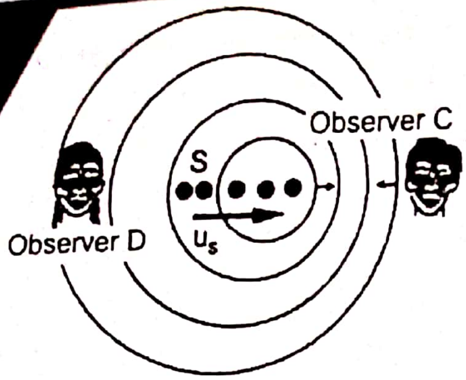


Chapter 8

WAVES

KEY POINTS

Waves:

- Waves transport energy without transporting matter.
- Wave is a disturbance created in a medium.
- **Mechanical waves:** They requires medium for their propagation. e.g. 1- sound waves 2- string waves 3- water waves
- **Electromagnetic waves:** They do not need a medium for their propagation. e.g. 1- T.V waves 2- Heat waves 3- Light waves
- **Progressive waves:** Progressive wave is that which propagates or distributes its pulses in space along specific direction.
- **Transverse waves:** If a particle of the medium vibrate perpendicular to the direction of propagation of the wave is called transverse waves e.g light waves
- **Longitudinal waves:** If a particle of the medium vibrate parallel to the direction of propagation of the wave is called transverse waves e.g sound waves

Velocity of Sound In Air:

- **Newton** was the first to derive a formula for speed of sound in any medium. Its base was that sound waves travel in air isothermally.

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

where E = modulus of elasticity of medium

ρ= density of medium

- **Laplace's relation:** $v = \sqrt{\frac{\gamma P}{\rho}}$

Effect of moisture:

Water vapours are lighter than air thus the presence of moisture in air reduces density hence the speed of sound increases in such cases.

Dependence of velocity of sound:

1- V is independent of pressure

2- $v \propto \frac{1}{\sqrt{\rho}}$

3- $v \propto \sqrt{T}$

4- $\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$

5- $V_t = V_0 + 0.61\ t$

Principle of Superposition:

If a particle of medium is simultaneously acted upon by two waves, then the resultant displacement of the particle is the algebraic sum of their individual displacements.

$Y_{total} = Y_1 + Y_2 + Y_3 + \ldots\ldots + Y_n$

- **Interference:** Two waves having same frequency and traveling in the same direction.
- **Beats:** Two waves of slightly different frequency and traveling in the same direction.
- **Stationary Waves:** Two waves having equal frequency and traveling in the opposite direction.

Interference of Sound:

Super position (mixing up) of two identical sound waves while passing through same medium propagating along same direction is called interference.

- **Constructive interference:** Whenever path difference is an integral multiple of wavelength, the two waves are added up, called constructive interference.
- Path difference = $n\lambda$ where $n = 0, \pm1, \pm2, \ldots\ldots$
- **destructive interference:** Whenever path difference is an odd integral multiple of half the wavelength, called destructive interference.
- Path difference = $(n + \frac{1}{2})\lambda$ where $n = 0, \pm1, \pm2, \ldots\ldots$

Stationary Waves:

- Interaction of two identical waves traveling opposite to each other in the same medium, gives rise stationary or standing waves
- Points of constructive interference are called antinodes while points of destructive interference are called nodes

Standing Waves In Stretched String:

- At fixed end of string always node is formed while at free end of string always antinode is formed.
- Speed of string wave is

$$V = \sqrt{T/m} = \sqrt{F/m}$$

m is called linear mass density.

- Frequency of stationary wave is

$$f_n = n\, f_1$$

$$\text{where } f_1 = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

- Stationary waves obey quantization of frequency.

$f_n = n\, f_1$; $n = 1, 2, 3,$ ---------

where f_1 is the fundamental frequency

Stationary Waves in Air Columns:

- Fundamental frequency in open organ pipe is $f_1 = \frac{v}{2l}$
- Fundamental frequency in closed organ pipe is: $f_1 = \frac{v}{4l}$

Doppler's Effect:

The Apparent change in pitch (frequency) of sound caused by relative motion of eith the sound or the listener called Doppler's effect.

- **When observer moves towards stationary source:**

$$f_A = f\left(\frac{v+u_o}{v}\right)$$

- **When observer moves away from stationary source:**

$$f_B = f\left(\frac{v-u_o}{v}\right)$$

- **When source moves towards stationary observer:**

$$f_C = f\left(\frac{v}{v-u_s}\right)$$

- **When source moves away from stationary observer:**

$$f_D = f\left(\frac{v}{v+u_s}\right)$$

- **Applications of Doppler's effect**

(1) Ships and submarine (sonar devices)
(2) Bats (for traveling)
(3) Radar (for detection)
(4) Determining velocity of a star w.r.t earth
(5) To monitor blood flow in major arteries.

TOPICAL MULTIPLE CHOICE QUESTIONS

Topic 8.1:

Progressive waves

(1) **Sound waves are in nature**
(a) transverse
(b) transverse in solid
(c) longitudinal in air
(d) transverse in liquid

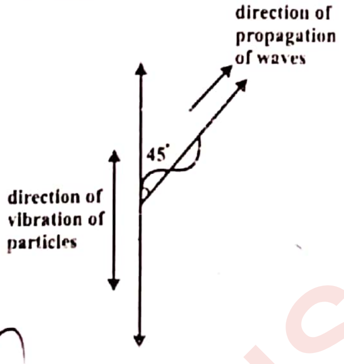
(2) **Which of the following quality remains same when waves traveling from one medium enters into another medium**
(a) frequency
(b) wavelength
(c) velocity
(d) none

(3) **The wave which can propagate through vacuum are**
(a) matter waves
(b) electromagnetic waves
(c) mechanical waves
(d) all of the above

