Q.1 The speed of a wave in a string is 20 m/s and frequency is 50 Hz. The phase difference between two points on the string 10 cm apart will be -

(A) $\pi/2$ (B) π (C) $3\pi/2$ (D) 2π

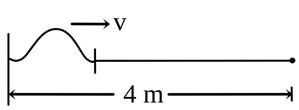
Sol.[A] $\Delta\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{v}.\ n.\ \Delta x$

$= \frac{2\pi}{20} \times 50 \times \frac{10}{100} = \frac{\pi}{2}$

Q.2 A wire is 4 m long and has a mass 0.2 kg. The wire is kept horizontally. A transverse pulse is generated by plucking one end of the taut (tight) wire. The pulse makes four trips back and forth along the cord in 0.8 sec. The tension is the cord will be -

(A) 80 N (B) 160 N (C) 240 N (D) 320 N

Sol.[A] 4 trips means 32 m



$t = \frac{d}{v} \quad \Rightarrow v = \frac{d}{t} = \frac{32}{0.8} = 40$ m/s

$v = \sqrt{\frac{T}{\mu}}$

$\Rightarrow T = \mu v^2$

$T = \frac{0.2}{4} \times (40)^2 = \frac{2\times16\times10}{4}$

T = 80 N

Q.3 A taut string for which $\mu = 5 \times 10^{-2}$ kg/m is under tension of 80 N. How much is the average rate of transport of potential energy if the frequency is 60Hz and amplitude is 6 cm (Given $4\pi^2 = 39.5$)

(A) 52W (B) 256 W

(C) 512 W (D) 215 W

Sol. [B] Average power $\cong P_{av} = \frac{1}{2}\mu v\omega^2 A^2$

Average rate of transport potential energy

$= \left(\frac{dU}{dt}\right) = \frac{P_{av}}{2} = \frac{1}{4}\mu v\omega^2 A^2$

= 256 W

Q.4 In case of standing waves -

(A) At nodes particles displacement is time dependent

(B) At antinodes displacement of particle may or may not be zero

(C) Wave does not travel but energy is transmitted

(D) Components waves traveling in same direction having same amplitude and same frequency are superimposed **[B]**

Q.5 A 1 cm log string vibrates with fundamental frequency of 256 Hz. If the length is reduced to $\frac{1}{4}$ cm keeping the tension unaltered, the new fundamental frequency will be :

(A) 64 Hz (B) 256 Hz

(C) 512 Hz (D) 1024 Hz **[D]**

Q.6 A stretched string of length ℓ, fixed at both ends can sustain stationary waves of wavelength λ, given by :

(A) $\lambda = \frac{n^2}{2\ell}$ (B) $\lambda = \frac{\ell^2}{2n}$

(C) $\lambda = \frac{2\ell}{n}$ (D) $\lambda = 2\ \ell\ n$ **[C]**

Q.7 If the tension of sonometer's wire increases four times then the fundamental frequency of the wire will increase by :

(A) 2 times (B) 4 times

(C) 1/2 times (D) None of these **[A]**

Q.8 A string of 7 m length has a mass of 0.035 kg. If tension in the string is 60.5 N, then speed of a wave on the string is :

(A) 77 m/s (B) 102 m/s

(C) 110 m/s (D) 165 m/s **[C]**

Q.9 The fundamental frequency of a sonometre wire is n. If its radius is doubled and its tension becomes half, the material of the wire remains same, the new fundamental frequency will be :

(A) n (B) $\frac{n}{\sqrt{2}}$ (C) $\frac{n}{2}$ (D) $\frac{n}{2\sqrt{2}}$ **[D]**

Q.10 The fundamental frequency of a string stretched with a weight of 4 kg is 256 Hz. The weight required to produce its octave is :

(A) 4 kg wt (B) 8 kg wt
(C) 12 kg wt (D) 16 kg wt **[D]**

Q.11 The frequency of transverse vibrations in a stretched string is 200 Hz. If the tension is increased four times and the length is reduced to non-fourth the original value, the frequency of vibration will be :

