WAVES

11th Standard CBSE

Date : 27-Nov-22

Physics

Reg.No. : | | | | | | |

Exam Time : 01:00:00 Hrs

Total Marks : 100

97 x 2 = 194

1) If the speed of a transverse wave on a stretched string of length 1 m is 60 m/s.What is the fundamental frequency of vibration?

2) The equation of a wave travelling on a string stretched along the X -axis is given by $Y = ke^{-\left(\frac{x}{b}+\frac{t}{T}\right)^2}$ Where , is the maximum of the pulse located at t = T? At t = 2T?

3) A progressive wave of frequency 500 Hz is travelling with a velocity of 360 m/s. How far particles are two points 60^o out of phase?

4) Third overtone of a closed organ pipe is in unison with fourth harmonic of an open organ pipe. Find the ration of lengths of the pipes.

5) What frequency of the sound you hear coming directly from the siren?

6) A steel wire has a length of 12 m and a mass of 2.10 kg. What will be the speed of a transverse wave on this wire when a tension of 2.06×10^4N is applied?

7) A metre-long tube open at one end, with a movable piston at the other end, shows resonance with a fixed frequency source (a tuning fork of frequency 340 Hz) when the tube length is 25.5 cm or 79.3 cm. Estimate the speed of sound in air at the temperature of the experiment. The edge effects may be neglected.

8) A tuning fork A, marked 512 Hz, produces 5 beats per sec, where sounded with another unmarked tuning fork B. If B is loaded with wax, the number of beats is again 5 per sec. What is the frequency of the tuning fork B when not loaded?

9) A pipe 20 cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by a source of 1237.5 Hz? (sound velocity in air = $330ms^{-1}$)

10) (i) For the wave on a string described by $Y = 0.06\sin 2\pi/3x\cos(120\pi t)$ do all the points on the string oscillate with the same (a) frequency, (b) phase, (c) amplitude? Explain your answer.
(ii) What is the amplitude of a point 0.375 m away from one end?

11) What is the amplitude of a point 0.375 m away from one end?

12) A narrow sound pulse (e.g. a short pip by a whistle) is sent across a medium.
(i) Does the pulse have a definite (a) frequency, (b) wavelength, (c) speed of propagation?
(ii) If the pulse rate is 1 after every 20 s, (that is the whistle is blown for a split of second after every 20 s), is the frequency of the note produced by the whistle equal to 1/20 or 0.05 Hz?

13) A narrow sound pulse (e.g. a short pip by a whistle) is sent across a medium.
If the pulse rate is 1 after every 20 s, (that is the whistle is blow for a split of second after every 20 s), is the frequency of the note produced by the whistle equal to 1/20 or 0.05 Hz?

14) A steel wire has a length of 12.0 m and a mass of 2.10 kg. What should be the tension in the wire so that speed of a transverse wave on the wire equals the speed of sound in dry air at 20°C = 343 m/s.

15) Equation of a plane progressive wave is given by y = 0.6 $\sin 2\pi\left(t-\frac{x}{2}\right)$ On reflection from a denser medium, its amplitude becomes 2/3 of the amplitude of incident wave. What will be equation of reflected wave?

16) At what temperature (in ^{0}C) Will be speed of sound air be 3 times its value at 0^0 C?

17) A sitar wire is replaced by another wire of same length and material but of three times the earlier radius. If the tension in the wire remains the same, then by what factor will the frequency change?

18) You have learnt that a travelling wave in one dimension is represented by a function y = f(x,t) where, x and t must appear in the combination x- vt or x + vt, i.e. y = f(x ± vt). Is the converse true? Examine if the following functions for Y can possibly represent a travelling wave
(i) $(x - vt)^2$
(ii) $\log [(x + vt)/x_0]$
(iii) 1/(x + vt)

19) You have learnt that a travelling wave in one dimension is represented by a function y = f(x,t) where, x and t must appear in the combination x- vt or x + vt, i.e. y = f(x ± vt). Is the converse true? Examine if the following functions for Y can possibly represent a travelling wave

20) You have learnt that a travelling wave in one dimension is represented by a function y = f(x,t) where, x and t must appear in the combination x-vt or x+vt, i.e. y = f(x ± vt). Is the converse true? Examine if the following functions for Y can possibly represent a travelling wave $(x - vt)^2$

21) Two sitar strings A and B playing the note 'Ga' are slightly out of tune and produce beats of frequency 6 Hz. The tension in the string A is slightly reduce and the beat frequency is found to reduce to 3 Hz. If the original frequency of A is 324 Hz, then what is the frequency of B?

22) A wire stretched between two rigid supports vibrates in its fundamental mode with a frequency of 45 Hz. The mass of the wire is 3.5×10^{-2} kg and its linear mass density is 4.0×10^{-2} kgm^{-1}.

