CHAPTER 11

WAVES

Life is a wave, which in no two consecutive moments of its existence is composed of the same particles.

"JOHN TYNDALL"

INTRODUCTION

Wave motion is the phenomenon that can be observed almost everywhere around us, as well it appears in almost every branch of physics. Surface waves on bodies of matter are commonly observed. Sound waves and light waves are essential to our perception of the environment. All waves have a similar mathematical description, which makes the study of one kind of wave useful for the study of other kinds of waves. In this chapter, we will concentrate on string waves, which are type of a mechanical waves. Mechanical waves require a medium to travel through. Sound waves, water waves are other examples of mechanical waves. Light waves are not mechanical waves, these are electromagnetic waves which do not require medium to propagate.

Mechanical waves originate from a disturbance in the medium (such as a stone dropping in a pond) and the disturbance propagates through the medium. The forces between the atoms in the medium are responsible for the propagation of mechanical waves. Each atom exerts a force on the atoms near it, and through this force the motion of the atom is transmitted to the others. The atoms in the medium do not, however, experience any net displacement. As the wave passes, the atoms simply move back and forth. Again for simplicity, we concentrate on the study of harmonic waves (that is those that can be represented by sine and cosine functions).

Also, $\tan\alpha = \dfrac{A_2 \sin\phi}{A_1 + A_2\cos\phi}$ (α is phase difference of the resultant wave with the first wave)

Since intensity is proportional to the square of the amplitude, therefore

$$I = I_1 + I_2 + 2\left(\sqrt{I_1 + I_2}\right)\cos\phi$$

Constructive Interference :

when $\cos\phi = +1$

i.e. when $\phi = 2n\pi$ $(n = 0, 1, 2, ...)$

i.e. when position of crests and through of one wave coincide with the positions of crests and thorough respectively of another wave then

$A = A_1 + A_2$ i.e. maximum

Also I is maximum

and $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

This is called constructive interference.

Destructive interference :

When $\cos\phi = -1$

i.e. when $\phi = (2n-1)\pi$ $(n = 1, 2, ...)$

i.e. when positive crests of one wave matches with troughs of another wave.

A is minimum and $A_{min} = |A_1 - A_2|$

and $I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

ETOOS KEY POINTS

(i) Maximum and minimum intensities in any interference wave form. $\dfrac{I_{Max}}{I_{Min}} = \left(\dfrac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2 = \left(\dfrac{A_1 + A_2}{A_1 - A_2}\right)^2$

(ii) Average intensity of interference wave form પ૭ $< I >$ or $I_{av} = \dfrac{I_{max} + I_{min}}{2} = I_1 + I_2$

if $A = A_1 = A_2$ and $I_1 = I_2 = I$ then $I_{max} = 4I$, $I_{min} = 0$ and $I_{AV} = 2I$

(iii) Degree of interference Pattern (f) : Degree of hearing (Sound Wave) or

Degree of visibility (Light Wave) $f = \dfrac{I_{max} - I_{min}}{I_{max} + I_{min}} \times 100$

In condition of perfect interference degree of interference pattern is maximum $f_{max} = 1$ or 100%

(iv) Condition of maximum contrast in interference wave form $a_1 = a_2$ and $I_1 = I_2$ then $I_{max} = 4I$ and $I_{min} = 0$

For perfect destructive interference we have a maximum contrast in interference wave form.

The resultant displacements of the particles of the string are given by the principle of superposition as

$$y = y_1 + y_2 \qquad = A\,[\sin(\omega t - kx) + \sin(\omega t + kx)] = 2A \sin \omega t \cos kx$$

or, $y = (2A \cos kx) \sin \omega t.$

we may write, $y = A_0 \sin(\omega t)$ [where $A_0 = 2A \cos kx$]

The result obtained from the above equation are :

1. As this equation satisfies the wave equation,

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}$$

it represents a wave. However, as it is not of the form $f(ax \pm bt)$, the wave is not travelling and so is called standing or stationary wave.

2. The amplitude of the wave

$$A_c = 2A \cos kx$$

is not same for all prints of the medium but varies periodically with position (and not with time as in beats).