(A) 25 Hz (B) 200 Hz
(C) 400 Hz (D) 1600 Hz **[D]**

Q.12 To increase the frequency from 100 Hz to 400 Hz the tension in the string has to be changed by :

(A) 4 times (B) 16 times
(C) 20 times (D) None of these **[B]**

Q.13 The tension of a stretched string is increased by 69 %. In order to keep its frequency of vibration constant, its length must be increased by :

(A) 20 % (B) 30 % (C) $\sqrt{69}$ % (D) 69 %

Sol. **[B]**

Q.14 A string vibrates according to the equation $y = 5\sin\left(\frac{2\pi x}{3}\right)\cos 20\pi t$, where x and y are in cm and t in sec. The distance between two adjacent nodes is

(A) 3 cm (B) 4.5 cm
(C) 6 cm (D) 1.5 cm **[D]**

Q.15 For the stationary wave $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$, the distance between a node and the next antinode is :

(A) 7.5 (B) 15 (C) 22.5 (D) 30 **[A]**

Q.16 The frequency of a stretched uniform wire under tension is in resonance with the fundamental frequency of a closed tube. If the tension in the wire is increased by 8 N, it is in resonance with the first overtone of the closed tube. The initial tension in the wire is :

(A) 1 N (B) 4 N
(C) 8 N (D) 16 N **[A]**

Q.17 The displacement of a particle in string stretched in X direction is represented by y. Among the following expressions for y, those describing wave motions are :

(A) $\cos kx \sin \omega t$ (B) $k^2x^2 - \omega^2t^2$
(C) $\cos(kx - \omega t)$ (D) $\cos(k^2x^2 - \omega^2t^2)$

[A]

Q.18 Wave in string is represented by :
$y(x, t) = 2\sin^2(k_1x - \omega_1 t)\cos^2(k_2x - \omega_2 t)$.
Numbers of component waves are -

(A) two (B) three
(C) four (D) six **[C]**

Sol. $y(x, t) = 2\sin^2(k_1x - \omega_1 t)\cos^2(k_2x - \omega_2 t)$

$= \frac{1}{2}\{(1 - \cos(2k_1x - 2\omega_1 t)\}\{1 + \cos(2k_2x - 2\omega_2 t)\}$

$= \frac{1}{2}[1 - \cos(2k_1x - 2\omega_1 t) - \cos(2k_2x - 2\omega_2 t)$

$+ \frac{1}{2}\{\cos(2k_1x + 2k_2x - 2\omega_1 t - 2\omega_2 t)\}$

$+ \frac{1}{2}\{\cos(2k_1x - 2k_2x - 2\omega_1 t + 2\omega_2 t)]$

$= \frac{1}{4}[1 - 2\cos(2k_1x - 2\omega_1 t) - 2\cos(2k_2x - 2\omega_2 t) +$

$\cos\{2(k_1 + k_2)x - 2(\omega_1 + \omega_2)t\}$

$+ \cos\{2(k_1 - k_2)x - 2(\omega_1 - \omega_2)t\}]$

Q.19 A string is stretched along x-axis. Shape of string transfering wave at t = t_1 sec is given by $y = e^{-2x}$. If wave velocity is 'v_0' in negative x-direction, then equation of waves is -

(A) $e^{-2(x - vt)}$ (B) $e^{-2x - v(t - t_0)}$
(C) $e^{-2\{x - v(t - t_0)\}}$ (D) $e^{-2\{x + v(t - t_0)\}}$

[D]

Sol. If shape of string at t = t_0 is given by y = f(x), the equation of wave traveling in negative x-direction will be $y(x, t) = f\{x + v(t - t_0)\}$.

