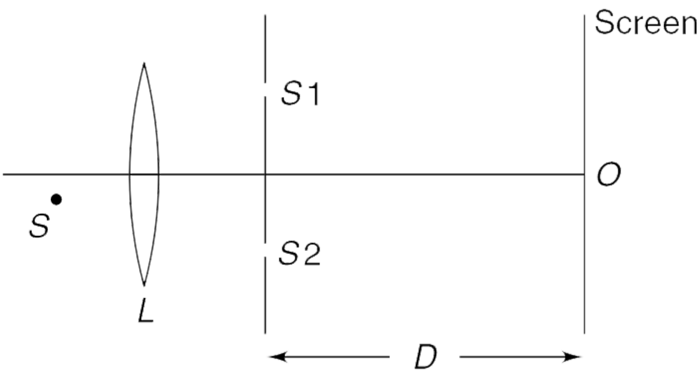
22. In a young's double slit experiment the distance between slits S1 and S2 is d and distance of slit plane from the screen is $D(>>d)$. The point source of light (S) is placed a distance $\frac{d}{2}$ below the principal axis in the focal plane of the convex lens (L). The slits S1 and S2 are located symmetrically with respect to the principal axis of the lens. Focal length of the lens is $f(>>d)$.

Find the distance of the central maxima of the fringe pattern from the centre (O) of the



screen.

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23. A Soap bubble has a thickness of 90 nm and its refractive index is $\mu = 1.4$. What colour does the bubble appear to be at a point on its surface closest to an observer when it is illuminated by white light?

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24. A parallel beam of white light falls from air on a thin film whose refractive index is $\sqrt{3}$. The medium on both sides of the film is air.

The angle of incdidence is 60°. Find the minimum film thickness if reflected light is most intense for $\lambda = 600$ nm.

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25. A thin film having refractive index $\mu = 1.5$ has air on both sides. It is illuminated by white light falling normally on it. Analysis of the reflected light shows that the wavelengths 450 nm and 540 nm are the only missing wavelengths in the visible portion of the spectrum. Assume that visible range is 400 nm to 780 nm.

(a) Find thickness of the film.

(b) Which wavelengths are brightest in the interference pattern of the reflected light?

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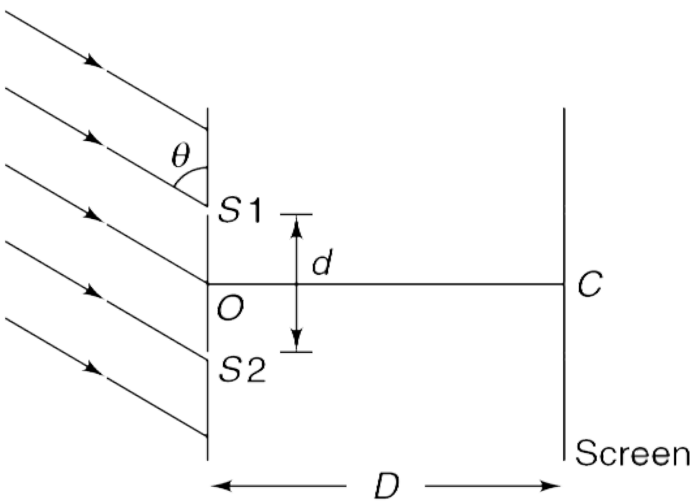
26. In a double slit experiment a parallel beam of light strikes the slit plane at an angle θ as shown in the figure. The two slits are covered with transparent plastic sheets of equal thickness t but of different refractive indices 1.2 and 1.5. The central maxima is formed at the centre of the screen at C.

(a) Which sheet was used to cover the slit S1?

(b) Findθ.



