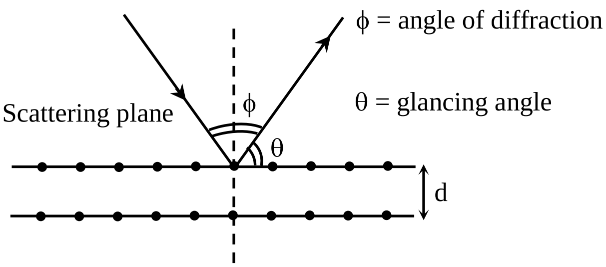
Q.1 The correct relation between the angle of diffraction ϕ and the glancing angle θ in Davission – Germer experiment will be –

(A) $\theta = 90^o - \frac{\phi}{2}$ (B)) $\phi = \frac{\theta}{2} - 90^o$

(C) $\theta = 90^o - \phi$ (D) $\phi = 90^o - \theta$ **[A]**

Sol.



From diagram $\theta = 90° - \phi/2$

Q.2 In a Fraunhoffer diffraction experiment at a single slit using light of wavelength 400 nm, the first minimum is formed at an angle of 30º. Then the direction θ of the first secondary maximum is -

(A) $\tan^{-1}\left(\frac{4}{3}\right)$ (B) 60º

(C) $\sin^{-1}\left(\frac{3}{4}\right)$ (D) $\tan^{-1}\left(\frac{3}{4}\right)$ **[C]**

Q.3 The total angular width of central maxima in diffraction at a single slit is -

(A) $\frac{\lambda}{a}$ (B) $\frac{2\lambda}{a}$

(C) $\frac{2a}{\lambda}$ (D) $\frac{2a}{3\lambda}$ **[B]**

Q.4 In a Young's double slit experiment, constructive interference is produced at a certain point P. The intensities of light at P due to the individual sources are 4 and 9 units. The resultant intensity at point P will be –

(A) 13 units (B) 25 units

(C) $\sqrt{97}$ units (D) 5 units **[B]**

Sol. $I_P = I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = \left(\sqrt{4} + \sqrt{9}\right)^2 = 25$ unit

Q.5 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 **[B]**

Sol $d = 2\lambda$

Path difference $\Delta = d \sin\theta = 2\lambda \sin\theta$
Maximum path difference $\Delta_{max} = 2\lambda$
So path difference for maxima

$\boxed{2\lambda, \lambda, 0, \lambda, 2\lambda}$

Q.6 If the intensities of the two interfering beams in Young's double slit experiment be I_1 and I_2, then the contrast between the maximum and minimum intensity is good when –

(A) I_1 is much greater than I_2

(B) I_1 is much smaller than I_2

(C) Either I_1 or I_2 is zero

(D) $I_1 = I_2$ **[D]**

Sol. For good visibility condition is

$I_{min} = 0 \Rightarrow \boxed{I_1 = I_2}$

Q.7 Fringe width observed in the Young's double slit experiment is β. If the frequency of the source is doubled, the fringe width will –

(A) remain β (B) become β/2

(C) become 2β (D) remain 3β/2 **[B]**

Sol Width of fringe = β

if frequency is doubled then, wavelength becomes halved, because velocity of light in air remain same

$\beta \propto \lambda \Rightarrow \frac{\beta'}{\beta} = \frac{\lambda'}{\lambda} = \frac{\lambda/2}{\lambda} = \frac{1}{2}$ $\boxed{\beta' = \frac{\beta}{2}}$

Q.8 Two light waves having the same wavelength λ in vacuum are in phase initially. Then the first ray travels a path of length L_1 through a medium of refractive index μ_1. The second ray travels a path of length L_2 through a medium of refractive index μ_2. The two waves are then combined to observe interference effects. The phase difference between the two, when they interfere, is –

(A) $\frac{2\pi}{\lambda}(L_1 - L_2)$ (B) $\frac{2\pi}{\lambda}(\mu_1 L_1 - \mu_2 L_2)$

(C) $\frac{2\pi}{\lambda}(\mu_2 L_1 - \mu_1 L_2)$ (D) $\frac{2\pi}{\lambda}\left[\frac{L_1}{\mu_1} - \frac{L_2}{\mu_2}\right]$ **[B]**

