CHAPTER- 10
WAVE OPTICS

One mark questions

1. Who gave the corpuscular model for light before Newton? (K)
2. What was the drawback of corpuscular theory of light? (K)
3. Who proposed wave theory of light? (K)
4. Who proved experimentally that the speed of light in denser medium is less than in rarer medium? (K)
5. Which model of light predicted that the speed of light in denser medium is less than in rarer medium? (K)
6. Why wave theory of light was not readily accepted in the beginning? (U)
7. Who experimentally proved the wave nature of light? (K)
8. Which experiment proved the wave theory of light? (K)
9. Who proposed electromagnetic theory of light? (K)
10. What is the nature of light waves according to Maxwell's electromagnetic theory of light? (K)
11. Define a wave front. (U)
12. What is the shape of a wave front obtained from a point source? (K)
13. Which type of wave front is obtained by a point source at a very large distance? (K)
14. To get a cylindrical wave front what should be the shape of the light source? (K)
15. What is the shape of the wave front obtained from a distant star? (K)
16. Which type of wave front is obtained when a plane wave is reflected by a concave mirror? (K)
17. State Huygens' Principle. (K)
18. Name the physicist who experimentally studied the interference of light for the first time. (K)
19. State the principle of superposition of waves. (U)
20. *What is* interference of light? (K)
21. What is constructive interference of light? (U)
22. What is destructive interference of light? (U)
23. Define fringe width of interference pattern in Young's double slit experiment. (U)
24. Write the expression for fringe width of interference pattern in Young's double slit experiment.(K)
25. What is the effect on the interference fringes in Young's double-slit experiment when the monochromatic source is replaced by a source of white light? (U)
26. How does the fringe width of interference pattern vary with the wavelength of incident light? (K)
27. How does the fringe width of interference pattern vary with the intensity of incident light? (K)
28. Draw the graph of the intensity distribution of light in Young's double-slit experiment. (S)
29. Instead of using two slits as in Young's experiment, if two separate but identical sodium lamps are used, what is the result on interference pattern? (U)
30. Does longitudinal wave exhibit the phenomenon of interference? (K)
31. If Young's double slit experiment is performed in water, what will be the effect on the fringe width? (U)
32. In which direction the energy of the light wave travels with respect to the wave front? (K)

33. Do the backward moving wave fronts exist in Huygens wave model for light? (K)

34. Young's double slit experiment is performed using red light. If red light is replaced by blue light, what is the effect on the fringe width of interference pattern? (K)

35. What happens to the fringe width of interference pattern when the distance of separation between two slits is doubled in Young's experiment? (U)

36. The distance between the slits and the screen in Young's double slit experiment is doubled. What happens to the fringe width? (U)

37. Let the fringe width in Young's double slit experiment be β. What is the fringe width if the distance between the slits and the screen is doubled and slit separation is halved?(U)

38. *What is the intensity of light due to constructive interference in Young's double slit experiment if the intensity of light emerging from each slit is I_o? (U)*

39. In a single slit diffraction experiment if the width of the slit is doubled what happens to the width of the central diffraction band? (U)

40. Name a phenomenon which confirms the wave nature of light. (K)

41. What is diffraction of light? (K)

42. Which colour of light undergoes diffraction to the maximum extent? (U)

43. How will the diffraction pattern due to a single slit change if violet light replaces green light? (U)

44. Do all types of waves exhibit diffraction or only light waves? (K)

45. What happens to the resolving power of an optical instrument when the wavelength of light used is increased? (U)

46. Define the resolving power of an optical instrument. (U)

47. Write the expression for limit of resolution of telescope. (K)

48. How can resolving power of telescope be increased? (U)

49. Name a factor which affects the resolving power of a microscope. (K)

50. Mention the expression for limit of resolution of microscope. (K)

51. Express Doppler shift in terms of wavelength of light used. (K)

52. Write the formula for the Doppler shift in terms of frequency of light used. (K)

53. Give one application of the study of Doppler effect in light. (U)

54. Which phenomenon confirms the transverse wave nature of light? (K)

55. What is polarization of light? (K)

56. What is pass axis of the Polaroid? (K)

57. By what percentage the intensity of light decreases when an ordinary unpolarised (like from sodium lamp) light is passed through a Polaroid sheet? (K)

58. The intensity of incident light on a Polaroid P_1 is I. What is the intensity of light crossing another Polaroid P_2 *when* the pass-axis of P_2 makes an angle 90^o with the pass-axis of P_1? (U)

