EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

EM Wave

1. If the wavelength of an electromagnetic radiation is of the order of size of a football field, which radiation is it ?

(A) Microwave (B) Gamma ray (C) Radio wave (D) *x*-ray

PW0079

2. Microwave oven acts on the principle of transferring electrons from lower to

(A) higher energy levels in water molecule

(B) giving rotational energy to water molecules

(C) giving translational energy to water molecules

(D) giving vibrational energy to water molecules

PW0081

3. A plane electromagnetic wave having a frequency ν = 23.9 GHz propagates along the positive z-direction in free space. The peak value of the electric field is 60 V/m. Which among the following is the acceptable magnetic field component in the electromagnetic wave?

(A) $\vec{B} = 2 \times 10^{7} \sin(0.5 \times 10^{3} z + 1.5 \times 10^{11} t)\hat{\imath}$

(B) $\vec{B} = 2 \times 10^{-7} \sin(1.5 \times 10^{2} x + 0.5 \times 10^{11} t)\hat{\jmath}$

(C) $\vec{B} = 2 \times 10^{-7} \sin(0.5 \times 10^{3} z - 1.5 \times 10^{11} t)\hat{\imath}$

(D) $\vec{B} = 60 \sin(0.5 \times 10^{3} x + 1.5 \times 10^{11} t)\hat{k}$

PW0082

4. The electric field of a plane polarized electromagnetic wave in free space at time t = 0 is given by an expression $\vec{E}(x, y) = 10\hat{\jmath}\cos[(6x + 8z)]$. The magnetic field $\vec{B}$ (x, z, t) is given by: (c is the velocity of light)

(A) $\frac{1}{c}(6\hat{k} + 8\hat{\imath})\cos[(6x - 8z + 10ct)]$

(B) $\frac{1}{c}(6\hat{k} - 8\hat{\imath})\cos[(6x + 8z - 10ct)]$

(C) $\frac{1}{c}(6\hat{k} + 8\hat{\imath})\cos[(6x + 8z - 10ct)]$

(D) $\frac{1}{c}(6\hat{k} - 8\hat{\imath})\cos[(6x + 8z + 10ct)]$

PW0083

5. A plane electromagnetic wave of frequency 500 MHz is travelling in vacuum along y-direction. At a particular point in space and time, $\vec{B} = 8.0 \times 10^{-8}\hat{z}T$. The value of electric field at this point is: (speed of light = 3×10^{8} ms^{-1}) $\hat{x}, \hat{y}, \hat{z}$ are unit vectors along x, y and z direction.

(A) $-24\hat{x}V/m$ (B) $2.6\hat{x}V/m$ (C) $24\hat{x}V/m$ (D) $-2.6\hat{y}V/m$

PW0084

6. A conducting circular loop made of a thin wire, has area 3.5×10^{-3} m^2 and resistance 10Ω. It is placed perpendicular to a time dependent magnetic field $B(t) = (0.4T)\sin(50\pi t)$. The field is uniform in space. Then the net charge flowing through the loop during t = 0 s and t = 10 ms is close to:

(A) 14 mC (B) 21 mC (C) 6 mC (D) 7 mC

PW0085

7. The amplitude of electric field in a parallel light beam of intensity 4 Wm^{-2} is:

(A) 35.5 NC^{-1} (B) 45.5 NC^{-1} (C) 49.5 NC^{-1} (D) 54.8 NC^{-1}

PW0086

8. A plane electromagnetic wave,

$E_z = 100 \cos(6 \times 10^8 t + 4x)\ V/m$

propagates in a medium of dielectric constant:

(A) 1.5 (B) 2.0 (C) 2.4 (D) 4.0

PW0087

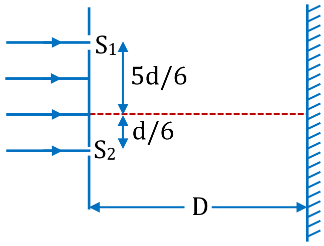
9. The rms value of the electric field of the light coming from the sun is 720 N/c. The average total energy density of the electromagnetic wave is:

(A) $4.58 \times 10^{-6}\ J/m^3$ (B) $6.37 \times 10^{-9}\ J/m^3$ (C) $81.35 \times 10^{-12}\ J/m^3$ (D) $3.3 \times 10^{-3}\ J/m^3$

PW0088

YDSE Interference

10. In the figure, if a parallel beam of white light is incident on the plane of the slits S_1 and S_2 then the distance of the nearest white spot on the screen from O is [Assume $D >> d$, $d >> \lambda$]



(A) 0 (B) $\frac{d}{3}$ (C) $\frac{d}{2}$ (D) $\frac{d}{6}$

PW0109

11. At a point on the screen at distance D from the slits in standard YDSE experiment, 3rd maxima is observed at $t = 0$. Now screen is slowly moved with constant speed away from the slits in such a way that the centre of slits and centre of screen always lie on same line and at $t = 1$ sec, the intensity at that point is observed to be $\left(\frac{3}{4}\right)^{th}$ of maximum intensity in between 2nd and 3rd maxima. The speed of screen is:

(A) $\frac{5D}{13}$ (B) $\frac{13D}{5}$ (C) $\frac{17D}{5}$ (D) $\frac{7D}{17}$

PW0114

12. Light of wavelength λ is incident normally on a thin film. The reflected light shows a minima for reflection. The thickness of film is minimum possible. Now the same film is placed in front of upper slit of the YDSE apparatus. The fringe pattern shifts up by 7.5 mm, the refractive index of material is: (Take: $D = 5\ m$, $d = 0.1\ mm$, $\lambda = 500\ nm$).

(A) 1.25 (B) 2.5 (C) 1.5 (D) 1.75

PW0122

13. When light is incident on a soap film of thickness $5 \times 10^{-5}\ cm$, wavelength reflected maximum in the visible region is 5320 Å. Refractive index of the film will be:

(A) 1.22 (B) 1.33 (C) 1.51 (D) 1.83

PW0123

14. What is the minimum thickness of a soap bubble needed for constructive interference in reflected light if the light incident on the film is 900 nm? Refractive index for the film is μ = 1.5.

(A) 100 nm (B) 150 nm (C) 200 nm (D) 250 nm

PW0124

15. Light of wavelength 6000Å is incident on a thin glass plate of refractive index 1.5 such that angle of refraction into the plate is 60°. Calculate the smallest thickness of plate which will make it appear dark by reflection.

(A) $6 \times 10^{-7} m$ (B) $4 \times 10^{-7} m$ (C) $8 \times 10^{-7} m$ (D) $12 \times 10^{-7} m$

PW0125

16. To prevent reflection from a camera lens, a thin film of magnesium is coated. In order that the light of wavelength 5000 Å not be reflected the minimum thickness of the film should be (μ for magnesium = 1.25 and μ for glass = 1.5)

(A) $2 \times 10^{-7} m$ (B) 10^{-7} m (C) 2×10^{-6} m (D) 2×10^{-8} m

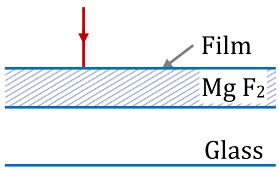
PW0126

17. White light is incident normally on a thin film which has n = 1.5 and a thickness of 5000 Å. For what wavelengths in the visible spectrum (4000 – 7000 Å) will the intensity of the reflected light be a maximum?

(A) 5000 Å, 6000 Å (B) 5260 Å, 6000 Å (C) 4285 Å, 6000 Å (D) 4500 Å, 6500 Å

PW0127

18. White light is incident normally on a glass surface (n = 1.52) that is coated with a film of MgF_2 (n = 1.38). For what minimum thickness of the film will yellow light of wavelength 550 nm (in air) be missing in the reflected light –



(A) 99.6 nm (B) 49.8 nm (C) 19.6 nm (D) 10.6 nm

PW0128

19. Dipping the frame in a soap solution forms a rectangle film of length ℓ = 0.02 m and height h = 0.030 m. White light falls on the film at an angle α = 30° (measured with respect to the normal direction). The reflected light displays green colour 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

PW0129

20. light of wavelength 5880Å is incident on a thin glass plate (μ = 1.5) such that the angle of refraction in the plate is 30°. The minimum thickness of the plate, so that it appears dark in the reflected light will be -

(A) 2940 Å (B) 4074 Å (C) 2263 Å (D) 3394 Å

PW0130

YDSE

21. In Young's double slit arrangement, water is filled in the space between screen and slits. Then:

(A) fringe pattern shifts upwards, but fringe width remains unchanged.

(B) fringe width decreases, and central bright fringe shifts upwards.

(C) fringe width increases, and central bright fringe does not shift.

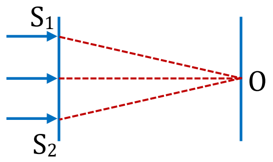
(D) fringe width decreases, and central bright fringe does not shift.

PW0093

22. **Statement-1:** In YDSE, as shown in figure, central bright fringe is formed at O. If a liquid is filled between plane of slits and screen, the central bright fringe is shifted in upward direction.

and

Statement-2: If path difference at O increases, y-coordinate of central bright fringe will change.



(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

PW0094

23. In a double slit experiment, when the width of one slit is made twice as wide as the other in compared to normal YDSE having slits of equal width. Then, in the interference pattern

(A) the intensities of both the maxima and the minima increase.

(B) the intensity of the maxima increases, and the minima has zero intensity.

(C) the intensity of the maxima decreases and that of the minima increases.

(D) the intensity of the maxima decreases, and the minima has zero intensity.

PW0096

24. **Statement-1:** In YDSE, the spacing between any two successive points having intensity half of the maximum intensity is same.

and

Statement-2: The intensity on the screen in YDSE varies uniformly with distance from central maximum.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

PW0097

25. In a Young's double slit experiment D equals the distance of screen and d is the separation between the slit. The distance of the nearest point to the central maximum where the intensity is same as that due to a single slit, is equal to:

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

PW0101

26. In a double slit experiment, the separation between the slits is $d = 0.25\ cm$ and the distance of the screen $D = 100\ cm$ from the slits. If the wavelength of light used is $\lambda = 6000$ Å and I_0 is the intensity of the central bright fringe, the intensity at a distance $x = 4 \times 10^{-5}\ m$ from the central maxima is :-

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

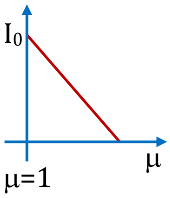
PW0102

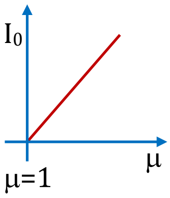
27. Light of wavelength λ in air enters a medium of refractive index μ. Two points in this medium, lying along the path of this light, are at a distance x apart. The phase difference between these points is :

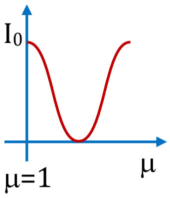
(A) $\frac{2\pi\mu x}{\lambda}$ (B) $\frac{2\pi x}{\mu\lambda}$ (C) $\frac{2\pi(\mu-1)x}{\lambda}$ (D) $\frac{2\pi x}{(\mu-1)\lambda}$

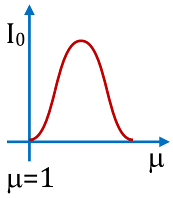
PW0103

28. In a YDSE experiment if a slab whose refractive index can be varied is placed in front of one of the slits then the variation of resultant intensity at mid-point of screen with μ ($\mu \geq 1$) will be best represented by [Assume slits of equal width and there is no absorption by slab]

(A) 

(B) 

(C) 

(D) 

PW0104

29. In a Young's double-slit experiment, let A and B be the two slits. Films of thicknesses t_A and t_B and refractive indices μ_A and μ_B, are placed in front of A and B respectively. If $\mu_A t_A = \mu_B t_B$, the central maximum will:

(A) not shift
(B) shift towards A
(C) shift towards B
(D) option (B), if $t_B > t_A$; option (C) if $t_B < t_A$

PW0105

30. Two monochromatic and coherent point sources of light are placed at a certain distance from each other in the horizontal plane. The locus of all those points in the horizontal plane which have constructive interference will be

(A) a hyperbola
(B) family of hyperbolas
(C) family of straight lines
(D) family of parabolas

PW0107

31. In a YDSE bi-chromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0.1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is :-

(A) 4 mm (B) 5.6 mm (C) 14 mm (D) 28 mm

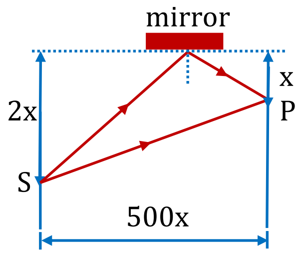
PW0108

32. Consider an YDSE that has different slits width, as a result, amplitudes of waves from two slits are A and $2A$, respectively. If I_0 be the maximum intensity of the interference pattern, then intensity of the pattern at a point where phase difference between waves is ϕ, is :-

(A) $I_0 \cos^2\phi$ (B) $\frac{I_0}{3}\sin^2\frac{\phi}{2}$ (C) $\frac{I_0}{9}$ $[5 + 4\cos\phi]$ (D) $\frac{I_0}{9}$ $[5 + 8\cos\phi]$

PW0153

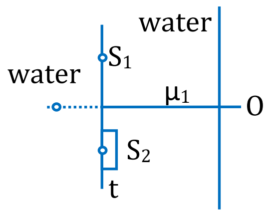
33. In the figure shown the point S is monochromatic source of light emitting light of wavelength λ. At the point P at a distance x from the mirror as shown in the figure, interference takes place between two light rays one directly coming from source S and another after reflection from the mirror such that a maxima is formed. The minimum value of x is



(A) 120λ (B) 125λ (C) 62.5λ (D) None of these

PW0154

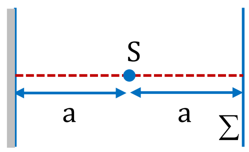
34. A young's double slit experiment is conducted in water (μ_1) as shown in the figure, and a glass plate of thickness t and refractive index μ_2 is placed in the path of S_2. Wavelength of light in water is λ. Find the magnitude of the phase difference between waves coming from S_1 and S_2 at 'O'.



