Waves

Assertion Reason Questions

Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

1. Assertion (A): The amplitude of vibration in a stationary wave is independent of the particle's position.

Reason (R): A particle of medium vibrates in the same phase but with different amplitude between two consecutive nodes in a standing wave pattern.

Ans. (c) A is true but R is false.

Explanation: There are points at regular intervals which are never displaced and are called nodes. And where the particles periodically attain maximum or minimum values are called antinodes. In stationary waves,

(1) All the particles are in a state of vibration except nodes.

(2) All the particles between two consecutive nodes have the same phase but differ in amplitude.

(3) The particles on the opposite side of nodes move in opposite directions. Hence, they are in opposite phases. In a standing wave, all particles move at different amplitudes.

Amplitude of a standing wave is.

$y = \alpha A \cos kx$

Amplitude depends on location x.

2. Assertion (A): When longitudinal waves propagate through a med- ium, it causes displace- ment of particles of motion along the direction of wave propagation and is called pressure waves.

Reason (R): Propagation of longitudinal waves through a medium involves changes in pressure (density of medium particles) when compressions rarefactions are formed. And

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: Longitudinal waves are waves in which the displacement of the medium is in the same direction as or the opposite direction to the direction of propagation of the wave. Mechanical longitudinal waves are called as pressure waves because they produce increases and decrease the pressure.When longitudinal waves propagate through a medium, it causes displacement of particles of motion along the direction of wave propagation. Hence, at some points, particles are close to each other while at some points, they are farther apart. This creates a density difference in medium, due to which a pressure difference arises in the material medium. Since, propagation of longitudinal waves through a medium creates pressure disturbances in the medium. Hence, these waves are called pressure waves.

3. Assertion (A): The particle velocity in a transverse wave is perpendicular to the direction of wave velocity.
Reason (R): Energy is always transferred in the direction of wave propagation in a wave motion.

Ans. (b) Both A and R are true and R is not the correct explanation of A.
Explanation: In a transverse wave, particles oscillate perpendicular to the axis of propagation of the wave. The particles move up and down and wave moves perpendicular to its direction. So we can say, the direction of velocity is perpendicular to the direction of propagation of waves. In any vibration there exists Kinetic Energy and Potential Energy. As the vibration gets transferred, the energy also gets transferred.

4. Assertion (A): Compression and rarefaction involve changes in density and pressure.
Reason (R): When particles are compressed, density of the medium increases and when they are rarefied, density of the medium decreases.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: Particles move closer to one another in an area of the medium known as compression, where their average distance from one another decreases. As a result, the volume temporarily decreases and the medium's density rises as a result. Similar to rarefaction, which results in a drop in density when particles are spaced further apart.

5. Assertion (A): We cannot hear beats when two vibrating tuning forks with frequencies of 240 Hz and 300 Hz are held close together.

Reason (R): Because of the property of hearing persistence, beats cannot be clearly heard.
Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: The principle of superposition does not state that the frequencies oscillation should be nearly equal. And for beats to be heard the condition is that the difference in frequencies of the two oscillations be not more than 16 times per sec for a normal human ear to recognize it. Hence, we cannot hear beats in the case of two tuning forks vibrating at frequencies 256 Hz and 512 Hz respectively.

6. Assertion (A): Harmonics are the notes of frequencies which are integral multiple of the fundamental frequency.
Reason (R): Tones of frequencies higher than fundamental notes are called overtones.

Ans. (b) Both A and Rare true and R is not the correct explanation of A.
Explanation: Integral multiple of something simply means a quantity multiplied by an integer. The overtones with frequencies which are integral multiples of the fundamental frequency are called harmonics. Hence, all harmonic are overtones. But overtones which are non-integrals multiples of the fundamental frequency are not harmonics. The waveforms of all sounds, apart from a basic sine wave, consist of the fundamental tone and many other tones of different frequencies. Non-fundamental tones that are whole-number multiples of the fundamental tone are known as overtones or harmonics.

7. Assertion (A): When a moth makes its way along the sand within a few tens of centimetres of a sand spider, the spider immediately turns and dashes towards the moth.
Reason (R): When When a moth disturbs the sand, pulses are sent along its surface. The first set of pulses is longitudinal, while the second set is transverse.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: When beetle moves along the sand it sends two sets of pulses, one longitudinal and the other transverse. Scorpions has the capacity to intercept the waves. By getting a sense of time interval between receipt of these two waves, it can determine the distance of moth also. The sand spider uses waves of both transverse and longitudinal motion to locate its prey. When a moth even slightly disturbs the sand, it sends pulses along the sand's surface. One set of pulses is longitudinal, travelling with speed V. A second set is transverse travelling with speed VT. The spider with its eight legs

spread roughly in a circle intercepts the faster longitudinal pulses first and learns the direction of the moth, it is in direction of whichever leg is disturbed earliest by the pulses. The spider then senses the time interval (At) between the first interception and the interception of the slower transverse waves and uses it to determine the distance d to the moth.

$$\Delta t = \frac{d}{v_T} - \frac{d}{v_L}$$

which gives the scorpion a perfect fix on the moth.

8. Assertion (A): The basis correction of Laplace was that, exchange of heat between the region of compression and rarefaction in air is not possible.
Reason (R): Air is a bad conductor of heat and velocity of sound in air is large.

Ans. (a) Both A and R are true and R is the correct explanation of A.
Explanation: According to the Laplace correction, the change in gas volume and pressure brought on by sound waves passing through it is an adiabatic process rather than an isothermal one. Since the air is a poor conductor, it prevents the transfer of heat between the layers and environment.