WAVE OPTICS

FACT/DEFINITION TYPE QUESTIONS

1. The locus of all particles in a medium, vibrating in the same phase is called
   (a) wavelet
   (b) fringe
   (c) wave front
   (d) None of these
2. Which of the following is correct for light diverging from a point source?
   (a) The intensity decreases in proportion for the distance squared.
   (b) The wavefront is parabolic.
   (c) The intensity at the wavelingth does depend of the distance.
   (d) None of these.
3. Wavefront is the locus of all points, where the particles of the medium vibrate with the same
   (a) phase (b) amplitude
   (c) frequency (d) period
4. The phenomena which is not explained by Huygen's construction of wavefront
   (a) reflection (b) diffraction
   (c) refraction (d) origin of spectra
5. Huygen's concept of secondary wave
   (a) allows us to find the focal length of a thick lens
   (b) is a geometrical method to find a wavefront
   (c) is used to determine the velocity of light
   (d) is used to explain polarisation
6. A plane wave passes through a convex lens. The geometrical shape of the wavefront that emerges is
   (a) plane (b) diverging spherical
   (c) converging spherical (d) None of these
7. Spherical wavefronts, emanating from a point source, strike a plane reflecting surface. What will happen to these wave fronts, immediately after reflection?
   (a) They will remain spherical with the same curvature, both in magnitude and sign.
   (b) They will become plane wave fronts.
   (c) They will remain spherical, with the same curvature, but sign of curvature reversed.
   (d) They will remain spherical, but with different curvature, both in magnitude and sign.
8. When light suffers reflection at the interface between water and glass, the change of phase in the reflected wave is
   (a) zero (b) π
   (c) $\pi/2$ (d) 2π
9. Two plane wavefronts of light, one incident on a thin convex lens and another on the refracting face of a thin prism. After refraction at them, the emerging wavefronts respectively become
   (a) plane wavefront and plane wavefront
   (b) plane wavefront and spherical wavefront
   (c) spherical wavefront and plane wavefront
   (d) spherical wavefront and spherical wavefront
   (e) elliptical wavefront and spherical wavefront
10. When a film is illuminated by white light, its upper portion appears dark. Path difference between two reflected beams at the spot must be
    (a) zero (b) $\lambda/2$
    (c) $2\lambda/2$ (d) π
11. If two coherent sources are vibrating in phase then we have constructive interference at any point P whenever the path difference is
    (a) $\left(n+\frac{1}{2}\right)\lambda$ (b) $\frac{n\lambda}{2}$
    (c) $\left(n-\frac{1}{2}\right)\lambda$ (d) $n\lambda$
12. If two sources are coherent, then the phase difference (ϕ) between the waves produced by them at any point
    (a) will change with time and we will have stable positions of maxima and minima.
    (b) will not change with time and we have unstable positions of maxima and minima.
    (c) Positions of will not change with time and we will have stable positions of maxima and minima.
    (d) will change with time and we will have unstable positions of maxima and minima.
13. The device which produces highly coherent sources is
    (a) Fresnel biprism (b) Young's double slit
    (c) Laser (d) Lloyd's mirror

14. Which of the following, cannot produce two coherent sources?
(a) Lloyd's mirror (b) Fresnel biprism
(c) Young's double slit (d) Prism

15. Coherence is a measure of
(a) capability of producing interference by wave
(b) waves being diffracted
(c) waves being reflected
(d) waves being refracted

16. Two sources of light are said to be coherent, when they give light waves of same
(a) amplitude and phase
(b) wavelength and constant phase difference
(c) intensity and wavelength
(d) phase and speed

17. Intensity of light depends on
(a) amplitude (b) frequency
(c) wavelength (d) velocity

18. The colour of bright fringe nearest to central achromatic fringe in the interference pattern with white light will be
(a) violet (b) red
(c) green (d) yellow

19. The correct formula for fringe visibility is
(a) $V = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ (b) $V = \frac{I_{max} + I_{min}}{I_{max} - I_{min}}$
(c) $V = \frac{I_{max}}{I_{min}}$ (d) $V = \frac{I_{min}}{I_{max}}$

20. Laser light is considered to be coherent because it consists of
(a) many wavelengths
(b) uncoordinated wavelengths
(c) coordinated waves of exactly the same wavelength
(d) divergent beam

21. The interfering fringes formed by a thin oil film on water are seen in yellow light of sodium lamp. We find the fringes
(a) coloured
(b) black and white
(c) yellow and black
(d) coloured without yellow

22. In Young's Double slit experiment, if the distance between the slit and screen (D) is comparable with fringe width (B), the fringe pattern on screen will
(a) strictly be a parabola (b) strictly be a hyperbola
(c) be a elliptical (d) be a straight line

23. If Young's double slit experiment is performed in water keeping the rest of the set-up same, the fringes will
(a) increase in width (b) decrease in width
(c) remain unchanged (d) not be formed

24. In the Young's Double slit experiment, when we place a converging lens after the slits and place the screen at the focus of the lens, it
(a) introduces an extra path difference in the parallel beam.
(b) introduces no path difference in the parallel beam.
(c) introduces an extra phase difference in the parallel beam.
(d) introduces an extra fringe in the diffraction pattern.

25. The fringe width for red colours as compared to that for violet colour is approximately
(a) 3 times (b) 2 times
(c) 4 times (d) 8 times

26. In Young's double slit experiment, the minimum amplitude is obtained when the phase difference of super-imposing waves is (where n = 1, 2, 3, ...)
(a) zero (b) $(2n-1)\pi$
(c) $n\pi$ (d) $(n+1)\pi$

27. The fringe width in a Young's double slit experiment can be increased if we decrease
(a) width of slits
(b) separation of slits
(c) wavelength of light used
(d) distance between slits and screen

28. In Young's double slit experiment, one slit is covered with red filter and another slit is covered by green filter, then interference pattern will be
(a) red (b) green
(c) yellow (d) invisible

29. Instead of using two slits, if we use two separate identical sodium lamps in Young's experiment, which of the following will occur?
(a) General illumination
(b) Widely separate interference
(c) Very bright maxima
(d) Very dark minima

30. Which of the following is not essential for two sources of light in Young's double slit experiment to produce a sustained interference?
(a) Equal wavelength
(b) Equal intensity
(c) Constant phase relationship
(d) Equal frequency

31. In Young's double slit experiment, the locus of the point P lying in a plane with a constant path difference between the two interfering waves is
(a) a hyperbola (b) a straight line
(c) an ellipse (d) a parabola

32. If the width of the slit in single slit diffrection experiment is doubled, then the central maximum of diffraction pattern becomes
(a) broader and brighter (b) sharper and brighter
(c) sharper and fainter (d) broader adn fainter.

33. A diffraction pattern is obtained by using beam of red. light what will happen, if red light is replced by the blue light?
(a) Bands disappear.
(b) Bands become broader and farther apart.
(c) No change will take place.
(d) Diffraction bands become narrow and crowded together.

34. When monochromatic light is replaced by white light in Fresnel's biprism arrangement, the central fringe is
(a) coloured (b) white
(c) dark (d) None of these

35. The condition for observing Fraunhoffer diffraction from a single slit is that the light wavefront incident on the slit should be
(a) spherical (b) cylindrical
(c) plane (d) elliptical

36. The phenomenon of diffraction can be treated as interference phenomenon if the number of coherent sources is
(a) one (b) two
(c) zero (d) infinity

37. The diffraction effects in a microscopic specimen become important when the separation between two points is
(a) much greater than the wavelength of light used.
(b) much less than the wavelength of light used.
(c) comparable to the wavelength of light used.
(d) independent of the wavelength of light used.

38. What is the Brewester angle for air to glass transition? $(\mu_g^a = 1.5)$
(a) $\tan(1.5)$ (b) $\sin(1.5)$
(c) $\sin^{-1}(1.5)$ (d) $\tan^{-1}(1.5)$

39. When ordinary light is made incident on a quarter wave plate, the emergent light is
(a) linearly polarised (b) circulary polarised
(c) unpolarised (d) elliptically polarised

40. Transverse nature of light was confirmed by the phenomenon of
(a) refreaction of light (b) diffraction of light
(c) dispersion of light (d) polarization of light

41. In the case of linearly polarized light, the magnitude of the electric field vector
(a) is parallel to the direction of propagation
(b) does not changes with time
(c) increases linearly with time
(d) varies periodically with time

42. Unpolarized light is incident on a plane glass surface The angle of incidence so that reflected and refracted rays are perpendicular to each other, them
(a) $\tan i_\beta = \frac{\mu}{2}$ (b) $\tan i_\beta = \mu$
(c) $\sin i_\beta = \mu$ (d) $\cos i_\beta = \mu$

43. Light waves can be polarised because they
(a) have high frequencies (b) have short wavelength
(c) are transverse (d) can be reflected

44. Light transmitted by nicol prism is
(a) unpolarised (b) plane polarised
(c) circularly polarised (d) elliptically polarised

45. Optically active substances are those substances which
(a) produces polarised light
(b) produces double refraction
(c) rotate the plane of polarisation of polarised light
(d) converts a plane polarised light into circularly polarised light.

46. Polaroid glass is used in sun glasses because
(a) it reduces the light intensity to half on account of polarisation
(b) it is fashionable
(c) it has good colour
(d) it is cheaper.