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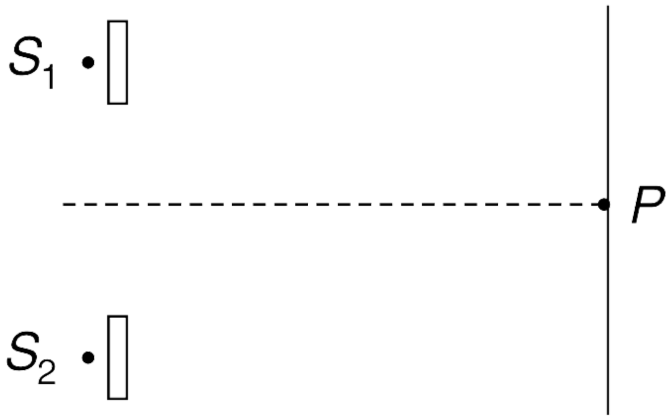
27. In Young's double slit experiment, the upper slit is covered by a thin glass plate of refractive index 1.4 while the lower slit is covered by another glass plate having same thickness as the first one but having refractive index 1.7.

Interference pattern is observed using light of wavelength$5400\overset{\circ}{A}$. It is found that the point P on the screen where the central maximum fell before the glass plates were inserted, now has $\frac{3}{4}$ the original intensity. It is also observed that what used to be 5^{th} maximum earlier, lies below the point P while the6_{th} minimum lies above P. Calculate the thick- ness of glass plates. Absorption of light by glass plate may be neglected.



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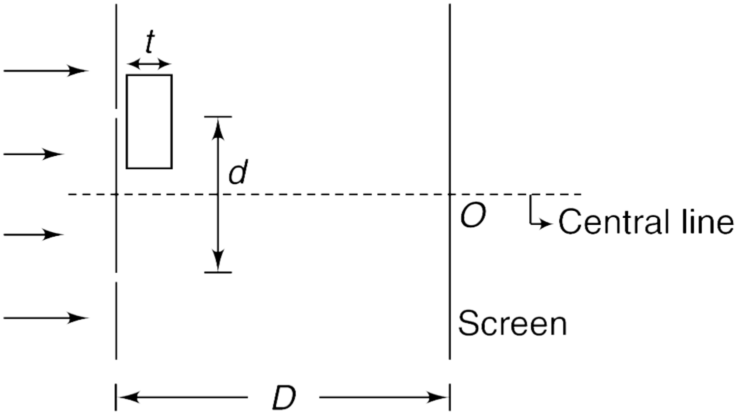
28. In Young's double slit experiment a transparent sheet of thickness t and refractive index μ is placed in front of one of the slits and the central fringe moves away from the central line. It was found that when temperature was raised by$\Delta\theta$the central fringe was back on the central line (at C). It is known that temperature coefficient of linear expan- sion of the material of the transparent sheet isα. A young scientist modeled that the refractive index of the material changes with temperature as $\Delta\mu = -gama\ \Delta\theta$. Find $\Delta\theta$ in terms of other given quantities. D and d are given and have usual meaning.



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29. In Young's double slit experiment a monochromatic light of wavelengthλ from a distant point source is inci- dent upon the two identical slits.The interference pattern is viewed on a distant screen. Intensity at a point P is equal to the intensity due to individual slits (equal toI_0). A thin piece of glass of thickness t and refractive index μ is placed in front of the slit which is at larger distance from point P, perpendicular to the light path. Assume no absorption of light energy by the glass.

(a) Write intensity at point P as a function of t.

(b) Write all values of t for which the intensity at P is minimum.

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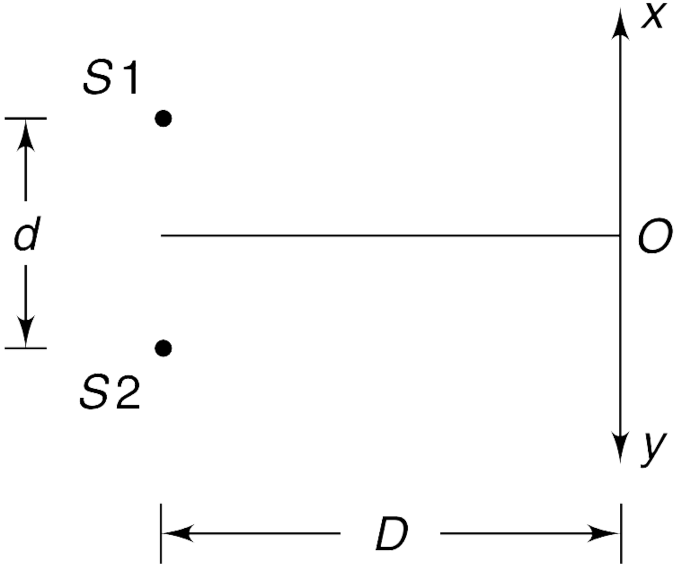
30. In the shown fig. S1 and S2 are two identical coher- ent sources of sound, separated by a distance d. A receiver moves along the line XY (which is parallel to line S1 S2) to detect the intensity of sound at various points on the line. Distance of line XY from line S1 S2 is$D(> \; > d)$. Point O is the foot of perpendicular bisector of the line S1 S2 on XY. Distance of first intensity maxima (on line XY) measured from O is y. Find percentage change in value of y if the temperature of air increases by 1%.



