NeetPreparation

**Oscillations and Waves Important Questions With Answers NEET Physics 2023**

1. The picture of a progressive transverse wave at a particular instant of time gives:
   **a) shape of the wave** b) motion of the particles of the medium c) velocity of the wave
   d) none of the above

   **Solution : -**
   The photograph of a progressive (travelling) transverse wave at a particular instant of time gives the shape of the wave.

2. Which of the following statements is true for wave motion?
   a) Mechanical transverse waves can propagate through all mediums
   b) Longitudinal waves can propagate through solids only.
   **c) Mechanical transverse waves can propagate through solids only**
   d) Longitudinal waves can propagate through vacuum.

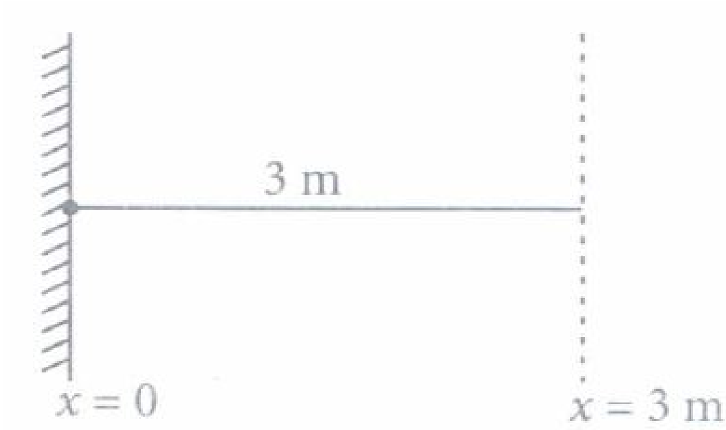
   **Solution : -**
   Mechanical transverse waves can propagate through solids only as solids have shear modulus of elasticity

3. The ratio of the velocity of sound in hydrogen $\left(\gamma=\frac{7}{5}\right)$ to that in helium $\left(\gamma=\frac{5}{3}\right)$ at the same temperature is
   a) $\sqrt{\frac{5}{42}}$ b) $\sqrt{\frac{5}{21}}$ **c)** $\frac{\sqrt{42}}{5}$ d) $\frac{\sqrt{21}}{5}$

   **Solution : -**
   Velocity of sound in gas
   $v=\sqrt{\frac{\gamma RT}{M}}$
   where the symbols have their usual meanings. At the same temperature,
   $v\alpha\sqrt{\frac{\gamma}{M}}$
   $\therefore \frac{v_{H_2}}{v_{He}}=\sqrt{\frac{\gamma_{H_2}}{\gamma_{He}}\times\frac{M_{He}}{M_{H2}}}=\sqrt{\frac{7}{5}\times\frac{3}{5}\times\frac{4}{2}}=\frac{\sqrt{42}}{5}.$

4. One end of a taut string of length 3 m along the x-axis is fixed at x = O. The speed of the waves in the string is 100 m $s^{-1}$. 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).
   a) $y(t)=Asin\frac{2\pi x}{6}cos\frac{50\pi t}{3}$ b) $y(t)=Asin\frac{\pi x}{3}cos\frac{100\pi t}{3}$ c) $y(t)=Asin\frac{5\pi x}{6}cos\frac{255\pi t}{3}$
   **d)** $y(t)=Asin\frac{5\pi x}{2}cos250\pi t$

   **Solution : -**




The fixed end is a node while the free end is an antinode. Therefore, at x = 0 is a node and at x = 3 m is an antinode. Possible modes of vibration are

$L=(2n+1)\frac{\lambda}{4}$ where n = 0, 1,2, 3, .

