Exercise-1

✍ Marked Questions can be used as Revision Questions.

OBJECTIVE QUESTIONS

Section (A) : Basic question

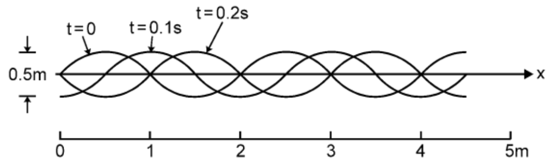
A-1.✍ The property of a medium necessary for Mechanical wave propagation is -
(1) Its inertia (2) Its elasticity
(3) Its low resistance (4) All of above

A-2. Water wave are -
(1) Transverse
(2) Longitudinal
(3) Sometimes longitudinal some time transverse
(4) Neither transverse nor longitudinal

A-3.✍ Superposition is the main characteristic of
(1) wave motion (2) particle motion
(3) wave and particle motion (4) none of the two motions

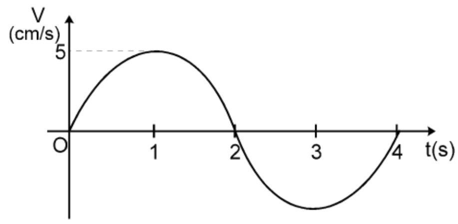
A-4. Which of the following are longitudinal waves ?
(1) sound waves (2) radio waves
(3) infrared waves (4) electromagnetic waves

A-5. Three consecutive flash photographs of a travelling wave on a string are reproduced in the figure here. The following observations are made. Mark the one which is correct. (Mass per unit length of the string = 3 g/cm.)



(1) displacement amplitude of the wave is 0.25 m, wavelength is 1 m, wave speed is 2.5 m/s and the frequency of the driving force is 0.2/s.
(2) displacement amplitude of the wave is 2.0 m, wavelength is 2 m, wave speed is 0.4 m/s and the frequency of the driving force is 0.7/s.
(3) displacement amplitude of the wave is 0.25 m, wavelength is 2 m, wave speed is 5 m/s and the frequency of the driving force is 2.5 /s.
(4) displacement amplitude of the wave is 0.5 m, wavelength is 2 m, wave speed is 2.5 m/s and the frequency of the driving force is 0.2/s.

A-6. A certain transverse sinusoidal wave of wavelength 20 cm is moving in the positive x direction. The transverse velocity of the particle at x = 0 as a function of time is shown. The amplitude of the motion is:



(1) $\frac{5}{\pi}$ cm (2) $\frac{\pi}{2}$ cm
(3) $\frac{10}{\pi}$ cm (4) 2π cm

A-7. Which of the following function correctly represents the progressive wave equation for finite values of x and t
(1) $y = x^2 - t^2$ (2) $y = \cos x^2 \sin t$
(3) $y = \log (x^2 - t^2) - \log(x - t)$ (4) $y = e^{2x} \sin t$

A-8. The equation of a wave is represented by :-

$y = 10^{-4} \sin\left(100t - \frac{x}{10}\right)$ m, where x and y are in meter and t in second; then the velocity of wave will be:-

(1) 0.01 m/s. (2) 10 m/s. (3) 100 m/s . (4) 1000 m/s.

A-9. The phase difference between two waves, represented by

$y_1 = 10^{-6} \sin \{100t + (x/50) + 0.5\}$ m

$y_2 = 10^{-6} \cos \{100t + \left(\frac{x}{50}\right)\}$ m

where x is expressed in meters and t is expressed in seconds, is approximately:-

(1) 1.07 rad (2) 2.07 rad (3) 0.5 rad (4) 1.5 rad

A-10. A wave in a string has an amplitude of 2 cm. The wave travels in the +ve direction of x axis with a speed of 128 ms^{-1} and it is noted that 5 complete waves fit in 4m length of the string. The equation describing the wave is

(1) y = (0.02)m sin (7.85 x + 100 5t) (2) y = (0.02)m sin (15.7 x – 2010t)

(3) y = (0.02)m sin (15.7 x + 2010t) (4) y = (0.02)m sin (7.85 x – 100 5t)

A-11. Equation of a progressive wave $y = a \sin\left(400\pi t - \frac{\pi x}{0.85}\right)$ then its velocity will be :

(1) 34 m/s (2) 40 m/s (3) 340 m/s (4) 400 m/s

A-12. A plane progressive wave is given by y = 25 cos (2πt – πx) Then the amplitude and frequency are respectively

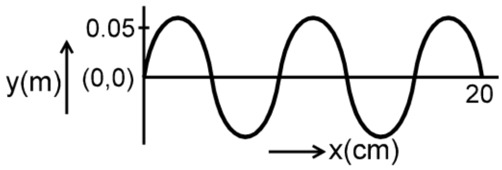
(1) 25, 100 (2) 25, 1 (3) 25, 2 (4) 50 π, 2

A-13. If the equation of motion of waves is y = 0.3 sin (314 t – 1.57x), then the velocity of wave will be :

(1) 400 m/s (2) 300 m/s (3) 200 m/s (4) 100 m/s

Section (B) : Equation of travelling wave

B-1. For the wave shown in figure, the equation for the wave, travelling along +x axis with velocity 350 ms^{-1} when its position at t = 0 is as shown



(1) $0.05 \sin\left(\frac{314}{4} x - 27475\, t\right)$

(2) $0.05 \sin\left(\frac{379}{5} x - 27475\, t\right)$

(3) $1 \sin\left(\frac{314}{4} x - 27475\, t\right)$

(4) $0.05 \sin\left(\frac{289}{5} x + 27475\, t\right)$

B-2. A transverse wave is described by the equation $Y = Y_0 \sin 2\pi (ft - x/\lambda)$. The maximum particle velocity is equal to four times the wave velocity if