3. The points for which amplitude is minimum are called nodes.

For nodes $\cos kx = 0$, i.e., $kx = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}$

i.e., $x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}, ...$ $\left[\text{as } k = \frac{2\pi}{\lambda}\right]$

In a stationary wave, consecutive nodes are equally spaced and their separation is $\frac{\lambda}{2}$.

4. The points for which amplitude is maximum are called antinodes

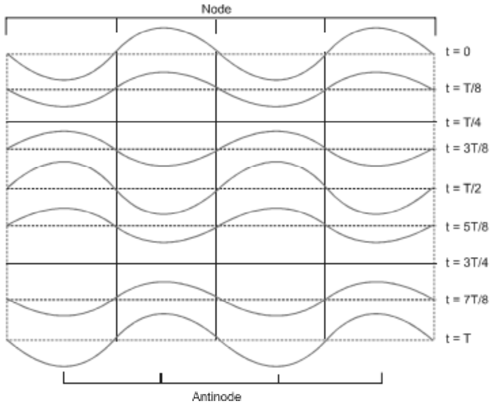
For antinodes, $\cos kx = \pm 1$, i.e., $kx = 0, \pi, 2\pi, 3\pi, ...$

i.e., $x = 0, \frac{\lambda}{2}, \frac{2\lambda}{2}, \frac{3\lambda}{2}, ...$ $\left[\text{as } k = \frac{2\pi}{\lambda}\right]$

i.e., like nodes, antinodes are also equally spaced with spacing $(\lambda/2)$ and $A_{max} = \pm 2A$.

Furthermore, nodes and antinodes are alternate with spacing $(\lambda/4)$.

5. The nodes divide the medium into segments (or loops). All the particles in a segment vibrate in same phase, but in opposite phase with the particles in the adjacent segment. Twice in one period all the particles pass through their mean position simultaneously with maximum velocity ($A\omega$), the direction of motion being reversed after each half cycle.



(a)

Etoos Tips & Formulas

A wave is a disturbance that propagates in space, transports energy and momentum from one point to another without the transport of matter.

1. Classification of Waves

- Medium Necessity
  - Mechanical (Elastic) waves
  - Non - mechanical waves (EM waves)
- Propagation of energy
  - Progressive waves
  - Stationary (standing) waves
- Vibration of medium particle
  - Transverse waves
  - Longitudinal waves
- Dimension
  - 1-D (Waves on strings)
  - 2-D (Surface waves or ripples on water)
  - 3-D (Sound or light waves)

(a) A mechanical wave will be transverse or longitudinal depending on the nature of medium and mode of excitation.

(b) In strings, mechanical waves are always transverse.

(c) In gases and liquids, mechanical waves are always longitudinal because fluids cannot sustain shear.

(d) Partially transverse waves are possible on a liquid surface because surface tension provide some rigidity on a liquid surface. The waves are called as ripples as they are combination of transverse & longitudinal.

(e) In solids mechanical waves (may be sound) can be either transverse or longitudinal depending on the mode of excitation.

(f) In longitudinal wave motion, oscillatory motion of the medium particles produce regions of compression (high pressure) and rarefaction (low pressure).

2. Plane Progressive Waves

(a) Wave equation : $y = A\sin(\omega t - kx)$ where $k = \frac{2\pi}{\lambda}$ = wave propagation constant.

(b) Differential equation : $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v_p^2}\frac{\partial^2 y}{\partial t^2}$

Wave velocity (phase velocity) $v = \frac{dx}{dt} = \frac{\omega}{k}$ $\quad \because\ \omega t - kx = \text{constant} \Rightarrow \frac{dx}{dt} = \frac{\omega}{k}$

(c) Particle Velocity $v_p = \frac{dy}{dt} = A\omega\cos(\omega t - kx)$ $\quad \because\ v_p = -v \times \text{slope} = -v\left(\frac{dy}{dx}\right)$

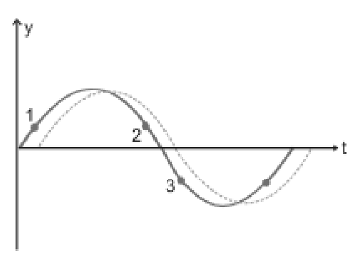
(d) Particle acceleration : $a_p = \frac{\partial^2 y}{\partial t^2} = -\omega^2 A\sin(\omega t - kx) = -\omega^2 y$