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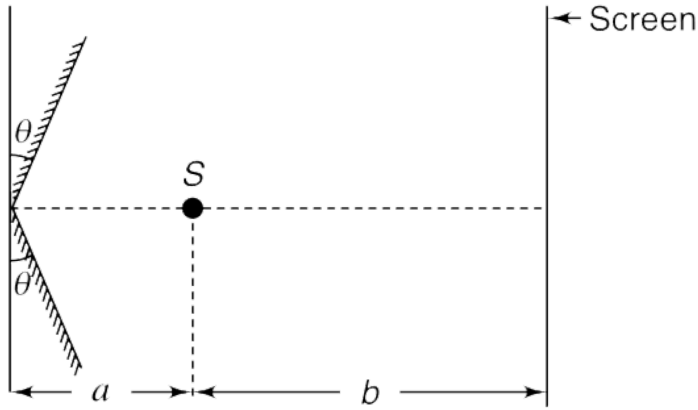
31. Two plane mirrors, a source S of light, emitting wavelengths of

$\lambda_1 = 4000\mathring{A}$ and$\lambda_2 = 5600\mathring{A}$and a screen are arranged as shown in figure. The angle θ shown is 0.05 radian and distance a and b are 1 cm and 38 cm respectively.

(a) Find the fringe width of interference pattern formed on screen by the blue light.

(b) Calculate the distance of first black line from central bright fringe.

(c) Find the distance between two black lines which are nearest to the central bright fringe.



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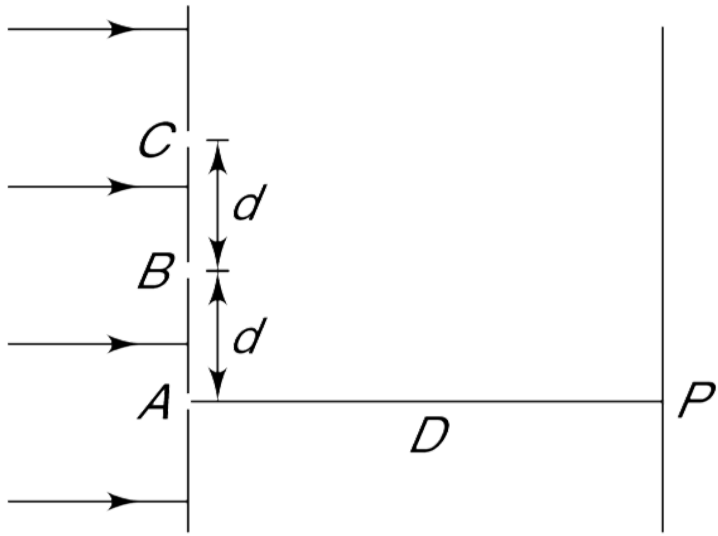
32. Three narrow slits A, B and C are illuminated by a parallel beam of light of wavelength λ, P is a point on the screen exactly in front of point A. Slit plane is at a distance D from the screen$(D >> \lambda)$. It is

know that $\mathrm{BP} - \mathrm{AP} = \frac{1}{3}$



(a) Find d in terms of D andλ

(b) Write the phase difference between waves reaching at P from C and A.

(c) If intensity of P due to any of the three slits individu- ally is I_0, find the resultant intensity at P.