(1) $\lambda = \pi Y_0/4$ (2) $\lambda = \pi Y_0/2$ (3) $\lambda = \pi Y_0$ (4) $\lambda = 2\pi Y_0$

B-3. A travelling wave on a string is given by $y = A \sin [\alpha x + \beta t + \frac{\pi}{6}]$. The displacement and velocity of oscillation of a point α = 0.56 /cm, β = 12/sec, A = 7.5 cm, x = 1 cm and t = 1s is

(1) 4.6 cm, 46.5 cm s^{-1} (2) 3.75 cm, 77.94 cm s^{-1}

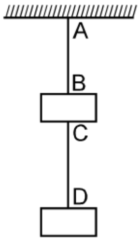
(3) 1.76 cm, 7.5 cm s^{-1} (4) 7.5 cm, 75 cm s^{-1}

B-4. A transverse wave of amplitude 0.50m, wavelength 1m and frequency 2 Hz is propagating in a string in the negative x-direction. The expression form of the wave is

(1) y(x, t) = 0.5 sin (2πx – 4πt) (2) y(x, t) = 0.5 cos (2πx + 4πt)

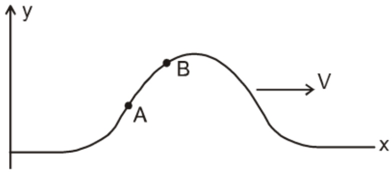
(3) y(x, t) = 0.5 sin (πx – 2πt) (4) y(x, t) = 0.5 cos (2πx – 2πt)

B-5. Two blocks each having a mass of 3.2 kg are connected by a wire CD and the system is suspended from the ceiling by another wire AB (figure). The linear mass density of the wire AB is 10 g/m and that of CD is 8 g/m. The speed of a transverse wave pulse produced in AB and in CD are :



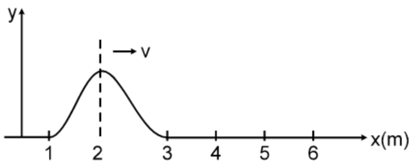
(1) 79 m/s and 63 m/s
(2) 63 m/s and 79 m/s
(3) 63 m/s in both
(4) 79 m/s in both

B-6. A wave pulse is generated in a string that lies along x-axis. At the points A and B, as shown in figure, if R_A and R_B are ratio of wave speed to the particle speed respectively then :



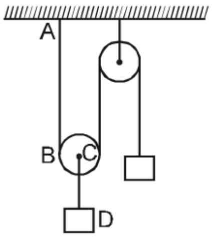
(1) $R_A > R_B$
(2) $R_B > R_A$
(3) $R_A = R_B$
(4) Information is not sufficient to decide.

B-7. Wave pulse on a string shown in figure is moving to the right without changing shape. Consider two particles at positions $x_1 = 1.5$ m and $x_2 = 2.5$ m. Their transverse velocities at the moment shown in figure are along directions :



(1) positive y–axis and positive y–axis respectively
(2) negative y–axis and positive y–axis respectively
(3) positive y–axis and negative y–axis respectively
(4) negative y–axis and negative y–axis respectively

B-8. Both the strings, show in figure, are made of same material and have same cross-section. The pulleys are light. The wave speed of a transverse wave in the string AB is v_1 and in CD it is v_2. The v_1/v_2 is



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

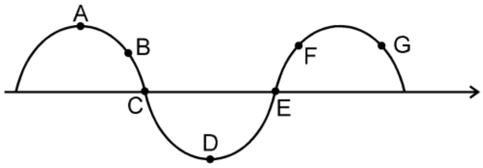
Section (C) : Interference, Reflection, Transmission, Power Transmited along the string.

C-1. When two waves of the same amplitude and frequency but having a phase difference of φ, travelling with the same speed in the same direction (positive x), interfere, then
(1) their resultant amplitude will be twice that of a single wave but the frequency will be same
(2) their resultant amplitude and frequency will both be twice that of a single wave
(3) their resultant amplitude will depend on the phase angle while the frequency will be the same
(4) the frequency and amplitude of the resultant wave will depend upon the phase angle.

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

C-3. Two waves of equal amplitude A, and equal frequency travels in the same direction in a medium. The amplitude of the resultant wave is
(1) 0
(2) A
(3) 2A
(4) between 0 and 2A

C-4. The following figure depicts a wave travelling in a medium. Which pair of particles are in phase.



(1) A and D
(2) B and F
(3) C and E
(4) B and G

C-5. The rate of transfer of energy in a wave depends
(1) directly on the square of the wave amplitude and square of the wave frequency
(2) directly on the square of the wave amplitude and square root of the wave frequency
(3) directly on the wave frequency and square of the wave amplitude
(4) directly on the wave amplitude and square of the wave frequency

C-6. A wave travels on a light string.The equation of the wave is $Y = A \sin (kx - \omega t + 30°)$.It is reflected from a heavy string tied to an end of the light string at x = 0.If 64% of the incident energy is reflected the equation of the reflected wave is
(1)$Y = 0.8 A \sin (kx - \omega t + 30° + 180°)$ (2)$Y = 0.8 A \sin (kx + \omega t + 30° + 180°)$
(3)$Y = 0.8 A \sin (kx + \omega t - 30°)$ (4)$Y = 0.8 A \sin (kx + \omega t + 30°)$

