# N.B.Navale

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**Time** : 03:00:00
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**TEST ID: 52**
**PHYSICS**

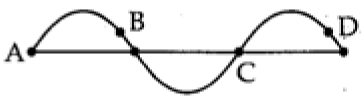
6.SUPERPOSITION OF WAVES ,7.WAVE MOTION

**Single Correct Answer Type**

1. Two tuning forks A and B produce 8 beats per second when sounded together. When B is slightly loaded with wax, the beats are reduced to 4 per second. If the frequency of A is 512 Hz, the frequency of B is
a) 508 Hz b) 516 Hz c) 504 Hz d) 520 Hz

2. A sonometer wire is under suitable tension having specific gravity ‘ρ’, vibrates with frequency ‘n’ in air. If the load is completely immersed in water, the frequency of vibration of wire will become
a) $n\left(\frac{\rho}{\rho+1}\right)^{1/2}$ b) $n\left(\frac{\rho}{\rho+1}\right)^{1/2}$
c) $n\left(\frac{\rho+1}{\rho}\right)^{1/2}$ d) $n\left(\frac{\rho}{\rho-1}\right)^{1/2}$

3. In the following figure the points are in the same phase are




a) 'A’ and 'B' b) 'A' and 'C’
c) ‘B’, ‘D’ and ‘A’, ‘C’ d) 'A"B' and 'c'

4. In a stationary wave all particles
a) Except at nodes vibrate in S. H. M. of same period but of different amplitudes
b) Except at nodes vibrate in S. H. M. of same period and same amplitude
c) Vibrate in S. H. M. of different periods and different amplitudes
d) Vibrate in S. H. M. of same period and amplitude

5. To increase the frequency by 20%, the tension in the string vibrating on a sonometer has to be increased by
a) 44% b) 33%
c) 22% d) 11%

6. A given metal wire has length 1 m, linear density 0.6 kg/m and uniform cross-sectional area $10^{-7}$ $m^2$ is fixed at both ends. The temperature of wire is decreased by 40°C. The fundamental frequency of the transverse wave is
$Y = 2 \times 10^{11}$ N/$m^2$, coefficient of linear expansion of metal is= $1.2 \times 10^{-5}$/°C
a) 2 Hz b) 2.5 Hz
c) 1 Hz d) 0.5 Hz

7. Sound energy can be transferred from one place to another place
a) through the bulk motion of matter
b) in the form of transverse waves
c) without bulk motion of the matter
d) none of these

8. A sine wave has an amplitude $A$ and a wavelength $\lambda$. Let $v$ be the wave velocity and $V$ be maximum velocity of a particle in the medium.
a) $V$ cannot be equal to $V$ b) $V = v$, if $A = \frac{\lambda}{2\pi}$
c) $V - v$, if $A = 2\pi\lambda$ d) $V = v$, if $\lambda = \frac{A}{\pi}$

9. A string in a musical instrument is 50 cm long and its fundamental frequency is 800 Hz. Keeping the tension applied to the string same, the change in the length to produce sound note of fundamental frequency 1000 Hz will be
a) 20 cm b) 10 cm
c) 60 cm d) 40 cm

10. The frequency of two tuning forks A and B are 1.5% more and 2.5% less than that of the tuning fork C. When A and B are sounded together, 12 beats are produced in 1 second. The frequency of tuning fork C is
a) 300 Hz b) 240 Hz
c) 360 Hz d) 200 Hz

11. A uniform metal wire has length $L$, mass $M$ and density $\rho$. It is under tension $T$ and $v$ is the speed of transverse wave along the wire. The area of cross-section of the wire is
a) $\frac{T}{v^2\rho}$ b) $\frac{v^2\rho}{T}$
c) $T^2\rho v$ d) $Tv^2\rho$

12. Distinguishing property of transverse and longitudinal waves is that
a) Both waves carry energy
b) Particles of the medium oscillate
c) Longitudinal waves cannot be polarized

d) Both waves pass through solids

13. The phase difference between two points separated by 0.8 m in a wave of frequency 120 Hz is 90°. The wave velocity is
a) 144 m/s b) 256 m/s c) 384 m/s d) 720 m/s

14. When a tuning fork A and B are sounded together, the number of beats heard are 4 per second. When tuning fork A is filed, the number of beats heard per second with B is changed to 3. If the frequency of tuning fork B is 384 Hz, the original frequency of A is
a) 388 Hz b) 387 Hz c) 381 Hz d) 380 Hz

15. Two waves of wavelengths 52.5 cm and 52 cm produces 5 beats per second. Their frequencies are
a) 490 Hz, 495 Hz b) 500 Hz, 505 Hz
c) 525 Hz, 520 Hz d) 500 Hz, 495 Hz

16. Two periodic waves of intensities $I_1$ and $I_2$ pass through a region at the same time in the same direction. The ratio of the maximum and minimum intensities is
a) $\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}$ b) $\frac{\sqrt{I_1^2+I_2^2}}{\sqrt{I_1^2-I_2^2}}$
c) $\frac{\sqrt{I_1}-\sqrt{I_2}}{\sqrt{I_1}+\sqrt{I_2}}$ d) $\left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$

17. To hear beats, it is essential that the two sound waves in air should
a) be travelling in opposite directions
b) be travelling in the same direction
c) have slightly different wavelengths
d) have slightly different amplitude

18. The distance between two successive particles which differ in phase by
a) $\pi$ radian is a wavelength
b) $2\pi$ radian is a wavelength
c) $\pi/2$ radian is a wavelength
d) $2\pi/3$ radian is a wavelength

19. When tuning fork vibrate, then two prong vibrate:
a) phase difference $\pi / 2$
b) phase difference $\pi$
c) phase difference $\pi / 4$
d) perfect in phase

20. The correct statement about stationary wave is that
a) Displacement at antinode is minimum
b) Displacement at node is maximum
c) Displacement at node is maximum and at antinode is zero
d) Displacement at node is zero and at antinode is maximum

21. The wave velocity is given by :
a) c / T b) λ / x c) λ / T d) v / a

22. The Laplace's correction in the expression for the velocity of sound given by Newton is needed because the sound waves
a) are longitudinal wave
b) have isothermal compression and rarefaction
c) have adiabatic compressions and rarefactions
d) are of longer wavelengths

23. If a stationary observer notes a change of 25% in the frequency of a whistle of an engine coming towards him, then the velocity of the engine is (velocity of sound = 332 m/s)
a) 66.4 m/s b) 64 m/s
c) 60 km/hr d) 32 km/hr

24. If the maximum particle velocity is 4 times of the wave velocity then relation between wavelength and amplitude is
a) $\lambda = \frac{A}{2\pi}$ b) $\lambda = \frac{\pi}{2A}$ c) $\lambda = \frac{\pi A}{2}$ d) $\lambda = \frac{\pi A}{3}$

25. A car blowing a horn of frequency 350 Hz is moving normally towards a wall with a speed of 5 m/s. The beat frequency heard by a person standing between the car and wall is (speed of sound in air = 350 m/s)
a) 0 b) 3.5 Hz c) 5 Hz d) 10 Hz

26. Equations of two progressive waves at a certain point in a medium are given by, $y_1 = a_1 \sin(\omega t + \phi_1)$ and $y_2 = a_2 \sin(\omega t + \phi_2)$. If amplitude and time period of resultant wave formed by the superposition of these two waves is same as that of both the waves, then $\phi_1 - \phi_2$ is
a) $\frac{\pi}{3}$ b) $\frac{2\pi}{3}$ c) $\frac{\pi}{6}$ d) $\frac{\pi}{4}$

27. An open organ pipe and a closed organ pipe have the frequency of their first overtone identical. The ratio of length of open pipe to that of closed pipe is
a) 3:4 b) 2:1
c) 1:2 d) 4:3

28. The distance between two consecutive points which are in the same state of oscillation is
a) displacement b) wavelength
c) amplitude d) intensity

29. For a particular sound wave propagating in air, a path difference between two points is 0.54 m

which is equivalent to phase difference $((1.8\pi)^c$. If the velocity of sound wave in air is 330 m/s, the frequency of this wave is

a) 110 Hz  b) 367 Hz
c) 550 Hz  d) 660 Hz

30. The lengths of two organ pipes open at both ends are $L$ and $L+d$. If they are sounded together, then the beat frequency will be

a) $\frac{2vd}{L(L+x)}$  b) $\frac{2vd}{L(L+d)}$
c) $\frac{2L(L+d)}{vd}$  d) $\frac{vd}{2L(L+d)}$

31. When a longitudinal wave is incident on a rigid will,

a) Compression is reflected as rarefaction with phase change of 0°
b) Compression is reflected as rarefaction with phase change of 180°
c) Compression is reflected as compression with no phase change
d) Compression is reflected as compression with phase change of 180°

32. A set of 56 tuning forks is arranged in series of increasing frequencies. If each fork gives 4 beats with preceding one and the frequency of the last is twice that of first, then frequency of the fork is

a) 220 Hz  b) 110 Hz  c) 224 Hz  d) 448 Hz

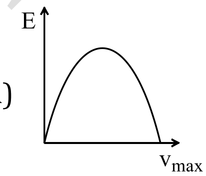
33. A tuning fork makes 256 vibrations/s in air. When velocity of sound is 330 $ms^{-1}$, then the wavelength of tone emitted is

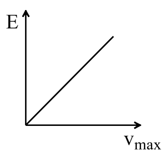
a) 1.29 m  b) 2.1 m
c) 0.5 m  d) 0.9 m

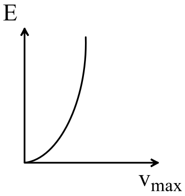
34. The apparent change in frequency of a sounding source and observer in relative motion is

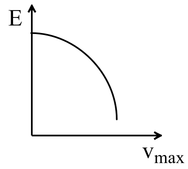
a) Phenomenon of beats  b) Doppler effect
c) Stationary waves  d) Resonance

35. A sound source emits sound waves in a uniform medium. If energy density is E and maximum speed of the particles of the medium is $v_{max}$. The plot between E and $v_{max}$ is best represented by

a) 


b) 


c) 


d) 


36. Two sound sources emitting sound each of wavelength $\lambda$ are fixed at a given distance apart. $A$ listener moves with a velocity $u$ along the line joining the two sources. The number of beats heard by him per second is

a) $\frac{2u}{\lambda}$  b) $\frac{u}{\lambda}$
c) $\frac{u}{3\lambda}$  d) $\frac{2\lambda}{u}$

37. A uniform wire has length 'L' and weight 'W'. One end of the wire is attached rigidly to a point in the roof and weight '$W_1$' is suspended from its lower end. If 'A' is the cross-sectional area of the wire then the stress in the wire at a height $\frac{3L}{4}$ from its lower end is

a) $\frac{3W_1-4W}{2A}$  b) $\frac{4W_1-3W}{4A}$
c) $\frac{4W_1+3W}{4A}$  d) $\frac{3W_1+4W}{2A}$

38. The Doppler's effect is not applicable

a) when the relative motion between source and observer
b) when source and observer are at rest
c) both are moving in opposite direction
d) both are moving in same direction with different velocity

39. A transverse wave is described by the equation, $y = y_0 \sin 2\pi \left[ft - \frac{x}{\lambda}\right]$. The maximum particle velocity is equal to four times the wave velocity, if

a) $\lambda = \pi y_0/4$  b) $\lambda = 2\pi y_0$
c) $\lambda = \pi/y_0$  d) $\lambda = \pi y_0/2$

40. If the star approaches the earth. The Doppler lines are shifted

a) towards the red colour of spectrum
b) towards the violet colour of spectrum
c) infrared region of spectrum
d) ultraviolet region of spectrum

41. Two waves are superimposed whose ratio of intensities is 9:1. The ratio of maximum and minimum intensity is

a) 3:1  b) 5:3
c) 9:1  d) 4:1

42. During a wave motion in a medium particle is executing two different simple harmonic

motions, mutually perpendicular, of different amplitudes and having phase difference of $\pi/2$. The path of the particle will be

a) circular  b) straight line
c) parabolic  d) elliptical

43. In resonance tube experiment, the first and second resonance are heard when water level is 24.1 cm and 74.1 cm respectively, below the open end of the tube. The inner diameter of the tube is

a) 5 cm  b) 2 cm
c) 3 cm  d) 4 cm

44. A tuning fork of frequency 'n' is held near the open end of tube which is closed at the other end and the lengths are adjusted until resonance occurs. The first resonance occurs at length $L_1$ and immediate next resonance occurs at length $L_2$. The speed of sound in air is

a) $n(L_2 - L_1)$  b) $\frac{n(L_2 - L_1)}{2}$
c) $2n(L_2 - L_1)$  d) $\frac{n(L_2 + L_1)}{2}$

45. A string consists of two parts attached at $x = 0$. The right part of the string $(x > 0)$ has mass per unit length $\mu_y$ and the left part of the string $(x < 0)$ has mass per unit length $\mu_l$. The tension in the string is T. If a wave of unit amplitude travels along the left part of the string, what is the amplitude of the wave that is transmitted to the right part of the string?

a) 1  b) $\frac{2}{1 + \sqrt{\mu_l/\mu_y}}$
c) $\frac{2\sqrt{\mu_l/\mu_y}}{1 + \sqrt{\mu_l/\mu_y}}$  d) $\frac{\sqrt{\mu_l/\mu_y} - 1}{\sqrt{\mu_l/\mu_y + 1}}$

46. A bomb explodes on the moon. You will hear its sound on earth after:

a) 2 hours 18 second  b) 10 min
c) 37min  d) never

47. A transverse wave is represented by, $y = y_0 \sin\left\{\frac{2\pi}{\lambda}(vt - x)\right\}$. For what value of $\lambda$, maximum particle velocity will be equal to twice the wave velocity?

a) $\lambda = 2\pi y_0$  b) $\lambda = \frac{\pi y_0}{3}$  c) $\lambda = \frac{\pi y_0}{2}$  d) $\lambda = \pi y_0$

