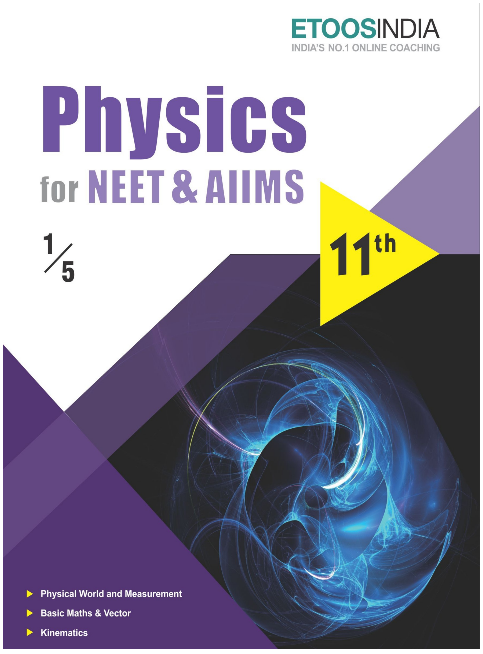
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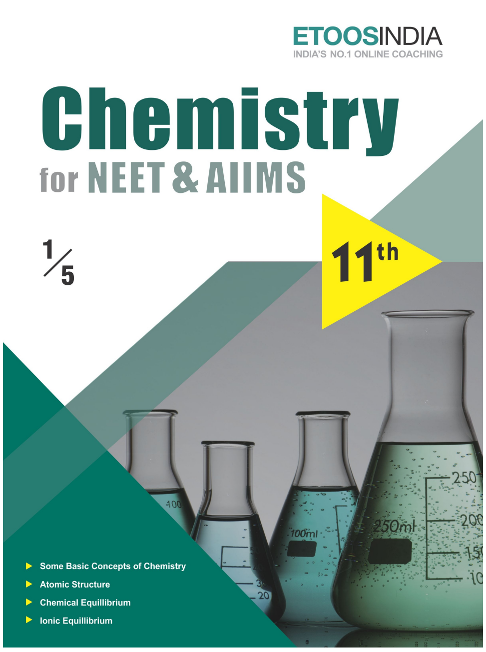
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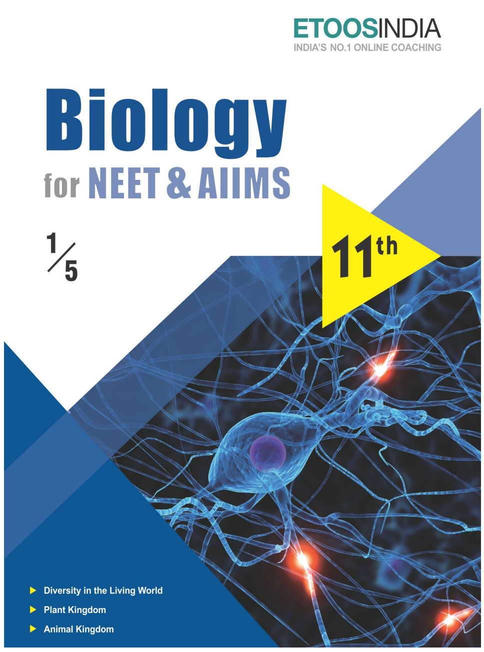
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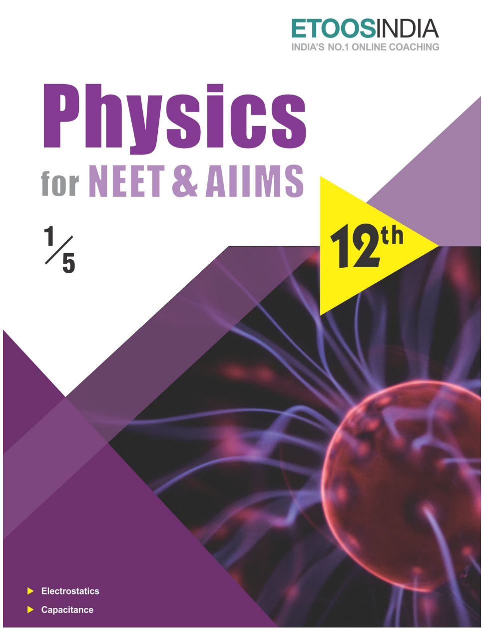
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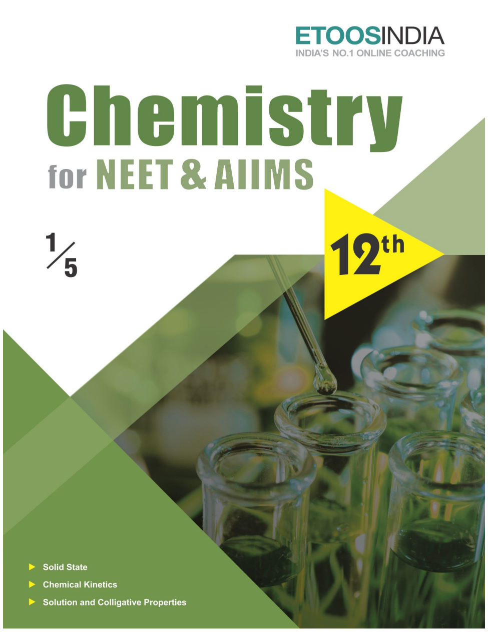
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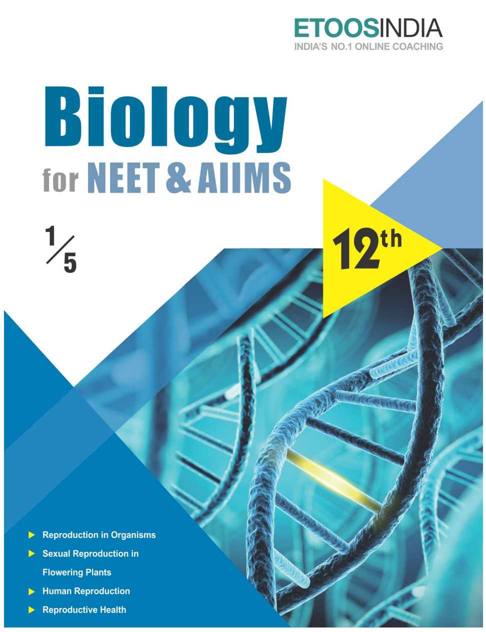
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Sexual Reproduction in Flowering Plants
Human Reproduction
Reproductive Health