Sol. Optical path length through $S_1 = \mu_1 L_1$

Optical path length through $S_2 = \mu_2 L_2$

Total path difference $\Delta = (\mu_1 L_1 - \mu_2 L_2)$

$\phi = \frac{2\pi}{\lambda}\Delta$ $\boxed{\phi = \frac{2\pi}{\lambda}(\mu_1 L_1 - \mu_2 L_2)}$

Q.9 In Young's experiment, the ratio of maximum and minimum intensities in the fringe system is 9 : 1. The ratio of amplitudes of coherent sources is –

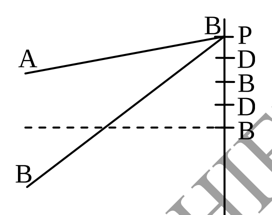
(A) 9 : 1 (B) 3 : 1

(C) 2 : 1 (D) 1 : 1 **[C]**

Sol. $\frac{I_{max}}{I_{min}} = \frac{9}{1} = \frac{(a_1 + a_2)^2}{(a - a_2)^2} \Rightarrow \frac{a_1 + a_2}{a - a_2} = \frac{3}{1}$

$\Rightarrow \frac{2a_1}{2a_2} = \frac{3+1}{3-1} = \frac{2}{1}$

Q.10 What is the difference between PA and PB ?

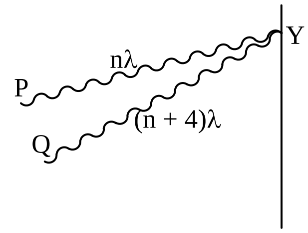


(A) $\frac{\lambda}{2}$ (B) λ (C) $\frac{3\lambda}{2}$ (D) 2λ **[D]**

Sol. For P point difference = Δ = PA – PB = for second bright

$\boxed{PA - PB = 2\lambda}$

Q.11 Figure shows a double slit experiment. P and Q are the two coherent sources. The path lengths PY and QY are $n\lambda$ and $(n + 4)\lambda$ respectively where n is a whole number and λ is wavelength. Taking the central bright fringe as zero, what is formed at Y ?



(A) First Bright (B) First Dark

(C) Fourth Bright (D) Second Dark **[C]**

Sol. $\Delta = (n + 4)\lambda - n\lambda = 4\lambda$

at Y point, forms $\boxed{\text{Fourth Bright Fringe}}$

Q.12 Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\pi/2$ at point A and π at point B. Then the difference between the resultant intensities at A and B is –

(A) 2I (B) 4I (C) 5I (D) 7I **[B]**

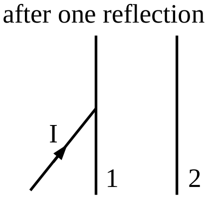
Sol. $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

$I_A = I + 4I + 2\sqrt{I \times 4I}\cos\frac{\pi}{2} = 5I$

$I_B = I + 4I + 2\sqrt{I \times 4I}\cos\pi = I$

$I_A - I_B = 5I - I = 4I$

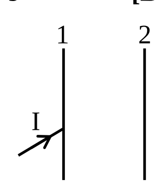
Q.13 A narrow monochromatic beam of light of intensity I is incident on a glass plate as shown in fig. Another identical glass plate is kept close to the first one and parallel to it. Each glass plate reflects 25% of the light incident on it and transmits the remaining. Then the ratio of the maximum to minimum intensities in the interference pattern formed by the two beams obtained after one reflection at each plate is -



(A) 7 : 1 (B) 49 : 1

(C) 4 : 1 (D) 16 : 9 **[B]**

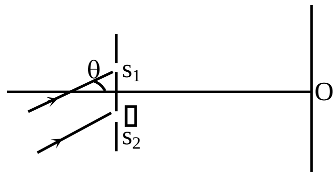
Sol. Intensity of light after reflection through I[st] plate, $I_1 = \frac{I}{4}$. Intensity of light after reflection through 2 & finally transmission through 2[nd] plate.



$I_2 = \frac{aI}{64}$

$$\frac{I_{max}}{I_{min}} = \left[\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right]^2 = 49 : 1$$

Q.14 A monochromatic beam of light falls on YDSE appratus at some angle (say θ) as shown in figure. A thin sheet of glass is inserted in front of the lower slit s_2. The central bright fringe (path difference = 0) will be obtained -



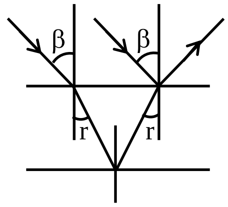
(A) at O
(B) above O
(C) below O
(D) anywhere depending on angle θ, thickness of plate t and refractive index of glass μ **[D]**

Sol. If $d\sin\theta = (\mu - 1)t$, central fringe is obtained at O.
If $d\sin\theta > (\mu - 1)t$, central fringe is obtained above O.
If $d\sin\theta < (\mu - 1)t$, central fringe is obtained below O.

