

Waves

Self-Assessment

Module 1 Propagation of Waves

Q.15.1.1 Given below are the names of different kinds of waves.

(P) Light wave (Q) Sound wave (R) X-rays (S) Radio wave. Which among the following is/are of transverse nature?

Options

- (A) (P) only
- (B) (Q) and (R)
- (C) (P), (R) and (S)
- (D) (P) and (R)

Q.15.1.2 It is said that mechanical waves require the inertia and the elasticity of the medium for its propagation.

Now, the velocity of a progressive wave in a gaseous medium is given by $v = \sqrt{\frac{\gamma P}{\rho}}$ where P is the ambient pressure, ρ = density of the medium and γ is the ratio of the specific heats of the gas at constant pressure and constant volume. Examine the statements given below-

- (P) Only P represents elasticity of the medium
- (Q) γ and P represent the inertia of the medium
- (R) Only ρ represents the inertia of the medium
- (S) Only γ represents the elasticity of the medium

Options:

- (A) (P) and (Q) are correct
- (B) (R) and (S) are correct
- (C) Only (R) is correct
- (D) (P) and (R) are correct

Q.15.1.3 (P), (Q), (R), (S) are four statements about the vibration of a tuning fork.

- (P) The prongs execute transverse vibration
- (Q) The prongs execute longitudinal vibration

(R) The stem executes longitudinal vibration

(S) The stem executes transverse vibration

Which among the above are correct?

(A) P and Q

(B) P and R

(C) P and S

(D) Q and S

Q.15.1.4 The velocity of propagation of a progressive wave is v if the amplitude of the wave is doubled then, the velocity of the wave

(A) will become 2θ

(B) will not change

(C) will become 4θ

(D) will become $\theta/2$

Q.15.1.5 In the path of a progressive wave two points are 14 cm apart. What is the phase difference between these two points if the wavelength is 28 cm?

(A) $\frac{\pi}{2}$

(B) π

(C) 2π

(D) $\frac{\pi}{4}$

Q.15.1.6 The source of a progressive wave in a non-dissipative medium is linear. What is the geometry of the wave fronts?

(A) Spherical

(B) Planes

(C) Cylindrical

(D) Parabolic

Q.15.1.7 In the case of a plane progressive wave, if the maximum possible particle velocity is twice the wave velocity, then the magnitude of the amplitude of the wave in terms of its wavelength λ is

- (A) $\frac{\lambda}{2\pi}$
- (B) $\frac{2\lambda}{\pi}$
- (C) 2λ
- (D) $\frac{\lambda}{\pi}$

Q.15.1.8 The phase of vibration of a simple pendulum

- (A) depends on its angular displacement only
- (B) depends on its angular velocity only
- (C) depends on both the angular velocity and the displacement
- (D) depends on neither the angular velocity nor the angular displacement.

Q.15.1.9 a_1 and a_2 are the amplitudes of two progressive waves. If they superimpose, the maximum possible value of the resulting amplitude is

- (A) $\sqrt{a_1^2 + a_2^2}$
- (B) $\sqrt{a_1 a_2}$
- (C) $a_1 + a_2$
- (D) $\frac{a_1 a_2}{a_1 + a_2}$

Q.15.1.10 What is the dimension of k in the equation of a plane progressive wave given by.

$$y = a \sin k(vt - x)$$

- (A) L
- (B) L^{-1}
- (C) T
- (D) T^{-1}

Module 2 Stationary Waves

Q.15.2.1 Which one among the following statements is correct with respect to the reflection of waves?

(P) When reflection takes place from a denser to a rarer medium, the longitudinal waves are reflected in the same phase, but move in opposite directions.

(Q) When reflection takes place from a denser to a rarer medium, the longitudinal waves are reflected in the opposite phase and move in opposite directions.

(R) On reflection from a rarer to a denser medium, a longitudinal wave is reflected back with a change in phase.

(S) On reflection from a rarer to a denser medium, a longitudinal wave is reflected back with no change in phase.