Q.20 The amplitude of wave disturbance propagating in the positive x-axis is given by y = $\frac{1}{x^2 - 2x + 1}$ at t = 2 sec and y = $\frac{1}{x^2 + 2x + 5}$ at t = 6 sec, where x and y are in meters. Velocity of the pulse is -

(A) 1 m/s in positive x-direction

(B) + 2 m/s in negative x-direction

(C) 0.5 m/s in negative x-direction

(D) 1 m/s in negative x-direction **[C]**

Sol. At t = 2 sec,

$$y = \frac{1}{x^2 - 2x + 1}$$

At t = 6 sec,

$$y = \frac{1}{x^2 + 2x + 5}$$

$$\Rightarrow y = \frac{1}{(x+2)^2 - 2x + 1}$$

$\therefore$ Wave velocity = $\frac{2}{4}$ = $\frac{1}{2}$ m/s in negative x-direction.

Q.21 In meldey experiment, 16 kg mass is hanged with wire and tuning fork is vibrated with its prong parallel to wire. Wire vibrates with 2 loops. When an unknown mass is hanged with wire and tuning fork is vibrated with its prong perpendicular to wire, wire vibrates in 8 loops. Unknown mass is -

(A) 1 kg (B) 2 kg

(C) 6 kg (D) 4 kg **[D]**

Sol. $\nu = \frac{n\sqrt{F/\mu}}{2\ell}$

As ℓ & μ are not changing

$\nu \propto n\sqrt{F}$

$$\frac{\nu_2}{\nu_1} = \frac{n_2\sqrt{F_2}}{n_1\sqrt{F_1}}$$

$$\Rightarrow \frac{\nu_2}{\nu_1} = \frac{n_2}{n_1}\sqrt{\frac{m_2}{m_1}}$$

$$\therefore m_2 = \left(\frac{\nu_2}{\nu_1} \times \frac{n_1}{n_2}\right)^2 . m_1$$

$\Rightarrow m_2 = 4$ kg

Q.22 Two strings of copper are stretched to the same tension. If their cross-section area are in the ratio 1 : 4, then the respective wave velocities will be -

(A) 4 : 1 (B) 2 : 1

(C) 1 : 2 (D) 1 : 4 **[B]**

Sol. $v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{\rho A}}$

where, ρ = density

A = Area of cross-section

$\mu = \rho A$ = mass of unit length

Q.23 The equation of stationary wave is $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$. The distance between a node and its next antinode is -

(A) 7.5 units (B) 1.5 units

(C) 22.5 units (D) 30 units **[A]**

Sol. $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$ ....(1)

$y = 2a \sin kx \cos \omega t$ ....(2)

from comparison 1 & 2

$k = \frac{\pi}{15} = \frac{2\pi}{\lambda}$

$\lambda = 30$

Distance b/w nearest node and Antinode = $\lambda/4$

$= \frac{30}{4} = 7.5$ unit

Q.24 The equation of a wave disturbance is given as y = 0.02 sin $\left(\frac{\pi}{2} + 50\pi t\right)$ cos (10 πx), where **x** and **y** are in metres and **t** is in seconds. Choose the correct statement(s) –

(A) The wavelength of wave is 0.2 m

(B) Displacement node occurs at x = 0.15 m

(C) Displacement antinode occurs at x = 0.3 m

(D) All of the above **[D]**

Sol. From the given expression for y :

amplitude A = 0.02 m

angular frequency $\omega = 50\pi$ rad/s and wave number k = 10 π m^{-1}

Now wave speed $v = \frac{\omega}{k} = \frac{50\pi}{10\pi} = 5$ m/s

Therefore, option (D) is wrong.

Displacement node occurs at

$10\pi x = \frac{\pi}{2}, \frac{3\pi}{2}$ etc.

or $x = \frac{1}{20}, \frac{3}{20}$

or x = 0.05 m and 0.15 m

Displacement antinode occurs at

$10\pi x = 0, \pi, 2\pi, 3\pi$ etc.

or x = 0, 0.1 m, 0.2 m and 0.3 m

Wavelength λ = 2 (distance between two consecutive nodes or antinodes)

= 2(0.1) = 0.2 m

Q.25 In a stationary wave system, all the particles of the medium –

(A) have zero displacement simultaneously at some instant

(B) have maximum displacement simultaneously at some instant

(C) are at rest simultaneously at some instant

(D) All of the above **[D]**

Q.26 For a sine wave passing through a medium, let **y** be the displacement of a particle, **v** be its velocity and **a** be its acceleration –

(A) y and a are always in opposite phase

(B) Phase difference between y and v is $\pi/2$

(C) Phase difference between v and a is $\pi/2$

(D) All of the above **[D]**

Q.27 A wire under tension vibrates with a frequency of 450 per second. What would be the fundamental frequency if the wire were half as long, twice as thick and under one-fourth tension ?