Q.15 Dipping the frame in a soap solution forms a rectangle film of length b = 0.02 m and height h = 0.030 m. White light falls on the film at an angle α = 30º (measured with respect to the normal direction). The reflected light displays a green color of wavelength λ_0 (500 nm). If density of soap = 1000 kg m^{-3}, then find the mass of the thinnest film (μ_{soap} = 1.33) -

(A) 0.18 mg (B) 0.30 mg
(C) 0.06 mg (D) 0.01 mg

Sol. **[C]**



$$2\mu t\cos r = (2n+1)\frac{\lambda}{2}$$

$$t = \frac{(2n+1)\lambda}{4\mu\cos r} = \frac{\lambda}{4\mu\cos r} \text{ (putting n = 0)}$$

$$\cos r = \sqrt{1-\sin^2 r} = \frac{1}{\mu}\sqrt{\mu^2-\sin^2\beta}$$

substitute all values

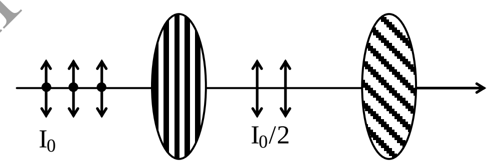
$t = 1.01 \times 10^{-7}$ m

mass of soap $\rho \times b \times h \times t = 6.06 \times 10^{-2}$ mg

Q.16 An unpolarised beam of intensity I_0 is incident on a pair of nicol prisms making an angle of 60º with each other. The intensity of light emerging from the pair is -

(A) I_0 (B) $I_0/2$
(C) $I_0/4$ (D) $I_0/8$

Sol **[D]**



$$\left(\frac{I_0}{2}\right)\cos^2 60º = \frac{I_0}{8}.$$

Q.17 A beam of light of wavelength 600 nm from a distant source falls on a single slit 1mm wide and the 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

Sol. **[D]** $\frac{2D\lambda}{a} = \frac{2\times2\times6\times10^{-7}}{1\times10^{-3}} = 24 \times 10^{-4}$ m
$= 2.4 \times 10^{-3}$ m $= 2.4$ mm

Q.18 A slit of width a is illuminated by white light. The first minimum for red light (λ = 6500Å) will fall at θ = 30º, when a is -

(A) 3250 Å (B) 6.5×10^{-4} cm
(C) 1.3 μm (D) 2.6×10^{-4} cm

Sol. **[C]** $\sin\theta = \frac{\lambda}{a}$

$\Rightarrow \sin 30^\circ = \frac{6500}{a}$ Å

$\therefore \frac{1}{2} = \frac{6500}{a}$ Å

$\therefore$ a = 2 × 6500 Å = 2 × 6500 × 10^{-10} m

$\therefore$ a = 1.3 × 10^{-6} m

Q.19 When unpolarised light beam is incident from air onto glass at polarising angle -

(A) Reflected light is polarised 100 percent

(B) Reflected & refracted beams are partially polarized

(C) Reflected & refracted beams are completely polarised

(D) Refracted light is polarised 100 percent

Sol **[A]**

Q.20 Light of wavelength 5000Å incidents over a slit of width 1 μm. The angular width of central maxima will be -

(A) 30º (B) 60º

(C) 90º (D) 120º

Sol **[B]** For I[st] minima;

$\sin\theta = \frac{\lambda}{a} = \frac{1}{2} \Rightarrow \theta = 30^\circ$

$\therefore$ Angular width of central maxima = 2 × 30 = 60

Q.21 If light of wavelength 4000Å incidents on a slit of width 0.5 mm and diffraction pattern is obtained on a screen 2m from slit then distance of first bright fringe from central bright ring -

(A) 1.2 mm (B) 0.8 mm

(C) 0.4 mm (D) none of these

Sol **[B]** $\frac{3D\lambda}{2a} - \frac{D\lambda}{a} = \frac{D\lambda}{2a} = \frac{2\times 4000\times 10^{-10}}{2\times 0.5\times 10^{-3}}$

= 0.8 × 10^{-3} m = 0.8 mm

Q.22 The angle of polarisation for any medium is 60º, what will be critical angle for this -