For particle 1 : $v_p \downarrow$ and $a_p \downarrow$

For particle 2 : $v_p \uparrow$ and $a_p \downarrow$

For particle 3 : $v_p \uparrow$ and $a_p \uparrow$

For particle 4 : $v_p \downarrow$ and $a_p \uparrow$

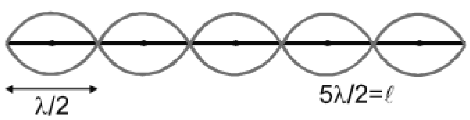


SOLVED EXAMPLE

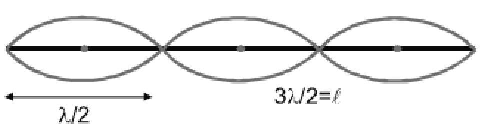
Ex.1 A sonometer wire resonates with a given tuning fork forming a standing wave with five antinodes between the two bridges when a mass of 9 kg is suspended from the wire . When this mass is replaced by a mass 'M' kg, the wire resonates with the same tuning fork forming three antinodes for the same positions of the bridges. Find the value of M.

(A) 25 **(B)** 20
(C) 15 **(D)** 10

Sol.



$$f = \frac{\sqrt{\frac{9g}{\mu}}}{\frac{2\ell}{5}}$$



$$f = \frac{\sqrt{\frac{Mg}{\mu}}}{\frac{2\ell}{3}} \Rightarrow f = \frac{\sqrt{\frac{9g}{\mu}}}{\frac{2\ell}{5}} = \frac{\sqrt{\frac{Mg}{\mu}}}{\frac{2\ell}{3}} \Rightarrow \sqrt{M} = 5$$

Ex.2 A particle of mass 50 g participates in two simple harmonic oscillations, simultaneously as given by $x_1 = 10(\text{cm}) \cos[80\pi(s^{-1})\, t]$ and $x_2 = 5(\text{cm}) \sin[(80\pi(s^{-1})\, t + \pi/6]$. The amplitude of particle's oscillations is given by 'A'. Find the value of A^2 (in cm^2).

(A) 175 **(B)** 165
(C) 275 **(D)** 375

Sol. $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$$= \sqrt{10^2 + 5^2 + 2 \times 5 \times 10 \times \frac{1}{2}} = \sqrt{175}$$

$\Rightarrow A^2 = 175$

Ex.3 A steel wire of length 1 m and mass 0.1 kg and having a uniform cross-sectional area of 10^{-6} m^2 is rigidly fixed at both ends. The temperature of the wire is lowered by 20°C. If the wire is vibrating in fundamental mode, find the frequency (in Hz).($Y_{steel} = 2 \times 10^{11}$ N/m^2, $\alpha_{steel} = 1.21 \times 10^{-5}$/°C)

(A) 11 **(B)** 20
(C) 15 **(D)** 10

Sol. $\Delta\ell = \alpha\ell\Delta\theta \Rightarrow Y = \dfrac{T/A}{\Delta\ell/\ell} \Rightarrow T = YA\dfrac{\Delta\ell}{\ell}$

$\Rightarrow T = \alpha YA\Delta\theta = 48.4\text{N}$;

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{48.4}{\left(\frac{0.1}{1}\right)}} = 22\text{m / s}$$

$\because$ for fundamental note $\ell = \dfrac{\lambda}{2} \Rightarrow \lambda = 2\text{m}$

$$\Rightarrow f = \frac{v}{\lambda} = \frac{22}{2} = 11\text{Hz}$$

Ex.4 Two tuning forks A and B lying on opposite sides of observer 'O' and of natural frequency 85 Hz move with velocity 10 m/s relative to stationary observer O. Fork A moves away from the observer while the fork B moves towards him. A wind with a speed 10 m/s is blowing in the direction of motion of fork A. Find the beat frequency measured by the observer in Hz. [Take speed of sound in air as 340 m/s]

(A) 5 **(B)** 6
(C) 7 **(D)** 8

Sol.