47. In the propagation of light waves, the angle between the plane of vibration and plane of polarisaiton is
(a) 0° (b) 90° (c) 45° (d) 80°

48. In the propagation of electromagnetic waves, the angle between the direction of propagation and plane of polarisation is
(a) 0° (b) 45° (c) 90° (d) 180°

49. When unpolarised light is incident on a plane glass plate at Brewster's angle, then which of the following statements is correct?
(a) Reflected and refracted rays are completely polarised with their planes of polarization parallel to each other
(b) Reflected and refracted rays are completely polarised with their planes of polarization perpendicular to each other
(c) Reflected light is plane polarised but transmitted light is partially polarised
(d) Reflected light is partially polarised but refracted light is plane polarised

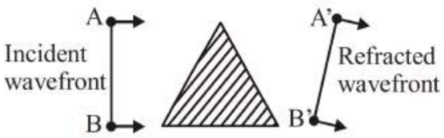
50. From Brewster's law of polarisation, it follows that the anlge of polarisaiton depends upon
(a) the wavelength of light
(b) plane of polarisation's orientation
(c) plane of vibration's orientation
(d) None of these

STATEMENT TYPE QUESTIONS

51. Shape of wavefront in case of
I. light diverging from a point source is spherical
II. light emerging out of a convex lens when a point source is placed at its focus is plane
III. the portion of the wavefront of light from a distant star intercepted by the Earth is plane.
Which of the above statements are correct?
(a) I and II (b) II and III
(c) I and III (d) I, II and III

52. Which of the following statements is/are correct ?
I. A point source emitting waves uniformly in all directions.
II. In spherical wave, the locus of point which have the some amplitude and vibrate in same phase are spheres.
III. At a small distance from the source, a small portion of sphere can be considered as plane wave.
(a) Only I (b) I and II
(c) Only III (d) I, II and III

53. Figure shows behavior of a wavefront when it passes through a prism.



Which of the following statements are correct ?
I. Lower portion of wavefront (B') is delayed resulting in a tilt.
II. Time taken by light to reach A' is equal to the time taken to reach B' from B.
III. Speed of wavefront is same everywhere.
IV. A particle on wavefront A' B' is in phase with a particle on wavefront AB.
(a) I and II (b) II and III
(c) III and IV (d) I and III

54. Which of the following cannot be explained on the basis of wave nature of light?
I Polarization II Total internal reflection
III Photoelectric effect IV Crompton effect
(a) II and III (b) III and IV
(c) IV and I (d) III only

55. The conditions for producing sustained interference are
I. phase difference between interfering waves remains constant with time.
II. interfering waves have nearly same amplitude levels.
III. interfering waves are of same frequency.
IV. interfering waves are moving in opposite directions.
(a) I, II and III (b) II and III
(c) III and IV (d) I and IV

56. Which of the following statement (s) is/are true about interference pattern due to double slits?
I. The interference pattern has equal number of bright and dark band width .
II. The pattern is obtained by superposition of two waves originating from the two narrow slits.
III. We get a minima at an angle of λ/a where 'a' is the distance between two slits
(a) I only (b) II only
(c) I and II only (d) I, II and III

57. In the double-slit experiment, the pattern on the screen is actually a superposition of ____ and ____.
I. single-slit diffraction from each slit
II. double-slit interference pattern
III. double-slit diffraction from each slit
IV. single-slit interference pattern
(a) I and II (b) I and III
(c) II and IV (d) II and III

58. Which of the following statements are true about the diffraction pattern?
I. It has a central bright maxima of twice the width of other maxima.
II. The first null occurs at an angle $\lambda/2a$.
III. The intensity of maxima falls as we move away from the central maxima.
IV. The bands are of decreasing width.
(a) II and III (b) I and II
(c) I, III and IV (d) I and III

59. Diffraction is a characteristic which is exhibited by
I. matter waves II. water waves
III. sound waves IV. light waves
(a) I and II (b) I, II and III
(c) III and IV (d) I, II, III and IV

60. We can listen to the sound on the other side of the wall but cannot see through it because
I. wavelength of light is greater than sound
II. wavelength of light is smaller than sound
III. wavelength of light is much smaller than the dimensions of most obstacles
IV. wavelength of sound is greater than the dimensions of most obstacles
(a) I and II (b) I, II and III
(c) II and III (d) I, III and IV

61. In order to observe good interference and diffraction pattern, the necessary and sufficient conditions are
I. the distance between the slits should be very small (~mm)
II. the slit width should be very small (~ mm)
III. the distance between the slits and the screen should be large (~ cm)
IV. the distance between slits and the screen should be small (~ mm)
(a) I and II (b) I and III
(c) I, II and III (d) II and III

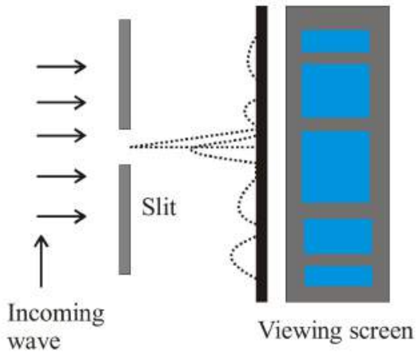
62. The resolving power of a telescope is limited by
I. the focal length of objective lens
II. the diameter of objective lens
III. the wavelength of the light used
IV. the thickness of the objective lens
(a) I and II (b) I, II and III
(c) II and III (d) I, III and IV

63. The magnification by objective lens of a microscope does not depend upon

I. the focal length of objective
II. the diameter of objective
III. the angle subtended by the diameter of the objective lens at the focus of the microscope
IV. the angle subtended by the eyepiece on the eye

(a) I and II (b) II and III
(c) III only (d) IV only

64. Diffraction at single slit, the figure shows



I. wavelength distribution
II. intensity distribution
III. diffraction
IV. fringe pattern

(a) I and II (b) II, III and IV
(c) II and IV (d) I III and IV

65. Which of the given statements is/are correct for phenomenon of diffraction ?

I. For diffraction through a single–slit, the wavelength of wave must be comparable to the size of the slit.
II. The diffraction is very common in sound waves but not so common in light waves.
III. Diffraction is only observed in electromagnetic waves.

(a) Only I (b) II and III
(c) I and II (d) I, II and III

66. Which of the following statements is/are correct ?

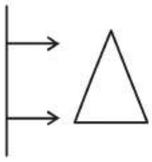
I. A polaroid consist of long chain molecules aligned in a particular direction.
II. Electric vectors along the direction of the aligned molecule in a polaroid gets absorbed.
III. An unpolarised light wave is incident on polaroid, then it will get linearly polarised.

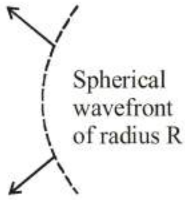
(a) Only I (b) II and III
(c) Only III (d) I, II and III

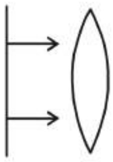
MATCHING TYPE QUESTIONS

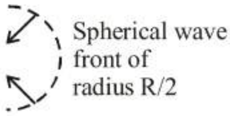
67. Match Plane wave incident on different surfaces. In column I with the emergent wavefront in Column II.

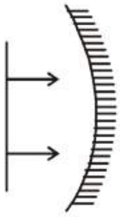
Column I **Column II.**

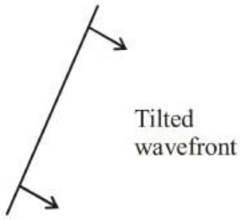
(A) 

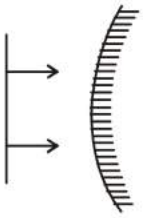
(1) 

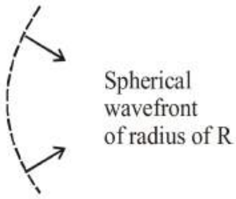
(B) 

(2) 

(C) 

(3) 

(D) 

(4) 

(a) (A) → (1); (B) → (3); (C) → (2); (D) → (4)
(b) (A) → (3); (B) → (4); (C) → (2); (D) → (1)
(c) (A) → (2); (B) → (4); (C) → (3); (D) → (1)
(d) (A) → (4); (B) → (2); (C) → (1); (D) → (3)

68.

Column I		Column II.	
(A)	Interference of light	(1)	$I = I_0 \cos^2 \theta$
(B)	Brewster's Law	(2)	Obstacle/aperture of size =1
(C)	Diffraction of light	(3)	$\mu = \tan i_p$
(D)	Law of Malus	(4)	Coherent sources

(a) (A) → (3); (B) → (4); (C) → (2); (D) → (1)
(b) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(c) (A) → (4); (B) → (3); (C) → (2); (D) → (1)
(d) (A) → (4); (B) → (3); (C) → (2); (D) → (1)

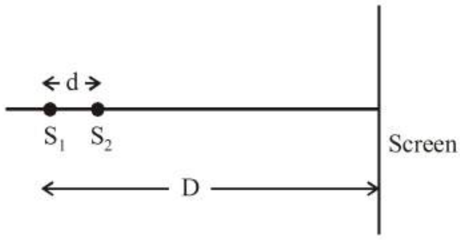
69.