(A) $\left|\left(\frac{\mu_2}{\mu_1}-1\right)t\right|\frac{2\pi}{\lambda}$ (B) $\left|\left(\frac{\mu_1}{\mu_2}-1\right)t\right|\frac{2\pi}{\lambda}$ (C) $|(\mu_2-\mu_1)t|\frac{2\pi}{\lambda}$ (D) $|(\mu_2-1)t|\frac{2\pi}{\lambda}$

PW0155

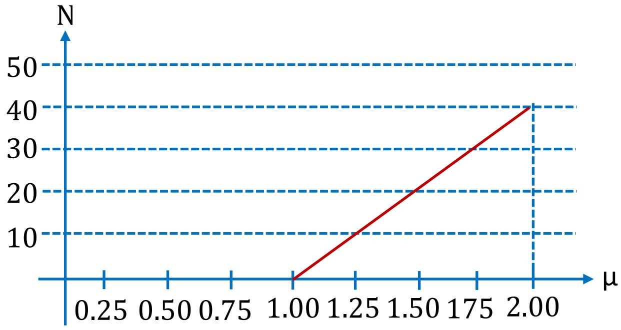
35. A point source of light S is place in front of a perfectly reflecting mirror as shown in the figure. Σ is a screen. The intensity at the centre of screen is found to be I. If the mirror is removed, then the intensity at the centre of screen would be :-



(A) I (B) $\frac{10I}{9}$ (C) $\frac{9I}{10}$ (D) $2I$

PW0156

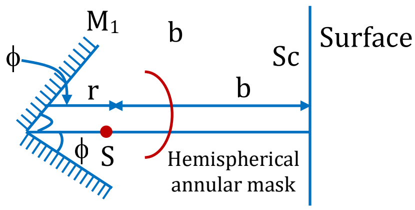
36. The slits in a double-slit interference experiment are illuminated by orange lights (λ = 600 nm). A thin transparent plastic of thickness t is placed in front of one of the slits. The number of fringes (N) shifting on screen is plotted versus the refractive index μ of the plastic in in graph shown. The value of t is:-



(A) 4.8 μm (B) 48 μm (C) 2.4 μm (D) 24 μm

PW0157

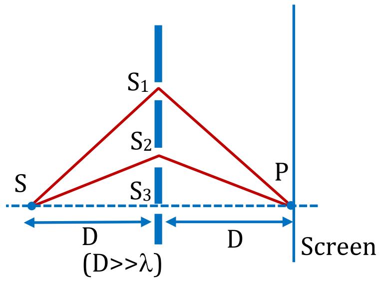
37. Two mirrors M_1 and M_2 make an angle ϕ with line AB. A point source S is kept at a distance r from the point of intersection of mirrors. A small hemispherical annular mask is kept close to S so that no ray emanating from S directly reaches the screen kept at a distance b from the source. Interference pattern of rays reflected from M_1 and M_2 is observed on the screen. Find the fringe width of this interference pattern. λ = wavelength of light being emitted by source.



(A) $\dfrac{\lambda(b+2r\sin^2\phi)}{2r\sin2\phi}$ (B) $\dfrac{\lambda(b+2r\cos2\phi)}{2r\sin2\phi}$ (C) $\dfrac{\lambda(b+r\cos2\phi)}{2r\sin2\phi}$ (D) $\dfrac{\lambda(b+2r\cos2\phi)}{r\sin2\phi}$

PW0158

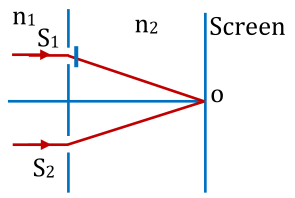
38. A monochromatic light source of wavelength λ is placed at S. Three slits S_1, S_2 and S_3, source S and point P is shown in the figure. If $S_1P - S_2P = \lambda/6$ and $S_1P - S_3P = 2\lambda/3$ and I be the intensity at P when only one slit is open, the intensity at P when all the three slits are open is :-



(A) $3I$ (B) $5I$ (C) $8I$ (D) 0

PW0159

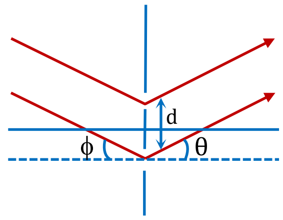
39. In a Young's double slit experiment the slits are illuminated by a parallel beam of light from the medium of refractive index $n_1 = 1.2$. A thin transparent film of thickness $1.2 \mu m$ and refractive index $n = 1.5$ is placed infront of s_1 perpendicular to path of light. Wavelength of light measured in medium n_1 is 400 nm. The refractive index of medium between plane of slits and screen is $n_2 = 1.4$. If the light coming from the film and s_2 have equal intensities I then intensity at geometrical centre of the screen is



(A) 0 (B) $2I$ (C) $4I$ (D) None of these

PW0160

40. Light is incident at an angle ϕ with the normal to a plane containing two slits of separation d. Select the expression that correctly describes the positions of the interference maxima in terms of the incoming angle ϕ and outgoing angle θ.

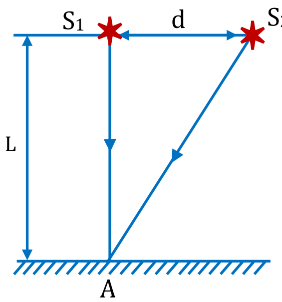


(A) $\sin\phi + \sin\theta = \left(m+\frac{1}{2}\right)\frac{\lambda}{d}$ (B) $d \sin\theta = m\lambda$

(C) $\sin\phi - \sin\theta = (m+1)\frac{\lambda}{d}$ (D) $\sin\phi + \sin\theta = m\frac{\lambda}{d}$

PW0161

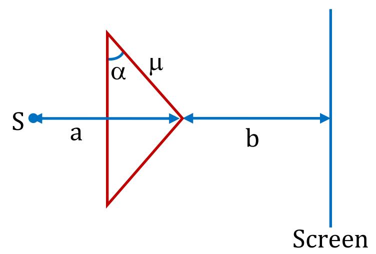
41. Two coherent sources S_1 and S_2, each of intensity I_0 on screen are emitting light with a wavelength $\lambda = 0.5\ \mu m$, are at a distance $d = 2\ mm$ from each other. A screen is kept at a distance $L = 2\ m$ from them. What will be the intensity at point A of the screen: ?



(A) $4I_0$ (B) $2I_0$ (C) I_0 (D) zero

PW0162

42. A fresnel biprism has a slit S as shown. This arrangement is used to obtain interference fringes on the screen. Which of the following modifications would definitely increase the number of fringes obtained on the screen.



(1) Increase a by moving slit further away.
(2) decrease a & increase b by moving biprism towards slit S.
(3) decrease wavelength λ.
(4) decrease angle of prism (α).

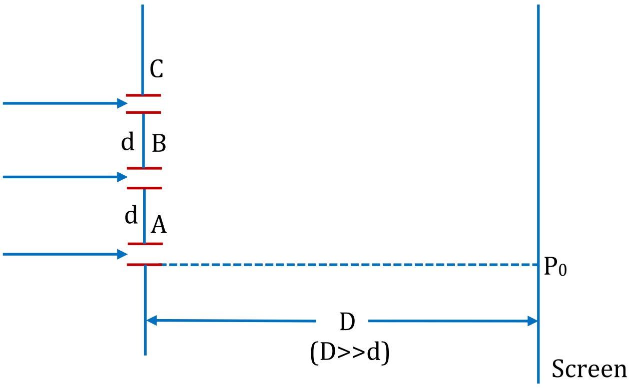
(A) All (B) 1, 2, 3 (C) 1, 2, 4 (D) 1, 3

PW0163

43. Consider superposition of waves coming from three light sources (slits) A, B and C as shown in fig. Given that

$$BP_0 - AP_0 = \frac{\lambda}{3} \quad \text{and} \quad d = \sqrt{\frac{2\lambda D}{3}}$$

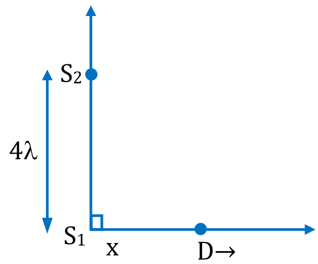
The ratio of intensity at P_0 compared to intensity due to individual slit is



(A) 1.5 (B) 2 (C) 2.5 (D) 3

PW0164

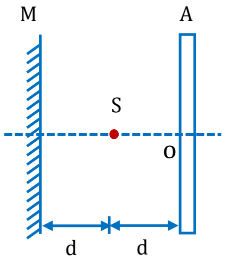
44. Two microwave sources S_1 and S_2 are located at a distance of 4λ from each other along Y-axis, with S_1 at the origin as shown in the figure. A microwave detector D moves along the X-axis away from S_1. The first maximum is obtained for x (> 0) equal to: (wavelength of the microwave is λ):



(A) λ (B) $\frac{1}{6}\lambda$ (C) 3λ (D) $\frac{7}{6}\lambda$

PW0165

45. A point source of light 'S' at a distance d from the screen A, produces light intensity I_0 at the centre O of the screen. If a completely reflecting mirror M is placed at a distance d behind the source as shown in the figure, treating object and its image as incoherent with each other, find the intensity at the centre of the screen.



(A) $\frac{9}{10}I_0$ (B) $\frac{10}{9}I_0$ (C) $\frac{8}{9}I_0$ (D) $\frac{9}{8}I_0$

PW0166

Diffraction

46. 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) $\pi/4$ (D) $\pi/2$

PW0131

47. Light with wavelength 500 *nm* falls on a slit of width 10 μm at an angle 30° to its normal. Find the angular position of the first minima located on both sides of the central Fraunhofer maxima :-

(A) 33° and 27° (B) 25° and 35° (C) 36° and 24° (D) 28° and 32°

PW0132

48. The image of a star (effectively a point source) is made by a convergent lens of focal length 1*m* and diameter of aperture 5.0 *cm*. If the lens is ideal and the effective wavelength in image formation is taken as 5×10^{-5} *cm*, the diameter of the image formed will be nearest to:

(A) zero (B) 10^{-6} *cm* (C) 10^{-5} *cm* (D) 10^{-3} *cm*

PW0136

49. A microscope objective gathers light over a cone of semi-vertex 30° and used visible light of wavelength 5500 Å. Its resolving limit is :

(A) 2.5×10^{-5} *cm* (B) 4.6×10^{-5} *cm* (C) 3.9×10^{-5} *cm* (D) 6.7×10^{-5} *cm*

PW0137

50. A person wishes to distinguish between two pillars located at a distance of 11 *km*. what should be the minimum distance between these pillars? [*R.L.* = 1'(one minute)]

(A) 6.4 (B) 1.6 (C) 3.2 (D) None of these

PW0138

51. Calculate the resolving power of a telescope, assuming the diameter of the objective lens to be 6 *cm* and the wavelength of light used to be 540 *nm*.

(A) 3.2×10^4 (B) 3.1×10^3 (C) 9.2×10^3 (D) 9.1×10^4

PW0139

52. Find limit of resolution of a microscope if an object of numerical aperture 0.06 is viewed by using light of wavelength 9600 Å.