C-7. Two sinusoidal waves with same wavelengths and amplitude travel in opposite directions along a string with a speed 10 ms^{-1}. If the minimum time interval between instants when the string is flat is 0.5s, the wavelength of the waves is :
(1) 25 m (2) 20 m (3) 15 m (4) 10 m

Section (D) : Standing wave and resonance

D-1. There are some points in a stationary waves which -
(1) Are never at rest (2) Are always in motion
(3) Are at rest twice in each cycle (4) Are at rest once in each cycle

D-2. The wave produced in the wire of a sonometer are -
(1) Transverse, progressive and polarized (2) Longitudinal
(3) Transverse, stationary and polarized (4) Transverse, stationary and un polarised

D-3. The equation of a stationary wave is $Y = 10 \sin \frac{\pi x}{4} \cos 20\pi t$. The distance between two consecutive nodes in meters is -
(1) 4 (2) 2 (3) 5 (4) 8

D-4. Stationary wave is represented by
$y = A \sin (100t) \cos (0.01x)$
where y and A are in mm, t in sec, and x in m. The velocity of the component wave -
(1) 1 m/s (2) 10^2m/s (3) 10^4 m/s (4) not derivable

D-5. A stretched sonometer wire resonates at a frequency of 350 Hz and at the next higher frequency of 420 Hz. The fundamental frequency of this wire is
(1) 350 Hz (2) 5 Hz (3) 70 Hz (4) 170 Hz

D-6. Two stretched wires A and B of the same lengths vibrate independently. If the radius, density and tension of wire A are respectively twice those of wire B, then the fundamental frequency of vibration of A relative to that of B is
(1) 1 : 1 (2) 1 : 2 (3) 1 : 4 (4) 1 : 8

D-7. If the tension and diameter of a sonometer wire of fundamental frequency n is doubled and density is halved then its fundamental frequency will become -

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

Exercise-2

Marked Questions can be used as Revision Questions.

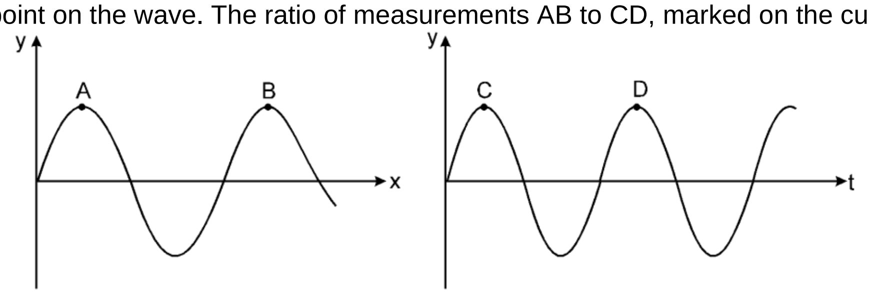
PART - I : ONLY ONE OPTION CORRECT TYPE

1. The equation $y = a \sin^2(kx - \omega t)$ represents a wave motion whose

(1) amplitude is a and frequency is $\frac{\omega}{\pi}$ (2) amplitude is 2a and frequency is $\frac{\omega}{\pi}$

(3) amplitude is $\frac{a}{2}$ and frequency is $\frac{\omega}{\pi}$ (4) amplitude is a and frequency is $\frac{2\omega}{\pi}$

2. The same progressive wave is represented by two graphs I and II. Graph I shows how the displacement 'y' varies with the distance x along the wave at a given time. Graph II shows how y varies with time t at a given point on the wave. The ratio of measurements AB to CD, marked on the curves, represents :



(I) (II)

(1) wave number k (2) wave speed V.

(3) frequency ν. (4) angular frequency ω.

3. A transverse periodic wave on a string with a linear mass density of 0.200 kg/m is described by the following equation

$$y = 0.05 \sin(420t - 21.0\,x)$$

where x and y are in metres and t is in seconds.

The tension in the string is equal to :

(1) 32 N (2) 42 N (3) 66 N (4) 80 N

4. The density of the material of a wire used in sonometer is 7.5×10^5kg/m^3. If the stress on the wire is 3.0×10^8N/m^2, the speed of transverse wave in the wire will be -

(1) 100 m/s (2) 20 m/s (3) 300 m/s (4) 400 m/s

5. The fundalmental frequency of a sitar wire is 440 vibrations per second. If the sitar player reduces the length of the wire by 1/5th, then the change in the frequency of sitater wire will be -

(1) 2200 vibrations/sec (2) 1760 vibrations/sec

(3) 440 vibrations /sec (4) 110 vibrations/sec

6. Equation of a standing wave is generally expressed as $y = 2A \sin\omega t \cos kx$. In the equation, quantity ω/k represents

(1) the transverse speed of the particles of the string.

(2) the speed of either of the component waves.

(3) the speed of the standing wave.

(4) a quantity that is independent of the properties of the string.