59. What should be the angle between the pass axes of two Polaroids to get the maximum intensity of transmitted light form the second Polaroid? (U)

60. State Brewster's Law. (K)

61. Define Brewster's angle (OR polarising angle). (U)

62. Write the relation between refractive index of a medium (reflector) and polarising angle. (K)

63. The intensity of light incident on a polariser is I and that of the light emerging from it is also I. Is the incident light polarised or unpolarised? (U)

64. A ray of light is incident at polarising angle on a glass plate. What is the angle between the reflected ray and refracted ray? (U)

65. What is partially polarised light? (K)

66. When can we have total transmission of light through a prism? (K)

67. Does the polarising angle depend on the refractive index of that medium? (K)

Two mark questions

1. Name the two theories of light in support of its wave nature. (K)
2. What are coherent sources? Give an example. (K)
3. Can two sodium vapour lamps be considered as coherent sources? Justify your answer. (U)
4. Which of the two, red and yellow produces wider interference fringes? Why? (U)
5. Name any two factors affecting fringe width of interference pattern in Young's double slit experiment. (K)
6. Is it possible to conclude that light is either transverse or longitudinal wave from interference phenomenon? Justify your answer. (U)
7. Write the conditions for constructive and destructive interference in terms of path difference of interfering waves. (U)
8. Mention the conditions for constructive interference in terms of path difference and phase difference. (U)
9. Write the conditions for constructive and destructive interference in terms of phase difference of interfering waves. (U)
10. Mention the conditions for destructive interference in terms of path difference and phase difference of interfering waves. (U)
11. We do not encounter diffraction effects of light in everyday observations. Explain why? (U)
12. Why diffraction effects due to sound waves are more noticeable than due to light waves? (U)
13. Explain how the principle of conservation of energy is consistent with interference and diffraction phenomena of light. (U)
14. Mention the conditions for diffraction minima and maxima in diffraction due to single slit. (K)
15. Represent graphically the variation of intensity of light due to diffraction at single slit. (S)
16. Give any two methods of increasing the resolving power of a microscope. (K)
17. What is Fresnel distance? Write its expression. (K)
18. What is red shift? What is its significance? (U)
19. What is blue shift? When does it occur? (U)
20. Write the mathematical expression for Malus law and explain the terms. (K)
21. Diagrammatically represent polarised light and unpolarised light. (S)
22. Mention any two methods of producing plane polarised light. (K)
23. Write any two uses of Polaroids. (K)
24. An unpolarised light is incident on a plane glass surface. Find the angle of incidence so that the reflected and refracted rays are perpendicular to each other? (For glass n = 1.5). (A)

    OR Give the value of Brewster angle for air to glass transmission of light if the refractive index of glass is 1.5. (A) [Ans.: $56^{o}18'$]
25. The polarising angle for a medium is 52^{0}. Find its critical angle? (A) [Ans.: 51.4^{o}]

26. Brewster's angle for a certain medium is 52^{o}. Find the refractive index of the medium? (A) [Ans.: n = 1.48]
27. The refractive index of certain glass is 1.5 for light whose wavelength in vacuum is 600nm. Find the wavelength of this light in glass? (A) [Ans.: 400nm]

Three mark questions

1. Who solved the major drawback of Huygens's wave theory? Explain how it was solved. (U)
2. Using Huygens wave theory of light, show that the angle of incidence is equal to angle of reflection in case of reflection of a plane wave by a plane surface. (U)
3. Using Huygens principle show that the frequency of light wave remains the same when light travels from one optical medium to another. (U)
4. Draw diagram representing refraction of a plane wave incident on a rarer medium from a denser medium, and explain critical angle and total internal reflection. (S) (U)
5. Illustrate with the help of suitable diagram, the refraction of a plane wave by (i) a thin prism (ii) a convex lens and reflection by a concave mirror. (S)
6. What is Doppler's effect in light? Write the formula for the Doppler shift. Where it is used? (U)
7. Briefly describe Young's double slit experiment with the help of a schematic diagram. (U) (S)
8. Give the theory of interference of light. (U)
9. Arrive at the condition for constructive and destructive interference in terms of phase difference between the two waves. (U)
10. What is the effect on (i) the angular fringe width (ii) the linear fringe width in Young's double-slit experiment due to each of the following operations:
(a) The screen is moved away from the plane of the slits
(b) One monochromatic source is replaced by another monochromatic source of shorter wavelength and
(c) The separation between the two slits is increased? (U)
11. Why interference pattern cannot be seen when pin hole of young's double slit experiment is illuminated by two identical but separate sodium sources? Explain (U)
12. How to get two coherent sources of light? Why they are said to be coherent? (U)
13. Compare the interference pattern of light obtained by young's double slit experiment with diffraction pattern due to single slit. (U)
14. Obtain the expression for limit of resolution of microscope. (U)
15. Briefly explain Polarization by reflection with the help of a diagram. (U) (S)
16. With the help of a diagram explain how polarised sun light is produced by scattering. (U) (S)
17. Show that the refractive index of a reflector is equal to tangent of the polarising angle.
OR show that $n = \tan i_B$ *OR* Arrive at Brewster's law. (U)
18. What are Polaroids? Mention any two uses of Polaroids. (K)