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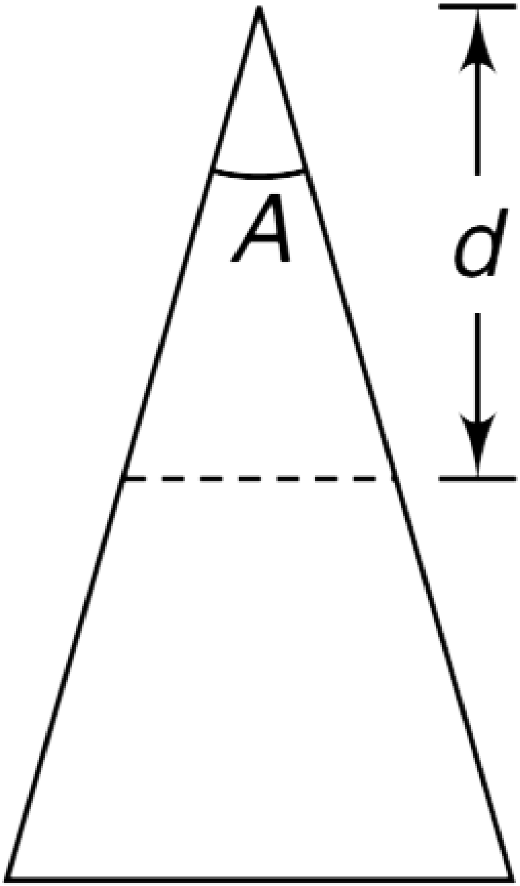
33. A very thin prism has an apex angle A and its material has refractive index$\mu = 1.48$. Light is made to fall on one of the refracting faces at near normal incidence. Interference results from light reflected from the outer surface and that emerging after reflection at the inner surface. When violet light of wavelength $\lambda = 400\ \mathrm{nm}$ is used, the first construc- tive interference band is observed at a distance $\mathrm{d} = 3.0\ \mathrm{cm}$ from the apex of the prism.

(a) Find the apex angle A.

(b) If red light ($\lambda = 800\ \mathrm{nm}$) is used, at what distance from the apex will we observe the first constructive interfer- ence band.



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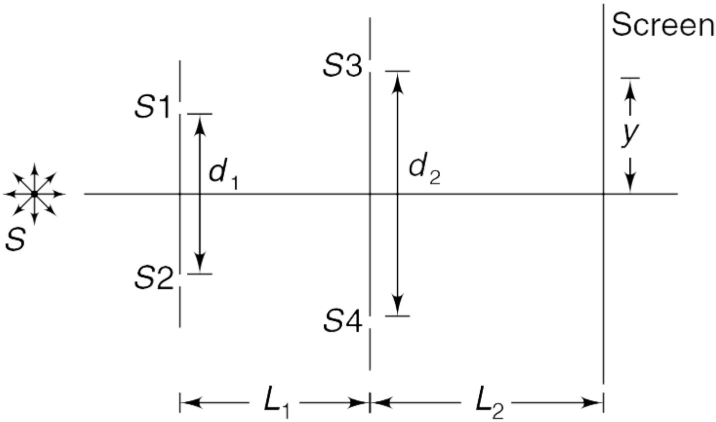
34. In the arrangement shown, S is a point source of monochromatic light. S1 and S2 are two slits located sym- metrically with respect to the source with separation between them d_1. Parallel to this slit plane there are two more slits (S3 and S4) at separationd_2. These slits are also symmetrically located with respect to S. A screen is at a distance L_2 from this slit plane. How does the intensity on the screen change with y and d_1?