$$f_{\text{observer for source 'A'}} = f_0\left[\frac{v_{\text{sound}} - v_{\text{medium}}}{v_{\text{sound}} - v_{\text{medium}} + v_{\text{source}}}\right] = \frac{33}{34}f_0 \ ;$$

$$f_{\text{observer for source 'B'}} = f_0\left[\frac{v_{\text{sound}} + v_{\text{medium}}}{v_{\text{sound}} + v_{\text{medium}} - v_{\text{source}}}\right] = \frac{35}{34}f_0$$

$$\therefore \text{Beat frequency} = f_1 - f_2 = \left(\frac{35 - 33}{34}\right)f_0 = 5$$

Exercise # 1

SINGLE OBJECTIVE | NEET LEVEL

1. The speed of sound in oxygen (O_2) at a certain temperature is 460 ms^{-1}. The speed of sound in helium (He) at the same temperature will be (assume both gases to be ideal)
(A) 500 ms^{-1} (B) 650 ms^{-1}
(C) 330 ms^{-1} (D) 1420 ms^{-1}

2. A wavelength 0.60 cm is produced in air and it travels at a speed of 330 ms^{-1} . It will be an
(A) Audible wave (B) Infrasonic wave
(C) Ultrasonic wave (D) None of the above

3. The speed of sound in air is 332 m/s. The speed of sound in air in units of km per hour will be
(A) 1.1952 km/h (B) 11.952 km/h
(C) 119.52 km/h (D) 1195.2 km/h

4. The speed of sound in a gas of density ρ at a pressure P is –
(A) $\left(\frac{p}{\rho}\right)^2$ (B) $\left(\frac{p}{\rho}\right)^{3/2}$
(C) $\sqrt{\frac{\rho}{P}}$ (D) $\sqrt{\frac{P}{\rho}}$
(E) $\left(\frac{\rho}{P}\right)^2$

5. The intensity of sound increases at night due to
(A) Increase in density of air
(B) Decreases in density of air
(C) Low temperature
(D) None of these

6. Sound waves travel at 350 m/s through a warm air and at 3500 m/s through brass. The wavelength of a 700 Hz acoustic wave ass it enters brass from warm air
(A) Decreases by a factor 20
(B) Decreases by a factor 10
(C) Increases by a factor 20
(D) Increases by a factor 10

7. When a sound wave of frequency 300 Hz passes through a medium the maximum displacement of a particle of the medium is 0.1 cm. The maximum velocity of the particle is equal to
(A) 60 π cm/sec (B) 30 π cm/sec
(C) 30 cm/sec (D) 60 cm/sec

8. Speed of sound in mercury at a certain temperature is 1450 m/s. Given the density of mercury as 13.6 × 10^3 kg/m^3, the bulk modulus for mercury is
(A) 2.86×10^{10} N/m^3 (B) 3.86×10^{10} N/m^3
(C) 4.86×10^{10} N/m^3 (D) 5.86×10^{10} N/m^3

9. Consider the following
I. Waves created on the surfaces of a water pond by a vibrating sources.
II. Wave created by an oscillating electric field in air.
III. Sound waves travelling under water.
Which of these can be polarized
(A) I and II (B) II only
(C) II and III (D) I, II and III

10. If the frequency of human heart beat is 1.25 Hz, the number of heart beats in 1 minute is
(A) 80 (B) 65
(C) 90 (D) 75
(E) 120

11. A progressive wave y = Asin(kx – ωt) is reflected by a rigid wall at x = 0. Then the reflected wave can br represented by
(A) y = Asin(kx + ωt) (B) y = Acos(kx + ωt)
(C) y = –Asin(kx – ωt) (D) y = –Asin(kx + ωt)
(E) y = acos (kx – ωt)

12. Two waves represented by the following equations are travelling in the same medium $y_1 = 5\sin 2\pi(75t - 0.25x)$,
$y_2 = 10\sin 2\pi(150t - 0.50x)$
(A) 1 : 2 (B) 1 : 4
(C) 1 : 8 (D) 1 : 16

13. A sound wave $y = A_0 \sin(\omega t - kx)$ is reflected from a rigid wall with 64% of its amplitude. The equation of the reflected wave is
(A) $y = \frac{64}{100}A_0\sin(\omega t + kx)$
(B) $y = -\frac{64}{100}A_0\sin(\omega t + kx)$
(C) $y = \frac{64}{100}A_0\sin(\omega t - kx)$
(D) $y = \frac{64}{100}A_0\cos(\omega t - kx)$

