SHORT QUESTIONS

Write short answer questions of the following.

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

Ans.

Progressive or Travelling Waves	Standing or Stationary Waves
1. Travelling waves transport energy from one area of space to another.	1. In Standing waves there is no net transport of energy.
2. In a progressive wave, all particles have the same amplitude.	2. In standing waves particles have different amplitudes in a standing wave
3. In a travelling wave, only points a wavelength apart oscillate in phase - the rest on that wavelength oscillate out of phase with the original point.	3. All points on a standing wave oscillate in phase i.e. there is no phase difference between vibrations of neighboring particles in a standing wave
4. A travelling wave can exist freely.	4. A standing wave is attached to two fixed points,
5. Travelling waves are characterized by crests and troughs.	5. Standing waves are characterized by nodes and antinodes.

2. Clearly explain the difference between longitudinal and transverse waves.

Ans.

Longitudinal Waves	Transverse waves
1. In transverse waves the particles of the medium vibrate in a perpendicular direction to the wave motion.	1. Longitudinal waves are waves where particles of the medium tend to vibrate along the direction of the wave motion.
2. Transverse waves cannot propagate in a gas or a liquid because there is no mechanism for driving motion perpendicular to the propagation of the wave.	2. Longitudinal waves can propagate in gases, liquids and solids.
3. The distance between two consecutive crests or troughs is called wave length λ.	3. The distance between the centers of two consecutive compressions or rarefactions troughs is called wave length λ.
4. Transverse waves exhibits the property of polarization.	4. Longitudinal waves cannot be polarized.
5. Transverse waves may be mechanical or electromagnetic in nature.	5. Longitudinal waves are only mechanical waves.

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6. Waves along a string, water waves, light waves, radio and T.V waves etc. are the example of transverse waves.	6. Sound waves, waves produced along a spring or slinky etc. are the examples of longitudinal waves.

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

Ans. The frequency of the spring-mass system is given by:

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

When mass is hung from the spring, it stretches to amplitude say x. In equilibrium conditions;

Weight of spring = elastic restoring force

$$m\,g = k\,x$$

$$\Rightarrow \quad \frac{K}{m} = \frac{g}{x} \qquad (2)$$

Putting values from equation (2) in equation (1), we get;

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{x}}$$

Thus by knowing the value of "x" only, the student can predict the frequency of the mass-spring system.

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

Ans. Stationary waves are waves which does not transport energy from one part of the medium to another. In a bounded medium, standing waves occur when a wave with the correct wavelength meets its reflection. The interference of these two waves produces a resultant wave that does not appear to move. The points of maximum displacement in the wave are called as anti-nodes and the points of zero displacement are called as nodes. Since the nodes always exists at the bounded ends, hence they do allow the transport of energy. This is why there is no transfer of energy through a medium when a stationary wave is produced in it.

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

Ans. The energy remains conserved when two wave pulses traveling in opposite direction completely cancel each other. At the instant of complete overlap, there is no resulting displacement of the particles of the medium. It means that the effect of one of the pulses on the displacement of a given particle of the medium is canceled by the effect of the other pulse. This is because the upward pull of one pulse is balanced by the downward pull of the other pulse. Once the two pulses pass through

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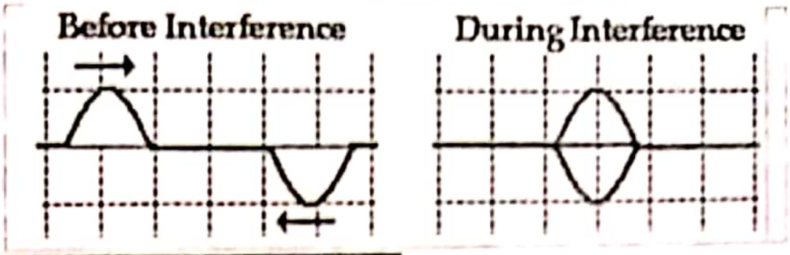
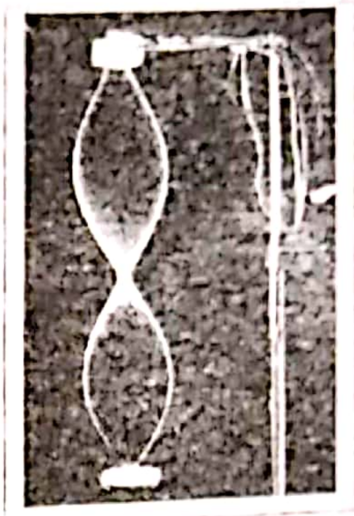
each other, there is still an upward displaced pulse and a downward displaced pulse heading in the same direction that they were heading before the interference.