(A) 2.69 (B) 3.59 (C) 6.09 (D) 9.76

PW0140

53. Find ratio of resolving powers of an optical microscope for two wave lengths λ_1 = 4200 Å and λ_2 = 7200 Å.

(A) $\frac{7}{12}$ (B) $\frac{12}{7}$ (C) $\frac{6}{7}$ (D) $\frac{6}{14}$

PW0141

54. Two towers on top of two hills are 40 *km* apart. The line joining them passes 50 *m* above a hill halfway the towers. What is the longest wavelength of radio waves, which can be sent between the towers without appreciable diffraction effects?

(A) 10.5 *cm* (B) 11.5 *cm* (C) 12.5 *cm* (D) 13.5 *cm*

PW0142

55. Consider diffraction by a slit of small width. O is point of central maxima; A is point closest to O where intensity is zero. Now if width of slit is increased slightly.
(A) Intensity of O increases and point A shifts away from O.
(B) Intensity of O increases and point A shifts towards O.
(C) Intensity of O decreases and point A shifts aways from O.
(D) Intensity of O decreases and point A shifts towards O.

PW0167

56. In single slit fraunhoffer diffraction pattern, resultant amplitude at the centre of central maxima is A_0 and it is A at an angular position of 30°. Then $\frac{A}{A_0}$ will be - [Slit width $a = \lambda$]

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

PW0168

57. What is the wavelength of a beam of x rays which is diffracted by a crystal in a direction making an angle of 60° with the Incident beam and corresponding to first order 'reflection' from crystal lattice planes separated by 3×10^{-10} m?
(A) 6 Å (B) 9 Å (C) 3 Å (D) 4 Å

PW0169

58. If I_0 is the intensity of the principal maxima in a Fraunhoffer single slit diffraction pattern, then what will be the intensity of the first secondary maxima :-

(A) $\frac{2}{5\pi^2} I_0$ (B) $\frac{1}{9\pi} I_0$ (C) $\frac{3}{5\pi^2} I_0$ (D) $\frac{4}{9\pi^2} I_0$

PW0170

Polarisation

59. Light waves can be polarised as they are
(A) Transverse (B) of high frequency (C) Longitudinal (D) Reflected

PW0143

60. 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°

PW0144

61. A polaroid is placed at 45° to an incoming light of intensity I_o. Now the intensity of light passing through polaroid after polarisation would be
(A) I_o (B) $I_o/2$ (C) $I_o/4$ (D) Zero

PW0145

62. Plane polarised light is passed through a polaroid. On viewing through the polaroid, we find that when the polaroid is given one complete rotation about the direction of the light, one of the following is observed.
(A) The intensity of light gradually decreases to zero and remains at zero.
(B) The intensity of light gradually increases to a maximum and remains at maximum.
(C) There is no change in intensity.
(D) The intensity of light is twice maximum and twice zero.

PW0146

63. 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, then the angle between reflected and refracted rays is

(A) $90 + \phi$ (B) $\sin^{-1}(\mu\cos\phi)$ (C) $90°$ (D) $90^o - \sin^{-1}(\sin\phi/\mu)$

PW0147

64. A light has amplitude A and angle between analyser and polariser is $60°$. Light is reflected by analyser has amplitude.

(A) $A\sqrt{2}$ (B) $A/\sqrt{2}$ (C) $\sqrt{3}A/2$ (D) $A/2$

PW0148

65. Unpolarized light of intensity 32 Wm^{-2} passes through three polarizers such that transmission axis of the first and second polarizer makes an angle of $30°$ with each other and the transmission axis of the last polarizer is crossed with that of the first. The intensity of final emerging light will be

(A) 32 Wm^{-2} (B) 3 Wm^{-2} (C) 8 Wm^{-2} (D) 4 Wm^{-2}

PW0149

66. Two polaroid are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second polaroid. If a third polaroid whose polarization axis makes an angle θ with the polarization axis of first polaroid, is placed between these polaroids then the intensity of light emerging from the last polaroid will be

(A) $\left(\frac{I_0}{8}\right)\sin^2 2\theta$ (B) $\left(\frac{I_0}{4}\right)\sin^2 2\theta$ (C) $\left(\frac{I_0}{2}\right)\cos^4\theta$ (D) $I_0\cos^4\theta$

PW0150

67. When unpolarized light beam is incident from air onto glass (n = 1.5) at the polarising angle

(A) Reflected beam is polarised 100 percent

(B) Reflected and refracted beams are partially polarised

(C) The reason for (a) is that almost all the light is reflected

(D) All of the above

PW0151

68. When the angle of incidence on a material is $60°$, the reflected light is completely polarized. The velocity of the refracted ray inside the material is (in ms^{-1})

(A) 3×10^8 (B) $\left(\frac{3}{\sqrt{2}}\right) \times 10^8$ (C) $\sqrt{3} \times 10^8$ (D) 0.5×10^8

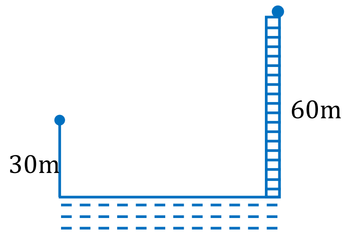
PW0152

69. When the angle of incidence on a material from air is $60°$, the reflected light is completely polarized. The velocity of the refracted ray inside the material is (in ms^{-1}) :

(A) 3×10^8 (B) $\left(\frac{3}{\sqrt{2}}\right)\times 10^8$ (C) $\sqrt{3}\times 10^8$ (D) 0.5×10^8

PW0171

70. A person lives in a high rise building at a height 30m on the bank of a river. Across the river is a well it towers of height 60m. When person looks through a polarizer at an appropriate angle at light from top of tower reflecting from the river surface, he finds intensity of light is least. If refractive index of water is $\frac{4}{3}$, width of river is:-

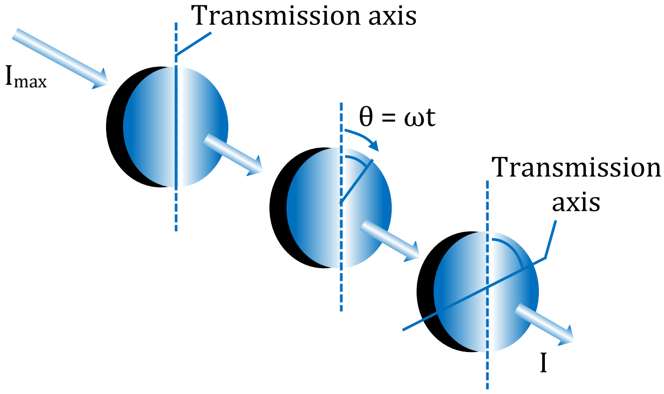


(A) 120m (B) 80m

(C) 60m (D) 40m

PW0172

71. In figure suppose the transmission axes of the left and right polarizing disks are perpendicular to each other. Also, let the center disk be rotated on the common axis with an angular speed ω. That if unpolarized light is incident on the left disk with an intensity I_{max} the intensity of the beam emerging from the right disk is given by :-

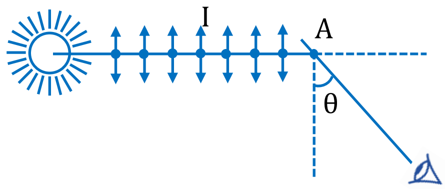


(A) $I = \frac{1}{16} I_{max}(1 - \cos 4\omega t)$ (B) $I = \frac{1}{16} I_{max}(1 - \cos 2\omega t)$

(C) $I = \frac{1}{8} I_{max}(1 - \cos 4\omega t)$ (D) $I = \frac{1}{8} I_{max}(1 - \cos 2\omega t)$

PW0173

72. Unpolarized light of intensity I scattered from point *A*. Intensity of light perceive by given observer is :-



(A) I (B) $\frac{I}{2}\cos^2\theta$ (C) $\frac{I}{2}+\frac{I}{2}\sin^2\theta$ (D) $\frac{I}{2}+\frac{I}{2}\cos^2\theta$

PW0174

MULTIPLE CORRECT TYPE QUESTIONS

EM Wave

73. As a wave propagates,

(A) the wave intensity remains constant for a plane wave.

(B) the wave intensity decreases with distance from source and is proportional to inverse of the distance, for a spherical wave.

(C) the wave intensity decreases with distance from source and proportional to inverse square of the distance, for a spherical wave.

(D) total average power of the spherical wave over any spherical surface centered at the source remains same.

PW0092

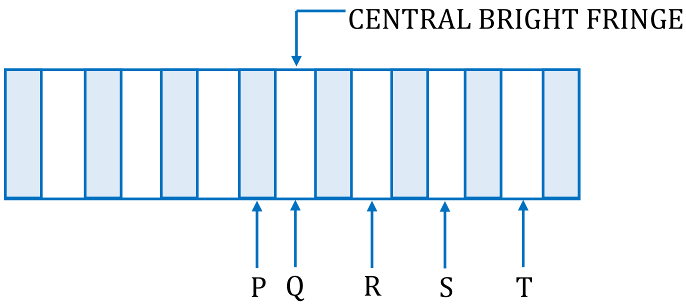
YDSE

74. To observe a sustained interference pattern formed by two light waves, it is not necessary that they must have:

(A) the same frequency
(B) same amplitude
(C) a constant phase difference
(D) the same intensity

PW0095

75. The figure shows the interference pattern obtained in double-slit experiment using light of wavelength 600 *nm*. *P*, *Q*, *R*, *S* and *T* are marked on five fringes.



(A) The third order bright fringe is *R*.

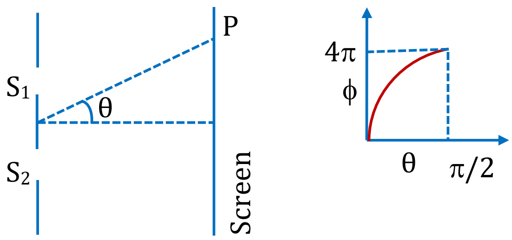
(B) The third order bright fringe is *T*.

(C) The fringe resulting from a phase difference of 4π is *S*.

(D) If ΔX_A and ΔX_C represent path differences between waves interfering at *P* and *R* respectively then $(|\Delta X_C| - |\Delta X_A|)$ is equal to 300*nm*.

PW0175

76. In a YDSE setup, we plot the phase difference (ϕ) between both waves at point *P* on the screen against the angular position (θ) of point *P* on the screen. The graph is as shown below.



(A) The distance $S_1S_2 = 2\lambda$

(B) There are a total of 4 minima on the screen

(C) The first maxima above the centre is at $\theta = \dfrac{\pi}{4}$

(D) At $\theta = \dfrac{\pi}{6}$, intensity is maximum

PW0176

77. A glass plate of refractive index μ_3 is coated with a thin layer of thickness t and refractive index μ_2 ($\mu_2 > \mu_3$). Light of wavelength λ travelling in air is incident normally on layer. It is partially reflected at the upper and the lower surfaces of layer. Choose correct option(s):

(A) The two reflected waves interfere constructively if $t = \dfrac{\left(n + \frac{1}{2}\right)\lambda}{2\mu_2}$.

(B) The two reflected waves interfere constructively if $t = \dfrac{\left(n + \frac{1}{2}\right)\lambda}{2\mu_3}$.

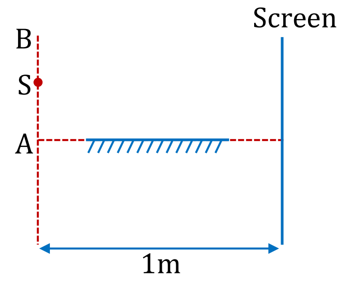
(C) The two reflected waves interfere destructively if $t = \dfrac{n\lambda}{2\mu_2}$.

(D) The two reflected waves interfere destructively if $t = \dfrac{n\lambda}{2\mu_3}$.

PW0177

YDSE Interference

78. In an interference experiment as shown in the figure, the source plane and screen are separated by a distance $1m$. At a certain position of source, fringe width is $\frac{1}{4}\,mm$ and by moving the source away from mirror along the line AB by 0.6 mm, the fringe width changed to $\frac{1}{6}\,mm$:-



(A) Wavelength of light used is 5000 Å

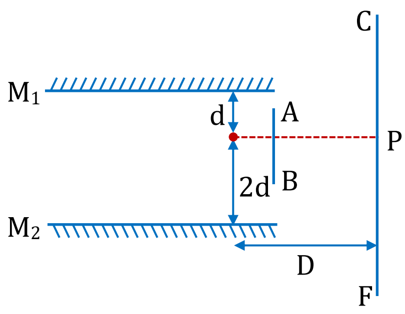
(B) Wavelength of light used is 6000 Å

(C) Initial distance of source from A is 1.2 mm

(D) Initial distance of source from A is 0.6 mm

PW0120

79. M_1 and M_2 are two plane mirror and S is monochromatic source. AB is a 'stop' which stops direct light to reach CF and allows reflected light from M_1 and M_2 to reach CF. P is a point on CF such that SP is parallel to M_1 and M_2 and perpendicular to CF :



(A) Circular fringes will be formed on CF

(B) P will be central maxima

(C) P will be a point of maxima if $\lambda = \dfrac{6d^2}{D}$

(D) P will be a point of maxima if $\lambda = \dfrac{d^2}{D}$

PW0121

COMPREHENSION TYPE QUESTIONS

EM Wave

PARAGRAPH FOR QUESTION NO. 80 TO 82

An initially parallel cylindrical beam travels in a medium of refractive index $\mu(I) = \mu_0 + \mu_2 I$, where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius.

