

CHAPTER - B

Diffraction and Polarisation

Date Planned : __ / __ / __	Daily Tutorial Sheet - 1	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 1	Exact Duration : _____

- A narrow slit of width 1 mm is illuminated by monochromatic light of wavelength 600 nm. The distance between the first minima on either side of a screen at a distance of 2 m is:
(A) 1.2 cm **(B)** 1.2 mm **(C)** 2.4 cm **(D)** 2.4 mm
- Mark the INCORRECT option(s)
(A) In an interference pattern, the minima are usually almost perfectly dark while in a diffraction pattern they are not so
(B) In an interference pattern, all the maxima are of same intensity but not so in the diffraction pattern
(C) In interference fringes are usually equispaced but diffraction fringes are never equally spaced
(D) None of the above
- In the case of double slit diffraction, if slit width Decreases,
(A) Central peak becomes sharper
(B) Fringe spacing does not change
(C) Less interference maxima fall within the central diffraction maximum
(D) None of the above
- Consider the diffraction through single slit of width b and wavelength of light λ . Match the Column I with Column II and mark the correct option from the codes given below.

Column I

- i** $\lambda \ll b$
ii $\lambda < b$
iii $\lambda = b$
iv $\lambda > b$

Column II

- P** Diffraction pattern is found on screen
Q No diffraction pattern is found on screen
R A sharp bright image of slit is formed on screen
S Central maxima will extend over whole screen

Code :

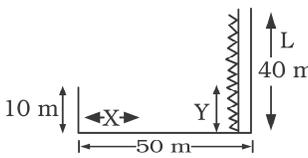
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|------------|------|----|------|----|------------|------|------|-----|------|
| | i | ii | iii | iv | | i | ii | iii | iv |
| (A) | Q, R | P | Q, S | Q | (B) | R | P | Q | S |
| (C) | P | Q | R | S | (D) | Q, R | P, Q | S | Q, S |

Direction 5 - 6

- (A)** Both Statement I and Statement II are correct and Statement II is the correct explanation of Statement I
(B) Both Statement I and Statement III are correct but Statement II is not the correct explanation of Statement I
(C) Statement I is correct but Statement II is incorrect
(D) Statement II is correct but Statement I is incorrect

5. **Statement I** Two objects of equal intensity will be just resolved by an optical instrument, if the central diffraction maximum of one lies at the first minimum of the other.
Statement II Diffraction can be explained on the basis of Huygens' theory.
6. **Statement I** In single slit diffraction, if slit is made narrower, central maximum becomes wider.
Statement II Presence of light in shadow is due to diffraction.
7. Which of the following phenomena can be demonstrated by light but not with sound wave in an air column?
(A) Reflection (B) Diffraction (C) Refraction (D) Polarisation
8. A light wave has amplitude A and angle between analyser and polariser is 45° . Light is reflected by analyser has amplitude
(A) $\frac{A}{2}$ (B) $\frac{A}{\sqrt{2}}$ (C) $2A$ (D) $\sqrt{3}A$
9. An electromagnetic wave travels in vacuum along x -direction, is $E = (E_1\hat{j} + E_2\hat{k})\sin(kx - \omega t)$. The corresponding magnetic field is
(A) $B = \frac{1}{c}(E_1\hat{j} + E_2\hat{k})\sin(kx + \omega t)$ (B) $B = \frac{1}{c}(E_2\hat{j} - E_1\hat{k})\sin(kx - \omega t)$
(C) $B = \frac{1}{c}(E_1\hat{j} - E_2\hat{k})\sin(kx - \omega t)$ (D) $B = \frac{1}{c}(-E_1\hat{j} + E_2\hat{k})\cos(kx - \omega t)$
10. In previous problem,
(A) electromagnetic wave is non-polarised (B) electromagnetic wave is plane polarised
(C) electromagnetic wave is circularly polarised
(D) electromagnetic wave is elliptically polarised
11. Unpolarised light is equivalent to
(A) The superposition of two mutually perpendicular identical unpolarised light
(B) Linearly polarised light (C) Circularly polarised light
(D) None of the above
12. If an unpolarised light is converted into plane polarised light, its intensity becomes
(A) half (B) one-fourth (C) one-third (D) one-eighth
13. The Fraunhofer diffraction pattern of a single slit is formed at the focal plane of a lens of focal length 1m. The width of the slit is 0.3 mm. If the third minimum is formed at a distance of 5 mm from the central maximum then the wavelength of light will be:
(A) 4500 Å (B) 3000 Å (C) 5000 Å (D) 4000 Å
14. A ray of light is incident on the surface of a glass plate at an angle of incidence equal to Brewster's angle ϕ . If μ represents the refractive index of glass with respect to air, the angle between the reflected and refracted ray is:
(A) $(90 + \phi)$ (B) $\sin^{-1}(\mu \cos \phi)$ (C) 90° (D) $\sin^{-1}\left(\frac{\sin \phi}{\mu}\right)$
15. Which of the following cannot be polarised?
(A) Light wave (B) Transverse wave (C) Radio wave (D) Ultrasonic wave