CHAPTER 08

WAVE OPTICS

A rainbow is the product of physics working for your appreciation of beauty.

"KYLE HILL"

INTRODUCTION

Phe dutch physicist Christiaan Huygens, in 1678 put forward the wave theory of light – it is this wave model of light that we will discuss in this chpater. As we will see, the wave model could satisfactorily explain the phenomena of reflection and refraction; however, it predicted that on refraction if the wave bends towards the normal then the speed of light would be less in the second medium. This is in contradiction to the prediction made by using the corpuscular model of light. It was much later confirmed by experiments where it was shown that the speed of light in water is less than the speed in air confirming the prediction of the wave model; Foucault carried out this experiment in 1850.

The wave theory was not readily accepted primarily because of Newton's authority and also because light could travel through vacuum and it was felt that a wave would always require a medium to propagate from one point to the other. However, when Thomas Young performed his famous interference experiment in 1801, it was firmly established that light is indeed a wave phenomenone. The wavelength of visible light was measured and found to be extremely small; for example, the wavelength of yellow light is about 0.5 μm. Because of the smallness of the wavelength of visible light (in comparison to the dimensions of typical mirrors and lenses), light can be assumed to approximately travel in straight lines. This is the field of geometrical optics, and a ray is defined as the path of energy propagation in the limit of wavelength tending to zero.

LIGHT

The physical cause, with the help of which our eyes experience the sensation of vision, is known as light or the form of energy, which excites our retina and produce the sensation of vision, is known as light.

PROPERTIES OF VISIBLE LIGHT

(i) No material medium is required for the propagation of light energy i.e. it travels even in vacuum.

(ii) Its velocity is constant in all inertial frames i.e. it is an absolute constant. It is independent of the relative velocity between source and the observer.

(iii) Its velocity in vacuum is maximum whose value is 3×10^8 m/s.

(iv) It lies in the visible region of electromagnetic spectrum whose wavelength range is from 4000 Å to 8000 Å.

(v) Its energy is of the order of eV.

(vi) It propagates in straight line.

(vii) It exhibits the phenomena of reflection, refraction, interference, diffraction, polarisation and double refraction.

(viii) It can emit electrons from metal surface i.e. it can produce photoelectric effect.

(ix) It produces thermal effect and exerts pressure when incident upon a surface. It proves that light has momentum and energy.