or $\lambda=\frac{4L}{2n+1}=\frac{12}{2n+1}\ (\therefore L=3\,(Given))$

$k=\frac{2\pi}{\lambda}=\frac{2\pi}{12/\,(2n+1)}=\frac{(2n+1)\pi}{6}$

$\omega=vk=100(2n+1)\frac{\pi}{6}=\frac{(2n+1)50\pi}{3}$

For, $n=0, k=\frac{\pi}{6}, \omega=\frac{50\pi}{3}$

$n=1, k=\frac{\pi}{2}, \omega=\frac{250\pi}{3}$

$n=2, k=\frac{5\pi}{6}, \omega=\frac{250\pi}{3}$

$n=7, k=\frac{5\pi}{6}, \omega=250\pi$

so on

For n = 0

$y(t)=Asin\frac{\pi x}{60}cos\frac{50\pi t}{3}$

For n = 2

$y(t)=Asin\frac{5\pi x}{6}cos\frac{250\pi t}{3}$

For n= 7

$y(t)=Asin\frac{5\pi x}{2}cos250\pi t$

5. The propagation constant of a wave is also called its
   a) wavelength  b) frequency  c) wave number  **d) angular wave number**

   **Solution : -**

   The propagation constant of a wave is also called its angular wave number.

6. Speed of sound waves in a fluid is

**a) directly proportional to the square root of bulk modulus of the medium.**

b) inversely proportional to the bulk modulus of the medium.

c) directly proportional to the density of the medium. d) inversely proportional to the density of the medium.

**Solution : -**

Speed of sound wave in a fluid is

$v = \sqrt{\frac{B}{\rho}}$

where B is the bulk modulus and p is the the density of the medium.

7. Resonance is an example of

**a) forced oscillation** b) damped oscillation c) free oscillation d) none of these

**Solution : -**

Resonance is an example of forced oscillation

8. When two displacements represented by $y_l$ = a sin (ωt) and $y_2$ = b cos (ωt)are superimposed the motion is :

a) not a simple harmonic b) simple harmonic with amplitude a/b

**c) simple harmonic with amplitude** $\sqrt{a^2 + b^2}$ d) simple harmonic with amplitude (a+b)/2

**Solution : -**

Let y = $y_1$ + $y_2$

Further, y = a sin ωt + b cos ωt

If a = A cos φ and b = A sin φ, then

y = A sin ωt cos φ + A cos ωt sin φ

= A [sin ωt cos φ + cos ωt sin φ]

y = A sin (ωt + φ) which is SHM

On combining values of a and b and squaring it, we have:

$a^2 + b^2 = A^2 \cos^2\varphi + A_2 \sin_2\varphi$

$A^2 = a^2 + b^2$

It shows simple harmonic with amplitude

A=$\sqrt{a^2 + b^2}$.

9. Which of the following is not a transverse wave?

a) X-rays b) γ-rays c) Visible light wave **d) Sound wave in a gas**

**Solution : -**

We know that if the given wave oscillates at right angles to the direction of its propagation, then it is a transverse wave. A transverse wave can be produced only in solids, having some rigidity. Since, the gases do not have rigidity, therefore transverse waves cannot be produced in gases.

10. Two waves are propagating along a taut string that coincides with the x-axis. The first wave has the wave function; $y_1 = A\cos\left[k(x - vt)\right]$ and the second has the wave function; $y_2 = A\cos\left[k(x + vt) + \phi\right]$ :

**a) for constructive interference at x= 0,**$\phi = \pi$ b) for constructive interference at x= 0,$\phi = 3\pi$

c) for destructive interference at x= 0,$\phi = \pi$ d) for destructive interference at x = 0,$\phi = 2\pi$

11. A wire is stretched between two rigid supports vibrates in its fundamental mode with a frequency of 50 Hz. The mass of the wire is 30 g and its linear density is 4 x 10-2 kg m S-I. The speed of the transverse wave at the string is

a) $25ms^{-1}$ b) $50ms^{-1}$ **c) $75ms^{-1}$** d) $100ms^{-1}$

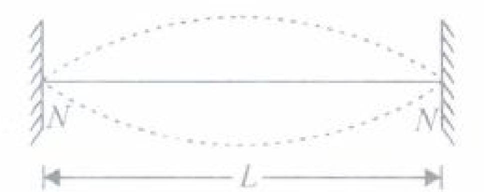
**Solution : -**

Here, Mass of the wire, M = 30 g = 30 X 10-3 kg

Mass per unit length of the wire,$\mu = 4 \times 10^{-2}$ $kgm^{-1}$

∴ Lngth of the wire,

$$L = \frac{M}{\mu} = \frac{30 \times 10^{-3} kg}{4 \times 10^{-2} kgm^{-1}} = 0.75m$$




for the fundamental mode,
$\lambda = 2L = 2 \times 0.75m = 1.5m$
Speed of the transverse wave,
$v = v\lambda = (50s^{-1})(1.5m) = 75ms^{-1}$

