Chapter- 10

Wave Optics

I. Very short answer type questions (1 mark each):

01. How does the angular separation of interference fringes change in Young's experiment, if the distance between the slits is increased?

02. Which special characteristic of light is demonstrated by the phenomenon of polarization?

03. Why is the diffraction of sound waves more easily observed than diffraction of light waves?

04. The refractive index of a medium is $\sqrt{3}$. What is the angle of refraction, if the unpolarized light is incident on it at the polarizing angle of the medium?

05. State two conditions for sustained interference of light.

06. Draw the type of wavefront diverging from a point source.

07. State Huygens' principle.

08. Sketch the wavefront emerging from a linear source of light like a slit.

09. How does the frequency of a beam of ultraviolet light change when it goes from air into glass?

10. Three beams of colors red, blue, and green incident normally on a rectangular glass slab simultaneously. Write down the order in which the lights come out of the slab.

11. Write down the expression for resulting intensity at a point when light coming from two close monochromatic sources have intensities I_0 each if (a) Sources are coherent (b) Sources are incoherent.

12. In YDSE setup a bright fringe is observed on the screen exactly in front of a slit. What is the order of the fringe?

13. What happens to fringe width if YDSE set up is dipped in water?

14. Why does the intensity of the secondary maximum become less as compared to the central maximum?

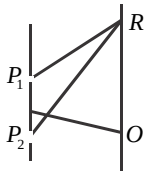
15. Sketch the wavefront emerging from a point source of light.

16. State the reason, why two independent sources of light cannot be considered as coherent sources.

17. The light of wavelength 600 nm is incident normally on a slit of width 3 mm. Calculate the linear width of the central maximum on a screen kept 3m away from the slit.

18. Yellow light is used in a single slit diffraction experiment with a slit width of 0.6 mm. If the yellow light is replaced by X-ray, how will the diffraction pattern be affected?

19. In the YDSE setup shown in the figure each slit emit light of intensity I_0. If $P_2R - P_1R = \frac{\pi}{6}$. What is the intensity at point R?



II. Short answer type questions (2 marks each):

20. In Young's double-slit experiment, three lights of blue, yellow, and red color are used successively. The fringe width will be maximum for which color of light and why?

21. Derive the laws of reflection of light based on Huygens principle of secondary wavelets.

22. Find the ratio of intensities of two points P and Q on a screen in Young's double-slit experiment when waves from sources S_1 and S_2 have a phase difference of (i) $\pi/3$ and (ii) $\pi/2$ respectively.

23. What is the effect on the interference fringes in Young's double experiment due to the following operation? Give a reason for your answer. Monochromatic sources are replaced by a source of white light.

24. Derive angular width of the fringe. How the angular width of the fringe changes if the separation between the slits & screen is increased. ***[CBSE - 2009]***

25. What happens to the fringe width of a youngs double-slit apparatus. If it is immersed in a liquid of refractive index (μ). ***[CBSE - 2001]***

26. Why is the interference pattern not detected when the two coherent sources are far apart?***[CBSE - 2004]***

27. In Young's experiment, two coherent sources are 1.5 mm apart and fringes are obtained at a distance of 2.5m from them. If the wavelength of light is 600 nm, find the number of fringes in the interference pattern, which is 5×10^{-3}m wide.

28. Laser light of wavelength 630 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 8.1 mm. A second light produces an interference pattern in which the fringes are separated by 7.2 mm. Calculate the wavelength of the second light.

29. In Young's double-slit experiment, using the light of wavelength 400 nm, interference fringes of width 'X' are obtained. The wavelength of light is increased to 600 nm and the separation between the slits is halved. If one wants the observed fringe width on the screen to be the same in the two cases, find the ratio of the distance between the screen and the plane of the interfering sources in the two arrangements.

30. In a single slit diffraction experiment, the slit width is made double that of the original width. What would happen to the size and intensity of the central diffraction band? Give the reason for your answer.

31. Compare and contrast the pattern which is seen with two coherently illuminated narrow slits in Young's experiment with that seen for a coherently illuminated single slit producing diffraction.