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. A boat at anchor is rocked by waves whose crests are 100m apart and velocity is 25m/s. The boat bounces up once in every :–
(A) 2500 s (B) 75 s
(C) 4 s (D) 0·25 s

2. The waves produced by a motorboat sailing in water are:–
(A) Transverse
(B) Longitudinal
(C) Longitudinal and transverse
(D) Stationary

3. A wave of frequency 500 Hz travels between X and Y, a distance of 600 m in 2 sec. How many wavelength are there in distance XY:–
(A) 1000 (B) 300
(C) 180 (D) 2000

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

5. The distance between two consecutive crests in a wave train produced in string is 5 m. If two complete waves pass through any point per second, the velocity of wave is:–
(A) 2.5 m/s (B) 5 m/s
(C) 10 m/s (D) 15 m/s

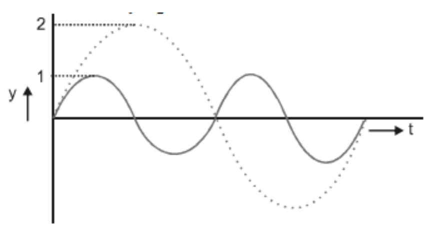
6. The displacement y of a particle executing periodic motion is given by : $y = 4\cos^2\left(\frac{1}{2}t\right)\sin(1000t)$.
This expression may be considered to be a result of the superposition of .... independent, simple harmonic motions.
(A) two (B) three
(C) four (D) five

7. The displacement of particles in a string stretched in the x–direction is represented by y. Among the following expressions for y, those describing wave motion are:–
(A) $\cos kx \sin\omega t$ (B) $k^2x^2 - \omega^2t^2$
(C) $\cos^2(kx + \omega t)$ (D) $\cos(k^2x^2 - \omega^2t^2)$

8. Two waves traveling in a medium in the x–direction are represented by $y_1 = A \sin(\alpha t - \beta x)$ and $y_2 = A\cos\left(\beta x + \alpha t - \frac{\pi}{4}\right)$, where y_1 and y_2 are the displacements of the particles of the medium, t is time, and α and β are constants. The two waves have different:–
(A) speeds
(B) directions of propagation
(C) wavelengths
(D) frequencies

9. A transverse wave is described by the equation $y = y_0 \sin 2\pi(ft - \frac{x}{\lambda})$. The maximum particle velocity is equal to four times the wave velocity if:–
(A) $\lambda = \frac{\pi y_0}{4}$ (B) $\lambda = \frac{\pi y_0}{2}$
(C) $\lambda = \pi y_0$ (D) $\lambda = 2\pi y_0$

10. Dependence of disturbances due to two waves on time is shown in the figure. The ratio of their intensities I_1 / I_2 will be:–



(A) 1 : 1 (B) 1 : 2
(C) 4 : 1 (D) 16 : 1

11. The equation of displacement of two waves are given as $y_1 = 10 \sin(3\pi t + \pi/3)$ and $y_2 = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$, then what is the ratio of their amplitude:–
(A) 1 : 2 (B) 2 : 1
(C) 1 : 1 (D) None of these

12. A plane progressive wave is represented by the equation $y = 0.25 \cos(2\pi t - 2\pi x)$. The equation of a wave is with double the amplitude and half frequency but travelling in the opposite direction will be:–
(A) $y = 0.5 \cos(\pi t - \pi x)$
(B) $y = 0.5 \cos(2\pi t + 2\pi x)$
(C) $y = 0.25 \cos(\pi t + 2\pi x)$
(D) $y = 0.5 \cos(\pi t + \pi x)$

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1.

	Column I		Column II
(A)	$y = 4\sin(5x-4t)+3\cos(4t-5x+\pi/6)$	(P)	Particles at every position are performing SHM
(B)	$y = 10\cos\left(t-\frac{x}{330}\right)\sin(100)\left(t-\frac{x}{330}\right)$	(Q)	Equation of travelling wave
(C)	$y=10\sin(2\pi x-120t)+10\cos(120t+2\pi x)$	(R)	Equation of standing wave
(D)	$y=10\sin(2\pi x-120t)+8\cos(118t-59/30\pi x)$	(S)	Equation of Beats

2. From a single source, two wave trains are sent in two different strings. Strings–2 is 4 times heavy than string–1. The two wave equations are : (area of cross–section and tension of both strings is same) $y_1 = A\sin(\omega_1 t - k_1 x)$ and $y_2 = 2A\sin(\omega_2 t - k_2 x)$. Suppose u= energy density, P=power transmitted and I=intensity of the wave.