12. Two simple harmonic motions with the same frequency act on a particle at right angles i.e., along X-axis and Y-axis. If the two amplitudes are equal and the phase difference is p/2, the resultant motion will be _______________ .
**a) a circle** b) an ellipse with the major axis along Y-axis c) an ellipse with the major axis along X-axis
d) a straight line inclined at 45$^{o}$ to the X-axis

**Solution : -**
The two simple harmonic motions can be written as
x = a sin wt ... (i)
and
$y = a \sin\left(\omega t + \frac{\pi}{2}\right)$ ....(ii)
$y = a \cos \mathrm{wt}$
On squaring and adding Eqs. (i) and (ii), we obtain $x^2 + y^2 = a^2 \left(\sin^2 \mathrm{wt} + \cos^2 \mathrm{wt}\right)$ or $x^2 + y^2 = a^2$
This is the equation of a circular motion with radius a. Note
Simple harmonic motion is of two types.
1. Linear simple harmonic motion
2. Angular simple harmonic motion

13. The velocity of sound waves in an ideal gas at temperatures $T_1$(K) and $T_2$ (K) are respectively $v_1$ and $v_2$. The rms velocities of gas molecules at these two temperatures are $W_1$ and $W_2$ respectively; then:
**a)** $\frac{v_1}{v_2} = \frac{w_1}{w_2}$ b) $\frac{v_1}{v_2} = \sqrt{\gamma}\left(\frac{w_1}{w_2}\right)$ c) $\frac{v_1}{v_2} = \sqrt{\frac{\gamma}{3}}\left(\frac{w_1}{w_2}\right)$ d) $\frac{v_1}{v_2} = \sqrt{\frac{w_1}{w_2}}$

**Solution : -**
$v_1 = \sqrt{\frac{\gamma RT_1}{M}}, v_2 = \sqrt{\frac{\gamma RT_2}{M}}$
$w_1 = \sqrt{\frac{3RT_1}{M}},; w_2 = \sqrt{\frac{3RT_2}{M}}$
$\therefore \frac{v_1}{v_2} = \frac{w_1}{w_2} = \sqrt{\frac{T_1}{T_2}}$

14. Ultrasonic waves produced by a vibrating quartz crystal are
**a) only longitudinal** b) only transverse c) both longitudinal and transverse
d) neither longitudinal nor transverse

**Solution : -**
Ultrasonic waves produced by a vibrating quartz crystal are longitudinal.

15. The frequency of a tuning fork with an amplitude, A = 1cm is 250 Hz. The maximum velocity of any particle in air is equal to:
a) $\frac{5}{\pi} m/sec$ **b)** $5\pi m/sec$ c) $\frac{3.30}{\pi} m/sec$ d) none of these

16. A travelling wave in a gas along the positive X-direction has an amplitude of 2 cm, velocity 45 m/s and frequency 75 Hz. Particle acceleration after an interval of 3 sec at a distance of 135 cm from the origin is:

a) $0.44 \times 10^2 cm/s^2$ **b) $4.4 \times 10^5 cm/s^2$** c) $4.4 \times 10^3 cm/s^2$ d) $44 \times 10^5 cm/s^2$

17. Ultrasonic, infrasonic and audio waves travel through a medium with speed $V_u$ ,$V_i$ and Va respectively; then:

**a) $V_u$ ,$V_i$ and $V_a$ are nearly equal** b) $V_u \geq V_a \geq V_i$ c) $V_u \leq V_a \leq V_i$ d) $V_a \leq V_u$ and $V_u \approx V_i$