Five mark questions

1. Using Huygens's wave theory of light, derive Snell's law of refraction. (U)
2. Obtain the expressions for resultant displacement and amplitude when two light waves having same amplitude and a phase difference ϕ superpose. Hence give the conditions for constructive and destructive interference in terms of path difference/phase difference.

   OR

   Give the theory of interference. Hence arrive at the conditions for constructive and destructive interferences in terms of path difference/phase difference. (U)
3. Derive the expression for the width of interference fringes in Young's double slit experiment. (U)
4. Explain the phenomenon of diffraction of light due to a single slit and mention the conditions for diffraction minima and maxima. (U)
5. State Brewster's law and arrive at it. (U)

NUMERICAL PROBLEMS

1. Light is incident on a glass plate at an angle of 60^o. The reflected and refracted rays are mutually perpendicular to each other. Calculate the refractive index of the material of the plate? (A)

   [**n = 1.732]**
2. In a Young's double-slit experiment, the slits are separated by 2.8 mm and the screen is placed 1.4 m away. The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2 mm. Determine the wavelength of light used in the experiment. Also find the distance of fifth dark fringe from the central bright fringe. (A) [**600nm and 1.35mm]**
3. A beam of unpolarised is incident on an arrangement of two Polaroids successively. If the angle between the pass axes of the two Polaroids is 60^0, then what percentage of light intensity emerges out of the second Polaroid sheet? (A) **[12.5%]**
4. An optical instrument resolves two points at a distance from it using light of wavelengths 450nm and 600nm, find the ratio of their respective resolving powers.(A) **[4:3]**
5. A monochromatic light of wavelength 700 nm is incident on a 3.5 mm wide aperture. Find the distance up to which the ray of light can travel so that its spread is less than the size of the aperture. (A) **[17.5 m]**
6. Assume that light of wavelength 5000Å is coming from a star. What is the limit of resolution and resolving power of a telescope whose objective has a diameter of 200 inch? (A)

   [**1.2×10^{-7} rad and 0.83×10^{7}]**
7. In Young's double slit experiment the two slits are 0.3 mm apart and are illuminated by a light of wavelength 650 nm. Calculate the distance of (i) the 3rd dark and (ii) 5th bright fringes from the mid-point in the interference pattern obtained on a screen 1.2 m away from the slits. (A)

   ` **[(i) 6.5mm (ii) 13 mm]**
8. In Young's double slit experiment, fringes of certain width are produced on the screen kept at a certain distance from the slits. When the screen is moved away from the slits by 0.1m, fringe width increases by 6×10^{-5} m. The separation between the slits is 1 mm. Calculate the wavelength of the light used. (A) **[600nm]**

9. In Young's double slit experiment, distances between 2nd and 10th bright fringes for a light of wavelength 486nm is same as that of the distance between 3rd and 9th bright fringes for the light of different wavelength is used. Find the wavelength of light. (A) [**648nm]**

10. In Young's double slit experiment with monochromatic light and slit separation of 1.2mm, the fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5cm towards the slits, the change in fringe width is 20 μm. Calculate the wavelength of the light used. (A) **[480 nm]**

11. A parallel beam of light of wavelength 625 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 80 cm away. It is observed that the first minimum is at a distance of 2.5 mm from the center of the screen. Find the (i) width of the slit (ii) angular width of central maximum.(iii) linear width of central maximum.(A) **[(i) 0.2 mm (ii)0.00625 rad (iii) 5mm]**

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