48. The waves used in sonography are:

a) Micro. waves  b) Sound waves
c) Infrared waves  d) Ultrasonic waves

49. When an observer moves towards a stationary source, then the apparent pitch will

a) becomes zero  b) increase
c) decrease  d) remains constant

50. Air column in two identical tube is vibrating. Tube A has one end closed and tube B has both ends open. Neglecting end correction, the ratio of the fundamental frequency of air column in tube A to that in tube B is

a) 1:2  b) 4:1
c) 1:4  d) 2:1

51. If $y_1 = \sin(2000\pi t)$ and $y_2 = a\sin(2008\pi t)$, then number of beats produced per second are

a) 2  b) 3  c) 4  d) 5

52. $n$ number of waves are produced on a string in 0.5 s. Now, the tension in the string is doubled (assume length and radius constant), the number of waves produced in 0.5 s for the same harmonic will be

a) $n$  b) $\sqrt{2}n$
c) $\frac{n}{\sqrt{2}}$  d) $\frac{n}{\sqrt{5}}$

53. A pipe opened at both ends produces a note of frequency $f_1$. When the pipe is kept with $\frac{3}{4}$ th of its length in water, it produces a note of frequency $f_2$. The ratio $\frac{f_1}{f_2}$ is

a) $\frac{3}{4}$  b) $\frac{4}{3}$
c) $\frac{1}{2}$  d) 2

54. Beats are produced by waves $y_1 = a\sin 2000\pi t$ and $y_2 = a\sin 2008\pi t$. The number of beats heard per second is

a) 4  b) 1
c) Zero  d) 8

55. If the distance between the observer and source decreases with time, then it shows that

a) Apparent frequency will be less than actual frequency
b) Apparent frequency will be greater than actual frequency
c) Apparent frequency will be equal to the actual frequency
d) Apparent frequencies cannot be noticed

56. In sine wave, minimum distance between 2 particles always having same speed is

a) $\frac{\lambda}{2}$  b) $\frac{\lambda}{4}$
c) $\frac{\lambda}{3}$  d) $\lambda$

57. The ratio of angular velocity to the propagation constant of the medium is

a) particle velocity  b) wave velocity

c) group velocity
d) momentum

58. The frequency of two tuning forks X and Y are respectively 1.4% more and 2.5% less than that of the tuning fork Z. When tuning forks X and Y are sounded together, 10 beats/second are produced. The frequency of tuning fork Z is
a) 300 Hz
b) 256 Hz
c) 100 Hz
d) 150 Hz

59. A pipe $P_c$ closed at one end and pipe $P_0$ open at both ends are vibrating in second overtone. They are in resonance with a given tuning fork. The ratio of the length of pipe $P_c$ to that of pipe $P_0$ is (Neglect end correction)
a) $\frac{5}{6}$
b) $\frac{2}{3}$
c) $\frac{3}{5}$
d) $\frac{4}{5}$

60. When a longitudinal wave propagates through a medium, the particles of the medium executes simple harmonic oscillations about their mean position. These oscillations of a particle are characterised by of invariant
a) kinetic energy
b) potential energy
c) sum of kinetic and potential energy
d) difference between kinetic and potential energy

61. The path difference between two waves $y_1 = a_1 \sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$ and $y_2 = a_2 \cos\left(\omega t - \frac{2\pi x}{\lambda} + \phi\right)$ is
a) $\frac{\lambda}{2\pi}(\phi)$
b) $\frac{\lambda}{2\pi}\left(\phi + \frac{\pi}{2}\right)$
c) $\frac{2\pi}{\lambda}\left(\phi - \frac{\pi}{2}\right)$
d) $\frac{2\pi}{\lambda}(\phi)$

62. In Melde's experiment, when wire is stretched by empty pan, four loops are obtained and when six gram weight is added in the pan, the number of loops becomes one. The mass of pan is
a) 1.2 gram
b) 1.5 gram
c) 0.8 gram
d) 0.4 gram

63. The human ear cannot distinguish between two sound notes, the time interval is
a) greater than $(1/10)^{th}$ second
b) within $(l/100)^{th}$ second
c) within $(1/10)^{th}$ second
d) equal to 10 second

64. For a stationary wave, $Y = 10 \sin\left(\frac{\pi x}{15}\right) \cos(48\pi t)$ cm, the distance between a node and the successive antinode is
a) 7.5 cm
b) 15 cm
c) 30 cm
d) 60 cm

65. The velocity of a transverse wave in a string depends upon
a) length of the string
b) tension applied only
c) temperature
d) tension in the string and the linear density of the material

66. The transverse displacement $y(x,t)$ of a wave on a string is given by $y(x,t) = e^{-(ax^2+bt^2+2\sqrt{ab}xt)}$. This represents a
a) wave moving in $-x$-direction with speed $\sqrt{b/a}$
b) standing wave of frequency $\sqrt{b}$
c) standing wave of frequency $\frac{1}{\sqrt{b}}$
d) wave moving in $+x$-direction with speed $\sqrt{a/b}$

67. The velocity of sound in air is not affected by changes in :
a) Moisture contents of the air
b) The atmospheric pressure
c) The temperature of the air
d) The composition of air

68. Following statement is true for ultrasonic waves:
a) Man can hear
b) Man cannot hear
c) It is high velocity
d) It is high amplitude

69. Two waves of wavelength 50 cm and 51 cm produce 12 beats $s^{-1}$. The velocity of sound will be
a) 340 $ms^{-1}$
b) 332 $ms^{-1}$
c) 153 $ms^{-1}$
d) 306 $ms^{-1}$

70. The change in ---------doesn't changes the velocity of sound in air:
a) density
b) humidity
c) temperature
d) pressure

71. The prongs of the tuning fork are filled a little, the frequency of the tuning fork after filled
a) increases
b) remains constant
c) decreases
d) cannot be predicated

72. The equation of a wave travelling in a string can be written as $y = 3\cos\pi(100t - x)$. Its wavelength is
a) 100 cm
b) 2 cm
c) 5 cm
d) 10 cm

73. When a simple harmonic progressive wave is travelling through the medium all the particles of the medium vibrate with
a) different amplitude and frequency

b) the same amplitude and same frequency
c) the same amplitude and different frequency
d) the different amplitude and same frequency

74. Intensity of sound depends upon
a) frequency b) velocity
c) amplitude d) wavelength

75. A pure sound note is produced by :
a) Mouth organ b) Tuning fork
c) Siren d) Organ pipe

76. The minimum distance between source of sound and reflection surface for the clear hearing of sound is
a) 17 m b) 1.7m c) 20 m d) 19.2 m

77. What is phase difference, when longitudinal wave is reflected from rigid wall?
a) 0° b) $\frac{\pi^c}{2}$ c) $\pi^c$ d) $2\pi^c$

78. A set of 25 tuning forks is arranged in order of decreasing frequencies. Each fork, produces 3 beats with succeeding one. If the first is octave of last, then the frequency of 1st and 15th fork in Hz is
a) 144,99 b) 72,99
c) 144,102 d) 72,102

79. A uniform metal wire has length 'L', mass 'M' and density 'ρ'. It is under tension 'T' and 'v' is the speed of transverse wave along the wire. The area of cross-section A of the wire is
a) $T^2\rho V$ b) $\frac{v^2\rho}{T}$
c) $\frac{T}{v^2\rho}$ d) $Tv^2\rho$

80. A set of 28 tuning forks is arranged in an increasing order of frequencies. Each fork produces 'x' beats per second with the preceding fork and the last fork is an octave of the first. If the frequency of the 10th fork is 144 Hz, the value of 'x' is
a) 2 b) 6
c) 4 d) 8

81. A wave of frequency 500 Hz has a velocity 360 $ms^{-1}$. The phase difference between two displacements at a certain point at time $10^{-3}$ s apart will be
a) $\pi$rad b) $(\pi/2)$rad
c) $(\pi/4)$rad d) $2\pi$rad

82. A transverse wave $Y = 2\sin(0.01x + 30t)$ moves on a stretched string from one end to another end in 0.5s. If X and Y are in cm and t in second, then the length of the string is
a) 20 m b) 15 cm
c) 10 m d) 5 m

83. Two waves are represented by $y_1 = A\sin\left(\omega t + \frac{\pi}{6}\right)$ and $y_2 = A\cos\omega t$. Their resultant amplitude is given by $(\sin 30^0 = \cos 60^0 = 0.5)$
a) A b) $\sqrt{3}A$
c) $\sqrt{2}A$ d) 2A

84. Transverse wave travels through
a) solids only b) gases only
c) liquids only d) solid and liquid

85. Transverse wave cannot travel through liquids and gases because
a) liquid and gases can flow
b) liquid and gases do not have elasticity
c) liquids and gases are compressible
d) liquids and gases have low density

86. Progressive wave with doubly periodic means
a) Form of the wave repeats itself and travel equal distance in equal interval of time
b) Repetition at equal distance
c) Repetition after equal intervals of time
d) Repetition in medium without inertia

87. Sound wave don't have:
a) Reflected b) Refracted
c) Polarized d) Diffracted

88. Two closed organ pipes 100 cm and 101 cm long gives 16 beats in 20 s, when each pipe is sounded in its fundamental mode. Calculate the velocity of sound.
a) 303 $ms^{-1}$ b) 332 $ms^{-1}$
c) 323.2 $ms^{-1}$ d) 300 $ms^{-1}$

89. The fundamental frequency of a sonometer wire is 50 Hz for some length and tension. If the length is increased by 25% keeping tension same, then frequency change of second harmonic is
a) Decreased by 10% b) Decreased by 15%
c) Decreased by 5% d) Decreased by 20%

90. A wave travelling along the x-axis is described by the equation $y(x,t) = 0.005\cos(\alpha x - \beta t)$. 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
a) $\alpha = \frac{0.08}{\pi}, \beta = \frac{2.0}{\pi}$ b) $\alpha = \frac{0.04}{\pi}, \beta = \frac{1.0}{\pi}$
c) $\alpha = 12.50\,\pi, \beta = \frac{\pi}{2.0}$ d) $\alpha = 25.00\,\pi, \beta = \pi$

91. The mechanical wave travels in a medium along the positive direction of X - axis, the particles of the medium vibrate

a) along X – axis b) along X or Y axis
c) along Y-axis d) along any direction

92. The angle between particle velocity and wave velocity in a transverse wave is
a) zero rad b) π/2 rad c) π/4 rad d) π rad

93. The phase difference between two points is $\pi/3$. If the frequency of wave is 50 Hz, then what is the distance between two points? (Take, $v = 330\ \text{ms}^{-1}$ )
a) 2.2 m b) 1.1 m
c) 0.6 m d) 1.7 m

94. In Quincke's tube experiment, the difference in amplitudes is due to
a) Refraction b) Reflection
c) Superposition d) Polarization

95. A tuning fork whose frequency is given by the manufacturer as 512 Hz is being tested using an accurate oscillator. It is found that they produce 2 beats per second, when the oscillator reads 514 Hz and 6 beats per second, when it reads 510 Hz. The actual frequency of the fork is
a) 508 Hz b) 512 Hz c) 516 Hz d) 518 Hz

96. In a resonance tube, using a tuning fork of frequency 325 Hz, two successive resonance lengths are observed as 25.4 cm and 77.4 cm respectively. The velocity of sound in air is
a) $338\ \text{ms}^{-1}$ b) $328\ \text{ms}^{-1}$
c) $330\ \text{ms}^{-1}$ d) $320\ \text{ms}^{-1}$

97. An organ pipe closed at one end has fundamental frequency of 1500 Hz. The maximum number of overtones generated by this pipe which a normal person can hear is
a) 4 b) 13
c) 6 d) 9

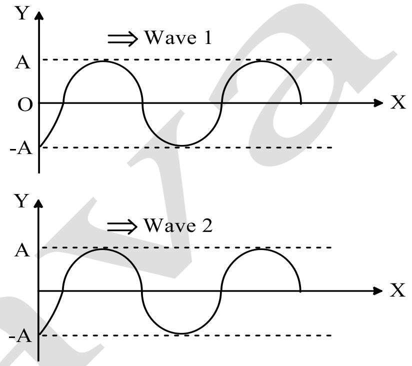
98. The superposition takes place between two waves of frequency f and amplitude a. The total intensity is directly proportional to:
a) a b) 2a c) $2a^2$ d) $4a^2$

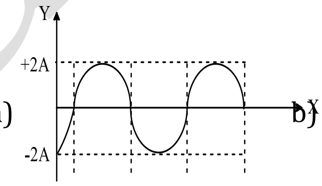
99. The equation of a wave is given by $y = 10\sin\left(\frac{2\pi}{45}t + \alpha\right)$. If the displacement is 5 cm at $t = 0$, then the total phase at $t = 7.5$ s is
a) $\frac{\pi}{3}$ b) $\frac{\pi}{2}$
c) $\frac{\pi}{6}$ d) $\pi$

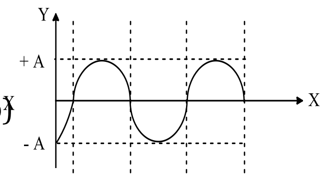
100. An organ pipe $P_1$ closed at one end has vibrating air column in its first overtone and another pipe $P_2$ open at both ends has vibrating air column in the third overtone, which are in resonance with a given tuning fork. The ratio of the length of pipe $P_1$ to that of $P_2$ is
a) 1:2 b) 5:8
c) 1:8 d) 3:8

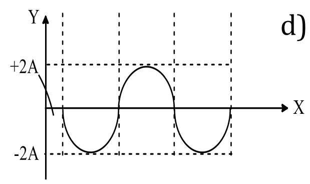
101. In fundamental mode, the time required for the sound wave to reach upto the closed end of a pipe filled with air is 't' second. The frequency of vibration of air column is
a) $\frac{0.5}{t}$ b) $\frac{0.25}{t}$
c) $\frac{1}{t}$ d) $\frac{2}{t}$