7. A 75 cm string fixed at both ends produces resonant frequencies 384 Hz and 288 Hz without there being any other resonant frequency between these two. Wave speed for the string is :

(1) 144 m/s (2) 216 m/s (3) 108 m/s (4) 72 m/s

8. A 110 cm long wire is to be divided into three segments by two bridges. The ratio of fundamental frequencies of three segments is 1 : 2 : 3. The positions of the bridges will be -
(1) 10 cm from one end 60cm from another end
(2) 60 cm from one end and 20cm from another end
(3) 30 cm from one end and 70 cm from another end
(4) 40 cm from one end and 50 cm from another end

9. The frequency ratio of two wires of copper is 2 : 3 if the diameter of the wire is 0.6 mm, the diameter of the other wire is
(1) 0.9 mm (2) 0.4 mm (3) 0.27 mm (4) 0.8 mm

10. A wire of linear mass density 9×10^{-3}kg/m is stretched between two rigid supports under a tension of 360 N. The wire resonates at frequency 210 Hz. The next higher frequency at which the same wire resonates is 280 Hz. The number of loops produced in first case will be -
(1) 1 (2) 2 (3) 3 (4) 4

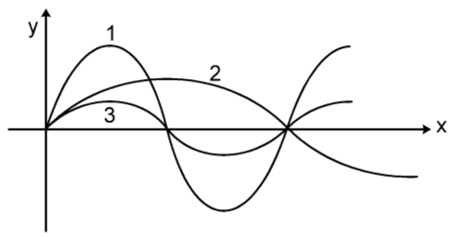
11. A sinusoidal wave with amplitude y_m is travelling with speed V on a string with linear density ρ. The angular frequency of the wave is ω. The following conclusions are drawn. Mark the one which is correct.
(1) doubling the frequency doubles the rate at which energy is carried along the string
(2) if the amplitude were doubled, the rate at which energy is carried would be halved
(3) if the amplitude were doubled, the rate at which energy is carried would be doubled
(4) the rate at which energy is carried is directly proportional to the velocity of the wave.

12. Sinusoidal waves 5.00 cm in amplitude are to be transmitted along a string having a linear mass density equal to 4.00×10^{-2} kg/m. If the source can deliver a average power of 90 W and the string is under a tension of 100 N, then the highest frequency at which the source can operate is (take $\pi^2 = 10$):
(1) 45 Hz (2) 50 Hz (3) 30 Hz (4) 62 Hz

13. One end of two wires of the same metal and of same length (with radius, r and 2r) are joined together. The wire is used as sonometer wire and the junction is placed in between two bridges. The tension T is applied to the wire. If at a junction a node is formed then the ratio of number of loops formed in the wires will be:
(1) 1 : 2 (2) 2 : 3 (3) 3 : 4 (4) 4 : 5

14. A heavy but uniform rope of length L is suspended from a ceiling. A particle is dropped from the ceiling at the instant when the bottom end is given the jerk. Where will the particle meet the pulse :
(1) at a distance $\frac{2L}{3}$ If from the bottom (2) at a distance $\frac{L}{3}$ from the bottom
(3) $\frac{3L}{4}$ at a distance from the bottom (4) None of these

15. Graph shows three waves that are separately sent along a string that is stretched under a certain tension along x–axis. If ω_1,ω_2 and ω_3 are their angular frequencies respectively then :
(1) $\omega_1 = \omega_3 > \omega_2$
(2) $\omega_1 > \omega_2 > \omega_3$
(3) $\omega_2 > \omega_1 = \omega_3$
(4) $\omega_1 = \omega_2 = \omega_3$



16. A wire of density 9 gm/cm^3 is stretched between two clamps 1.00 m apart while subjected to an extension of 0.05 cm. The lowest frequency of transverse vibrations in the wire is
(Assume Young's modulus $Y = 9 \times 10^{10}$ N/m^2)
(1) 35 Hz (2) 45 Hz (3) 75 Hz (4) 90 Hz

17. In a stationary wave represented by $y = a \sin \omega t \cos kx$, amplitude of the component progressive wave is

(1) $\frac{a}{2}$ (2) a (3) 2a (4) None of these

18. A sonometer wire is devided in many sagments using bridges. If fundamental natural frequencies of the segments are n_1, n_2, n_3.... then the fundamental natural frequency of entire sonometer wire will be (If the divisions were not made) :

(1) $n = n_1 + n_2 + n_3 + ...$ (2) $n = \sqrt{n_1 \times n_2 \times n_3 \times ....}$

(3) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + ...$ (4) none of the above

19. The equation of motion of a progres-sive wave is $y = 0.3 \sin (314\, t - 1.57\, x)$ where x and y are in metre and t is in second. The velocity of wave is

(1) 100 m/s (2) 200 m/s (3) 400 m/s (4) 5 mm/s

20. The displacement of a wave disturbance propagating in the positive x-direction is given by $y = 1/(1 + x^2)$ at time t = 0 and $y = 1/[1 + (x - 1)^2]$ at t = 2 seconds where x and y are in metres. The shape of the wave disturbance does not change during the propagation. The velocity of the wave is

(1) 2.5 m/s (2) 0.25 m/s (3) 0.5 m/s (4) 5 m/s

PART - II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion/Reasoning

Read the assertion and reason carefully to mark the correct option out of the options given below:

(1) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(2) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(3) If both assertion is true but reason is false.

(4) If the assertion is false and reason is true.

A-1. **Assertion :** In a small segment of string carrying sinusoidal wave, total energy is conserved.

Reason : Every small part moves in SHM and in SHM total energy is conserved.

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

A-2. **Assertion :** Two waves moving in a uniform string having uniform tension cannot have different velocities.

Reason : Elastic and inertial properties of string are same for all waves in same string. Moreover speed of wave in a string depends on its elastic and inertial properties only.

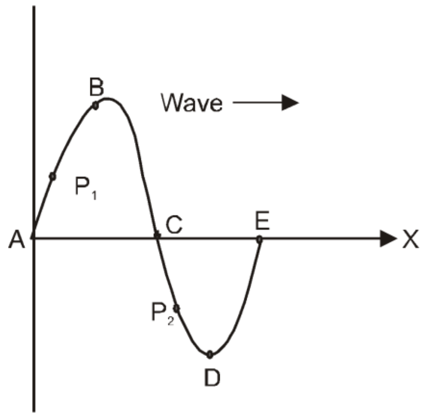
(1) A (2) B (3) C (4) D

A-3. **Assertion** : In standing wave pattern particle of medium between two consecutive nodes vibrates in same phase but with different ampliutde.

