Wave Optics

Date Planned : __ / __ / __	CBSE PATTERN	Duration : 3 Hours
Actual Date of Attempt : __ / __ / __	Level - 0	Maximum Marks : 70

VSA: Very Short Answer Type **(1 mark)**

1. State Huygen's principle of light.

2. What type of wavefront will emerge from a (i) point source, and (ii) distant light source?

3. Define the term 'coherent sources' which are required to produce interference pattern in Young's double slit experiment.

4. How does the fringe width of interference fringes change, when the whole apparatus of Young's experiment is kept in a liquid of refractive index 1.3?

5. How does the angular separation between fringes in single – slit diffraction experiment change when the distance of separation between the slit and screen is doubled?

SA-I: Short Answer Type - I **(2 marks)**

6. For a given single slit, the diffraction pattern is obtained on a fixed screen, first by using red light and then with blue light. In which case, will the central maxima, in the observed diffraction pattern, have a larger angular width?

7. **(i)** Write the conditions under which light sources can be said to be coherent.
(ii) Why is it necessary to have coherent sources in order to produce an interference pattern?

8. Define resolving power of a microscope and write one factor on which it depends.

9. State Brewster's law.
The value of Brewster angle for a transparent medium is different for light of different colours. Give reason.

10. Two slits are made one millimeter apart and the screen is placed one metre away. What is the fringe separation when blue-green light of wavelength 500 nm is used?

11. Define the term wavefront. Consider a plane wavefront incident on a thin convex lens. Draw a proper diagram to show how the incident wavefront traverses through the lens and after refraction focusses on the focal point of the lens, giving the shape of the emergent wavefront.

12. What is the effect on the interference fringes in Young's double slit experiment when (i) the width of the source slit is increased : (ii) the monochromatic source is replaced by a source of white light.

SA-II: Short Answer Type - II **(3 marks)**

13. Define the term 'resolving power' of an astronomical telescope. How does it get affected on
(i) Increasing the aperture of the objective lens?
(ii) Increasing the wavelength of the light used?
Justify your answer in each case.

14. For a single slit of width 'a', the first minimum of the interference pattern of a monochromatic light of wavelength λ occurs at an angle of $\frac{\lambda}{a}$. At the same angle of $\frac{\lambda}{a}$, we get a maximum for two narrow slits separated by a distance 'a'. Explain.

15. Laser light of wavelength 640 *nm* incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 7.2 *mm*. Calculate the wavelength of another source of light which produces interference fringes separated by 8.1 *mm* using same arrangement. Also find the minimum value of the order (n) of bright fringe of shorter wavelength which coincides with that of the longer wavelength.

16. Distinguish between polarized and unpolarized light. Does the intensity of polarized light emitted by a Polaroid depend on its orientation?
Explain briefly.
The vibration in beam of polarized light make an angle of $60°$ with the axis of the Polaroid sheet. What percentage of light is transmitted through the sheet?

17. Answer the following questions:

(i) In a double slit experiment using light of wavelength 600 *nm*, the angular width of the fringe formed on a distant screen is $0.1°$. Find the spacing between the two slits.

(ii) Light of wavelength 500 Å propagating in air gets partly reflected from the surface of water. How will the wavelengths and frequencies of the reflected and refracted light be affected?

18. **(i)** The ratio of the width of two slits in Young's double slit experiment is 4: 1.
Evaluated the ratio of intensities at maxima and minima in the interference pattern.

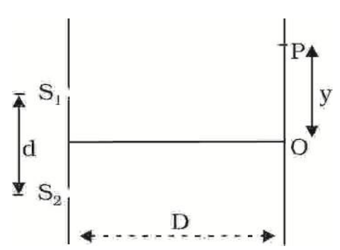
(ii) Does the appearance of bright and dark fringes in the interference pattern violate, in any way, conservation of energy? Explain.

19. In Young's double slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. Find out the intensity of light at a point where path difference is $\frac{\lambda}{3}$.

20. **(i)** Using the phenomenon of polarization, show how transverse nature of light can be demonstrated.

(ii) Two Polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity I_0 is incident on P_1, A third Polaroid P_3 is kept in between P_1 and P_2 such that its pass axis makes an angle of $30°$ with that of P_1. Determine the intensity of light transmitted through P_1, P_2 and P_3.

21. The intensity at the central maxima (*O*) in Young's double slit experiment is I_0. If the distance OP equals one-third of the fringe width of the pattern, show that the intensity at point P would be $\frac{I_0}{4}$.



22. A beam of light, consisting of two wavelengths, 600 *nm* and 450 *nm* is used to obtained interference fringes in a Young's double slit experiment. Find the least distance, from the central maximum, where the bright fringes, due to both the wavelengths, coincide. The distance between the two slits is 4.0 mm and the screen is at a distance 1.0 *m* from the slits.

23. Consider two coherent source S_1 *and* S_2 producing monochromatic waves to produce interference pattern. Let the displacement of the wave produced by S_1 be given by $Y_1 = a\cos\omega t$ and the displacement by S_2 be $Y_2 = a\cos(\omega t + \phi)$.

Find out the expression for the amplitude of the resultant displacement at a point and show that the intensity at that point will be $I = 4a^2 \cos^2 \phi / 2$.

Hence establish the conditions for constructive and destructive interference.

24. In Young's double slit experiment, the two slits 0.15 *mm* apart are illuminated by monochromatic light of wavelength 450 *nm*. The screen is 1.0 *m* away from the slits.

(i) Find the distance of the second (a) bright fringe, (b) dark fringe from the central maximum.

(ii) How will the fringe pattern change if the screen is moved away from the slits?

LA: Long Answer Type **(5 marks)**

25. **(i)** Obtain the conditions for the bright and dark fringes in diffraction pattern due to a single narrow slit illuminated by a monochromatic source.

(ii) When the width of the slit is made double, how would this affect the size and intensity of the central diffraction band? Justify.

26. **(i)** State Huygen's principle. Using this principle draw a diagram to show how a plane wave front incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence verify Snell's law of refraction.

(ii) Using Huygen's construction, draw a figure showing the propagation of a plane wave reflecting at the interface of the two media. Show that the angle of incidence is equal to the angle of reflection.

27. Describe Young's double slit experiment to produce interference pattern due to a monochromatic source of light. Deduce the expression for the fringe width

Wave Optics

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

Topics Covered – *Wave properties of light, Huygens's Principle, Interference*

1. Light travels outwards from a point source such that the wavefronts are spherical. Then, the intensity is related to the distance from the source as:

(A) $I \propto r^2$ **(B)** $I \propto \frac{1}{r}$ **(C)** $I \propto \frac{1}{r^2}$ **(D)** $I \propto \frac{1}{r^{5/2}}$

2. A ray of light travelling in air is incident on one face of a parallel glass slab of thickness t and refractive index μ at an angle of incidence i. The total time spent by the ray inside the slab is:

(Speed of light in air = c)

(A) $\frac{\mu^2 t}{c\sqrt{1-\mu^2 \sin^2 i}}$ **(B)** $\frac{t}{c\sqrt{\mu^2 - \sin^2 i}}$

(C) $\frac{\mu t}{c\sqrt{\mu^2 - \sin^2 i}}$ **(D)** $\frac{\mu^2 t}{c\sqrt{\mu^2 - \sin^2 i}}$

3. Electromagnetic radiation of frequency n, wavelength λ, travelling with velocity v in air, enters a glass slab of refractive index μ. The frequency, wavelength and velocity of the wave in glass slab respectively are :

(A) $\frac{n}{\mu}, \frac{\lambda}{\mu}, \frac{v}{\mu}$ **(B)** $n, \frac{\lambda}{\mu}, \frac{v}{\mu}$ **(C)** $n, \lambda, \frac{v}{\mu}$ **(D)** $\frac{n}{\mu}, \frac{\lambda}{\mu}, v$

4. When interference of light takes place :

(A) Energy is created in the region of maximum intensity
(B) Energy is destroyed in the region of maximum intensity
(C) Conservation of energy holds good and energy is redistributed
(D) Conservation of energy does not hold good

5. 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) $\mu \frac{2\pi}{\lambda} x$ **(B)** $\frac{1}{\mu} . \frac{2\pi}{\lambda} x$ **(C)** $(\mu - 1)\frac{2\pi}{\lambda} x$ **(D)** $\frac{1}{(\mu - 1)} , \frac{2\pi}{\lambda} x$

6. Spherical wavefronts, emanating from a point source, strike a plane reflecting surface. What will happen to these wave front, immediately after reflection?

(A) They will remain spherical with the same curvature, both in magnitude and sign
(B) They will become plane wave fronts
(C) They will remain spherical, with the same curvature, but sign of curvature reversed
(D) They will remain spherical, but with different curvature, both in magnitude and sign.

7. Interference pattern is obtained with two coherent light sources of intensity ratio n. In the interference pattern. The ratio $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ will be :

(A) $\frac{\sqrt{n}}{(n+1)}$ **(B)** $\frac{2\sqrt{n}}{(n+1)}$ **(C)** $\frac{\sqrt{n}}{(n+1)^2}$ **(D)** $\frac{2\sqrt{n}}{(n+1)^2}$

8. Two coherent sources of different intensities send waves which interfere. The ratio of maximum intensity to minimum intensity is 25 : 1. The intensities of the sources are in the ratio :

(A) 25 : 1 **(B)** 5 : 1 **(C)** 9 : 4 **(D)** 25 : 16

9. Light waves travel in vacuum along the X-axis. Which of the following may represent the wavefronts?

(A) $x = c$ **(B)** $y = c$ **(C)** $z = c$ **(D)** $x + y + z = c$

10. The refractive index of glass is 1.5 for light waves of X = 6000Å wavelength in vacuum. Its wavelength in glass is:

(A) 2000 Å **(B)** 4000 Å **(C)** 1000 Å **(D)** 3000 Å

11. The wavefront due to a source situated at infinity is:

(A) Spherical **(B)** Cylindrical **(C)** Planar **(D)** Circular

12. Upon reflection from a surface, the phase angle of a light wave shifts by π if:

(A) the reflecting surface is opaque

(B) the medium containing the wave has a lower refractive index than the medium behind the reflecting surface

(C) the medium containing the wave has a higher refractive index than the medium behind the reflecting surface

(D) in all cases

13. Light travels from a point source and falls on a screen. Now a glass slab is introduced between the source and the screen such that its two faces are parallel to the screen. The slab does not absorb or reflect any light. The size of the slab is sufficiently large to ensure that all the light that falls on the screen passes through the slab. Then, due to the introduction of the slab, the incident intensity of light at any point on the screen:

(A) stays the same **(B)** increases

(C) decreases **(D)** increases for some points and decreases for others

14. Wavefront is the locus of all points, where the particles of the medium vibrate with the same.

(A) Phase **(B)** Amplitude **(C)** Frequency **(D)** Period

15. Which among the following isn't a suitable phenomenon to establish that light is wave motion?

(A) Interference **(B)** Diffraction **(C)** Reflection **(D)** Polarization

Date Planned : __ / __ / __	Daily Tutorial Sheet - 2	Expected Duration : 90 Min
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Topics Covered – *Young's Double slit Experiment*		

16. How is the interference pattern affected if the Young's experiment was performed in still water than in air?

(A) Fewer fringes will be visible **(B)** Fringes will be broader

(C) Fringes will be narrower **(D)** No fringes will be observed

17. In Young's double slit experiment the fringe width with light of wavelength $6000 Å$ is found to be 4.0 mm. What will be the fringe width if light of wavelength $4800 Å$ is used ?