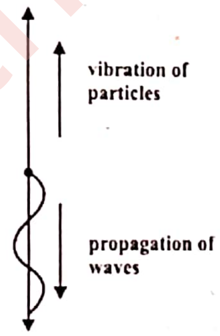
(4) **The waves which require a medium for their propagation are called**
(a) matter waves
(b) electromagnetic waves
(c) mechanical waves
(d) complex waves

(5) **Motion of electrons with high velocities behave like**
(a) matter waves
(b) water waves
(c) light waves
(d) electronic waves

(6) **In the figure below which of the figure best represent a transverse waves.**



(a)



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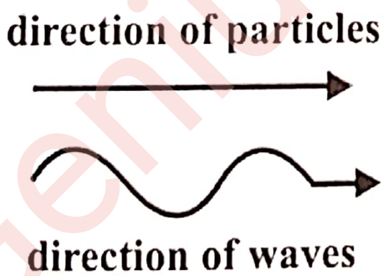
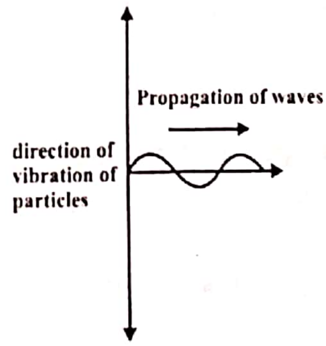


(c)



(d)

(7) **The primary requirement for the generation of a wave is the presence of**
(a) receiver
(b) medium
(c) object
(d) all of these

(8) **In longitudinal waves the particles of the medium vibrate**
(a) Perpendicular to the direction of wave motion
(b) along the direction of wave motion
(c) opposite to the direction of wave motion
(d) any direction of wave motion

(9) **No energy is transmitted in a**
(a) transverse progressive waves
(b) stationary waves
(d) longitudinal progressive waves
(d) none of these

(10) **Waves transmit from one place to another**
(a) wavelength
(b) amplitude
(c) mass
(d) energy

(11) **Transverse waves are those in which particles of the medium are displaced in a direction.**
(a) parallel to direction of propagation
(b) perpendicular to direction of propagation
(c) along to direction of propagation
(d) none to direction of propagation

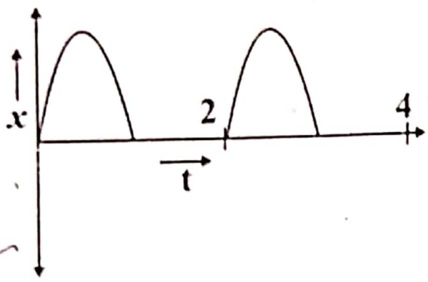
Topic 8.2:

Periodic Waves

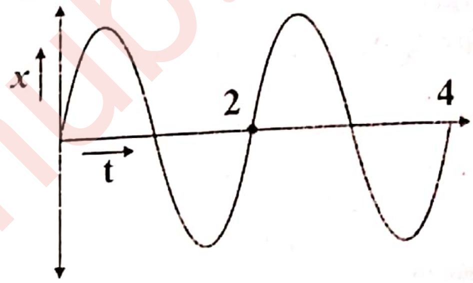
(12) **The speed of periodic wave can be found indirectly from its**
(a) frequency
(b) wavelength
(c) both a and b
(d) none of these

(13) **In wave pattern, all parts move with**
(a) same speed
(b) double speed
(c) different speed
(d) half speed

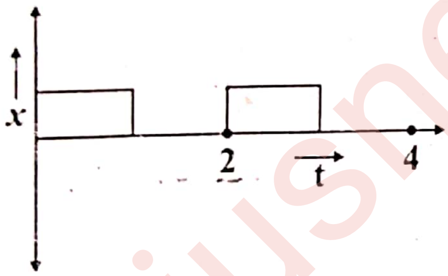
(14) **Which of the following waves have greater frequency?**



(a)



(b)

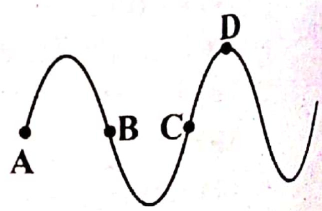


(c)
(d) all have same frequency

(15) **When wave passes from medium to another, deviate from it's path is called**
(a) reflection
(b) refraction
(c) diffraction
(d) transmission

(16) **When two identical waves are superposed, the velocity of the resultant wave**
(a) decreases
(b) increases
(c) remain unchanged
(d) becomes zero

(17) **Consider the figure as shown below. What is the path difference and phase difference between points**
(a) $\frac{5\lambda}{4}, \frac{5\pi}{2}$
(b) $\lambda, 2\pi$
(c) $\frac{5\lambda}{4}, 2\pi$
(d) $\frac{5\lambda}{4}, 4\pi$



(18) **The product of time period and frequency is**
(a) velocity
(b) 1
(c) 2

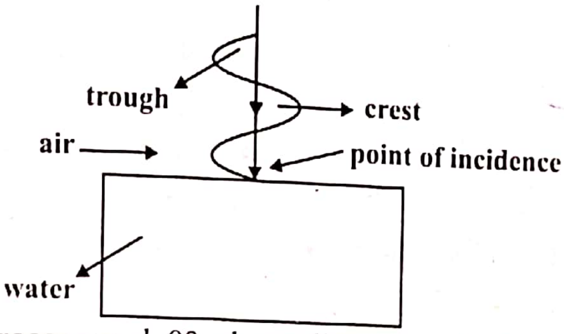
(19) **The portion of a wave below the mean level is called.**

(a) crest (b) trough
(c) node (d) anti-node

(20) **Continuous, regular and rhythmic disturbance in a medium is called**

(a) periodic waves (b) pulse
(c) stationary waves (d) complex waves

(21) **A wave shown in the figure reflects back from the surface of water and remain in air. What must be true for it?**