(x) Its velocity is different in different media. In rarer medium it is more and in denser medium it is less.

(xi) Light energy propagates via two processes.

(a) The particles of the medium carry energy from one point of the medium to another.

(b) The particles transmit energy to the neighbouring particles and in this way energy propagates in the form of a disturbance.

DIFFERENT THEORIES OF LIGHT

1. Newton's corpuscular theory of light.
2. Hygen's wave theory of light.
3. Maxwell's electromagnetic theory of light.
4. Plank's Quantum theory of light.
5. De-Broglie's dual theory of light.

1. Newton's corpuscular theory of light

This theory was enuciated by Newton.

(i) Characteristics of the theory

(a) Extremely minute, very light and elastic particles are being constantly emitted by all luminous bodies (light sources) in all directions

(b) These corpuscles travel with the speed of light..

(c) When these corpuscles strike the retina of our eye then they produce the sensation of vision.

(d) The velocity of these corpuscles in vacuum is 3×10^8 m/s.

(e) The different colours of light are due to different size of these corpuscles.

(f) The rest mass of these corpuscles is zero.

TYPES OF INTERFERENCE

(i) Constructive Interference

When both waves are in same phase. So phase difference is an even multiple of $\pi \Rightarrow \phi = 2n\pi$; $n = 0,1,2 \ldots$

(a) When path difference is an even multiple of $\frac{\lambda}{2}$

$$\because \frac{\phi}{2\pi} = \frac{\delta}{\lambda} \Rightarrow \frac{2n\pi}{2\pi} = \frac{\delta}{\lambda} \Rightarrow \delta = 2n\left(\frac{\lambda}{2}\right) \Rightarrow \delta = n\lambda \text{ (where } n = 0,1,2\ldots)$$

(b) When time difference is an even multiple of $\frac{T}{2}$ $\quad \therefore \Delta t = 2n\left(\frac{T}{2}\right)$

(c) In this condition the resultant amplitude and Intensity will be maximum.

$$A_{max} = (a_1 + a_2) \Rightarrow I_{max} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} = (\sqrt{I_1} + \sqrt{I_2})^2$$

(ii) Destructive Interference

When both the waves are in opposite phase. So phase difference is an odd multiple of π.

$\phi = (2n-1)\pi$; $n = 1, 2 \ldots$

(a) When path difference is an odd multiple of $\frac{\lambda}{2}$, $\delta = (2n-1)\frac{\lambda}{2}$, $n = 1, 2 \ldots$

(b) When time difference is an odd multiple of $\frac{T}{2}$, $\Delta t = (2n-1)\frac{T}{2}$, (n=1,2...)

In this condition the resultant amplitude and intensity of wave will be minimum.

$$A_{min} = (a_1 - a_2) \Rightarrow I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$$

ETOOS KEY POINTS

(i) Interference follows law of conservation of energy.

(ii) Average Intensity $I_{av} = \frac{I_{max} + I_{min}}{2} = I_1 + I_2 = a_1^2 + a_2^2$

(iii) Intensity $\propto$ width of slit $\propto$ (amplitude)$^2 \Rightarrow I \propto w \propto a^2 \Rightarrow \frac{I_1}{I_2} = \frac{w_1}{w_2} = \frac{a_1^2}{a_2^2}$

(iv) $$\frac{I_{max}}{I_{min}} = \left[\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right]^2 = \left[\frac{a_1 + a_2}{a_1 - a_2}\right]^2 = \left[\frac{a_{max}}{a_{min}}\right]^2$$

(v) Fringe visibility $V = \frac{I_{max} - I_{min}}{I_{max} + I_{min}} \times 100\%$ when $I_{min} = 0$ then fringe visibility is maximum

i.e. when both slits are of equal width the fringe visibility is the best and equal to 100%.

Ex. If two waves represented by $y_1 = 4 \sin \omega t$ and $y_2 = 3 \sin\left(\omega t + \frac{\pi}{3}\right)$ interfere at a point. Find out the amplitude of the resulting wave.