	Column I		Column II.
(A)	Reflection	(1)	Used for reducing glare
(B)	Refraction	(2)	Change in path of light without change in medium
(C)	Interference	(3)	$\mu = \sin i / \sin r$
(D)	Polarization	(4)	Light added to light produces darkness

(a) (A) → (2); (B) → (3); (C) → (4); (D) → (1)
(b) (A) → (1); (B) → (2); (C) → (3); (D) → (4)
(c) (A) → (4); (B) → (3); (C) → (2); (D) → (1)
(d) (A) → (1); (B) → (3); (C) → (2); (D) → (1)

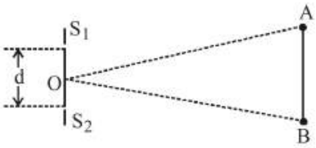
DIAGRAM TYPE QUESTIONS

70. Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown in figure. The fringes obtained on the screen will be



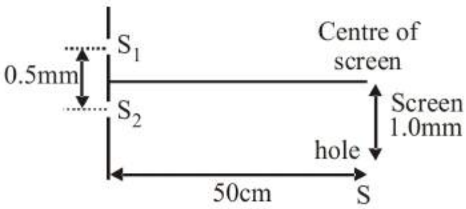
(a) points (b) straight lines
(c) semi-circles (d) concentric circles

71. Figure shows two coherent sources S_1 and S_2 vibrating in same phase. AB is an irregular wire lying at a far distance from the sources S_1 and S_2. Let $\frac{\lambda}{d} = 10^{-3}$ and $\angle BOA = 0.12°$. How many bright spots will be seen on the wire, including points A and B?



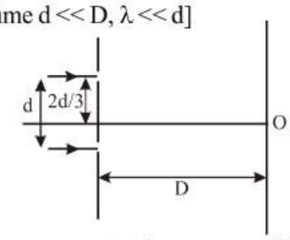
(a) 5 (b) 4 (c) 3 (d) 7

72. In Young's double slit experiment shown in figure S_1 and S_2 are coherent sources and S is the screen having a hole at a point 1.0mm away from the central line. White light (400 to 700nm) is sent through the slits. Which wavelength passing through the hole has strong intensity?



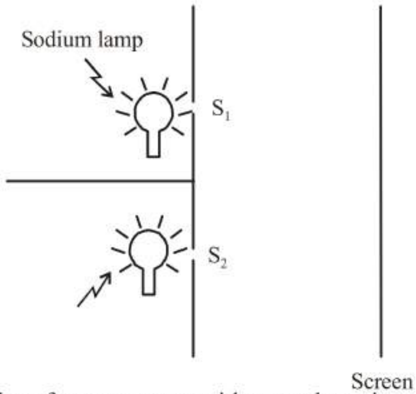
(a) 400nm (b) 700nm
(c) 500nm (d) 667nm

73. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the nearest white spot on the screen from O is d/A. Find the value of A. (assume $d << D$, $\lambda << d$]



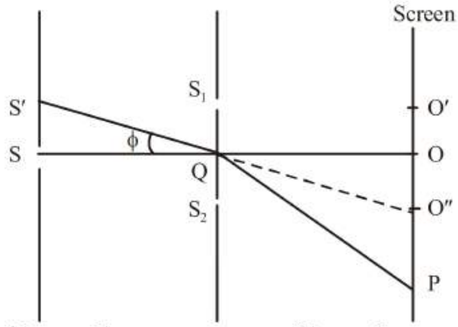
(a) 3
(b) 5
(c) 6
(d) 4

74. For the given arrangement, the screen will have



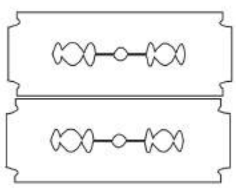
(a) interference pattern with central maxima
(b) interference pattern with central minima
(c) two separate interference patterns with central maxima
(d) doubly illuminated screen with no interference pattern at all

75. In the double slit experiment, the monochromatic source is shifted to a position S' at an angle ϕ above SQ. The position of central bright fringe will be



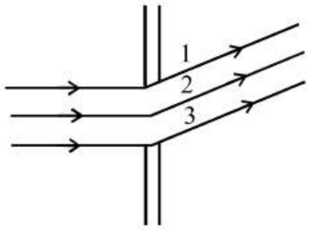
(a) at O' (b) at O
(c) at O'' (d) at P

76. A single-slit-diffraction pattern, through following arrangement using an electric bulb as the source of light only will be



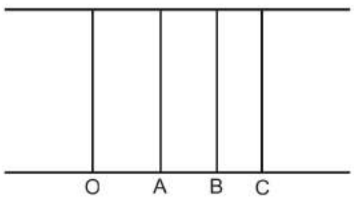
(a) central dark fringe followed by bright fringe of red colour
(b) central bright fringe followed by dark fringe than bands of varying intensity
(c) central bright fringe followed by dark fringe then wider red fringes and narrower blue fringes.
(d) central bright fringe followed by dark fringe then wider blue fringes followed by narrower red fringes.

77. The figure shows Fraunhoffer's diffraction due to a single slit. If first minimum is obtained in the direction shown, then the path difference between rays 1 and 3 is



(a) 0
(b) $\lambda/4$
(c) $\lambda/2$
(d) λ

78. The position of the direct image obtained at O, when a monochromatic beam of light is passed through a plane transmission grating at normal incidence as shown in Fig. The diffracted images A, B and C correspond to the first, second and third order diffraction. When the source is replaced by another source of shorter wave-length



(a) all the four will shift in the direction C to O
(b) all the four will shift in the direction O to C
(c) the images C, B and A will shift towards O
(d) the images C, B and A will shift away from O

ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

79. **Assertion :** According to Huygen's principle, no backward wave-front is possible.
Reason : Amplitude of secondary wavelet is proportional to $(1 + \cos\theta)$ where θ is the angle between the ray at the point of consideration and the direction of secondary wavelet.

80. **Assertion :** Thin film such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.
Reason : It happens due to the interference of light reflected from upper and lower face of the thin film.

81. **Assertion :** No interference pattern is detected when two coherent sources are infinitely close to each other.
Reason : The fringe width is inversely proportional to the distance between the two sources.

82. **Assertion :** It is necessary to have two waves of equal intensity to study interference pattern.
Reason : There will be an effect on clarity if the waves are of unequal intensity.

83. **Assertion :** White light falls on a double slit with one slit is covered by a green filter. The bright fringes observed are of green colour.
Reason : The fringes observed are coloured.

84. **Assertion :** In YDSE, if a thin film is introduced in front of the upper slit, then the fringe pattern shifts in the downward direction.
Reason : In YDSE if the slit widths are unequal, the minima will be completely dark.

85. **Assertion :** In YDSE, if $I_1 = 9I_0$ and $I_2 = 4I_0$ then $\frac{I_{max}}{I_{min}} = 25$.
Reason : In YDSE $I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$ and $I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$.

86. **Assertion :** In Young's double slit experiment if wavelength of incident monochromatic light is just doubled, number of bright fringe on the screen will increase.
Reason : Maximum number of bright fringe on the screen is inversely proportional to the wavelength of light used

87. **Assertion :** In YDSE number of bright fringe or dark fringe can not be unlimited
Reason : In YDSE path difference between the superposing waves can not be more than the distance between the slits.

88. **Assertion :** Interference pattern is made by using yellow light instead of red light, the fringes becomes narrower.
Reason : In YDSE, fringe width is given by $\beta = \frac{D\lambda}{d}$.

89. **Assertion :** Coloured spectrum is seen when we look through a muslin cloth.
Reason : It is due the diffraction of white light on passing through fine slits.

90. **Assertion :** Diffraction takes place for all types of waves mechanical or non-mechanical, transverse or longitudinal.
Reason : Diffraction's effect are perceptible only if wavelength of wave is comparable to dimensions of diffracting device.

CRITICAL THINKING TYPE QUESTIONS

91. On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam :

(a) bends downwards
(b) bends upwards
(c) becomes narrower
(d) goes horizontally without any deflection

92. Light from two coherent sources of the same amplitude A and wavelength λ illuminates the screen. The intensity of the central maximum is I_0. If the sources were incoherent, the intensity at the same point will be

(a) $4I_0$ (b) $2I_0$
(c) I_0 (d) $\frac{I_0}{2}$

93. Two light waves superimposing at the mid-point of the screen are coming from coherent sources of light with phase difference 3π rad. Their amplitudes are 1 cm each. The resultant amplitude at the given point will be.