(i) What is the speed of a transverse wave on the string?
(ii) the tension in the string?

23) A wire stretched between two rigid supports vibrates in its fundamental mode with a frequency of 45 Hz. The mass of the wire is 3.5×10^{-2} kg and its linear mass density is $4.0 \times 10^{-2} kgm^{-1}$. What is the tension in the string?

24) A bat emits ultrasonic sound of frequency 1000 kHz in air. If the sound meets a water surface, then what is the wavelength of
(i) the reflected sound,
(ii) the transmitted sound? Speed of sound in air is 340 ms^{-1} and in water 1486 ms^{-1}

25) You have learnt, that a travelling wave in one dimension is represented by a function y = f(x, t), where x and t must appear in the combination x - v t or x + vt i.e., y = f (x ± vt). Is the converse true? That is, does every function of (x - vt) or (x + vt) represent a travelling wave? Examine, if the following functions for y can possibly represent a travelling wave?
(a) $(x-vt)^2$ (b) $log[\frac{(x+vt)}{x_0}]$ (c) $\frac{1}{x+vt}$

26) Is it possible to have interference between the waves produced by two violins? Why?

27) What is the relation between path difference and phase difference?

28) What determines the type of wave motion in a medium?

29) What type of graph you expect between speed of sound through a gas and pressure of gas?

30) In which type of wave alternate crests and troughs are formed?

31) What is the phase difference between two successive crests in a transverse wave?

32) What is the nature of light waves?

33) Which harmonics are absent in a closed organ pipe?

34) In which gas, hydrogen or oxygen, will sound have greater velocity?

35) What is the nature of ultrasonic waves and what is their frequency?

36) When a source moves at a speed greater than that of sound, will Doppler formula hold? What will happen?

37) At the same temperature and pressure, the densities of two diatomic gases are d_1 and d_2. What is the ratio of the speeds of sound in these gases?

38) In a longitudinal wave, what is the distance between a compression and its nearest rarefraction ?

39) On what factors does the speed of transverse waves setup in a string depend?

40) When a vibrating tunning fork is moved speedily towards a wall, beats are heard. Why?

41) The ratio of amplitude of two waves is 2 : 3. What is the ratio of intensitites of these waves?

42) If oil of density higher than that of water is used in place of water in a resonance tube, how does the frequency change?

43) Two medium particles are separated by a distance $\frac{\lambda}{2}$. What is the relationship between phase of these particles at any instant?

44) If radius of a stretched wire is reduced to half, how is the wave speed affected?

45) An observer at a sea-coast observes waves reaching the coast. What type of waves does he observe? Why?

46) An observer places his ear at the end of a long steel pipe. He can hear two sounds, when a workman hammers the other end of the pipe. Why?

47) If tension of a wire is increased to four times, how is the wave speed changed?

48) What do you mean by reverberation time?

49) What is reverberation?

50) What is the ratio of frequencies of fundamental tone and various overtones formed in a vibrating string?

51) Why bells are made of metal and not wood?

52) How does velocity of sound in air change when temperature rises by 1^0C?

53) Why do we not hear beats if the frequency of two sounds are widely different?

54) Two sound sources produce 20 beats in 5s. By how much do their frequencies differ?

55) What sort of waves are formed in a sitar wire when it is once plucked in the middle and then released?

56) Two astronauts on the surface of moon cannot talk to each other. Why?

57) Define the terms 'node' and 'antinode'?

58) Does sound travel faster on a wet hot day or a dry cold day? Why?

59) A light wave is reflected from the mirror. The incident and the reflected waves superimpose to form
stationary wave, but the nodes and anti-nodes are not seen. Why?

60) Examine whether the following functions of Y represent a travelling wave
(i) $(x - vt)^2$
(ii) $\frac{1}{x+vt}$

61) If density is made four times, what will be the effect on the velocity of sound ?

62) A child blows air at one end of a straw and slowly cuts pieces of the straw from the other end. What will be the outcome that will be observed?

63) The intensity maxima due to two interfering waves of equal amplitude $a_1 = a_2 = a$ is $4a^2$. Does this violate the law of conservation of energy? Justify.

64) Two sitars A and B, playing the note 'Dha' are slightly out of tune and produce beats of frequency 5Hz. Then tension of the string B is slightly increased and the beat frequency is found to decrease to 3 Hz. what is the Original frequency of B if the frequency of A is 427 Hz?

65) Why should a bat be able to sense high frequencies?

66) A closed and an open pipe are sounded for same frequency. What is the ratio of their lengths?

67) What is the change in frequency when a source goes past a stationary observer with velocity v_s? (Given: velocity of sound is c and the frequency is v).

68) Show graphically, the intensity variation of beats formation?

69) The speed of sound wave depends on temperature but speed of light waves does not. Why?