102. The resultant wave when two given waves superimposed is best represented by




a) 


b) 


c) 


d) None of the above

103. A sonometer wire is in unison with a tuning fork, when it is stretched by weight $w$ and the corresponding resonating length is $L_1$. If the weight is reduced to $\left(\frac{w}{4}\right)$, the corresponding resonating length becomes $L_2$. The ratio $\left(\frac{L_1}{L_2}\right)$ is
a) 4: 1 b) 1: 4
c) 1: 2 d) 2: 1

104. If the end correction of an open organ pipe is 0.8 cm then the radius of the pipe will be
a) $\frac{1}{3}$ cm b) $\frac{2}{3}$ cm
c) $\frac{3}{2}$ cm d) 0.5 cm

105. The phase difference between two particles in a medium separated by a distance x is π/6. If the frequency of the oscillation is 50 Hz and

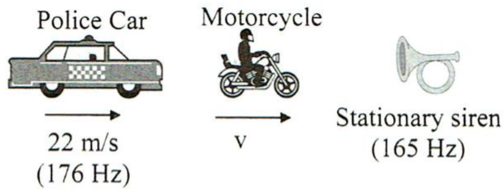
the velocity of propagation of the wave is 100 m/s, then x =

a) 1/3 m b) 1/4 m c) 1/6 m d) 1/12 m

106. A transverse wave of amplitude 0.05 m and frequency 250 Hz is travelling along a stretched string with a speed of 100 m/s. What would be the displacement of a particle at a distance 1.1 m origin after 0.02 second? $\left[\sin\frac{\pi}{2} = \cos\frac{\pi}{2} = 0\right]$

a) 0.1 m b) 0.15 m
c) 0.05 m d) 0.02 m

107. A police car moving at 22 m/s, chases a motorcyclist. The police man sounds his horn at 176 Hz while both of them move towards a stationary siren of frequency 165 Hz. Calculate the speed of the motorcycle, if it is given that he does not observes any beats




a) 33 m/s b) 22 m/s c) Zero d) 11 m/s

108. Two adjacent piano keys are struck simultaneously. The notes emitted by them have frequencies $f_1$ and $f_2$. The number of beats heard per second is :

a) $\frac{1}{2(f_1 - f_2)}$ b) $\frac{1}{2(f_1 + f_2)}$
c) $f_1 \sim f_2$ d) $2(f_1 + f_2)$

109. When two progressive waves $y_1 = 4\sin(2x - 6t)$ m and $y_2 = \sin(2x - 6t-)$ are superimposed, the amplitude of the resultant wave is (in m) $(\cos 90^0 = 0)$

a) 5 b) $\frac{1}{5}$
c) $\frac{5}{3}$ d) $\sqrt{17}$

110. Four sound sources produce the following four waves

(i) $y_1 = a\sin(\omega t + \phi_1)$
(ii) $y_2 = a\sin 2\omega t$
(iii) $y_3 = a'\sin(\omega t + \phi_2)$
(iv) $y_4 = a'\sin(3\omega t + \phi)$

Superposition of which two waves gives rise to interference?

a) (i) and (ii) b) (ii) and (iii)
c) (i) and (iii) d) (iii) and (iv)

111. What is the phase difference between two successive crests in the wave?

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

112. Two waves represented by $y = a\sin(\omega t - kx)$ and $y = a\cos(\omega t - kx)$ are superimpose. The resultant wave will have an amplitude

a) $a$ b) $\sqrt{2a}$
c) $2a$ d) zero

113. The displacement of a particle in a medium is $Y = 10^{-4}\sin\left[100t + 20x + \frac{\pi}{3}\right]$ m where t is in second and x is in metre. The speed of the wave is

a) 20 m/s b) 5 m/s
c) 10 m/s d) 15 m/s

114. Two strings $A$ and $B$ are slightly out tune and produces beats of frequency 5 Hz. Increasing the tension in B reduces the beat frequency to 3 Hz. If the frequency of string $A$ is 450 Hz, calculate the . frequency of string $B$.

a) 460 Hz b) 455 Hz
c) 445 Hz d) 440 Hz

115. Of the following properties of a wave, the one that is different from others, is its:

a) Amplitude b) Wavelength
c) Frequency d) Velocity

116. A closed and open organ pipe of same length produce 2 beats when they are set into vibrations simultaneously in their fundamental mode. The length of the open organ pipe is now halved and that of the closed pipe is doubled. The number of beats produced will be

a) 7 b) 8
c) 5 d) 9

117. A progressive wave of frequency 50 Hz is travelling with velocity 350 m/s through a medium. The change in phase at a given time interval of 0.01 s is

a) $\frac{\pi}{2}$ rad b) $\frac{\pi}{4}$ rad
c) π rad d) π rad

118. The propagation of wave through the medium is possible only when the medium has

a) property of elasticity
b) low frictional resistance
c) inertial property
d) all of the above

119. A simple harmonic progressive wave is represented as $Y = A\sin 2\pi\left(nt - \frac{x}{\lambda}\right)$ cm. If the maximum particle velocity is four times the wave velocity then the wavelength of the wave is

a) $\frac{\pi A}{2}$  b) $\frac{\pi A}{2}$
c) $4\pi A$  d) $2\pi A$

120. The superstition phenomenon between:
a) Light and x-rays
b) Light and sound waves
c) Two or more than two sound waves
d) Light and 13 - rays

121. A closed organ pipe of length 1.2 m vibrates in its first overtone mode. The pressure variation is maximum at
a) 0.4 m from the open end  b) 0.4 m from the closed end
c) Both (a) and (b)  d) 0.8 m from the open end

122. A note produces 4 beat/s with a tuning fork of frequency 510 Hz and 6 beat/s with a fork of frequency 512 Hz. The frequency of the note is
a) 518 Hz  b) 506 Hz
c) 510 Hz  d) 514 Hz

123. The sound waves require more reflecting surface than, the light wave because of
a) longer wavelength  b) low speed
c) high speed  d) lower wavelength

124. The phenomenon of beat is due to
a) alternate production of waxing and waning
b) 'interference between two sound waves having same amplitude and same frequencies
c) interference between two sound waves having slightly different frequency and same amplitude
d) 'a' and 'c'

125. A tuning fork of known frequency 256 Hz makes 5 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per second when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was
a) 256 + 5 Hz  b) 256 + 2 Hz
c) 256 – 2 Hz  d) 256 – 5 Hz

126. On closing an open organ pipe from one end, it is noticed that the frequency of third harmonic is 50 Hz more than the fundamental frequency of vibration in open organ pipe. The fundamental frequency of open organ pipe is
a) 250 Hz  b) 100 Hz
c) 50 Hz  d) 200 Hz

127. A wire of length 'L' having tension 'T' and radius 'r' vibrates with natural frequency 'N'. Another wire of the same metal with length '2L', having tension '2T' and radius '2r' will vibrate with natural frequency
a) $2\sqrt{2}N$  b) $N/2\sqrt{2}$
c) 2N  d) N

128. If two waves $x_1 = A\sin(\omega t - 0.1x)$ and $x_2 = A\sin(\omega t - 0.1x - \phi/2)$ are combined with each other, then resultant amplitude of the combined wave is
a) $2A\cos\frac{\phi}{4}$  b) $A\sqrt{2\cos\frac{\phi}{2}}$
c) $2A\cos\frac{\phi}{2}$  d) $A\sqrt{2\left(1+\cos\frac{\phi}{4}\right)}$

129. The difference between the apparent frequency of a source of sound as perceived by the observer during its approach and recession is 2% of the frequency of the source. If the speed of sound in air 300 $ms^{-1}$, then the velocity of the source is
a) 1.5 $ms^{-1}$ b) 12 $ms^{-1}$ c) 6 $ms^{-1}$ d) 3 $ms^{-1}$

130. The equation of stationary wave on a string clamped at both ends and vibrating in third harmonic is $Y = 0.5\sin(0.314x)\cos(600\pi t)$ where x and y are in cm, t in second. The length of the vibrating string is
a) 20 cm  b) 30 cm
c) 40 cm  d) 10 cm

131. The equation of a transverse wave is given by $\Psi = 10^{-2}\sin\pi[30t - x\sqrt{3} - y]$ 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 the value of n
a) 1  b) 2  c) 3  d) 4

132. Two tuning forks of frequency $n_1$ and $n_2$ produces $n$ beats per second. If $n_2$ and $n$ are known, $n_1$ may be given by
a) $\frac{n_2}{n} + n_2$  b) $n_2 n$
c) $n_2 \pm n$  d) $\frac{n_2}{n} - n_2$

133. The velocity of sound in a gas is
a) directly proportional to square root of temperature
b) directly proportional to the temperature
c) inversely proportional to the square root of temperature
d) directly proportional to the square of temperature

134. The displacement of a wave travelling in the x direction is $y = 10^{-4} \sin\left[600t - 2x + \frac{\pi}{3}\right]$ m. Where x is in metre and t in second. The speed of the wave is
a) 150 m/s
b) 300 m/s
c) 200 m/s
d) 600 m/s

135. Of the following, the equation of plane progressive wave is
a) $y = r \sin \omega t$
b) $y = r \sin(\omega t - kx)$
c) $y = \frac{a}{\sqrt{r}} \sin(\omega t - kx)$
d) $y = \frac{a}{r} \sin(\omega t - kr)$

136. The frequencies of two tuning forks A and B are respectively. 1.5% more and 2.5% less than that of the tuning fork C. When A and B are sounded together, 12 beats are produced in 1 second. The frequency of the tuning fork C is
a) 200 Hz
b) 360 Hz
c) 240 Hz
d) 300 Hz

137. The sound wave propagates through
a) solids
b) gases
c) liquids
d) in all three states

138. The equation $y$ a $\sin \frac{2\pi}{\lambda}(vt - x)$ is the equation of
a) Stationary wave of single frequency along x-axis
b) A simple harmonic motion
c) A progressive wave of single frequency along x-axis
d) The resultant of two S.H.M's of slightly different frequencies

139. Ten tuning forks are arranged in increasing order of frequency in such a way that any two nearest tuning forks produce 4 beats $s^{-1}$. The highest frequency is twice that of the lowest. Possible highest and lowest frequencies are
a) 80 and 40
b) 100 and 50
c) 44 and 32
d) 72 and 36

140. The wavelength $\lambda$ is :
a) Distance between two successive crest
b) Distance between two successive crest trough
c) Distance between two successive trough
d) Both (a) & (c) are true

141. Oscillatory disturbance travelling through the medium is
a) energy
b) momentum
c) wave
d) wave motion

142. Three sound waves of equal amplitude have frequencies $(v - 1), (v + 1)$. They superpose to give beats. The number of beats produced per second will be
a) 4
b) 3
c) 2
d) 1

143. One important similarity between sound and light waves is that both
a) travel at the same speed in air
b) can show interference phenomenon
c) can pass through any medium
d) are transverse waves

144. An observer is standing on a rail ay platform. He hears the whistle of railway engine moving towards him and then passing. He feels that
a) the pitch appears to increase and then decrease
b) the pitch appears to decrease continuously
c) the pitch does not change
d) the pitch appears to increase continuously

145. Waves transport
a) energy only
b) momentum only
c) intensity
d) energy and momentum

146. In a resonance column, first and second resonance are obtained at depths 22.7 cm and 70.2 cm. The third resonance will be obtained at a depth of
a) 117.7 cm
b) 92.9 cm
c) 115.5 cm
d) 113.5 cm

147. The particles of the medium vibrates in a direction parallel to the direction of propagation of the wave then the wave is
a) transverse wave
b) stationary wave
c) longitudinal wave
d) electromagnetic wave

148. The equation of sound wave is $y = 0.0015 \sin(62.4x + 316t)$
Find the wavelength of this wave.
a) 0.2 unit
b) 0.1 unit
c) 0.3 unit
d) None of these

149. Two vibrating tuning forks produce progressive waves given by $y_1 = \sin 500\pi t, y_2 = 2 \sin 506\, \pi t$ and are held near the ear of a person. Number of beats heard per minute is
a) 180
b) 3
c) 360
d) 60

150. The equation of sound wave travelling along negative X-direction is given by, $y = 0.04 \sin \pi(500t + 1.5x)$m. The shortest distance between two particles having phase difference of $\pi$ at the same instant is
a) 0.66 m
b) 0.3 m
c) 0.33 m
d) 0.2 m

151. The angle between particle velocity and wave

velocity in a transverse wave is

a) zero b) $\pi/4$

c) $\pi/2$ d) $\pi$

152. A wave of frequency 100 Hz is sent along a string towards a fixed end. When this wave travels back, after reflection, a node is formed at a distance of 10 cm from the fixed end of the string. The speed of incident (and reflected) waves is

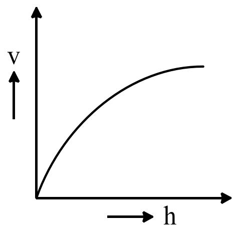
a) $5\ ms^{-1}$ b) $10\ ms^{-1}$

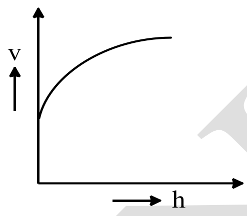
c) $20\ ms^{-1}$ d) $40\ ms^{-1}$

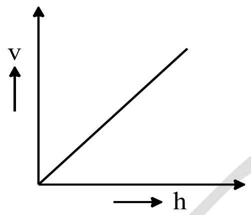
153. A passenger is sitting in a fast moving train. The engine of the train blows a whistle of frequency 'n'. If the apparent frequency of sound heard by the passenger is n', then

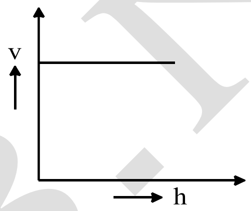
a) $n' < n$ b) $n' > n$ c) $n' = n$ d) $n' \geq n$

154. A uniform rope having mass $m$ hangs vertically from a rigid support. A transverse wave pulse is produced at the lower end. The speed ($v$) of wave pulse varies height $h$ from the lower end as shown in figure

a) 


b) 


c) 


d) 