Sol. Resultant amplitude $A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi} = \sqrt{(4)^2 + (3)^2 + 2.(4)(3)\cos\frac{\pi}{3}} \Rightarrow A \simeq 6$

Etoos Tips & Formulas

1. **Huygen`s Wave Theory :**

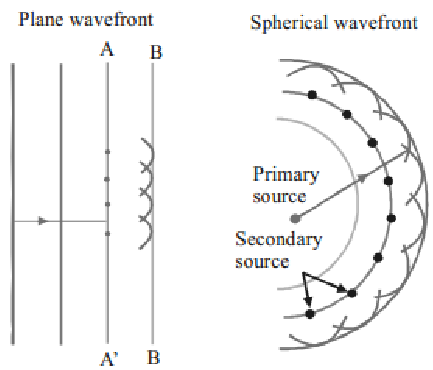
Huygen`s in 1678 assumed that a body emits light in the form of waves.

(a) Each point source of light is a centre of disturbance from which waves spread in all directions. The locus of all the particles of the medium vibrating in the same phase at a given instant is called a wavefront.

(b) Each point on a wave front is a source of new disturbance, called secondary wavelets. These wavelets are spherical and travel with speed of light in that medium.

(c) The forward envelope of the secondary wavelets at any instant gives the new wavefront.

(d) In homogeneous medium, the wavefront is always perpendicular to the direction of wave propagation.



2. **Coherent Sources :**

Two sources will be coherent if and only if they produce waves of same frequency (and hence wavelength) and have a constant initial phase difference.

3. **Incoherent Sources :**

The sources are said to be incoherent if they have different frequency and initial phase difference is not constant w.r.t. time.

4. **Interference : YDSE**

5. Resultant intensity for coherent sources $I = I_1 + I_2 + \sqrt{I_1 I_2}\cos\phi_0$

6. Resultant intensity for incoherent sources $I = I_1 + I_2$

7. Intensity $\propto$ width of slit $\propto$ amplitude

$$\Rightarrow \frac{I_1}{I_2} = \frac{W_1}{W_2} = \frac{a_1^2}{a_2^2} \Rightarrow \frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2} = \left(\frac{a_1+a_2}{a_1-a_2}\right)^2$$

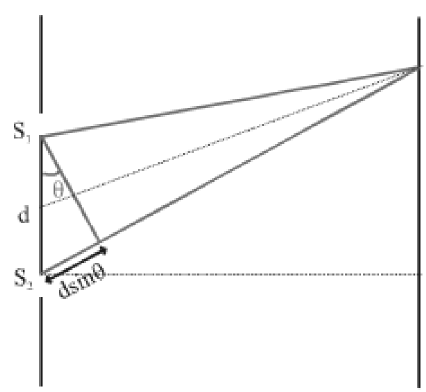
8. Distance of n^{th} bright fringe $X_n = \frac{n\lambda D}{d}$

Path difference $= n\lambda$

where n = 0, 1, 2, 3, ...

Distance of m^{th} dark fringe

$$X_m = \frac{(2m+1)\lambda D}{2d}$$



SOLVED EXAMPLE

Ex.1 Young's double slit experiment is carried out using microwaves of wavelength λ = 3 cm. Distance in between plane of slits and the screen is D = 100 cm. and distance in between the slits is 5 cm. Find

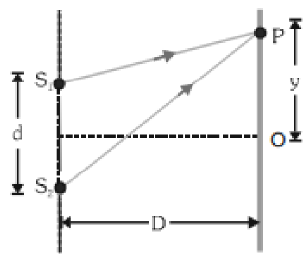
(A) the number of maximas and

(B) their positions on the screen

Sol. (A) The maximum path difference that can be produced = distance between the sources or 5 cm. Thus, in this case we can have only three maximas, one central maxima and two on its either side for a path difference of λ or 3 cm.

(B) For maximum intensity at P, $S_2P - S_1P = \lambda$

$$\Rightarrow \sqrt{(y + d/2)^2 + D^2} - \sqrt{(y - d/2)^2 + D^2} = \lambda$$



substiuting d = 5 cm, D = 100 cm and λ = 3cm we get y = ± 75 cm

Thus, the three maximas will be at y = 0 and y = ± 75 cm

Ex.2 State two conditions to obtain sustained interference of light. In Young's double slit experiment, using light of wavelength 400 nm, interference fringes of width 'X' are obtained. The wavelength of light is increased to 600 nm and the separation between the slits is halved. If one wants the observed fringe width on the screen to be the same in the two cases, find the ratio of the distance between the screen and the plane of the slits in the two arrangements.

Sol. Conditions for sustained interference of light

(i) Sources should be coherent.

