LJPS Gurgaon	**Class – XII- Physics - Assignment** **Topic: -** ***Wave Optics***

1. If the angle between the planes of the polarizer and analyser is 60 degree, by what factor does the intensity of transmitted light change when passing through the analyser?

2. Draw wave fronts emerging out of a convex lens when a point source of light is placed at its force?

3. Sketch the variation of intensity of the interference pattern in young's double slit experiment.

4. What is the polarizing angle of medium of refractive index $\sqrt{3}$?

5. What is the polarizing angle of medium of refractive index1.732?

6. What is the shape of the wavefront in each of the following cases:
1. light diverging from a point source.
2. light emerging out of a convex lens when a point source is placed at its focus.
3. The portion of the wavefront of light from a distant star intercepted by the earth.

7. two coherent sources emit waves of amplitude and 2a. They meet at a point P equidistant from the two sources. If the intensity of the first is I, what is the resultant intensity at point P?

[Ans: 9I]

8.A ray of light falls on a transparent slab of refractive index 1.732. If reduced and refracted rays are mutually perpendicular, what is the angle of incidence?

[Ans : $i_P = 60^\circ$ **]**

9. Two Polaroids $P_1 and P_2$ are placed 90 degree to each other. Find the transmitted intensity if a third Polaroid P_3 is placed between $P_1 and P_2$ bisecting the angle between them.

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

[Ans: 560nm]

11. Find the ratio of intensities of two points P and Q on a screen in a young double slit experiment when waves from sources $S_1 and S_2$ have phase difference of (i) $\frac{\pi}{3}$ and

(ii) $\frac{\pi}{2}$ **[Ans: 3:2]**

12. The refractive index of the denser medium is 1.732 Calculate:
(i) the polarizing angle of medium.
(ii) the angle of refraction.

[Ans :(i) 60 degree (ii) 30 degree.

13. in a Young double slit interference experiment , the first minima on the screen is found Just in front of one of the slits when the slits are illuminated with a monochrome source of wavelength 6000Å. If the distance of the screen from the slits is 60 cm , calculate the separation between the slits.

14. The ratio of intensity at maxima and minima is 25 : 16. What will be the ratio of the width of the two slits in Young's double slit experiment?

15. What is the effect on the interference fringes in a Young's double slit experiment due to each of the following operations:
1. the screen is moved away from the plane of the slits;
2. the (monochromatic) source is replaced by another (monochromatic) source of shorter wavelength
3. the separation between the two slits is increased
4. the source slit is moved closer to the double – slits plane;
5. the width of the source slit is increased;
6. the monochromatic source is replaced by source of white light
In each operation, take all parameters other than the one specified, to remain unchanged.

16. Light of wavelength 5000 Å falls on a plane reflecting surface. What are the wavelength and frequency of the reflected light? For what angle of incidence is is the reflected ray normal to the incident ray?

[Ans: 5000 Å, 6 $\times 10^{14} Hz; 45^{\circ}$ **]**

17. 1. The refractive index of glass is 1.5. What is the speed of light in glass? (Speed of light in Vacuum is 3.0 $\times 10^{8} ms^{-1}$ **[Ans: 2.0** $\times 10^{8} ms^{-1}$**]**

2.Is the speed of light in glass Independent of the color of light? If not, which of the two colors red and violet travels slower in a glass prism?

[Ans: No, Violet travels shower]

18. In a Young's experiment the width of the fringes obtained with light of wavelength 6000 Å is 2.0mm. What will be the fringe width if the entire apparatus is immersed in a liquid of refractive index 1.33?

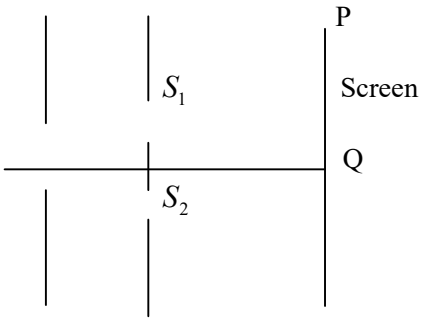
[Ans: 1.33]

19. in a double slit experiments the angular width of a fringe is found to be 0.2 degree on a screen placed 1 m away. The wavelength of light used is 600 nm. What will be the angular width of fringe if the entire experimental apparatus is immersed in water? Take refractive index of water into be 4/3.

20. What are coherent sources? How does the width of interferences fringes in Young's double slit experiment change when?
(a) The distance between the slits and screen is decreased.
(b) Frequency of the source is increased.
Justify your answer.

21. Using Huygen's principle explain the refraction of a plane wave front at a plane surface. Hence prove Snell's law.

22. The figure given below shows an experimental set up for Young's double slit experiment to observe interference of light on the screen OP. Given :
($S_1P-S_2P = \lambda/4$). Find condition for maxima & minima.