(a) 5 cm (b) 3 cm
(c) 2 cm (d) zero

94. Two coherent sources of intensity ratio 1 : 4 produce an interference pattern. The fringe visibility will be

(a) 1 (b) 0.8
(c) 0.4 (d) 0.6

95. Two beams of light of intensity I_1 and I_2 interfere to give an interference pattern. If the ratio of maximum intensity to that of minimum intensity is 25/9, then I_1/I_2 is

(a) 5/3 (b) 4
(c) 81/625 (d) 16

96. In Young's double slit experiment with sodium vapour lamp of wavelength 589 nm and the slits 0.589 mm apart, the half angular width of the central maximum is

(a) $\sin^{-1}(0.01)$ (b) $\sin^{-1}(0.0001)$
(c) $\sin^{-1}(0.001)$ (d) $\sin^{-1}(0.1)$

97. The ratio of intensities at two points P and Q on a screen in young's double slit experiment when waves from sources S_1 and S_2 have phase difference of (a) 0° and (b) $\pi/2$ respectively, is

(a) 1 : 4 (b) 4 : 1
(c) 1 : 2 (d) 2 : 1

98. Laser light of wavelength 540 nm incident on a pair of slit produces interference pattern in which the bright fringes are separated by 9.00 mm. A second light on the same setup produces an interference pattern in which the fringes are separated by 8.1 mm. The wavelength of the second light is

(a) 720 nm (b) 486 nm
(c) 630 nm (d) 450 nm

99. In Young's double slit experiment, the source S and two slits A and B are lying in a horizontal plane. The slit A is above slit B. the fringes are obtained on a vertical screen K. The optical path from S to B is increased by putting a transparent material of higher refractive index. The path from S to A remains unchanged. As a result of this the fringe pattern moves somewhat

(a) upwards
(b) downwards
(c) towards left horizontally
(d) towards right horizontally

100. In a Young's double-slit experiment, let β be the fringe width, and let I_0 be the intensity at the central bright fringe. At a distance x from the central bright fringe, the intensity will be

(a) $I_0 \cos\left(\frac{x}{\beta}\right)$ (b) $I_0 \cos^2\left(\frac{x}{\beta}\right)$

(c) $I_0 \cos^2\left(\frac{\pi x}{\beta}\right)$ (d) $\left(\frac{I_0}{4}\right)\cos^2\left(\frac{\pi x}{\beta}\right)$

101. In Young's double slit experiment, the slits are 2 mm apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000$Å and $\lambda_2 = 10000$Å. At what minimum distance from the common central bright fringe on the screen 2 m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other ?

(a) 6mm (b) 4mm (c) 3mm (d) 8mm

102. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is

(a) three (b) five (c) infinite (d) zero

103. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of light used) is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to

(a) $\frac{3}{4}$ (b) $\frac{1}{\sqrt{2}}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{1}{2}$

104. In Young's double slit experiment, one of the slit is wider than other, so that amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I when they interfere at phase difference ϕ is given by

(a) $\frac{I_m}{9}(4+5\cos\phi)$ (b) $\frac{I_m}{3}\left(1+2\cos^2\frac{\phi}{2}\right)$

(c) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$ (d) $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$

105. Monochromatic light of wavelength 400 nm and 560 nm are incident simultaneously and normally on double slits apparatus whose slits separation is 0.1 mm and screen distance is 1m. Distance between areas of total darkness will be

(a) 4mm (b) 5.6mm (c) 14mm (d) 28mm

106. In Young's double slit experiment intensity at a point is (1/4) of the maximum intensity. Angular position of this point is

(a) $\sin^{-1}(\lambda/d)$ (b) $\sin^{-1}(\lambda/2d)$
(c) $\sin^{-1}(\lambda/3d)$ (d) $\sin^{-1}(\lambda/4d)$

107. In the Young's double slit experiment using a monochromatic light of wavelength λ, the path difference (in terms of an integer *n*) corresponding to any point having half the peak intensity is

(a) $(2n+1)\frac{\lambda}{2}$ (b) $(2n+1)\frac{\lambda}{4}$

(c) $(2n+1)\frac{\lambda}{8}$ (d) $(2n+1)\frac{\lambda}{16}$

108. Light of wavelength 6.5×10^{-7} m is made incident on two slits 1 mm apart. The distance between third dark fringe and fifth bright fringe on a screen distant 1 m from the slits will be

(a) 0.325 mm (b) 0.65 mm
(c) 1.625 mm (d) 3.25 mm

109. In Young's expt., the distance between two slits is $\frac{d}{3}$ and the distance between the screen and the slits is 3 D. The number of fringes in $\frac{1}{3}$m on the screen, formed by monochromatic light of wavelength 3λ, will be

(a) $\frac{d}{9D\lambda}$ (b) $\frac{d}{27D\lambda}$

(c) $\frac{d}{81D\lambda}$ (d) $\frac{d}{D\lambda}$

110. In Young's double slit expt. the distance between two sources is 0.1 mm. The distance of the screen from the source is 20 cm. Wavelength of light used is 5460 Å. The angular position of the first dark fringe is

(a) 0.08° (b) 0.16°
(c) 0.20° (d) 0.32°

111. The separation between successive fringes in a double slit arrangement is x. If the whole arrangement is dipped under water what will be the new fringe separation? [The wavelenght of light being used is 5000 Å]

(a) 1.5x (b) x
(c) 0.75x (d) 2x

112. In Young's double slit experiment, we get 10 fringes in the field of view of monochromatic light of wavelength 4000Å. If we use monochromatic light of wavelength 5000Å, then the number of fringes obtained in the same field of view is

(a) 8 (b) 10 (c) 40 (d) 50

113. With a monochromatic light, the fringe-width obtained in a Young's double slit experiment is 0.133 cm. The whole set-up is immersed in water of refractive index 1.33, then the new fringe-width is

(a) 0.133 cm (b) 0.1 cm

(c) 1.33×1.33 cm (d) $\frac{1.33}{2}$cm

114. A beam of light of λ = 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between first dark fringes on either side of the central bright fringe is

(a) 1.2 cm (b) 1.2 mm
(c) 2.4 cm (d) 2.4 mm

115. In the Young's double-slit experiment, the intensity of light at a point on the screen where the path difference is λ is K, (λ being the wave length of light used). The intensity at a point where the path difference is λ/4, will be

(a) K (b) K/4
(c) K/2 (d) Zero

116. In a double slit experiment, the two slits are 1 mm apart and the screen is placed 1 m away. A monochromatic light wavelength 500 nm is used. What will be the width of each slit for obtaining ten maxima of double slit within the central maxima of single slit pattern ?

(a) 0.1 mm (b) 0.5 mm
(c) 0.02 mm (d) 0.2 mm

117. For a parallel beam of monochromatic light of wavelength 'λ', diffraction is produced by a single slit whose width 'a' is of the wavelength of the light. If 'D' is the distance of the screen from the slit, the width of the central maxima will be

(a) $\frac{D\lambda}{a}$ (b) $\frac{Da}{\lambda}$

(c) $\frac{2Da}{\lambda}$ (d) $\frac{2D\lambda}{a}$

118. Light of wavelength 5000 A° is incident normally on a slit of width 2.5×10^{-4} cm. The angular position of second minimum from the central maximum is

(a) $\sin^{-1}\left(\frac{1}{5}\right)$ (b) $\sin^{-1}\left(\frac{2}{5}\right)$

(c) $\left(\frac{\pi}{3}\right)$ (d) $\left(\frac{\pi}{6}\right)$

119. In young's double-slit experiment, the intensity of light at a point on the screen where the path difference is λ is I, λ being the wavelength of light used. The intensity at a point where the path difference is $\frac{\lambda}{4}$ will be

(a) $\frac{I}{4}$ (b) $\frac{I}{2}$ (c) I (d) zero

120. In Young's double slit experiment, the fringes are displaced by a distance x when a glass plate of refractive index 1.5 is introduced in the path of one of the beams. When this plate is replaced by another plate of the same thickness, the shift of fringes is (3/2) x. The refractive index of the second plate is

(a) 1.75 (b) 1.50
(c) 1.25 (d) 1.00

121. 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 10^{-3} m. Then the wavelength of light used is (given that distance between the slits is 0.03 mm)

(a) 4500 Å (b) 5000 Å
(c) 5500 Å (d) 6000 Å.

122. In Fresnel's biprism expt., a mica sheet of refractive index 1.5 and thickness 6×10^{-6} m is placed in the path of one of interfering beams as a result of which the central fringe gets shifted through 5 fringe widths. The wavelength of light used is

(a) 6000 Å (b) 8000 Å
(c) 4000 Å (d) 2000 Å

123. A beam of light of wavelength 600 nm from a distance source falls on a single slit 1 mm wide and a resulting diffraction pattern is observed on a screen 2m away. The distance between the first dark fringes on either side of central bright fringe is

(a) 1.2 cm (b) 1.2 mm (c) 2.4 cm (d) 2.4 mm

124. The width of a slit is 0.012 mm. Monochromatic light is incident on it. The angular position of first bright line is 5.2°. The wavelength of incident light is
[sin 5.2° = 0.0906].

(a) 6040 Å (b) 4026 Å
(c) 5890 Å (d) 7248 Å

125. Light of wavelength 6328 Å is incident normally on a slit having a width of 0.2 mm. The angular width of the central maximum measured from minimum to minimum of diffraction pattern on a screen 9.0 metres away will be about

(a) 0.36 degree (b) 0.18 degree
(c) 0.72 degree (d) 0.09 degree

126. A plane wave of wavelength 6250 Å is incident normally on a slit of width 2×10^{-2} cm. The width of the principal maximum on a screen distant 50 cm will be

(a) 312.5×10^{-3} cm (b) 312.5×10^{-3} m
(c) 312.5×10^{-3} m (d) 312 m

127. A slit of width a is illuminated by red light of wavelength 6500 Å. If the first minimum falls at $\theta = 30°$, the value of a is

(a) 6.5×10^{-4} mm (b) 1.3 micron
(c) 3250 Å (d) 2.6×10^{-4} cm

128. A parallel beam of light is incident on a convex lens which has been corrected for aberrations, then the image will be

(a) focused to a line because of refraction.
(b) focused to a spot of finite area because of diffraction.
(c) focused to a spot of radius $\frac{0.16\lambda f}{a}$ because of diffraction (f = focal length, a = radius of lens)
(d) focused to a band pattern of radius $\frac{1.22\lambda f}{2a}$

129. The Fraunhoffer 'diffraction' pattern of a single slit is formed in the focal plane of a lens of focal length 1 m. The width of slit is 0.3 mm. If third minimum is formed at a distance of 5 mm from central maximum, then wavelength of light will be

(a) 5000 Å (b) 2500 Å
(c) 7500 Å (d) 8500 Å

130. A single slit Fraunhoffer diffraction pattern is formed with white light. For what wavelength of light the third secondary maximum in the diffraction pattern coincides with the second secondary maximum in the pattern for red light of wavelength 6500 Å?