(a) speed of wave increases and 0° phase difference is observed

(b) trough remains trough yet $\frac{\pi}{2}$ phase difference is observed

(c) trough is converted in crest with phase inversion of 180°

(d) all of these

(22) **The formation of compressions and rarefactions are in**

(a) transverse wave (b) longitudinal waves
(c) electromagnetic wave (d) none of these

Topic 8.3:

Speed of Sound in Air

(23) **Which of the following is true?**

(a) speed of sound in moisture is greater than in dry air
(b) speed of sound does not depend upon pressure
(c) speed of sound varies directly with temperature and inversely with density
(d) all

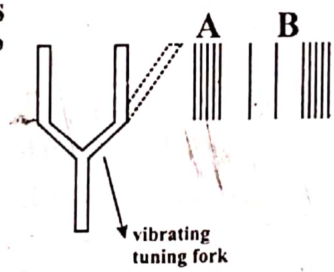
(24) **Expression for Newton's speed of sound in fluids is**

(a) $v = \sqrt{E/\rho}$ (b) $v = \sqrt{\frac{\rho}{E}}$
(c) $v = \sqrt{E\rho}$ (d) $v = \sqrt{\frac{1}{E\rho}}$

(25) **The process followed by Newton for the determination of speed of sound in air is:**

(a) adiabatic (b) isothermal
(c) isobaric (d) isochoric

(26) **When sound passes through air in the form of compressions and rarefactions as shown in the figure then at point "B" what is not true?**



(a) density of air decreases yet speed remains same
(b) temperature decreases yet speed remains same
(c) pressure decreases, volume increases & temperature decreases
(d) none of these

(27) The speed of sound higher in solids than
(a) liquid
(b) gases
(c) both a and b
(d) none of these

(28) If V_t and V_o are velocities of sound in air at temperature T and T_o then
(a) $\frac{V_t}{V_o}=\sqrt{\frac{T}{T_o}}$
(b) $\frac{V_t}{V_o}=\sqrt{\frac{T_o}{T}}$
(c) $\frac{V_o}{V_t}=\sqrt{\frac{T_o}{T_o}}$
(d) $\frac{V_t}{V_o}=\frac{T_o}{T}$

(29) The value of constant (γ) for diatomic gas is:
(a) 1.87
(b) 1.40
(c) 1.29
(d) 1.90

(30) Lap lace's value for speed of sound in a gas at S.T.P
(a) 333 ms^{-1}
(b) 332 ms^{-1}
(c) 280 ms^{-1}
(d) 300 ms^{-1}

(31) The value of constant (γ) for mono-atomic gas is.
(a) 1.40
(b) 1.28
(c) 1.67
(d) 1.90

(32) A conical surface of concentrated sound energy sweeps over the ground as a super sonic plane passes over head called
(a) ultra sonic boom
(b) ultra violet boom
(c) infrasonic boom
(d) sonic boom

(33) At what temperature the velocity of sound in air is two times its velocity at 10^0C
(a) 859K
(b) 10 C°
(c) 1132K
(d) 890 C°

(34) The experimental value of speed of sound in air at 0 C° is
(a) 333 ms^{-1}
(b) 340 ms^{-1}
(c) 330 ms^{-1}
(d) 332 ms^{-1}

(35) Velocity of sound in vacuum at 0^0C is
(a) 340m/sec
(b) 332 m/sec
(c) 280 m/sec
(d) zero

(36) Newton's formula for the speed of sound in air
(a) $\sqrt{\frac{P}{\rho}}$
(b) $\sqrt{\frac{\gamma P}{\rho}}$
(c) $\sqrt{\frac{\rho}{P}}$
(d) $\sqrt{\frac{\rho\gamma}{P}}$

(37) The ratio of the speed of sound in hydrogen to the speed of sound oxygen is
(a) 1:2
(b) 2:1
(c) 1:4
(d) 4:1

(38) Audible frequency range for a normal human being is
(a) 200 to 2000Hz
(b) 20 to 20000 Hz
(c) 10 to 20000Hz
(d) 200 to 200000Hz

(39) Speed of sound at 1 atm pressure is 332m/sec. the speed of sound at 2atm pressure at same temperature is

(a) 332m /sec
(b) 664m/sec
(c) 166m/sec
(d) 83m/sec

(40) The speed of sound is independent of

(a) moisher
(b) temperature
(c) density
(d) pressure

(41) For all gases

(a) $v_t = v_o\sqrt{1-\frac{t}{273}}$
(b) $v_t = v_o\sqrt{1+\frac{t}{273}}$
(c) $v_t = v_o\sqrt{1+273t}$
(d) $v_t = v_o\sqrt{1+\frac{273}{t}}$

(42) Newton proposed that the speed of sound in air is

(a) $333ms^{-1}$
(b) $280ms^{-1}$
(c) $330ms^{-1}$
(d) $332ms^{-1}$

(43) The speed of sound is higher in solid than the gases due to high

(a) temperature
(b) frequency
(c) elasticity
(d) density

(44) For small changes in temperature, the velocity of sound can be find by the relation

(a) $v_t = v_o + 0.61t$
(b) $v_t = v_o + 0.061t$
(c) $v_t = v_o - 0.61t$
(d) $v_t = v_o - 0.061t$

(45) If speed of source becomes greater than speed of sound then it produces

(a) Doppler's effect
(b) silence zone
(c) sonic boom
(d) all

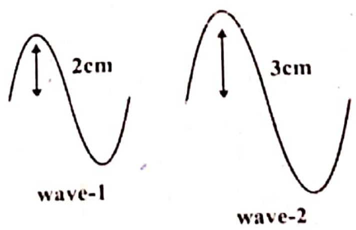
(46) One degree Celsius rise in temperature increases the speed of sound by

(a) $0.661ms^{-1}$
(b) $1.62ms^{-1}$
(c) $0.61ms^{-1}$
(d) $1.67ms^{-1}$

Topic 8.4:

Principle of Superposition

(47) Two identical waves of different amplitudes are shown in the figure. What will be the ratio of their intensities?



(a) 9:4
(b) 3:2
(c) 5:1
(d) none of these

(48) The resultant displacement of the super position of two waves of amplitudes y_1 and y_2 same frequency which are exactly in phase

(a) 0
(b) $y_1 + y_2$
(c) $y_1 - y_2$
(d) none of these

(49) If two waves having same frequency and traveling in the same direction, superpose the phenomenon is known as

(a) Beats
(b) Interference
(c) Stationary waves
(d) Diffraction

(50) **Two pulses in a stretched string whose centers are initially 8 cm apart are moving towards each other as shown in Fig. 7. The speed of each pulse is 2 cms^{-1}. After 2 second the total energy of the pulses will be**

(a) zero
(b) purely kinetic
(c) purely potential
(d) partly kinetic and partly potential

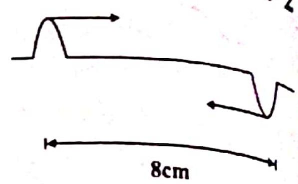


Fig. 7

(51) **Two waves of slightly different frequencies could traveling in the same direction's called**

(a) Interference
(b) Beats
(c) dispersion
(d) Stationary waves

Topic 8.5:

Interference

(52) **The path difference for constructive interference of sound can be expressed as**

(a) $\Delta S = (m+1/2)\lambda$
(b) $\Delta S = m\lambda$
(c) $(2m+1)\lambda/2$
(d) $\Delta S = \left(1+\frac{m}{2}\right)\frac{\lambda}{2}$

(53) **During destructive interference of two waves of same amplitude, the CRO shows the**

(a) maximum displacement
(b) double of original displacement
(c) zero displacement
(d) half of the original displacement.

(54) **The series of path differences for two identical waves to go through interference is**

(a) $\pm\frac{\lambda}{2}, \pm\frac{3\lambda}{2}, \pm\frac{5\lambda}{2}, ...$
(b) $0, \pm\lambda, \pm2\lambda, \pm3\lambda, \pm4\lambda......$
(c) $\pm\frac{5\lambda}{3}, \pm\frac{7\lambda}{3}, ...$
(d) both A and B

(55) **When two waves of same frequency meet destructively then resultant displacement displayed on C.R.O**

(a) zero
(b) maximum
(c) minimum
(d) none

(56) **Which of the following property is followed by the superposition principle of the wave.**

(a) simple multiplication
(b) simple addition
(c) simple division
(d) none of these

57) **The CRO is a device to display the input signal into**

(a) pulses
(b) wave form
(c) data form
(d) none of these

58) **The condition for destructive interference has the path difference of**

(a) $\Delta S = n\lambda$
(b) $\Delta S = \left(\frac{n}{2}+1\right)\lambda$
(c) $\Delta S = (2n+1)\frac{\lambda}{2}$
(d) $\Delta S = \left(n+\frac{1}{2}\right)\frac{\lambda}{2}$

59) **Whenever the path difference of two waves is an integral multiple of wavelength then two waves are**

(a) subtracted
(b) added up
(c) multiplied
(d) divided

(60) In interference, the points where the displacements of two waves cancel the each other's effect, then
(a) path difference is an odd multiple of half of wavelength
(b) path difference is an even multiple of half of wavelength
(c) path difference is an odd multiple of a wavelength
(d) path difference is an even multiple of a wavelength

Topic 8.6:

Beats

(61) Phenomenon of beats is due to
(a) interference (b) diffraction
(c) polarization (d) refraction

(62) Which of the following is not an application of superposition principle?
(a) interference (b) beats
(c) stationary waves (d) none

(63) Two tuning forks A and B give four beats / sec. If one of the tuning fork is loaded with wax then number of beats/sec
(a) increases (b) decreases
(c) remains same (d) may increase or decrease

(64) If a tuning fork is loaded with some wax, its frequency
(a) increases
(b) decreases
(c) may increase or decrease depending upon frequency
(d) remains same

(65) Two waves of frequency f_1 and f_2 ($f_1 > f_2$) produces beats. The number of beats produced per sec are
(a) $f_1 - f_2$ (b) $f_1 + f_2$
(c) $\frac{f_1}{f_2}$ (d) $\frac{f_2}{f_1}$

(66) Beats cannot be heard if the difference of frequencies is more than about
(a) 6 HZ (b) 10Hz
(c) 4 Hz (d) 9 Hz

(67) Beats are produce when
(a) sound is heard after multiple reflections
(b) interference of two sound waves of slightly different frequencies take place
(c) sound waves enter into a highly dispersive medium
(d) interference of two sound waves of the same frequency but different in amplitude take place

(68) The pitch of sound depends upon
(a) frequency (b) amplitude
(c) harmonics (d) intensity

(69) Two tuning forks of frequency 260 Hz and 257 Hz are sounded together the number of beats per second is:
(a) 3 (b) 2
(c) zero (d) 4

(70) Loudness of sound depends upon
(a) frequency (b) pitch
(c) amplitude (d) none

Topic 8.7:

Reflection of Waves

(71) The reflected wave has the same frequency and wavelength but its phase may change depending upon the

(a) speed of wave
(b) nature of wave
(c) nature of boundary
(d) time period

(72) When a transverse wave is reflected from the boundary of denser medium it under goes a change of phase

(a) 0^{o}
(b) 90^{o}
(c) 180^{o}
(d) 360^{o}

(73) A slinky spring is a loose spring which has

(a) small initial length
(b) relatively large extended length
(c) both a & b
(d) none of these

(74) If transverse wave traveling in a denser medium is incident on a rare medium, it is reflected by

(a) phase change of 360^{0}
(b) change of 180^{0}
(c) without change in phase
(d) phase change of 90^{0}

(75) The maximum destructive interference happened when waves are out of phase by.

(a) 90^{0}
(b) 180^{0}
(c) 270^{0}
(d) 360^{0}

(76) When the wave comes across the boundary of two medium.

(a) total wave is reflected back
(b) a part of it is reflected back
(c) total wave is transmitted
(d) none of these

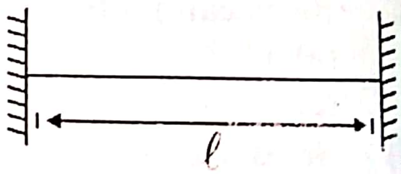
Topic 8.8 & 8.9:

Stationary Waves & Stationary Waves in a Stretched String

(77) Distance between two consecutive nodes is

(a) $\lambda/4$
(b) $\lambda/2$
(c) λ
(d) $3\lambda/2$

(78) A string stretched between two rigid supports is plucked from $\frac{\ell}{3}$ then the number of loops formed are

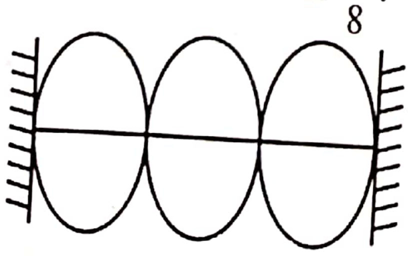


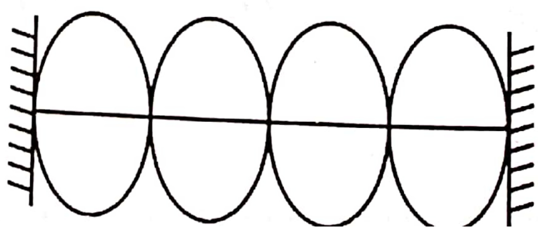
(a) 1
(b) 2
(c) 1.5
(d) no loop will be formed

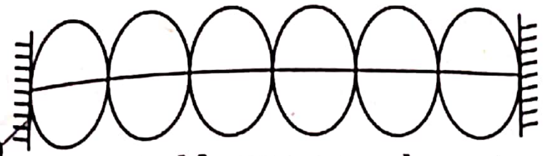
(79) The fixed ends of vibrating string are called

(a) nodes
(b) antinodes
(c) overtone
(d) none

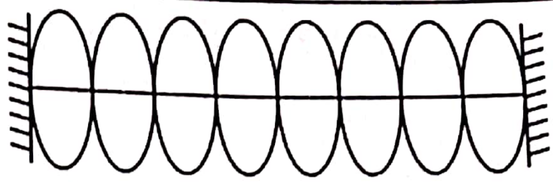
(80) Which of the following is the correct figure if a string stretched from both ends is plucked at a distance of $\frac{\ell}{8}$?

(a)


(b)




(c)



(d)

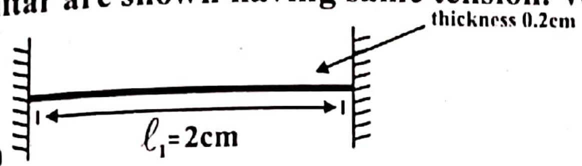
(81) The product of frequency and wavelength is equal to.
(a) speed of wave
(b) time period (T)
(c) force
(d) none of these

(82) The distance between two consecutive crests or troughs is called
(a) Frequency
(b) wavelength
(c) time period
(d) amplitude

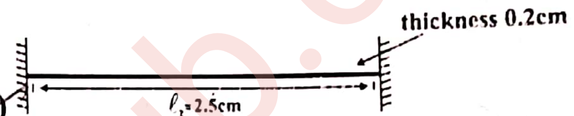
(83) When the antinodes are all at their extreme displacements, the energy stored is
(a) K.E
(b) P.E
(c) thermal energy
(d) all of these

(84) A musician use a guitar which can produce maximum fundamental frequency. Four guitar are shown having same tension. Which be must select?

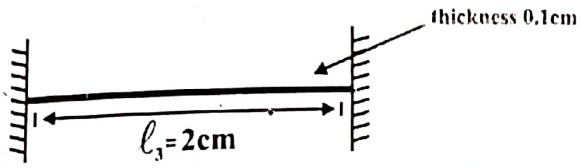
(a)



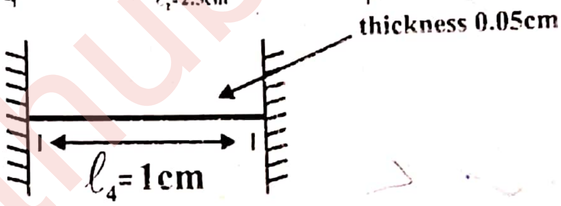
(b)



(c)



(d)



(85) The fundamental frequency of stationary wave in a stretched string is
(a) maximum frequency
(b) minimum frequency
(c) average frequency
(d) zero

(86) The frequency of a string on a musical instrument can be changed by
(a) changing the length
(b) changing the amplitude
(c) changing the tension
(d) either a or b

(87) The speed of the waves in the string is given by
(a) $v=\sqrt{\frac{F}{g}}$
(b) $v=\sqrt{\frac{m}{F}}$
(c) $v=g\sqrt{\frac{F}{m}}$
(d) $v=\sqrt{\frac{F}{m}}$

(88) When the string vibrates in two loops, its frequency becomes ________ than when it vibrates in one loop.
(a) half
(b) double
(c) 4 times
(d) remain same

(89) If the string vibrates in 'n' loops, the wavelength is given by
(a) $\lambda_n=\frac{2}{nl}$
(b) $\lambda_n=\frac{2l}{n}$
(c) $\lambda_n=\frac{l}{2n}$
(d) none of these

(90) For 'n' number of loops in a string the fundamental frequency is given by

(a) $f_1 = \frac{f_n}{2n}$ (b) $f_1 = \frac{f_n}{n}$

(c) $f_1 = nf_n$ (d) $f_1 = \frac{n}{f_n}$

(91) When the string vibrates in three loops then the length 'l' of the string is expressed as

(a) $l = \frac{3\lambda}{4}$ (b) $l = \frac{\lambda}{2}$

(c) $l = \frac{3\lambda}{2}$ (d) $l = \frac{2\lambda}{3}$

(92) A standing-wave pattern is formed when the length of the string is an integral multiple of

(a) half wavelength (b) double wavelength

(c) quarter of wavelength (d) 1/4 of wavelength

(93) If tension in a string is made four times then speed of wave becomes

(a) double (b) four times

(c) one times (d) none

(94) The energy remains standing in the medium.

(a) between nodes (b) between antinodes

(c) between node and antinodes (d) none of these

(95) Stationary waves are also known as

(a) micro waves (b) sound waves

(c) standing waves (d) ultra sonics

(96) When the string vibrate in one segment (loop) then length of string is

(a) $l = \lambda$ (b) $l = \frac{\lambda}{2}$

(c) $l = \frac{\lambda}{4}$ (d) $l = 2\lambda$

Topic 8.10:

Stationary Waves in Air Column

(97) In open pipe, harmonics generated are

(a) even (b) odd

(c) both even and odd (d) no

(98) Velocity of sound in air is 320 ms^{-1}. The resonant pipe shown in Fig. 40 cannot vibrate with a sound of frequency

(a) 80 Hz (b) 240 Hz

(c) 320 Hz (d) 400 Hz

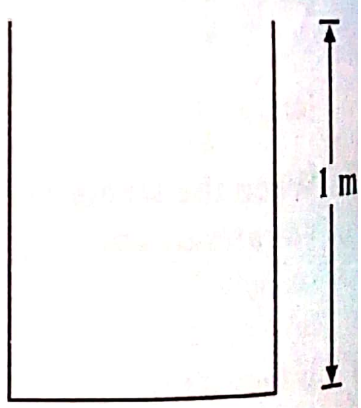


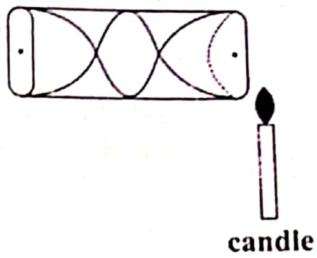
Fig. 40

(99) The stationary longitudinal waves in a pipe closed at one end, only _______ harmonics are present.

(a) even (b) odd

(c) just multiple of 5 (d) all of these

(100) An organ pipe with both ends open is shown in the figure. If its fundamental frequency is f_1 such that a candle is brought near one end then the frequency will



(a) increase
(b) decrease
(c) cant be effected
(d) cant be predicted

(101) In fundamental mode of vibration of a closed end pipe, the wavelength is

(a) l
(b) 2l
(c) $\frac{l}{2}$
(d) 4l

(102) When one end of organ is closed, then the wave length of stationary wave of any harmonic in it is given by

(a) $\lambda n = \frac{4l}{n}$
(b) $\lambda n = \frac{4n}{l}$
(c) $\lambda n = \frac{l}{4n}$
(d) $\lambda n = \frac{n}{4l}$

(103) The organ pipe which is open at both ends is

(a) weaker in harmonics
(b) richer in harmonics
(c) no harmonics produce
(d) none of these

Topic 8.11:

Doppler Effect

(104) A rocket is going away from earth at a speed 0.26, where c=speed of light. If emits signals $4x10^7$ Hz. Which frequency will be observed by an observer on earth?

(a) 4×10^6Hz
(b) 3.2×10^7Hz
(c) 3×10^6Hz
(d) 5×10^7Hz

(105) Sonar depends upon

(a) interference
(b) beats
(c) resonance
(d) acoustical echo

(106) Stars moving towards earth shows

(a) blue shift
(b) red shift
(c) no shift
(d) may be 'a' may be 'b' depending upon speed of stars

(107) A car is shown in the figure which is moving towards a high cliff. The car driver sounds a horn of frequency f. The reflected sound heard by the driver has a frequency 2f if v be the velocity of sound, then the velocity of the car, in the same velocity units will be

(a) $\frac{v}{3}$
(b) $\frac{v}{4}$
(c) $\frac{v}{2}$
(d) $\frac{v}{\sqrt{2}}$

(d) may increase or decrease depending upon speed of listener

(108) Doppler's effect can be used to calculate the

(a) speed of light
(b) speed of galaxy
(c) speed of sound
(d) speed of electromagnetic waves

(109) **Sonar is used to detect**
(a) location of submarine
(b) depth of sea
(c) control anti-submarine weapons
(d) all of them

(110) **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 the wall is (speed of sound is air=350 m/s)**
(a) zero
(b) 3.5 Hz
(c) 5 Hz
(d) 10 Hz

(111) **Bats navigate and find food by**
(a) ultrasonic
(b) echo location
(c) amplitude
(d) refraction

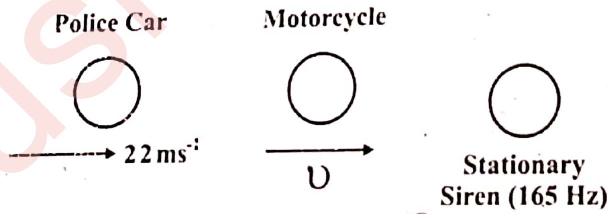
(112) **The sonar is a technique for detecting the presence of objects under water by**
(a) ultra sonic
(b) infrasonic
(c) frequency
(d) echo

(113) **When an observer is moving away with the velocity 'u_o' from the stationary source of sound of frequency 'f' the speed of sound in air is 'v' then the changed frequency 'f_B' of sound is given by**

(a) $f_B = \frac{v+u_o}{v} f$
(b) $f_B = \frac{v-u_o}{v} f$
(c) $f_B = \frac{v}{v-u_o} f$
(d) $f_B = \frac{v}{v+u_o} f$

(114) **The speed of stars and galaxies can be calculated by**
(a) Compton's effect
(b) Doppler's effect
(c) Pascal's law
(d) Stefan's law

(115) **A police car moving at 22 ms^{-1}, chase 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 ms^{-1}
(b) 22 ms^{-1}
(c) zero
(d) 11 ms^{-1}

(116) **Doppler effect is not applicable for**
(a) microwaves
(b) ultra Sonics
(c) electro magnetic waves
(d) standing waves

(117) **When the observer and source move with same velocity along same direction then**
(a) relative velocity will be zero
(b) no change in frequency
(c) both a and b
(d) none

(118) **When the source moves away from the stationary observers then frequency will be**
(a) decrease
(b) increase
(c) remain same
(d) none

(119) **When an aeroplane move towards air port, then its frequency received by radar**
(a) decreases (b) increases
(c) remain some (d) become zero

(120) **Stars moving away from the earth show**
(a) red shift (b) blue shift
(c) yellow shift (d) green shift

(121) **In the blue shift, the spectrum is shifted towards**
(a) larger wavelength (b) smaller wave length
(c) zero wavelength (d) none of these

(122) **Radar is a device which**
(a) transmit radio wave (b) receive radio waves
(c) both a and b (d) none of these

MULTIPLE CHOICE QUESTIONS

(From Past Papers 2012-2017)
(Federal Board)

(1) The temperature at which the velocity of sound in air is two times it velocity at 10°C is ____ (FDR 2012)
(a) 1321K
(b) 1213K
(c) 1132K
(d) 1231K

(2) For constructive interference path difference between two sound waves is ____ (FDR 2012)
(a) $S = n\lambda + \lambda$
(b) $S = (2n+1)\frac{1}{\lambda}$
(c) $S = (2+\frac{1}{\lambda})n$
(d) $S = n\lambda$

(3) The frequency for nth mode of vibration for stationary longitudinal waves in pipe open at both end is ____ (FDR 2012)
(a) $f_n = \frac{nv}{4v}$
(b) $f_n = \frac{4t}{nv}$
(c) $f_n = \frac{2\ell}{nv}$
(d) $f_n = \frac{nv}{2\ell}$

(4) The waves which propagate by the oscillation of material particles are known as ____. (FDR 2013)
(a) Magnetic waves
(b) Material waves
(c) E.M waves
(d) Mechanical waves

(5) To monitor the blood flow, ultrasonic waves of ____ frequency are used (FDR 2013)
(a) 5MHz→10MHz
(b) 25MHz→30MHz
(c) 9MHz→90MHz
(d) 20MHz→200MHz

(6) An organ pipe is 5 m long, with one end closed its fundamental frequency will be ____. (FDR 2013)
(a) 16.6 Hz
(b) 20 Hz
(c) 18 Hz
(d) 60 Hz

(7) If a pipe is closed at one end and open at the other, the fundamental note produced by it is ____ (FDR 2014)
(a) $f_1 = \frac{v}{4l}$
(b) $f_1 = \frac{v}{2l}$
(c) $f_1 = \frac{2l}{v}$
(d) None of these

(8) When two notes of frequencies 'f_1' and 'f_2' are sounded together, beats are produced. If $f_1 > f_2$, what will be the period of beats? (FDR 2016)
(a) $\frac{1}{f_1 + f_2}$
(b) $\frac{1}{f_1 - f_2}$
(c) $f_1 + f_2$
(d) $f_1 - f_2$

(9) A stationary sound wave has series of nodes. The wavelength of the sound wave is 'λ'. What is the distance between first and fifth node? (FDR 2016)
(a) $\frac{3\lambda}{2}$
(b) 2λ
(c) $\frac{\lambda}{}$
(d) $\frac{\lambda}{2}$

ANSWER KEYS

(Topical Multiple Choice Questions)

1	c	21	c	41	b	61	a	81	a	101	d	121	b
2	a	22	b	42	b	62	d	82	b	102	a	122	c
3	b	23	c	43	c	63	a	83	b	103	b		
4	c	24	a	44	a	64	b	84	b	104	d		
5	a	25	b	45	c	65	a	85	a	105	d		
6	a	26	a	46	c	66	b	86	d	106	a		
7	b	27	c	47	a	67	b	87	d	107	b		
8	b	28	a	48	b	68	a	88	b	108	c		
9	b	29	b	49	b	69	a	89	b	109	d		
10	d	30	a	50	b	70	c	90	b	110	a		
11	b	31	c	51	b	71	c	91	c	111	b		
12	c	32	d	52	b	72	c	92	a	112	a		
13	a	33	c	53	c	73	c	93	a	113	b		
14	a	34	d	54	d	74	c	94	a	114	b		
15	b	35	d	55	a	75	b	95	c	115	b		
16	c	36	a	56	b	76	b	96	b	116	d		
17	c	37	d	57	b	77	b	97	c	117	c		
18	b	38	b	58	c	78	b	98	c	118	a		
19	b	39	a	59	b	79	a	99	b	119	b		
20	a	40	d	60	a	80	c	100	b	120	a		

SHORT QUESTIONS
(From Textbook Exercise)

8.1. What features do longitudinal waves have in common with transverse waves?

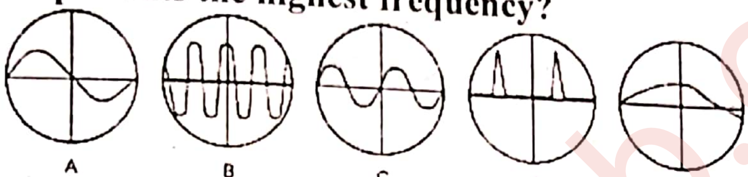
Ans: The common features of transverse and longitudinal waves are as follows.

- They produce disturbance in the medium through which they pass.
- Both transport energy from one place to another but not matter.
- Both are mechanical waves.
- Both have frequency "f", wavelength" λ " and speed: $v=f\lambda$.
- Both have amplitude

8.2. The five possible waveforms obtained, when the output from a microphone is fed into the Y-input of cathode ray oscilloscope, with the time base on, are shown in fig 8.23. Theses waveforms are obtained under the same adjustment of the cathode ray oscilloscope controls. Indicate the waveform

(a) Which trace represents the loudest note?

(b) Which trace represents the highest frequency?



Ans: (a) As the loudness depends upon the amplitude. Therefore, trace **D** represents the loudest note.

(b) As the frequency is defined as the number of waves crossing a point per second. Therefore, the trace **B** represents the highest frequency.

8.3. It is possible for two identical waves traveling in the same direction along a string to give rise to a stationary wave?

Ans: No, it is not possible for two identical waves traveling in the same direction along a string to give rise to stationary waves. As production of stationary waves requires two identical waves traveling along a straight line in opposite direction.

8.4. A wave is produced along a stretched string but some of its particles permanently show zero displacement. What type of wave is it?

Ans: We know that in stationary waves, nodes and antinodes are formed. Nodes are the points at which the amplitude of the particles is zero. Therefore, a wave produced along a stretched string in which some of its particles permanently show zero displacement is a stationary wave.

8.5. Explain the terms crest, trough, node and anti-node.

Ans: **Crest:**

"The portion of the wave above the equilibrium position in case of transverse waves is called a crest."

Trough:

"The portion of the wave below the equilibrium position in case of transverse waves is called a trough."

Node:

"The point having zero displacement in case of stationary wave is called a node."

Anti-node:

"The point having maximum displacement in case of stationary waves is called an anti-node."

8.6. Why does sound travel faster in solids than in gases?

Ans: The velocity of sound in a medium is directly proportional to the square root of the elasticity of the medium.

As by formula:

$$V = \frac{\sqrt{E}}{\sqrt{\rho}} \Rightarrow V \propto \sqrt{E}$$

Since, the elasticity of solids is very larger than that of gases. Therefore sound travels faster in solids than in gases.

8.7. How are beats useful in tuning musical instruments?

Ans: To tune a musical instrument, we compare the note of the instrument with some other note of known frequency. We have to avoid beats are equal to the difference of frequencies, therefore we can use knowledge of beats in tuning musical instruments by adjusting the desired frequency by tightening or loosening the string until no beats are heard.

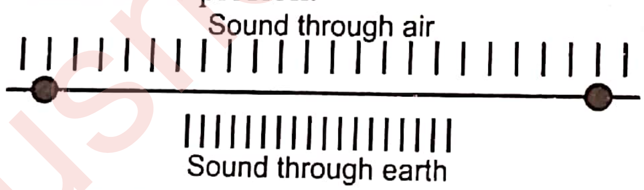
8.8. When two notes of frequencies f_1 and f_2 are sounded together, beats are formed. If $f_1 > f_2$, what will be the frequency of beats?

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

Ans: As the number of beats produced per second is equal to the difference of the frequencies of the two waves. Therefore, the correct answer is $f_1 - f_2$.

8.9. As a result of a distant explosion, an observer senses a ground tremor and then hears the explosion. Explain the time difference.

Ans: In case of distant explosion, sound reaches the observer by air as well as by ground. As, speed of sound is greater in solids than in gases. Therefore, the observer senses ground tremor first and then hears the explosion.



8.10. Explain why sound travels faster in warm air than in cold air.

Ans: The velocity of sound in a medium is inversely proportional to the square root of density of the medium i.e.

$$V \propto \frac{1}{\sqrt{\rho}}$$

As the density of warm air is lesser than that of cold air. Therefore, sound travels faster in warm air then in cold air.

8.11. How should a sound source move with respect to an observer so that the frequency of its sound does not change?

Ans: If source of sound moves in a circular path with observer, at the centre of the circular path, then the distance between the observer and the source does not change. Therefore, the frequency of sound with respect to observer remains same.

SHORT QUESTIONS

(From past papers 2012-2017)
(Federal Board)

(1) How are beats useful in tuning musical instruments? **(FDR 2012)**

(2) How should a sound source move with respect to an observer so that the frequency of its sound does not change? **(FDR 2012)**

(3) Write an expression for harmonics are integral multiple of fundamental note, stationary waves? **(FDR 2013)**

(4) What is Laplace correction? **(FDR 2014)**

(5) What do "RADAR" and "SONAR" stand for? Which has larger wavelength sound or light? **(FDR 2015)**

(6) A closed organ pipe has a length of 0.25 m. Determine the frequencies of the fundamental and first two harmonic (speed of sound in air = $340ms^{-1}$) **(FDR 2015)**

(7) An organ pipe has a length of 50 cm. Find the frequency of its fundamental note. When it is **(a)** open at both ends **(b)** closed at one end (speed of sound = $350ms^{-1}$) **(FDR 2016)**

(8) Why does sound travel faster in solids than the gases? Explain. **(FDR 2016)**

(9) A pipe has length one meter, determine the frequencies of the fundamental and first two harmonics: (speed of sound = $350ms^{-1}$)

a. If the pipe is open at its both ends **(FDR 2017)**

b. If the pipe is closed at its both ends **(FDR 2017)**

(10) Define Doppler's Effect. And also write its few applications.