23. In Young's double slit experiment, explain with reason what happens to the interference fringes when
i. width of the slits are increased.
ii. Monochromatic light source is replaced by a white light source and
iii. One of slit is closed

24. What is meant by interference of light?
In a double 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 slits is 10^{-3} m, calculate the wavelength of light used.

25. Which of the following can be polarized?
(i) X rays (ii) sound waves. Give reason

Two Polaroids are used to study polarization. One of them (The polarizer) is kept fixed and other (the analyser) is initially kept with its axis parallel to the polarizer axis. The analyser in then rotated through angles of 45 degree, 90 degree and 180 degree in turn. How would the intensity of light coming out of the analyser be affected for these angles of rotation, as compared to the initial intensity and why?

26. Why is Diffraction of sound waves more easily observed than diffraction of light waves? A monochromatic light of wavelength diffraction of light waves.? A slit of width X is illuminated by monochromatic light of wavelength 650 nm at normal incidence. Calculate the value of X for the position of (i)first minimum at an angle of diffraction of 30 degree and (ii) first maximum at an angle of diffraction of 30 degree

[Ans : (i) d = $1300\times10^{-9}m$ (ii) d = $1950\times10^{-9}m$

27. What is the phenomenon of polarization? Derive the relation connecting the polarizing angle of a medium and its refractive index?

28. Verify Snell's law of reflection using Huygen's wave theory?

29. A slit of width d is illuminated by light of wavelength 6500 Å. For what values of d will the
i. first minimum fall at an angle of diffraction of 30 degree/
ii. first maximum fall at an angle of diffraction of 30 degree?

[Ans: $13\times10^{7}m$, (ii) 19.5 $\times10^{7}m$]

30. Monochromatic light of wavelength 589nm is incident from air on a water surface. What are the wavelength, frequency and speed of (a) reflected, and (b) refracted light ? Refractive index of water is 1.33.

Ans. 2.25 x 10^{8}m/s

31. In YDSE, the two slits pass the light of intensities I_0 and $4I_0$ and the interference pattern is obtained on the screen, then answer the following;
a. Ratio of widths of two S_1 and S_2.
b. Amplitude ratio of two waves.

Ans. ¼ , ½

32. a. The refractive index of glass is 1.5. What is the speed of light in glass ? (Speed of light in vacuum is 3.0 x 10^{8} ms^{-1})

Ans. 2 x 10^8 ms^{-1}

b. Is the speed of light in glass independent of the colour of light ? If not, which of the two colours red and violet travels slower in a glass prism ?

33. In a Young's double-slit experiment, the slits are separated by 0.28mm and the screen is placed 1.4m away. The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2cm. Determine the wavelength of light used in the experiment. Ans. 600nm

34. In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of light at a point where path difference is $\lambda/3$? Ans. K/4 units

35. In a double-slit experiment, the angular width of a fringe is found to be 0.2^0 on a screen placed 1m away. the wavelength of light used is 600nm. What will be the angular width of the fringe if the entire experimental apparatus is immersed in water ? Take refractive index of water to be 4/3. Ans. 0.15^0

36. Estimate the distance for which ray optics is good approximation for an aperture of 4mm and wavelength 400nm. Ans. 40m

37. Two towers on top of two hills are 40km apart. The line joining them passes 50 m above a hill halfway between the towers. What is the longest wavelength of radio waves, which can be sent between the towers without appreciable diffraction effects ? Ans. 12.5cm

38. When a low flying aircraft passes overhead, we sometimes notice a slight shaking of the picture on our TV screen. Suggest a possible explanation.

39. As you have learnt in the text, the principle of linear superposition of wave displacement is basic to understanding intensity distributions in diffraction and interference patterns. What is the justification of this principle ?

40. How does the fringe width, in Young's double slit experiment, change when the distance of separation between the slits and screen is doubled ?

41. An unpolarised light of intensity I is passed through a Polaroid. What is the intensity of the light transmitted by the Polaroid ?

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

43. What is meant by interference of light ?

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

45. When light travels from a rarer to denser medium, the speed decreases. Does the reduction in speed imply a reduction in the energy carried by the light wave ?

46. In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determine the intensity of light in the photon picture of light.

47. Sketch the shape of wavefront emerging from a point source of light and also mark the rays.

48. What type of wavefront will emerge from a (i) point source, and (ii) distant light source ?

49. a. In Young's slit experiment, derive the condition for (i) constructive interference, and (ii) destructive interference at a point on the screen.

    b. A beam of light consisting of two wavelengths, 800nm and 600nm is used to obtain the interference fringes in a Young's double slit experiment on a screen placed 1.4m away. If the two slits are separated by 0.28mm, calculate the least distance from the central bright maximum where the bright fringes of te two wavelengths coincide.