70) Define longitudinal wave motion. What are the essential conditions required for the formation of longitudinal wave motion?

71) Air gets thinner as we go up in the atmosphere. Will the velocity of sound change?

72) What travels faster - a rifle bullet or the sound of a shot?

73) In an open organ pipe, third harmonic is 450 Hz. What is the frequency of fifth harmonic?

74) We hear two distinct sounds on placing our ear at one end of the metallic pipe when the other end is being hammered. Why?

75) Explain graphically that number of beats formed per second is $n = v_1 - v_2$ where v_1 and v_2 be the frequency of two superimposing waves.

76) The frequencies of two tuning forks A and Bare 250 Hz and 255 Hz respectively. Both are sounded together. How many beats will be heard in 5 seconds?

77) Set up a relation between speed of sound in a gas and root mean square velocity of the molecules of that gas.

78) If a balloon is filled will CO_2 gas, then how can it behave as a lens for sound waves? If it was filled with hydrogen gas, then what will happen?

79) Write a formula for the frequency of vibration of a stretched string in the case of a sonometer.

80) A spring of mass 2.50 kg is under a tension of 200 N. The length of the stretched string is 20.0 m. If a transverse jerk is struck at one end of the string, how long does the disturbance take to reach the other end?

81) The audible frequency range of a human ear is 20 Hz-20 kHz. Convert this into the corresponding wavelength range. Take the speed of sound in air at ordinary temperature to be 340 m/s.

82) An open organ pipe vibrates in harmonic modes. What is the ratio of their wavelengths?

83) If the frequency of a tuning fork is 400 Hz and the velocity of sound in air is 320 m/s, find how far does the sound travel when the fork executes 30 vibrations.

84) If the earth is moving towards a stationary star at a speed of 30 km/s, find the apparent wavelength of light emitted from the star. The real wavelength has the value 5875Å

85) The apparent frequency of the whistle of an engine changes in the ratio 3 : 2 as the engine passes a stationary observer. If the velocity of sound is 330 m/s, calculate the velocity of the engine.

86) In an experiment, it was found that a tuning fork and a sonometer wire gave 5 beats per second, both when the length of the wire was 1 m, and 1.05 m. Calculate the frequency of the fork,

87) The frequencies of the two tuning forks A and Bare 250 Hz and 255 Hz respectively. Both are sounded together. How many beats will be heared in 5 s?

88) Obtain an expression for apparent frequency of sound when the source is moving with a velocity v_s towards the stationary listener.

89) How is the speed of sound waves in atmosphere affected by the humidity an temperature?

90) The equation for the transverse wave on a string is $y = 4\sin 2\pi\left(\frac{t}{0.05} - \frac{x}{50}\right)$ with length expressed in cm and time in second. Calculate the wave velocity and maximum particle velocity.

91) Equation of a wave travelling on a string is
Y = 0.1 sin (300 t - 0.01x)
Here x is in cm and t is in seconds.
Find : (a) Wavelength of the wave;
(b) Time taken by the wave to travel 1 m.

92) If the frequency of a tuning fork is 256 Hz and speed of sound in air is 320 m/s, find how far does the sound travel when the fork executes 64 vibrations?

93) If y = 3 sin (36t + .018x + $\pi/4$) cm, find the amplitude and velocity of the wave.

94) An open pipe resonates. with a frequency v. When half of it is immersed in a dense liquid, what is the fundamental frequency?

95) What is the physical reason to take both +1 and -1 as the cosine maxima in beats formation?

96) Why do we see the flash of lightning first and hear the thunder later?

97) Define temperature coefficient of the velocity of sound.

****

97 x 2 = 194

1) 30 Hz

2) x = -b and x = -2b

3) 0.12m

4) Let n_1 be the frequency of the closed pipe and n_2 of the open pipe and l_1, l_2 their corresponding lengths.

$v = 4l_1n_1 = 2l_2n_2$

or $n_1 = \frac{v}{4l_1}$ and $n_2 = \frac{v}{2l_2}$

Third overtone of the closed pipe (seventh harmonic) = 7n,

First overtone of the open pipe = $2n_2$

Given : $7n_1 = 2n_2$ or $\frac{7v}{4l_1} = \frac{2v}{2l_2}$ or $\frac{l_1}{l_2} = \frac{7}{4}$

5) 1031.25 Hz

6) l = 12m, M = 2.10 kg, T = 2.06 × 10^4N, v =?

$$\mu = \frac{M}{l} = \frac{2.10}{12} kg/m$$

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{2.06 \times 10^4}{2.10/12}} = 3.43 \times 10^2 m/s$$

---

7) As, there is piston at one end, it behaves as a closed organ pipe. Hence, it will produce odd harmonics only.

Hence, resonant frequencies will be first and third harmonics.