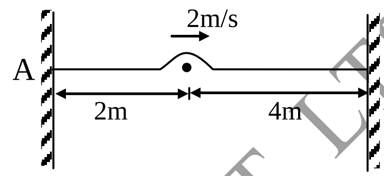
(A) 225 Hz (B) 190 Hz

(C) 247 Hz (D) 174 Hz **[A]**

Sol. $n = \frac{1}{2\ell}\sqrt{\frac{T}{\pi r^2 \rho}} = 450$

$$n' = \frac{1}{2\left(\frac{\ell}{2}\right)}\sqrt{\frac{T/4}{\pi 4 r^2 \rho}} = \frac{n}{2} = \frac{450}{2} = 225 \text{ Hz}$$

Q.28 A string is tied at two rigid support. A pulse is generated on the string as shown in figure. Minimum time after which string will regain its shape : (Neglect the time during reflection)



(A) 2 sec (B) 4 sec

(C) 6 sec (D) None of these **[C]**

Sol. At 'B' shape of pulse gets inverted. The pulse will become erect after reflection at 'A'.

Q.29 Equation of wave traveling on string is given by $y = A \sin (kx - \omega t)$. It is reflected at $x = \pi/k$. Equation of reflected wave will be –

(A) $A \sin(kx + \omega t + \pi)$

(B) $A \sin (kx + \omega t - 2\pi)$

(C) $A \sin(-kx - \omega t + \pi)$

(D) $A \sin (kx + \omega t + 2\pi)$ **[B]**

Sol. Let equation of reflected wave be

$y = A \sin(-kx - \omega t + \phi)$

Phase difference between incident wave and reflected wave must be 'π' at $x = \pi/k$.

$\Rightarrow -2k\left(\frac{\pi}{k}\right) + \phi = \pi$

$\Rightarrow \phi = 3\pi$

$\therefore$ Equation of reflected wave

$= A \sin (kx + \omega t - 2\pi)$

Q.30 A mechanical wave moving in a gas -

(A) must be longitudinal

(B) may be longitudinal

(C) must be transverse

(D) may be transverse **[A]**

Q.31 Which of the following waves can not travel through vacuum ?

(A) Light waves (B) X-rays

(C) Heat waves (D) Sound waves **[D]**

Q.32 A mechanical wave propagates in a medium along the X axis. The particles of the medium-

(A) must move on the X axis

(B) must move on the Y axis

(C) may move on the X axis

(D) may move on the Y axis **[D]**

Q.33 The property of medium necessary for wave propagation is its -
(A) Inertia (B) Elasticity
(C) Low resistance (D) All of above **[D]**

Q.34 Elastic waves in solid are-
(A) Transverse
(B) Longitudinal
(C) Either transverse or Longitudinal
(D) Neither transverse nor longitudinal **[C]**

Q.35 The displacement of a particle of a string carrying a travelling wave is given by
y = (3 cm) sin 6.28 (0.50 x – 50 t)
where x is in centimeter and t is in second. The velocity of the wave is-
(A) 100 m/s (B) 50 cm/s
(C) 100 cm/s (D) 10 m/s **[C]**

Q.36 A transverse wave is described by equation $y = a \sin\ 2\pi\left(\nu t - \frac{x}{\lambda}\right)$
The maximum velocity of the particle will be four times the velocity of the wave provided-
(A) $\lambda = \pi a$ (B) $\lambda = \pi \frac{a}{2}$
(C) $\lambda = 2\pi a$ (D) $\lambda = \pi \frac{a}{4}$ **[B]**