	Column I		Column II
(A)	u_1/u_2 is equal to	(P)	1/8
(B)	P_1/P_2 is equal to	(Q)	1/16
(C)	I_1/I_2 is equal to	(R)	1/4

3.

	Column I		Column II
(A)	Interference	(P)	Intensity varies periodically with time
(B)	Beats	(Q)	Intensity varies periodically with position
(C)	Echo	(R)	Reflection of waves
		(S)	Refraction of waves

4.

	Column I		Column II
(A)	Infrasonic	(P)	Speed is greater than speed of sound
(B)	Ultrasonic	(Q)	Frequency < 20 Hz
(C)	Audible (sonic)	(R)	Frequency > 20 kHz
(D)	Supersonic	(S)	20 Hz < frequency < 20 kHz

5.

	Column I		Column II
(A)	Pitch	(P)	Number of overtones
(B)	Quality	(Q)	Intensity
(C)	Loudness	(R)	Frequency
(D)	Musical interval	(S)	Difference of the frequencies of two notes
		(T)	Ratio of the frequencies of two notes

Exercise # 4 PART - 1 PREVIOUS YEAR (NEET/AIPMT)

1. Two sources are at a finite distacne apart. They emit sounds of wavelength λ. An observer situated between them on line joining approaches one source with speed u. Then, the number of beat heart/second by observer will be [CBSE AIPMT 2000]

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

(C) $\frac{u}{2\lambda}$ (D) $\frac{\lambda}{u}$

2. A sonometer wire when vibrated in full length has frequency n. Now, it is divided by the help of bridges into a number of segments of lengths l_1, l_2, l_3, ... When vibrated these segments have frequencies n_1, n_2, n_3, ... The, the correct, relation is [CBSE AIPMT 2000]

(A) $n = n_1 + n_2 + n_3 + ...$

(B) $n_2 = n_1^2 + n_2^2 + n_3^2 + ...$

(C) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + ...$

(D) $\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}} + \frac{1}{\sqrt{n_3}} + ...$

3. Two strings A and B have lengths l_A and l_B and carry masses M_A and M_B at their lower ends, the upper ends being supported by rigid supports. If n_A and n_B are the frequencies of their vibrations and $n_A = 2\,n_B$, then [CBSE AIPMT 2000]

(A) $l_A = 4l_B$, regardless of masses

(B) $l_B = 4l_A$, regardless of masses

(C) $M_A = 2\,M_B$, $l_A = 2l_B$

(D) $M_B = 2\,M_A$, $l_B = 2\,l_A$

4. Equations of two progressive waves are given by $y_1 = a\sin(\omega t + \phi_1)$ and $y_2 = a\sin(\omega t + \phi_2)$. If amplitude and time period of resultant wave are same as that of both the waves, then $(\phi_1 - \phi_2)$ is [CBSE AIPMT 2001]

(A) $\frac{\pi}{3}$ (B) $\frac{2\pi}{3}$

(C) $\frac{\pi}{6}$ (D) $\frac{\pi}{4}$

5. A wave enters to water from air. In air frequency, wavelength, intensity and velocity are n_1, λ_1 and v_1 respectively. In water the corresponding quantities are n_2, l_2, I_2 and v_2 respectively, then [CBSE AIPMT 2001]

(A) $l_1 = l_2$ (B) $n_1 = n_2$

(C) $v_1 = v_2$ (D) $\lambda_1 = \lambda_2$

6. The equation of a wave is given by $y = a\sin\left(100t - \frac{x}{10}\right)$, where x and y are in metre and t in second, then velocity of wave is [CBSE AIPMT 2001]

(A) 0.1 m/s (B) 10 m/s

(C) 100 m/s (D) 1000 m/s

7. A wave of amplitude a = 0.2 m, velocity v = 360 m/s and wavelength 60 m is travelling along positive x-axis, then the correct expression for the wave is [CBSE AIPMT 2002]

