Chapter 7. WAVE OPTICS

MCQ's (1 Mark Each)

1) When light travels from an optically rarer medium to an optically denser medium, the speed decreases because of change in:
a) Wavelength
b) Frequency
c) Amplitude
d) Phase

   Ans – a) Wavelength

2) Light of wavelength 5000 A.U. falls on a plane reflecting surface. The frequency of reflected light is…
a) 6×10^{14}Hz
b) 5×10^{14}Hz
c) 2×10^{14}Hz
d) 1.666×10^{14}Hz

   Ans – a) 6×10^{14}Hz

3) Light follows wave nature because…
a) Light rays travel in a straight line
b) Light exhibits the phenomenon of reflection and refraction.
c) Light exhibits the phenomenon of interference.
d) Light causes the phenomenon of photoelectric effect.

   Ans – c) Light exhibits the phenomenon of interference.

4) Young's double slit experiment is carried out using green, red and blue light, one colour at a time. The fringe widths recorded are W_G, W_R, and W_B respectively then…
a) $W_G > W_B > W_R$
b) $W_B > W_G > W_R$
c) $W_R > W_B > W_G$
d) $W_R > W_G > W_B$

   Ans – d) $W_R > W_G > W_B$

5) The path difference between two waves meeting at a point is (11/4) λ. The phase difference between the two waves is…

   a) 11 π/4

   b) 11 π/2

   c) 11 π

   d) 22 π

Ans – b) 11 π/2

6) Which of the following cannot produce two coherent sources?

   a) Lloyd's mirror

   b) Fresnel biprism

   c) Young's double slit

   d) Prism

Ans. – d) Prism

7) The bending of beam of light around corners of obstacle is called…

   a) Reflection

   b) Diffraction

   c) Refraction

   d) Interference

Ans. – b) Diffraction

8) In a single slit diffraction pattern, first minima obtained with red light of wavelength 6600

   A.U. coincides with first maxima f some other wavelength λ then is…

   a) 5500 A.U.

   b) 5000 A.U.

   c) 4800 A.U.

   d) 4400 A.U.

Ans. – d) 4400 A.U.

Very Short Answer (VSA) (1 MARK Each)

1) What is the shape of the wave front on Earth for Sunlight?

2) In Young's double slit experiment if there is no initial phase difference between the light from the two slits, a point on the screen corresponds to the 5th minimum. What is the path difference?

3) Two coherent sources whose intensity ratio is 25:1 produce interference fringes. Calculate the ratio of amplitudes of light waves coming from them.

4) Why two light sources must be of equal intensity to obtain a well-defined interference pattern?

5) What is the relation between phase difference and Optical path in terms of speed of light in vacuum?

6) What should be the slit width to obtain pronounced diffraction with a single slit illuminated by light of wavelength λ?

7) What must be ratio of the slit width to the wavelength for a single slit, to have the first diffraction minimum at 45°?

Short Answer I (SA1) (2 MARKS Each)

1) What are Secondary sources? State Huygens' Principle.

2) A Plane Wavefront of light of wavelength 5500 A.U. is incident on two slits in a screen perpendicular to the direction of light rays. If the total separation of 10 bright fringes on a screen 2 m away is 2 cm. Find the distance between the slits.
(Answer: d =5.5 x 10⁻⁴m)

3) State any four Conditions for Obtaining well – defined and Steady Interference Pattern.

4) Draw a neat, labelled ray diagram of Fresnel Biprism experiment showing the region of interference.

5) What is Optical Path length? How is it different from actual Path length?

6) What is difference between Fresnel and Fraunhofer diffraction?

7) Compare Young's Double Slit Interference Pattern and Single Slit Diffraction Pattern.

8) Define unpolarised light.

9) Define plane of polarisation.

10) Define plane of vibration.

11) State any two postulates of newtons corpuscular theory.

12) White light consists of wavelengths from 400 nm to 700 nm. What will be the wavelength range seen, When white light is passed through glass of refractive index 1.55 ? *(Ans: (258.1 to 451 nm)*

13) The Optical Path of a ray of light of a given wavelength travelling a distance of 3 cm in flint glass having refractive index 1.6 is same as that on travelling a distance x cm through a medium having refractive index 1.25. Determine the value of x. *(Ans: 3.84 cm)*

Short Answer II (SA2) (3 MARKS Each)

1) Explain reflection of light at a plane surface with the help of a neat ray diagram.
2) Describe Young's double slit experiment with a neat diagram showing points of maximum and minimum intensity.
3) Explain experimental setup for Fraunhofer diffraction with neat diagram.
4) The distance between two bright fringes in a biprism experiment using light of wavelength 6000 A.U. 0.32 mm. By how much will the distance change, if light of wavelength 4800 A.U. is used? **(Ans: Change in distance x = 0.06 mm)**
5) A parallel beam of green light of wavelength 546 nm passes through a slit of width 0.4mm. The intensity pattern of the transmitted light is seen on a screen which is 40 cm away. What is the distance between the two first order minima? **(Ans: We = 1mm)**
6) In Fraunhofer diffraction by a narrow slit, a screen is placed at a distance of 2 m from the lens to obtain the diffraction pattern. If the slit width is 0.2mm and the first minimum is 5mm on either side of central maximum. Find the wavelength of light **(Ans.: 5000 A.U.)**

Long Answer (LA) (4 marks Each)

1) Describe geometry of the Young's double slit experiment with the help of ray diagram. What is fringe width? Obtain an expression of it. Write the conditions for constructive as well as destructive interference.
2) Explain Fraunhofer diffraction at a single slit with neat ray diagram. Obtain expression for width of the central bright fringe.
3) What is interference? Explain constructive and destructive interference with the help of diagram. What are coherent sources of light?