(ii) There should be point sources

$\because$ fringe width $\beta = \frac{\lambda D}{d}$ Here, $\beta_1 = \frac{\lambda_1 D_1}{d_1}$ and

$$\beta_2 = \frac{\lambda_2 D_2}{d_2}$$

As $\beta_1 = \beta_2 \Rightarrow \frac{\lambda_1 D_1}{d_1} = \frac{\lambda_2 D_2}{d_2}$

$$\Rightarrow \frac{D_1}{D_2} = \frac{\lambda_2 d_1}{\lambda_1 d_2} = \frac{600}{400} \times \frac{1}{1/2} = \frac{6}{2} = \frac{3}{1}$$

Ex.3 A beam of light consisting of two wavelengths 6500 Å and 5200 Å is used to obtain interference fringes in a young's double slit experiment. The distance between the slits is 2 mm and the distance between the plane of the slits and screen is 120 cm.

(A) Find the distance of the third bright fringe on the screen from the central maxima for the wavelength 6500 Å.

(B) What is the least distance from the central maxima where the bright fringes due to both the wave-lengths coincide?

Sol. (A) Distance of third bright fringe from centre of screen

$$x_3 = \frac{nD\lambda}{d} = \frac{3 \times 120 \times 10^{-2} \times 6500 \times 10^{-10}}{2 \times 10^{-3}}$$

$= 1.17 \times 10^{-3}$ m = 1.17 mm

(B) When bright fringes coincide to each other then

$$n_1\lambda_1 = n_2\lambda_2 \Rightarrow \frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{5200Å}{6500Å} = \frac{4}{5}$$

for minimum value of n_1 & n_2 $n_1 = 4$, $n_2 = 5$

So $x = \frac{n_1\lambda_1 D}{d} = \frac{4 \times 6500 \times 10^{-10} \times 120 \times 10^{-2}}{2 \times 10^{-3}}$

$= 0.156 \times 10^{-2}$ m = 0.156 cm

Ex.4 Two slits separated by a distance of 1 mm are illuminated with red light of wavelength 6.5×10^{-7} m. The interference fringes are observed on a screen placed 1m from the slits. The distance between the third dark fringe and the fifth bright fringe is equal to

(A) 0.65 mm (B) 1.625 mm

(C) 3.25 mm (D) 0.975 mm

Sol. Distance between third dark fringe and the fifth bright fringe

$$= 2.5\beta = 2.5\frac{\lambda D}{d} = 2.5\frac{6.5 \times 10^{-7} \times 1}{10^{-3}} = 1.625 \text{ mm}$$

Exercise # 1 — SINGLE OBJECTIVE — NEET LEVEL

1. By corpuscular theory of light, the phenomenon which can be explained is
(A) Refraction (B) Interference
(C) Diffraction (D) Polarisation

2. According to corpuscular theory of light, the different colours of light are due to
(A) Different electromagnetic waves
(B) Different force of attraction among the corpuscles
(C) Different size of the corpuscles
(D) None of the above

3. Huygen's conception of secondary waves
(A) Allow us to find the focal length of a thick lens
(B) Is a geometrical method to find a wavefront
(C) Is used to determine the velocity of light
(D) Is used to explain polarisation

4. The idea of the quantum nature of light has emerged in an attempt to explain
(A) Interference
(B) Diffraction
(C) Radiation spectrum of a black body
(D) Polarisation

5. Two coherent sources of light can be obtained by
(A) Two different lamps
(B) Two different lamps but of the same power
(C) Two different lamps of same power and having the same colour
(D) None of the above

6. By Huygen's wave theory of light, we cannot explain the phenomenon of
(A) Interference (B) Diffraction
(C) Photoelectric effect (D) Polarisation

7. The phenomenon of interference is shown by
(A) Longitudinal mechanical waves only
(B) Transverse mechanical waves only
(C) Electromagnetic waves only
(D) All the above types of waves

8. Two coherent monochromatic light beams of intensities I and $4I$ are superposed. The maximum and minimum possible intensities in the resulting beam are
(A) $5I$ and I (B) $5I$ and $3I$
(C) $9I$ and I (D) $9I$ and $3I$

9. Light appears to travel in straight lines since
(A) It is not absorbed by the atmosphere
(B) It is reflected by the atmosphere
(C) Its wavelength is very small
(D) Its velocity is very large

10. The idea of secondary wavelets for the propagation of a wave was first given by
(A) Newton (B) Huygen
(C) Maxwell (D) Fresnel