155. If we add 3 kg load to the hanger of sonometer, the fundamental frequency becomes two times its initial value. The initial load must be

a) 1.5 kg b) 1 kg

c) 2 kg d) 2.5 kg

156. The longitudinal wave can be observed in

a) elastic media b) inelastic media

c) Both (a) and (b) d) None of these

157. A source emitting sound of frequency $f_o$ is moving in a circle of radius R, having centre at the origin, with a uniform speed = c/3 where c is the speed of sound. Find the maximum and minimum frequencies heard by stationary listener at the point (R/2, O)

a) $\frac{6f_o}{5}, \frac{6f_o}{7}$

b) $f_o\left(\frac{2\sqrt{3}}{2\sqrt{3}-1}\right), \left(f_o\frac{2\sqrt{3}}{2\sqrt{3}+1}\right)$

c) $\frac{3f_o}{2}, \frac{3f_o}{5}$

d) $\frac{4f_o}{3}, \frac{4f_o}{5}$

158. Two tuning forks are sounded together and beats are heard. We can infer that:

a) The pitches of the two notes are nearly the same

b) The intensities of the two notes are nearly the same

c) The qualities of the two notes are nearly the same

d) The velocities of the two sounds are nearly the same

159. A standing wave having 5 nodes and 4 antinodes is formed on the string stretched between two rigid supports separated by a distance 100 cm. What is the length of each loop of the standing wave?

a) 25 cm b) 20 cm

c) 50 cm d) 40 cm

160. Which of the following phenomenon cannot take place with sound waves in air? :

a) Refraction b) Diffraction

c) Interference d) Polarization

161. In the fundamental mode, time taken by the wave to reach the closed end of the air filled pipe is 0.01 s. The fundamental frequency is

a) 25 b) 12.5

c) 20 d) 15

162. When a stone is dropped into the still water, the waves produced on the surface of water surface will be

a) transverse

b) stationary

c) longitudinal

d) electromagnetic waves

163. The two identical waves of different materials are stretched under the same tension. Velocity of the transverse wave in the string is

a) same

b) proportional to their densities

c) different

d) inversely proportional to their densities

164. The phase difference between two points separated by 0.8 m, in a wave of frequency 120 Hz, is $\frac{\pi}{2}$. The velocity of wave is

a) $720\ ms^{-1}$ b) $384\ ms^{-1}$

c) $250\ ms^{-1}$ d) $1\ ms^{-1}$

165. Of the following, the equation of progressive wave is

a) $y = a\sin(\omega t + kx^2)^2$ b) $y = a\sin(\omega t - kx)$
c) $y = \frac{a}{\sqrt{2}}\sin(\omega t^2 - kx^2)$ d) $y = \frac{a}{2}\sin(\omega t^2 - kx^2)$

166. A train is moving with a uniform speed of 33 m/s and an observer is approaching the train with the same speed. If the train blows a whistle of frequency 1000 Hz and the velocity of sound is 333 m/s then the apparent frequency of the sound that the observer hears is
a) 1220 Hz b) 1099 Hz c) 1110 Hz d) 1200 Hz

167. Two waves represented by the following equations are travelling in the same medium $y_1 = 5\sin 2\pi(75t - 0.25x), y_2 = 10\sin 2\pi(150t - 0.50x)$. The intensity ratio $I_1/I_2$ of the two waves is
a) 1 : 2 b) 1 : 4 c) 1 : 8 d) 1 : 16

168. The fundamental frequency of an air column in a pipe closed at one end is 100 Hz. If the same pipe is open at both the ends, the frequencies produced in Hz are
a) 100,200,300,400, … b) 100,300,500,700, …
c) 200,300,400,500, … d) 200,400,600,800

169. While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18 cm during winter. Repeating the same experiment during summer, she measures the column length to be $x$ cm for the second resonance. Then
a) $18 > x$ b) $x > 54$
c) $54 > x > 36$ d) $36 > x > 18$

170. The velocity of particle in sound waves is:
a) Always constant
b) Depends upon time
c) Depends upon position of particle from source
d) Depends upon time & p6sition of particle from source

171. Find the wrong statement from the following about the equation of stationary wave given by $Y = 0.04\cos(\pi x)\sin(50\pi t)$ m where t is in second. Then for the stationary wave.
a) Velocity = 50 m/s b) Time period = 0.02 s
c) Amplitude = 0.02 m d) Wavelength = 2 m

172. In a resonance tube open at one end, the end correction is 1 cm. For the first resonance the length of pipe is 15 cm for the tuning fork. Then for the second resonance with the same tuning fork the length of the pipe will be
a) 40 cm b) 35 cm
c) 64 cm d) 47 cm

173. When a little wax is put on the prongs of a tuning fork, then the frequency of vibration of a tuning fork will
a) increase b) remain constant
c) decrease d) both a and b

174. Two stretched strings of same material are vibrating under same tension in fundamental mode. The ratio of their frequencies is 1: 2 and ratio of the length of the vibrating segments is 1: 4. Then, the ratio of the radii of the strings is
a) 2: 1 b) 4: 1
c) 3: 2 d) 8: 1

175. Choose the WRONG statement
a) Waves are called progressive waves, if they travel in same straight line
b) Waves are called progressive waves, if they travel without change of form
c) Waves are called progressive waves, if they travel in opposite direction
d) Waves are called progressive waves, if they are not transverse or longitudinal

176. If the equation of a transverse wave is $y = 5\sin 2\pi\left[\frac{t}{0.04} - \frac{x}{40}\right]$, where distance is in cm and time in second, then the wavelength of the wave is
a) 10 cm b) 25 cm c) 40 cm d) 60 cm

177. Two vibrating strings of the same material but lengths $L$ and $2L$ have radii $2r$ 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 $v_1$ and the other with frequency $v_2$. The ratio $v_1/v_2$ is
a) 2 b) 4
c) 3 d) 1

178. Two vibrating tuning forks produce progressive waves given by $Y_1 = 4\sin 500\pi t$ and $Y_2 = 2\sin 506\pi t$. Number of beats produced per minute is
a) 360 b) 180 c) 3 d) 60

179. If the pressure of the gas is doubled, the velocity of sound at the same temperature is
a) doubled b) remain constant
c) halved d) four times

180. What is the change in phase, when longitudinal wave is reflected from denser medium:
a) π / 2 b) π c) 3 π /2 d) 0°

181. The wave generated from up and down jerk given to the string or by up and down motion of the piston at the end of the pipe is

a) transverse or longitudinal
b) progressive
c) standing
d) Both (a) and (b)

182. A progressive wave is represented by $y = 12\sin(5t - 4x)$cm. On this wave, how far away are the two points having phase difference of 90° ?

a) $\frac{\pi}{2}$ cm
b) $\frac{\pi}{4}$ cm
c) $\frac{\pi}{8}$ cm
d) $\frac{\pi}{16}$ cm

183. A wire is under tension of 2 kg wt and a wave is travelling through it with some speed. Tension in wire is so increased that the wave travels through it with thrice the original speed. The increase in tension is

a) 12 kg wt
b) 6 kg wt
c) 18 kg wt
d) 16 kg wt

184. The frequency of a tuning fork is 256 Hz. It will not resonate with a fork of frequency

a) 256 Hz
b) 768 Hz
c) 738 Hz
d) 512 Hz

185. A uniform metal wire has length 'L', mass 'M' and cross-sectional area 'A'. It is under tension 'T' and 'V' is the speed of transverse wave along the wire. The density of the wire is

a) $\frac{V^2}{A^2T}$
b) $\frac{AT}{V^2}$
c) $\frac{T}{A^2V}$
d) $\frac{T}{V^2A}$

186. Velocity of sound in a gas is proportional to :

a) Square root of isothermal elasticity
b) Adiabatic elasticity
c) Square root of adiabatic elasticity
d) Isothermal elasticity

187. The resonance tube is filled with a liquid of density higher than that of water, then resonating frequency

a) Will not change
b) May increase or decrease
c) Will decrease
d) Will increase

188. Two identical strings of length / and 2/ vibrate with fundamental frequencies NHz and 1.5 N Hz, respectively. The ratio of tensions for smaller length to large length is

a) 1: 3
b) 1: 9
c) 3: 1
d) 9: 1

189. The string of length 'l' is vibrating between two bridges. The length of the string for first harmonic will be ($\lambda$ = wavelength of the wave)

a) $\frac{3\lambda}{4}$
b) $\lambda$
c) $\frac{\lambda}{2}$
d) $\frac{\lambda}{4}$

190. A wave is expressed by the equation, $y = 0.5\sin[\pi(0.01x - 3t)$, where y and x are in metre and t is in second. The speed of propagation of the wave is

a) 100 m/s b) 150 m/s c) 200 m/s d) 300 m/s

191. A wave travelling along x-axis is given by the equation $y = 0.005\cos(\alpha x - \beta t)$. If the wavelength and time period of the wave are 0.08 m and 2.0 second respectively, then the value of $\alpha$ and $\beta$ is

a) $\alpha = 12.50\pi, \beta = 2.0\pi$
b) $\alpha = \frac{0.04}{\pi}, \beta = \frac{1.0}{\pi}$
c) $\alpha = \frac{0.08}{\pi}, \beta = \frac{2.0}{\pi}$
d) $\alpha = 25.00\pi, \beta = \pi$

192. The equation of a stationary wave on a string clamped at both ends and vibrating in third harmonic is given by $Y = 0.5\sin(0.314x)\cos(600\pi t)$ where x and y are in cm and t in second. The length of the vibrating string is

a) 40 cm
b) 50 cm
c) 20 cm
d) 30 cm

193. The fundamental frequency of a wire stretched by 2 kgwt is 100 Hz. The weight required to produce its octave is

a) 12 kgwt
b) 8 kgwt
c) 4 kgwt
d) 16 kgwt

194. The velocity of sound is generally greater in solids than in gases because

a) the density of solids is high and the elasticity
b) the density of solids is high but the elasticity of solids is very high
c) both the density and elasticity of solids are low
d) the density of solids is low, but the elasticity is high

195. The equation of simple harmonic wave is given as $y = 5\sin\frac{\pi}{2}(100t - x)$, where 'x' and 'y' are in metre and time in second. The period of the wave is

a) 0.02 s
b) 25 s
c) 0.04 s
d) 5 s

196. Two cars are approaching each other with same speed of 20 m/s. A man in car A fires bullets at regular intervals of 10 seconds. What will be the time interval noted by a man in car

B between 2 bullets?
(velocity of sound = 340 m/s)
a) 11.1 s b) 10 s c) 8.9 s d) 12 s

197. Equation of two simple harmonic waves are given by $Y_1 = 2\sin 8\pi\left(\frac{t}{0.2} - \frac{x}{2}\right)$ m and $Y_2 = 4\sin 8\pi\left(\frac{t}{0.16} - \frac{x}{1.6}\right)$ m then both waves have
a) Same period b) Same frequency
c) Same wavelength d) Same velocity

198. A wire under tension vibrates with a fundamental frequency of 600 Hz. If the length of the wire is doubled, the radius is halved and the wire is made to vibrate under one-ninth the tension. Then, the fundamental frequency will became
a) 400 Hz b) 600 Hz
c) 300 Hz d) 200 Hz

199. Consider a pipe which is open at both ends. If 'v' is velocity of wave, 'I' is length of air column and 'e' is end correction then the lowest frequency of vibration of air column in pipe is
a) $\frac{V}{2(l+2e)}$ b) $\frac{V}{2(l+e)}$
c) $\frac{V}{4(l+e)}$ d) $\frac{V}{4(l+2e)}$

200. An open organ pipe and a closed organ pipe have the frequency of their first overtone identical. The ratio of length of open pipe to that of closed pipe is
a) 1: 2 b) 3: 4
c) 4: 3 d) 2: 1

# N.B.Navale

**Date** : 28.03.2025
**Time** : 03:00:00
**Marks** : 200

**TEST ID: 52**
**PHYSICS**

6.SUPERPOSITION OF WAVES ,7.WAVE MOTION

## : ANSWER KEY :

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) | d | 2) | b | 3) | c | 4) | a | 105) | c | 106) | c | 107) | b | 108) | c |
| 5) | a | 6) | a | 7) | c | 8) | b | 109) | d | 110) | c | 111) | c | 112) | b |
| 9) | c | 10) | a | 11) | a | 12) | c | 113) | b | 114) | c | 115) | a | 116) | a |
| 13) | c | 14) | d | 15) | c | 16) | d | 117) | d | 118) | d | 119) | b | 120) | c |
| 17) | c | 18) | b | 19) | d | 20) | d | 121) | a | 122) | b | 123) | a | 124) | c |
| 21) | c | 22) | c | 23) | a | 24) | c | 125) | d | 126) | b | 127) | b | 128) | a |
| 25) | a | 26) | b | 27) | d | 28) | b | 129) | d | 130) | b | 131) | d | 132) | c |
| 29) | c | 30) | d | 31) | d | 32) | a | 133) | a | 134) | b | 135) | b | 136) | d |
| 33) | a | 34) | b | 35) | c | 36) | a | 137) | d | 138) | c | 139) | a | 140) | d |
| 37) | c | 38) | b | 39) | d | 40) | b | 141) | a | 142) | c | 143) | b | 144) | a |
| 41) | d | 42) | d | 43) | c | 44) | c | 145) | a | 146) | a | 147) | c | 148) | b |
| 45) | c | 46) | d | 47) | d | 48) | d | 149) | a | 150) | a | 151) | c | 152) | c |
| 49) | b | 50) | a | 51) | c | 52) | b | 153) | c | 154) | a | 155) | b | 156) | a |
| 53) | c | 54) | a | 55) | b | 56) | a | 157) | a | 158) | a | 159) | a | 160) | d |
| 57) | b | 58) | b | 59) | a | 60) | c | 161) | a | 162) | a | 163) | d | 164) | b |
| 61) | b | 62) | d | 63) | c | 64) | a | 165) | b | 166) | a | 167) | b | 168) | d |
| 65) | d | 66) | a | 67) | b | 68) | c | 169) | b | 170) | d | 171) | b | 172) | d |
| 69) | d | 70) | d | 71) | a | 72) | b | 173) | c | 174) | d | 175) | b | 176) | c |
| 73) | b | 74) | c | 75) | b | 76) | a | 177) | d | 178) | b | 179) | b | 180) | b |
| 77) | c | 78) | c | 79) | c | 80) | c | 181) | d | 182) | c | 183) | d | 184) | c |
| 81) | a | 82) | b | 83) | b | 84) | a | 185) | d | 186) | c | 187) | a | 188) | b |
| 85) | b | 86) | a | 87) | c | 88) | c | 189) | c | 190) | d | 191) | d | 192) | d |
| 89) | d | 90) | b | 91) | b | 92) | b | 193) | b | 194) | b | 195) | c | 196) | c |
| 93) | b | 94) | c | 95) | c | 96) | a | 197) | d | 198) | d | 199) | a | 200) | c |
| 97) | c | 98) | d | 99) | b | 100) | d | | | | | | | | |
| 101) | b | 102) | a | 103) | d | 104) | b | | | | | | | | |

# N.B.Navale

**Date** : 28.03.2025 **TEST ID: 52**
**Time** : 03:00:00 **PHYSICS**
**Marks** : 200

6.SUPERPOSITION OF WAVES ,7.WAVE MOTION

## : HINTS AND SOLUTIONS :

**Single Correct Answer Type**

1 **(d)**

$n_A = 512\text{Hz}$

Given that, $n_A \sim n_B = 8$

When B is loaded with wax, the number of beats reduces to 4 per second

$\Rightarrow n_B - n_A = 8$ is the correct equation

$\Rightarrow n_B = n_A + 8 = 512 + 8 = 520\text{Hz}$

2 **(b)**

weight in air $W = v\rho g$

Weight in water $W' = v\rho g - vg = vg(\rho - 1)$

$$\therefore \frac{W'}{W} = \frac{\rho - 1}{\rho} = \frac{T'}{T}$$

$$\frac{n'}{n} = \sqrt{\frac{T'}{T}} = \sqrt{\frac{\rho - 1}{\rho}}$$

4 **(a)**

In a stationary wave all particles except at nodes vibrate in S. H. M. of same period but of different amplitudes.