18. For the travelling harmonic wave

y(x, t) = 2 cos2$\pi$(10t - 0.008x + 0.35) where x and y are in em and t is in s. The phase difference between oscillatory motion of two points separated by a distance of 0.5 m is

a) 0.2$\pi$ rad b) 0.4$\pi$ rad c) 0.6$\pi$ rad **d) 0.8$\pi$ rad**

**Solution : -**

The given equation is

y = 2 cos2$\pi$(10t - 0.008x + 0.35)

Y = 2 cos(20$\pi$t - 0.016$\pi$x + 0.7$\pi$) ... (i)

The standard equation of travelling harmonic wave is

y = acos($\omega$t - kx + $\phi$) ... (ii)

Comparing (i) and (ii), we get

k = 0.016$\pi$, $\frac{2\pi}{\lambda} = 0.016\pi \quad or \quad \lambda = \frac{1}{0.008} cm$

Phase difference = $\frac{2\pi}{\lambda}$ xPath difference or $\Delta\phi \frac{2\pi}{\lambda}$ $\Delta$x

When, $\Delta$x = 0.5 m = 50 cm

$\therefore \Delta\phi$= 2$\pi$ x 0.008 x 50 = 0.8$\pi$ rad

19. A particle is subjected to two mutually perpendicular simple harmonic motions such that its x and Y coordinates are given by $x = 2\sin\omega t$ and $y = 2\sin\left(\omega t + \frac{\pi}{4}\right)$. The path of the particle will be:

**a) an ellipse** b) a straight line c) a parabola d) a circle

20. Two point isotropic sound sources A and B emitting waves of equal frequency with equal power are located in a medium, some distance apart. A long line AB:

a) a stationary wave is established between A and B

b) though stationary wave is not formed but nodes and antinodes are formed between A and B

c) superposition of two waves is impossible between A and B **d) none of the above**

**Solution : -**

Since, sound sources are point isotropic, therefore, intensity due to these sources varies with distance from the sources. Since, intensity varies with distance from the sources, therefore, the amplitude of oscillation of medium particles also varies with distance. If a point on the line passing through positions of these sources is considered, then at all the points (except mid-points), the amplitudes due to these two waves will be unequal. Hence, stationary waves cannot be produced at these points. Therefore, option (a) is wrong.

Since, a stationary wave is not produced, therefore, the question of nodes and antinodes does not arise. Hence, option (b) is also wrong. Since, any two waves can be superposed in a medium, therefore, option (c) is also wrong. Obviously, option (d) is correct.

21. Two waves: $y = 0.25\sin 316t,\ y = 0.25\sin 310t$ are travelling in same direction. The number of beats produced per second will be:

a) 6 b) 3 **c) $3/\pi$** d) $3\pi$

22. The maximum particle velocity in a wave motion is half the wave velocity, then the amplitude of the wave is equal to:

**a) $\lambda/4\pi$** b) $2\lambda/\pi$ c) $\lambda/2\pi$ d) $\lambda$

**Solution : -**

$For \quad a \quad wave: \quad y = a\sin\left(\frac{2\pi \upsilon t}{\lambda} - \frac{2\pi x}{\lambda}\right)$

$Here \quad \upsilon = velocity \quad of \quad wave$

$\therefore \quad y = a\sin\left(\frac{2\pi \upsilon}{\lambda}t - \frac{2\pi x}{\lambda}\right)$

$\therefore \frac{dy}{dt} = a\left(\frac{2\pi \upsilon}{\lambda}\right)\cos\left(\frac{2\pi \upsilon t}{\lambda} - \frac{2\pi x}{\lambda}\right)$

$\therefore Velocity = \frac{2\pi a \upsilon}{\lambda}\cos\left(\frac{2\pi \upsilon t}{\lambda} - \frac{2\pi x}{\lambda}\right)$