11. Young's experiment establishes that
(A) Light consists of waves
(B) Light consists of particles
(C) Light consists of neither particles nor waves
(D) Light consists of both particles and waves

12. In the interference pattern, energy is
(A) Created at the position of maxima
(B) Destroyed at the position of minima
(C) Conserved but is redistributed
(D) None of the above

13. Monochromatic green light of wavelength $5 \times 10^{-7}\,m$ illuminates a pair of slits 1 mm apart. The separation of bright lines on the interference pattern formed on a screen 2 m away is
(A) 0.25 mm (B) 0.1 mm
(C) 1.0 mm (D) 0.01 mm

14. In Young's double slit experiment, if the slit widths are in the ratio 1 : 9, then the ratio of the intensity at minima to that at maxima will be
(A) 1 (B) 1/9
(C) 1/4 (D) 1/3

Exercise # 2

SINGLE OBJECTIVE | AIIMS LEVEL

1. Huygen's principle is applicable to
(A) Only light waves
(B) Only sound waves
(C) Only mechanical waves
(D) For all the above waves

2. Which of the following phenomenon can not be explained by the Huygen's theory-
(A) Refraction (B) Reflection
(C) Diffraction
(D) Formation of spectrum

3. According to huygen's theory of secondary waves, following can be explained-
(A) Propagation of light in medium
(B) Reflection of light
(C) Refraction of light
(D) All of the above

4. The main drawback of huygen's theory was-
(A) Failure in explanation of rectilinear propagation of lignt
(B) Failure of explain the spectrum of white light
(C) Failure to explain the formation of newton's rings
(D) A failure of experimental verification of ether medium

5. Huygen's theory of secondary waves can be used to find-
(A) Velocity of light
(B) The wavelength of light
(C) Wave front geometrically
(D) Magnifying power of microscope

6. Two coherent sources of intensities I_1 and I_2 produce an interference pattern. The maximum intensity in the interference pattern will be :–
(A) $I_1 + I_2$ (B) $I_1^2 + I_2^2$
(C) $(I_1 + I_2)^2$ (D) $(\sqrt{I_1} + \sqrt{I_2})^2$

7. The colour are characterized by which of following character of light–
(A) Frequency (B) Amplitude
(C) Wavelength (D) Velocity

8. Light has a wave nature, because-
(A) the light travel in a straight line
(B) Light exhibts phenomenon of reflection and re fraction
(C) Light exhibits phenomenon interference
(D) Light exhibits phenomenon of photo electric ef fect

9. Two wave are represented by the equations $y_1 = a \sin \omega t$ and $y_2 = a \cos \omega t$. The first wave :–
(A) leads the second by π
(B) lags the seconds by π
(C) leads the second by $\frac{\pi}{2}$
(D) lags the seconds by $\frac{\pi}{2}$

10. The phase difference corresponding to path difference of x is :–
(A) $\frac{2\pi x}{\lambda}$ (B) $\frac{2\pi\lambda}{x}$
(C) $\frac{\pi x}{\lambda}$ (D) $\frac{\pi\lambda}{x}$

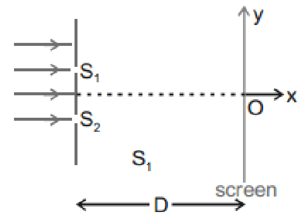
11. The resultant amplitude of a vibrating particle by the superposition of the two waves
$y_1 = a\sin\left[\omega t + \frac{\pi}{3}\right]$ and $y_2 = a \sin \omega t$ is :–
(A) a (B) $\sqrt{2}$ a
(C) 2a (D) $\sqrt{3}$ a

12. The energy in the phenomenon of interference :–
(A) is conserved, gets redistributed
(B) is equal at every point
(C) is destroyed in regions of dark fringes
(D) is created at the place of bright fringes

13. Phenomenon of interference is observed :–
(A) only for light waves
(B) only for sound waves
(C) for both sound and light waves
(D) none of above

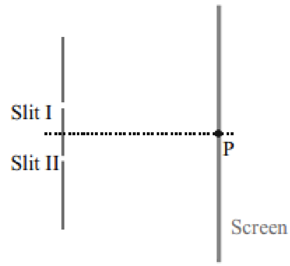
Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. A monochromatic parallel beam of light of wavelength λ is incident normally on the plane containing slits S_1 and S_2. The slits are of unequal width such that intensity only due to one slit on screen is four times that only due to the other slit. The screen is placed perpendicular to x-axis as shown. The distance between slits is d and that between screen and slit is D. Match the statements in column-I with results in column-II. ($S_1S_2 << D$ and $\lambda << S_1S_2$)