(A) 2.8 mm **(B)** 3.2 mm **(C)** 4.0 mm **(D)** 4.8 mm

18. In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by a distance of $5\times10^{-2} m$ towards the slits, the change in the fringe width is $3\times10^{-5} m$. If the separation between the slits is $10^{-3} m$, the wavelength of light used is :

(A) $5\times10^{-7} m$ **(B)** $6\times10^{-7} m$ **(C)** $7\times10^{-7} m$ **(D)** $6\times10^{-6} m$

19. The intensity of the central maximum in an interference experiment using two identical slits is I. When one of the slits is closed, the intensity is I_0. The ratio I / I_0 is :

(A) 2 : 1 **(B)** 4 : 1 **(C)** 1 : 2 **(D)** 1 : 4

20. Monochromatic light of wavelength 500 nm is incident on two parallel slits separated by a distance of $5\times10^{-4} m$. The interference pattern is obtained on a screen at a distance of 1.0 m from the slits. The intensity of the central maximum is I_0. When one of the slits is covered by a glass sheet of thickness $5\times10^{-6} m$ and refractive index 1.5, the intensity at the centre of the screen will be equal to (Assuming 100% Light transmission by the glass sheet) :

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

21. A double slit apparatus is immersed in a liquid of refractive index 1.33. It has slit separation of 1mm and distance between the plane of slits and screen 1.33 m. The slits are illuminated by a parallel beam of light whose wavelength in air is $6300 Å$. What is the fringe width?

(A) $(1.33\times0.63) mm$ **(B)** $\frac{0.63}{1.33} mm$

(C) $\frac{0.63}{(1.33)^2} mm$ **(D)** $0.63\ mm$

22. In Young's experiment, the ratio of maximum to minimum intensities of the fringe system is 4 : 1. the amplitudes of the coherent sources are in the ratio :

(A) 4 : 1 **(B)** 3 : 1 **(C)** 2 : 1 **(D)** 1 : 1

23. In the Young's double slit experiment with sodium light, the slits are $0.589\,m$ apart. The angular separation of the third maxima from the central maximum will be : (Given $\lambda = 589\,\text{Å}$)

(A) $\sin^{-1}\left(0.33\times10^{8}\right)$ **(B)** $\sin^{-1}\left(0.33\times10^{-6}\right)$

(C) $\sin^{-1}\left(3\times10^{-8}\right)$ **(D)** $\sin^{-1}\left(3\times10^{6}\right)$

24. In Young's double slit experiment, the wave length of the light used is doubled and distance between two slits is made half of initial distance. The resultant fringewidth becomes :

(A) 2 times **(B)** 3 times **(C)** 4 times **(D)** Half

25. In the ideal double-slit experiment, when a glass plate $(\mu = 1.5)$ of thickness t is introduced in the path of one of the intersecting beams (wavelength λ) the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass plate is :

(A) 2λ **(B)** $2\lambda/3$ **(C)** $\lambda/3$ **(D)** λ

26. In an interference experiment, third bright fringe is obtained at a point on the screen with a light of 700 *nm*. What should be the wavelength of the light source in order to obtain 5th bright fringe at the same point ?

(A) 500 *nm* **(B)** 630 *nm* **(C)** 750 *nm* **(D)** 420 *nm*

27. In Young's experiment, the third bright band for light of wavelength $6000\,\text{Å}$ coincides with the fourth bright band from another source of light in the same arrangement. Then the wavelength of second source is :

(A) $3600\,\text{Å}$ **(B)** $4000\,\text{Å}$ **(C)** $5000\,\text{Å}$ **(D)** $4500\,\text{Å}$

28. In Young's double-slit experiment, the separation between the slits is d, distance between the slit and screen is D ($D >> d$). In the interference pattern, there is a maxima exactly in front of each slit. Then the possible wavelength (*s*) used in the experiment are :

(A) $d^2/D, d^2/2D, d^2/3D$ **(B)** $d^2/D, d^2/3d, d^2/5D$

(C) $d^2/2D, d^2/4D, d^2/6D$ **(D)** None of these

29. When one of the slits of Young's experiment is covered with a transparent sheet of thickness 4.8 *mm*, the central fringe shifts to a position originally occupied by the 30th bright fringe. What should be the thickness of the sheet if the central fringe has to shift to the position occupied by 20th bright fringe?

(A) $3.8\,mm$ **(B)** $1.6\,mm$ **(C)** $7.6\,mm$ **(D)** $3.2\,mm$

30. In a Young's double slit experiment, the intensity at the central maximum is I_0 and the fringe width is β. Then, the minimum separation between two points where the intensity is $\frac{I_0}{4}$ is:

(A) $\frac{\beta}{6}$ **(B)** $\frac{\beta}{3}$ **(C)** $\frac{2\beta}{3}$ **(D)** $\frac{3\beta}{4}$

Date Planned : __ / __ / __	Daily Tutorial Sheet - 3	Expected Duration : 90 Min
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Topics Covered – *Diffraction and Polarisation*		

31. A narrow slit of width 1 mm is illuminated by monochromatic light of wavelength 600 *nm*. The distance between the first minima on either side of a screen at a distance of 2 *m* is:

(A) 1.2 cm **(B)** 1.2 mn **(C)** 2.4 cm **(D)** 2.4 mm

32. Mark the INCORRECT option(s)

(A) In an interference pattern, the minima are usually almost perfectly dark while in a diffraction pattern they are not so

(B) In an interference pattern, all the maxima are of same intensity but not so in the diffraction pattern

(C) In interference fringes are usually equispaced but diffraction fringes are never equally spaced

(D) None of the above

33. In the case of double slit diffraction, if slit width Decreases,

(A) Central peak becomes sharper

(B) Fringe spacing does not change

(C) Less interference maxima fall within the central diffraction maximum

(D) None of the above

34. Consider the diffraction through single slit of width b and wavelength of light λ. Match the Column I with Colum II and mark the correct option from the codes given below.

	Column I		Column II
i	$\lambda << b$	**P**	Diffraction pattern is found on screen
ii	$\lambda < b$	**Q**	No diffraction pattern is found on screen
iii	$\lambda = b$	**R**	A sharp bright image of slit is formed on screen
iv	$\lambda > b$	**S**	Central maxima will extend over whole screen

Code :

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

Direction 50 - 51

(A) Both Statement I and Statement II are correct and Statement II is the correct explanation of Statement I

(B) Both Statement I and Statement III are correct but Statement II is not the correct explanation of Statement I

(C) Statement I is correct but Statement II is incorrect

(D) Statement II is correct but Statement I is incorrect

35. **Statement I** Two objects of equal intensity will be just resolved by an optical instrument, if the central diffraction maximum of one lies at the first minimum of the other.

Statement II Diffraction can be explained on the basis of Huygens' theory.

36. **Statement I** In single slit diffraction, if slit is made narrower, central maximum becomes wider.

Statement II Presence of light in shadow is due to diffraction.

37. Which of the following phenomena can be demonstrated by light but not with sound wave in an air column?

(A) Reflection **(B)** Diffraction **(C)** Refraction **(D)** Polarisation

38. A light wave has amplitude A and angle between analyser and polariser is 45°. Light is reflected by analyser has amplitude

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

39. An electromagnetic wave travels in vacuum along x-direction, is $E = (E_1\hat{j} + E_2\hat{k})\sin(kx - \omega t)$. The corresponding magnetic field is

(A) $B = \frac{1}{c}(E_1\hat{j} + E_2\hat{k})\sin(kx + \omega t)$ **(B)** $B = \frac{1}{c}(E_2\hat{j} - E_1\hat{k})\sin(kx - \omega t)$

(C) $B = \frac{1}{c}(E_1\hat{j} - E_2\hat{k})\sin(kx - \omega t)$ **(D)** $B = \frac{1}{c}(-E_1\hat{j} + E_2\hat{k})\cos(kx - \omega t)$

40. In previous problem,

(A) electromagnetic wave is non-polarised

(B) electromagnetic wave is plane polarised

(C) electromagnetic wave is circularly polarised

(D) electromagnetic wave is elliptically polarised

41. Unpolarised light is equivalent to

(A) The superposition of two mutually perpendicular identical unpolarised light

(B) Linearly polarised light **(C)** Circularly polarised light

(D) None of the above

42. If an unpolarised light is converted into plane polarised light, its intensity becomes

(A) half **(B)** one-fourth **(C)** one-third **(D)** one-eighth

43. The Fraunhofer diffraction pattern of a single slit is formed at the focal plane of a lens of focal length 1m. The width of the slit is 0.3 mm. If the third minimum is formed at a distance of 5 mm from the central maximum then the wavelength of light will be:

(A) 4500 Å **(B)** 3000 Å **(C)** 5000 Å **(D)** 4000 Å

44. A ray of light is incident on the surface of a glass plate at an angle of incidence equal to Brewster's angle ϕ. If μ represents the refractive index of glass with respect to air, the angle between the reflected and refracted ray is:

(A) $(90 + \phi)$ **(B)** $\sin^{-1}(\mu\cos\phi)$ **(C)** $90°$ **(D)** $\sin^{-1}\left(\frac{\sin\phi}{\mu}\right)$

45. Which of the following cannot be polarised?

(A) Light wave **(B)** Transverse wave **(C)** Radio wave **(D)** Ultrasonic wave

Date Planned : __ / __ / __	Daily Tutorial Sheet - 4	Expected Duration : 90 Min
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Topics Covered – *Mixed* (*Numerical questions*)		

46. In a Young's double slit experiment, the distance between the slits is 0.2 mm, the slits are at a distance 2 m from the screen, and monochromatic light of wavelength 500 nm is used.The distance between two closest points on the screen where intensity is one-fourth the maximum intensity on the screen is ___________mm.