Options:

- (A) (P) and (Q)
- (B) (Q) and (R)
- (C) (P) and (R)
- (D) (Q) and (S)

Q.15.2.2 Given below are statements regarding transfer of energy in progressive and stationary waves.

(P) Continuous transfer of energy takes place from particle to particle in a progressive wave

(Q) Transfer of energy takes place from a particle to another particle provided they are in same phase during the propagation of a progressive wave.

(R) In a stationary wave no transfer of energy takes place across the 'node' points.

(S) In a stationary wave no transfer of energy takes place across the 'antinode' points.

Examine the above statements and identify, which among them are correct.

Options:

- (A) (P) and (Q)

- (B) (P) and (R)
- (C) (P) and (S)
- (D) (R) and (S)

Q.15.2.3 Identify the correct statement among the following for a stationary wave.

- (A) No change of density takes place at the nodes
- (B) Maximum change of density takes place at the antinodes.
- (C) Velocity of particles is zero at antinodes.
- (D) Velocity of particles is maximum at antinodes.

Q.15.2.4 The equation of a stationary wave is given by,

$$y = 2 \cos 4x \sin 20t$$

where x, y are in cm and t is in seconds.

Find the value of the velocity of the wave in cm s^{-1}

- (A) 2
- (B) 4
- (C) 5
- (D) 10

Q.15.9.2.5 The equation of a plane progressive harmonic wave is $y_1 = 2 \sin (4\pi t - \pi x)$, where x, y are in cm and t is in s. This wave reflects at a boundary and the reflected wave interferes with the original wave to form a stationary wave. Find the equation of the resulting stationary wave.

- (A) $y = 4 \sin \pi t \cos 4\pi x$
- (B) $y = 4 \sin 4\pi t \cos \pi x$
- (C) $y = 2 \sin 2\pi t \cos \pi x$
- (D) $y = 2 \sin 4\pi t \cos \pi x$

Q.15.2.6 A string of length 120 cm fixed at its two ends is undergoing stationary vibration. Considering the fundamental to be the first harmonic, the positions (in cm) of maximum change in pressure in the third harmonic are:

- (A) 0, 40, 80, 120
- (B) 20, 60, 100
- (C) 0, 20, 60, 100, 120
- (D) 40, 80

Q.15.2.7 The material of a string undergoing stationary vibration is changed so that the density increases eight-fold. The tension in the string is then doubled. The frequency of the fundamental becomes 'x' times its former value. Then x is equal to

- (A) $\frac{1}{2}$
- (B) 2
- (C) 4
- (D) $\frac{1}{4}$

Q.15.2.8 The second harmonic of the stationary vibration in an organ pipe of length 68 cm and one end closed is in unison with the vibration of a tuning fork. If the velocity of sound is 340 ms^{-1} , what is the frequency of the tuning fork?

- (A) 300 Hz
- (B) 350 Hz
- (C) 375 Hz
- (D) 400 Hz

Q.15.2.9 In an experiment to determine the velocity of sound by using the resonance tube method, the first two resonances occur at the lengths 24 cm and 70 cm respectively. If the velocity of sound so determined is 345 ms^{-1} then the frequency of the tuning fork is

- (A) 288 Hz
- (B) 324 Hz
- (C) 375 Hz
- (D) 405 Hz

Q.15.2.10 A stationary wave having wavelength λ originates at the point O. A, B, C are three points in the medium in which the wave exists. At a given instant of time, the displacement at A is y . if $AB = BC = \frac{\lambda}{2}$, then the corresponding displacements at B and C are-

- (A) y, y
- (B) $-y, y$
- (C) $y, -y$
- (D) $-y, -y$

Module 3 Beats and Doppler Effect

Q 15.3.1 The phenomenon of transient beats can be observed

- (P) When two stationary waves of very nearly equal frequencies superpose.
- (Q) When two progressive waves of very nearly equal frequencies superpose.
- (R) When a driving vibration forces its vibration on a driven oscillating system and the frequency of the driven system approaches, that of the driver.

Which of the above statements is/are correct?