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- The angle of incidence at which reflected light 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]**
- 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) $\frac{1}{2}I_0$ **(B)** $\frac{1}{4}I_0$ **(C)** zero **(D)** I_0 **[2005]**
- 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) $2I_0$ **(B)** $4I_0$ **(C)** I_0 **(D)** $I_0/2$ **[2005]**
- Statement-1:** On viewing the clear blue portion of the sky through a Calcite Crystal, the intensity of transmitted light varies as the crystal is rotated. **[2011]**
Statement-2: The light coming from the sky is polarized due to scattering of sun light by particles in the atmosphere. The scattering is largest for blue light.
(A) Statement-1: is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1: is true, Statement-2 is true; Statement-2 is not a correct explanation for Statement-1.
(C) Statement-1: is true, Statement-2 is false.
(D) Statement-1: is false, Statement-2 is true.
- A beam of unpolarized 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) $I_0/2$ **(B)** $I_0/4$ **(C)** $I_0/8$ **(D)** I_0 **[2013]**
- A person lives in high rise building on the bank of a river 50 m wide. Across the river is a well lit tower of height 40 m. When the person, who is at height of 10 m, looks through a polarizer at an appropriate angle at light of the tower reflecting from the river surface, he notes that intensity of light coming from distance X from his building is the least and this corresponds to the light coming from light bulbs at height 'Y' on the tower. The values of X and Y are respectively close to (refractive index of water $\approx 4/3$)

(A) 25 m, 10 m **(B)** 13 m, 27 m **(C)** 22 m, 13 m **(D)** 17 m, 20 m **[2013]**
- In a young's double slit experiment, the distance between the two identical slits is 6.1 times larger than the slit width. Then the number of intensity maxima observed within the central maximum of the single slit diffraction pattern is:
(A) 3 **(B)** 6 **(C)** 12 **(D)** 24 **[2014]**
- 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 I_A/I_B equals:
(A) 1 **(B)** $1/3$ **(C)** 3 **(D)** $3/2$ **[2014]**

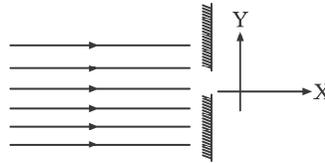
9. In an experiment of single slit diffraction pattern, first minimum for red light coincides with the first maximum of some other wavelength. If wavelength of red light is 6600\AA , then wavelength of first maximum will be: [2014]

(A) 3300\AA (B) 4400\AA (C) 5500\AA (D) 6600\AA

10. A ray of light is incident from a denser to a rarer medium. The critical angle for total internal reflection θ_{iC} . And the Brewster's angle of incidence is θ_{iB} , such that $\sin \theta_{iC} / \sin \theta_{iB} = \eta = 1.28$. The relative refractive index of the two media is: [2014]

(A) 0.2 (B) 0.4 (C) 0.8 (D) 0.9

11. A parallel beam of electrons travelling in x-direction falls on a slit of width d (see figure). If after passing the slit an electron acquires momentum P_y in the y-direction then for a majority of electrons passing through the slit (h is Plank's constant): [2015]



(A) $|P_y| d > h$ (B) $|P_y| d \gg h$ (C) $|P_y| d \approx h$ (D) $|P_y| d < h$

12. The box of a pin hole camera of length L , has a hole of radius a . It is assumed that when the hole is illuminated by a parallel beam of light of wavelength λ the spread of the spot (obtained on the opposite wall of the camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would then have its minimum size (say b_{\min}) when [2016]

(A) $a = \frac{\lambda^2}{L}$ and $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$ (B) $a = \sqrt{\lambda L}$ and $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$

(C) $a = \sqrt{\lambda L}$ and $b_{\min} = \sqrt{4\lambda L}$ (D) $a = \frac{\lambda^2}{L}$ and $b_{\min} = \sqrt{4\lambda L}$

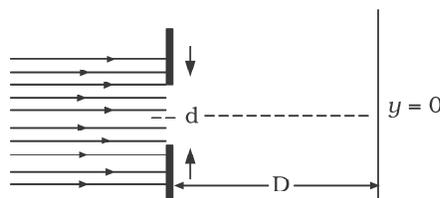
13. The angular width of the central maximum in a single slit diffraction pattern is 60° . The width of the slit is $1\mu\text{m}$. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance 50 cm from the slits. If the observed fringe width is 1 cm, what is slit separation distance? (i.e. distance between the centres of each slit.)