Reason : In stationary wave the amplitude of vibration does not depends on the position of the particle.

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

A-4. **Assertion** : The transveres wave is travelling along a string in the positive x axis is shown



Points (A&P_1) moving (downward) and points (C&P_2) moving (upward).

Reason : In a wave propagating in positive x direction the points with +ve slope move downward and vice versa.

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

A-5. **Assertion** : In transverse wave particle velocity is perpendicular to the direction of wave velocity.

Reason : In wave motion energy always transfered in the direction of wave propagation.

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

A-6. **Assertion** : The wave function of a pulse is given by $y = \frac{3}{(2x + 3t^2 + 4)}$ is propagates in (– ve x– direction)

Reason : The given wave function is of the form y = f (kx+ ωt) which represent a wave travelling in nagative X – direction.

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

A-7. **Assertion** : Standing waves do not transfered energy in the medium.

Reason : Every particle vibrates with its own energy and it does not share its energy with any other particle

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

A-8. **Assertion** :For stationary wave general equation is $2A\sin(Bt + \varphi)\sin(Kx + \frac{\phi}{2})$

Reason : For progressive wave general equation is $A\sin(Bt \pm kx)$

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

A-9. **Assertion** : A wave can represented by function $y = (kx \pm \omega t)$.

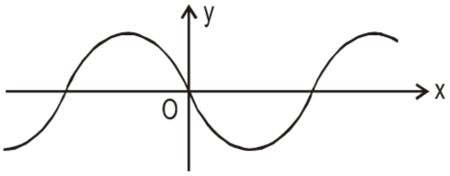
Reason : Becauese it satisfy the differential equation

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\left(\frac{\partial^2 y}{\partial t^2}\right) \text{ where } v = \frac{\omega}{k}$$

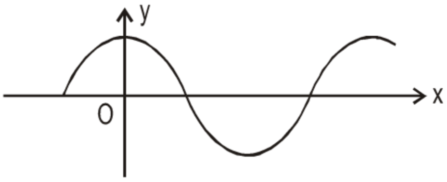
(1) A (2) B (3) C (4) D

Section (B) : Match the column

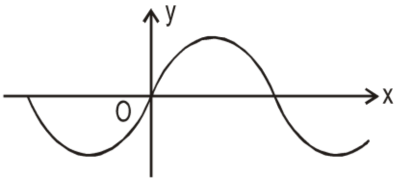
B-1. For four sine waves, moving on a string along positive x direction, displacement-distance curves (y-x curves) are shown at time t = 0. In the right column, expressions for y as function of distance x and time t for sinusoidal waves are given. All terms in the equations have general meaning. Correctly match y-x curves with corresponding equations.



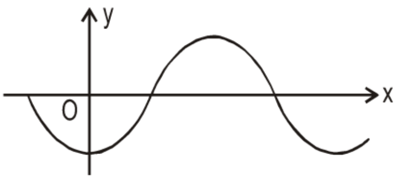
(1) (P) $y = A\cos(\omega t - kx)$



(2) (Q) $y = -A\cos(kx - \omega t)$



(3) (R) $y = A\sin(\omega t - kx)$



(4) (S) $y = A\sin(kx - \omega t)$

Section (C) : One or More Than One Options Correct

C-1. The plane wave represented by an equation of the form $y = f(x - vt)$ implies the propagation along the positive x-axis without change of shape with constant velocity v :

(1) $\frac{\partial y}{\partial t} = -v\left(\frac{\partial y}{\partial x}\right)$ (2) $\frac{\partial y}{\partial t} = -v\left(\frac{\partial^2 y}{\partial x^2}\right)$ (3) $\frac{\partial^2 y}{\partial t^2} = -v^2\left(\frac{\partial^2 y}{\partial x^2}\right)$ (4) $\frac{\partial^2 y}{\partial t^2} = v^2\left(\frac{\partial^2 y}{\partial x^2}\right)$

C-2. A wave equation which gives the displacement along the Y direction is given by

$$y = 10^{-4}\sin(60t + 2x)$$

where x and y are in meters and t is time in seconds. This represents a wave

(1) travelling with a velocity of 30 m/s in the negative x direction
(2) of wavelength π meter
(3) of frequency $30/\pi$ hertz
(4) of amplitude 10^{-4} meter travelling along the negative x direction.

C-3. The displacement of a particle in a medium due to a wave travelling in the x-direction through the medium is given by $y = A\sin(\alpha t - \beta x)$, where t = time, and α and β are constants :

(1) the frequency of the wave is α (2) the frequency of the wave is $\alpha/2\pi$
(3) the wavelength is $2\pi/\beta$ (4) the velocity of the wave is α/β

C-4. The displacement of particles in a string stretched in x-direction is represented by y . Among the following expressions for y , those describing wave motion are :

(1) $\cos(kx)\sin(\omega t)$ (2) $k^2x^2 - \omega^2t^2$
(3) $\cos^2(kx + \omega t)$ (4) $\cos(k^2x^2 - \omega^2t^2)$