80. The initial shape of the wave front of the beam is :-
(A) planar
(B) convex
(C) concave
(D) convex near the axis and concave near the periphery

PW0089

81. The speed of the light in the medium is:
(A) maximum on the axis of the beam
(B) minimum on the axis of the beam
(C) the same everywhere in the beam
(D) directly proportional to the intensity I

PW0090

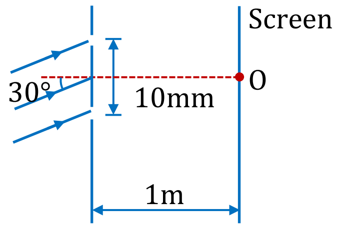
82. As the beam enters the medium, it will:
(A) travel as a cylindrical beam
(B) diverge
(C) converge
(D) diverge near the axis and converge near the periphery

PW0091

YDSE Interference

PARAGRAPH FOR QUESTION NO. 83 TO 85

In a Young's double slit experiment, a parallel beam of light of wavelength 4000 Å is incident on the slit at an angle of 30^o as shown in the figure.



83. Find fringe width of the interference pattern
(A) 40 μm
(B) 20 μm
(C) 30 μm
(D) 10 μm

PW0111

84. Find phase difference between the light coming from the two slits at O.
(A) zero
(B) $\pi/2$
(C) $\pi/6$
(D) $\pi/4$

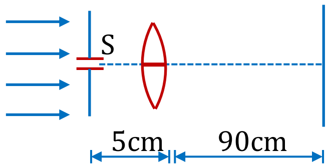
PW0112

85. Find the position of centre bright fringe on screen.
(A) 50 cm
(B) 30 cm
(C) 40 cm
(D) 45 cm

PW0113

PARAGRAPH FOR QUESTION NO. 86 TO 88

A convex lens of focal length $f = 10\ cm$ is cut through a optical axis into two semicircular halves. In doing so, glass of 0.5 mm thickness is lost. The two halves are then joined together. This lens is placed symmetrically 5 cm in front of a slit which is illuminated with light of wavelength $\lambda = 5000 Å$. A screen is placed on the other side of the lens at a distance of 90 cm from the lens, perpendicular to the optical axis of the lens.



86. What is the distance between two images of S ?

(A) $\frac{1}{2}\ mm$ (B) $1\ mm$ (C) $\frac{1}{4}\ mm$ (D) $\frac{3}{2}\ mm$

PW0117

87. What is the fringe width on the screen?

(A) $\frac{1}{2}\ mm$ (B) $\frac{3}{4}\ mm$ (C) $1\ mm$ (D) $\frac{5}{4}\ mm$

PW0118

88. Total number of maximas on the screen are

(A) 5 (B) 4 (C) 2 (D) 7

PW0119

MATRIX MATCH TYPE QUESTION

EM Wave

89. Match List-I with List-II.

	List-I		List-II
(a)	Source of microwave frequency	(i)	Radioactive decay on nucleus
(b)	Source of infrared frequency	(ii)	Magnetron
(c)	Source of Gamma Rays	(iii)	Inner shell electrons
(d)	Source of X-rays	(iv)	Vibration of atoms and molecules
		(v)	LASER
		(vi)	RC circuit

PW0080

EXERCISE - S

EM Wave

1. A plane electromagnetic wave of frequency v = 10 MHz propagates in a poorly conducting medium with conductivity σ = 10 ms/m and permittivity e = 9. Find the ratio of amplitudes of conduction and displacement current densities.

PW0178

2. A plane electromagnetic wave $E = E_m \cos(\omega t\text{-}kr)$ propagates in vacuum. Assuming the vectors Em and k to be known, find the vector H as a function of time t at the point with radius vector r =0.

PW0179

3. A plane electromagnetic wave $E = Em$ cos (wt - kr), where Em = Emey, k = kex, ex, eu are the unit vectors of the x, y axes propagates in vacuum. Find the vector H at the point with radius vector $r = xe_x$ at the moment (a) t = 0, (b) $t = t_0$.

PW0180

4. A plane electromagnetic wave $E = E_m$, cos $(\omega t\text{-}kx)$ propagating in vacuum, induces the emf in, in a square frame with side l. The orientation of the frame is shown in figure below. Find the amplitude value ε_{ind}, E_m= 0.50 m v/m, the frequency v = 5.0 MHz and l = 50 cm

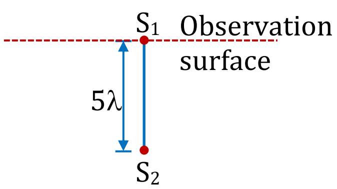
PW0181

5. A plane electromagnetic wave falls at right angles to the surface of a plane parallel to the thickness l. The plate is made of non-magnetic substance whose permittivity decreases exponentially from a value al at the front surface down to a value a, at the rear one. How long does it take a given wave phase to travel across this plate?

PW0182

YDSE Interference

6. Two microwave coherent point sources emitting waves of wavelength λ are placed at 5λ distance apart. The interference is being observed on a flat non-reflecting surface along a line passing through one source, in a direction perpendicular to the line joining the two sources (refer figure). Considering λ as 4 mm, calculate the positions of maxima and draw shape of interference pattern. Take initial phase difference between the two sources to be zero.



PW0115

7. In a biprism experiment with sodium light, bands of width 0.0195 cm are observed on screen at 100 cm from slit. On introducing a convex lens 30 cm away from the slit between biprism and screen, two images of the slit are seen 0.7 cm apart on screen. Calculate the wavelength of sodium light.

PW0116

YDSE

8. The distance between two slits in a YDSE apparatus is $3mm$. The distance of the screen from the slits is $1m$. Microwaves of wavelength 1 mm are incident on the plane of the slits normally. Find the distance of the first maxima on the screen from the central maxima. Also find the total number of maxima on the screen.

PW0098

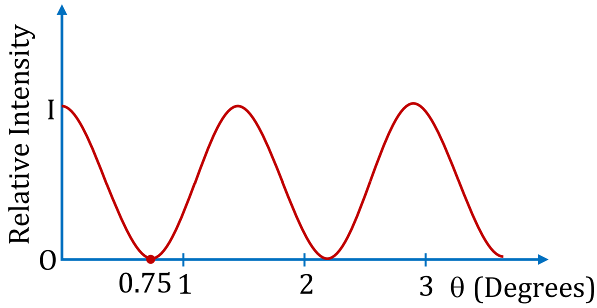
9. Two coherent waves are described by the following expressions.

$$E_1 = E_0 \sin\left(\frac{2\pi x_1}{\lambda} - 2\pi ft + \frac{\pi}{6}\right)\ ;\ E_2 = E_0 \sin\left(\frac{2\pi x_2}{\lambda} - 2\pi ft + \frac{\pi}{8}\right)$$

Determine the relationship between x_1 and x_2 that produces constructive interference when the two waves are superposed.

PW0099

10. Light of wavelength 520 nm passing through a double slit, produces interference pattern of relative intensity versus angular position θ as shown in the figure. Find the separation d between the slits.

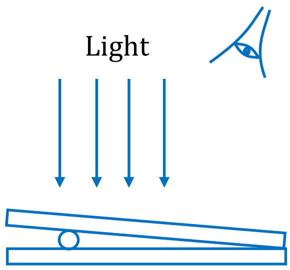


PW0100

11. One slit of a double slit experiment is covered by a thin glass plate of refractive index 1.4 and the other by a thin glass plate of refractive index 1.7. The point on the screen, where central bright fringe was formed before the introduction of the glass sheets, is now occupied by the 5th bright fringe. Assuming that both the glass plates have same thickness and wavelength of light used is 4800 $\mathring{A}$, find their thickness.

PW0106

12. A very fine hair-like fiber is stuck between two microscope slides. As a result of this, there is a wedge of air between them. When the slides are illuminated normally (from above) with light of wavelength 550 nm, bright and dark interference bands are formed. The fiber is seen to lie at the position of fifth dark band counting from the common edge. What is the diameter (in nm) of the fiber?



PW0183

13. A narrow light beam is incident on a plane-parallel plate having a refractive index of $n = \frac{17}{16}$ at an angle of 30° to the normal from air. As a result, it is partially reflected and refracted. The refracted beam is reflected by the rear surface of the plate and then undergoes refraction again, emerging from the plate with a displacement of $4\sqrt{3}$ *cm* parallel to the primary reflected beam. The thickness of the plate is given as 't' *m*. Find the value of 40 t .

PW0184

Diffraction

14. A horizontal laser beam of wavelength 660 *nm* has a circular cross section 2.00 *mm* in diameter. A rectangular aperture is to be placed in the center of the beam so that when the light falls perpendicularly on a wall 4.50 *m* away, the central maximum fills a rectangle 110 *mm* wide and 6.00 *mm* high. The dimensions are measured between the minima bracketing the central maximum.

(a) Find the required width and height of the aperture.

(b) Is the longer dimension of the aperture horizontal or vertical ?

PW0133

15. A 20 × microscope objective is designed for use in an oil immersion microscope with a 16 *cm* tube length. The lens is marked *NA* = 0.90. What is the diameter of the objective lens?

PW0134

16. You've been asked to build a 12 × microscope from a 2.0 × magnifying lens and a 4.0 × magnifying lens.

(a) Which lens should be used as the objective?

(b) What will be the tube length of your microscope?

PW0135

Polarisation

17. A beam of plane-polarized light falls on a polarized which rotates about the axis of the ray with angular velocity ω = 21 *rad/s*. Find the energy of light passing through the polarizer per one revolution if the flux of energy of the incident ray is equal to φ_0 = 4.0 *mW*.

PW0185

18. A beam of natural light galls on a system on N = 6 Nicol prisms whose transmission planes are turned each through an angle $\phi = 30°$ with respect to that of the foregoing prism. What fraction of luminous flux passes through this system?

PW0186

EXERCISE - JEE (Main) PYQ

1. 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 intensitites of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals :

[JEE (Main) 2014]

(1) 1 (2) $\frac{1}{3}$ (3) 3 (4) $\frac{3}{2}$

PW0034

2. A red LED emits light at 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is: **[JEE (Main) 2015]**

(1) 5.48 V/m (2) 7.75 V/m (3) 1.73 V/m (4) 2.45 V/m

PW0035

3. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is: **[JEE (Main) 2015]**

(1) 100 μm (2) 300 μm (3) 1 μm (4) 30 μm

PW0036

4. 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 :- **[JEE (Main) 2016]**

(1) $a = \frac{\lambda^2}{L}$ and $b_{min} = \sqrt{4\lambda L}$ (2) $a = \frac{\lambda^2}{L}$ and $b_{min} = \left(\frac{2\lambda^2}{L}\right)$

(3) $a = \sqrt{\lambda L}$ and $b_{min} = \left(\frac{2\lambda^2}{L}\right)$ (4) $a = \sqrt{\lambda L}$ and $b_{min} = \sqrt{4\lambda L}$

PW0037

5. The angular width of the central maximum in a single slit diffraction pattern is 60°. The width of the slit is 1 μm. 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.) **[JEE (Main) 2018]**

(1) 50 μm (2) 75 μm (3) 100 μm (4) 25 μm

PW0038

6. An EM wave from air enters a medium. The electric fields are $\vec{E}_1 = E_{01}\hat{x}\cos\left[2\pi v\left(\frac{z}{c} - t\right)\right]$in air and $\vec{E}_2 = E_{02}\hat{x}\cos[k(2z - ct)]$in medium, where the wave number k and frequency v refer to their values in air. The medium is non-magnetic. If ϵ_{r_1} and ϵ_{r_2} refer to relative permittivity of air and medium respectively, which of the following options is correct ? **[JEE (Main) 2018]**

(1) $\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = 2$ (2) $\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = \frac{1}{4}$ (3) $\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = \frac{1}{2}$ (4) $\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = 4$

PW0039

7. If the magnetic field of a plane electromagnetic wave is given by (The speed of light = $3 \times 10^8 / m/s$) $B = 100 \times 10^{-6} \sin\left[2\pi \times 2 \times 10^{15}\left(t - \frac{x}{c}\right)\right]$ then the maximum electric field associated with it is:

[JEE (Main) 2019]

(1) $4 \times 10^4\ N/C$ (2) $4.5 \times 10^4\ N/C$ (3) $6 \times 10^4\ N/C$ (4) $3 \times 10^4\ N/C$

PW0040

8. The magnetic field of an electromagnetic wave is given by:

$\vec{B} = 1.6 \times 10^{-6} \cos(2 \times 10^7 z + 6 \times 10^{15} t)\,(2\hat{\imath} + \hat{\jmath})\frac{Wb}{m^2}$

The associated electric field will be: **[JEE (Main) 2019]**

(1) $\vec{E} = 4.8 \times 10^2 \cos(2 \times 10^7 z + 6 \times 10^{15} t)\,(\hat{\imath} - 2\hat{\jmath})\frac{V}{m}$

(2) $\vec{E} = 4.8 \times 10^2 \cos(2 \times 10^7 z - 6 \times 10^{15} t)\,(2\hat{\imath} + \hat{\jmath})\frac{V}{m}$

(3) $\vec{E} = 4.8 \times 10^2 \cos(2 \times 10^7 z - 6 \times 10^{15} t)\,(-2\hat{\jmath} + \hat{\imath})\frac{V}{m}$

(4) $\vec{E} = 4.8 \times 10^2 \cos(2 \times 10^7 z + 6 \times 10^{15} t)\,(-\hat{\imath} + 2\hat{\jmath})\frac{V}{m}$

PW0041

9. In a double-slit experiment, green light (5303 Å) falls on a double slit having a separation of 19.44 μm and a width of 4.05 μm. The number of bright fringes between the first and the second diffraction minima is: **[JEE (Main) 2019]**

(1) 09 (2) 10 (3) 04 (4) 05

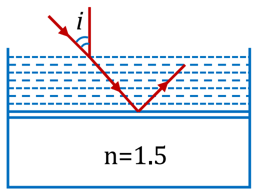
PW0042

10. A light wave is incident normally on a glass slab of refractive index 1.5. If 4% of light gets reflected and the amplitude of the electric field of the incident light is $30 V/m$, then the amplitude of the electric field for the wave propagating in the glass medium will be: **[JEE (Main) 2019]**

(1) $10\ V/m$ (2) $24\ V/m$ (3) $30\ V/m$ (4) $6\ V/m$

PW0043

11. 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 :



[JEE (Main) 2019]

(1) $\frac{3}{\sqrt{5}}$ (2) $\frac{5}{\sqrt{3}}$ (3) $\sqrt{\frac{5}{3}}$ (4) $\frac{4}{3}$

PW0044

12. The electric field of a plane electromagnetic wave is given by $\vec{E} = E_0 \frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}} \cos(kz + \omega t)$

At $t = 0$, a positively charged particle is at the point $(x, y, z) = \left(0, 0, \frac{\pi}{k}\right)$. If its instantaneous velocity at $(t = 0)$ is $v_0\,\hat{k}$, the force acting on it due to the wave is: **[JEE (Main) 2020]**

(1) zero (2) parallel to $\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}$ (3) antiparallel to $\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}$ (4) parallel to $\hat{k}$

PW0045

13. In a plane electromagnetic wave, the directions of electric field and magnetic field are represented by $\hat{k}$ and $2\hat{i} - 2\hat{j}$, respectively. What is the unit vector along direction of propagation of the wave. **[JEE (Main) 2020]**

(1) $\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$ (2) $\frac{1}{\sqrt{5}}(\hat{i} + 2\hat{j})$ (3) $\frac{1}{\sqrt{5}}(2\hat{i} + \hat{j})$ (4) $\frac{1}{\sqrt{2}}(\hat{j} + \hat{k})$

PW0046

14. The magnetic field vector of an electromagnetic wave is given by $B = B_0 \frac{\hat{i}+\hat{j}}{\sqrt{2}} \cos(kz - \omega t)$; where $\hat{i}, \hat{j}$ represents unit vector along x and y-axis respectively. At $t = 0s$, two electric charges q_1 of 4π coulomb and q_2 of 2π coulomb located at $\left(0,0,\frac{\pi}{k}\right)$ and $\left(0,0,\frac{3\pi}{k}\right)$, respectively, have the same velocity of $0.5\ c\hat{i}$ (where c is the velocity of light). The ratio of the force acting on charge q_1 to q_2 is: **[JEE (Main) 2021]**

(1) $2\sqrt{2} : 1$ (2) $1 : \sqrt{2}$ (3) $2 : 1$ (4) $\sqrt{2} : 1$

PW0047

15. Electric field of plane electromagnetic wave propagating through a non-magnetic medium is given by $E = 20\cos(2 \times 10^{10}\ t - 200x)\ V/m$. The dielectric constant of the medium is equal to: (Take $\mu_r = 1$) **[JEE (Main) 2021]**

(1) 9 (2) 2 (3) $\frac{1}{3}$ (4) 3

PW0048

16. Light wave travelling in air along x-direction is given by $E_y = 540 \sin \pi \times 10^4 (x - ct)\ Vm^{-1}$. Then, the peak value of magnetic field of wave will be (Given $c = 3 \times 10^8\ ms^{-1}$) **[JEE (Main) 2022]**

(1) $18 \times 10^{-7} T$ (2) $54 \times 10^{-7} T$ (3) $54 \times 10^{-8} T$ (4) $18 \times 10^{-8} T$

PW0049

17. The ratio of average electric energy density and total average energy density of electromagnetic wave is: **[JEE (Main) 2023]**

(1) 2 (2) 1 (3) 3 (4) $\frac{1}{2}$

PW0050

18. A beam of light consisting of two wavelengths 7000 Å and 5500 Å is used to obtain interference pattern in Young's double slit experiment. The distance between the slits is 2.5 *mm* and the distance between the plane of slits and the screen is 150 *cm*. The least distance from the central fringe, where the bright fringes due to both the wavelengths coincide, is $n \times 10^{-5}\ m$. The value of n is________. **[JEE (Main) 2023]**

PW0187

19. A monochromatic light wave with wavelength λ_1 and frequency v_1 in air enters another medium. If the angle of incidence and angle of refraction at the interface are 45° and 30° respectively, then the wavelength λ_2 and frequency v_2 of the refracted wave are : **[JEE (Main) 2023]**

(1) $\lambda_2 = \lambda_1, v_2 = \sqrt{2}v_1$ (2) $\lambda_2 = \frac{1}{\sqrt{2}}\lambda_1, v_2 = v_1$

(3) $\lambda_2 = \sqrt{2}\lambda_1, v_2 = v_1$ (4) $\lambda_2 = \lambda_1, v_2 = \frac{1}{\sqrt{2}}v_1$

PW0188

20. The width of fringe is 2 mm on the screen in a double slits experiment for the light of wavelength of 400 nm. The width of the fringe for the light of wavelength 600 nm will be: **[JEE (Main) 2023]**

(1) 4 mm (2) 1.33 mm (3) 3 mm (4) 2 mm

PW0189

21. A single slit of width a is illuminated by a monochromatic light of wavelength 600 *nm*. The value of 'a' for which first minimum appears at $\theta = 30°$ on the screen will be : **[JEE (Main) 2023]**

(1) 0.6 μm (2) 1.2 μm (3) 1.8 μm (4) 3 μm

PW0190

EXERCISE - JEE (Advanced) PYQ

1. 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:-

[JEE (Advanced) 2013]

(A) $(2n+1)\frac{\lambda}{2}$ (B) $(2n+1)\frac{\lambda}{4}$ (C) $(2n+1)\frac{\lambda}{8}$ (D) $(2n+1)\frac{\lambda}{16}$

PW0071

2. A light source, which emits two wavelengths $\lambda_1 = 400\ nm$ and $\lambda_2 = 600\ nm$, is used in a Young's double slit experiment. If recorded fringe widths for λ_1 and λ_2 are β_1 and β_2 and the number of fringes for them within a distance y on one side of the central maximum are m_1 and m_2, respectively, then: **[JEE (Advanced) 2014]**

(A) $\beta_2 > \beta_1$

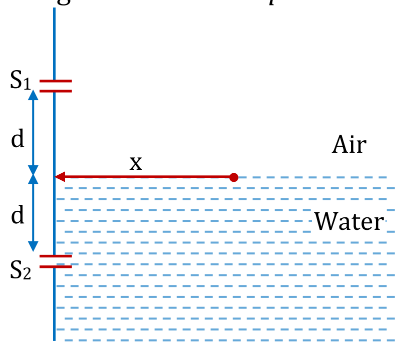
(B) $m_1 > m_2$

(C) From the central maximum, 3rd maximum of λ_2 overlaps with 5th minimum of λ_1

(D) The angular separation of fringes of λ_1 is greater than λ_2

PW0072

3. A Young's double slit interference arrangement with slits S_1 and S_2 is immersed in water (refractive index = 4/3) as shown in the figure. The positions of maxima on the surface of water are given by $x^2 = p^2m^2\lambda^2 - d^2$, where λ is the wavelength of light in air (refractive index = 1), $2d$ is the separation between the slits and m is an integer. The value of p is. **[JEE (Advanced) 2015]**



PW0073

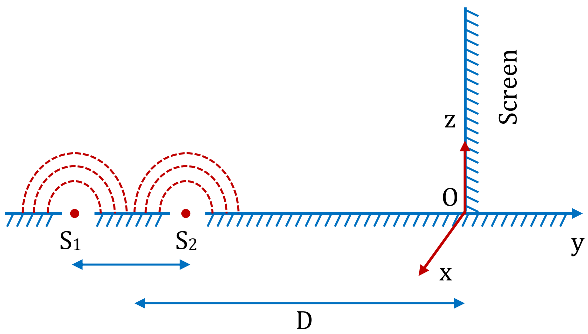
4. While conducting the Young's double slit experiment, a student replaced the two slits with a large opaque plate in the x-y plane containing two small holes that act as two coherent point sources (S_1, S_2) emitting light of wavelength 600 nm. The student mistakenly placed the screen parallel to the x-z plane (for $z > 0$) at a distance $D = 3m$ from the mid-point of S_1S_2, as shown schematically in the figure. The distance between the sources $d = 0.6003\ mm$. The origin O is at the intersection of the screen and the line joining S_1S_2. Which of the following is (are) true of the intensity pattern on the screen ? **[JEE (Advanced) 2016]**

(A) Hyperbolic bright and dark bands with foci symmetrically placed about O in the x-direction.

(B) Semi-circular bright and dark bands centered at point O.

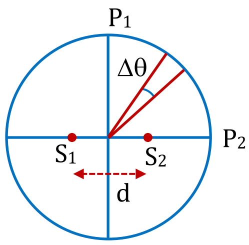
(C) The region very close to the point O will be dark.

(D) Straight bright and dark bands parallel to the x-axis.



PW0074

5. Two coherent monochromatic point sources S_1 and S_2 of wavelength λ = 600 *nm* are placed symmetrically on either side of the center of the circle as shown. The sources are separated by a distance d = 1.8 *mm*. This arrangement produces interference fringes visible as alternate bright and dark spots on the circumference of the circle. The angular separation between two consecutive bright spots is $\Delta\theta$. Which of the following options is/are correct? **[JEE (Advanced) 2017]**



(A) A dark spot will be formed at the point P_2.

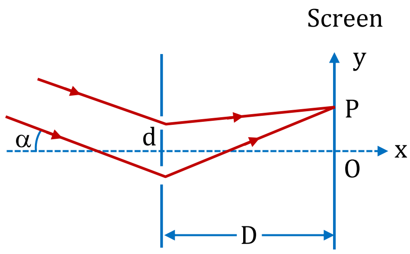
(B) The angular separation between two consecutive bright spots decreases as we move from P_1 to P_2 along the first quadrant.

(C) At P_2 the order of the fringe will be maximum.

(D) The total number of fringes produced between P_1 and P_2 in the first quadrant is close to 3000.

PW0075

6. In a Young's double slit experiment, the slit separation d is 0.3*mm* and the screen distance D is 1*m*. A parallel beam of light of wavelength 600 *nm* is incident on the slits at angle α as shown in figure. On the screen, the point O is equidistant from the slits and distance PO is 11.0 *mm*. Which of the following statement(s) is/are correct? **[JEE (Advanced) 2019]**



(A) For $\alpha = \dfrac{0.36}{\pi}$ degree, there will be destructive interference at point O.

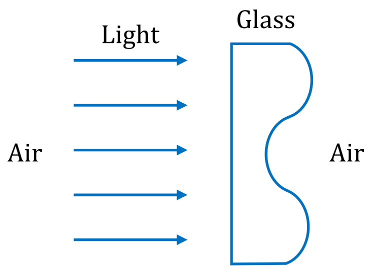
(B) Fringe spacing depends on α.