Q.37 The equation of a wave travelling in the (+) x-direction -
(A) $y = a \sin 2\pi \left(\frac{vt}{\lambda} - x\right)$
(B) $y = a \sin \frac{2\pi}{\lambda} (vt + x)$
(C) $y = a \sin \frac{2\pi}{\lambda} (vt - x)$
(D) All of the above **[C]**

Q.38 The equation of a progressive wave is
$y = 0.4 \sin \left(120\pi t - \frac{4\pi}{5} x\right)$
Where distance is in meters and time is in seconds. Calculate frequency and wavelength.
(A) 60 Hz, 2.5 m (B) 30 Hz, 3 m
(C) 90 Hz, 2.5 m (D) 60 Hz, 5 m **[A]**

Q.39 The relation between frequency ν, wavelength λ and velocity of propagation v of a wave is-
(A) $\nu\lambda = \upsilon$ (B) $\frac{\lambda\upsilon}{v} = 1$
(C) $\frac{\nu\upsilon}{\lambda} = 1$ (D) $\frac{\upsilon}{v} + \frac{\lambda}{v} = 1$ **[B]**

Q.40 The velocity of a wave is 330 m/s and its frequency is 330 Hz. Then its wavelength is-
(A) 100 cm. (B) 10 cm.
(C) 1 cm. (D) 330 cm. **[A]**

Q.41 If the frequency of wave is 100 Hz than the particles of the medium cross the mean position in one second-
(A) 100 times (B) 200 times
(C) 400 times (D) 50 times **[B]**

Q.42 A string is stretched by a force of 40 Newton. The mass of 10m length of this string is 0.01 kg. The speed of transverse waves in this string will be -
(A) 400 m/s (B) 40 m/s
(C) 200 m/s (D) 80 m/s **[C]**

Q.43 Two strings A and B, made of same material are stretched by same tension. The radius of string A is double of the radius of B. A transverse wave travels on A with speed v_A and on B with speed v_B. The ratio $\frac{v_A}{v_B}$ is –
(A) $\frac{1}{2}$ (B) 2
(C) $\frac{1}{4}$ (D) 4 **[A]**

Q.44 A string of length 2x is streched by 0.1x and the velocity of transverse wave along it is v. When it is streched by 0.4x, the velocity of the wave is-
(A) $\sqrt{\frac{5}{6}}.v$ (B) $\sqrt{\frac{11}{7}}.v$

(C) $\sqrt{\frac{32}{7}}.v$ (D) $\sqrt{\frac{27}{6}}.v$ **[C]**

Q.45 A long string having a cross-sectional area $0.80\ mm^2$ and density $12.5\ g/cm^3$ is subjected to a tension of 64 N along the X-axis. One end of the string is attached to a vibrator moving in transverse direction. At t = 0, the source is at maximum displacement y = 1 cm. Find the speed of wave travelling on the string.

(A) 40 m/s (B) 80 m/s
(C) 20 m/s (D) 100 m/s **[B]**

Q.46 A transverse wave described by
$y = (0.02m) \sin [(1.0\ m^{-1})\ x + (30s^{-1})\ t]$
propagates on a stretched string having a linear mass density of 1.2×10^{-4} kg/m. Find the tension in the string.

(A) 0.108 N (B) 1 N
(C) .02 N (D) 2 N **[A]**

Q.47 Two waves are represented by
$y_1 = a_1 \cos (\omega t - kx)$ and
$y_2 = a_2 \sin(\omega t - kx + \pi/3)$
Then the phase difference between them is-

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{2}$
(C) $\frac{5\pi}{6}$ (D) $\frac{\pi}{6}$ **[D]**

Q.48 Standing waves are produced by superposition of two waves
$y_1 = 0.05 \sin (3\pi t - 2x)$ and
$y_2 = 0.05 \sin (3\pi t + 2x)$
Where x and y are measured in meter and t in second. Find the amplitude of particle at x = 0.5m
[cos 57.3 = 0.54]