C-5. The particle displacement in a wave is given by

$$y = 0.2 \times 10^{-5}\cos(500t - 0.025x)$$

where the distances are measured in meters and time in seconds. Now

(1) wave velocity is 2×10^4 ms^{-1}

(2) particle velocity is 2×10^4 ms^{-1}

(3) initial phase difference is $\frac{\pi}{2}$

(4) wavelength of the wave is (80π) m

C-6. Two particles A and B have a phase difference of π when a sine wave passes through the region
(1) A and B oscillates with same frequency
(2) A and B move in opposite directions
(3) A and B are separated by odd multiple of half of the wavelength
(4) the displacements at A and B have equal magnitudes

C-7. A wave given by $\xi = 10 \sin [80\pi t - 4\pi x]$ propagates in a wire of length 1m fixed at both ends. If another wave of similar amplitude is superimposed on this wave to produce a stationary wave then
(1) the superimposed wave is $\xi = -10 \sin [80\pi t + 4\pi x]$
(2) the maximum amplitude of the stationary wave is 20 m.
(3) the wave length of the wave is 0.5 m.
(4) the number of total nodes produced in the wire are 3.

Exercise-3

✍ Marked Questions can be used as Revision Questions.

*** Marked Questions may have more than one correct option.**

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. A wave $y = a \sin (\omega t - kx)$ on a string meets with another wave producing a node at x = O. Then the equation of the unknown wave is : **[AIEEE 2002; 3/225, –1]**

(1) $y = a \sin (\omega t + kx)$ (2) $y = -a \sin (\omega t + kx)$ (3) $y = a \sin (\omega t - kx)$ (4) $y = -a \sin (\omega t - kx)$

2. Length of a string tied to two rigid supports is 40 cm. Maximum length (wavelength in cm) of a stationary wave produced on it, is - **[AIEEE 2002; 3/225, –1]**

(1) 20 (2) 80 (3) 40 (4) 120

3. The displacement y of a wave travelling in the x-direction is given by **[AIEEE 2003; 3/225, –1]**

$$y = 10^{-4} \sin\left(600t - 2x + \frac{\pi}{3}\right) \text{ metre,}$$

where x is expressed in metres and t in seconds. The speed of the wave-motion, in ms^{-1} is :

(1) 300 (2) 600 (3) 1200 (4) 200

4. A metal wire of linear mass density of 9.8 g/m is stretched with a tension of 10 kg-wt between two rigid supports 1 metre apart. The wire passes at its middle point between the poles of a permanent magnet and it vibrates in resonance when carrying an alternating current of frequency n. The frequency n of the alternating source is : **[AIEEE 2003; 3/225, –1]**

(1) 50 Hz (2) 100 Hz (3) 200 Hz (4) 25 Hz

5. The displacement y of a particle in a medium can be expressed as : **[AIEEE 2004; 3/225, –1]**

$y = 10^{-6} \sin (100t + 20x + \frac{\pi}{4})$m, where t is in second and x in metre. The speed of the wave is:

(1) 2000 m/s (2) 5 m/s (3) 20 m/s (4) 5π m/s

6. A string is stretched between fixed points separated by 75 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. Then, the lowest resonant frequency for this string is **[AIEEE 2006; 3/165, –1]**

(1) 10.5 Hz (2) 105 Hz (3) 1.05 Hz (4) 1050 Hz

7. A wave travelling along the x- axis is described by the equation y(x,t) = 0.005 cos (αx –βt). If the wavelength and the time period of the wave are 0.08 m and 2.0 s, respectively, then α and β in appropriate units are **[AIEEE-2008; 3/105, –1]**

(1) $\alpha = \frac{0.08}{\pi}, \beta = \frac{2.0}{\pi}$ (2) $\alpha = \frac{0.04}{\pi}, \beta = \frac{1.0}{\pi}$

(3) $\alpha = 12.50\pi, \beta = \frac{\pi}{2.0}$ (4) α = 25.00 π, β = π

8. The equation of a wave on a string of linear mass density 0.04 kg m^{-1} is given by y = 0.02 (m) sin $\left[2\pi\left(\frac{t}{0.04(s)} - \frac{x}{0.50(m)}\right)\right]$. The tension in the string is : **[AIEEE-2010; 144/4 –1]**

(1) 4.0 N (2) 12.5 N (3) 0.5 N (4) 6.25 N

9. The transverse displacement y(x,t) of a wave on a string is given by

$y(x,t) = e^{-\left(ax^2 + bt^2 + 2\sqrt{ab}\ xt\right)}$

This represents a : **[AIEEE - 2011; 1 MAY; 4/120, –1]**

(1) wave moving in +x–direction with speed $\sqrt{\frac{a}{b}}$

(2) wave moving in –x-direction with speed $\sqrt{\frac{b}{a}}$

(3) standing wave of frequency $\sqrt{b}$

(4) standing wave of frequency $\frac{1}{\sqrt{b}}$

10. A travelling wave represented by y = A sin ((wt – kx) is superimposed on another wave represented by y = A sin (wt + kx). The resultant is : **[AIEEE 2011, 11 MAY; 4/120, –1]**

(1) A wave travelling along + x direction

(2) A wave travelling along – x direction

(3) A standing wave having nodes at x = $\frac{n\lambda}{2}$, n = 0, 1, 2 ....

(4) A standing wave having nodes at x = $\left(n + \frac{1}{2}\right)\frac{\lambda}{2}$; n = 0, 1, 2 .....

11. **Statement - 1 :** **[AIEEE 2011, 11 May; 4, –1]**

Two longitudinal waves given by equations: y_1 (x, t) = 2a sin (ωt – kx) and y_2 (x, t) = a sin (2ωt – 2kx) will have equal intensity.