47. In a Young's double slit experiment, the distance between the slits is 1 mm, the slits are at a distance 2 m from the screen,and monochromatic light of wavelength 600 nm is used. If a thin transparent sheet of thickness 0.1 mm and refractive index 1.5 is introduced in front of one of the slits, the interference pattern shifts on the screen by a distance _________ cm.

48. The screen in a Young's double slit experiment is placed at a distance 2 m from the slits. When monochromatic light of wavelength 500 nm is used, the distance between a bright spot and the closest dark spot on the screen is found to be 0.5 cm. Then, the separation between the slits is __________ μm .

49. In a Young's double slit experiment, the path difference between the two interfering waves at a point is $\frac{5}{2}$ times the wavelength. Then, ratio of the distance of this point from the central maximum to the fringe width is __________.

50. In a Young's double slit experiment performed with green light of wavelength 510 nm, the interference pattern shifts by exactly 50 fringe widths when a transparent sheet of glass of thickness 50 μm is introduced in front of one of the slits. The refractive index of the glass for green light is given by $\mu = 1 + \frac{N}{100}$. Then, N is equal to __________.

51. In a Young's double slit experiment, the distance between the two slits is 0.5 mm and the distance between the screen and the slits is 1 m. When a light of wavelength 500 nm is incident on the slits, what would be distance between the two second bright fringes? [In mm}___________.

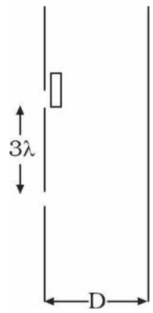
52. A Young's double slit experiment is performed with white light containing all wavelengths in the range 400-700 nm. The separation between the slits in 0.2 mm and the distance between the slits and the screen is 2 m. The longest wavelength which has a maximum at a point at a distance 2 cm from the central maximum is _________.

53. In the interference pattern in a Young's double slit experiment, the ratio of the maximum intensity and minimum intensity on the screen is 4. Then, the ratio of the maximum intensity to the intensity at a point mid-way between any maximum and minimum is __________.

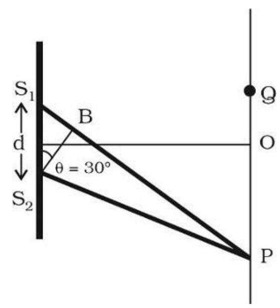
54. In a Young's double slit experiment, the distance between the slits is 0.2 mmand monochromatic light of wavelength 480 nm is used. The angular fringe width in the interference pattern is __________ $\times 10^{-4}$ rad.

55. In a Young's double slit experiment, the distance between the slits is 0.2 mm, the slits are at a distance 2 m from the screen. If the sixth order maximum is located at a distance 3 cm from the central maximum, the wavelength of the light used is __________nm.

56. In the diagram shown, the separation between the slit is equal to 3λ, where λ is the wavelength of the light incident on the plane of the slits. A thin film of thickness 3λ and refractive index 2 has been placed in the front of the upper slit. Find the distance of the central maxima on the screen from O if D = 2m.



57. The double slit experiment of Young has been shown in figure. Q is the position of the first bright fringe on the right side and P is the 11^{th} bright fringe on the other side as measured from Q. If wavelength of the light used is 6000 Å, S_1B, will be equal to 6×10^{-x} m find x.

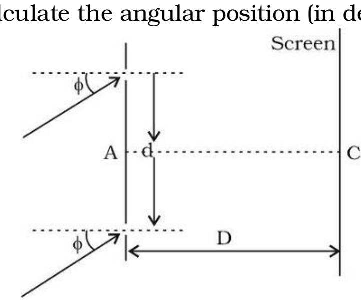


(a) 6×10^{-6} m (b) 6.6×10^{-6} m (c) 3.138×10^{-7} m (d) 3.144×10^{-7} m

58. In YDS, the width of the fringes obtained from a light of wavelength 500 nm is 3.6 mm. What is the fringe width if the apparatus is immersed in liquid of refractive index 1.2 ? {In mm}.

59. White light is used in a Young's double slit experiment. Find the minimum order of the violet fringe (λ = 400 nm) which overlaps with 4th red fringe (λ = 700 nm).

60. Light of wavelength $\lambda = 500$ nm falls on two narrow slits placed at a distance d = 50 × 10^{-4} cm apart, at an angle $\phi = 30°$ relative to the slits shown in figure. On the lower slit a transparent slab of thickness 0.1 mm and refractive index 3/2 is placed. The interference pattern is observed on a screen at a distance D = 2m from the slits. Then calculate the angular position (in degrees) of central maxima?



Wave Optics

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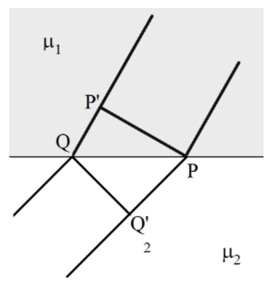
Topics Covered – *Wave properties of light, Huygens's Principle, Interference*		

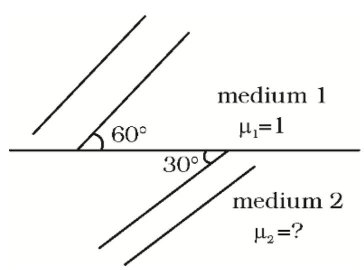
61. A parallel beam of light passes from a medium of refractive index μ_1 into a medium of refractive index μ_2 as shown. The points P and Q lie on the interface between the mediums. PP' is a wavefront in the first medium and QQ' is a wavefront in the second medium. The ratio $\frac{P'Q}{PQ'}$ is equal to:



(A) $\frac{\mu_1}{\mu_2}$ **(B)** $\frac{\mu_2}{\mu_1}$ **(C)** $\left(\frac{\mu_1}{\mu_2}\right)^2$ **(D)** $\left(\frac{\mu_2}{\mu_1}\right)^2$

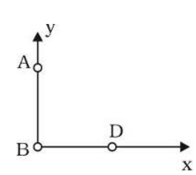
62. Two waves, $y_1 = A\sin\left(\frac{\pi}{6}z + 4\pi t + \frac{\pi}{6}\right)$ *and* $y_2 = A\cos\left(\frac{\pi}{4}x + 4\pi t + \frac{\pi}{3}\right)$ interfere at the point $(2, 0, -1)$. The intensity reaching the point due to each wave is *I*, and the resultant intensity at the point is I_R. Then $\frac{I_R}{I} =$ __________.

63. Incident and refracted parallel plane wavefronts in medium (1) and (2) respectively are shown in figure. Medium (1) is air. Find the refractive index of medium (2).

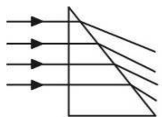


(A) $\sqrt{2}$ **(B)** $\sqrt{3}$ **(C)** 2 **(D)** $\sqrt{3}/\sqrt{2}$

64. An interference is observed due to two coherent sources 'A' & 'B' having zero phase difference separated by a distance 4λ along the y-axis where λ is the wavelength of the source. A detector D is moved on the positive x-axis. The number of points on the x-axis excluding the points x = 0 & x = ∞ at which maximum will be observed is.



65. **MATCH THE FOLLOWING :**

	Column 1		**Column 2**
(A)	Light diverging from a point source	**(P)**	Plane wavefront
(B)	Light emerging from a convex lens when a point source is placed at its focus	**(Q)**	Spherical wavefront
(C)	Light reflected from a concave mirror when a point source is placed at its focus	**(R)**	Cylindrical wavefront
(D)		**(S)**	Concave right wave front

***66.** The wavelength of sodium light in air is 589 nm;

(A) its frequency in air is $5.09\times10^{14}Hz$

(B) its wavelength in water ($\mu_w = 1.33$) is 443 nm

(C) its frequency in water is 3.78×10^{14} Hz

(D) its speed in water is $2.25\times10^{8}m$ / sec

67. A beam of light of intensity I_0 travelling in medium 1 is incident on an interface with medium 2 at an angle of incidence θ. The refractive index of medium 2 is lower than the refractive index of medium 1, and the critical angle for the pair of mediums is θ_c. Let the intensity of the beam reflected back into medium 1 be I_R and let the intensity of the beam transmitted into medium 2 be I_T. Then:

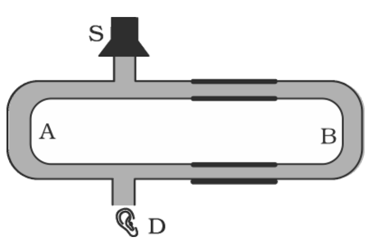
(A) $I_R = I$ *and* $I_T = 0$ *if* $\theta > \theta_c$

(B) $I_R = 0$ *and* $I_T = I$ *if* $\theta < \theta_c$

(C) $I_R + I_T = I$ *in all cases*

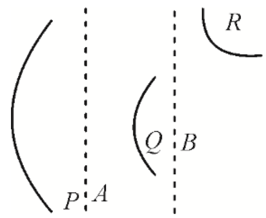
(D) $I_R + I_T < I$ *in all cases*

68. In the shown figure interferometer is used to demonstrate the interference of sound waves. S is a source of wave, and D is a detector, Path SBD can be varied in length, but path SAD is fixed. The interferometer contains air, and it is found that the resultant intensity at D has a minimum value of 10 W/cm² at its (of SBD path) one position and climbs gradually to 90 W/cm² at a second position 1.65 cm from the first. The frequency of sound emitted from the source is $\eta\times10^{3}Hz$. Then find value of η ? ☐



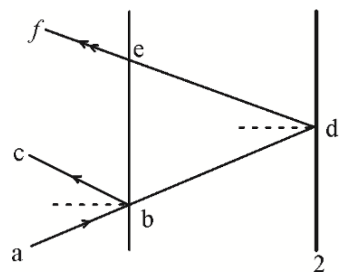
(Take speed of sound in air as 330 m/s)

69. Figure shows a wavefront P passing through two systems A and B, and emerging as Q and then as R. The system A and B could, respectively, be:



(A) a prism and a convergent lens
(B) a convergent lens and a prism
(C) a divergent lens and a prism
(D) a convergent lens and a divergent lens

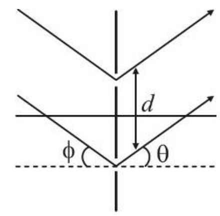
70. A narrow monochromatic beam of light of intensity 1 is incident on a glass plate as shown in the figure. Another identical glass plate is kept close to the first one and parallel to it. Each glass plate reflects 25% of the light incident on it and transmits the remaining. Find the ratio $\sqrt{\frac{I_{max}}{I_{min}}}$ the interference pattern formed by two beams obtained after one reflection at each plate. ☐