(a) 4400 Å (b) 4100 Å
(c) 4642.8 Å (d) 9100 Å

131. The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n), is

(a) $\tan^{-1}(1/n)$ (b) $\sin^{-1}(1/n)$
(c) $\sin^{-1}(n)$ (d) $\tan^{-1}(n)$

132. When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is

(a) $\frac{1}{4}I_0$ (b) $\frac{1}{2}I_0$ (c) I_0 (d) zero

133. A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is

(a) I_0 (b) $I_0/2$
(c) $I_0/4$ (d) $I_0/8$

134. A ray of light is incident on the surface of a glass plate at an angle of incidence equal to Brewster's angel ϕ. If μ represents the refractive index of glass with respect to air, then the angle between the reflected and the refracted rays is

(a) $90° + \phi$ (b) $\sin^{-1}(\mu \cos \phi)$
(c) 90° (d) $90° - \sin^{-1}\left(\frac{\sin \phi}{\mu}\right)$

135. Unpolarised light of intensity 32 W m^{-2} passes through three polarizers such that the transmission axis of the last polarizer is crossed with that of the first. The intensity of final emerging light is 3 W m^{-2}. The intensity of light transmitted by first polarizer will be

(a) 32 W m^{-2} (b) 16 W m^{-2}
(c) 8 W m^{-2} (d) 4 W m^{-2}

136. A parallel beam of monochromatic unpolarised light is incident on a transparent dielectric plate of refractive index $\frac{1}{\sqrt{3}}$. The reflected beam is completely polarised. Then the angle of incidence is

(a) 30° (b) 60°
(c) 45° (d) 75°

137. Two nicols are oriented with their principal planes making an angle of 60°. Then the percentage of incident unpolarised light which passes through the system is

(a) 100 (b) 50 (c) 12.5 (d) 37.5

138. A beam of unpolarised light passes through a tourmaline crystal A and then through another such crystal B oriented so that the principal plane is parallel to A. The intensity of emergent light is I_0. Now B is rotated by 45° about the ray. The emergent light will have intensity

(a) $I_0/2$ (b) $I_0/\sqrt{2}$ (c) $I_0\sqrt{2}$ (d) $2I_0$

139. If the polarizing angle of a piece of glass for green light is 54.74°, then the angle of minimum deviation for an equilateral prism made of same glass is
[Given, tan 54.74° = 1.414]

(a) 45° (b) 54.74°
(c) 60° (d) 30°

140. When the angle of incidence is 60° on the surface of a glass slab, it is found that the reflected ray is completely polarised. The velocity of light in glass is

(a) $\sqrt{2}\times10^8\,ms^{-1}$ (b) $\sqrt{3}\times10^8\,ms^{-1}$
(c) $2\times10^8\,ms^{-1}$ (d) $3\times10^8\,ms^{-1}$

141. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals:

(a) 3 (b) $\frac{3}{2}$
(c) 1 (d) $\frac{1}{3}$

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. **(c)** Light is an electromagnetic wave of wavelength range 4000A° to 7800 A°
2. **(a)**
3. **(a)** Wavefront is the locus of all points, where the particles of the medium vibrate with the same phase.
4. **(d)** The Huygen's construction of wavefront does not explain the phenomena of origin of spectra.
5. **(b)** Huyghen's principle gives us a geometrical method of tracing a wavefront.
6. **(c)** Converging spherical
7. **(c)**
8. **(b)** Phase reversal occurs i.e. phase change = π takes place on reflection, because glass is much denser than water.
9. **(c)** Emerging wavefront will be spherical from convex lens and plane wavefront from the prism.
10. **(b)**
11. **(d)** When path difference = $n\lambda$ (n = 0, 1, 2...) the resultant intensity is $4I_0$.
12. **(c)**
13. **(c)** Highly coherent sources are produced using laser.
14. **(d)** A prism cannot produce coherent sources.
15. **(a)** Coherence is a measure of capability of producing interference by waves.
16. **(b)** For coherent sources λ is same and phase is also same or phase diff. is constant.
17. **(a)** According to wave theory, intensity of light is directly proportional to square of amplitude.
18. **(a)** As $\beta = \frac{\lambda D}{d} \therefore \beta \propto \lambda$.

    As λ for violet is least, therefore, fringe nearest to central achromatic fringe will be violet.
19. **(a)** Fringe visibility (V) is given by $V = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$.
20. **(c)** Laser light is coherent, because it consists of coordinated (parallel) waves of exactly same wavelength (i.e monochromatic wave).
21. **(a)** Bright fringes are yellow and dark fringes are black.
22. **(b)** This time he saw a number of dark lines, regularly spaced; the first clear proof that light added to light can produce darkness.

    Keeping the distance between the slits as constant, the locus of point P in the xy plane is a hyperbola
23. **(b)** The wavelength of light in water $\left(\lambda_w = \frac{\lambda_a}{\mu}\right)$ is less than that in air. When the set-up is immersed in water, fringe width $\beta(\propto \lambda)$ will decrease.
24. **(b)** Introducing a converging lens in the path of parallel beam does not introduce any extra path differences in a parallel beam. Rather it gives a more intense pattern on the screen.
25. **(b)** As $\lambda_r \approx 8000A°$ and $\lambda_v \approx 4000\,Å$ and $\beta = \frac{\lambda D}{d}$ i.e.

    $\beta \propto \lambda$, therefore β_{red} is roughly double of β_{violet}.
26. **(b)** For minima, phase diff. = odd integral multiple of $\pi = (2n-1)\pi$.
27. **(a)** $\beta = \frac{\lambda D}{d}$
28. **(d)** Interference pattern will be invisible, because red and green are complimentary colours.
29. **(a)** There will be general illumination as super imposing waves do not have constant phase difference.
30. **(b)** Wavelength/frequency must be same and phase difference must be constant for producing sustained interference.
31. **(a)**
32. **(b)** Width of central maximum in diffraction pattern due to single slit = $\frac{2\lambda D}{d}$ where λ is the wavelength, D is the distance between screen and slit and a is the slit width.

    As the slit width a increases, width of central maximum becomes sharper or narrower. As same energy is distributed over a smaller area. therefore central maximum becomes brigther.
33. **(d)** When red light is replaced by blue light the diffraction bands become narrow and crowded.
34. **(b)** At the centre, all colours meet in phase, hence central fringe is white.

35. (c) Because both source & screen are effectively at infinite distance from the diffractive device

36. (d) Diffraction on a single slit is equivalent to interference of light from infinite number of coherent sources contained in the slit.

37. (c) When the wavelength of light used is comparable with the separation between two points, the image of the object will be a ϕ diffraction pattern whose size will be

$$\theta = \frac{1.22\lambda}{D}$$

where λ = wavelength of light used
D = diameter of the objective
Two objects whose images are closer than this distance, will not be resolved.

38. (d) As we know Bresster angle tan i_B = 4 tan i_B = 1.5
$i_B = \tan^{-1}(1.5)$

39. (d)

40. (d) : The phenomenon of polarization confirmed that light is a transverse wave.

41. (d) In the case of linearly polarised light the magnitued of th electric field vector varies periodically with time.

42. (b) Brewster's law is given by μ tan i_β

43. (c) Light waves can be polarized because they are transverse in nature.

44. (b) Light transmitted by nicol prism is plane polarised.

45. (c) Such substances rotate the plane of polarised light.

46. (a) Polaroid glass polarises light reducing the light intensity to half its original value.

47. (b) Angle between plane of vibration and plane of polarisation is 90º.

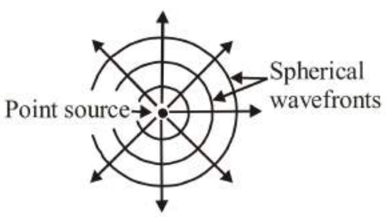
48. (a) Plane of vibration is $\perp^r$ to direction of propagation and also $\perp^r$ to plane of polarisation. Therefore, angle between plane of polarisation and direction of propagation is 0º.

49. (c) At Brewster's angle, only the reflected light is plane polarised, but transmitted light is partially polarised.

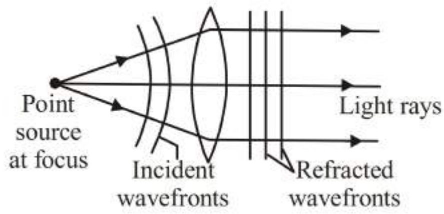
50. (a)

STATEMENT TYPE QUESTIONS

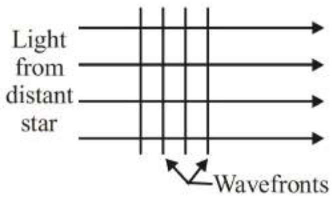
51. (b) **Case I** A light rays diverging from a point source.



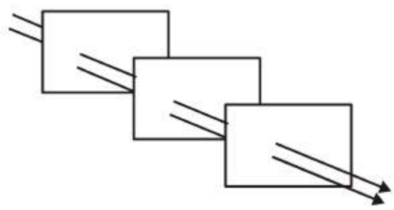
Case II. A light ray emerging out of convex lens when a point source is placed at its focus.