(C) For $\alpha = \dfrac{0.36}{\pi}$ degree, there will be destructive interference at point P.

(D) For α = 0, there will be constructive interference at point P.

PW0076

7. A parallel beam of light strikes a piece of transparent glass having cross section as shown in the figure below. Correct shape of the emergent wavefront will be (figures are schematic and not drawn to scale)- **[JEE (Advanced) 2020]**



(A)  (B)  (C)  (D) 

PW0077

8. A physical quantity $\vec{S}$ is defined as $\vec{S} = (\vec{E} \times \vec{B}) / \mu_0$, where $\vec{E}$ is electric field, $\vec{B}$ is magnetic field and μ_0 is the permeability of free space. The dimensions of $\vec{S}$ are the same as the dimensions of which of the following quantity (ies)? **[JEE (Advanced) 2021]**

(A) $\dfrac{\text{Energy}}{\text{Charge} \times \text{current}}$ (B) $\dfrac{\text{Force}}{\text{Length} \times \text{Time}}$ (C) $\dfrac{\text{Energy}}{\text{Volume}}$ (D) $\dfrac{\text{Power}}{\text{Area}}$

PW0078

9. The electric field associated with an electromagnetic wave propagating in a dielectric medium is given by $\vec{E} = 30(2\hat{x} + \hat{y})\, sin\left[2\pi\left(5 \times 10^{14}t - \frac{10^7}{3}z\right)\right] V\ m^{-1}$. Which of the following option(s) is(are) correct?

[Given: The speed of light in vacuum, $c = 3 \times 10^8\ ms^{-1}$] **[JEE (Advanced) 2023]**

(A) $B_x = -2 \times 10^{-7} \sin\left[2\pi\left(5 \times 10^{14}t - \frac{10^7}{3}z\right)\right] Wbm^{-2}$

(B) $B_y = 2 \times 10^{-7} \sin\left[2\pi\left(5 \times 10^{14}t - \frac{10^7}{3}z\right)\right] Wbm^{-2}$

(C) The wave is polarized in the xy-plane with polarization angle 30° with respect to the x-axis.

(D) The refractive index of the medium is 2.

PW0191

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in <u>one of the following categories</u>:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

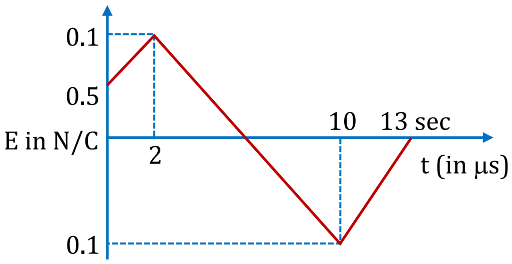
---

1. Instantaneous displacement current of 1.0 A in the space between the parallel plates of 1μF capacitor can be established by changing potential difference of:

(1) 10^{-6} V/s (2) 10^{6} V/s (3) 10^{-8} V/s (4) 10^{8} V/s

PW0001

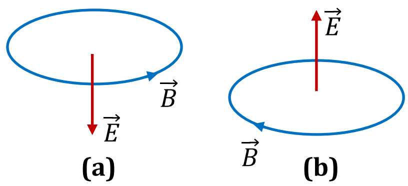
2. The electric field through an area of 2 m^2 varies with time as shown in the graph. The greatest displacement current through the area is at:



(1) t = 1 sec. (2) t = 4 sec. (3) t = 8 sec. (4) t = 12 sec.

PW0002

3. Figure shows, in two situations and electric field vector and an induced magnetic field line. In each, is the magnitude of increasing or decreasing?



(1) increasing in a and decreasing in b.
(2) increasing in a and b.
(3) decreasing in a and b.
(4) decreasing in a and increasing in b.

PW0003

4. A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3 Vm^{-1}. The magnetic induction is:

(1) 3.1×10^{-8} T (2) 3×10^{-5} T (3) 3.1×10^{-6} T (4) 9.3×10^{-6} T

PW0004

5. A plane electromagnetic wave travelling along the X-direction has a wavelength of $3mm$. The variation in the electric field occurs in the Y-direction with an amplitude $66Vm^{-1}$. The equation for the electric and magnetic fields as a function of x and t are respectively.

(1) $E_y = 33 \cos \pi \times 10^{11} \left(t - \frac{x}{c}\right)$; $B_z = 1.1 \times 10^{-7} \cos \pi \times 10^{11}\left(t - \frac{x}{c}\right)$

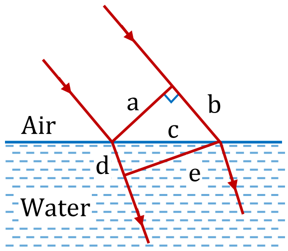
(2) $E_y = 11 \cos 2\pi \times 10^{11} \left(t - \frac{x}{c}\right)$; $B_y = 1.1 \times 10^{-7} \cos 2\pi \times 10^{11} \left(t - \frac{x}{c}\right)$

(3) $E_x = 33 \cos \pi \times 10^{11} \left(t - \frac{x}{c}\right)$; $B_x = 1.1 \times 10^{-7} \cos \pi \times 10^{11} \left(t - \frac{x}{c}\right)$

(4) $E_y = 66 \cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$; $B_z = 2.2 \times 10^{-7} \cos 2\pi \times 10^{11} \left(t - \frac{x}{c}\right)$

PW0005

6. Figure shows plane waves refracted from air to water using Huygen's principle (where a, b, c, d, e are lengths on the diagram). The refractive index of water wrt air is the ratio :-



(1) a/e (2) b/e (3) b/d (4) $d/$b

PW0006

7. 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 :

(1) $2I$ (2) $4I$ (3) $5I$ (4) $7I$

PW0007

8. Two coherent monochromatic light beams of intensities I and $4I$ are superposed. The maximum and minimum possible intensities in the resulting beam are:

(1) $5I$ and I (2) $5I$ and $3I$ (3) $9I$ and I (4) $9I$ and $3I$

PW0008

9. In YDSE how many maxima can be obtained on the screen if wavelength of light used is $200nm$ and $d = 700\ nm$:

(1) 12 (2) 7 (3) 18 (4) None of these

PW0009

10. In a YDSE, the central bright fringe can be identified:

(1) as it has greater intensity than the other bright fringes.
(2) as it is wider than the other bright fringes.
(3) as it is narrower than the other bright fringes.
(4) by using white light instead of single wavelength light.

PW0010

11. In a Young's double slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which of the following changes would cause the observed fringes to be more closely spaced?

(1) Reducing the separation between the slits.
(2) Using blue light instead of green light.
(3) Used red light instead of green light.
(4) Moving the light source further away from the slits.

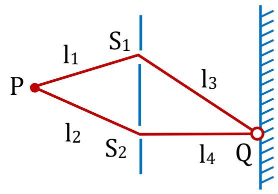
PW0011

12. In Young's double slit experiment, the wavelength of red light is 7800 Å and that of blue light is 5200 Å. The value of n for which n^{th} bright band due to red light coincides with $(n + 1)^{th}$ bright band due to blue light, is :

(1) 1 (2) 2 (3) 3 (4) 4

PW0012

13. Two identical narrow slits S_1 and S_2 are illuminated by light of wavelength λ from a point source P. If, as shown in the diagram, the light is then allowed to fall on a screen, and if n is a positive integer, the condition for destructive interference at Q is:-



(1) $(\ell_1 - \ell_2) = (2n + 1)\lambda/2$ (2) $(\ell_3 - \ell_4) = (2n + 1)\lambda/2$

(3) $(\ell_1 + \ell_2) - (\ell_3 + \ell_4) = n\lambda$ (4) $(\ell_1 + \ell_3) - (\ell_2 + \ell_4) = (2n + 1)\lambda/2$

PW0013

14. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude A and wavelength λ. In another experiment with the same setup the two slits are sources of equal amplitude A and wavelength λ but are incoherent. The ratio of the average intensity of light at the midpoint of the screen in the first case to that in the second case is:-

(1) 1 : 1 (2) 2 : 1 (3) 4 : 1 (4) none of these

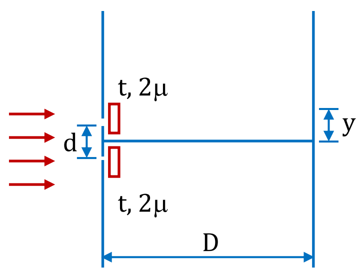
PW0014

15. In a Young's double slit experiment, a small detector measures an intensity of illumination of I units at the centre of the fringe pattern. If one of the two (identical) slits is now covered, the measured intensity will be:

(1) $2I$ (2) I (3) $I/4$ (4) $I/2$

PW0015

16. In the YDSE shown the two slits are covered with thin sheets having thickness t and $2t$ and refractive index 2μ and μ. Find the position (y) of central maxima



(1) zero (2) $\frac{tD}{d}$ (3) $-\frac{tD}{d}$ (4) None

PW0016

17. In a stack of three polarizing sheets the first and third are crossed while the middle one has its axis at 45° to the axes of the other two. The fraction of the intensity of an incident unpolarized beam of light that is transmitted by the stack is:

(1) 1/2 (2) 1/3 (3) 1/4 (4) 1/8

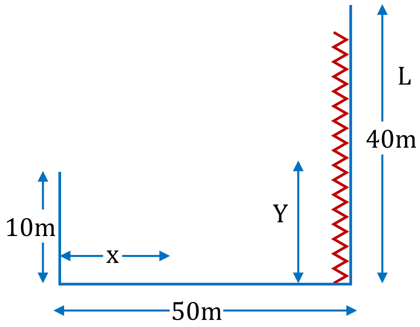
PW0017

18. A beam of light strikes a piece of glass at an angle of incidence of 60° and the reflected beam is completely plane polarised. The refractive index of the glass is:

(1) 1.5 (2) $\sqrt{3}$ (3) $\sqrt{2}$ (4) (3/2)

PW0018

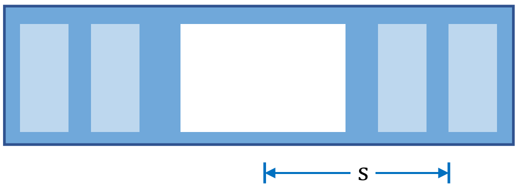
19. A person lives in a high-rise building on the bank of a river 50m wide. Across the river is a well lit tower of height 40 m. When the person, who is at a height of 10m, looks through a polarizer at an appropriate angle at light of the tower reflecting from the river surface, he notes that intensity 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 4/3)



(1) 13 m, 27 m (2) 22 m, 13 m (3) 25 m, 10 m (4) 17 m, 29 m

PW0019

20. Light of wavelength 600 nm is incident upon a single slit with width 4×10^{-4} m. The figure shows the pattern observed on a screen positioned 2 m from the slits. Determine the distance s.



(1) 0.002 m (2) 0.003 m (3) 0.004 m (4) 0.006 m

PW0020

SECTION–B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4,	if only correct answer is given.
Zero Marks	:	0,	if no answer is given.
Negative Marks	:	–1	for incorrect answer.

1. The amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is $B_0 = 510\ nT$. What is the amplitude (in N/C) of the electric field part of the wave?

PW0021

2. An electromagnetic wave of frequency 5 GHz, is travelling in a medium whose relative electric permittivity and relative magnetic permeability both are 2. Its velocity in this medium is ________ × $10^7\ m/s$.

PW0022

3. Call the intensity at the center of the central Fraunhofer diffraction maximum of a single slit I_0 and the intensity at some other point in the pattern I. Obtain the value of $9\pi^2 \dfrac{I}{I_0}$ for a point on the screen that is 3/4 wavelength farther from one edge of the slit than the other.

PW0023

4. A two-slit apparatus is covered with a red (670 nm) filter. When white light is shone on the filter, on the screen beyond the two-slit apparatus, there are nine interference maxima within the 4.50 cm-wide central diffraction maximum. When a blue (450 nm) filter replaces the red, how many interference maxima will there be in the central diffraction maximum be?

PW0024

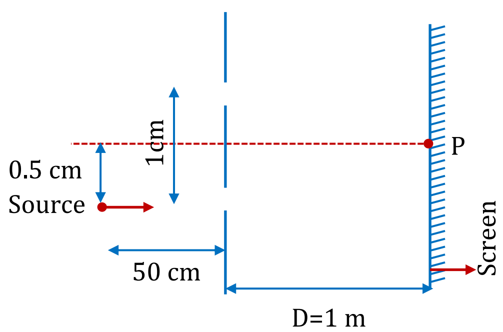
5. Your biology textbook tells you that a certain structure in the cell has a size of 0.61 μm. You would like to see this structure using orange light with a wavelength of 600 nm. The minimum numerical aperture will be $x \times 10^{-1}$. Then find x.