Date Planned : __ / __ / __	Daily Tutorial Sheet - 6	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 2	Exact Duration :________

Topics Covered – *Young's Double slit Experiment*

71. 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)** $\sin\phi + \sin\theta = m\frac{\lambda}{d}$

72. In a Young's double slit experiment performed with identical slits and monochromatic light of wavelength λ, it is observed that if one of the slits is covered with an opaque sheet, the intensity at a point Q on the screen remains unaffected. Then, the angular position of the point Q may be:

(A) $\sin^{-1}\left(\frac{\lambda}{3d}\right)$ **(B)** $\sin^{-1}\left(\frac{2\lambda}{3d}\right)$ **(C)** $\sin^{-1}\left(\frac{3\lambda}{4d}\right)$ **(D)** $\sin^{-1}\left(\frac{5\lambda}{4d}\right)$

73. Two identical coherent sources are placed on a diameter of a circle of radius R at separation x ($<< R$) symmetrical about the centre of the circle. The sources emit identical wavelength λ each. The number of point on the circle of maximum intensity is $(x = 5\lambda)$

(A) 20 **(B)** 22 **(C)** 24 **(D)** 26

74. In Young's double-slit experiment using monochromatic light, the light pattern shifts by a certain distance on the screen when a mica sheet of refractive index μ and thickness t microns is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the plane of slits and the screen is doubled. It is found that the distance between successive maxima (or minima) now is the same as the observed fringe shift upon the introduction of the mica sheet. Calculate the wavelength of light ?

(A) $(1/2)t(\mu - 1)$ **(B)** $t(\mu - 1)$ **(C)** μt **(D)** $3\mu t$

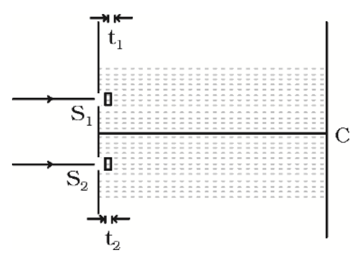
75. In a Young's double slit experiment, the angular fringe width close to the central maximum is $\Delta\theta_0 = 0.0025\ rad.$ Then, between (and including) the two points with angular position $\theta = 30^o$ on either side of the central maximum, the number of:

(A) points of maximum is 401 **(B)** points of maximum is 201

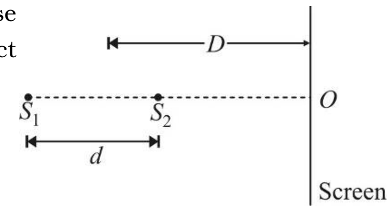
(C) points with intensity half the intensity at the central maximum is 800

(D) points with intensity half the intensity at the central maximum is 400

76. A screen is at a distance $D = 80cm$ from a diaphragm having two narrow slits S_1 and S_2 which are $d = 2mm$ apart. Slit S_1 is covered by a transparent sheet of thickness $t_1 = 2.5\mu m$ and S_2 by another sheet of thickness $t_2 = 1.25\mu m$ as shown in figure. Both sheets are made of same material having refractive index $\mu = 1.40$ and water is filled in space between diaphragm and screen. A monochromatic light beam of wavelength $\lambda = 5000\,Å$ is incident normally on the diaphragm. Assuming intensity of beam to be uniform, calculate ratio of intensity at central point on screen to individual identical beams through slits, $(\mu_w = 4/3)$. [ ]



***77.** Two points monochromatic and coherent sources of light of wavelength λ each are placed as shown in figure. The initial phase difference between the sources is zero O. $(D >> d)$. Mark the correct statement (s).



(A) If $d = \frac{7\lambda}{2}, O$ will be a minima.

(B) If $d = \lambda$, only one maxima can be observed on the screen.

(C) If $d = 4.8\lambda$; then total 10 minima would be there on the screen

(D) If $d = \frac{5\lambda}{2}$, the intensity at O would be minimum.

***78.** In Young's double-slit experiment, two wavelengths of light are used simultaneously where $\lambda_2 = 2\lambda_1$. in the fringe pattern observed on the screen,

(A) Maxima of wavelength λ_2 can coincide with minima of wavelength λ_1.

(B) Fringe width of λ_2 will be double that of fringe width of λ_1 and nth order maxima of λ_2 will coincide with 2^{nd} order maxima of λ_1

(C) n^{th} order minima of λ_2 will coincide with 2nd order minima of λ_1

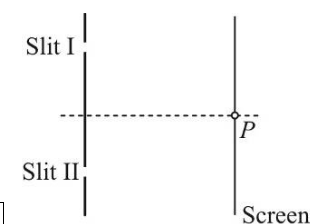
(D) None of the above

79. In a Young's double slit experiment, the fringe width close to the central maximum is β_0. Then, the fringe width close to a point with angular position θ is:

(A) β_0 **(B)** $\frac{\beta_0}{\cos\theta}$ **(C)** $\frac{\beta_0}{\cos^2\theta}$ **(D)** $\frac{\beta_0}{\cos^3\theta}$

80. **MATCH THE FOLLOWING :**

A double-silt interference pattern is produced on a screen, as shown in figure, using monochromatic light of wavelength 500 nm. 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 Column 1, how the strips have been placed, is mentioned whereas in column 2, order of the fringe at point P on the screen that will be produced due to the placement of the strip(s), is shown. Correctly match both the columns.



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

	Column 1		**Column 2**
(A)	Only strip B is placed over slit 1.	**(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 slit I and strip B and strip C are placed over 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

Date Planned : __ / __ / __	Daily Tutorial Sheet - 7	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 2	Exact Duration :________
Topics Covered – *Diffraction and Polarization*		

81. A laser beam of 10 *mW* power and wavelength 7000Å has aperture 3 *mm*. If it is focused by a lens of focal length 5 *cm*, calculate the intensity of image :

(A) $3.12\,kW / cm^2$ **(B)** $3.12\,W / cm^2$ **(C)** $1.56\,kW / cm^2$ **(D)** $1.56\,W / cm^2$

Paragraph for Q. 82-Q. 83

A parallel beam of light of wavelength 6000Å falls on a single slit of width 0.3 *mm* and a diffraction pattern is observed on a screen 2 *m* away from the slit. A point on the screen receives light waves diffracted at angle 45°.

82. Find path difference between secondary waves at this point that are emitted by the top end and the midpoint of the slit.

(A) 1.06 *cm* **(B)** 1.06 *mm* **(C)** 0.106 *mm* **(D)** None of these

83. Find corresponding phase difference at the given point.

(A) 353.33° **(B)** 353.33 π **(C)** 706.66° **(D)** 706.66 $\pi\, rad$

84. Two polaroids are oriented with their planes perpendicular to incident light and transmission axis making an angle of 30° with each other. What fraction of incident unpolarized light is transmitted?

(A) $\frac{5}{8}$ **(B)** $\frac{3}{8}$ **(C)** $\frac{3}{4}$ **(D)** $\frac{1}{4}$

85. A single slit is illuminated with a parallel beam of light of wavelength 5890 Å and a diffraction pattern is obtained on a screen 1.2 *m* from the slit. The distance between positions of zero intensity on both side of central maximum is found to be 3.5 *mm*. Find the width of slit.

(A) 4*mm* **(B)** 4*cm* **(C)** 0.4*mm* **(D)** 0.04 *mm*

86. In a class room of large dimensions, sound waves of frequency 4000 *Hz* and speed 330 *m/sec* diffract through the opening of a speaker. The opening has a shape of a rectangle with a horizontal width of 15 *cm*. The speaker is installed in the middle of a wall 'A' the other wall 'B' being 60 *m* away from this wall. Find the position (in *m*) of first diffraction minimum along the wall 'B' (On either sides from central line of wall) so that a listener sitting there will be unable to clearly hear the sound. Assume that the speaker and the listeners sitting along wall 'B' are at the same height from the floor.

87. In a single slit diffraction experiment first minimum for red light (660 *nm*) coincides with first maximum of some other wavelength λ'. Then λ' in *nm* is ☐.

88. A mixture of plane polarized and unpolarized light falls normally on a polarizing sheet. On rotating the polarizing sheet about the direction of the incident beam, the transmitted intensity varies by a factor of 4. Next the axis of the polarizing sheet is fixed at an angle of 45° with the direction when the transmitted intensity is maximum. Then the total intensity of the transmitted beam is $\frac{xI_0}{4}$. The value of x is ☐.

Paragraph for Q. 89 to Q. 90

Unpolarized light of intensity $32Wm^{-2}$ passes through three polarisers such that the transmission axis of the last polarizer is crossed with the first.

89. If the intensity of the emerging light is $3Wm^{-2}$, what is the angle between the transmission axis of the first two polarisers?

(A) 30° **(B)** 60° **(C)** 45° **(D)** 90°

90. At what angle will the transmitted intensity be maximum?

(A) 90° **(B)** 45° **(C)** 30° **(D)** 60°

Wave Optics

JEE Main (Archive)	Level -1

1. To demonstrate the phenomenon of interference, we require two sources which emit radiation : **[2003]**

(A) Of the same frequency and having a definite phase relationship
(B) Of nearly the same frequency
(C) Of the same frequency
(D) Of different wavelengths

2. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is : **[2004]**

(A) Infinite **(B)** five **(C)** three **(D)** zero

3. The angle of incidence at which reflected light totally polarized for reflection from air to glass (refractive index *n*), is :

(A) $\sin^{-1}(n)$ **(B)** $\sin^{-1}(1/n)$ **(C)** $\tan^{-1}(1/n)$ **(D)** $\tan^{-1}(n)$ **[2004]**

4. When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is:

(A) $\frac{1}{2}I_0$ **(B)** $\frac{1}{4}I_0$ **(C)** zero **(D)** I_0 **[2005]**

5. If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled?

(A) $2I_0$ **(B)** $4I_0$ **(C)** I_0 **(D)** $I_0/2$ **[2005]**

6. In Young's double-slit experiment, the intensity at a point where the path difference is $\lambda/6$ (λ being the wavelength of the light used) is *I*. If I_0 denotes the maximum intensity, I/I_0 is equal to : **[2007]**

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

7. A mixture of lights, consisting of wavelength 590 *nm* and an unknown wavelength illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of the known light coincides with the fourth bright fringe of the unknown light. From this data, the wavelength of the unknown light is : **[2009]**

(A) 393.4 *nm* **(B)** 885.0 *nm* **(C)** 442.5 *nm* **(D)** 776.8 *nm*

PARAGRAPH FOR QUESTIONS 8 - 10

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 radial distance from the axis of the beam.