- (A) only (P)
- (B) only (Q)
- (C) (P) of (Q), but not (R)
- (D) only (R)

Q 15.3.2 An open pipe of length l and another 1% longer than it, produces beats of period 0.202 second when sounded together. If the velocity of sound is 340 ms^{-1} , then the value of l in cm is equal to

- (A) 17
- (B) 34
- (C) 50
- (D) 100

Q. 15.3.3 Two closed organ pipes of the same length ' l ', when sounded respectively in their fundamental and the second harmonic respectively, produce four beats per second. Then the velocity of sound is

- (A) $2l$
- (B) $4l$
- (C) $8l$
- (D) $9l$

Q. 15.3.4 Two sonometers when sounded together produce two beats per second. They are made of wire of the same material and their lengths are equal. The tension in the second sonometer is 44% more than the first. The frequency of the fundamental of the first sonometer is

- (A) 5 Hz
- (B) 10 Hz
- (C) 20 Hz
- (D) 40 Hz

Q. 15.3.5 T_1, T_2, T_3, T_4 and T_5 are five tuning forks of very nearly equal frequencies. Beats of periods 1 s, 0.5 s, 0.33 s and 0.25 s are produced when the combination first-second, second-third, third-fourth and fourth-fifth respectively are sounded together. Find the beat frequency when the first and the fifth forks are sounded together

- (A) 1 Hz
- (B) 2 Hz
- (C) 5 Hz

(D) 10 Hz

Q. 15.3.6 Bus No. 123 leaves terminus A and travels along a straight road to point B and the time of travel is more than five hours. The bus maintains a uniform speed of 10 ms^{-1} and four such buses leave terminus A every hour. A person travels from B towards A with a uniform speed of 5 ms^{-1} . How many such buses (No. 123) will the person encounter from the opposite direction in an hour?

- (A) 4
- (B) 5
- (C) 6
- (D) 8

Q. 15.3.7 Two cars A and B, each moving with a speed of 10 ms^{-1} , are approaching each other on a long straight two-way road. What will be the apparent frequency of the horn of car A, as heard by the driver of car B, before the cars cross each other, if the original frequency of the horn is 500 Hz and the speed of sound in air is 320 ms^{-1} ?

- (A) $\frac{33}{31} \times 500 \text{ Hz}$
- (B) $\frac{33}{33} \times 500 \text{ Hz}$
- (C) $\frac{33}{32} \times 500 \text{ Hz}$
- (D) $\frac{32}{31} \times 500 \text{ Hz}$

Q. 15.3.8 Two cars A and B, each moving with a speed of 10 ms^{-1} , are approaching each other on a long straight two-way road. Then what will be the apparent frequency of the horn of car A as heard by the driver of car B, after the cars cross each other? The original frequency of the horn is 600 Hz and the speed of sound in air is 300 ms^{-1} ?

- (A) $\frac{17}{16} \times 600 \text{ Hz}$
- (B) $\frac{16}{17} \times 600 \text{ Hz}$

(C) $\frac{33}{34} \times 600 \text{ Hz}$

(D) $\frac{32}{33} \times 600 \text{ Hz}$

Q. 15.3.9 A source of musical sound is placed exactly midway between a detector and a reflecting wall. When the source starts moving towards the reflecting wall, the detector observes beats with time period T produced by the direct and the reflected sounds. Find the speed of the source if the velocity of sound is v and the original frequency of the musical sound is n . Assume that the velocity of the source is much less than the velocity of sound.

(A) $\frac{4v}{nT}$

(B) $\frac{2v}{nT}$

(C) $\frac{v}{nT}$

(D) $\frac{v}{2nT}$

Q. 15.3.10 Find the apparent wavelength of a line of wavelength $6000 \text{ \AA}$, as observed from the light received from a distant receding source. It is given that the velocity of light is $3 \times 10^8 \text{ ms}^{-1}$ and the velocity of the star along the line of sight is $6 \times 10^6 \text{ ms}^{-1}$.

(A) $5800 \text{ \AA}$

(B) $5880 \text{ \AA}$

(C) $6050 \text{ \AA}$

(D) $6120 \text{ \AA}$



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