In the fundamental mode, $\frac{\lambda}{4} = 25.5\ cm$

$\Rightarrow \lambda = 4 \times 25.5 = 102 \quad cm = 1.02\ m$

Speed of sound in air

$v = V\lambda \quad = 340 \times (1.02) = 346.8 m/s$

---

8) Frequency of A, v_0 = 512 Hz

Number of beats/s = 5

Frequency of B = 512 ± 5 = 517 or 517 Hz

On loading its frequency decreases from 571 to 507, so that number of beats/s remain 5.

Hence, frequency of B when not loaded = 517Hz.

---

9) Length of pipe(l) = 20 cm = 20 x 10^{-2} m

$$v_{funda} = \frac{v}{4L} = \frac{330}{4 \times 20 \times 10^{-2}}$$

$$v_{funda} = \frac{330 \times 100}{80} = 412.5 \quad Hz$$

$$\frac{v_{given}}{v_{funda}} = \frac{1237.5}{412.5} = 3$$

Hence, 3rd harmonic mode of the pipe is resonantly excited by the source of given frequency.

---

10) (i) All the points except the nodes on the string have the same frequency and phase but not the same amplitude.

(ii) Given, $Y = 0.06 \sin\frac{2\pi}{3} x \cos(120\pi)$

Putting x = 0.375 m

Amplitude, $Y = 0.06 \sin\frac{2\pi}{3} \times (0.375)$

$= 0.06 \sin\frac{\pi}{4} = \frac{0.06}{\sqrt{2}} = 0.042\ m$

---

11) Given, $Y = 0.06 \sin\frac{2\pi}{3} x \cos(120\pi)$

Putting x = 0.375 m

Amplitude, $Y = 0.06 \sin\frac{2\pi}{3} \times (0.375)$

$= 0.06 \sin\frac{\pi}{4} = \frac{0.06}{\sqrt{2}} = 0.042 \quad m$

---

12) (i) A short pip by a whistle

(a) will not have a fixed frequency.

(b) will not have fixed wavelength.

(c) will have the definite speed that will be equal to the speed of sound in air.

(ii) 0.05 Hz will be the frequency of repetition of the short pip.

---

13) 0.05 Hz will be the frequency of repetition of the short pip.

---

14) Given, l = 12.0m, M = 2 $\sqrt{\frac{T}{\mu}}$.10kg, T = ?, v = 343m/s

μ = mass per unit length

= $\frac{M}{l} = \frac{2.10}{12} = 0.175\ kgm^{-1}$

Also we know that, v = $\sqrt{\frac{T}{\mu}}$

$\Rightarrow T = v^2\mu = (343)^2 \times (0.175)$

$\Rightarrow T = 2.06 \times 10^4 N$

---

15) On reflection from the denser medium, there will be a phase change of 180^0

Net amplitude = $\frac{2}{3} \times 0.6 = 0.4$

Hence, equation of reflected wave will be

y = 0.4sin $2\pi\left[t + \frac{x}{2} + \pi\right]$

$= 0.4 sin 2\pi(t + x/2)$

---

16) We know that, speed, $v \infty \sqrt{T}$

By formula v = $\frac{xRT}{p}$

Where T is in kelvin

$\frac{v_t}{v_0} = \sqrt{\frac{273+t}{273+0}} = 3$

$\Rightarrow \frac{273+t}{273} = 9 \Rightarrow\ t = 9 \times 273 - 273 = 2184^0 C$

---

17) $v_1 = \frac{1}{l_1 D_1}\sqrt{\frac{T_1}{\pi\rho_1}}$

Where, D = diameter of wire

$v_2 = \frac{1}{l_2 D_2}\sqrt{\frac{T_2}{\pi\rho_2}}$

$l_1 = l_2,\ \rho_2 = \rho_1$

$T_2 = T_1,\ D_2 = 3D_1$

$\Rightarrow V_2 = \frac{V_1}{3}$

New frequency is $\frac{1}{3}$ rd of the original frequency.

---

18)

Conceptual question based on fundamentals of characteristics of travelling wave.

The converse is not true means if the function can be represented in the form y = f(x ± vt), it does not necessarily express a travelling wave. As the essential condition for a travelling wave is that the vibrating particle must have finite displacement value for all x and t.

(i) For x = 0

If t $\rightarrow$ 0, then $(x - vt)^2 \rightarrow 0$ which is finite, hence, it is a wave as it passes the two tests.

(ii) log $\left(\frac{x+vt}{x_0}\right)$

l$At\ x = 0\ and\ t = 0,$

$f(x, t) = log\left(\frac{0+0}{x_0}\right)$

= log 0 $\rightarrow$ not defined

Hence, it is not a wave.

(iii) $\frac{1}{x+vt}$

$For\ x = 0,\ t = 0,\ f(x) \rightarrow \infty$

Though the function is of (x ± vt) type still at x = 0, it is infinite, hence, it is not a wave.

19)

Conceptual question based on fundamentals of characteristics of travelling wave.

The converse is not true means if the function can be represented in the form y = f(x ± vt), it does not necessarily express a travelling wave. As the essential condition for a travelling wave is that the vibrating particle must have finite displacement value for all x and t.

$\frac{1}{x+vt}$

$For\ x = 0,\ t = 0,\ f(x) \rightarrow \infty$

$Though\ the\ function\ is\ of\ (x \pm vt)\ type\ still\ at\ x = 0,$

$it\ is\ infinite,\ hence,\ it\ is\ not\ a\ wave$

20)

Conceptual question based on fundamentals of characteristics of travelling wave.

The converse is not true means if the function can be represented in the form y = f(x ± vt), it does not necessarily express a travelling wave. As the essential condition for a travelling wave is that the vibrating particle must have finite displacement value for all x and t.

For x = 0,

If t $\rightarrow$ 0, then $(x-vt)^2 \rightarrow 0$ which is finite, hence, it is a wave as it passes the two tests.

21)

Given, frequency of A, f_A = 324 Hz

Now, frequency of B, $f_B = f_A \pm$ beat frequency

= 324 ± 6

f_B = 330 or 318 Hz

Now, if tension in the string is slightly reduced, its frequency will also reduce from 324 Hz.

Now, if f_B = 330 and f_A reduces, then beat frequency should increase which is not the case but if f_B = 318 Hz and f_A decrease, the beat frequency should decrease, which is the case and hence, f_B = 318 Hz.

22) (i) Here, given v = 45 Hz, M = 3.5 x 10^{-2}kg

$\mu = \frac{Mass}{Length} = 4.0 \times 10^{-2} kgm^{-1}$

$l = \frac{M}{\mu} = \frac{3.5 \times 10^{-2}}{4 \times 10^{-2}} = \frac{7}{8} ml = \frac{\lambda}{2} = \frac{7}{8}$

$\Rightarrow \lambda = \frac{7}{4} m = 1.75m$

$Speed,\ v = v \times \lambda\ = 45 \times 1.75\ = 78.75 m/s$

(ii) $As\ v = \sqrt{\frac{T}{\mu}} \Rightarrow T = v^2 \times \mu$

$\Rightarrow T = (78.75)^2 \times 4 \times 10^{-2}$

$\Rightarrow T = 248.06\ N$

23) Here, given v = 45 Hz, M = 35 x 10^{-2} kg

$\mu = \frac{\text{Mass}}{\text{Length}} = 4.0 \times 10^{-2} \text{kgm}^{-1}$

$l = \frac{M}{\mu} = \frac{3.5 \times 10^{-2}}{4 \times 10^{-2}} = \frac{7}{8}$ m

$l = \frac{\lambda}{2} = \frac{7}{8} \Rightarrow \lambda = \frac{7}{4}$ m = 1.75 m

(i) Speed $v = v \times \lambda = 45 \times 1.75 = 78.75$ m/s

(ii) As $v = \sqrt{\frac{T}{\mu}} \Rightarrow T = v^2 \times \mu$

$\Rightarrow T = (78.75)^2 \times 4 \times 10^{-2} \Rightarrow T = 248.06$ N

24) Give, v = 1000 kHz =10^6 Hz

v_a = 340 m/s, v_w = 1486 m/s

Wavelength of reflected sound, $\lambda_a = v\frac{v_a}{v}$

$= \frac{340}{10^6} = 3.4 \times 10^{-4} m$

Wavelength of transmitted sound,

$\lambda_w = \frac{v_s}{v} = \frac{1486}{10^6} = 1486 \times 10^{-6}$

$\lambda_w = 1.486 \times 10^{-3} m$

25) No, the converse is not true. The basic requirement for a wave function to represent a travelling wave is that for all values of x and t, wave function must have a finite value. Out of the given functions for y none satisfies this condition. Therefore, none can represent a travelling wave.

26) No. This is because the sounds produced will not have a constant phase difference.

27) Phase difference = $\frac{2\pi}{\lambda} \times$ path difference.

28) Type of wave motion is determined by

(i) nature of the medium,

(ii) mode of excitation of wave motion.

29) The graph will be straight line parallel to pressure axis.

30) In a transverse wave.

31) Phase difference between two successive crests in a transverse wave is 2π rad.

32) Transverse.

33) All even harmonics are absent.

34) Since $v \propto \sqrt{\frac{1}{\rho}}$, therefore velocity of sound will be greater in hydrogen gas.

35) Ultrasonic waves are longitudinal waves in nature and have frequency greater than 20 kHz.

36) No, as it is valid only when $v_s < v$. When $v_s > v$,shock waves are produced.

37) $\frac{v_1}{v_2}\sqrt{\frac{d_2}{d_1}}$

38) $\frac{\lambda}{2}$

39) Speed of transverse waves setup in a string depends upon the tension (T) in the string and the linear mass density (μ) of the string. In fact, $v = \sqrt{\frac{T}{\mu}}$.

40) This is due to the difference in the frequency of the incident wave and the apparent frequency of the reflected wave.

41) $\frac{I_1}{I_2} = \frac{a^2}{b^2} = \frac{2^2}{3^2} = \frac{4}{9}$

42) The frequency is governed by the air column and does not depend upon the nature of the liquid. So frequency would not change.

43) The phase difference between two given particles = $\frac{2\pi}{\lambda} \times \frac{\lambda}{2} = \pi$ radian, i.e., the two particles are in mutually opposite phase conditions.

44) As $v \propto 1/\sqrt{r}$, therefore, wave speed becomes twice.

45)

Elliptical waves while the waves on the surface of water are transverse, the waves just below the surface of water are longitudinal. So the resultant waves are elliptical.

46) This is because sound is transmitted both through air and medium.

47) As $v \propto \sqrt{T}$, therefore, wave speed becomes twice.

48) The time during which the intensity of sound decreases to 10^{-6} times its original intensity.

49) The persistence of audible sound after the source has ceased to produce the sound is called reverberation.

50)

The frequencies of various harmonics (or fundamental tone and overtones) in vibrating string are in the ratio: $v_1:v_2:v_3....$ $= 1:2:3:4 ....$

51) This is because wood has high damping.

52) Velocity of sound in air increases by 0.61 m/ s, when temperature rises by 1^0C.

53) The beats cannot be heard due to persistence of hearing if the difference in frequencies is more than 10.

54) Number of beats per second = $\frac{20}{5} = 4$

$\therefore v_1 - v_2 = 4$.

55) Transverse stationary waves are formed in the sitar wire.

56) This is because moon has no atmosphere and sound cannot travel in vacuum.

57) **Node:** It is a point on stationary wave at which amplitude of vibration of the particle is zero.

Antinode: It is a point on stationary wave at which amplitude of vibration of the particle is maximum.

58) Sound travels faster on a wet hot day due to high temperature and lesser density of wet air.

59)

The distance between successive nodes or anti-nodes is $\frac{\lambda}{2}$.The wavelength (λ) of the light is of the order of 10^{-7}m, so the distance between successive nodes or antinodes is also of the order of 10^{-7} m. Since this distance is very small and cannot be detected by the eye or by an ordinary optical instrument, Hence nodes and antinodes are not seen.

60) Both the functions are not continuous and definite at all values of x and θ. So, they do not represent a wave.

61) If ρ is made four times, the velocity will become half since $v \propto \frac{1}{\sqrt{\rho}}$.

62)

As the pipe gets cut, the length of the resonating column varies, and so at a particular length, there Will he III audible frequency that will be heard.

63)

No, The average intensity of maxima and minima will be, which is the sum of their intensities. So, energy conservation is obeyed, but redistribution of energy has taken place.

64)

Beat Frequency is 5Hz

Original frequency of A 427 Hz

Then tension of the string B is slightly increased and beat frequency is found to decrease to 3 Hz.

i.e. $v_A - v_B = 5$

or $v_B - v_A = 5$

According to question, when tension of B increases, v_B should be increased.

$\Rightarrow v_A - v_B = 5$ is valid relation

$\Rightarrow 427 - v_B = 5$

$\Rightarrow v_B = 422$ Hz

65)

Due to less inertia, the ear drum of bats can resonate faster than human ears. So they can receive high frequencies.

66)

$$v_0 = \frac{nv}{2l_o} \cdot v_c = (2n-1) \times \frac{v}{4l_c}$$

since the velocity of medium is same and frequencies are equal,

$$\frac{v}{2l_0} = \frac{v}{4l_c}$$

$$\therefore \frac{l_c}{l_0} = \frac{2}{4} = \frac{1}{2} = 1:2$$

67)

When a source approaches a stationary observer,

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

When the source goes away,

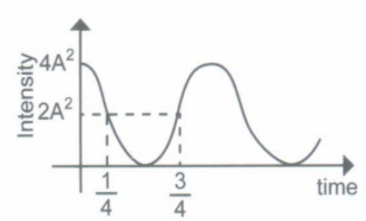
$$v'' = v\left(\frac{c}{c+v_s}\right)$$

$\therefore$ Change when the source goes past stationary observer is

$$v' - v'' = vc\left[\frac{c}{c-v_s} - \frac{c}{c+v_s}\right] = \frac{2vcv_s}{\left(c^2-v_s^2\right)}$$

68)

When beats are formed by two sources having same amplitude but slightly different frequencies, the amplitude is given by 2A cos $2\pi v_m t$ where $v_m = \frac{v_1 - v_2}{2}$. Intensity = $4A^2 \cos^2(2\pi v_m t)$ and is shown graphically here.



69)

Sound waves are mechanical waves whose velocity $v = \sqrt{\gamma_0 RT/m}$. Light waves are non- mechanical waves or electromagnetic waves for which $c = 1/\sqrt{\mu_0 \varepsilon_0}$, where μ_0 is absolute electrical permittivity of free space. Therefore, v depends upon T, but c does not.

70)

It is that wave motion in which the particles of the medium through which the wave is travelling vibrate in a direction parallel to the direction of the motion of the wave. In the figure given below, the wave is travelling from left to right and the particles of the medium vibrate in the horizontal direction simple harmonically. It represents the longitudinal wave motion.

For their propagation, the medium must possess
(i) elasticity,
(ii) inertia,
(iii) absence of frictional resistance

71)

As we move up, the pressure (P) of air and density of air (ρ), both decrease. As v = $\sqrt{\frac{\gamma RT}{m}}$, therefore velocity of sound will not change so long as temperature T of air remains constant.

72)
Rifle bullet travels faster than the sound of shot. The ratio of V_b and V_s is nearly 3 : 1.

73)
Given: v_3 = 450 Hz

∵ $v_3 = 3v_1$

$\Rightarrow v_1 = \frac{v_3}{3} = \frac{450}{3} = 150 \text{ Hz}$

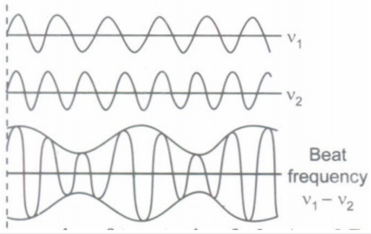
∴ Frequency of fifth harmonic, $v_5 = 5v_1$

$\Rightarrow v_5 = 5 \times 150 \text{ Hz} = 750 \text{ Hz}$

74)

When the metallic pipe is hammered, there are two distinct sounds, through the solid layer, and through the air within the pipe. The sound through the solid reaches much earlier than the sound through air.

75)



76)

f_1=250 Hz, f_2= 255 Hz

No. of beats per second or beat frequency = 255 - 250 =5

No. of beats heard in 5 seconds = 5 x 5 = 25

77)

Speed of sound in gas is

$v = \sqrt{\gamma \frac{P}{\rho}}$...........(i)

According to kinetic theory of gases, root mean square velocity (C) of molecules of gas is obtained from the relation.

$P = \frac{1}{3}\rho C^2, \quad C = \sqrt{\frac{3P}{\rho}}$.....(ii)

Dividing (i) by (ii), we get

$\frac{v}{C} = \sqrt{\frac{\gamma}{3}}$ or $v = \sqrt{\frac{\gamma}{3}} \times C$

This is the required relation.

78)

Velocity of sound in CO_2 is less than that in air. Therefore, balloon will behave as a convex lens for sound waves. In hydrogen, velocity of sound is greater than that in air. Therefore, balloon filled with hydrogen will behave as a concave lens.

79)

Frequency of vibration, V_5 given by,

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

where l is the length of the string between wedges, T is the tension in the string, and μ is mass per unit length of the string. k is a constant which depends upon the mode of vibration of the string.

80)

T = 200 N, l = 20 m

$\mu = \frac{2.50}{20}$ kg/m

$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{200}{2.5/20}} = 40 \text{ ms}^{-1}$

$t = \frac{20}{40} = 0.5$ s

81) $v = \nu\lambda$

For 20 Hz, $\lambda_1 = \frac{v}{\nu} = \frac{340}{20} = 17 \text{ m}$

For 20kHz, $\lambda_2 = \frac{v}{\nu_1} = \frac{340}{20,000} = 0.017 \text{ m}$

Thus, the wavelength range at the audible sound is 0.017 m - 17 m.

82) In open harmonic pipes, $l = \frac{n\lambda}{2}$ and $\nu = \frac{nv}{2l}$. So, the wavelengths will be in the ratio $\frac{1}{1} : \frac{1}{2} : \frac{1}{3} : \frac{1}{4}$ etc.

83) v = 320 m/s;

ν = 400 Hz;

$\lambda = \frac{v}{\nu} = \frac{320}{400} = 0.8 \text{ m}$

∴ The required distance travelled during the time the fork makes 30 vibrations = 30 x 0.8 = 24 m.

84) $\Delta\lambda = \lambda - \lambda'$

$= \frac{u_0\lambda}{c} = \frac{3 \times 10^4 \times 5875 \text{ Å}}{3 \times 10^8}$

$= 5875 \times 10^{-4}\text{Å}$

The apparent wave length,

$\lambda' = \lambda - \Delta\lambda$

$= 5875\text{Å} - \left(5875 \times 10^{-4}\text{Å}\right)$

$= 0.9999 \times 5875\text{Å}$

$= 5874.4 \text{ Å}$

85) $\frac{\nu_1}{\nu_2} = \frac{c + u_0}{c - u_0} = \frac{3}{2}$

Solving we get, $u_0 = \frac{c}{5} = \frac{330}{5} = 66 \text{ ms}^{-1}$.

86) We know $\nu = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

I case : $\nu_1 = \frac{1}{2 \times 1}\sqrt{\frac{T}{\mu}}$ ....(i)

II case : $\nu_2 = \frac{1}{2 \times 1.05}\sqrt{\frac{T}{\mu}}$........(ii)

Let ν he the frequency of the tuning fork, therefore,

ν_1 - ν = 5 and ν - ν_2 = 5 or ν - ν_2

or ν_1 = ν + 5

and $\nu_2 = \nu - 5$ or $\frac{\nu_1}{\nu_2} = \frac{5 + \nu}{\nu - 5}$

From (i) and (ii), we have

$\frac{\nu + 5}{\nu - 5} = \frac{1}{2} \times 2 \times 1.05 = 1.05$

$or \ \frac{\nu + 5}{\nu - 5} = \frac{105}{100} = \frac{21}{20}$

$\Rightarrow \ \nu = 205 \text{ Hz}$

87) Given: v_A = 250 Hz, v_B = 255 HZ, t = 5s

v_B - v_A = 255 Hz - 250 Hz= 5 Hz = Beat frequency

∴ No. of beats heard in 5s = 5 x 5 = 25

---

88)

Let v be the velocity of sound and v_s he the velocity of source towards observer.

As the source approaches, the space between source and observer gets reduced hut should accommodate the same number of waves (as frequency) So wavelength reduces. The new wavelength is

$$\lambda' = \frac{\text{velocity of sound w.r.t. source}}{\text{frequency}}$$

Also, $\lambda' = \frac{v}{v'}$

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

---

89)

(i) Speed of sound wave in atmosphere is more in moist air (humid) than in dry air since density of moist air is less than that of dry air.

(ii) Speed of sound wave in atmosphere is directly proportional to the square root of absolute temperature.

---

90)

$$y = 4\sin\left(\begin{matrix}2\pi t & 2\pi x \\ 0.05 & 50\end{matrix}\right)\text{cm}$$

$$\text{wave velocity } = \frac{\omega}{k}\frac{2\pi/0}{2}$$

$$= \frac{50}{0.05}\ \text{cm/sec}$$

$$= 1000\ \text{cm/sec}$$

= 10 ms^{-1}

$$\text{Particle velocity } = \frac{dy}{dt} = 4 \times \frac{2\pi}{0.05}\cos\left(\frac{2\pi t}{0.05} - \frac{2\pi x}{50}\right)$$

$$\text{Maximum particle velocity } = 4 \times \frac{2\pi}{0} = 502.4\text{cms}^{-1}$$

---

91) (a) Since K = 0.01 cm^{-1},

we get $\frac{2\pi}{\lambda} = 0.01$

or $\lambda = \frac{2\pi}{0.01} = 628\ \text{cm}$

(b) Since ω = 300

$\text{T} = \frac{2\pi}{300}$ for travelling λ

Time for travelling l m

$$= \frac{\text{T}}{\lambda \text{ in m}} = \frac{2\pi}{300 \times 6.28}$$

$$= \frac{1}{300} = 3.33\ \text{ms}$$

92)
$\lambda = \frac{u}{v}$
$= \frac{320\ \mathrm{m/s}}{256\ \mathrm{s}^{-1}}$
$= \frac{320}{256}\ \mathrm{m}$
Distance covered in n viberations = nλ
$= \frac{64 \times 320}{256}$
= 80 m

93)
y = 3 sin (36 t + 0.018 x + π/4)
Amplitude = 3 cm
Velocity of wave $= \frac{\omega}{k} = \frac{36}{0.018} = \frac{36 \times 10^3}{18}$
= 2 x 10^3 crn/sec.

94)
$v = \frac{v}{2l}$ with fundamental frequency. When half immersed in a denser liquid, it will act as a closed pipe of length $\frac{l}{2}$.
$\therefore \quad v' = \frac{v}{4l'} = \frac{v}{4l/2} = \frac{v}{2l}$
So, v = v'

95)
Since Intensity ∝ $(\text{Amplituder})^2$ both +1 and -1 are to be considered in beats.

96)
Since light travels much faster than sound, the flash of lightning is seen first, and the thunder is heard later.

97)
The temperature coefficient of the velocity of sound is defined as the change in the velocity of sound when the temperature changes by 1°C (or I K). It is denoted by α.