Column-I		Column-II	
(A)	The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{1}{9}$th of maximum intensity.	(P)	$\frac{D\lambda}{3d}$
(B)	The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{3}{9}$th of maximum intensity.	(Q)	$\frac{D\lambda}{d}$
(C)	The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{5}{9}$th of maximum intensity.	(R)	$\frac{2D\lambda}{d}$
(D)	The distance between two points on screen having equal intensities, such that intensity at those points is $\frac{7}{9}$th of maximum intensity.	(S)	$\frac{3D\lambda}{d}$

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



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

Exercise # 4

PART - 1

PREVIOUS YEAR (NEET/AIPMT)

1. Which of the following phenomena exhibits particle nature of light? **[CBSE AIPMT 2001]**
   (A) Interference (B) Diffraction
   (C) Polarisation (D) Photoelectric effect

2. Transmission of light in optical fibre is **[CBSE AIPMT 2001]**
   (A) scattering
   (B) diffraction
   (C) polarisation
   (D) multiple total internal reflections

3. A beam of light composed of red and green rays in incident obliquely at a point on the face of a rectangular glass slab. when coming out on the opposite parallel face, the red and green rays emerge from **[CBSE AIPMT 2001]**
   (A) two points propagating in two different non-parallel directions
   (B) two points propagating in two different parallel directions
   (C) one point propagating in two different directions
   (D) one point propagating in the same direction

4. A telescope has an objective lens of 10 cm diameter and is situated at a distance of one kilometre from two objects. The minimum distance between these two objects, which can be resolved by the telescope, when the mean wavelength of light is 5000 Å, is of the order of **[CBSE AIPMT 2004]**
   (A) 0.5 m (B) 5 m
   (C) 5 mm (D) 5 cm

5. The angular resolution of a 10 cm diameter telescope at a wavelength of 5000 Å is of the order of **[CBSE AIPMT 2005]**
   (A) 10^{6} rad (B) 10^{-2} rad
   (C) 10^{-4} rad (D) 10^{-6} rad

6. Which of the following is not due to total internal reflection? **[CBSE AIPMT 2011]**
   (A) Difference between apparent and real depth of a pond
   (B) Mirage on hot summer days
   (C) Brilliance of dimond
   (D) Working of optical fibre

7. In Young's double slit experiment, the slits are 2 mm apart and are illuminated by photons of two wavelengths λ_1 = 12000 Å and λ_2 = 10000 Å. At what minimum distance from the common central bright fringe on the screen 2 m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other? **[NEET 2013]**
   (A) 8 mm (B) 6 mm
   (C) 4 mm (D) 3 mm

8. If the focal length of objective lens is increased, then magnifying power of **[CBSE AIPMT 2014]**
   (A) microscope will increase but that of telescope decrease
   (B) microscope and telescope both will increase
   (C) microscope and telescope both will decrease
   (D) microscope will decrease but that of telescope will increase

9. In the Young's double-slit experiment, the intensity of light at a point on the screen (where the path difference is λ) is K, (λ being the wavelength of light used). The intensity at a point where the path difference is $\lambda/4$, will be **[CBSE AIPMT 2014]**
   (A) K (B) K/4
   (C) K/2 (D) zero

10. A beam of light of λ = 600 nm from a distant source falls ona single slit 1 nm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between first dark fringes on either side of the central bright fringe is **[CBSE AIPMT 2014]**
    (A) 1.2 cm (B) 1.2 mm
    (C) 2.4 cm (D) 2.4 mm

11. The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross-section, one of steel and another of brass are suspended from the same roof. It we want the lower ends of the wires to be at the same level, then the weight added to the steel and brass wires must be in the ratio of **[CBSE AIPMT 2015]**
    (A) 1 : 2 (B) 2 : 1
    (C) 4 : 1 (D) 1 : 1

MOCK TEST

STRAIGHT OBJECTIVE TYPE

1. Two light waves are given by, $E_1 = 2\sin(100\pi t - kx + 30^\circ)$ and $E_2 = 3\cos(200\pi t - k'x + 60^\circ)$
The ratio of intensity of first wave to that of second wave is :

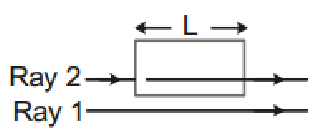
(A) $\frac{2}{3}$ (B) $\frac{4}{9}$ (C) $\frac{1}{9}$ (D) $\frac{1}{3}$