    Ans.12 $x10^{-3}$m

50. What is the ratio of the fringe width for bright and dark fringes in Young's double slit experiment ?

51. One of the two slits in Young's double slit experiment is so painted that it transmits half the intensity of the other. What is the effect on interference fringes ?

52. Draw the wavefront, if a point source is placed at point 2F of a convex lens.

53. Find the ratio of intensities of two points P and Q on a screen in Young's double slit experiment when waves from source S1 and S2 have phase difference of (i) 0^0, (ii) $\pi/2$ respectively. Ans. i. $4I_0$ ii. 2:1

54. For a single slit of width a, the first minimum of the interference pattern of a monochromatic light of wavelength occurs at an angle of λ/a. At the same angle of λ/a, we get a maximum for two narrow slits separated by a distance a. Explain.

55. Define resolving power of a compound microscope. How does the revolving power of a compound microscope change when
i. refractive index of the medium between the object and objective lens increases ?
ii. Wavelength of the radiation used is increased ?

56. How will the interference pattern in Young's double slit experiment get affected, when (i) distance between the slits S_1 and S_2 is reduced, and (ii) the entire set-up is immersed in water ? Justify your answer in each case.

57. Is the phenomenon of interference of light in accordance with the law of conservation of energy ? justify .

58. a. In what way is diffraction from each slit related to the interference pattern in a double slit experiment ?
b. Two wavelengths of sodium light 590nm and 596nm are used, in turn, to study the diffraction taking place at a single slit of aperture 2×10^{-4}m. The distance between the slit and the screen is 1.5m. Calculate the separation between the positions of the first maxima of the diffraction pattern obtained in the two cases. Ans. 6.75×10^{-5}m

with the help of Young's arrangement to produce interference pattern, an expression for the fringe width.

59. Sketch of a graph showing the variation of fringe width versus the distance of the screen from the plane of the slits (keeping other parameters same) in Young's double slit experiment. What information can one obtain from the slope of this graph ?

64. Two polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity $I_0$is incident on P_1. A third Polaroid P_3 is kept in between P_1 and P_2 such that its pass axis makes an angle of 45^0 with that of P_1. Determine the intensity of light transmitted through P_1, P_2 and P_3. Ans. $I_0/8$

60. In the double-slit experiment, the pattern on the screen is due to superposition of single-slit diffraction from each slit. Justify this statement.

65. a. Light passes through two polaroids P_1 and P_2 with pass –axis of P_2 making an angle θ with the pass-axis of P_1. For what value of θ is the intensity of emergent light zero ?

b. A third Polaroid is placed between P_1 and P_2 with its pass –axis making an angle β with the pass-axis of P_1. Find a value of β for which the intensity of light emerging from P_2 is I0/8, where I_0 is the intensity of light on the Polaroid P_1.

61. Using the phenomenon of polarization, show how transverse nature of light can be demonstrated.

62. a. distinguish between unpolarised and linearly polarized light.
b. A partially plane polarized beam of light is passed through a polarized. Show graphically the variation of the transmitted light intensity with angle of rotation of the Polaroid.

66. In a double slit interference experiment, the two coherent beams have slightly different intensities I and I+ δI (δI <<I). Show that the resultant intensity at the maxima is nearly 4I while that at the mixima is nearly $[\delta I]^2/4I$. Ans. ¼.$(\delta I)^2/I$

63. Why can not two independent monochromatic sources produce sustained interference patterns ? Deduce,

67. a. State Huygen's principle. Using this principle draw a diagram to show how a plane wavefront incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence verify Snell's law of refraction.

    b. When monochromatic light travels from a rarer to a denser medium, explain the following, giving reasons;

    i. Is the frequency of reflected and refracted light same as the frequency of incident light ?

    ii. does the decrease in speed imply a reduction in the energy carried by light wave ?

68. a. i. two independent monochromatic sources of light can not produce a sustained interference pattern. Give reason.
    ii. Light waves each of amplitude a and frequency, emanating from two coherent light sources superpose at a point. If the displacements due to these waves is given by $y_1 = a \cos t$ and $y_2 = a \cos (\omega t + \phi)$, where is the phase difference between the two, obtain the expression for the resultant intensity at the point.

69. In Young's double slit experiment, using monochromatic light of wavelength, the intensity of light at a point on the screen where path difference is, is K units. Find out the intensity of light at a point where path difference is $\lambda/3$. Ans. a.ii. $\phi/2$ b. k/4

70. In Young's double slit experiment, describe briefly how bright and dark fringes are obtained on the screen kept in front of a double slit. Hence obtain the expression for the fringe width.