(A) $y = 0.2\sin 2\pi\left(6t + \frac{\pi}{60}\right)$

(B) $y = 0.2\sin \pi\left(6t + \frac{x}{60}\right)$

(C) $y = 0.2\sin 2\pi\left(6t - \frac{x}{60}\right)$

(D) $y = 0.2\sin \pi\left(6t - \frac{x}{60}\right)$

8. A whistle revolves in a circle with angular velocity ω = 20 rad/s using a string of length 50 cm.If the actual frequency of sound from the whistle is 385 Hz, then the minimum frequency heard by the observer far away from the centre is (velocity of sound v = 340 m/s) [CBSE AIPMT 2002]

(A) 385 Hz (B) 374 Hz

(C) 394 Hz (D) 333 Hz

MOCK TEST

STRAIGHT OBJECTIVE TYPE

1. A travelling wave $y = A \sin (kx - \omega t + \theta)$ passes from a heavier string to a lighter string. The reflected wave has amplitude 0.5 A. The junction of the strings is at x = 0. The equation of the reflected wave is:
(A) $y' = 0.5 A \sin (kx + \omega t + \theta)$
(B) $y' = -0.5 A \sin (kx + \omega t + \theta)$
(C) $y' = -0.5 A \sin (\omega t - kx - \theta)$
(D) $y' = -0.5 A \sin (kx + \omega t - \theta)$

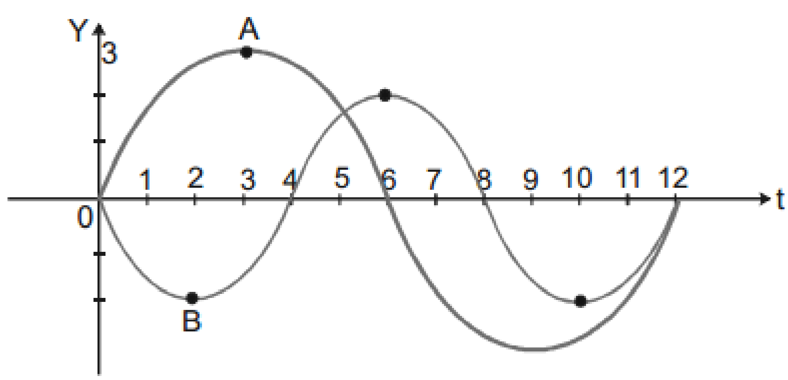
2. Which of the following travelling wave will produce standing wave, with node at x = 0, when superimposed on $y = A \sin (\omega t - kx)$
(A) $A \sin (\omega t + kx)$
(B) $A \sin (\omega t + kx + \pi)$
(C) $A \cos (\omega t + kx)$
(D) $A \cos (\omega t + kx + \pi)$

3. A wire of length 'ℓ' having tension T and radius 'r' vibrates with fundamental frequency 'f'. Another wire of the same metal with length '2ℓ' having tension 2 T and radius 2 r will vibrate with fundamental frequency:
(A) f
(B) 2 f
(C) $\frac{f}{2\sqrt{2}}$
(D) $\frac{f}{2}\sqrt{2}$

4. A string of length 1.5 m with its two ends clamped is vibrating in fundamental mode. Amplitude at the centre of the string is 4 mm. Distances between the two points having amplitude 2 mm is:
(A) 1 m
(B) 75 cm
(C) 60 cm
(D) 50 cm

5. Two particles of medium disturbed by the wave propagation are at $x_1 = 0$ and $x_2 = 1$cm. The respective displacements (in cm) of the particles can be given by the equations :
$y_1 = 2\sin 3\pi t$
$y_2 = 2\sin(3\pi t - \pi/8)$
The wave velocity is :
(A) 16 cm/sec
(B) 24 cm/sec
(C) 12 cm/sec
(D) 8 cm/sec.

6. The displacement Vs time graph for two waves A and B which travel along the same string are shown in the figure. Their intensity ratio I_A / I_B is



(A) $\frac{9}{4}$
(B) 1
(C) $\frac{81}{16}$
(D) $\frac{3}{2}$

11th Class Modules Chapter Details

Physics
5
Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS

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

CHEMISTRY

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

BIOLOGY

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	CHEMISTRY	BIOLOGY
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	**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	**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