8. As the beam enters the medium, it will: **[2010]**

(A) Diverge **(B)** converge

(C) diverge near the axis and converge near the periphery

(D) travel as a cylindrical beam

9. The initial shape of the wave front of the beam is: **[2010]**

(A) convex **(B)** concave

(C) convex near the axis and concave near the periphery

(D) planar

10. The speed of light in the medium is: **[2010]**

(A) minimum on the axis of the beam **(B)** the same everywhere in the beam

(C) directly proportional to the intensity I **(D)** maximum on the axis of the beam

11. The question has a paragraph followed by two statements, Statement – 1 and statement –2. Of the given four alternatives after the statements, choose the one that describes the statements.

A thin air film is formed by putting the convex surface of a plano – convex lens over a plane glass plate. With monochromatic light, this film gives an interference pattern due to light reflected from the top (convex) surface and the bottom (glass plate) surface of the film. **[2011]**

Statement 1 : When light reflects from the air-glass plate interface, the reflected wave suffers a phase change of π.

Statement 2 : The centre of the interference pattern is dark.

(A) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1.

(B) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of statement-1

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

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

12. **Statement-1:** On viewing the clear blue portion of the sky through a Calcite Crystal, the intensity of transmitted light varies as the crystal is rotated. **[2011]**

Statement-2: The light coming from the sky is polarized due to scattering of sun light by particles in the atmosphere. The scattering is largest for blue light.

(A) Statement-1: is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1: is true, Statement-2 is true; Statement-2 is not a correct explanation for Statement-1.

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

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

13. In Young's double slit experiment, one of the slit is wider than other, so that amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I when they interfere at phase difference ϕ is given by : **[2012]**

(A) $\frac{I_m}{9}(4+5\cos\phi)$ **(B)** $\frac{I_m}{3}\left(1+2\cos^2\frac{\phi}{2}\right)$

(C) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$ **(D)** $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$

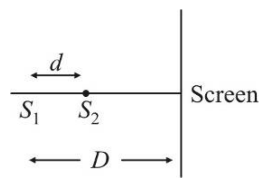
14. In a Young's double slit experiment, the two slits act as coherent sources of waves of equal amplitude A and wavelength λ. In another experiment with the same arrangement the two slits are made to act as incoherent sources of waves of same amplitude and wavelength. If the intensity at the middle point of the screen in the first case is I_1 and in the second case is I_2 then the ratio I_1 / I_2 is : **[2012]**

(A) 0.5 **(B)** 4 **(C)** 2 **(D)** 1

15. At two points P and Q on a screen, in Young's double slit experiment, waves from slits S_1 and S_2 have a path difference of 0 and $\lambda / 4$ respectively. The ratio of intensities at P and Q will be:

(A) 4 : 1 **(B)** 3 : 2 **(C)** 2 : 1 **(D)** $\sqrt{2}:1$

16. Two coherent point sources S_1 and S_2 are separated by a small distance d as shown. The fringes obtained on the screen will be : **[2013]**



(A) Straight line
(B) Semi-circles
(C) Concentric circles
(D) Points

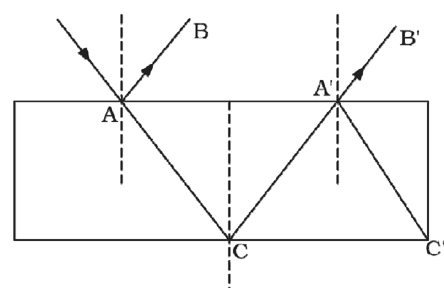
17. This question has statement-1 and statement-2, of the four choices given after the statements, choose the one that best describes the two statements. **[2013]**

Statement 1: In Young's double slit experiment, the number of fringes observed in the field of view is small with longer wavelength of light and is large with shorter wavelength of light.

Statement 2: In the double slit experiment, the fringe width depends directly on the wavelength of light.

(A) Statement 1 is true, and statement 2 is true and statement 2 is not the correct explanation of the statement 1.
(B) Statement 1 is false and the statement 2 is true
(C) Statement 1 is true and statement 2 is true and the statement 2 is true explanation of the statement 1
(D) Statement 1 is true and the statement 2 is false.

18. A ray of light of intensity I is incident on a parallel glass slab at point A as shown in diagram. It undergoes partial reflection and refraction. At each reflection, 25% of incident energy is reflected. The rays AB and $A'B'$ undergo interference. The ratio of I_{max} and I_{min} is: **[2013]**

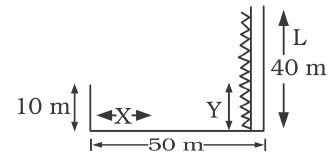


(A) 49 : 1 **(B)** 7 : 1
(C) 4 : 1 **(D)** 8 : 1

19. A beam of unpolarized light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is:

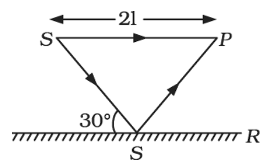
(A) $I_0 / 2$ **(B)** $I_0 / 4$ **(C)** $I_0 / 8$ **(D)** I_0 **[2013]**

20. A person lives in high rise building on the bank of a river 50 m wide. Across the river is a well lit tower of height 40 m. When the person, who is at height of 10 m, looks through a polarizer at an appropriate angle at light of the tower reflecting from the river surface, he nodes that intensity of light coming from distance X from his building is the least and this corresponds to the light coming from light bulbs at height 'Y' on the tower. The values of X and Y are respectively close to (refractive index of water $\approx 4/3$)



(A) 25 *m*, 10 *m* **(B)** 13 *m*, 27 *m* **(C)** 22 *m*, 13 *m* **(D)** 17 *m*, 20 *m* **[2013]**

21. Interference pattern is observed at 'P' due to superimposition of two rays coming out from a source 'S' as shown in the figure. The value of l for which maxima is obtained at 'P' is (R is perfect reflecting surface): **[2014]**



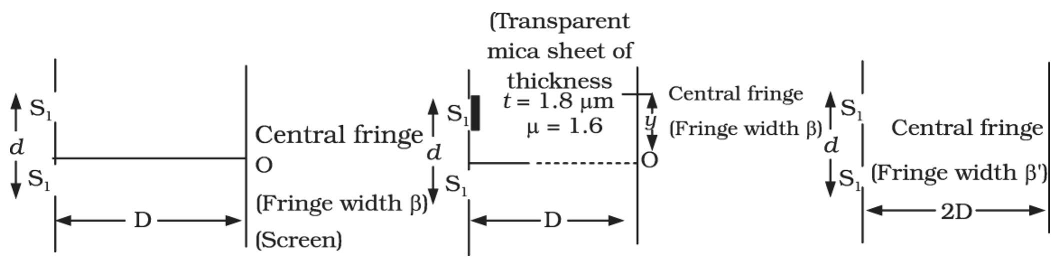
(A) $l = \dfrac{2n\lambda}{\sqrt{3}-1}$ **(B)** $l = \dfrac{(2n-1)\lambda}{2(\sqrt{3}-1)}$

(C) $l = \dfrac{(2n-1)\sqrt{3}\lambda}{4(2-\sqrt{3})}$ **(D)** $l = \dfrac{(2n-1)\lambda}{(\sqrt{3}-1)}$

22. Two monochromatic light beams of intensity 16 and 9 units are interfering. The ratio of intensities of bright and dark parts of the resultant pattern is: **[2014]**

(A) 16/9 **(B)** 7/1 **(C)** 4/3 **(D)** 49/1

23. Using monochromatic light of wavelength λ an experimentalist sets up the Young's Double slit experiment in three ways as shown. If he observes that $y = \beta'$, the wavelength of light used is: **[2014]**



(A) 520 nm **(B)** 540 nm **(C)** 560 nm **(D)** 580 nm

24. In a young's double slit experiment, the distance between the two identical slits is 6.1 times larger than the slit width. Then the number of intensity maxima observed within the central maximum of the single slit diffraction pattern is: **[2014]**

(A) 3 **(B)** 6 **(C)** 12 **(D)** 24

25. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of Polaroid through 30° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then I_A / I_B equals: **[2014]**

(A) 1 **(B)** 1/3 **(C)** 3 **(D)** 3/2

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

(A) 3300 Å **(B)** 4400 Å **(C)** 5500 Å **(D)** 6600 Å

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

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

28. In Young's double slit experiment with light of wavelength λ the separation of slits is d and distance of screen is D such that $D >> d >> \lambda$. If the fringe width is β, the distance from point of maximum intensity to the point where intensity falls to half of maximum intensity on either side is: **[2015]**

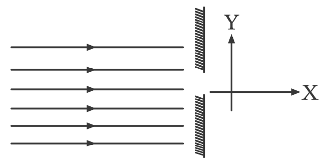
(A) $\frac{\beta}{2}$ **(B)** $\frac{\beta}{4}$ **(C)** $\frac{\beta}{3}$ **(D)** $\frac{\beta}{6}$

29. On a hot summer night, the refractive index of air is smallest near the ground and it increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam : **[2015]**

(A) Goes horizontally without any deflection **(B)** Bends downwards

(C) Bends upwards **(D)** Becomes narrower

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



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

31. In Young's double slit experiment, the distance between slits and the screen is 1.0 m and monochromatic light of 600 nm is being used. A person standing near the slits is looking at the fringe pattern. When the separation between the slits is varied, the interference pattern disappears for a particular distance d_0 between the slits. If the angular resolution of the eye is $\frac{1^\circ}{60}$, the value of d_0 is close to: **[2016]**

(A) 1 mm **(B)** 3 mm **(C)** 2 mm **(D)** 4 mm

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

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

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

33. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is: **[2017]**

(A) 15.6 mm **(B)** 1.56 mm **(C)** 7.8 mm **(D)** 9.75 mm

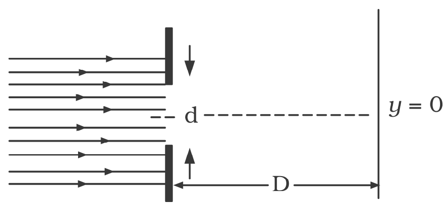
34. The angular width of the central maximum in a single slit diffraction pattern is 60°. The width of the slit is $1\mu m$. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance 50 cm from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

(A) $100\,\mu m$ **(B)** $25\,\mu m$ **(C)** $50\,\mu m$ **(D)** $75\mu m$ **[2018]**

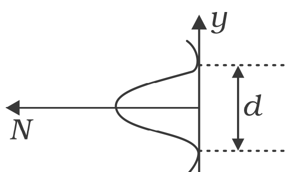
35. Unpolarized light of intensity I passes through an ideal polarizer A. Another identical polarizer B is placed behind A. The intensity of light beyond B is found to be $\frac{I}{2}$. Now another identical polarizer C is placed between A and B. The intensity beyond B is now found to be $\frac{I}{8}$.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

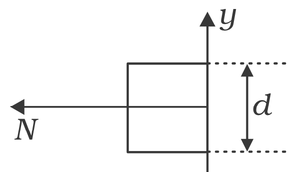
(A) 60° **(B)** 0° **(C)** 30° **(D)** 45° **[2018]**

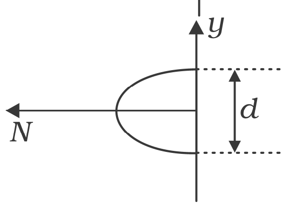
36. In an experiment, electrons are made to pass through a narrow slit of width 'd' comparable to their de Broglie wavelength. They are detected on a screen at a distance 'D' from the slit (see figure).