∴Maximum velocity is obtained when

$\cos\left(\frac{2\pi \upsilon t}{\lambda} - \frac{2\pi x}{\lambda}\right) = 1$

$\therefore \upsilon_m = \frac{2\pi a \upsilon}{\lambda}$

$\therefore \upsilon_m = \frac{\upsilon}{2} \qquad (given)$

$\therefore \frac{2\pi a \upsilon}{\lambda} = \frac{\upsilon}{2} \quad or \quad a = \frac{\lambda}{4\pi}.$

23. A stretched string resonates with tuning fork of frequency 512 Hz when length of the string is 0.5 m. The length of the string required to vibrate resonantly with a tuning fork of frequency 256 Hz would be:

a) 0.25 m  b) 0.5 m  **c) 1 m**  d) 2 m

**Solution : -**

The frequency of fundamental note of the stretched string is given by $n = \frac{1}{2L}\sqrt{\left(\frac{T}{\mu}\right)} \ldots . (i)$

where, T is tension in string and m is mass per unit length of the string.

From Eq. (i) $n\mu\frac{1}{L}$

[As string is same so m will be same]

For two different case

$\therefore \quad \frac{v_1}{v_2} = \frac{L_2}{L_1}$

$\text{Here,} \quad n_1 = 512 \text{ Hz}, L_1 = 0.5 \text{ m}$

$n_2 = 256 \text{ Hz}, L_2 = ?$

$\therefore \quad \frac{512}{256} = \frac{L_2}{0.5}$

$\Rightarrow \quad L_2 = 0.5 \times 2 = 1 \text{ m}$

24. In a stationary wave:

a) energy is uniformly distributed  b) energy is maximum at nodes and minimum at antinodes

**c) energy is minimum at nodes and maximum at antinodes**

d) alternating maxima and minima of energy are produced at nodes and antinodes

25. A pulse of a wave train travels along a stretched string and reaches the fixed end of the string. It will be reflected back with

**a) a phase change of 1800 with velocity reversed**

b) the same phase as the incident pulse with no reversal of velocity

c) a phase change of 180° with no reversal of velocity

d) the same phase as the incident pulse but with velocity reversed.

**Solution : -**

On reflection from a fixed end, there is a phase change of π.

26. The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is:

a) p  b) 0707p  c) zero  **d) 0.5p**

**Solution : -**

Let $y = \mathrm{A} \sin \mathrm{w} t$

Differentiating w.r.t. t,

$v_{inst} = \frac{dy}{dt} = A\omega \cos \omega t$

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

$\therefore$ Acceleration $= \frac{dv}{dt} = -A\omega^2 \sin \omega t$

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

$\therefore \phi = \frac{\pi}{2} = 0.5\pi$

27. A speeding motorcyclist sees traffic jam ahead of him. He slows down to 36 km/hour. He finds that traffic has eased and a car moving ahead of him at 18 km/hour is honking at a frequency of 1392 Hz. If the speed of sound is 343 m/s, the frequency of the honk as heard by him will be:

a) 1332 Hz b) 1372 Hz **c) 1412 Hz** d) 1454 Hz

**Solution : -**

n' = n (v + $v_0$/v + $v_s$)

Now, $V_c$ = 18 x 5/18= 5 m/s

Also, n' = n (v + $v_M$/v + $v_C$)

Now, $v_M$ = 36 x 5/18 = 10 m/s

Hence, 1392 x (343+10/343+5)

n' = 1392 x (353/348)= 1412 Hz

28. The equation of a plane progressive wave is given by: y = 0.025 sin (100 t + 0.25x) . The frequency of this wave would be:

**a)** $(50/\pi)Hz$ b) 100 Hz c) $(100/\pi)Hz$ d) 50 Hz

29. Assertion: Variation in air pressure do not affect the speed of sound when temperature remains constant.

Reason: Speed of sound is directly proportional to square root of pressure.

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

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

c) If assertion is true but reason is false. d) If both assertion and reason are false.

**Solution : -**

Speed of sound, v = $\sqrt{\frac{\gamma P}{\rho}}$ .