(A) $100\mu\text{m}$ (B) $25\mu\text{m}$ (C) $50\mu\text{m}$ (D) $75\mu\text{m}$ [2018]

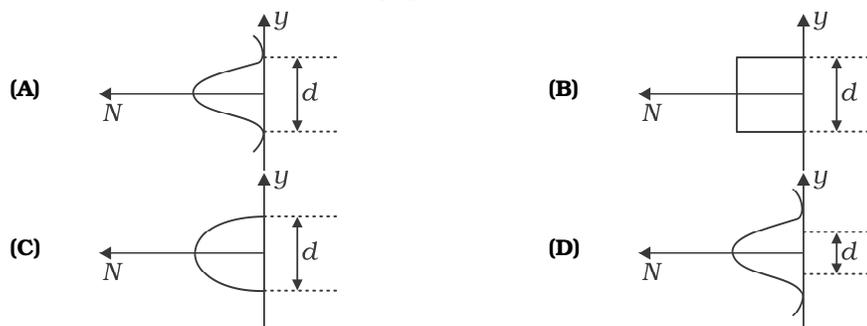
14. Unpolarized light of intensity I passes through an ideal polarizer A. Another identical polarizer B is placed behind A. The intensity of light beyond B is found to be $\frac{I}{2}$. Now another identical polarizer C is placed between A and B. The intensity beyond B is now found to be $\frac{I}{8}$. The angle between polarizer A and C is:

(A) 60° (B) 0° (C) 30° (D) 45° [2018]

15. In an experiment, electrons are made to pass through a narrow slit of width 'd' comparable to their de Broglie wavelength. They are detected on a screen at a distance 'D' from the slit (see figure).



Which of the following graph can be expected to represent the number of electrons 'N' detected as a function of the detector position 'y' (y = 0 corresponds to the middle of the slit)?

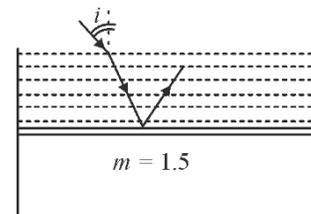


[2018]

16. In a double-slit experiment, green light (5303\AA) falls on a double slit having a separation of $19.44\mu\text{m}$ and a width of $4.05\mu\text{m}$. The number of bright fringes between the first and the second diffraction minima is:

(A) 10 (B) 04 (C) 09 (D) 05 [2019]

17. Consider a tank made of glass (refractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ . A student finds that, irrespective of what the incident angle i (see figure) is for a beam of light entering the liquid, the light reflected from the liquid-glass interface is never completely polarized. For this to happen, the minimum value of μ is:



[2019]

(A) $\frac{5}{\sqrt{3}}$ (B) $\sqrt{\frac{5}{3}}$ (C) $\frac{4}{3}$ (D) $\frac{3}{\sqrt{5}}$

18. A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1 . The pass axis of P_2 is inclined at 60° to the pass axis of P_3 . When a beam of unpolarized light of intensity I_0 is incident on P_1 , the intensity of light transmitted by the three polarizers is I . The ratio (I_0 / I) equals (nearly):

[2019]

(A) 10.67 (B) 1.80 (C) 16.00 (D) 5.33

19. Visible light of wavelength $6000 \times 10^{-8}\text{cm}$ falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minimum is at 60° from the central maximum. If the first minimum is produced at θ_1 then θ_1 is close to:

[2020]

(A) 30° (B) 45° (C) 20° (D) 25°

20. A polarizer-analyser set is adjusted such that the intensity of light coming out of the analyser is just 10% of the original intensity. Assuming that the polarizer-analyser set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero, is: **[2020]**
(A) 18.4° **(B)** 90° **(C)** 45° **(D)** 71.6°
21. A beam of plane polarized light of large cross-sectional area and uniform intensity of 3.3 Wm^{-2} falls normally on a polarizer (cross sectional area $3 \times 10^{-4} \text{ m}^2$) which rotates about its axis with an angular speed of 31.4 rad/s. The energy of light passing through the polarizer per revolution, is close to :
(A) $1.5 \times 10^{-4} \text{ J}$ **(B)** $1.0 \times 10^{-5} \text{ J}$ **(C)** $5.0 \times 10^{-4} \text{ J}$ **(D)** $1.0 \times 10^{-4} \text{ J}$
22. Orange light of wavelength $6000 \times 10^{-10} \text{ m}$ illuminates a single slit of width $0.6 \times 10^{-4} \text{ m}$. The maximum possible number of diffraction minima produced on both sides of the central maximum is ____.