Statement - 2:

Intensity of waves of given frequency in same medium is proportional to square of amplitude only.

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

(2) Statement-1 is true, statement-2 is true, statement-2 is the correct explanation of statment-1

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

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

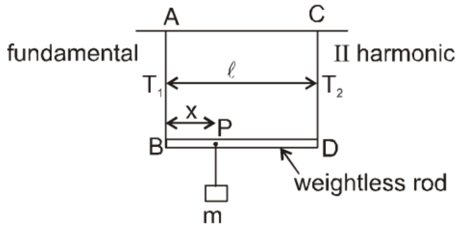
12. A sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are 7.7 × 10^3 kg/m^3 and 2.2 × 10^{11} N/m^2 respectively? **[JEE(Main)-2013; 4/120, –1]**

(1) 188.5 Hz (2) 178.2 Hz (3) 200.5 Hz (4) 770 Hz

13. A uniform string of length 20 m is suspended from a rigid support. A short wave pulse is introduced at its lowest end. It starts moving up the string. The time taken to reach the support is : (take g = 10 ms^{-2}) **[JEE(Main)-2016; 4/120, –1]**

(1) 2 s (2) $2\sqrt{2}$ s (3) $\sqrt{2}$ s (4) $2\pi\sqrt{2}$ s

14. A massless rod BD is suspended by two identical massless strings AB and CD of equal lengths. A block of mass 'm' is suspended point P such that BP is equal to 'x', if the fundamental frequency of the left wire is twice the fundamental frequency of right wire, then the value of x is : **[JEE(Main) 2006; 3/184]**



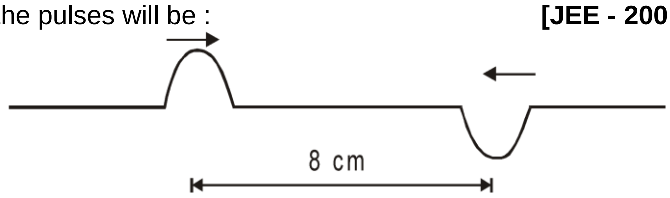
(1) l/5 (2) l/4
(3) 4l/5 (4) 3l/4

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. Two vibrating strings of the same material but lengths L & 2 L have radii 2 r and r respectively. They are stretched under the same tension. Both the strings vibrate in their fundamental modes, the one of length L with frequency f_1 and the other with frequency f_2. The ratio f_1/f_2 is given by :
[JEE - 2000 (Screening), 1/100]
(A) 2 (B) 4 (C) 8 (D) 1

2. The ends of a stretched wire of length L are fixed at x = 0 & x = L . In one experiment the displacement of the wire is $y_1 = A \sin(\pi x/L) \sin \omega t$ & energy is E_1 and in other experiment its displacement is $y_2 = A \sin(2\pi x/L) \sin 2\omega t$ and energy is E_2 . Then : **[JEE - 2001 Screening, 2/200]**
(A) $E_2 = E_1$ (B) $E_2 = 2E_1$ (C) $E_2 = 4E_1$ (D) $E_2 = 16E_1$

3. Two symetrical and identical pulses in a stretched string, whose centres are initially 8 cm apart, are moving towards each other as shown in the figure. The speed of each pulse is 2 cm/s. After 2 seconds, the total energy of the pulses will be : **[JEE - 2001 (Screening), 2/200]**



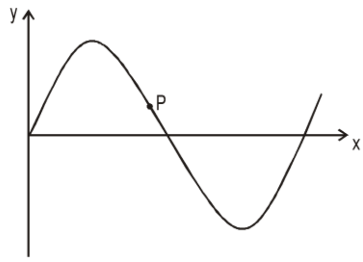
(A) zero (B) purely kinetic
(C) purely potential (D) partly kinetic and partly potential

4. A sonometer wire resonates with a given tuning fork forming standing waves 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, the wire resonates with the same tuning fork forming three antinodes for the same positions of the bridges. The value of M is **[JEE - 2002 (Screening), 3/300]**
(A) 25 kg (B) 5 kg (C) 12.5 kg (D) 1/25 kg

5. A sonometer wire resonates with a given tuning fork forming standing waves 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, the wire resonates with the same tuning fork forming three antinodes for the same positions of the bridges. The value of M is **[JEE - 2002 Screening, 3/300]**
(A) 25 kg (B) 5 kg (C) 12.5 kg (D) 1/25 kg

6. A transverse wave travelling in a string produces maximum transverse velocity of 3 m/s and maximum transverse acceleration 90 m/s^2 in a particle. If the velocity of wave in the string is 20 m/s. Determine the equation of the wave? **[JEE(Mains) 2005 ; 4/60]**

7. A transverse sinusoidal wave moves along a string in the positive x-direction at a speed of 10 cm/s. The wavelength of the wave is 0.5 m and its amplitude is 10 cm. At a particular time t, the snap-shot of the wave is shown in figure. The velocity of point P when its displacement is 5 cm is **[JEE - 2008, 3/163]**
Figure :



(A) $\frac{\sqrt{3}\pi}{50}\hat{j}$ m/s (B) $-\frac{\sqrt{3}\pi}{50}\hat{j}$ m/s

(C) $\frac{\sqrt{3}\pi}{50}\hat{i}$ m/s (D) $-\frac{\sqrt{3}\pi}{50}\hat{i}$ m/s

8. A 20cm long string, having a mass of 1.0 g, is fixed at both the ends. The tension in the string is 0.5 N. The string is set into vibrations using an external vibrator of frequency 100 Hz. Find the separation (**in cm**) between the successive nodes on the string. **[JEE - 2009, 4/160, –1]**