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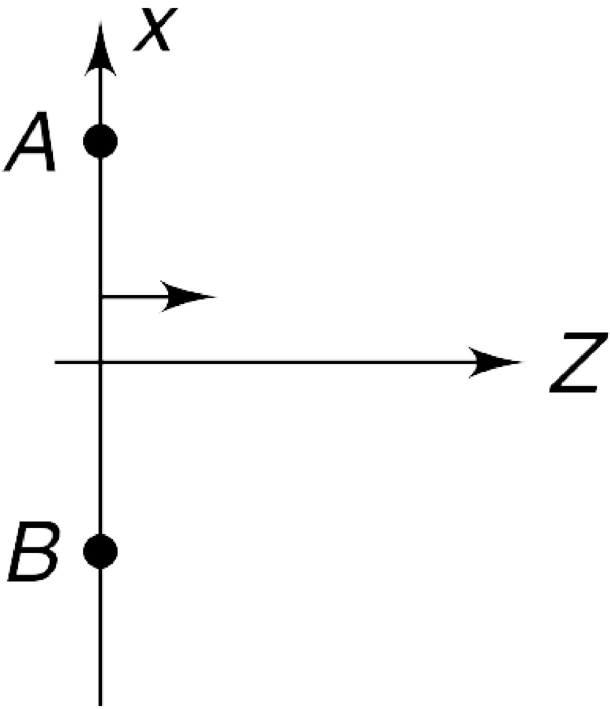
35. The refractive index of a medium changes as $\mu = \mu_0 \left[1 - \frac{x^2 + y^2}{d_2}\right]^{1/2}$ where μ_0 is the refractive index on the z axis. A plane wavefront (AB) is incident along z axis as shown in the figure. Draw the wavefront at a later timeΔt. Is the wavefront getting focused?



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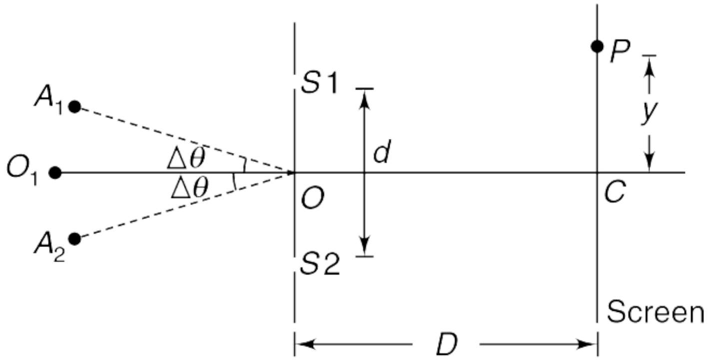
36. In the arrangement shown in the figure, S1 and S2 are two parallel slits at a separation d. There is a screen at a distance$D(> > d)$ from the slits. Two point sources A1 and A2 have been placed symmetrically with respect to the slits at a large distance with $< < A_1OO_1 = < < A_2OO_1 = \Delta\theta.$ The sources are monochromatic giving out light of wavelength l but they are incoherent. Write the intensity of light at a point P on the screen as a function of y. TakeI_0 to be maximum intensity on the screen when one of the two sources (A1 and A2) is switched on. Assume y to be small.



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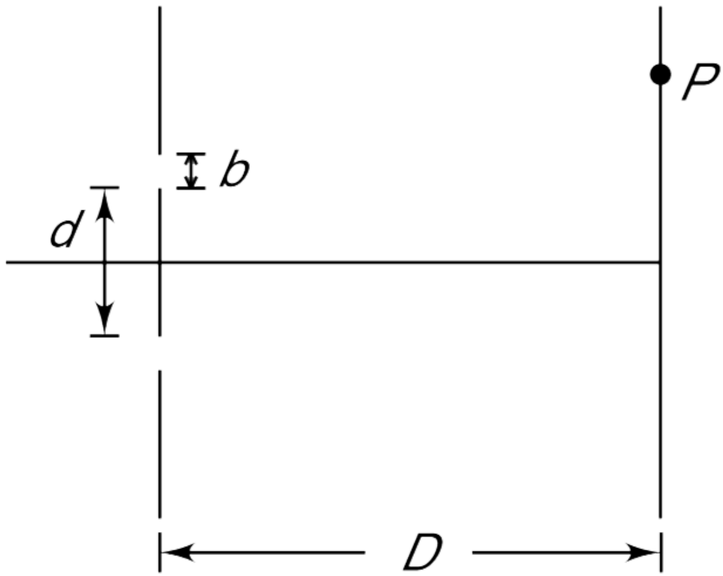
37. The figure represents two identical slits in a Young's double slit experiment. The width of each slit is b and distance between the centres of the two slits is d. Consider a point P on the screen that is close to centre of the screen. $\Delta\ x_t$ represents the optical path difference to point P from the top edges of the two slits and $\Delta\ x_b$ represents the optical path difference to P from the bottom edges of the two slits. Find $\Delta\ x_b - \Delta\ x_t$.



It is given that $D >> d$.