5 **(a)**

We know that, $v \propto \sqrt{T}$

Let tension has to be increased by $x\%$, then

$$\frac{v + 20\% \text{ of } v}{v} = \sqrt{\frac{T + x\% \text{ of } T}{T}}$$

$$\frac{6}{5} = \sqrt{\left(1 + \frac{x}{100}\right)}$$

$$\frac{36}{25} = 1 + \frac{x}{100} \text{ or } x = 44\%$$

Thus, tension has to be increased by 44%.

6 **(a)**

$$m = 0.6\frac{\text{kg}}{\text{m}}, L = 1\text{m}, A = 10^{-8}\text{m}^2$$

$$\Delta\theta = 40°\text{C}, Y = 2 \times 10^{11}\frac{\text{N}}{\text{m}^2}, \alpha = 1.2 \times \frac{10^{-5}}{°\text{C}}$$

$$\Delta L = L\alpha\Delta\theta = 1 \times 1.2 \times 10^{-5} \times 40$$

$$= 4.8 \times 10^{-4}$$

Tension in the wire $F = \frac{YA\Delta L}{L}$

$$= \frac{2 \times 10^{11} \times 10^{-7} \times 4.8 \times 10^{-4}}{1} = 9.6 \text{ N}$$

$$n = \frac{1}{2L}\sqrt{F/m} = \frac{1}{2 \times 1}\sqrt{9.6/0.6} = \frac{1}{2}\sqrt{16} = 2 \text{ Hz}$$

8 **(b)**

Let the equation of wave, $y = A\sin(\omega t - kx)$

where, $\omega = 2\pi n$ and $k = \frac{2\pi}{\lambda}$.

Wave velocity, $V = n\lambda = \frac{\omega}{2\pi} \times \frac{2\pi}{k} = \frac{\omega}{k}$

Maximum particle velocity, $v = A\omega$

For $V = v, \frac{\omega}{k} = A\omega$ or $A = \frac{1}{k} = \frac{\lambda}{2\pi}$.

9 **(c)**

If tension in the string is constant then

$nl = \text{constant}$ or

$n_1 l_1 = n_2 l_2$

$\therefore 800 \times 50 = 1000 \times l_2$

$\therefore l_2 = 40 \text{ cm}$

$\therefore$ Change in length $= 50 - 40 = 10$ cm

10 **(a)**

$f_A = f_c \times 1.015$

$f_B = f_c \times 0.975$

$f_A - f_B = 12$

$(1.015 - 0.975)f_c = 12$

$0.040f_c = 12$

$\therefore f = \frac{12}{0.040} = 300$ Hz

11 **(a)**

The speed of transverse wave along a wire is given by

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

where, $\mu =$ mass per unit length.
= volume of unit length × density
= area × density

$$v = \sqrt{\frac{T}{A_p}} \Rightarrow A = \frac{T}{v^2\rho}$$

13 **(c)**

Phase difference of 90° of $\frac{\pi}{2}$ rad corresponds to a path difference of $\frac{\lambda}{4}$

$\therefore \lambda = 4 \times 0.8 \text{ m} = 3.2 \text{ m}$

Using, $v = n\lambda = 120 \times 3.2 = 12 \times 32 = 384$ m/s

14 **(d)**

$n_B = 384$ Hz

Given that $n_1 \sim n_2 = 4$

When A is filed, the number of beats reduce to 3 per second ⇒ The correct equation is, $n_B - n_A = 4 \Rightarrow n_A = n_B - 4 = 384 - 4 = 380$Hz

15 **(c)**

Using, $v = n\lambda$ we get, $n = \frac{v}{\lambda}$

Given that, $n_2 - n_1 = 5$

$\therefore v\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right) = 5$

$\therefore v\left(\frac{1}{52} - \frac{1}{52.5}\right) = 5 \Rightarrow v = \frac{5 \times 52 \times 52.5}{0.5}$

$= 10 \times 52 \times 52.5 = 273$ m/s

$\therefore n_1 = \frac{273}{52.5 \times 10^{-2}} = 520$ Hz and

$n_2 = \frac{273}{52 \times 10^{-2}} = 525$ Hz

16 **(d)**

Resultant Intensity due to coherent source is given by

$$I_{\max} = I_1 + I_2 + 2\sqrt{I_1 I_2 \cos\phi}$$

and

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

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

$$= \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} - \sqrt{I_2}\right)^2} = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2$$

23 **(a)**

$n' = \left(\frac{v}{v - v_s}\right) n$

$\therefore n' - n = \left(\frac{v}{v - v_s}\right) n - n = \frac{vn - vn + v_s n}{v - v_s}$

$\therefore \frac{n' - n}{n} = \frac{v}{v - v_s} = \frac{25}{100} = \frac{1}{4}$

$\therefore 4v_s = v - v_s \Rightarrow 5v_s = 332 \Rightarrow v_s = 66.4$m/s

24 **(c)**

Given that, $v_{max} = 4\, v_p$

$\therefore A\omega = 4 \times n\lambda$

$\therefore A \times \frac{2\pi}{T} = 4 \times \frac{1}{T} \times \lambda \;\therefore A \times \pi = 2\lambda$ or $\lambda = \frac{\pi A}{2}$

26 **(b)**

$a^2 = a_1^2 + a_2^2 + 2a_1 a_2 \cos\phi$ ...(i)

Here, $\phi = \phi_1 - \phi_2$

$a_1 = a_2 = a$

Substituting these values in equation (i) we get,

$\cos\phi = -\frac{1}{2} \Rightarrow \phi = 2\pi/3$

27 **(d)**

$\frac{l_0}{l_c} = ?$

For closed pipe $n_p = n_0(2p + 1) \Longrightarrow n_{lc} = n_0^1$

For open pipe $n_p = n_0(p + 1) \Longrightarrow n_{lo} = n_0^2$

$n_{lc} = 3n_0 = \frac{3V}{4l_c}$

$n_{lo} = 2n_o = \frac{2V}{2l_o}$

$\therefore \frac{3V}{4l_c} = \frac{2V}{2l_0}$

$\therefore \frac{l_o}{l_c} = \frac{4}{3}$

29 **(c)**

Path difference $x = 0.54$ m, phase difference $\phi = (1.8\pi)^C$

$V = 330 \frac{m}{s}$

$\therefore \lambda = \frac{2\pi x}{\phi} = \frac{2\pi \times 0.54}{1.8\pi} = \frac{1.08}{1.8} = 0.6$ m

Frequency $f = \frac{V}{\lambda} = \frac{330}{0.6} = 550$ Hz

30 **(d)**

$n_1 = \frac{v}{2L}$ and $n_2 = \frac{v}{2(L+d)}$

$\therefore n_1 - n_2 = \frac{v}{2}\left[\frac{1}{L} - \frac{1}{L+d}\right] = \frac{vd}{2L(L+d)}$

32 **(a)**

$n_{56} = n_1 + (56-1)4$

Also, $n_{56} = 2n_1$

$\therefore 2n_1 = n_1 + 55 \times 4$

$\therefore n_1 = 220$ Hz

33 **(a)**

Wave motion is a disturbance travelling through a medium. Wave velocity, $v = n\lambda$

This relation holds for transverse as well as longitudinal waves.

Here, $v_s = 330\ \text{ms}^{-1}, n = 256$

So, $\lambda = \frac{v_s}{n} = \frac{330}{256} = 1.29$ m

35 **(c)**

Energy density (E) $= \frac{1}{v} = 2\pi^2\rho n^2 A^2$

$v_{max} = \omega A = 2\pi nA \Rightarrow E \propto (v_{max})^2$

i.e., graph between E and $v_{max}$ will be a parabola symmetrical about E axis

36 **(a)**

Number of extra waves received per second $= \frac{u}{\lambda} - (-u/\lambda) = \frac{2u}{\lambda}$

37 **(c)**

The weight of length L of the wire is W. Hence weight of $\frac{3L}{4}$ length will be $\frac{3W}{4}$

The tension at a height $\frac{3L}{4}$ from the lower end will be due to the weight of the wire of length $\frac{3L}{4}$ and due to the weight $W_1$ attached to it. Total tension will be $W_1 + \frac{3W}{4}$

Stress $= \frac{W_1 + \frac{3W}{4}}{A} = \frac{4W_1 + 3W}{4A}$

39 **(d)**

$y = y_0 \sin 2\pi\left[ft - \frac{x}{\lambda}\right]$

$\therefore \frac{dy}{dt} = v_{\text{Particle}} = y_0 2\pi f \cos 2\pi\left[ft - \frac{x}{\lambda}\right]$

for $v_{\text{Particle max}} = y_0 2\pi f$ ........(i)

Wave velocity, $v = \frac{\omega}{k} = \frac{2\pi f}{\frac{2\pi}{\lambda}} \Rightarrow v = f\lambda$ ......(ii)

According to the question,

$\Rightarrow y_0 2\pi f = 4f\lambda$ [from, Eqs. (i) and (ii)]

$\therefore \lambda = \frac{y_0\pi}{2}$

41 **(d)**

$\frac{I_1}{I_2} = \frac{9}{1}$

$\therefore \frac{A_1}{A_2} = \frac{3}{1}$

$\therefore \frac{A_{max}}{A_{min}} = \frac{3+1}{3-1} = \frac{4}{2} = 2$

$\therefore \frac{I_{max}}{I_{min}} = (2)^2 = 4$

42 **(d)**

As the different amplitudes are mutually perpendicular which have phase difference of $\frac{\pi}{2}$, therefore particle will follow elliptical path.

43 **(c)**

$74.1 + e = \frac{3\lambda}{4}$ and $24.1 + e = \frac{\lambda}{4}$

$\therefore 74.1 - 24.1 = \frac{3\lambda}{4} - \frac{\lambda}{4} = \frac{\lambda}{2}$

$\therefore 50\text{cm} = \frac{\lambda}{2}$

$\therefore \frac{\lambda}{4} = 25$ cm

$\therefore e = 25 - 24.1 = 0.9$ cm

$\therefore 0.3d = 0.9$ cm

$\therefore d = \frac{0.9}{0.3} = 3$ cm

44 **(c)**

For first resonance

$L_1 = \frac{\lambda}{4}$

For second resonance

$$L_2 = \frac{3\lambda}{4}$$

$$\therefore L_2 - L_1 = \frac{\lambda}{2} \text{ or } \lambda = 2(L_2 - L_1)$$

$$V = n\lambda = 2n(L_2 - L_1)$$

47 **(d)**

Wave velocity $= v$

Particle velocity, $v_{max} = \frac{dy}{dt}$

$= y_0\left(\frac{2\pi v}{\lambda}\right)\cos\left\{\frac{2\pi}{\lambda}(vt - x)\right\}$

$\therefore v_{max} = y_0\left(\frac{2\pi v}{\lambda}\right)$

Let, $v_{max} = 2v$

$y_0\left(\frac{2\pi v}{\lambda}\right) = 2v \Rightarrow \lambda = \pi y_0$

50 **(a)**

For tube A fundamental frequency $n_A = \frac{v}{4l}$ (pipe closed at one end)

For tube B fundamental frequency $n_B = \frac{v}{2l}$ (pipe open at both ends)

$$\therefore \frac{n_A}{n_B} = \frac{1}{2}$$

51 **(c)**

Given equations are,

$y_1 = a\sin(2000\pi\, t) = a\sin 2\pi(1000\, t)$ and

$y_2 = a\sin(2008\pi\, t) = a\sin 2\pi(1004\, t)$

$\therefore$ Comparing with the standard form,

$y = A\sin 2\pi\ nt$ we get,

$n_1 = 1000$ Hz and $n_2 = 1004$ Hz

$\therefore$ Number of beats $= 1004 - 1000 = 4$ beats/s

52 **(b)**

For a stationary wave,

$$n = \frac{1}{2L}\sqrt{\frac{T}{m}} \quad \text{........(i)}$$

where, $T$ = tension in string

$L$ = length of string

and $m$ = mass of string.