(A) 0.54 m (B) 5.4 m
(C) 54 m (D) 0.054 m **[D]**

Q.49 The principle on which a stethoscope works is-

(A) Reflection (B) Interference
(C) Refraction (D) Diffraction **[A]**

Q.50 A standing wave is produced on a string clamped at one end and free at the other. The length of the string -

(A) Must be an integral multiple of $\frac{\lambda}{4}$
(B) Must be an integral multiple of $\frac{\lambda}{2}$
(C) Must be an integral multiple of λ
(D) May be an integral multiple of $\frac{\lambda}{2}$ **[A]**

Q.1 A 50 cm string fixed at both ends produces resonant frequency 384 Hz and 288 Hz with out there being any other resonant frequency between two. Wave speed for the string is ......cm/sec.

Sol. **9600 cm/sec.**

$f_n - f_{n-1} = \frac{v}{2\ell} = 384 \times 288$

$\frac{v}{2 \times 0.5} = 96$

v = 96 m/sec

[v = 9600 cm/sec]

Q.2 The waves is a string (all in SI units) are $y_1 = 0.6 \sin(10t - 20x)$ and $y_2 = 0.4 \sin(10t + 20x)$, mass per unit length of string is 10^{-2} kg/m.
Net energy transfer per unit time through any section of the string is –

Sol. **[0.0500 J/s]**

$\rho s = \mu$ = mass per unit length = 10^{-2} kg

$v = \frac{\omega}{k} = \frac{10}{20} = 0.5$ m/s

$P_1 = \frac{1}{2} \times 10^{-2} \times (10)^2 \times (0.6)^2\,(0.5) = 0.09$ J/s

Q.3 A string of length ℓ is fixed at both ends and is vibrating in second harmonic. The amplitude at antinodes is 2mm and the amplitude of a particle at a distance $\frac{\ell}{8}$ from fixed end is $\frac{a}{\sqrt{2}}$ mm then the value of a is…………mm.

Sol. **[0002]**

y = 2a sin kx cos ωt

$\therefore$ A = 2a sin kx

as from second harmonic

$\lambda = \ell$

$\therefore k = \frac{2\pi}{\lambda} = \frac{2\pi}{\ell}$

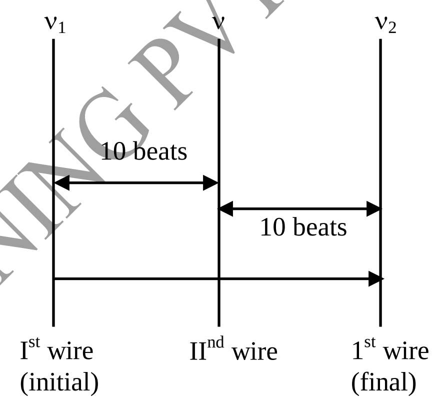
$\therefore A = 2a \sin kx = 2\sin\left(\frac{2\pi}{\lambda} \times \frac{\ell}{8}\right)$

$= 2\sin\frac{\pi}{4} = \frac{2}{\sqrt{2}}$ mm

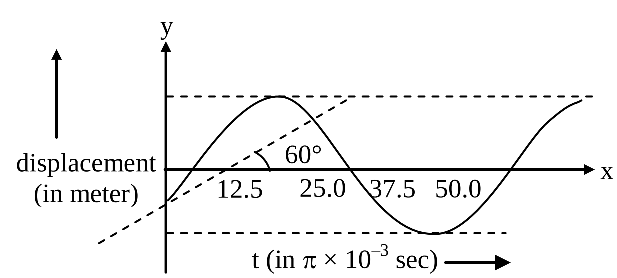
Q.4 Two wires are vibrating together to produce 10 beats/sec. Frequency of one wire is 200 Hz. When tension in this wire is increased, beat frequency remains unchanged. Frequency of other wire (in Hertz) is. **[210 Hz]**

Sol. Frequency of first wire is less than that of second wire as upon increasing tension beats frequency remains unchanged.

$\therefore \nu = \nu_1 + 10 = 210$ Hz.