PW0025

6. One radio transmitter A operating at 60.0 MHz is 10.0 m from another similar transmitter B that is 180° out of phase with transmitter A. The observer moves $n \times 10^{-2}\ m$ from transmitter A toward transmitter B along the line connecting A and B to reach the nearest point where the two beams are in phase. Find n.

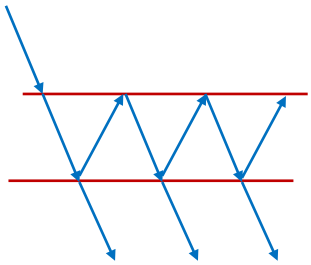
PW0026

7. In a typical Young's double slit experiment a point source of monochromatic light is kept as shown in the figure. If the source is given an instantaneous velocity v = 1 mm per second towards the screen, then the instantaneous velocity of central maxima is given as $\alpha \times 10^{-\beta}\ m/s$ upward. Find the value of $\alpha + \beta$.



PW0027

8. A narrow beam of light has entered a large thin glass plate. Each refraction is accompanied by reflection of one third of the beam's energy. What percentage of the light energy is transmitted through the plate?



PWO028

9. In Young's double slit experiment the slits are 0.5 *mm* apart and the interference is observed on a screen at a distance of 100 *cm* from the slit. It is found that the 9th bright fringe is at a distance of 7.5 *mm* from the second dark fringe from the centre of the fringe pattern on same side. Find the wavelength (in nm) of the light used.

PWO029

10. In a Young's double slit experiment, two wavelengths of 500 *nm* and 700 *nm* were used. The minimum distance (in *mm*) is $n \times 10^{-1}$ from the central maximum where their maxima coincide again? (Take $D/d = 10^3$. Symbols have their usual meanings.)

PWO030

JEE (Advanced) Practice Paper

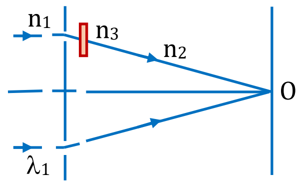
This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

1. In the figure shown in YDSE, a parallel beam of light is incident on the slit from a medium of refractive index n_1. The wavelength of light in this medium is λ_1. A transparent slab of thickness t and refractive index n_3 is put in front of one slit. The medium between the screen and the plane of the slits is n_2. The phase difference between the light waves reaching point 'O' (symmetrical, relative to the slits) is:



(A) $\frac{2\pi}{n_1\lambda_1}(n_3 - n_2)\, t$

(B) $\frac{2\pi}{\lambda_1}(n_3 - n_2)\, t$

(C) $\frac{2\pi n_1}{n_2\lambda_1}\left(\frac{n_3}{n_2} - 1\right)t$

(D) $\frac{2\pi n_1}{\lambda_1}(n_3 - n_1)t$

PW0051

2. An electromagnetic wave of intensity 50 Wm^{-2} enters in a medium of refractive index 'n' without any loss. The ratio of the magnitudes of electric fields, and the ratio of the magnitudes of magnetic fields of the wave before and after entering into the medium are respectively, given by:

(A) $\left(\frac{1}{\sqrt{n}}, \frac{1}{\sqrt{n}}\right)$ (B) $\left(\sqrt{n}, \frac{1}{\sqrt{n}}\right)$ (C) $\left(\sqrt{n}, \sqrt{n}\right)$ (D) $\left(\frac{1}{\sqrt{n}}, \sqrt{n}\right)$

PW0052

SECTION-II

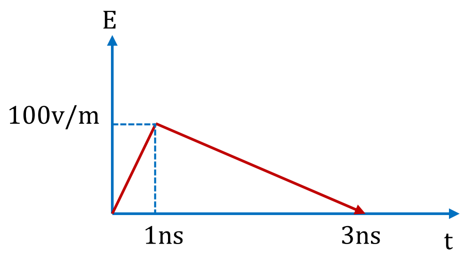
- This section contains **NINE** questions.
- Each question has **FOUR** options for correct answer(*s*). **ONE OR MORE THAN ONE** of these four option(*s*) is (are) correct option(*s*).
- For each question, choose the correct option(*s*) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

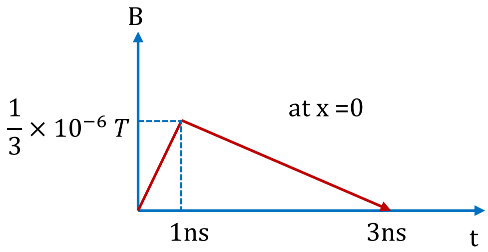
Full Marks : +4 if only (all) the correct option(*s*) is (are) chosen.
Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.
Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –2 in all other cases.

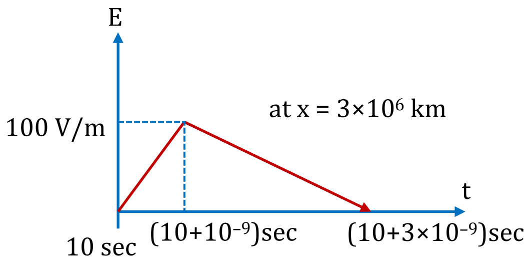
For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(*s*) (second option in this case), with or without selection of any correct option(*s*) will result in –2 marks.

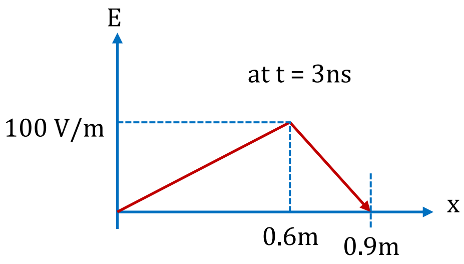
---

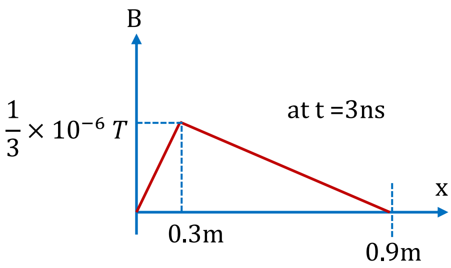
3. Consider a pulse of plane electromagnetic wave whose electric field is in *y* direction and is propagating in +*x* direction. The electric field at *x* = 0 varies as shown in the graph. Choose the correct graph (s) for electric field and magnetic field as *x* and *t*.



(A)


(B)


(C)


(D)


PW0053

4. A silver wire has resistivity of $1.62 \times 10^{-8}\ \Omega m$ and a cross-sectional area of 5.00 mm^2. The current in the wire is uniform and changing at the rate of 2000 A/s when the current is 100 A.

(A) The magnitude of the (uniform) electric field in the wire when the current in the wire is 100 A is 0.324 V/m.

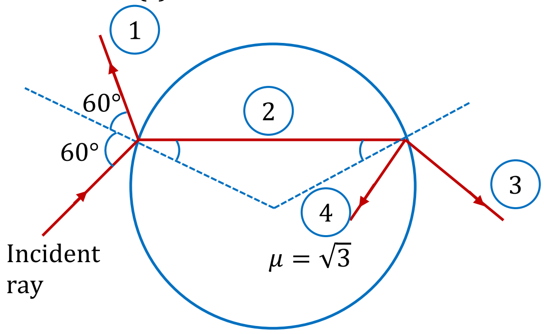
(B) Displacement current in the wire at that time $2.87 \times 10^{-16}\ A$.

(C) The ratio of the magnitude of the magnetic field due to the displacement current to that due to the current at a distance r from the wire is 2.87×10^{-18}.

(D) The displacement current density lines are circular.

PW0054

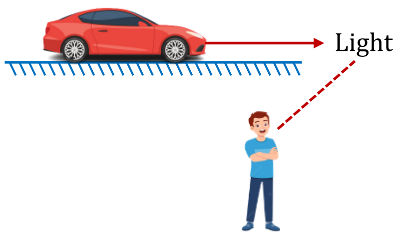
5. Consider an unpolarized light ray incident on a transparent sphere of refractive index as shown. Which of the following statement (*s*) are correct ?



(A) Ray 1 is completely polarized.
(B) Ray 2 is partially polarized.
(C) Ray 4 is completely polarized.
(D) Ray 3 is partially polarized.

PW0055

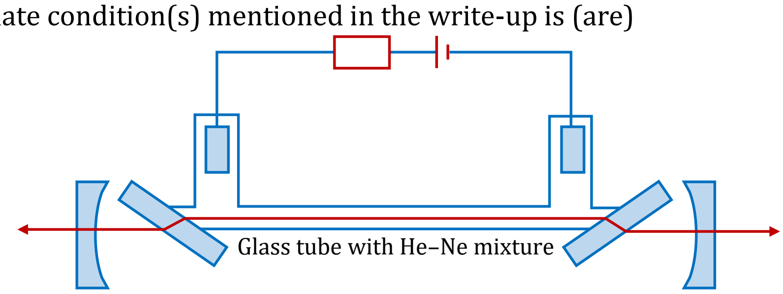
6. Light coming from an automobile headlights is normally polarized such that plane of electric field is vertical. This light strikes dust particles in air & is scattered. Suppose an observer is standing $\perp$ to road as shown. The light that he receives is only scattered light. The light is



(A) Having no intensity in direction of observer.
(B) Has electric field in vertical plane $\perp$ to car's velocity.
(C) Has magnetic field parallel to car's velocity but in horizontal plane.
(D) Has magnetic field in vertical plane parallel to car's velocity.

PW0056

7. A Brewster window is used to minimize losses by reflection. A typical example is a helium-neon laser with a sealed glass tube as shown in Figure, where glass windows separate the laser gas mixture from ambient air. The light coming from laser is polarized. This light emanating from the glass tube strikes the two glass plates at each of the ends as shown. If the conditions are appropriate, there is no partial reflection from the glass plates. The light (shown by red colour) is then focused using convex lens shown at each of the ends. The refractive index of glass can be assumed to be 1.5 and that of both the sides of glass can be assumed to be 1.
The appropriate condition(s) mentioned in the write-up is (are)



(A) The angle made by each of the glass plate with the direction of light beam should be the same.
(B) The angle between the light beam and the glass plate surface should be $\tan^{-1}(2/3)$.
(C) The incident beam should be plane polarized with the plane of electric field same as the plane of paper.
(D) The incident beam should be plane polarized with the plane of electric field perpendicular to the plane of paper.

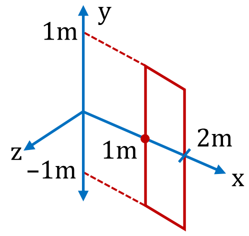
PW0057

8. In a Young's double-slit experiment, let A and B be the two slits. A thin film of thickness t and refractive index μ is placed in front of A. Let β = fringe width. The central maximum will shift:

(A) towards A (B) towards B (C) by $t(\mu - 1)\dfrac{\beta}{\lambda}$ (D) by $\mu t\dfrac{\beta}{\lambda}$

PW0058

9. A plane electromagnetic wave $\vec{E} = 3000\frac{N}{c}\hat{j}\sin(\pi x - 3\pi \times 10^8 t)$ is travelling in vacuum. A conducting loop of dimensions as shown is kept in xy plane as shown. The induced emf in the loop:



(A) At $t = 0$ is 0

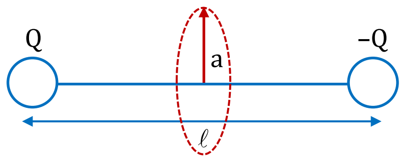
(B) At $t = 0.01\ \mu s$ is 12000 V

(C) At $t = 0.003\ \mu s$ is 12000 V

(D) At $t = \dfrac{1}{1800}\ \mu s$ is 6000 V

PW0059

10. Consider 2 charged metallic balls of radius r connected by a thin metallic wire. The initial charge on balls is equal and opposite. Assume $r << \ell$ so that at any instant, the charge on the balls is spherically symmetric. Consider an amperian loop in the symmetry plane of system having radius a as shown.



(A) The displacement current through the loop is towards left and conduction current to right.

(B) The magnetic field at the amperian loop when current in the wire is i is $\dfrac{\mu_0 i}{2\pi a}$.

(C) The magnetic field at the amperian loop when current in the wire is i is $\dfrac{\mu_0 i}{4\pi a}\left(\dfrac{\ell}{\sqrt{a^2+\frac{\ell^2}{4}}}\right)$.

(D) The magnetic field at the amperian loop when current in the wire is i is zero.

PW0060

11. A small charged bead of charge + Q mass m is threaded on a long smooth rod oriented along y axis. An electromagnetic wave $\vec{E} = E_0\hat{j}\sin(kx - \omega t)$ is incident on the system. Choose the correct statement (s). Neglect gravity. Initially bead was at rest.