For a given gas, if $\rho$ remains same, the velocity would increase with increase in pressure. But at constant temperature, change in pressure is accompanied by change in volume. So $\frac{P}{\rho}$ remains constant.

The correct reason is that $\rho$ and vary in the same manner and the velocity of sound depends upon the ratio $\frac{P}{\rho}$.

30. When the potential energy of a particle executing simple harmonic motion is one-fourth of the maximum value during the oscillation, its displacement from the equilibrium position in terms of amplitude 'a' is :

a) a/4 b) a/3 **c) a/2** d) 2a/3

**Solution : -**

The potential energy = (1/4) maximum Energy

or, $\frac{1}{2}m\omega^2y^2 = \frac{1}{4}\left(\frac{1}{2}m\omega^2a^2\right)$

$\therefore$ y=a/2

31. A simple harmonic oscillator has an amplitude A and time period T.The time required by it to travel from x = A to x = A/2 is :

**a) T/6** b) T/4 c) T/3 d) T/2

**Solution : -**

x = $Asin\left(\frac{2\pi}{T}\right)$
When x=A, then
A=A sin$\left(\frac{2\pi}{T}\right)$t
or $sin\left(\frac{2\pi}{T}\right)t = sin\frac{\pi}{2}$
⇒ t=$\frac{T}{4}$
When x=$\frac{A}{2}$, then
$\frac{A}{2} = Asin\left(\frac{2\pi}{T}t\right)$
or $sin\left(\frac{2\pi}{T}\right)t = sin\frac{\pi}{6}$
or t=$\frac{T}{12}$
Hence, time taken from x = A to x=$\frac{A}{2}$
=$\frac{T}{4} - \frac{T}{12} = \frac{T}{6}$.

32. The Doppler effect is applicable for
a) sound waves only b) light waves only **c) both sound and light waves** d) none of these

**Solution : -**
The Doppler effect is applicable for both sound and light waves.

33. Two waves are represented by the equations
Y1 = asin($\omega$t + kx + 0.57) m and
Y2 = acos($\omega$t + kx) m,
where x is in metres and t is in seconds. The phase difference between them is
**a) 1.0 radian** b) 1.25 radian c) 1.57 radian d) 0.57 radian

**Solution : -**
Y1 = asin($\omega$t + kx + 0.57)
∴Phase, $\phi_1$=1 ($\omega$t + kx + 0.57)
$Y_2$ = acos($\omega$t + kx) = asin($\omega$t + kx + $\frac{\pi}{2}$ )
∴Phase, $\phi_2$= $\omega$t + kx + $\frac{\pi}{2}$
Phase difference,$\Delta\phi$=$\phi_2$-$\phi_1$
($\omega$t + kx + $\frac{\pi}{2}$)-($\omega$t + kx + 0.57)
=$\frac{\pi}{2}$- 0.57 = 1.57 - 0.57 = 1radian

34. The period of oscillation of a mass M suspended from a spring of negligible mass is 7. If along with it another mass M is also suspended, the period of oscillation will now be:
a) T b) T$\sqrt{2}$ c) 2T **d) $\sqrt{2}$T**

**Solution : -**
$T = 2\pi\sqrt{\frac{m}{K}}$
$\therefore \frac{T_1}{T_2} = \sqrt{\frac{M_1}{M_2}}$
$\therefore T_2 = T_1\sqrt{\frac{M_2}{M_1}} = T_1\sqrt{\frac{2M}{M}}$
$T_2 = T_1\sqrt{2} = \sqrt{2}T$ (where $T_1 = T$ )

35. The equation of the propagating wave is, y = 25sin(20t + 5x), where y is displacement. Which of the following statements is not true?
a) The amplitude of the wave is 25 units. **b) The wave is propagating in positive X-direction.**
c) The velocity of the wave is 4 units. d) The maximum velocity of the particles is 500 units.