Something like that happens with the light waves. If the electric fields exactly cancel, the magnetic fields add up, so all the energy is magnetic.

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

Ans. Refer to theory

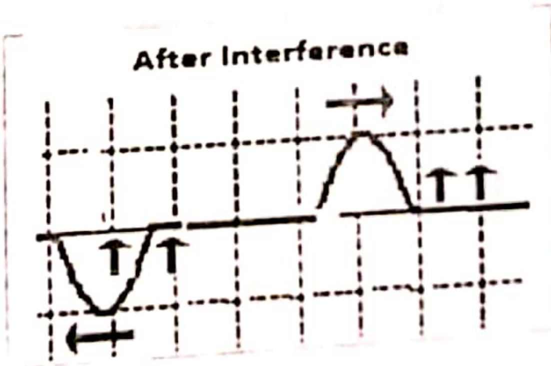


7. How might one can locate the position of nodes and anti-nodes in a vibrating string?

Ans. Consider a vibrating string as shown in the adjacent figure. There are some points in the vibrating string which remain at rest and some points which vibrate with maximum amplitude. The points which remain at rest all the time during the vibration of string are called as nodes and the points which vibrates with maximum amplitude are called as anti-nodes. Hence one can locate the position of nodes and anti-nodes in a vibrating string by identifying the positions of particles at rest and position of particles in motion.

8. Is it possible for an object which is vibrating transversely to produce sound wave?

Ans. Yes it is possible for an object which is vibrating transversely to produce sound wave. In solids, sound can exist as either a longitudinal or a transverse wave. But in mediums which are fluid (e.g., gases and liquids), sound waves can only be longitudinal waves. Since the nature of wave being transverse or longitudinal depends upon the source producing it, hence whether the vibration of the source is transverse or longitudinal or transverse, the wave thus produced due to vibrating source is always sound wave.



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

Ans. The speed of sound in a material medium is given by;

$$V = \sqrt{E/\rho}$$

Now the elasticity of solids is much greater than that of gases, and in a liquid or a solid, the energy is incapable of causing a large displacement of the matter involved. The atoms (or molecules) are much closer together and they affect each other at much smaller distances and in much less time. The result is that the

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disturbance not only travels faster, but less of the energy is lost, so it will also travel farther. For this reason, longitudinal sound waves travel faster in solids than they do in liquids than they do in gases. Even though the inertial factor may favor gases, the elastic factor has a greater influence on the speed of a wave, thus yielding this general pattern:

$$V_{solids} > V_{liquids} > V_{gases}$$

A classic example of this of which you are probably aware is sound passing through steel rails. You can hear the train coming through the steel long before you can hear it coming through the air.

NOTE

Within a single phase of matter, the inertial property of density tends to be the property that has a greatest impact upon the speed of sound. A sound wave will travel faster in a less dense material than a more dense material. Thus, a sound wave will travel nearly three times faster in Helium than it will in air. This is mostly due to the lower mass of Helium particles as compared to air particles.

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

Ans. The speed of the sound is given by formula;

$$V = \sqrt{\frac{\gamma RT}{m}}$$

$$\Rightarrow \quad V \propto \sqrt{T}$$

The above proportionality shows that the speed of sound is directly related to the square root of the temperature of the gas. When the temperature Increases, the average translational kinetic energy of the molecules a gas increases which results in an increase in the molecular interaction. Due to this increased molecular interaction the energy transport from particle to particle increases. Hence the speed of the sound in a gas increases. In fact, the increase of sound for each degree rise in temperature of gas above 0°C is 0.6 m/sec.

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

Ans. No, it is not possible for two astronauts in space to talk directly to one another even if they remove their helmets. This is because of the fact that sound waves are mechanical waves and they require medium for their propagation. Since there is no medium i.e., no particles in space, therefore there is no sound wave can propagate.

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

Ans.

V = 332 m/s

Length of tube L = 15 cm = 0.15 m

Frequency = ?

$L = \lambda/4$ $\qquad \lambda = 4L$

$f = v/\lambda = V/4L = 332/4 \times 0.15\ m = 553\ Hz$

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