III. Short answer type questions (3 marks each):

32. Draw and explain the graph showing the variation of intensity in the interference pattern in Young's double-slit experiment. Show that phenomenon of interference is in accordance with the conservation of energy.

33. Derive an expression the ratio of intensities at maxima and minima in the interference pattern is $\frac{Imax}{Imin} = \left(\frac{r+1}{r-1}\right)^2$ where $r = \frac{a_1}{a_2}$. ***[CBSE - 2005]***

34. Find the expression for the (i) angular width (ii) linear width of central maxima. Prove that width of central maxima is twice that of any secondary maxima.

35. State with reason how would the linear width of central maxima change, if (i) monochromatic yellow light is replaced by red light (ii) the distance between the slit and screen is increased. ***[CBSE - 2003]***

36. In a single slit diffraction pattern, how does the angular width of central maxima change i) Slit width is decreased (ii) distance between slit and screen is increased, iii) light of small visible wavelength is used. ***[CBSE - 1994, 2002, 2007]***

37. Light of λ = 600 nm is incident on an aperture of size 2 mm. Calculate the distance up to which the ray of light can travel such that it spreads less than the size of the aperture. ***[CBSE - 1996]***

38. Five sheets of polaroids lie on top of each other with their transmission axis oriented at 30^0 to the previous one. Calculate the transmitted intensity if the incident unpolarized light intensity is I_0.

39. Discuss the intensity of the transmitted light when the polarised sheet is rotated between two crossed polaroids. When the transmitted intensity will be maximum? ***[NCERT]***

40. Graphically show that the variation of transmitted light intensity through analyzer and angle between analyses & polariser for (i) complete polarised light (ii) Partially polarised. ***[CBSE - 2008]***

41. Define Brewster's angle show that the Brewster angle i_B for a given pair of transparent media is related to critical i_C through the relation. $i_C = \sin^{-1}(\cot i_B)$ [***CBSE - 2008]***

42. Two narrow slits are illuminated by a single monochromatic source. Name the pattern obtained on the screen. One of the slits is now completely covered. What is the name of the pattern now obtained on the screen? Draw intensity pattern obtained in the two cases. Also, write two differences between the patterns obtained in the above two cases.

43. In a single slit diffraction pattern, how does the angular width of the central maximum vary, when

(i) the aperture of the slit is increased, (ii) distance between the slit and screen is decreased and

(iii) monochromatic visible light of larger wavelength is used? Justify your answer in each case.

IV. Long answer type questions (5 marks each):

44. (a) How is a wave different from a ray? Draw the geometrical shape of the wavefronts when (i) light diverges from a point source and (ii) light emerges out of a convex lens when a point source is placed at its focus.

(b) State Huygens' principle. With the help of a suitable diagram, prove Snell's law of refraction using Huygens' principle.

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45. (a) What are coherent sources of light? Two slits in Young's double-slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed?

(b) Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.

(c) If's is the size of the source and d its distance from the plane of the two slits, what should be the criterion for the interference fringes to be seen?

46. What is the diffraction of light? Draw a graph showing the variation of intensity with the angle in a single slit diffraction experiment. Write one feature which distinguishes the observed pattern from the double-slit interference pattern. How would the diffraction pattern of a single slit be affected when (i) the width of the slit is decreased,

(ii) The monochromatic source of light is replaced by a source of white light.

47. State the condition under which the phenomenon of diffraction of light takes place. Derive an expression for the width of the central maximum due to the diffraction of light at a single slit. A slit of width 'a' is illuminated by monochromatic light of wavelength 700 nm at normal incidence. Calculate the value of 'a' for the position of

(i) first minimum at an angle of diffraction of 30^0.

(ii) first maximum at an angle of diffraction of 30^0.

48. (a) What is plane-polarized light? Two polaroids are placed at 90^0 to each other and the transmitted intensity is zero. What happens when one more polaroid is placed between these two, bisecting the angle between them? How will the intensity of transmitted light vary on further rotating the third polaroid?

(b) If a light beam shows no intensity variation

(c) If a light beam shows no intensity variation when transmitted through a polaroid which is rotated, does it mean that the light is unpolarised? Explain briefly.