Case III A portion of the wavefront of light from a distant star intercepted by the Earth.



52. (b) For a point emitting waves uniformly in all direction, the locus of points which have the same amplitude and vibrate in the same phase are spheres. But at a large distance from the source, the small portion of the sphere can be considered as plane wave as shown in Figure



53. (a) When incident wavefronts passes through a prism, then lower portion of wavefront (B) is delayed resulting in a tilt. So, time taken by light to reach A' from A is equal to the time taken to reach B' from B.

54. (b)

55. (a) When interfering sources have same frequency and their phase difference remains constant with time, interference is sustained (stayed for a finite time interval).
If amplitudes are of nearby values then contrast will be more pronounced.

56. (c) The double slit interference pattern has a central maxima followed by minima. The dark and bright fringes are of equal width and intensity.

57. (a) 58. (d)

59. (d) Diffraction is a general characteristics exhibited by all types of waves.

60. **(c)** The wavelength of sound is comparable to the size of the obstacles so the effects of diffraction can be observed and hence we can listen to the sound on the other side of the wall, while wavelength of light is much smaller (visible light 4000A° to 7800A°) than the obstacle size so the diffraction effects cannot be observed and we cannot see through the wall.

61. **(c)** As is clear from the relation.

Fringe with $\beta = \frac{\lambda D}{d}$

D = distance between the slit and screen

d = distance between the slits.

Smaller the 'd' higher will be the value of fringe width.

62. **(c)** Since, $\Delta\theta \approx \frac{0.61\lambda}{a}$

where $\Delta\theta$ = angle subtended by the image of the object on focus of the length.

λ = wavelength of light used

a = aperture of the objective lens

For '$\Delta\theta$' to be small, 'a' must be large

63. **(d)** The magnification produced by a microscope

$$m = \frac{v}{f} = \frac{D}{f} = 2 \tan \beta$$

64. **(c)**

65. **(c)**

I. For diffraction pattern, the size of slit should be comparable to the wavelength of wave used.

II. Diffraction phenomenon is commonly observed in our daily routine in case of sound waves (Which is a longitudinal wave) because wavelength of sound waves is large (0.1 – 1m). However, as wavelength of light waves is extremely small ($10^{-6} - 10^{-7}$ m), we do not observe diffraction of light in daily routine.

III. Diffraction is a wave phenomenon. It is observed in electromagnetic and longitudinal waves as well.

66. **(d)** A polaroid consists of long chain molecules aligned in a particular direction. The electric vectors (associated with the propagating light wave) along the direction of the aligned molecules get obsorbed. Thus, if an unpolarised light wave is incident on such a polaroid then the light wave will get linearly polarised with the electric vector oscillating along a direction perpendicular to the aligned molecules; this direction is known as the pass-axis of the polaroid.

MATCHING TYPE QUESTIONS

67. **(b)** **68.** **(d)** **69.** **(a)**

DIAGRAM TYPE QUESTIONS

70. **(d)** It will be concentric circles.

71. **(c)** Angular width $= \frac{\lambda}{d} = 10^{-3}$ (given)

$\therefore$ No. of fringes within 0.12° will be

$$n = \frac{0.12 \times 2\pi}{360 \times 10^{-3}} \cong [2.09]$$

$\therefore$ The number of bright spots will be three.

72. **(c)** Wavelength for which maximum obtained at the hole has the maximum intensity on passing. So,

$$x = \frac{n\lambda D}{d}$$

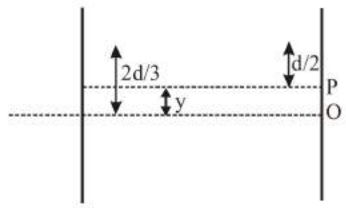
$$\lambda = \frac{xd}{nD} = \frac{1 \times 10^{-3} \times 0.5 \times 10^{-3}}{n \times 50 \times 10^{-2}} = \frac{1 \times 10^{-6}}{n} = \frac{1000\text{nm}}{n}$$

$n = 1$, $\lambda = 1000$ nm $\rightarrow$ Not in the given range

$n = 2$, $\lambda = 500$nm

73. **(c)** The nearest white spot will be at P, the central maxima.

$$\therefore \ y = \frac{2d}{3} - \frac{d}{2} = \frac{d}{6}$$



74. **(d)** Light waves coming out of two independent sources do not have any fixed phase difference as they undergo phase changes in time of the order of 10^{-10}s. Hence, the sources are incoherent and the intensities on the screen just add up. Hence no interference fringer will be observed on the screen.

75. **(c)** When the source of light shifts by angle ϕ then central fringe appears at angle $-\phi$ as source S', the mid point Q, and the central fringe are in a straight line.

76. **(c)** The position of all the bands depends on the wavelength, higher the wavelength, wider is the band.

77. **(c)** In Fraunhoffer diffraction, for minimum intensity,

$$\Delta x = m\frac{\lambda}{2}$$

For first minimum, $m = 1$

$$\therefore \ \Delta x = \frac{\lambda}{2}$$

78. **(c)**

ASSERTION- REASON TYPE QUESTIONS

79. (b) **80.** (a)

81. (a) $\beta = \frac{D\lambda}{d}$. When $d \to 0$, $\beta \to \infty$, and so fringes will not be seen over the screen.

82. (d) For interference, the waves may be of unequal intensities.

83. (c) Interference will take place in green light only.

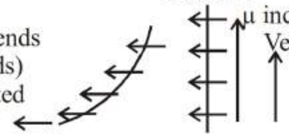
84. (d) **85.** (b) **86.** (a) **87.** (b)

88. (a) As $\beta = \frac{D\lambda}{d}$ and wavelength of yellow light is shorter than red, so fringe width is narrower for yellow light.

89. (a) **90.** (b)

CRITICAL THINKING TYPE QUESTIONS

91. (b)



92. (d) : If source are coherent $I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\ \cos\phi$

$I_0 = I + I + 2I\cos 0° = 4I$

If source are incoherent,

$$I_R = I_1 + I_2 + 2I = \frac{4I}{2} = \frac{I_0}{2}$$

93. (d) : Resultant amplitude,

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

Here, $A_1 = A_2$ 1 cm, $\phi = 3\pi$ rad

$$\therefore A = \sqrt{1^2 + 1^2 + 2\times1\times1\times\cos 3\pi}$$

$$= \sqrt{2 + 2\times(-1)} = 0$$

94. (b) $\frac{I_1}{I_2} = \frac{1}{4} \Rightarrow I_1 = k$ and $I_2 = 4k$

$$\therefore \text{ Fringe visibility } V = \frac{2\sqrt{I_1 I_2}}{(I_1 + I_2)} = \frac{2\sqrt{k\times 4k}}{(4+4k)} = 0.8$$

95. (d) $\frac{I_{max}}{I_{min}} = \frac{25}{9}$ or $\left(\frac{a_1 + a_2}{a_1 - a_2}\right)^2 = \frac{25}{9}$

where a denotes amplitude.

$\frac{a_1 + a_2}{a_1 - a_2} = \frac{5}{3}$ or $5a_1 - 5a_2 = 3a_1 + 3a_2$

or, $5a_1 - 5a_2 = 3a_1 + 3a_2$ or $2a_1 = 8a_2$

or, $\frac{a_1}{a_2} = 4$ or $\left(\frac{a_1}{a_2}\right)^2 = 16 = \frac{I_1}{I_2}$.

96. (c) $\sin\theta = \frac{\lambda}{d} = \frac{589\times10^{-9}}{0.589\times10^{-3}} = 10^{-3} = \frac{1}{1000} = 0.0001$

97. (d) Intensity $I \propto 1 + \cos\phi$ where ϕ = phase difference

$$\therefore \frac{I_P}{I_Q} = \frac{1+\cos 0°}{1+\cos\frac{\pi}{2}} = \frac{1+1}{1+0} = \frac{2}{1}$$

98. (b) Here $\lambda_1 = 540$ nm; $\beta_1 = 9.0$ mm; $\beta_2 = 8.1$ mm, $\lambda_2 = ?$

For constant D and d, $\beta \propto \lambda$

$$\Rightarrow \frac{\beta_2}{\beta_1} = \frac{\lambda_2}{\lambda_1} \Rightarrow \lambda_2 = \frac{\beta_2\lambda_1}{\beta_1} = \frac{8.1}{9.0}\times 540 = 486 \text{ nm}$$

99. (b) As optical path SB of lower slit is increased, therefore, fringe pattern shifts somewhat downwards.

100. (c) $\Delta = x\frac{d}{D}$, where Δ is path difference between two waves.

$\therefore$ phase difference $= \phi = \frac{2\pi}{\lambda}\Delta$.

Let a = amplitude at the screen due to each slit.

$\therefore$ $I_0 = k(2a)^2 = 4ka^2$, where k is a constant.

For phase difference ϕ,

amplitude $= A = 2a\cos(\phi/2)$.