Q.5 Figure shows, displacement of a particle on a string transmitting wave along x-axis as a function of time. At t = 0 particle is at half its maximum displacement. Amplitude of wave (in cm) is. **[0005]**



Sol. Phase of particle at t = 0 = – π/6

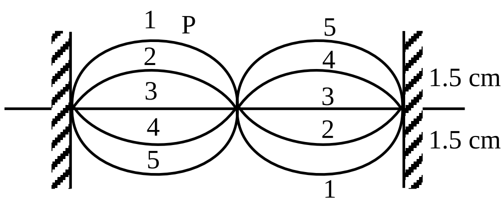
$\therefore$ Velocity of particle = $v_{max} \cos(-\pi/6)$

$= \frac{\sqrt{3}}{2} A\omega = \sqrt{3}$ (By figure)

$\therefore$ A = 5 cm

$\because \omega = \frac{2\pi}{50 \times \pi \times 10^{-3}}$ sec^{-1}

Q.6 A vibrating string 50.0 cm long is under a tension of 1.00 N. The results from five successive stroboscopic pictures are shown is observations reveal that the maximum displacement occurred at flashes 1 and 5 with no other maxima in between. Speed of the traveling waves on the string is (x.y) m/s where x and y are single non zero digit number. Find x.



Sol.[5] x = 5

$\frac{1}{2}$ T = $\frac{4}{5000}$ min

T = 1.6×10^{-3} min

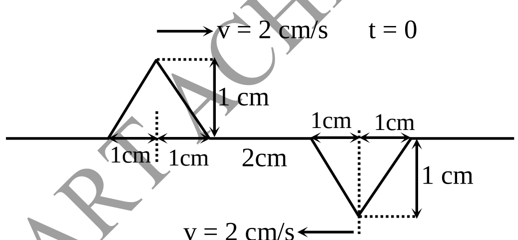
= 9.6×10^{-2} s

f = $\frac{1}{9.6} \times 10^{-2}$ s = 10.4 Hz

λ = L = 0.5 m

v = fλ = 5.2 m/s

Q.7 Two triangular wave pulses are traveling towards each other on a stretched string as shown in figure.



Speed of each pulse is 2 cm/s. Find maximum displacement of particle of string at t = 1s. The leading edges of the pulses are 2.00 cm apart at t = 0. **[0]**

Sol. At t = 1s, both pulses superimpose and cancel out.

Q.8 A wave pulse described by the function

$$\gamma(x, t) = \frac{A^3}{A^2 + (x - vt)^2}$$

propagates down the string, where A = 1.00 cm, and v = 20.0 m/s. At the point x = 4.00 cm, at the t = n × 10^{-3}s the displacement is maximum. Find n.

Sol. **[2]** Displacement will be maximum

when x – vt = 0

t = x/v = $\frac{4\text{cm}}{20\text{m/s}}$ = 2×10^{-3} s

$\therefore$ n = 2

Q.9 The equation of a transverse wave is given by

$\Psi = 10^{-2} \sin \pi[30t - \sqrt{3} - y]$

where x, y and Ψ are in metre, and t in second. If phase difference between two points A ($2\sqrt{3}$ m, 2m) and B($3\sqrt{3}$ m, 3m) be nπ. Find value of n.

Sol. **[4]**

$\Psi = a \sin\left[\omega t - \frac{2\pi}{\lambda}(x\cos\alpha + y\cos\beta)\right]$

represents a wave travelling along a line in x-y plane through origin making an angle α with x-axis and β with the y-axis.

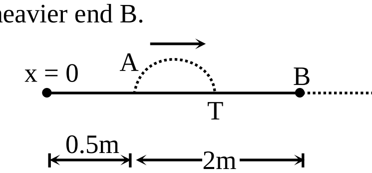
$\Delta\phi = \frac{2\pi}{\lambda}$ [$(x_2 - x_1)\cos\alpha + (y_2 - y_1)\cos\beta$]

comparing with the given equation, we get

α = 30º, β – 60º, λ = 1m, ω = 30/s

Also, $\Delta\phi = 4\pi$

Q.10 A transverse wave pulse starts propagating in the +x direction along a non-uniform wire of length (2m) under tension 9N. The mass per unit length of wire varies as m = $4x^2$ kg, where x is measured from the lighter end of the wire as shown. Find the time (in seconds) taken by the pulse to reach to the heavier end of the wire, it is starts travelling from lighter end A towards heavier end B.