(A) $\sin^{-1}\sqrt{3}$ (B) $\tan^{-1}\sqrt{3}$

(C) $\cos^{-1}\sqrt{3}$ (D) $\sin^{-1}\frac{1}{\sqrt{3}}$

Sol.[D] $\mu = \tan\theta_p \Rightarrow \mu = \tan 60^\circ = \sqrt{3}$

$\Rightarrow \frac{1}{\sin c} = \sqrt{3}$; $c = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

Q.23 Two Nicols are oriented with their principal planes making an angle of 60º. The percentage of incident unpolarised light which passes through the system is-

(A) 50% (B) 100% (C) 12.5% (D) 37.5%

Sol.[C] Intensity of polarized light from 1[st] polarizer

$= \frac{100}{2} = 50$

$I = 50\cos^2 60^\circ = \frac{50}{4} = 12.5\%$

Q.24 When the angle of incidence on the material is 60º, the reflected light is completely polarised. The velocity of refracted ray inside the material is-

(A) 3 × 10^8 m/s (B) $\frac{3}{\sqrt{2}}$ × 10^8 m/s

(C) $\sqrt{3}$ × 10^8 m/s (D) $\frac{1}{3}$ × 10^8 m/s

Sol.[C] $\mu = \tan i_p$ $\therefore \frac{c}{v} = \tan i_p$

$\therefore v = \frac{3\times 10^8}{\sqrt{3}} = \sqrt{3} \times 10^8$ m/s

Q.25 A beam of light of wavelength 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2m away. The distance between the first dark fringes on either side of the central bright fringe is -

(A) 1.2 cm (B) 1.2mm

(C) 2.4 cm (D) 2.4 mm

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

= 2.4 × 10^{-3} m = 2.4mm

Q.26 Consider fraunhofer diffraction pattern obtained with a single slit illuminated at normal incidence. At the angular position of the first diffraction minimum, the phase difference (in radians) between the wavelets from the opposite edges of the slit is -

(A) π (B) 2π (C) π/4 (D) π/2

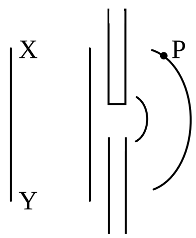
Sol.[B] For I[st] minimum $\theta = \frac{\lambda}{a}$.

and $\phi = \frac{2\pi}{\lambda} \,.\, \Delta x = \frac{2\pi}{\lambda} a \sin\theta$

$\phi = \frac{2\pi}{\lambda} \,.\, a\theta = \frac{2\pi}{\lambda} a \frac{\lambda}{a}$

$\therefore \phi = 2\pi$

Q.27 A monochromatic plane wave of speed c and wavelength λ is diffracted at a small aperture. The diagram illustrates successive wavefronts. After what time will some portion of the wavefront XY reach P ?



(A) $\frac{3\lambda}{2c}$ (B) $\frac{2\lambda}{c}$ (C) $\frac{3\lambda}{c}$ (D) $\frac{4\lambda}{c}$

Sol. [C] Distance between successive wave fringes is a wavelength λ so path difference 3λ time table : $\frac{3\lambda}{C}$

Q.28 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 on 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

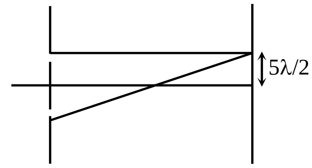
Sol. [D] $2\theta = \frac{2\times\lambda}{d} = \frac{2\times 600\times 10^{-9}}{1\times 10^{-3}}$;

so $2x = D\,(2\theta) = \frac{2\times 600\times 10^{-9}}{10^{-3}} = 2.4$ mm

Q.29 The maximum intensity in Young's double slit experiment is I_0. Distance between the slits is $d = 5\lambda$, where λ is the wavelength of monochromatic light used in the experiment -

(A) $\frac{I_0}{2}$ (B) $\frac{3I_0}{4}$ (C) I_0 (D) $\frac{I_0}{4}$

Sol.[A] $\Delta P = \frac{yd}{D} = \frac{5\lambda}{2} \times \frac{5\lambda}{10\lambda} = \frac{25\lambda}{20} = \frac{5\lambda}{4}$



$\phi = \frac{2\pi}{\lambda} \times \Delta P = \frac{2\pi}{\lambda} \times \frac{5\lambda}{4} = \frac{5\pi}{2}$

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