[Since, $a^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\phi$, here $a_1 = a_2$]

Intensity I,

$$I = kA^2 = k(4a^2)\cos^2(\phi/2) = I_0\cos^2\left(\frac{\pi x}{\beta}\Delta\right)$$

$$= I_0\cos^2\left(\frac{\pi}{\lambda}.\frac{xd}{D}\right) = I_0\cos^2\left(\frac{\pi x}{\beta}\right)$$

101. (a) $\because y = \frac{n\lambda D}{d}$

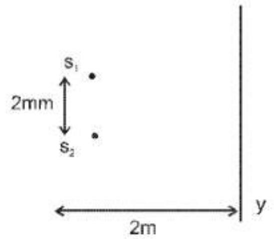
$\therefore n_1\lambda_1 = n_2\lambda_2$

$\Rightarrow n_1 \times 12000\times10^{-10} = n_2\times 10000\times10^{-10}$

or, $n(12000\times10^{-10}) = (n+1)(10000\times10^{-10})$

$\Rightarrow n = 5$

$(\because \lambda_1 = 12000\times10^{-10}\text{m};\ \lambda_2 = 10000\times10^{-10}\text{m})$



Hence, $y_{common} = \frac{n\lambda_1 D}{d}$

$$= \frac{5\left(12000 \times 10^{-10}\right) \times 2}{2 \times 10^{-3}} \quad (\because\ d = 2\text{ mm and } D = 2\text{m})$$

$= 5 \times 12 \times 10^{-4}$ m
$= 60 \times 10^{-4}$ m
$= 6 \times 10^{-3}$ m $= 6$ mm

102. (b) For constructive interference $d \sin\theta = n\lambda$

given $d = 2\lambda \Rightarrow \sin\theta = \frac{n}{2}$

$n = 0, 1, -1, 2, -2$ hence five maxima are possible

103. (a) For path difference of λ, the phase difference is 2π

For path difference of $\frac{\lambda}{6}$, the phase difference is

$$\frac{2\pi \times \lambda / 6}{\lambda} = \frac{\lambda}{3}$$

$\therefore$ Intensity $I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} \cos\frac{\pi}{3}$

$\therefore\ I = I_1 + I_2 + \sqrt{I_1}\sqrt{I_2}$

when $I_1 = I_2 = I'$ (say) then $I = 3I'$

$$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$$

$$= \left(\sqrt{I'} + \sqrt{I'}\right)^2 = \left(2\sqrt{I'}\right)^2 = 4\underline{I'}$$

$$\therefore\ \frac{\underline{I}}{I_{max}} = \frac{3}{4}$$

ALTERNATIVELY : The intensity of light at any point of the screen where the phase different due to light coming from the two slits is ϕ is given by

$I = I_o \cos^2\left(\frac{\phi}{2}\right)$ where to is the maximum intensity.

NOTE : This formula is applicable when $I_1 = I_2$.

Here $\phi\ \phi = \pi/3$

$$\therefore\ \frac{I}{I_0} = \cos^2\frac{\pi}{6} = \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3}{4}$$

104. (d) Let $a_1 = a, I_1 = a_1^2 = a^2$
$a_2 = 2a, I_2 = a_2^2 = 4a^2$
$I_2 = 4I_1$
$I_r = a_1^2 + a_2^2 + 2a_1a_2 \cos\phi$
$= I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$

$I_r = I_1 + 4I_1 + 2\sqrt{4I_1^2} \cos\phi$

$\Rightarrow I_r = 5I_1 + 4I_1 \cos\phi$ ...(1)

Now, $I_{max} = (a_1 + a_2)^2 = (a + 2a)^2 = 9a^2$

$I_{max} = 9I_1 \Rightarrow I_1 = \frac{I_{max}}{9}$

Substituting in equation (1)

$$I_r = \frac{5I_{max}}{9} + \frac{4I_{max}}{9}\cos\phi$$

$$I_r = \frac{I_{max}}{9}[5 + 4\cos\phi\quad]$$

$$I_r = \frac{I_{max}}{9}\left[5 + 8\cos^2\frac{\phi}{2} - 4\right]$$

$$I_r = \frac{I_{max}}{9}\left[1 + 8\cos^2\frac{\phi}{2}\right]$$

105. (d) At the area of total darkness minima will occur for both the wavelength.

$$\therefore\ \frac{(2n+1)}{2}\lambda_1 = \frac{(2m+1)}{2}\lambda_2$$

$$\Rightarrow\ (2n+1)\lambda_1 = 2(m+1)\lambda_2$$

or $\frac{(2n+1)}{(2m+1)} = \frac{560}{400} = \frac{7}{5}$

or $10n = 14m + 2$
by inspection for $m = 2, n = 3$
for $m = 7, n = 10$
the distance between them will be the distance between such points

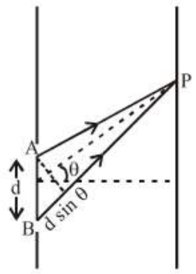
i.e., $\Delta s = \frac{D\lambda_1}{d}\left\{\frac{(2n_2 + 1) - (2n_1 - 1)}{2}\right\}$

put $n_2 = 10, n_1 = 3$
on solving we get, $\Delta s = 28$ mm

106. (c) Let P be the point on the central maxima whose intensity is one fourth of the maximum intensity.
For interference we know that

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

Where I is the intensity at P and I_1, I_2 are the intensity of light originating from A and B respectively and ϕ is the phase difference at P.



In YDSE, $I_1 = I_2 = I$ and $I_{max} = 4I$
We are concentrating at a point where the intensity is one fourth of the max intensity.
$\therefore I = I + I + 2I\cos\phi$

$$\Rightarrow \quad -\frac{1}{2}\cos\phi \Rightarrow \phi = \frac{2\pi}{3}$$

[P1 note that we take the least value of the angle as the point is in central maxima]
For a phase difference of 2π, the path difference is λ

For a phase difference of $\frac{2\pi}{3}$, the path difference is

$$\frac{\lambda}{2\pi} \times \frac{2\pi}{3} = \frac{\lambda}{3}$$

But the path difference (in terms of P and Q) is d sin θ as shown in fig.

$$\therefore \quad d\sin\theta = \frac{\lambda}{3} \Rightarrow \sin\theta = \frac{\lambda}{3d}$$

$$\Rightarrow \quad \theta = \sin^{-1}\left(\frac{\lambda}{3d}\right)$$

107. (b) The intensity I is given as

$I = I_o \cos^2\frac{\phi}{2}$ where I_o is the peak intensity

Here $I = \frac{I_o}{2}$, $\therefore \frac{I_o}{2} = I_o\cos^2\frac{\phi}{2}$ $\therefore \phi = \frac{\pi}{2}(2n+1)$

For a phase difference of 2π the path difference is λ

$\therefore$ For a phase difference of (2n+1) $\frac{\pi}{2}$ the path difference is $(2n+1)\frac{\lambda}{4}$. option (b) is correct.

108. (c) $x_5 = n\lambda\frac{D}{d} = \frac{5\times6.5\times10^{-7}\times1}{10^{-3}} = 32.5\times10^{-4}$ m

$$x_3 = (2n-1)\frac{1}{2}\frac{D\lambda}{d} = \frac{5\times6.5\times10^{-7}\times1}{2\times10^{-3}}$$

$$= 16.25\times10^{-4}\,m$$

$x_5 - x_3 = 16.25\times10^{-4}\,m = 1.625$ mm.

109. (c) $\beta = \frac{\lambda' D'}{d'} = \frac{3\lambda\,3D}{d/3} = 27\frac{\lambda D}{d}$.

No. of fringes $= \frac{1/3}{\beta} = \frac{d}{81\lambda D}$.

110. (b) The position of n^{th} dark fringe. So position of first dark fringe in $x_1 = \lambda D/2d$.
$d = 20$ cm, $D = 0.1$mm, $\lambda = 5460$ Å, $x_1 = 0.16$

111. (c) When the arrangement is dipped in water;

$$\beta' = \beta/\mu = \frac{x}{4/3} = \frac{3}{4}x = 0.75x$$

112. (a) As $\beta \propto \lambda$

$\therefore$ fringe width becomes $\frac{5}{4}$ times,

No, of fringes $= \frac{4}{5}\times10 = 8$

113. (b) $\beta' = \frac{\beta}{\mu} = \frac{0.133}{1.33} = 0.1$ cm

114. (d) Given: $D = 2$m; $d = 1$ mm $= 1\times10^{-3}$ m
$\lambda = 600$ nm $= 600\times10^{-6}$ m
Width of central bright fringe ($= 2\beta$)

$$= \frac{2\lambda D}{d} = \frac{2\times600\times10^{-6}\times2}{1\times10^{-3}}\,m$$

$= 2.4\times10^{-3}$ m $= 2.4$ mm

115. (c) For path difference λ, phase difference $= 2\pi$ rad.

For path difference $\frac{\lambda}{4}$, phase difference $= \frac{\pi}{2}$ rad.

As $K = 4I_0$ so intensity at given point where path difference is $\frac{\lambda}{4}$

$$K' = 4I_0\cos^2\left(\frac{\pi}{4}\right)\left(\cos\frac{\pi}{4} = \cos 45^o\right)$$

$$= 2I_0 = \frac{K}{2}$$

116. (d) Here, distance between two slits,
$d = 1mm = 10^{-3}m$
distance of screen from slits, D = 1 m
wavelength of monochromatic light used,
$\lambda = 500nm = 500 \times 10^{-9}m$
width of each slit a = ?