(A) The maximum speed of the bead is $\dfrac{QE_0}{m\omega}$.

(B) The maximum speed of the bead is $\dfrac{2QE_0}{m\omega}$.

(C) The average force on the bead over one time period due to magnetic field of the wave is zero.

(D) If the bead was negatively charged, the average force on the bead over one time period due to magnetic field is in positive x direction.

PW0061

SECTION–III

- This section contains **ONE** paragraph.
- Based on each paragraph, there are **THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONE OR MORE THAN ONE** of these four option(s) is(are) correct.
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 if only (all) the correct option(s) is (are) chosen.

Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.

Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.

Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.

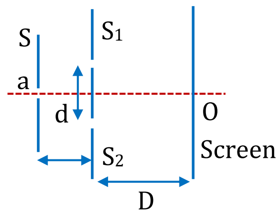
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).

Negative Marks : –2 in all other cases.

For Example: If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

PARAGRAPH FOR QUESTION NO. 12 TO 14

The figure shows a schematic diagram showing the arrangement of Young's Double Slit Experiment



12. Choose the correct statement(s) related to the wavelength of light used

(A) Larger the wavelength of light larger the fringe width.

(B) The position of central maxima depends on the wavelength of light used.

(C) If white light is used in YDSE, then the violet colour forms its first maxima closest to the central maxima.

(D) The central maxima of all the wavelengths coincide.

PW0062

13. If the distance *D* is varied, then choose the correct statement(s)

(A) The angular fringe width does not change.

(B) The fringe width changes in direct proportion.

(C) The change in fringe width is same for all wavelengths.

(D) The position of central maxima remains unchanged.

PW0063

14. If the distance d is varied, then identify the correct statement(s)

(A) The angular width does not change.
(B) The fringe width changes in inverse proportion.
(C) The positions of all maxima change.
(D) The positions of all minima change.

PW0064

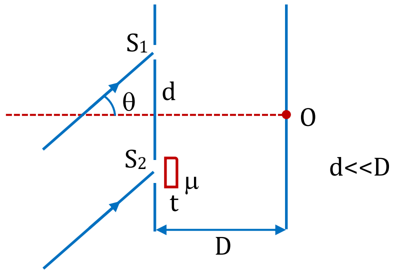
SECTION-IV

- This section contains **ONE** paragraph.
- Based on each paragraph, there are **THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.
Zero Marks : 0 in all other cases.

PARAGRAPH FOR QUESTION NO. 15 TO 17

A monochromatic beam of light falls on Young's double slit experiment apparatus as shown in figure. A thin sheet of glass is inserted in front of lower slit S_2.



15. The central bright fringe can be obtained

(A) at *O* only
(B) at *O* or below *O* only
(C) at *O* or above *O* only
(D) Anywhere on the screen

PW0065

16. If central bright fringe is obtained on screen at *O* :-

(A) $(\mu-1)\,t = d\sin\theta$
(B) $(\mu-1)\,t = d\cos\theta$
(C) $(\mu-1)t + d\sin\theta = 0$
(D) $\dfrac{t}{\mu-1} = \dfrac{d}{\sin\theta}$

PW0066

17. The phase difference between the waves interfering at fifth minima is

(A) 5π
(B) 7π
(C) 9π
(D) 11π

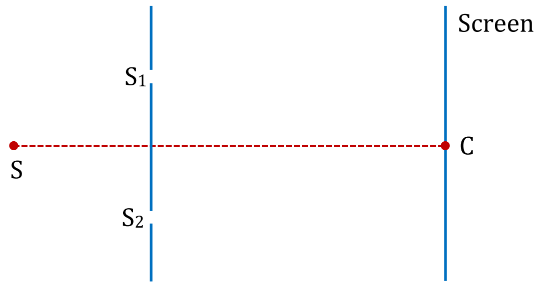
PW0067

SECTION–V

- This section contains **TWO** questions.
- **Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

18. In a YDSE setup, light of wavelength $4000\mathring{A}$ is used. Distance of screen from the slits is $2m$ and distance between slits is $1mm$. There are three slabs slab 1(thickness $2mm$, $\mu = 2$), slab 2 (thickness $1mm$, $\mu = 3$), slab 3(thickness 4 mm, $\mu = \frac{3}{2}$)

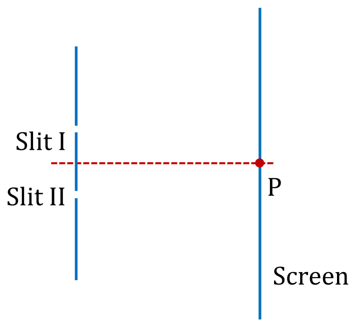


	List-I		List-II
(A)	If slab 1 is placed in front of slit S_1	(P)	Central maxima at C
(B)	If the slab 2 is placed in front of slit S_2 along with condition (A)	(Q)	Central maxima above C
(C)	If slab 3 is placed in front of slab 1 along with condition (B)	(R)	Fringe width is equal to 0.8 mm
		(S)	No. of fringes crossing centre as a result of slab placing is 5000

(A) (A-R,S), (B-P,R), (C-R,S)
(B) (A-R,S), (B-P,S), (C-R,S)
(C) (A-P,S), (B-P,R), (C-R,S)
(D) (A-R,S), (B-P,R), (C-Q,S)

PW0068

19. A double slit interference pattern is produced on a screen, as shown in the figure, using monochromatic light of wavelength $500nm$. Point P is the location of the central bright fringe, that is produced when light waves arrive in phase without any path difference. A choice of three strips A, B and C of transparent materials with different thicknesses and refractive indices is available, as shown in the table. These are placed over one or both of the slits, singularly or in conjunction, causing the interference pattern to be shifted across the screen from the original pattern. In the List–I, how the strips have been placed, is mentioned whereas in the List–II, order of the fringe at point P on the screen that will be produced due to the placement of the strips(s), is shown. Correctly match both the list.



Film	A	B	C
Thickness (in μm)	5	1.5	0.25
Refractive index	1.5	2.5	2

	List-I		List-II
(A)	Only strip B is placed over slit–I	(P)	First Bright
(B)	Strip A is placed over slit–I and strip C is placed over slit–II	(Q)	Fourth Dark
(C)	Strip A is placed over the slit–I and strip B and strip C are placed over the slit–II in conjunction	(R)	Fifth Dark
(D)	Strip A and strip C are placed over slit–I (in conjunction) and strip B is placed over Slit–II	(S)	Central Bright

(A) (A-P), (B-R), (C-S), (D-P)
(B) (A-R), (B-Q), (C-S), (D-P)
(C) (A-R), (B-R), (C-S), (D-P)
(D) (A-R), (B-R), (C-S), (D-S)

PW0069

SECTION-VI

- This section contains **ONE** question.
- Each question contains two columns, **Column-I** and **Column-II.**
- **Column-I** has **four** entries (A), (B), (C) and (D).
- **Column-II** has **five** entries (P), (Q), (R), (S) and (T).
- Match the entries in **Column-I** with the entries in **column-II.**
- One or more entries in **Column-I** may match with one or more entries in **Column-II.**
- The ORS contains a 4 × 5 matrix whose layout will be similar to the one shown below:

(A)	(P)	(Q)	(R)	(S)	(T)
(B)	(P)	(Q)	(R)	(S)	(T)
(C)	(P)	(Q)	(R)	(S)	(T)
(D)	(P)	(Q)	(R)	(S)	(T)

- For each entry in **column-I,** darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q), (R) and (T), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- For each question, marks will be awarded in one of the following categories :

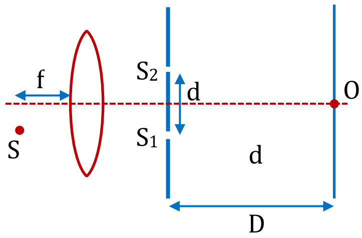
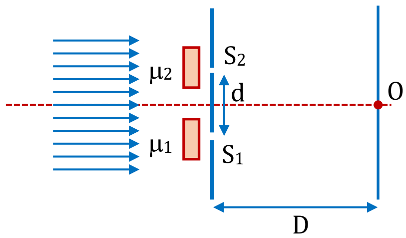
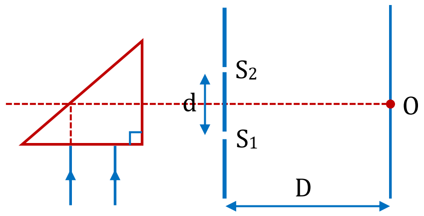
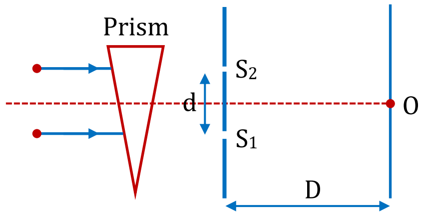
For each entry in **Column-I**

Full Marks : +2 if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.

Zero Marks : 0 if none of the bubbles is darkened.

Negative Marks : –1 in all other cases.

20. Column-I shows some modifications in a standard YDSE setup. Column-II shows the associated characteristics.

Column-I	Column-II
(A)  Monochromatic point source S placed in focal plane.	(P) Zero order maxima lies above O.
(B)  Monochromatic parallel beam incident on S_1S_2 through transparent slabs of same thickness but $\mu_1 > \mu_2$	(Q) If a transparent mica sheet is introduced in front of S_2 central bright fringe can be obtained at O.
(C)  Monochromatic parallel beam incident on a right angled isosceles prism of refractive index 1.50	(R) Fringe width $\beta = \frac{\lambda D}{d}$
(D)  Monochromatic parallel beam incident on a thin prism	(S) Point O can be a minima
	(T) Point O can be a least order minima.

PW0070

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	C	B	A	A	D	D	A	B
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	A	B	B	B	B	B	C	A	C	C
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	D	D	A	C	C	C	A	C	D	B
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	D	C	C	A	C	D	A	A	B	D
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	A	D	D	D	D	B	A	D	D	C
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	D	D	B	C	B	B	C	D	A	A
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	B	D	C	D	B	A	A	C	C	A
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	A	C	ACD	BD	BCD	ABD	AC	BC	CD	A
Que.	81	82	83	84	85	86	87	88	89	
Ans.	B	C	A	A	A	A	C	A	(a-ii), (b-iv), (c-i), (d-iii)	

EXERCISE - S

1. 2

2. $\sqrt{\frac{\varepsilon_0}{\mu_0}}\frac{\vec{k}\times\vec{E}_m}{k}\cos ckt$

3. (a) $\vec{H}=\sqrt{\frac{\varepsilon_0}{\mu_0}}E_m\hat{e}_x\cos kx$ (b) $\vec{H}=\sqrt{\frac{\varepsilon_0}{\mu_0}}E_m\hat{e}_x\cos\left(kx-\omega t_0\right)$

4. $25\cos\left(\omega t-\frac{\pi}{3}\right)mV$

5. $\frac{2l}{e}\frac{\sqrt{\varepsilon_1}-\sqrt{\varepsilon_2}}{\ln\frac{\varepsilon_1}{\varepsilon_2}}$

6. $48, 21, \frac{32}{3}, \frac{9}{2}, 0\ m.m.$; 

7. $\lambda = 5850\ \mathring{A}$

8. 35.35 *cm* approximate, 5

9. $\left(n-\frac{1}{48}\right)\lambda = x_1 - x_2$

10. $1.99\times10^{-2}\ mm$

11. $8\ \mu m$

12. 1100

13. 3

14. (a) 5.4 μm wide, (b) 0.99 *mm* high

15. $\left(\frac{25}{9}cm\right)$

16. (a) 2.0 × is eyepiece, 4.0 × is objective (b) 37.5 *cm*

17. $0.6mJ$

18. 30°

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	4	4	4	4	2	4	4	4	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	1	3	1	3	1	1	4	462	2	3
Que.	21									
Ans.	2									

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9
Ans.	B	ABC	3	BC	CD	C	A	BD	AD

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	2	4	3	1	4	3	2	3	2	4
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	2	2	4	2	3	2	4	2	1	4
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	153	15	8	9	6	125	7	50	500	35

JEE (Advanced) Practice Paper

Section-I	Q.	1	2							
	A.	A	B							
Section-II	Q.	3	4	5	6	7	8	9	10	11
	A.	ABC	ABC	ABCD	BC	ABC	AC	AD	AC	BC
Section-III	Q.	12	13	14						
	A.	ACD	ABD	BD						
Section-IV	Q.	15	16	17						
	A.	D	A	C						
Section-V	Q.	18	19							
	A.	A	C							
Section-VI	Q.	20								
	A.	(A-P,R,S,T), (B-Q,R,S,T), (C-R), (D-P,R,S,T)								

Important Notes