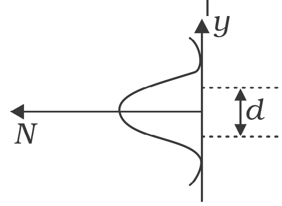


Which of the following graph can be expected to represent the number of electrons 'N' detected as a function of the detector position 'y'($y = 0$ corresponds to the middle of the slit)?

(A)


(B)


(C)


(D)


[2018]

37. In a Young's double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength $\lambda = 500\ nm$ is incident on the slits. The total number of bright fringes that are observed in the angular range $-30° \le \theta \le 30°$ is : **[2019]**

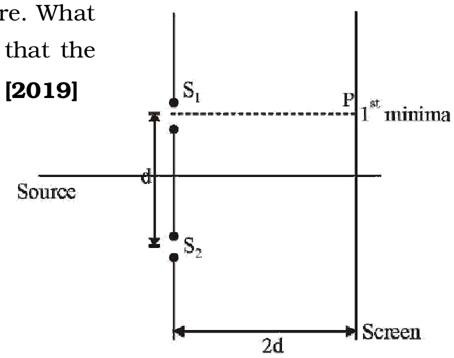
(A) 640 **(B)** 321 **(C)** 641 **(D)** 320

38. In a Young's double slit experiment with Slit separation 0.1 mm, one observes a bright fringe at angle $\frac{1}{40}$ rad by using light of wavelength λ_1. When the light of wavelength λ_2 is used a bright fringe is seen at the same angle in the same set up. Given that λ_1 *and* λ_2 are in visible range (380 nm to 740nm), their values are: **[2019]**

(A) 380 nm, 525 nm **(B)** 625 nm, 500 nm

(C) 400 nm, 500 nm **(D)** 380 nm, 500 nm

39. Consider a Young's double slit experiment as shown in the figure. What should be the slit separation d in terms of wavelength λ such that the first minima occurs directly in front of the slit (S_1) ? **[2019]**



(A) $\frac{\lambda}{(\sqrt{5}-2)}$ **(B)** $\frac{\lambda}{2(\sqrt{5}-2)}$

(C) $\frac{\lambda}{(5-\sqrt{2})}$ **(D)** $\frac{\lambda}{2(5-\sqrt{2})}$

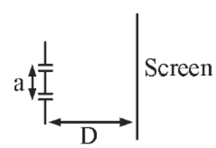
40. In a Young's double slit experiment, the path difference, at a certain point on the screen, between two interfering waves is $\frac{1}{8}th$ of wavelength. The ratio of the intensity at this point to that at the centre of a bright fringe is close to: **[2019]**

(A) 0.94 **(B)** 0.80 **(C)** 0.74 **(D)** 0.85

41. In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2}=\frac{1}{3}$. The ratio of maximum and minimum intensities of fringes will be : **[2019]**

(A) 9 **(B)** 18 **(C)** 4 **(D)** 2

42. The figure shows a Young's double slit experimental setup. It is observed that when a thin transparent sheet of thickness t and refractive index μ is put in front of one of the slits, the central maximum gets shifted by a distance equal to n fringe widths. If the wavelength of light used is λ, t will be: **[2019]**



(A) $\frac{nD\lambda}{a(\mu-1)}$ **(B)** $\frac{2D\lambda}{a(\mu-1)}$ **(C)** $\frac{D\lambda}{a(\mu-1)}$ **(D)** $\frac{2nD\lambda}{a(\mu-1)}$

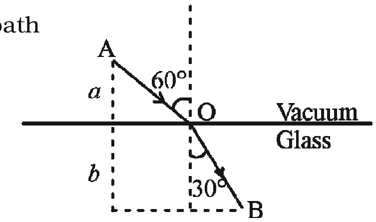
43. In a Young's double slit experiment, the ratio of the slit's width is 4 : 1. The ratio of the intensity of maxima to minima, close to the central fringe on the screen, will be: **[2019]**

(A) $(\sqrt{3}+1)^4 : 16$ **(B)** 25 : 9 **(C)** 4 : 1 **(D)** 9 : 1

44. In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used): **[2019]**

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

45. A ray of light AO in vacuum is incident on a glass slab at angle 60° and refracted at angle 30° along OB as shown in the figure. The optical path length of light ray from A to B is: **[2019]**



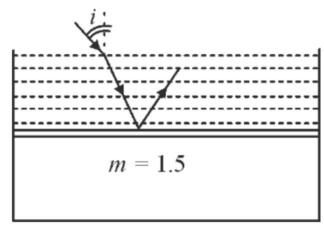
(A) $2a + \frac{2b}{3}$ **(B)** $\frac{2\sqrt{3}}{a} + 2b$

(C) $2a + 2b$ **(D)** $2a + \frac{2b}{\sqrt{3}}$

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

(A) 10 **(B)** 04 **(C)** 09 **(D)** 05

47. Consider a tank made of glass (refractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ. A student finds that, irrespective of what the incident angle i (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass interface is never completely polarized. For this to happen, the minimum value of μ is: **[2019]**



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

48. A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1. The pass axis of P_2 is inclined at $60°$ to the pass axis of P_3. When a beam of unpolarized light of intensity I_0 is incident on P_1, the intensity of light transmitted by the three polarizers is I. The ratio $((I_0 / I)$ equals (nearly): **[2019]**

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

49. Interference fringes are observed on a screen by illuminating two thin slits 1 *mm* apart with a light source $(\lambda = 632.8 nm)$. The distance between the screen and the slits is 100 *cm*. If a bright fringe is observed on a screen at a distance of 1.27 *mm* from the central bright fringe, then the path difference between the waves, which are reaching this point from the slits is close to: **[2020]**

(A) 2.87 *nm* **(B)** 2 *nm* **(C)** 2.05 μm **(D)** 1.27 μm

50. In a Young's double slit experiment, 16 fringes are observed in a certain segment of the screen when light of wavelength 700 nm is used. If the wavelength of light is changed to 400 nm, the number of fringes observed in the same segment of the screen would be: **[2020]**

(A) 24 **(B)** 30 **(C)** 18 **(D)** 28

51. In a Young's double slit experiment, light of 500 nm is used to produce an interference pattern. When the distance between the slits is 0.05 mm, the angular width (in degree) of the fringes formed on the distance screen is close to : **[2020]**

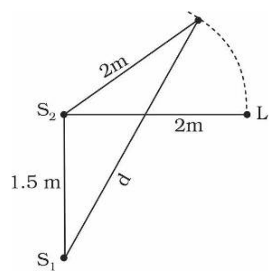
(A) 0.17° **(B)** 0.07° **(C)** 0.57° **(D)** 1.7°

52. Two light waves having the same wavelength λ in vacuum are in phase initially. Then the first wave travels a path L_1 through a medium of refractive index n_1 while the second wave travels a path of length L_2 through a medium of refractive index n_2. After this the phase difference between the two waves is: **[2020]**

(A) $\frac{2\pi}{\lambda}(n_2L_1 - n_1L_2)$ **(B)** $\frac{2\pi}{\lambda}\left(\frac{L_1}{n_1} - \frac{L_2}{n_2}\right)$

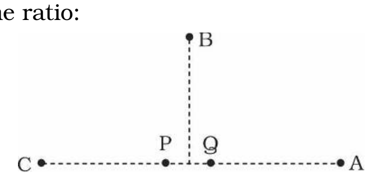
(C) $\frac{2\pi}{\lambda}(n_1L_1 - n_2L_2)$ **(D)** $\frac{2\pi}{\lambda}\left(\frac{L_2}{n_1} - \frac{L_1}{n_2}\right)$

53. Two coherent sources of sound, S_1 and S_2, produce sound waves of the same wavelength, $\lambda = 1$ m, in phase. S_1 and S_2 are placed 1.5 m apart (see fig). A listener, located at L, directly in front of S_2 finds that the intensity is at a minimum when he is 2 m away from S_2. The listener moves away from S_1, keeping his distance from S_2 fixed. The adjacent maximum of intensity is observed when the listener is at a distance d from S_1. Then, d is : **[2020]**



(A) 2 m **(B)** 3 m **(C)** 5 m **(D)** 12 m

54. In the figure below, P and Q are two equally intense coherent sources emitting radiation of wavelength 20m. The separation between P and Q is 5m and the phase of P is ahead of that of Q by 90°. A, B and C are three distinct points of observation, each equidistant from the midpoint of PQ. The intensities of radiation at A, B, C will be in the ratio: **[2020]**



(A) 0 : 1 : 4 **(B)** 2 : 1 : 0 **(C)** 0 : 1 : 2 **(D)** 4 : 1 : 0

55. A Young's double-slit experiment is performed using monochromatic light of wavelength λ. The intensity of light at a point on the screen, where the path difference is λ, is K units. The intensity of light at a point where the path difference is $\frac{\lambda}{6}$ is given by $\frac{nK}{12}$, where n is an integer. The value of n is_______.