36. A tuning fork of frequency 512 Hz makes 4 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per sec when the tension in the piano string increased. The frequency of the piano string before increasing the tension was ____________ .

a) 510 Hz  b) 514 Hz  c) 516 Hz  **d) 508 Hz**

**Solution : -**

Piano string's frequency =512 $\pm$ 4=516 or 508. When the tension is increased, beat frequency decreased to 2, it means that frequency of the string is 508 as frequency of string increased with tension.

37. A tuning fork when sounded together with a tuning fork of frequency 256 Hz emits two beats. On loading the tuning fork of frequency 256 Hz. the number of beats heard is one per second. The frequency of tuning fork is :

a) 257 Hz  b) 258 Hz  c) 256 Hz  **d) 254 Hz**

**Solution : -**

Now $n_A$ = 256 Hz having beats = 2

Also, $n_B$ = 256 ± 2 = 254 or 258

On loading first fork A, its frequency along with beat frequency decreases, that is acceptable when

$n_B$ = 254 Hz

38. Two wires are in unison. If the tension in one of the wires is increased by 2%, 5 beats are produced per second. The initial frequency of each wire is:

a) 200 Hz  b) 400 Hz  **c) 500 Hz**  d) 1000 Hz

39. I here are 26 tuning forks arranged in the decreasing order of their frequencies. Each tuning fork gives 3 beats with the next. The first one is octave of the last. What IS the frequency of 18th tuning fork?

a) 100 Hz  **b) 99 Hz**  c) 96 Hz  d) 103 Hz

**Solution : -**

Let the frequency of first tuning fork is u. The frequencies of other tuning forks are

$(v-3),(v-2\times 3),\ldots(v-17\times 3)\ldots,(v-25\times 3)$

As per given condition

$v=2(v-25\times 3)$

or $v=2v-25\times 6$

The frequency of the 18th tuning fork

= $v-17\times 3=150-51=99Hz$

40. Which one of the following is a simple harmonic motion?

a) Ball bouncing between two rigid vertical walls  b) Particle moving in a circle with uniform speed

**c) Wave moving through a string fixed at both ends**  d) Earth spinning about its own axis.

**Solution : -**

Problem Solving Strategy To calculate the time period of combined oscillation, calculate the beat produced from the given frequencies.

In transverse wave motion individual particles of the medium execute simple harmonic motion about their mean position in a direction perpendicular to the direction of propagation of wave motion. Wave moving through a string fixed at both ends executes SHM.

41. The time period of a simple pendulum is 2s. If its length is increased by 4 times, then its period becomes ____________ .

a) 16 s  b) 12 s  c) 8 s  **d) 4 s**

**Solution : -**

Time period of simple pendulum

$T=2\pi\sqrt{\frac{l}{g}}$

where, l= length of pendulum

g= acceleration due to gravity
i.e.,
$T \propto \sqrt{l}$
Hence, $\frac{T_2}{T_1} = \sqrt{\frac{l_2}{l_1}} \ldots (i)$
Given, $l_2 = 4l_1, T_1 = 2 \text{ s}$
Substituting the values in Eq. (i), we get
$T_2 = \sqrt{\frac{4l_1}{l_1}} \times 2 = 2 \times 2 = 4 \text{ s}$

42. If $n_1$, $n_2$ and $n_3$ are the fundamental frequencies of three segments into which a string is divided, then the original fundamental frequency n of the string is given by:
**a) $1/n = 1/n_l + 1/n_2 + 1/n_3$** b) $1/\sqrt{n_1}+1/\sqrt{n_2}+1/\sqrt{n_3}$ c) $\sqrt{n}=\sqrt{n_1}+\sqrt{n_2}+\sqrt{n_3}$ d) $n=n_1+n_2+n_3$

**Solution : -**
$l = l_1 + l_2 + l_3$
$n_{string} = (1/2l) \times \sqrt{\frac{T}{m}}$
So, $n \propto \frac{1}{l}$
∴ $1 \propto 1/n$
Hence, $1/n = 1/n_1+1/n_2+1/n_3$

43. The speed of a wave on a string is 150 m/s when the tension is 120 N. The percentage increase in the tension in order to raise the wave speed by 20% is:
**a) 44%** b) 40% c) 20% d) 10%