Width of central maxima in single slit pattern $= \frac{2\lambda D}{a}$

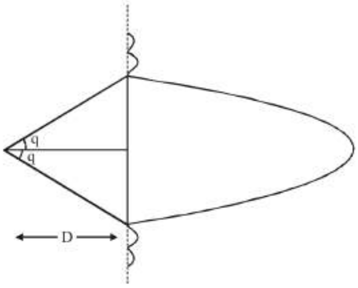
Fringe width in double slit experiment $\beta = \frac{\lambda D}{d}$

So, required condition $\frac{10\lambda D}{d} = \frac{2\lambda D}{a}$

$\Rightarrow \quad a = \frac{d}{5D} = \frac{1}{5} \times 10^{-3} m = 0.2\, mm$

117. (d) Linear width of central maxima

$= D(2q) = 2Dq \frac{2D\lambda}{a}$



118. (d) Let the two positive numbers be 'a' and 'b'.
Therefore,

$$a : b = 3 + 2\sqrt{2} : 3 - 2\sqrt{2}$$

$$\text{A. M.} = \frac{a+b}{2} = \frac{6}{2} = 3$$

$$\text{G.M.} = \sqrt{ab} = \sqrt{1} = 1$$

$$\therefore \quad \frac{\text{A.M}}{\text{G.M}} = \frac{3}{1} \Rightarrow \text{A.M : G.M} = 3 : 1.$$

119. (b) For path difference λ, phase

difference $= 2\pi \left(Q = \frac{2\pi}{\lambda} x = \frac{2\pi}{\lambda} . \lambda = 2\pi \right)$

$\Rightarrow I = I_0 + I_0 + 2I_0 \cos 2\pi$

$\Rightarrow I = 4I_0 \ (\because \cos 2\pi = 1)$

For $x = \frac{\lambda}{4}$, phase difference $= \frac{\pi}{2}$

$\therefore I' = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} \cos\frac{\pi}{2}$

If $I_1 = I_2 = I_0$ then $I' = 2I_0 = 2.\frac{I}{4} = \frac{I}{2}$

120. (a)

121. (d) Fringe width $\beta = \frac{\lambda D}{d}$

Where D is the distance between slit and the screen, d is the distance between two slits, λ is the wavelength of light.

$\therefore \Delta\beta = \frac{\lambda \Delta D}{d}$

or, $\lambda = \frac{\Delta\beta d}{\Delta D} = \frac{10^{-3} \times 0.03 \times 10^{-3}}{5 \times 10^{-2}} = \frac{10^{-3} \times 3 \times 10^{-5}}{5 \times 10^{-2}}$

$= 6 \times 10^{-7}$ m = 6000 Å.

122. (a) Where n is equivalent number of fringe by which the centre fringe is shifted due to mica sheet

$\lambda = \frac{(\mu - 1)t}{n} = \frac{(1.5-1)6 \times 10^{-6}}{5}$

$= 6 \times 10^{-7}$ m = 6000 Å

123. (d) The distance between the first dark fringe on either side of the central bright fringe
= width of central maximum

$= \frac{2D\lambda}{a} = \frac{2 \times 2 \times 600 \times 10^{-9}}{10^{-3}}$

$= 2.4 \times 10^{-3}$ m = 2.4 mm

124. (d) It is a one of Fraunhoffer diffraction from single slit. so for bright fringe where a is the width of slit.

$a \sin\theta = (2n+1)\frac{\lambda}{2}$

$\lambda = \frac{2a\sin\theta}{2n+1} = \frac{2 \times 1.2 \times 10^{-5} \times 0.0906}{2 \times 1 + 1}$

$= 7248 \times 10^{-10}$ m = 7248Å.

125. (a) The angular width of central maxi. is

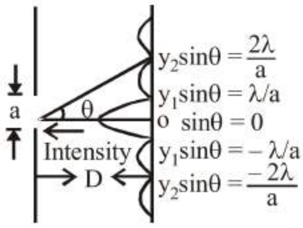
$2\theta = 2\frac{\lambda}{a} = \frac{2 \times 6328 \times 10^{-10}}{2 \times 10^{-4}}$ radian.

$= 6328 \times 10^{-6} \times \frac{180}{\pi}$ degree $= 0.36^\circ$

126. (a) Width of central maximum

$$= \frac{2\lambda D}{a} = \frac{2\times 6250\times 10^{-10}\times 0.5}{2\times 10^{-4}}$$

$$= 3125\times 10^{-6}\,m = 312.5\times 10^{-3}\,cm.$$



Screen position of various minima for Fraunhoffer diffraction pattern of a single slit of width a.

127. (b) According to principle of diffraction, a sin θ = nλ where, n = order of secondary minimum
or, $a \sin 30° = 1 \times (6500 \times 10^{-10})$
or, $a = 1.3 \times 10^{-6}$ m, or, a = 1.3 micron.

128. (b) According to geometrical optics, a beam of parallel light falling on convex lens will get focused to a point. However because of diffraction the beam gets focused to a spot of radius $\frac{r_0 = -0.61\lambda f}{a}$

129. (a) $a \sin\theta = n\lambda$

$$\frac{a\,x}{f} = 3\lambda$$

(since θ is very small so $\sin\theta \approx \tan\theta \approx \theta = x/f$)

$$\text{or } \lambda = \frac{a\,x}{3f} = \frac{0.3\times 10^{-3}\times 5\times 10^{-3}}{3\times 1}$$

$$= 5\times 10^{-7}\,m = 5000\,Å.$$

130. (c) $x = \frac{(2n+1)\lambda D}{2a}$

For red light, $x = \frac{(4+1)D}{2a}\times 6500Å$

For other light, $x = \frac{(6+1)D}{2a}\times \lambda Å$

x is same for each.

$$\therefore\ 5\times 6500 = 7\times\lambda \Rightarrow \lambda = \frac{5}{7}\times 6500 = 4642.8\,Å.$$

131. (d) The angle of incidence for total polarization is given by $\tan\theta = n \Rightarrow \theta = \tan^{-1} n$

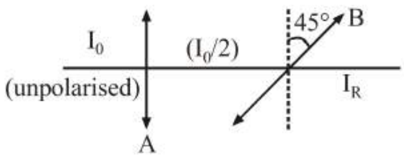
132. (b) $I = I_0 \cos^2\theta$

Intensity of polarized light $= \frac{I_0}{2}$

⇒ Intensity of untransmitted light

$$= I_0 - \frac{I_0}{2} = \frac{I_0}{2}$$

133. (c)



Relation between intensities

$$I_R = \left(\frac{I_0}{2}\right)\cos^2(45°)$$

$$= \frac{I_0}{2}\times\frac{1}{2} = \frac{I_0}{4}$$

134. (c) $\because i_p = \phi$, therefore, angle between reflected and refracted rays is 90°.

135. (b) Intensity of polarised light transmitted from 1st polariser,
$I_1 = I_0 \cos^2\theta$

but $(\cos^2\theta)_{av} = \frac{1}{2}$

So $I_1 = \frac{1}{2} I_0 = \frac{32}{2} = 16\,Wm^{-2}$

136. (a) When angle of incidence i is equal to angle of polarisation i.e, then reflected light is completely plane-polarised whose vibration is perpendicular to plane of incidence.

137. (c) Suppose intensity of unpolarised light = 100.
∴ Intensity of polarised light from first nicol prism

$$= \frac{I_0}{2} = \frac{1}{2}\times 100 = 50$$

According to law of Malus,

$$I = I_0\cos^2\theta = 50\ (\cos 60°)^2 = 50\times\left(\frac{1}{2}\right)^2 = 12.5$$

138. (a) According to law of Malus

$$\mathbf{I} = \mathbf{I}_0\cos^2\theta = \mathbf{I}_0(\cos 45°)^2 = \mathbf{I}_0\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{\mathbf{I}_0}{2}$$

139. (d) By principle of polarization, $\mu = \tan\theta_p$

or $\mu = \tan 54.74°$ or $\mu = 1.414$

For an equilateral prism, $\angle A = 60°$

$$\therefore \ \mu = \frac{\sin\left(\frac{A+\delta}{2}\right)}{\sin(A/2)} = \frac{\sin\left(\frac{60°+\delta}{2}\right)}{\sin(60°/2)}$$

or, $\frac{1.141 \times 1}{2} = \sin\left(\frac{60°+\delta}{2}\right) \left[\because 1.414 = \sqrt{2}\right]$

or, $\frac{\sqrt{2}}{2} = \sin\left(\frac{60°+\delta}{2}\right)$ or $\frac{1}{\sqrt{2}} = \sin\left(\frac{60°+\delta}{2}\right)$

or, $\sin 45° = \sin\left(\frac{60°+\delta}{2}\right)$ or $45° = \left(\frac{60°+\delta}{2}\right)$

140. (b) ${}^a\mu_g = \tan\theta_P$ where θ_P = polarising angle.

or, ${}^a\mu_g = \tan 60°$

or, $\frac{c}{v_g} = \sqrt{3}$

or, $v_g = \frac{c}{\sqrt{3}} = \frac{3 \times 10^8}{\sqrt{3}} = \sqrt{3} \times 10^8 \, ms^{-1}$

141. (d) According to malus law, intensity of emerging beam is given by,

$I = I_0 \cos^2\theta$

Now, $I_{A'} = I_A \cos^2 30°$

$I_{B'} = I_B \cos^2 60°$

As $I_{A'} = I_{B'}$

$\Rightarrow \ I_A \times \frac{3}{4} = I_B \times \frac{1}{4}$

$\frac{I_A}{I_B} = \frac{1}{3}$