[2020]

56. In a Young's double slit experiment, the separation between the slits is 0.15 mm. In the experiment, a source of light of wavelength 589 nm is used and the interference pattern is observed on a screen kept 1.5 m away. The separation between the successive bright fringes on the screen is: **[2020]**

(A) 3.9 mm **(B)** 4.9 mm **(C)** 5.9 mm **(D)** 6.9 mm

57. In a double-slit experiment, at a certain point on the screen the path difference between the two interfering waves is $\frac{1}{8}$th of a wavelength. The ratio of the intensity of light at that point to that at the centre of a bright fringe is: **[2020]**

(A) 0.672 **(B)** 0.760 **(C)** 0.568 **(D)** 0.853

58. Three harmonic waves having equal frequency υ and same intensity I_0, have phase angles $0, \frac{\pi}{4}$ and $-\frac{\pi}{4}$ respectively. When they are superimposed the intensity of the resultant wave is close to : **[2020]**

(A) $5.8I_0$ **(B)** I_0 **(C)** $0.2I_0$ **(D)** $3I_0$

59. In a Young's double slit experiment 15 fringes are observed on a small portion of the screen when light of wavelength 500 nm is used. Ten fringes are observed on the same section of the screen when another light source of wavelength λ is used. Then the value of λ is (in nm) **[2020]**

60. Visible light of wavelength $6000 \times 10^{-8} cm$ falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minimum is at 60° from the central maximum. If the first minimum is produced at θ_1 then θ_1 is close to: **[2020]**

(A) 30° **(B)** 45° **(C)** 20° **(D)** 25°

61. A polarizer-analyser set is adjusted such that the intensity of light coming out of the analyser is just 10% of the original intensity. Assuming that the polarizer-analyser set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero, is: **[2020]**

(A) 18.4° **(B)** 90° **(C)** 45° **(D)** 71.6°

62. A beam of plane polarized light of large cross-sectional area and uniform intensity of $3.3\ Wm^{-2}$ falls normally on a polarizer (cross sectional area $3 \times 10^{-4}\ m^2$) which rotates about its axis with an angular speed of 31.4 rad/s. The energy of light passing through the polarizer per revolution, is close to :

(A) $1.5 \times 10^{-4}\ J$ **(B)** $1.0 \times 10^{-5} J$ **(C)** $5.0 \times 10^{-4}\ J$ **(D)** $1.0 \times 10^{-4}\ J$ **[2020]**

63. Orange light of wavelength $6000 \times 10^{-10} m$ illuminates a single slit of width $0.6 \times 10^{-4} m$. The maximum possible number of diffraction minima produced on both sides of the central maximum is_____. **[2020]**

Wave Optics

JEE Advanced (Archive)	Level -2

SINGLE OPTION CORRECT TYPE

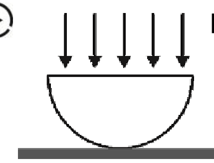
1. In Young's double slit experiment, the separation between the slit is halved and the distance between the slits and the screen is doubled. The fringe width is : **[1981]**

(A) Unchanged **(B)** halved **(C)** doubled **(D)** quadrupled

2. Two coherent monochromatic light beams of intensities I and $4I$ are superposed. The maximum and minimum possible intensities in the resulting beam are : **[1988]**

(A) $5I$ and I **(B)** $5I$ and $3I$ **(C)** $9I$ and I **(D)** $9I$ and $3I$

3. A thin slice is cut out of a glass cylinder along a plane parallel to its axis. The slice is placed on a flat plat as shown. The observed interference fringes from this combination shall be: **[1999]**



(A) Straight
(B) Circular
(C) Equally spaced
(D) Having fringes spacing which increases as we go outwards.

4. In a double-slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then in the interference pattern: **[2000]**

(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

5. Two beams of light having intensities I and $4I$ interfere to produce a fringe pattern. 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 : **[2001]**

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

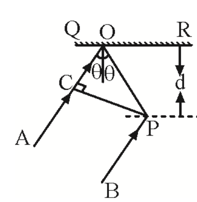
6. In Young's double-slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 *nm*, is used. If the wavelength of light is changed to 400 *nm*, number of fringes observed in the same segment of the screen is given by : **[2001]**

(A) 12 **(B)** 18 **(C)** 24 **(D)** 30

7. In the ideal double-slit experiment, when a glass plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glassplate is : **[2002]**

(A) 2λ **(B)** $2\lambda/3$ **(C)** $\lambda/3$ **(D)** λ

8. In the below figure, *CP* represents a wavefront and *AO* and *BP*, the corresponding two rays. Find the condition on θ for constructive interference at *P* between the ray *BP* and reflected ray *OP*. **[2003]**



(A) $\cos\theta = 3\lambda/2d$ **(B)** $\cos\theta = \lambda/4d$

(C) $\sec\theta - \cos\theta = \lambda/d$ **(D)** $\sec\theta - \cos\theta = 4\lambda/2d$

9. In a YDSE bi-chromatic light of wavelength 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 : **[2004]**

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

10. In Young's double-slit experiment, intensity at point is (1 / 4) of the maximum intensity. Angular position of the point is : **[2005]**

(A) $\sin^{-1}(\lambda / d)$ **(B)** $\sin^{-1}(\lambda / 2d)$ **(C)** $\sin^{-1}(\lambda / 3d)$ **(D)** $\sin^{-1}(\lambda / 4d)$

11. In YDSE, an electron beam is used to obtain interference pattern. If speed of electron is increased then:
(A) No interference pattern will be observed
(B) Distance between two consecutive fringes will increase
(C) Distance between two consecutive fringes will decrease
(D) Distance between two consecutive fringes remains same **[2005]**

12. When a ray of light enters a glass slab from air,
(A) It's wavelength decreases
(B) Its wavelength increases
(C) Its frequency increases
(D) Neither its wavelength nor its frequency changes

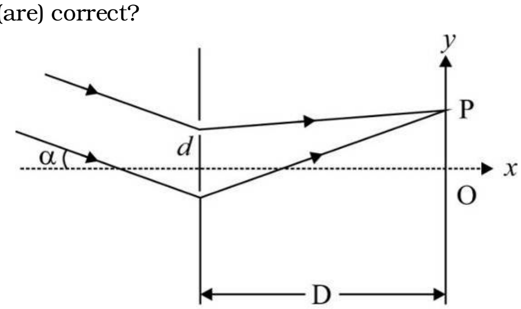
13. Young's double slit experiment is carried out by using green, red and blue light, one colour at a time. The fringe widths recorded are β_G, β_R and β_B, respectively, then: **[2012]**

(A) $\beta_G > \beta_B > \beta_R$ **(B)** $\beta_B > \beta_G > \beta_R$ **(C)** $\beta_R > \beta_B > \beta_G$ **(D)** $\beta_R > \beta_G > \beta_B$

14. In 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 : **[2013]**

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

15. 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? **[2019]**



(A) For $\alpha = \frac{0.36}{\pi}$ degree, there will be destructive interference at point P
(B) For $\alpha = 0$, there will be constructive interference at point P
(C) Fringe spacing depends on α
(D) For $\alpha = \frac{0.36}{\pi}$ degree, there will be destructive interference at point O

MULTIPLE OPTION CORRECT TYPE

***16.** In Young's double-slit experiment, the interference pattern is found to have an intensity ratio between the bright and dark fringes as 9. This implies that: **[1982]**

(A) The intensities at the screen due to the two slits are 5 units and 4 units, respectively

(B) The intensities at the screen due to the two slits are 4 units and 1 units, respectively

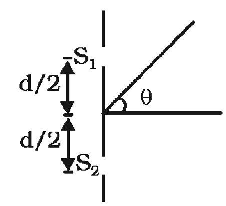
(C) The amplitude ratio is 3

(D) The amplitude ratio is 2

***17.** White light is used to illuminate the two slits in Young's double –slit experiment. The separation between the slits is b and the screen is at a distance $d(> b)$ from the slits. At a point on the screen directly in front of one of the slits certain wavelengths are missing. Some of these missing wavelengths are : **[1984]**

(A) $\lambda = \frac{b^2}{d}$ **(B)** $\lambda = \frac{2b^2}{d}$ **(C)** $\lambda = \frac{b^2}{3d}$ **(D)** $\lambda = \frac{2b^2}{3d}$

***18.** In an interference arrangement similar to Young's double-slit experiment, the slits $S_1 \, and \, S_2$ are illuminated with coherent microwave sources, each of frequency $10^6 Hz$. The sources are synchronized to have zero phase difference. The slits are separated by a distance $d = 150.0m$. The intensity $I(\theta)$ is measured as a function of θ, where θ is defined as shown. If I_0 is the maximum intensity, then $I(\theta)$ for $0 \le \theta \le 90°$ is given by: **[1995]**



(A) $I(\theta) = I_0/2$ for $\theta = 30°$

(B) $I(\theta) = I_0/4$ for $\theta = 90°$

(C) $I(\theta) = I_0$ *for* $\theta = 0°$

(D) $I(\theta) = I_0$ *for* $\theta = 0°$ is constant for all values of θ

***19.** In a Young's double slit experiment, the separation between the two slits is d and the wavelength of the light is λ. The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Choose the correct choice (s). **[2008]**

(A) If $d = \lambda$, the screen will contain only one maximum

(B) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central maximum) will be observed on the screen.

(C) If the intensity of light falling on slit 1 is reduced so that it becomes equal to the of slit 2, the intensities of the observed dark and bright fringes will increase.

(D) If the intensity of light falling on slit 2 is increased so that it becomes equal to that of slit 1, the intensities of the observed dark and bright fringes will increase.

