20 Wave Optics

1. To demonstrate the phenomenon of interference we require two sources which emit radiation of
(a) nearly the same frequency
(b) the same frequency
(c) different wavelength
(d) the same frequency and having a definite phase relationship.
(2003)

2. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is
(a) infinite (b) five (c) three (d) zero.
(2004)

3. The angle of incidence at which reflected light in totally polarized for reflection from air to glass (refractive index n), is
(a) $\sin^{-1}(n)$ (b) $\sin^{-1}(1/n)$
(c) $\tan^{-1}(1/n)$ (d) $\tan^{-1}(n)$.
(2004)

4. A Young's double slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen
(a) straight line (b) parabola
(c) hyperbola (d) circle
(2005)

5. If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled?
(a) I_0 (b) $I_0/2$ (c) $2I_0$ (d) $4I_0$
(2005)

6. 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) zero (b) I_0
(c) $\frac{1}{2}I_0$ (d) $\frac{1}{4}I_0$
(2005)

7. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye? [Take wavelength of light = 500 nm]
(a) 6 m (b) 3 m (c) 5 m (d) 1 m
(2005)

8. 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) $\frac{1}{2}$
(2007)

Answer Key

1.	(d)	**2.**	(b)	**3.**	(d)	**4.**	(a)	**5.**	(a)	**6.**	(c)
7.	(c)	**8.**	(a)								

EXPLANATIONS

1. **(d) :** For interference phenomenon, two sources should emit radiation of the same frequency and having a definite phase relationship.

2. **(b) :** For interference maxima, $d\sin\theta = n\lambda$

$\therefore \quad 2\lambda\sin\theta = n\lambda$

or $\quad \sin\theta = \frac{n}{2}$

This equation is satisfied if $n = -2, -1, 0, 1, 2$. $\sin\theta$ is never greater than (+1), less than (–1)

$\therefore$ Maximum number of maxima can be five.

3. **(d) :** According to Brewster's law of polarization, $n = \tan i_p$ where i_p is angle of incidence

$\therefore \quad i_p = \tan^{-1}(n)$.

4. **(a) :** Straight line fringes are formed on screen.

5. **(a) :** For diffraction pattern

$I = I_0\left(\frac{\sin\phi}{\phi}\right)^2$ where ϕ denotes path difference

For principal maxima, $\phi = 0$. Hence $\left(\frac{\sin\phi}{\phi}\right) = 1$

Hence intensity remains constant at I_0

$I = I_0\,(1) = I_0$.

6. **(c) :** Intensity of polarized light $= I_0/2$

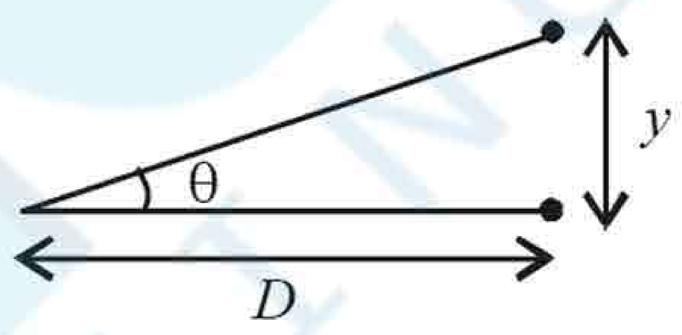
$\therefore$ Intensity of light not transmitted

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

7. **(c) :** Resolution limit $= \frac{1.22\lambda}{d}$

Again resolution limit $= \sin\theta = \theta = \frac{y}{D}$

$\therefore \quad \frac{y}{D} = \frac{1.22\lambda}{d}$



or $\quad D = \frac{yd}{1.22\lambda}$

or $\quad D = \frac{(10^{-3})\times(3\times10^{-3})}{(1.22)\times(5\times10^{-7})} = \frac{30}{6.1} \approx 5$ m.

8. **(a) :** In Young's double slit experiment intensity at a point is given by

$I = I_0\cos^2\left(\frac{\phi}{2}\right)$

where ϕ = phase difference, I_0 = maximum intensity

or $\quad \frac{I}{I_0} = \cos^2\left(\frac{\phi}{2}\right) \quad$ ... (i)

Phase difference $\phi = \frac{2\pi}{\lambda}\times$ path difference

$\therefore \quad \phi = \frac{2\pi}{\lambda}\times\frac{\lambda}{6}$ or $\phi = \frac{\pi}{3} \quad$ ... (ii)

Substitute eqn. (ii) in eqn. (i), we get

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