44. Frequency of variation of kinetic energy of a simple harmonic motion of frequency n is
**a) 2n** b) n c) $\frac{n}{2}$ d) 3n

**Solution : -**
Frequency of variation of kinetic energy = 2n

45. How long after the beginning of motion is the displacement of a harmonically oscillating point equal to one half its amplitude, if the period is 24 see and initial phase is zero?
a) 12 see **b) 2 see** c) 4 sec d) 6 see

**Solution : -**
From the equatio.n, $y = Asin\frac{2\pi t}{T}$

$\frac{A}{2} = A\sin\left(\frac{2\pi t}{T}\right)$ or $t = \frac{T}{12} = 2s$

46. Which one of the following statements is true for the speed 'v' and the acceleration 'a' of a particle executing simple harmonic motion:
a) Value of a is zero, whatever may be the value of 'v' b) When 'v' is zero, a is zero
**c) When 'v' is maximum, a is zero** d) When 'v' is maximum, a is maximum

**Solution : -**
In simple harmonic motion,
When $v = v_{max}$, then $a = 0$
$v = 0$, then $a = a_{max}$

47. A 10m long steel wire has mass 5 g. If the wire is under a tension of 80 N, the speed of transverse waves on the wire is
a) 100 m $S^{-1}$ b) 200 m $S^{-1}$ **c) 400 m $S^{-1}$** d) 500 m $S^{-1}$

**Solution : -**

Here, Length, L = 10 m
Mass, M = 5 g = 5 X $10^{-3}$ kg
Tension, T = 80 N
Mass per unit length of the wire is
$\mu = \frac{M}{L} = \frac{5\times10^{-3}kg}{10m} 5 \times 10^{-4} kgm^{-1}$
Speed of the transverse wave on the wire is
$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{80N}{5\times10^{-3}kgm^{-1}}}$
= 4 x 102m $S^{-1}$ = 400 m $S^{-1}$

48. Two waves of wavelength 50 m and 51 cm produce 12 beat/s. The speed of sound is _______________ .
**a) 306 m/s** b) 331 m/s c) 340 m/s d) 360 m/s

**Solution : -**
Beats produced due to the two frequencies is given by
$n_1 - n_2$
where, $n_1$ and $n_2$ are the frequencies of two waves.
Here, number of beats $= 12/\mathrm{s}$
$\mathrm{l}_1 = 50 \mathrm{~cm} = 0.50 \mathrm{~m}$
$\mathrm{l}_2 = 51 \mathrm{~cm} = 0.51 \mathrm{~m}$
$n_1 - n_2 = 12$
or $\frac{v}{\lambda_1} - \frac{v}{\lambda_2} = 12 \left[n = \frac{v}{\lambda}\right]$
or $v\left(\frac{\lambda_2-\lambda_1}{\lambda_1\lambda_2}\right) = 12$
or $v = \frac{12\lambda_1\lambda_2}{\lambda_2-\lambda_1}$
$\therefore v =$ speed of sound
$= \frac{12\times0.50\times0.51}{(0.51-0.50)}$
$= \frac{12\times0.50\times0.51}{0.01}$
$= 306 \mathrm{~m/s}$
Thus, speed of sound is 306 m/s.

49. Assertion: The interference of two identical waves moving in same direction produces standing waves.
Reason: Various elements of standing waves do not remain in constant phase
a) If both assertion and reason are true and reason is the correct explanation of assertion.
b) If both assertion and reason are true but reason is not the correct explanation of assertion.
c) If assertion is true but reason is false. **d) If both assertion and reason are false.**

**Solution : -**
The interference of two identical waves moving in opposite directions produces standing waves. Various elements of standing waves remain in constant phase.

50. The bob of a simple pendulum of mass m and total energy E will have maximum linear momentum equal to:
a) $\sqrt{2E/m}$ **b)** $\sqrt{2mE}$ c) 2mE d) $mE^2$

**Solution : -**
Kinetic Energy = $p^2/2m$
Max. momentum p = $\sqrt{2mE}$