***20.** A light source, which emits two wavelength $\lambda_1 = 400\,\text{nm}$ and $\lambda_2 = 600\,\text{nm}$, 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 : **[2014]**

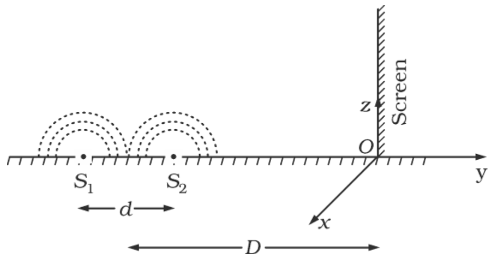
(A) $\beta_2 > \beta_1$

(B) $m_1 > m_2$

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

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

***21.** 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? **[2016]**



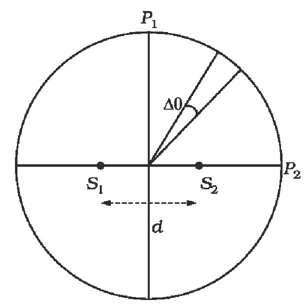
(A) Hyperbolic bright and dark bands with foci symmetrically placed about O in the x-direction

(B) Semi circular bright and dark bands centred 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

***22.** Two coherent monochromatic point sources S_1 and S_2 of wavelength $\lambda = 600\,nm$ are placed symmetrically on either side of the centre of the circle as sown. The sources are separated by distance d = 1.8 *mm*. This arrangement produces interferences 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? **[2017]**



(A) A dark sport will be formed at the point P_2

(B) At P_2 the order of the fringe will be maximum

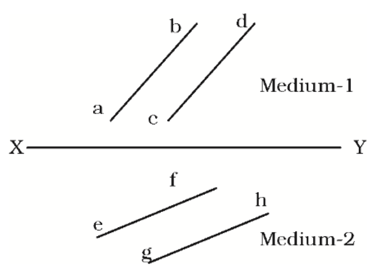
(C) The total number of fringes produced between P_1 and P_2 in the first quadrant is close to 3000

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

<u>LINK COMPREHENSION TYPE</u>

<u>PARAGRAPH FOR QUESTIONS 23 - 25</u>

The figure shows a surface XY separating two transparent media, medium-1 and medium-2. The lines *ab* and *cd* represent wavefronts of a light wave travelling in medium-1 and incident on XY. The lines *ef* and *gh* represent wavefronts of the light wave in medium-2 after refraction. **[2007]**



23. Light travels as a:

(A) Parallel beam in each medium **(B)** Convergent beam in each medium

(C) Divergent beam in each medium

(D) Divergent beam in one medium and convergent beam in the other medium

24. The phases of the light wave at *c, d, e* and *f* are ϕ_c, ϕ_d, ϕ_e and ϕ_f respectively. It is given that $\phi_c \neq \phi_f$. Then :

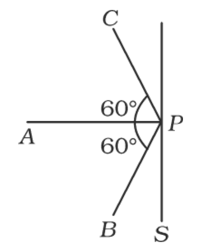
(A) ϕ_c cannot be equal to ϕ_d
(B) ϕ_d can be equal to ϕ_e
(C) $(\phi_d - \phi_f)$ is equal to $(\phi_c - \phi_e)$
(D) $(\phi_d - \phi_c)$ is not equal to $(\phi_f - \phi_e)$

25. Speed of light is :

(A) the same in medium-1 and medium-2
(B) larger in medium-1 than in medium-2
(C) larger in medium-2 than in medium-1
(D) different at *b* and *d*

NUMERICAL VALUE TYPE

26. Screen *S* is illuminated by two point sources *A* and *B*. Another source *C* sends a parallel beam of light towards point *P* on the screen. Line *AP* is normal to the screen and the lines *AP*, *BP* and *CP* are in one plane. The distance *AP*, *BP* and *CP* are 3*m*, 1.5 *m* and 1.5 *m* respectively. The radiant powers of sources *A* and *B* are 90 watts and 180 watts respectively. The beam from *C* is of intensity 20 watts/m^2. Calculate the intensity at *P* on the screen (in W/m^2). ☐ **[1982]**



27. In Young's double slit experiment using monochromatic light, the fringe pattern shifts by a certain distance of the screen when a mica sheet of refractive index 1.6 and thickness 1.964 microns is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the slits and the screen is doubled. It is found that the distance between successive maxima (or minima) now is the same as the observed fringe shift upon the introduction of the mica sheet. Calculate the wavelength of monochromatic light used in the experiment. (in Å) ☐ **[1983]**

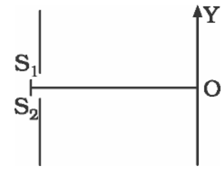
28. In a Young's experiment, the upper slit is covered by a thin glass plate of refractive index 1.4, while the lower slit is covered by another glass plate, having the same thickness as the first one but having refractive index 1.7. Interference pattern is observed using light of wavelength 5400Å. It is found that the point P on the screen, where the central maximum $(n = 0)$ fall before the glass plates were inserted, now has ¾ the original intensity. It is further observed that what used to be the fifth maximum earlier lies below the point P while the sixth minima lies above P. Calculate the thickness of glass plate (in μM). (Absorption of light by glass plate may be neglected). ☐ **[1997]**

29. In Young's experiment, the source is red light of wavelength $7 \times 10^{-7} m$. When a thin glass plate of refractive index 1.5 at this wavelength is put in the path of one of the interfering beam. the central bright fringe shifts by $10^{-3} m$ to the position previously occupied by the 5th bright fringe.

(i) Find the thickness of the plate ☐.

(ii) When the source is now changed to green light of wavelength $5 \times 10^{-7} m$ the central fringe shifts to a position initially occupied by the 6th bright fringe due to red light. Find the refractive index of glass for the green light. Also estimate the change in fringe width due to the change in wavelength ☐. **[1997]**

30. The Young's double slit experiment is done in a medium of refractive index 4/3. A light of 600 nm wavelength is falling on the slits having 0.45 mm separation. The lower slit S_2 is covered by a thin glass sheet of thickness $10.4 \mu m$ and refractive index 1.5. The interference pattern is observed on a screen placed 1.5 m from the slits as shown in figure.



(i) Find the location of the central maximum (bright fringe with zero path difference) on the y-axis. ☐

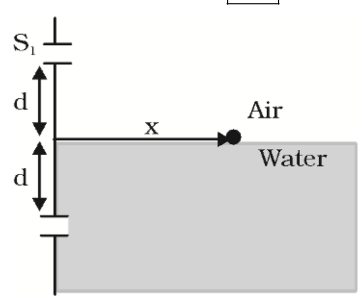
(ii) Find the light intensity at point O relative to the maximum fringe intensity ☐.

(iii) Now, If 600 nm light is replaced by white light of range 400 to 700 nm, find the wavelengths of the light that from maxima exactly at point O ☐.

[All wavelengths in this problem are for the given medium of refractive index 4/3. Ignore dispersion.] **[1999]**

31. In a Young's double slit experiment light consisting of two wavelength $\lambda_1 = 500 nm$ and $\lambda_2 = 700\ nm$ is incident normally on the slits. Find the distance (in mm) from the central maxima where the maxima due to two wavelengths coincide for the first time after central maxima. (Given $\frac{D}{d} = 1000$) where D is the distance between the slits and the screen and d is the separation between the slits. ☐ **[2004]**

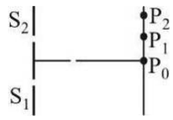
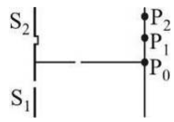
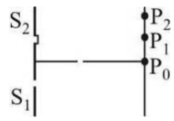
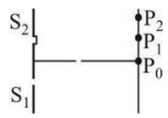
32. A young's double slit interference arrangement with slits S_1 and S_2 is immersed in water (refractive index = 4 / 3) as shown in the figure. The positions of maxima on the surface of water are given by $x^2 = p^2 m^2 \lambda^2 - d^2$, where λ is the wavelength of light in air (refractive index =1),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



MATCH MATRIX TYPE

The question given in this section contains statements given in two columns, which have to be matched. The statements in column I are labeled *a*, *b*, *c*, and *d*, while the statements in column II are labeled *p*, *q*, *r*, *s*, and *t*. Any given statement in column I can have correct matching with one or more statements (s) in column II.

33. Column 1 shows four situations of standard Young's double-slit arrangement with the screen placed far away from the slits S_1 and S_2. In each of these cases, $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda / 4$, and $S_1P_2 - S_2P_2 = \lambda / 3$, where λ is the wavelength of the light used. In the cases B, C and D, a transparent sheet of refractive index μ and thickness t is pasted on slit S_2. The thickness of the sheets are different in the different cases. The phase difference between the light waves reaching point P on the screen from the two slits is denotes by $\delta(P)$ and the intensity by $I(P)$. Match each situation given in Column 1 with the statements (s) in Column 2 valid for that situation. **[2009]**

	Column 1		**Column 2**
(A)		**(P)**	$\delta(P_0) = 0$
(B)	$(\mu-1)t = \lambda/4$ 	**(Q)**	$\delta(P_1) = 0$
(C)	$(\mu-1)t = \lambda/2$ 	**(R)**	$I(P_1) = 0$
(D)	$(\mu-1)t = 3\lambda/4$ 	**(S)**	$I(P_0) > I(P_1)$
		(T)	$I(P_2) > I(P_1)$

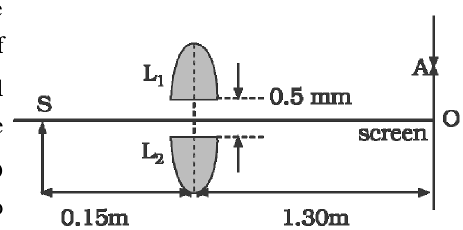
FILL IN THE BLANKS TYPE

34. A light wave of frequency $5 \times 10^{14} Hz$ enters a medium of refractive index 1.5. In the medium, the velocity of the light wave is .... and its wavelength is .... **[1983]**

35. In Young's double-slit experiment, the two slits act as coherent sources of equal amplitude A and of wavelength λ. In another experiment with the same set-up the two slits are sources of equal amplitude A and wavelength λ, but are incoherent. The ratio the intensity of light at the mid-point of the screen in the first case to that in the second case is............. . **[1986]**

36. If ε_0 and μ_0 are, respectively, the electric permittivity and magnetic permeability of free space, ε and μ are the corresponding quantities in a medium, the index of refraction of the medium in terms of the above parameters is .... **[1992]**

37. In the figure shown, S is a monochromatic point source emitting light of wavelength $\lambda = 500 nm$. A thin lens of circular shape and focal length 0.10m is cut into two identical halves L_1 and L_2 by a plane passing through a diameter. The two halves are placed symmetrically about the central axis SO with a gap of 0.5 mm. The distance along the axis from S to L_1 and L_2 is 0.15m, while that from L_1 and L_2 to O is 1.30 m. The screen at O is normal to SO.



(i) If the third intensity maximum occurs at point A on the screen, find distance OA._____

(ii) If the gap between L_1 and L_2 is reduced from its original value of 0.5 mm, will the distance OA increase, decrease, or remain the same? .... **[1993]**

38. A light of wavelength 6000 Å in air, enters a medium with refractive index 1.5. Inside the medium its frequency is .... Hz and its wavelength is .... Å **[1997]**

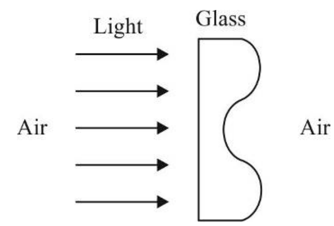
TRUE OR FALSE

39. Two slits in a Young's double slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. No interference pattern will be observed on the screen. **[1984]**

40. In a Young's double slit experiment performed with a source of white light, only black and white fringes are observed. **[1987]**

JEE ADVANCED 2020 QUESTION

41. 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) **[2020]**



(A) 

(B) 

(C) 

(D)