2. The wavefront of a light beam is given by the equation x + 2y + 3z = c, (where c is arbitrary constant) then the angle made by the direction of light with the y-axis is :

(A) $\cos^{-1}\frac{1}{\sqrt{14}}$ (B) $\cos^{-1}\frac{2}{\sqrt{14}}$ (C) $\sin^{-1}\frac{1}{\sqrt{14}}$ (D) $\sin^{-1}\frac{2}{\sqrt{14}}$

3. If the ratio of the intensity of two coherent sources is 4 then the visibility $[(I_{max} - I_{min})/(I_{max} + I_{min})]$ of the fringes is
(A) 4 (B) 4/5 (C) 3/5 (D) 9

4. As shown in arrangement waves with identical wavelengths and amplitudes and that are initially in phase travel through different media, Ray 1 travels through air and Ray 2 through a transparent medium for equal length L, in four different situations. In each situation the two rays reach a common point on the screen. The number of wavelengths in length L is N_2 for Ray 2 and N_1 for Ray 1. In the following table, values of N_1 and N_2 are given for all four situations, The order of the situations according to the intensity of the light at the common point in descending order is :



Situations	1	2	3	4
N_1	2.25	1.8	3	3.25
N_2	2.75	2.8	2.25	4

(A) $I_3 = I_4 > I_2 > I_1$ (B) $I_1 > I_3 = I_4 > I_2$ (C) $I_1 > I_2 > I_3 > I_4$ (D) $I_2 > I_3 = I_4 > I_1$

5. If the distance between the first maxima and fifth minima of a double slit pattern is 7mm and the slits are separated by 0.15 mm with the screen 50 cm from the slits, then wavelength of the light used is :
(A) 600 nm (B) 525 nm (C) 467 nm (D) 420 nm

6. In a YDSE: D = 1 m, d = 1 mm and λ = 5000 nm. The distance of 100th maxima from the central maxima is:

(A) $\frac{1}{2}$ m (B) $\frac{\sqrt{3}}{2}$ m (C) $\frac{1}{\sqrt{3}}$ m (D) does not exist

11^{th} Class Modules Chapter Details

Physics 5 Modules

Chemistry 5 Modules

Mathematics 5 Modules

PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal Properties of Matter **Module-5** 1. Oscillations 2. Waves	**Module-1(PC)** 1. Some Basic Conceps of Chemistry 2. Atomic Structure 3. Chemical Equilibrium 4. Ionic Equilibrium **Module-2(PC)** 1. Thermodynamics & Thermochemistry 2. Redox Reaction 3. States Of Matter (Gaseous & Liquid) **Module-3(IC)** 1. Periodic Table 2. Chemical Bonding 3. Hydrogen & Its Compounds 4. S-Block **Module-4(OC)** 1. Nomenclature of Organic Compounds 2. Isomerism 3. General Organic Chemistry **Module-5(OC)** 1. Reaction Mechanism 2. Hydrocarbon 3. Aromatic Hydrocarbon 4. Environmental Chemistry & Analysis Of Organic Compounds	**Module-1** 1. Diversity in the Living World 2. Plant Kingdom 3. Animal Kingdom **Module-2** 1. Morphology in Flowering Plants 2. Anatomy of Flowering Plants 3. Structural Organization in Animals **Module-3** 1. Cell: The Unit of Life 2. Biomolecules 3. Cell Cycle & Cell Division 4. Transport in Plants 5. Mineral Nutrition **Module-4** 1. Photosynthesis in Higher Plants 2. Respiration in Plants 3. Plant Growth and Development 4. Digestion & Absorption 5. Breathing & Exchange of Gases **Module-5** 1. Body Fluids & Its Circulation 2. Excretory Products & Their Elimination 3. Locomotion & Its Movement 4. Neural Control & Coordination 5. Chemical Coordination and Integration

12th Class Modules Chapter Details

Physics
5
Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS

Module-1
1. Electrostatics
2. Capacitance

Module-2
1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3
1. Electromagnetic Induction
2. Alternating Current

Module-4
1. Geometrical Optics
2. Wave Optics

Module-5
1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)
1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)
1. Electrochemistry
2. Surface Chemistry

Module-3(IC)
1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)
1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)
1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1
1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2
1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3
1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4
1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5
1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues