EXERCISE

Select the correct answer of the following questions.

1) A water wave moves in two dimensions from the source point and at a far distance the curvature of the wave front becomes plane. As the wave proceeds the energy carried by the wave.

a. Decreases b. Increases

c. Remains constant d. It needs some more information

2) When a wave goes from one medium to another medium, which one of the following characteristics of the wave remains constant

a. Velocity b. Frequency c. Wave length d. Phase

3) When a transverse wave is reflected from the boundary of a denser to a rarer medium, it under goes a phase change of

a. 0 b. $\frac{\pi}{2}$ c. π d. 2π

4) If the tension in the string is doubled and its mass per unit length is reduced to half. Then the speed of transverse wave on it is

a. Doubled b. Halved c. Constant d. One fourth

5) Which one of the following properties is not exhibited by the longitudinal waves?

a. Reflection b. Interference c. Diffraction d. Polarization

6) A sounding source and a listener are both at rest relative to each other. If wind blows from the listener towards the source, then which one of the following of sound will change?

a. Frequency b. Speed

c. Both Frequency and Speed d. Wavelength

7) Which one of the following factors has no effect on the speed of sound in gas?

a. Humidity b. Pressure c. Temperature d. Density

8) When sound waves travel from air to water which of these remain constant?

a. Velocity b. Frequency c. Wavelength d. All the above

9) There is no net transfer of energy by particles of medium in.

a. Longitudinal wave b. Transverse wave

c. Progressive wave d. Stationary wave

10) Which one of the following could be the frequency of ultraviolet radiation?

a. 1.0×10^{6} Hz b. 1.0×10^{9} Hz c. 1.0×10^{12} Hz d. 1.0×10^{15} Hz

11) When a stationary wave is formed then its frequency is

a. Same as that of the individual waves b. Twice that of the individual waves

c. Half that of the individual waves d. that of the individual waves

e. Triple that of the individual waves

12. Which of the following changes at an antinode in a stationary wave?

a. Density only

b. Pressure only

c. Both pressure and density

d. Neither density nor pressure

13. A sound source is moving towards stationary listener with $1/10^{th}$ of the speed of sound. The ratio of apparent of real frequency is

a. $\frac{11}{10}$

b. $\left[\frac{11}{10}\right]^2$

c. $\left[\frac{9}{10}\right]^2$

d. $\frac{10}{9}$

Answers:

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(a)	**5.**	(d)
6.	(d)	**7.**	(b)	**8.**	(b)	**9.**	(d)	**10.**	(d)
11.	(a)	**12.**	(b)	**13.**	(d)	-	-	-	-

Write the short answer of the following:

1) What is the difference between progressive and stationary waves?

Answer

Progressive waves:

Those waves which transmit energy from one point to another point are called progressive waves. Many vibrating objects act as sources for the generations of waves. When an object vibrates, it does work on the particles of the medium and imparts energy, due to which particles of the medium start vibration. As a result, energy is transferred from one place to another place without the transportation of material object.

- For example, sound waves can originate from a vibrating tuning fork and electromagnetic waves can originate from vibrating atoms.
- In case of progressive waves principle of superposition may or may not be applied.

Standing waves:

When two or more than two waves having the same amplitude & frequency, traveling with the same speed in opposite direction along a line, are superposed, a wave is obtained is called stationary wave or standing wave. These waves can be set up in any medium which do not transmit energy from one place to another place. Since the wave form does not move in the direction of either the incident waves or the reflected waves.

That is why it is called stationary or standing wave.

To produce stationary waves superposition principle must be applied.

2) Clearly explain the difference between longitudinal & transverse waves.

Answer

Longitudinal waves

Those waves in which the particles of the medium have displacements along the direction of propagation of waves, are called longitudinal waves. Generally longitudinal waves require a material medium for their propagation.

- For example, sound waves are longitudinal waves which cannot travel through vacuum.

Transverse waves:

Those waves in which the particles of the medium have displacement perpendicular to the direction of propagation of waves are called transverse waves. Transverse waves may or may not require a material medium for their propagation.

For example, transverse waves in water certainly require medium while electromagnetic waves do not require material medium for their propagation.

3) A careful student says that he can predict the frequency of mass spring system even though he knows that how far the spring stretches when the mass is hung from it. How he justified himself?

Answer

Since the frequency of mass spring system is given by the formula

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad \text{......(1)}$$

Where 'k' = spring constant & m = mass attached to the spring. Knowing the values of 'k' & 'm' one can calculate the frequency of mass spring system. If the student does not know even that how far the spring stretches, when the mass is hung from it, he can predict the frequency of oscillation, because frequency is independent of the amplitude of vibration.

4) Is there a transfer of energy through a medium when a stationary wave is produced in it? Explain.

Answer

In stationary waves energy is confined between nodes. Since nodes always remain at rest so energy cannot flow past these points. Hence energy remains standing in the medium between nodes, although energy remains standing in the medium between nodes, although energy alternates between potential and kinetic forms.

5) Two wave pulses travelling in opposite direction completely cancel each other as they pass. What happens to the energy possessed by the waves?

Answer

Energy in a wave moves because of the motion of the particles of the medium. When two wave pulses travelling in opposite direction completely cancel each other, results standing waves. The nodes always remain at rest so energy cannot flow these points. Hence energy remains standing in the medium between nodes although it alternates between potential and kinetic forms.

When the anti-nodes are all at their extreme displacements. The energy stored is wholly potential and when they are simultaneously passing through their equilibrium position, the energy is wholly kinetic.

6) What are the conditions of constructive and destructive interference?

Answer

- **Condition for constructive interference:**

For constructive interference the waves must be in phase. The path difference between the waves must be either zero or integral multiple of wave length 'λ' i.e.

$$d = \Delta S = n\lambda \quad \text{where } n=0, \pm 1, \pm 2, \ldots\ldots$$

- **Condition for destructive interference:**

For destructive interference the two waves must be out of phase by 180° & the path difference between the waves must be half integral multiple of wave length 'λ' i.e.

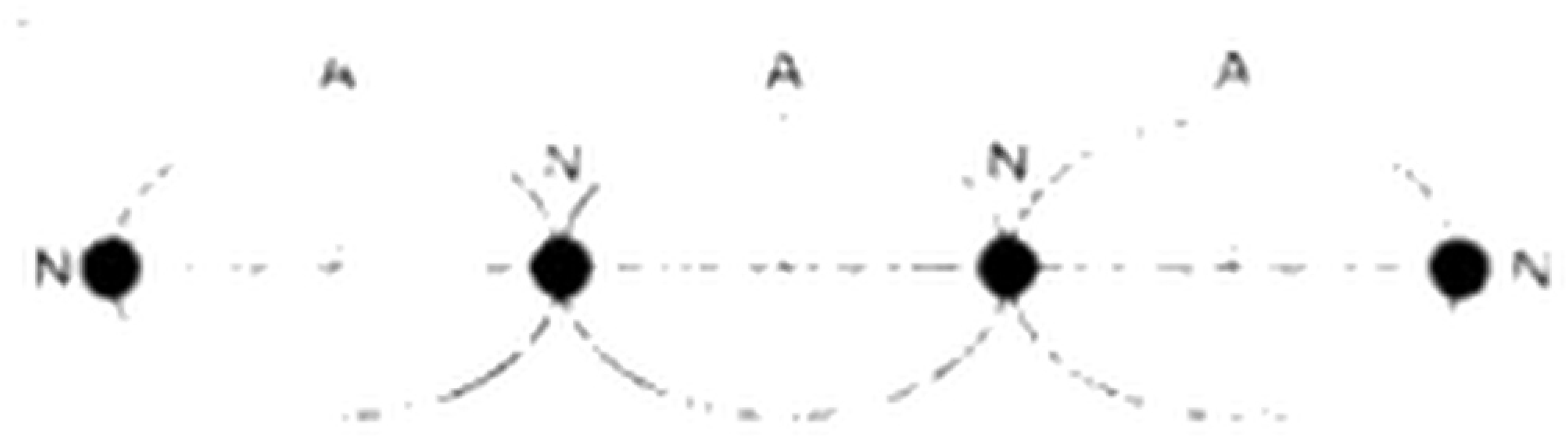
$$d = \Delta S = \left(n + \frac{1}{2}\right)\lambda$$

or $$d = \left(2^{nd} + 1\right)\frac{\lambda}{2}$$ when n=0, ±1, ±2,..........

7) How might one can locate the position of nodes & anti-nodes in vibrating string?

Answer

In a vibrating string the points which do not vibrate at all are called nodes, so one can locate the position of nodes on a string where there is zero displacement. But those points which have maximum amplitude of oscillation between nodes are called antinodes. So, one can locate the position of antinodes on a vibrating string where the amplitude of oscillation is maximum, as known in fig.



8) Is it possible for an object which is vibrating transversely to produce sound waves?

Answer

No, it is not possible for an object which is vibrating transversely to produce sound waves, because sound waves are longitudinal or compressional waves in nature which can only be produced when the object is vibrating longitudinally.

9) Why does a sound wave travel faster in solid than in gases?

Answer

The speed of sound is given by the formula

$$\upsilon = \sqrt{\frac{E}{\varsigma}}$$

The speed of sound is much higher in solids than in gases, because the molecules in a solid are closer than in gas and hence, respond more quickly to a disturbance due to larger elastic modules.

- Sound travel more slowly in gases than in solids because gases are more compressible & hence have a smaller elastic module.

10) Why does the speed of sound wave in gas change with temperature?

Answer

Since gases expand on heating so density of the gases decreases and contract on cooling, so density of the gases increases.

As speed of sound in gases is given as

$$\upsilon = \sqrt{\frac{rp}{\varsigma}}$$

$$y \propto \frac{1}{\sqrt{\varsigma}} \qquad \text{............(1)}$$

From the above relation it is clear that with rise in temperature, density of a gas decreases & speed of sound increases. But with the fall in temperature density of a gas increases & hence speed of sound decreases. That is why speed of sound waves in a gas changes with rise & fall in temperature.

11) Is it possible for two astronauts to talk directly to one another even if they remove their helmets?

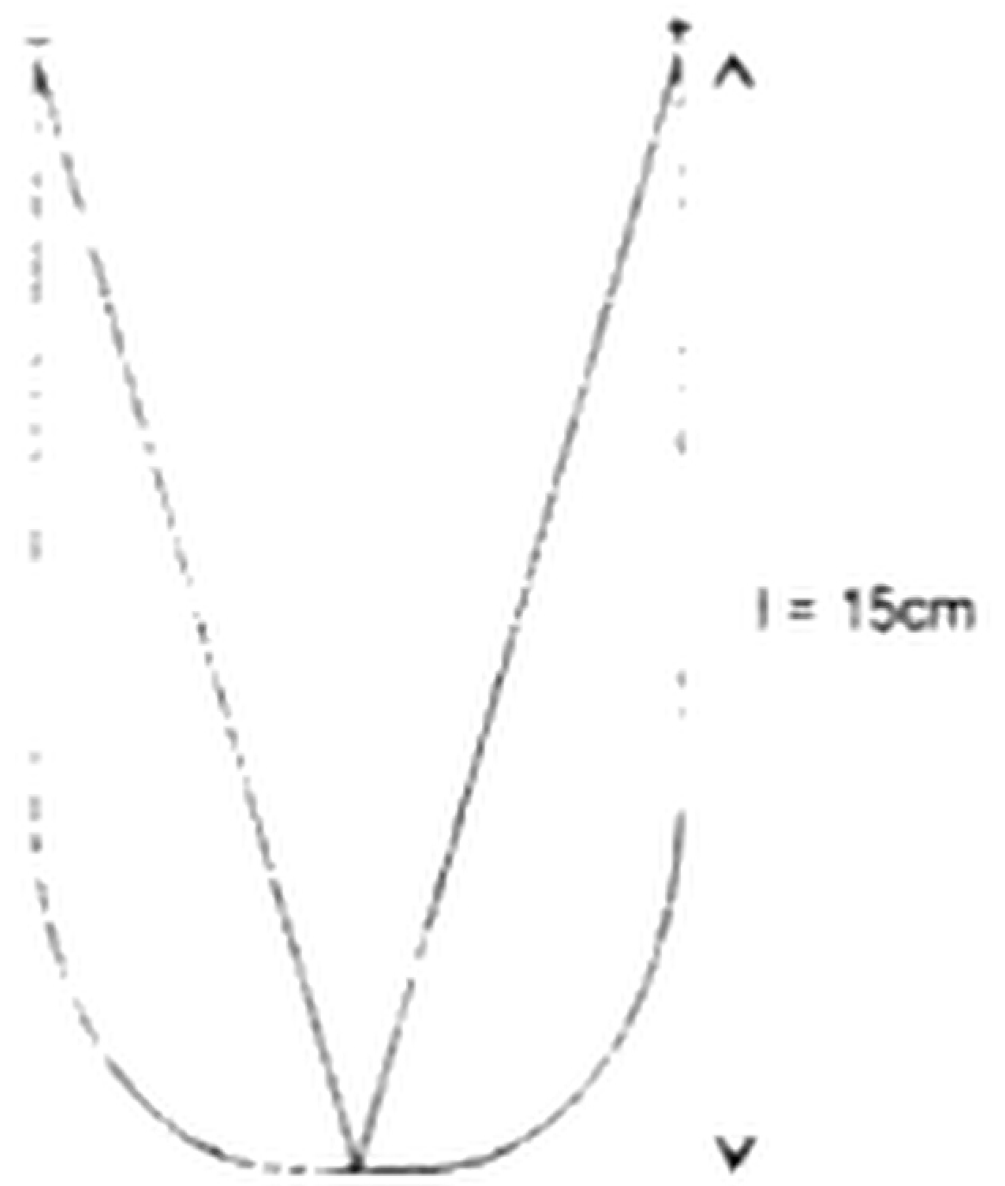
Answer

Since sound waves are mechanical waves, which require medium for their propagation. So, in vacuum sound waves cannot travel. That is why it is not possible for two astronauts to talk directly to one another.

12) Estimate the frequencies at which a test tube 15 cm long resonates when you blow across its lips.

Answer

As the test tube is closed at one end & open at the other, so it will act like resonance tube. Since the expression for frequency of 1st harmonic is given as



$$f_1 = \frac{v}{4l} \qquad ....(1)$$

If v = 332 m/s and l =15 cm = 0.15 m

So, $$f_1 = \frac{332 m/sec}{4 \times 0.15 m}$$

$$\boxed{f_1 = 553.3 Hz}$$