According to the question,

$$n' = \frac{1}{2L}\sqrt{\frac{T'}{m}}$$

Here, $T' = 2T$

$$n' = \frac{1}{2L}\sqrt{\frac{2T}{m}} \Rightarrow n' = \sqrt{2}\frac{1}{2L}\sqrt{\frac{T}{m}}$$

From Eq. (i), we get

$$n' = \sqrt{2}n$$

53 **(c)**

For open pipe, $f_1 = \frac{v}{2l}$ and for closed pipe $f_2 = \frac{v}{4\times\left(\frac{l}{4}\right)} = \frac{v}{l} = 2f_1 \Rightarrow \frac{f_1}{f_2} = \frac{1}{2}$

54 **(a)**

$y_1 = a\sin 2000\pi t$

$\therefore 2\pi n_1 = 2000\pi$

$\therefore n_1 = 1000$ Hz

$y_2 = a\sin 2008\pi t$

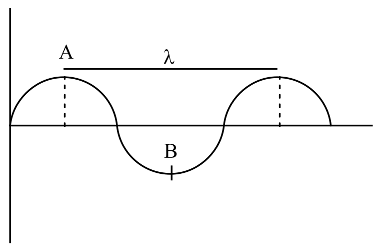
$\therefore 2\pi n_2 = 2008\pi$

$\therefore n_2 = 1004$ Hz

$\therefore$ Beat frequency $= n_2 - n_1 = 4$ Hz

56 **(a)**

Sine wave,




Particle velocity, $v_p = \frac{dy}{dt}$ = slope of wave at that point.

As slope at $A$ and $B$ is zero, hence the velocity at $A$ and $B$ will be same. Distance between $A$ and $B$ is $\frac{\lambda}{2}$.

58 **(b)**

$f_x = f_z + 0.014f_z, f_y = f_z - 0.025f_z$

$\therefore f_x - f_y = 0.014f_z + 0.025f_z = 0.039f_z$

$\therefore 0.039f_z = 10$

$\therefore f_z = \frac{10}{0.039} = 256$ Hz

59 **(a)**

Second overtone of closed pipe

$$n_c = \frac{5V}{4L_e}$$

Second overtone of open pipe

$$n_0 = \frac{3V}{2L_0}$$

$$n_e = n_0$$

$$n_e = n_0$$

$$\therefore \frac{5V}{4L_e} = \frac{3V}{2L_0}$$

$$\therefore \frac{L_e}{L_0} = \frac{5}{6}$$

61 **(b)**

As, $y_2 = a_2 \cos\left(\omega t - \frac{2\pi x}{\lambda} + \phi\right)$

$$= a_2 \sin\left[\frac{\pi}{2} + \left(\omega t - \frac{2\pi x}{\lambda} + \phi\right)\right]$$

Compare it with $y_1 = a_1 \sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$,

we get Phase difference $= \left(\frac{\pi}{2} + \phi\right)$

$\therefore$ Path difference $= \frac{\lambda}{2\pi}\left(\frac{\pi}{2} + \phi\right)$.

62 **(d)**

$$P_1^2 T_1 = P_2^2 T_2$$

$$16 \times m = 1(m + 6)$$

$$16m = 6$$

$$m = \frac{6}{15} = 0.4 \text{ gm}$$

64 **(a)**

The amplitude of the stationary wave is

$$10 \sin\left(\frac{\pi x}{15}\right)$$

Amplitude will be zero when $\sin\left(\frac{\pi x}{15}\right) = 0$

or $\frac{\pi x}{15} = 0$ or $x = 0$

Amplitude will be maximum when $\sin\left(\frac{\pi x}{15}\right) = 1$

or $\frac{\pi x}{15} = \frac{\pi}{2}$

$$\therefore x = \frac{15}{2} = 7.5 \text{ cm}$$

Hence the distance between a mode and the adjacent antinodes in 7.5 cm.

66 **(a)**

$$y(x,t) = e^{-(ax^2 + bt^2 + 2\sqrt{abxt})} = e^{-(\sqrt{a}x + \sqrt{b}t)^2}$$

It is a function of type, $y = f(\omega t + kx)$

$\therefore y(x,t)$ represents wave travelling along $-x$-direction.

Speed of wave $= \frac{\omega}{k} = \frac{\sqrt{b}}{\sqrt{a}} = \sqrt{\frac{b}{a}}$

69 **(d)**

The frequency of beats is given by

$$n = n_1 - n_2 = \frac{v}{\lambda_1} - \frac{v}{\lambda_2} = v\left(\frac{1}{0.5} - \frac{1}{0.51}\right)$$

$$\Rightarrow 12 = v(2 - 1.9608) = v \times 0.0392$$

or, $v = \frac{12}{0.0392} \approx 306 \text{ ms}^{-1}$

72 **(b)**

Comparing the give equation with

$y = A\cos(\omega t - kx)$ we get,

$$k = \frac{2\pi}{\lambda} = \pi \Rightarrow \lambda = 2\text{cm}$$

78 **(c)**

$$n_2 = n_1 - 3$$

$$n_3 = n_1 - 2 \times 3$$

$$n_{25} = n_1 - (25 - 1).3$$

$$\frac{n_1}{2} = n_1 - 72$$

$$\therefore n_1 = 72 \times 2 = 144 \text{ Hz}$$

$$n_{15} = 144 - 14.3 = 144 - 42 = 102 \text{ Hz}$$

79 **(c)**

$$V = \sqrt{\frac{T}{m}} \left[m = \frac{M}{L} = \frac{AL\rho}{L} = A\rho\right]$$

$$\therefore V = \sqrt{\frac{T}{A\rho}}$$

$$\therefore V^2 = \frac{T}{A\rho}$$

$$A = \frac{T}{V^2\rho}$$

80 **(c)**

$n_2 = n_1 + x$

$n_3 = n_1 + 2x$

$n_{10} = n_1 + 9x = 144 \quad \text{... (i)}$

$n_{28} = n_1 + 27x = 2n_1 \quad \text{... (ii)}$

by Eq. (ii) $n_1 = 27x$

Putting this value in Eq. (i)

$27x + 9x = 144$

$\therefore 36x = 144$

$\therefore x = 4$

81 **(a)**

Here, $n = 500$ Hz, $T = \frac{1}{n} = \frac{1}{500} = 2 \times 10^{-3}$ s

Phase difference corresponding to $2 \times 10^{-3}$ s $= 2\pi$

Phase differences corresponding to $1 = 10^{-3}$ s

$$= \frac{2\pi \times 1 \times 10^{-3}}{2 \times 10^{-3}} = \pi \text{rad}$$

82 **(b)**

$Y = 2\sin(0.01x + 30t)$

$\therefore \omega = 30 \frac{\text{rad}}{\text{s}}, k = 0.01/\text{cm}$

speed of the wave $= \frac{\omega}{k} = \frac{30}{0.01} = 3000 \frac{\text{cm}}{\text{s}}$

$= 30$ m/s

$\therefore$ Distance travelled in 0.5 s $= 30 \times 0.5 = 15$ m

83 **(b)**

$y_1 = A\sin\left(\omega t + \frac{\pi}{6}\right)$

$= A\cos\left(\omega t + \frac{\pi}{6} + \frac{\pi}{2}\right)$

$= A\cos\left(\omega t + \frac{2\pi}{3}\right)$

$y_2 = A\cos\omega t$

Phase difference $\phi = \frac{2\pi}{3}$

$\therefore$ Resultant amplitude is given by

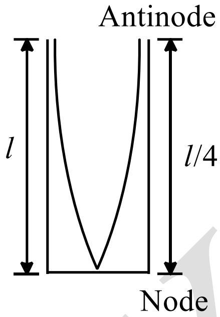
$$R = \sqrt{A^2 + A^2 + 2A^2\cos\frac{2\pi}{3}}$$

$$= \sqrt{A^2 + A^2 + 2A^2\left(-\frac{1}{2}\right)} = A$$

88 **(c)**

Let / be the length of pipe and $v$ is the velocity of sound, then the frequency of note emitted from the pipe is

$$n = \frac{V}{4l}$$




Number of beats in 1 s $= \frac{16}{20} = \frac{4}{5}$

For a closed organ pipe, $x = n_1 - n_2 = \frac{v}{4}\left(\frac{1}{l_1} - \frac{1}{l_2}\right)$

$$\Rightarrow \frac{4}{5} = \frac{v}{4}\left(\frac{1}{1} - \frac{1}{1.01}\right) = \frac{0.01v}{4 \times 1 \times 1.01}$$

$\Rightarrow 0.01 \times 5v = 16 \times 1.01$

$$\therefore v = \frac{16 \times 1.01}{0.05} = 323.2 \text{ ms}^{-1}$$

89 **(d)**

$n_2 l_2 = n_1 l_1$

$\therefore n_2 = \frac{l_1}{l_2} . n_1 = \frac{l_1}{1.25R_1} n_1 = 0.8n_1$

$\therefore n_1 - n_2 = n_1(1 - 0.8) = 0.2n_1$

$$\frac{n_1 - n_2}{n_1} = 0.2$$

90 **(b)**

By comparing given equation of progressive wave with standard equation

$y = a\cos(kx - \omega t)$ we get,

$k = \frac{2\pi}{\lambda} = \alpha \Rightarrow \alpha = \frac{2\pi}{0.08} = 25\pi$

and $\omega = \frac{2\pi}{T} = \beta \Rightarrow \beta = \frac{2\pi}{2} = \pi$

91 **(b)**

Mechanical waves require material medium for its propagation mechanical waves propagates along the direction of propagation of waves.

93 **(b)**

Phase difference $= \frac{2\pi}{\lambda} \times$ Path difference

From relation, $\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x$

$\Rightarrow \Delta x = \frac{\lambda}{2\pi} \times \Delta\phi$ ......(i)

Also, $\lambda = \frac{v}{n}$ ........(ii)

Now, from Eqs. (i) and (ii), we get

$$\Delta x = \frac{v}{2\pi n} \times \Delta\phi$$

$$= \frac{330}{2\pi \times 50} \times \frac{\pi}{3} = 1.1 \text{ m}$$

95 **(c)**

Let n be a frequency of given fork

We have following possibilities for n:

Case I: When 2 beats/s are produced, oscillator reads 514 Hz

$\therefore$ n − 2 = 514 or n + 2 = 514

$\therefore$ n = 516Hz or n = 512 Hz ...(i)

Case II: When 6 beats/s are produced, oscillator reads 510 Hz

$\therefore$ n − 6 = 510 or n + 6 = 510

$\therefore$ n = 516Hz or n = 504 Hz

$\therefore$ From equations (i) and (ii),

$\therefore$ n = 516Hz

96 **(a)**

Velocity of sound in air,

$v = 2n(l_2 - l_1) = 2 \times 325(77.4 - 25.4)$

$$\Rightarrow v = \frac{650 \times 52}{100} = 338 \text{ ms}^{-1}$$

97 **(c)**

We know that, the man can hear the frequencies upto 20000 Hz.

The frequency of closed pipe, $v = n\left(\frac{v}{4l}\right)$.

where, $n$ e odd numbers $v = n \times$ fundamental frequency

$\therefore 20000 = n \times 1500 \Rightarrow n = 13$

Hence, maximum possible harmonics obtained

= 1,3,5,7,9,11,13

Thus, the man can hear upto 13 th harmonic =

7 − 1 = 6 So, number of overtones heard = 6

99 **(b)**

Given, $y = 10 \sin\left[\frac{2\pi}{45}t + \alpha\right]$

At

$y = 5$ cm at $t = 0$

$5 = 10(\sin\alpha)$

or $\sin\alpha = \frac{1}{2}$ or $\alpha = \frac{\pi}{6}$

Again if $t = 7.5$ s

Then, total phase $= \frac{2\pi}{45} \times \frac{15}{2} + \frac{\pi}{6} = \frac{\pi}{3} + \frac{\pi}{6}$

$$= \frac{2\pi + \pi}{6} = \frac{3\pi}{6} = \frac{\pi}{2}$$

100 **(d)**

First overtone of closed pipe is given by

$$n_1 = 3\left(\frac{V}{4L_1}\right)$$

Third overtone of open pipe is given by

$$n_3 = 4\left(\frac{V}{2L_2}\right)$$

$$\frac{3V}{4L_1} = \frac{4V}{2L_2}$$

$$\therefore \frac{L_1}{L_2} = \frac{3}{8}$$

101 **(b)**

In fundamental mode, the length of the tube is equal to $\frac{\lambda}{4}$. Hence time required to travel a distance equal to wavelength λ will be 4t. This is the periodic time, frequency is reciprocal of the periodic time.

$$\therefore f = \frac{1}{4t} = \frac{0.25}{t}$$

102 **(a)**

The two given waves are in phase, i.e. $\phi = 0$. Thus, these waves interfere constructively, amplitude is a function of the phase difference $\phi$ between the constituent two waves. $\Rightarrow A(\phi) = 2A\cos\frac{\phi}{2}$, where $A$ is the amplitude of the individual waves.

For $\phi = 0, A(0) = 2A\cos 0 = 2A$

103 **(d)**

When sonometer is stretched by weight $w$ (tension), then frequency of vibration in the string,

$$v = \frac{1}{2l}\sqrt{\frac{T}{m}} \Rightarrow v = \frac{1}{2L}\sqrt{\frac{w}{m}} \qquad \text{......(i)}$$

where, $L$ is the resonating length and $m$ is mass per unit length of the string.
Similarly, when weight reduces to $\frac{w}{4}$ and resonating length is $L_2$, then

$$v = \frac{1}{2L_2}\sqrt{\frac{\frac{w}{4}}{m}} \Rightarrow v = \frac{1}{4L_2}\sqrt{\frac{w}{m}} \qquad \text{.....(ii)}$$

From Eqs. (i) and (ii), we have

$$\therefore \ \frac{1}{2L_1}\sqrt{\frac{W}{m}} = \frac{1}{4L_2}\sqrt{\frac{W}{m}} \Rightarrow L_1 = 2L_2$$

$$\frac{L_2}{L_2} = 2$$

$$\therefore \ L_1 : L_2 = 2 : 1$$

104 **(b)**

If r is the radius of the open tube, then the end correction is given by

$$e = 0.6 \times 2r = 1.2r$$

$$\therefore 0.8 = 1.2r$$

$$\therefore r = \frac{0.8}{1.2} = \frac{2}{3}\text{cm}$$

105 **(c)**

Given that, phase difference of $\frac{\pi}{6}$ rad corresponds to a path difference of x m
$\because$ A path difference of $2\pi$ rad corresponds to path difference of $\lambda$, we get,
Now, $\lambda = \frac{v}{n} = \frac{100}{50} = 2\text{m} \ \therefore x = \frac{2}{12} = \frac{1}{6}\text{m}$

106 **(c)**

Equation of a travelling wave is given by

$$y = A\sin 2\pi n\left(t - \frac{x}{v}\right)$$

$$n = 250 \text{ Hz}, v = 100\frac{\text{m}}{\text{s}}$$

$$\therefore y = 0.05\sin 500\pi\left(t - \frac{x}{100}\right)$$

For t = 0.02 s and x = 1.1 m

We have

$$t = 0.05\sin 500\pi\left(0.02 - \frac{1.1}{100}\right)$$

$$= 0.05\sin 500\pi\left(\frac{0.9}{100}\right)$$

$$= 0.05\sin 4.5\pi$$

$$= 0.05\sin\left(4 + \frac{1}{2}\right)\pi = 0.05\sin\left(4\pi\pi + \frac{\pi}{2}\right)$$

$$= 0.05\sin\frac{\pi}{2}$$

$$= 0.05 \text{ m}$$

107 **(b)**

$n_1$ = Frequency of the police car's horn heard by motorcyclist
$n_2$ = Frequency of the siren heard by motorcyclist
v = Speed of motor cyclist

$n_1 = \frac{330 - v}{330 - 22} \times 176$ and

$$n_2 = \frac{330 + v}{330} \times 165$$

$\because n_1 - n_2 = 0$

$$\therefore \frac{330 - v}{308} \times 176 = \frac{330 + v}{330} \times 165$$

$\therefore v = 22\text{m/s}$

109 **(d)**

Amplitudes of the two waves are $A_1 = 4$m and $A_2 = 1$ m, phase difference $\phi = \frac{\pi}{2}$

$\therefore$ Resultant amplitude A

$$= \sqrt{A_1^2 + A_2^2 + 2A_1A_1.\cos\frac{\pi}{2}}$$

$$= \sqrt{16 + 1}$$

$$= \sqrt{17} \text{ m}$$

110 **(c)**

According to the principle of superposition, the wave should have same frequency, hence (i) and (iii) have same frequency.

111 **(c)**

Phase difference between any two particles in a wave determines lack of harmony in the vibrating state of two particles, i.e. how far one particle

leads the other or lags behind the other.
Relation of path difference and phase difference is given by $\Delta\emptyset = \frac{2\pi}{\lambda} \times \Delta x$, where $\Delta x$ is path difference.
But path difference between two crests, $\Delta x = \lambda$
Hence, $\Delta\phi = \frac{2\pi}{\lambda} \times \lambda = 2\pi$

112 **(b)**
Given that, two waves

$y = a\sin(\omega t - kx)$ and $y = a\cos(\omega t - kx)$

Here, the phase difference between the two waves is $\frac{\pi}{2}$.
So, the resultant amplitude, $A = \sqrt{a_1^2 + a_2^2 + 2a_1 a_2 \cos\phi}$
[ Here, $a_1 = a, a_2 = a$ and $\phi = \frac{\pi}{2}$]

$$\therefore A = \sqrt{a^2 + a^2 + 2a^2\cos\frac{\pi}{2}}$$

or $A = \sqrt{a^2 + a^2 + 0} \Rightarrow A = \sqrt{2}a$

113 **(b)**

$$Y = 10^{-4} \sin\left[100t + 20x + \frac{\pi}{3}\right]$$

Standard equation of the 0 wave is

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

$$\therefore \omega = 100\frac{rad}{s}, k = 20\ m^{-1}$$

$$V = \frac{\omega}{K} = \frac{1}{20} = 5\ m/s$$

114 **(c)**
$n_A$ = known frequency = 450 Hz, $n_B$ =?, $x$ = 5 Hz which is decreasing after tension is increased (i.e. $x\downarrow$)
Hence, $n_A\downarrow - n_B = x\downarrow \cdots$ (i) correct
$\Rightarrow n_B = n_A - x = 450 - 5 = 445$ Hz

116 **(a)**

$$n_e = \frac{V}{4L}$$

$$n_o = \frac{v}{2L}$$

$$n_o - n_e = 2$$

$$\therefore 2 = \frac{v}{L}\left[\frac{1}{2} - \frac{1}{4}\right]$$

$$\therefore \frac{v}{L} = 8$$

$$n_o' = \frac{v}{2 \times \frac{L}{2}} = \frac{v}{L}$$

$$\therefore n_e' = \frac{v}{4 \times 2L} = \frac{v}{8L}$$

$$n_o' - n_e' = \frac{v}{L}\left[1 - \frac{1}{8}\right] = \frac{v}{L} \times \frac{7}{8} = 8 \times \frac{7}{8} = 7$$

117 **(d)**

$$\phi = \frac{2\pi t}{T}, t = 0.01\ s \text{ and } T = \frac{1}{f} = \frac{1}{50} = 0.02\ s$$

$$\therefore \phi = 2\pi \times \frac{0.01}{0.02} = \pi\ rad$$

119 **(b)**

$$Y = A\sin 2\pi\left(nt - \frac{x}{\lambda}\right) cm$$

Particle velocity $V_P = \frac{dy}{dt} = 2\pi nA\ \cos 2\pi\left(nt - \frac{x}{\lambda}\right)$

Maximum particle velocity= $2\pi nA$

Wave velocity= $n\lambda$

$$\therefore 2\pi nA = 4n\lambda$$

$$\therefore \lambda = \frac{\pi A}{2}$$

121 **(a)**
In first overtone mode,

$$I = \frac{3\lambda}{4} \Rightarrow \frac{\lambda}{4} = \frac{1}{3} = \frac{12}{3} = 0.4\ m$$

Pressure variation will be maximum displacement nodes, $i, \theta$. at 0.4 m from the open end.

122 **(b)**
It produces 4 beats/s with a fork of frequency 510 Hz.

Hence its frequency can be 514 or 506 Hz. It also produces 6 beats/s with a fork of frequency 512 Hz. Hence its frequency can be 518 Hz of 506 Hz.

Hence the frequency 506 Hz is possible in both the cases.

125 **(d)**
Suppose $n_p$ = frequency of piano
$n_f$ = Frequency of tuning fork = 256 Hz

$x =$ Beat frequency $= 5$ b.p.s., which is decreasing $(5 \rightarrow 2)$ after clanging the tension of piano wire

Now, $n_p \propto \sqrt{T}$

Also, tension of piano wire is increasing so $n_p \uparrow$

Hence, $n_p \uparrow - n_f = x \downarrow \rightarrow$ Wrong

$n_f - n_p \uparrow = x \downarrow \rightarrow$ Correct

$\Rightarrow n_p = n_f - x = 256 - 5\text{Hz}$

126 **(b)**

Fundamental frequency of closed pipe

$$= n_1 = \frac{V}{4l}$$

Frequency of third harmonic

$$n_3 = \frac{3V}{4l}$$

Fundamental frequency of open pipe

$$= n_1' = \frac{V}{2l}$$

$$\frac{3V}{4l} - \frac{V}{2l} = 50$$

$$\therefore \frac{V}{4l} = 50$$

$$\therefore \frac{V}{2l} = 100 \text{ Hz}$$

127 **(b)**

$$N = \frac{1}{2L}\sqrt{\frac{T}{m}} = \frac{1}{2L\sqrt{\frac{T}{\pi r^2 \rho}}}$$

$$N_2 = \frac{1}{42}\sqrt{\frac{2T}{\pi 4 r^2 \rho}}$$

$$\therefore \frac{N_2}{N} = \frac{1}{2\sqrt{2}}$$

$$\therefore N_2 = \frac{N}{2\sqrt{2}}$$

128 **(a)**

$x_1 = A\sin(\omega t - 0.1x)$ and

$x_2 = A\sin(\omega t - 0.1x - \phi/2)$

$x_1 + x_2 = A\sin(\omega t - 0.1x)$
$\qquad + A\sin(\omega t - 0.1x - \phi/2)$

$$= A\left[\sin(\omega t - 0.1x) + \sin\left(\omega t - 0.1x - \frac{\phi}{2}\right)\right]$$

$$= A \times 2\sin\left[\frac{\omega t - 0.1x + \omega t - 0.1x - (\phi/2)}{2}\right]$$

$$\cos\left[\frac{\omega t - 0.1x - \omega t + 0.1x + (\phi/2)}{2}\right]$$

$$= 2A\sin\left[\omega t - 0.1x - \frac{\phi}{4}\right]\cos\left(\frac{\phi}{4}\right)$$

$$= 2A\sin\left(\frac{\phi}{4}\right)\sin\left(\omega t - 0.1x - \frac{\phi}{4}\right)$$

Required amplitude $= 2A\cos\frac{\phi}{4}$

129 **(d)**

The apparent frequency, when observer is approaching source is

$$n_1 = \left(\frac{300 + v}{300}\right)n$$

The apparent frequency, when observer is moving away from the source is

$$n_2 = \left(\frac{300 - v}{300}\right)n$$

According to given question,

$$n_1 - n_2 = \frac{2}{100}n$$

$$\therefore \frac{300 + v}{300} - \frac{300 - v}{300} = \frac{2}{100}$$

$\therefore 2v = 2 \times 3 \Rightarrow v = 3\text{m/s}$

130 **(b)**

$Y = 0.5\sin(0.314x)\cos(600\pi t)$ cm

Standard equation of stationary wave

$$y = A\sin\frac{2\pi x}{\lambda}\cos\omega t$$

$$\therefore \frac{2\pi x}{\lambda} = 0.314x$$

$$\therefore \lambda = \frac{2\pi}{0.314} = \frac{2 \times 3.14}{0.314} = 20 \text{ cm}$$

In third harmonic the string will vibrate forming three loops.

$$\therefore \text{Length of the string} = 3\frac{\lambda}{2} = \frac{3 \times 20}{2} = 30 \text{ cm}$$

132 **(c)**

Beat frequency = Number of beats $s^{-1}$.

$$n = n_2 \pm n_1$$

$$\therefore n_1 = n_2 \pm n$$

134 **(b)**

$$y = 10^{-4}\sin\left[600t - 2x + \frac{\pi}{3}\right]$$

Comparing with standard equation

$y = A\sin[\omega t - kx + \phi]$

$\omega = 600 \frac{\text{rad}}{\text{s}}, k = 2 \text{ m}^{-1}$

$v = \frac{\omega}{k} = \frac{600}{2} = 300 \text{ m/s}$

135 **(b)**

The position of such a wave changes in two dimensional plane with time . Therefore (B) represents the correct equation.

136 **(d)**

$f_A = f_C + \frac{1.5}{100} f_c,$

$f_B = f_c - \frac{2.5}{100} f_c$

$\therefore f_A - f_B = \left(\frac{1.5}{100} + \frac{2.5}{100}\right) f_C = \frac{4}{100} f_c = \frac{1}{25} f_C$

$\therefore 12 = \frac{f_C}{25}$

$\therefore f_C = 25 \times 12 = 300 \text{ Hz}$

139 **(a)**

If $n$ is frequency of first fork, then frequency of the last (10 th fork ) $= n + 4(10 - 1) = 2n$

$\therefore n = 36$ and $2n = 72$.

142 **(c)**

Maximum number of beats $= v + 1 - (v - 1) = 2$

146 **(a)**

As, $4_4 + x = \frac{\lambda}{4} = 22.7$

$I_2 + x = \frac{3\lambda}{4} = 70.2$ and $I_3 + x = \frac{5\lambda}{4}$

$\therefore\ x = \frac{I_2 - 3l_1}{2} = \frac{70.2 - 68.1}{2} = \frac{2.1}{2} = 1.05 \text{ cm}$

Now, $\frac{l_3 + x}{4 + x} = 5$

$\Rightarrow\ l_3 = 5L_4 + 4x = 5 \times 22.7 + 4 \times 1.05$
$= 117.7 \text{ cm}$

148 **(b)**

General equation of plane prograssive wave is given by

$y = a\sin(kx + \omega t)$

Given equation

$y = 0.0015\sin(62.4x + 316t)$

Comparing Eqs. (i) and (ii), we get

$k\ = 62.4$

$\therefore\ \frac{2\pi}{\lambda}\ = 62.4$

$\lambda\ = \frac{2\pi}{62.4} = 0.1$ unit

149 **(a)**

Here, $\omega_1 = 2\pi n_1 = 500\pi, n_1 = 250\text{Hz}$

$\therefore \omega_2 = 2\pi n_2 = 506\pi, n_2 = 253\text{Hz}$

No. of beats/s $= n_2 - n_1 = 253 - 250 = 3\text{Hz}$

No. of beats/minute $= 3 \times 60 = 180$

150 **(a)**

Phase difference $= \frac{2\pi}{\lambda} \times$ Path difference

$\therefore \pi = \frac{2\pi}{\lambda} \times x \Rightarrow \frac{\lambda}{2} = x$

From equation, $y = 0.04 \sin(500\pi t + 1.5\pi x)$

Compare with standard wave equation,

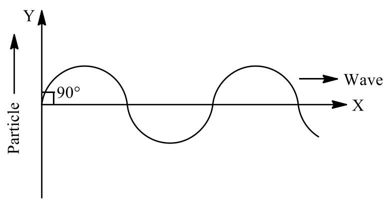
$y = A \sin\left(\frac{2\pi t}{T} + \frac{2\pi x}{\lambda}\right)$ we get,

$\frac{2\pi}{\lambda} = 1.5\pi \Rightarrow \frac{\lambda}{2} = \frac{1}{1.5} = 0.66$

$\therefore x = 0.66 \text{ m}$

151 **(c)**

In a transverse wave, the particles of the medium vibrate about their mean positions in a direction perpendicular to the direction of wave propagation.




Here, the particle velocity is given by $\frac{dy}{dt}$ and wave velocity is given by $\frac{dx}{dt}$.

Hence, the angle between particle velocity in a transverse wave is $\frac{\pi}{2}$.

152 **(c)**

As fixed end is a node, therefore distance between two consecutive nodes $= \frac{\lambda}{2} = 10$ cm

$\lambda = 20 \text{ cm} = 0.2 \text{ m}$

Now,

$v = v\lambda$

$\therefore\ v = 100 \times 0.2 = 20 \text{ ms}^{-1}$

153 **(c)**

There is no relative motion between source and listener

154 **(a)**

Let $m$ be the total mass of the rope of length —.

Tension in the rope at a height $h$ from lower end = Weight of rope of length $h$, i.e. $T = \frac{mg}{l}(h)$

As, $v = \sqrt{\frac{T}{\left(\frac{m}{l}\right)}} = \sqrt{\frac{mg(h)}{l\left(\frac{m}{l}\right)}} = \sqrt{gh},$

$v^2 = gh$ which is a parabola. Therefore,

$h$ versus $v$ graph is a parabola option (a) is correct.

155 **(b)**

$n \propto \sqrt{T}$

$\frac{n_1}{n_2} = \sqrt{\frac{T_1}{T_2}}$

$\frac{1}{2} = (\frac{T}{T+3})^{1/2} \Rightarrow \frac{1}{4} = \frac{T}{T+3}$

$1 + \frac{3}{T} = 4$

$\frac{3}{T} = 3 \Rightarrow T = 1\text{ kg}$

156 **(a)**

The longitudinal wave can be observed in elastic media.

159 **(a)**

$\frac{100}{4} = 25\text{ cm}$

161 **(a)**

In the fundamental mode, frequency,

$n = \frac{v}{\lambda}$

$\Rightarrow n = \frac{v}{4/}$

$\left[\because v = \frac{1}{t}\right]$

$\Rightarrow n = \frac{1}{0.01 \times 4} = 25$

164 **(b)**

It is given that, = 120 Hz, phase difference, $\Delta\phi = \frac{\pi}{2}$ and path difference, $\Delta x = 0.8$ m.

As, $\Delta\phi = \frac{2\pi}{\lambda} \cdot \Delta x \Rightarrow \lambda = \frac{2\pi}{\Delta\phi} \cdot \Delta x = \frac{2\pi \times 0.8}{\pi/2} = 3.2$ m

Hence, wave velocity, $= v\lambda = 120 \times 3.2 = 384\text{ ms}^{-1}$.

165 **(b)**

As generalised equation of a progressive wave is $y = a\sin(\omega t - vx)$. Therefore, option (b) represents the correct equation.

166 **(a)**

$n' = n\left(\frac{v + v_o}{v - v_s}\right) = 1000\left(\frac{333 + 33}{333 - 33}\right) = 1220\text{Hz}$

167 **(b)**

$\frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} \Rightarrow \frac{I_1}{I_2} = \frac{25}{100} = \frac{1}{4}$

168 **(d)**

For a closed pipe, fundamental frequency, $v_1 = \frac{v}{4L} = 100$ Hz

For an open pipe fundamental frequency, $v_1 = \frac{v}{2L} = 200$ Hz In a pipe open at both the ends, all multiples of the fundamental are produced.

169 **(b)**

Given, $l_1 = 18$ cm $f = \frac{V_1}{4l_1} = \frac{3V_2}{4l_2}$, where $I_2 = x$ according to given situation and also $v_1 < v_2$ as during summer temperature would be higher.

$\frac{3v_2}{4l_2} = \frac{V_1}{4l_1} \Rightarrow I_2 = 3l_1 \times \frac{V_2}{v_1}$

$\Rightarrow x = 54 \times$ ($A$ quantity greater than 1)

So, $x > 54$

171 **(b)**

$y = 2a \cos kx \sin \omega t$

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

$\lambda = 2\text{m}$

$a = \frac{0.04}{2} = 0.02\text{ m}$

$V = \frac{\omega}{K} = \frac{50\pi}{\pi} = 50\frac{m}{s}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{50\pi} = 0.04\text{ s}$

172 **(d)**

For the first resonance, length of the pipe $l_1 = 15$ cm

$\therefore$ The length of the air column $L_1 = l_1 + e = 15 + 1 = 16$ cm

For the second resonance, the length of the air column

$L_2 = 16 \times 3 = 48$ cm

$\therefore$ Length of the pipe $l_2 = L_2 - e = 48 - 1$
$= 47$ cm

174 **(d)**

$$n = \frac{1}{2l}\sqrt{\frac{T}{\pi r^2 d}}$$

where, $l$ is length, $T$ is tension, $r$ is radius and $d$ is density.

Given, $\frac{n_1}{n_2} = \frac{1}{2}, \frac{1}{l_2} = \frac{1}{4}$

$$\frac{n_1}{n_2} = \frac{l_2}{l_1}\sqrt{\frac{r_2^2}{r_1^2}}$$

$$\Rightarrow \frac{n_1}{n_2} = \frac{l_2 r_2}{l_2 r_1}$$

$$\Rightarrow \therefore \frac{r_1}{r_2} = \frac{n_2 l_2}{n_1 l_1} = 2 \times 4 = 8:1$$

176 **(c)**

Given equation is

$y = 5 \sin 2\pi\left(\frac{t}{0.04} - \frac{x}{40}\right)$

Comparing with the standard form,

$y = A \sin 2\pi\left[\frac{t}{T} - \frac{x}{\lambda}\right]$ we get,

$\lambda = 40$cm

177 **(d)**

Fundamental frequency,

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}} = \frac{1}{2I}\sqrt{\frac{T}{\pi r^2 \rho}}$$

or

$$n \propto \frac{1}{rr}$$

$$\frac{n_1}{n_2} = \frac{l_2 r_2}{l_1 r_1} = \frac{2L \times r}{L \times 2r} = 1$$

178 **(b)**

From the given equations of progressive waves,

$\omega_1 = 500\pi$ and $\omega_2 = 506\pi$

$\therefore n_1 = 250$ Hz and $n_2 = 253$ Hz

Hence, beat frequency $= n_2 - n_1 = 253 - 250 = 3$ beats per second

$\therefore$ Number of beats per minute $= 180$

179 **(b)**

Speed of sound independent of pressure.

181 **(d)**

The wave generated in first case is transverse wave while in second case, the wave is longitudinal. Both waves are travelling waves (progressive).

182 **(c)**

According to question, the progressive wave is represented by $y = 12 \sin(5t - 4x)$ cm

Comparing this equation with standard equation of progressive wave,

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

So, we have $A = 12$

$\omega = 5 \Rightarrow k = 4$

Here, $(\omega t - kx)$ is phase difference $= \frac{\pi}{2}$

When $t = 0$,

$$5t - 4x = \frac{\pi}{2}$$

$$4x = \frac{\pi}{2}$$

$$\therefore x = \frac{\pi}{8} \text{ cm}$$

183 **(d)**

Speed of transverse wave in a wire

$$V = \sqrt{\frac{T}{m}}$$

$$\therefore \frac{V_2}{V_1} = \sqrt{\frac{T_2}{T_1}}$$

$$\therefore \frac{T_2}{T_1} = \left(\frac{V_2}{V_1}\right)^2 = (3)^2 = 9$$

$$\therefore T_2 = 9T_1 = 9 \times 2 = 18 \text{ kg wt}$$

Increase in tension $= 18 - 2 = 16$ kg wt

184 **(c)**
The frequency 738 Hz is not an integral multiple of 256 Hz. Hence it will not resonate with 256 Hz.

185 **(d)**
The speed of transverse waves in given by

$$V = \sqrt{\frac{T}{m}} \text{ where } m = \frac{M}{L} = \frac{AL\rho}{L} = A\rho$$

$$\therefore V = \sqrt{\frac{T}{A\rho}}$$

$$\therefore V^2 = \frac{T}{A\rho}$$

$$\therefore \rho = \frac{T}{V^2 A}$$

188 **(b)**
The fundamental frequency of wave produced in a string,

$$f = \frac{n}{2l}\sqrt{\frac{T}{m}}$$

where, $n =$ mode of harmonic,

$I =$ length of string,
$T =$ tension in string
and $m =$ mass per unit length of string.

$$\Rightarrow f \propto \frac{\sqrt{T}}{I}$$

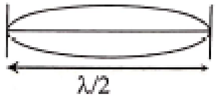
$$\text{or } \frac{f_1}{f_2} = \sqrt{\frac{T_1}{T_2}} \times \frac{I_2}{L_1}$$

Given, $f_1 = N, f_2 = 1.5$ N, $l_1 = I$ and $I_2 = 21$

$$\therefore \frac{N}{1.5N} = \sqrt{\frac{T_1}{T_2}} \times \frac{2l}{I}$$

$$\Rightarrow \sqrt{\frac{T_1}{T_2}} = \frac{1}{3} \Rightarrow \frac{T_1}{T_2} = \frac{1}{9}$$

189 **(c)**
For fundamental frequency in a string




$$\therefore \lambda = 2l$$

$$l = \frac{\lambda}{2}$$

190 **(d)**
$y = 0.5\sin[\pi(0.01x - 3t)]$
$= 0.5\sin[0.01\pi x - 3\pi t]$
Comparing with standard wave equation,
$y = A\sin\left[\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right]$ we get,
$\frac{2\pi}{T} = 3\pi \Rightarrow T = \frac{2}{3}$
$\therefore n = \frac{1}{T} = \frac{3}{2}$Hz
$\frac{2\pi}{\lambda} = 0.01\pi \Rightarrow \lambda = 200$m
$\therefore$ Velocity $= n\lambda = \frac{3}{2} \times 200 = 300$m/s

191 **(d)**
$y = 0.005\cos(\alpha x - \beta t)$

If we compare with the standard equation of a travelling wave

$$\alpha = \frac{2\pi}{\lambda} \text{ and } \beta = \frac{2\pi}{T}$$

$$\therefore \alpha = \frac{2\pi}{0.08} = 25\pi$$

$$\text{and } \beta = \frac{2\pi}{2} = \pi$$

192 **(d)**
The standard equation of a stationary wave is

$$y = 2A\sin\frac{2\pi x}{\lambda}\cos\omega t$$

Comparing the given equation with this equation we get

$$0.314x = \frac{2\pi x}{\lambda}$$

$$\therefore \lambda = \frac{2\pi}{0.314} = \frac{2 \times 3.14}{0.314} = 20 \text{ cm}$$

Since the string is vibrating in third harmonic forming three loops, its length is $\frac{3\lambda}{4} = 30$ cm

193 **(b)**

Fundamental frequency

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

Frequency of octave = 2n

$$\therefore \frac{n_2}{n_1} = 2 = \sqrt{\frac{T_2}{T_1}}$$

$\therefore T_2 = 4T_1 = 4 \times 2$ kgwt $= 8$ kg wt

195 **(c)**

$y = 5\sin\frac{\pi}{2}(100t - x)$

$= 5\sin\left(50\pi t - \frac{x\pi}{2}\right)$

$\therefore \omega = 50\pi$ or $\frac{2\pi}{T} = 50\pi$

$\therefore T = \frac{1}{25} = 0.04$ s

196 **(c)**

$n' = \left(\frac{v + v_o}{v - v_s}\right)n$

$\therefore \frac{1}{T'} = \left(\frac{v + v_o}{v - v_s}\right) \times \frac{1}{T} \quad ...\left[\because n = \frac{1}{T}\right]$

$\therefore \frac{1}{T'} = \left(\frac{340 + 20}{340 - 20}\right) \times \frac{1}{10} = \frac{360}{3200}$

$\therefore T' = \frac{3200}{360} = 8.9s$

197 **(d)**

The two equations can be written as

$$Y_1 = 2\sin 2\pi\left(\frac{4t}{0.2} - \frac{4x}{2}\right) = 2\sin 2\pi\left(\frac{t}{0.05} - \frac{x}{0.5}\right)$$

and $Y_2 = 4\sin 2\pi\left(\frac{4t}{0.16} - \frac{4x}{1.6}\right)$

$$= 2\sin 2\pi\left(\frac{t}{0.04} - \frac{x}{0.4}\right)$$

Comparing with standard equation

$$Y = A\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$$

We get, for the first wave

$T = 0.05s$ and $\lambda = 0.5$ m

For the second wave,

$T = 0.04$ s and $\lambda = 0.4$ m

Hence their periods (hence frequencies) are not same.

Their wavelength are also not same.

For first wave velocity

$$= \frac{\lambda}{T} = \frac{0.5}{0.05} = 10\frac{m}{s}$$

For second wave velocity

$$= \frac{0.4}{0.04} = 10\frac{m}{s}$$

Hence velocity in same.

198 **(d)**

Fundamental frequency, $f = \frac{1}{2rl}\sqrt{\frac{T}{\pi\rho}}$

$$\therefore \frac{f_1}{f_2} = \frac{l_2}{l_1} \times \frac{r_2}{r_1} \Rightarrow \frac{600}{f_2} = \frac{2}{1} \times \frac{1}{2} \times \sqrt{\frac{T}{T/9}}$$

$f_2 = 200$ Hz

199 **(a)**

For a pipe open at both the ends the fundamental frequency is given by

$n = \frac{V}{2L}$

where $L = l + 2e$

$\therefore n = \frac{V}{2(l + 2e)}$

200 **(c)**

The frequency higher than the fundamental frequency of sound is known as overtone.

For open organ pipe, first overtone is $v_0 = \frac{2v}{2L_o} = \frac{v}{L_0}$ For closed organ pipe, first overtone is $v_c = \frac{3v}{4L_c}$

It is given that, their first overtone are identical, i.e.

$$v_o = v_c$$

$$\frac{v}{L_0} = \frac{3v}{4L_c}$$

$$\frac{L_0}{L_c} = \frac{4}{3}$$