9. When two progressive waves $y_1 = 4 \sin (2x - 6t)$ and $y_2 = 3 \sin\left(2x - 6t - \frac{\pi}{2}\right)$ are superimposed, the amplitude of the resultant wave is : **[JEE - 2010, 3/163, –1]**

10.* A horizontal stretched string, fixed at two ends, is vibrating in its fifth harmonic according to the equation, $y(x, t) = (0.01\text{ m}) \sin [(62.8\text{ m}^{-1}) x] \cos [(628\text{ s}^{-1})t]$. Assuming $\pi = 3.14$, the correct statement(s) is (are) : **[JEE-Advanced 2013, 3/60]**

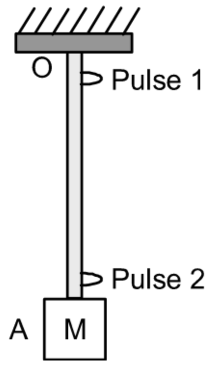
(A) The number of nodes is 5.
(B) The length of the string is 0.25 m.
(C) The maximum displacement of the midpoint of the string its equilibrium position is 0.01 m.
(D) The fundamental frequency is 100 Hz.

11.* One end of a taut string of length 3m along the x-axis is fixed at x = 0. The speed of the waves in the string is 100m/s. The other end of the string is vibrating in the y-direction so that stationary waves are set up in the string. The possible waveform(s) of these stationary waves is (are) **[JEE (Advanced)-2014,P-1, 3/60]**

(A) $y(t) = A \sin \frac{\pi x}{6} \cos \frac{50\pi t}{3}$ (B) $y(t) = A \sin \frac{\pi x}{3} \cos \frac{100\pi t}{3}$

(C) $y(t) = A \sin \frac{5\pi x}{6} \cos \frac{250\pi t}{3}$ (D) $y(t) = A \sin \frac{5\pi x}{2} \cos 250\pi t$

12*. A block M hangs vertically at the bottom end of a uniform rope of constant mass per unit length. The top end of the rope is attached to a fixed rigid support at O. A transverse wave pulse (Pulse 1) of wavelength λ_0 is produced at point O on the rope. The pulse takes time T_{OA} to reach point A. If the wave pulse of wavelength λ_0 is produced at point A (Pulse 2) without disturbing the position of M it takes time T_{AO} to reach point O. Which of the following options is/are correct. **[JEE (Advanced)-2017,P-1, 4/61, -2]**



(A) The velocities of the two pulses (Pulse 1 and Pulse 2) are the same at the midpoint of rope
(B) The velocity of any pulse along the rope is independent of its frequency and wavelength
(C) The wavelength of Pulse 1 becomes longer when it reaches point A
(D) The time TAO = TOA

Answers

EXERCISE # 1

PART - I

Section (A)

A-1.	(4)	**A-2.**	(3)	**A-3.**	(1)
A-4.	(1)	**A-5.**	(3)	**A-6.**	(3)
A-7.	(3)	**A-8.**	(4)	**A-9.**	(1)
A-10.	(4)	**A-11.**	(3)	**A-12.**	(2)
A-13.	(3)				

Section (B)

B-1.	(1)	**B-2.**	(2)	**B-3.**	(2)
B-4.	(2)	**B-5.**	(1)	**B-6.**	(2)
B-7.	(2)	**B-8.**	(4)		

Section (C)

C-1.	(3)	**C-2.**	(3)	**C-3.**	(4)
C-4.	(4)	**C-5.**	(1)	**C-6.**	(3)
C-7.	(4)				

Section (D)

D-1.	(3)	**D-2.**	(3)	**D-3.**	(1)
D-4.	(3)	**D-5.**	(3)	**D-6.**	(2)
D-7.	(3)				

EXERCISE # 2

PART - I

1.	(3)	**2.**	(2)	**3.**	(4)
4.	(2)	**5.**	(4)	**6.**	(2)
7.	(1)	**8.**	(2)	**9.**	(2)
10.	(3)	**11.**	(4)	**12.**	(3)
13.	(1)	**14.**	(2)	**15.**	(1)
16	(1)	**17.**	(1)	**18.**	(3)
19.	(2)	**20.**	(3)		

PART - II

Section (A)

A-1.	(4)	**A-2.**	(4)	**A-3.**	(3)
A-4.	(1)	**A-5.**	(2)	**A-6.**	(4)
A-7.	(3)	**A-8.**	(2)	**A-9.**	(1)

Section (B)

B-1. $(1 \rightarrow R); (2 \rightarrow P); (3 \rightarrow S); (4 \rightarrow Q)$

Section (C)

C-1.	(1,4)	**C-2.**	(1,2,3,4,)	**C-3.**	(2,3,4)
C-4.	(1,3)	**C-5.**	(1,4)	**C-6.**	(1,2,3,4)
C-7.	(1,2,3)				

EXERCISE # 3

PART - I

1.	(2)	**2.**	(2)	**3.**	(1)
4.	(2)	**5.**	(2)	**6.**	(2)
7.	(4)	**8.**	(4)	**9.**	(2)
10.	(4)	**11.**	(1)	**12.**	(2)
13.	(2)	**14.**	(1)		

PART - II

1.	(D)	**2.**	(C)	**3.**	(B)
4.	(A)	**5.**	(A)	**7.**	(1)
8.	(5)	**9.**	(5)	**10.**	(B,C)
11.	(A,C,D)	**12.**	(B,C)		