Sol. **[2]**

$$v = \frac{dx}{dt} = \sqrt{\frac{9N}{4x^2}}$$

integrate from $\frac{L}{4}$ to $\frac{5L}{4}$

$$t = \frac{3\times(2)^2}{4}\sqrt{\frac{4}{9}} = 2 \text{ sec.}$$

Q.11 $y = f(x, t) = \dfrac{10}{(2x+10t)^2+2}$ represents a moving pulse where, x and y are in meters and t is in seconds. Find the numerical ratio of maximum displacement of moving pulse and the wave speed.

Sol. **[1]**

$y_{max} = \frac{10}{2} = 5$, putting $(2x + 10t)^2 = 0$

comparing with f(x + vt), v = – 5m/sec

ratio = $\frac{5}{5} = 1$

Q.12 The equation (wave function) of a transverse wave travelling on a stretched string is $Y = (4mm)\ e^{-(2x+5t)^2}$ where x is in cm and t in sec. If tension in the string be 20N, determine the rate of energy flow along + x axis through the point x = 0 at a time t = 0.

Sol. **[0]**

$$\left(\frac{\partial Y}{\partial x}\right)_{\substack{x=0\\t=0}} = 0$$

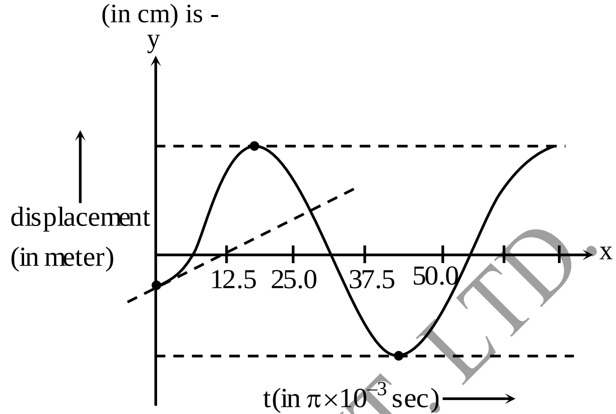
$$P = -T\left(\frac{\partial Y}{\partial x}\right)\left(\frac{\partial Y}{\partial t}\right) = 0$$

at x = 0, t = 0

Q.13 Two boats are floating on a pond in same direction and with the same speed v. Each boat sends through the water, a signal to the other. The frequencies ν_0 of the generated signals are the same. Find the ratio of frequencies received by the boats.

Sol. **[1]**

Q.14 Figure shows displacement of a particle on a string transmitting wave along x-axis as a function of time. At t = 0 particle is at half its maximum, displacement. Amplitude of wave (in cm) is -



Sol. **[5]**

Phase of particle at t = 0 = – π/6

$\therefore$ velocity of particle = $V_{max} \cos\left(\frac{-\pi}{6}\right)$

$= \frac{\sqrt{3}}{2}A\omega \qquad = \sqrt{3}$ (By figure)

$\therefore$ A = 5 cm $\because$ $\omega = \frac{2\pi}{50\times\pi\times10^{-3}}$ se

Q.15 A standing wave exist in a string of length 150 cm which is fixed at both ends with rigid supports the displacement amplitude of a point at a distance 10 cm from one end is $5\sqrt{3}$ mm. The distance between the two nearest point within the same loop and having displacement amplitude $5\sqrt{3}$ mm is 10 cm. Max. displacement amplitude of the particles in the string (in mm) divided by two is -

Sol. **[5]**

y = A sin kx cos ωt

$5\sqrt{3}$ = A sin 10k = A sin 20k

$\Rightarrow k = \frac{\pi}{30}$

$$\therefore A = \frac{5\sqrt{3}}{\sin(\pi/30\times10)} = 10 \text{ mm}$$