71. The ratio of the intensities at minima to the maxima in the Young's double slit experiment is 9:25. Find the ratio of the widths of the two slits. Ans. 16/1

72. In Young's double slit experiment, deduce the conditions for obtaining constructive and destructive interference fringes. Hence deduce the expression for the fringe width.

73. Show that the fringe pattern on the screen is actually a superposition of single slit diffraction from each slit.

74. What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern, for green light of wavelength 500nm, if the separation between two slits is 1mm ? Ans. 0.2mm

75. 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 ?

76. Obtain the conditions for getting dark and bright fringes in young's experiment. Hence write the expression for the fringe width.

77. 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 ?

78. Using Huygen's construction of secondary wavelets explain how diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.

79. Show that the angular width of the first diffraction fringe is half that of the central fringe.

80. Explain why the maxima at $\theta = (n + \frac{1}{2})\lambda/a$ become weaker and weaker with increasing n.

81. Write three characteristic features to distinguish between the interference fringes in Young's double slit experiment and the diffraction pattern obtained due to a narrow single slit.

82. A parallel beam of light of wavelength 500nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is a distance of 2.5 mm away from the centre. Find the width of the slit. Ans. 200μm.

83. In Young's double slit experiment, deduce the condition for (a) constrictive and (b) destructive interference at a point on the screen. Draw a graph showing variable of intensity in the interference pattern against position x on the screen.

84. Compare the interference pattern observed inYoung's double slit experiment with single slit diffraction pattern, pointing out three distinguishing features.

distance of the screen from the slits is 60cm, calculate the separation between the slits. Ans. 6 x 10^{-4}m

85. In a double slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. I the screen is moved by 5 x 10^{-2} m towards the slits, the change in fringe width is 3 x 10^{-5} m. If the distance between slits is 10^{-3}m. Calculate the wavelength of light used. Ans. 6 x10^{-7}m

86. Laser light of wavelength 630 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 7.2mm. Calculate the wavelength of another sources of laser light which produces interference fringes separated by 8.1 mm using same pair of slits. Ans. 708.75nm

87. In an interference experiment, the amplitudes of the two waves are of 2 units each. Calculate the resultant amplitude at a point P in the interference pattern where the wave meet
a. with a phase difference of 60^0.
b. With a path difference of λ/2. Consider the interfering waves to be in phase initially.
Ans. a. 2√3 unit b. 0 unit

88. In a Young's double slit interference experiment, the first minima on the screen is found just in front of one of the slits when the slits are illuminated with a monochromatic source of wavelength 6000Å. If the

89. A parallel beam of monochromatic light of wavelength 500nm falls normally on a narrow slit and the resulting diffraction pattern is obtained on a screen 1m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find
a. the width of the slit.
b. the distance of the second maximum from the centre of the screen.
c. the width of the central maximum.

90. In a Young's experiment the width of the fringes obtained with light of wavelength 6000Å is 2.0mm. What will be the fringe width if the entire apparatus is immersed in a liquid of refractive index 1.33 ?
Ans. 1.50mm

91. In Young's double slit experiment, two slits are separated by 3mm distance and illuminated by light of wavelength 480 nm. The screen is at 2m from the plane of the slits. Calculate the separation between the 8^{th} bright fringe and the 3^{rd} dark fringe observed with respect to the central bright fringe. Ans. 1.76 x 10^{-3}m

92. In a single slit diffraction experiment, the first minima for red light (660nm) coincide with first maxima of some other wavelength λ'. Find the value of λ'.

Ans. 440nm

93. In a single slit diffraction experiment, a slit of width d is illuminated by red light of wavelength 650nm. For what value of d will

a. the first minimum fall at an angle of diffraction of 30^0,

b. the first maximum fall at an angle of diffraction of 30^0 ?

Ans. i. 1300 x 10^{-9}m ii.1950 x 10^{-9}m

94. What is the value of polarizing angle of a medium of refractive index $\sqrt{3}$. Ans. 60^0

95. What is the effect on interference fringes in Young's double slit experiment if one stil is covered ?

96. Which nature of light is provided by polarization and explain why sound wave can not be polarized ?

97. Use Huygen's principle to explain the formation of diffraction pattern due to a single slit illuminated by a monochromatic source of light.

When the width of the slit is made double the original width, how would this affect the size and intensity of the central diffraction band.

98. a. Describe briefly how a diffraction pattern is obtained on a screen due to a single narrow slit illuminated by a monochromatic source of light. Hence obtain the conditions for the angular width of secondary maxima and secondary minima.

Ans. 58(a)

b. Two wavelengths of sodium light of 590 nm and 596nm are used in turn to study the diffraction taking place at a single slit of aperture 2 x 10^{-6}m. The distance between the slit and the screen is 1.5m. Calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases. Ans.6.75 x 10^{-3}m