

**Exemplar Solutions for Class 11 Physics Chapter 14 – Waves****Multiple Choice Questions I**

1. Water waves produced by a motor boat sailing in water are:

- a) neither longitudinal nor transverse
- b) both longitudinal and transverse
- c) only longitudinal
- d) only transverse

**Answer:** b) both longitudinal and transverse

**Explanation:** Water waves are surface waves that exhibit both longitudinal and transverse characteristics. The water particles move in circular orbits, combining both horizontal (longitudinal) and vertical (transverse) motions.

2. Sound waves of wavelength  $\lambda$  travelling in a medium with a speed of  $v$  m/s enter into another medium where its speed is  $2v$  m/s. Wavelength of sound waves in the second medium is:

- a)  $\lambda$
- b)  $\lambda/2$
- c)  $2\lambda$
- d)  $4\lambda$

**Answer:** c)  $2\lambda$

**Explanation:** When waves enter a new medium, frequency remains constant while speed and wavelength change. Using  $v = f\lambda$ :

- First medium:  $v_1 = f\lambda_1$  where  $\lambda_1 = \lambda$
- Second medium:  $v_2 = f\lambda_2$  where  $v_2 = 2v$
- Since  $f$  is constant:  $\lambda_2 = v_2/f = 2v/f = 2\lambda$

3. Speed of sound wave in air:

- a) is independent of temperature
- b) increases with pressure
- c) increases with increase in humidity
- d) decreases with increase in humidity

**Answer:** c) increases with increase in humidity

**Explanation:** The speed of sound in air increases with humidity because water vapor is less dense than dry air, making the medium less dense and allowing sound to travel faster.

4. Change in temperature of the medium changes:

- a) frequency of sound waves
- b) amplitude of sound waves
- c) wavelength of sound waves
- d) loudness of sound waves

**Answer:** c) wavelength of sound waves

**Explanation:** Temperature change affects the speed of sound ( $v \propto \sqrt{T}$ ). Since  $v = f\lambda$  and frequency remains constant for a given source, wavelength must change proportionally with speed.

**5. With propagation of longitudinal waves through a medium, the quantity transmitted is:**

- a) matter
- b) energy
- c) energy and matter
- d) energy, matter, and momentum

**Answer:** b) energy

**Explanation:** Waves transmit energy through a medium without net transport of matter. The particles oscillate about their equilibrium positions, transferring energy from one particle to the next.

**6. Which of the following statements are true for wave motion?**

- a) mechanical transverse waves can propagate through all mediums
- b) longitudinal waves can propagate through solids only
- c) mechanical transverse waves can propagate through solids only
- d) longitudinal waves can propagate through vacuum

**Answer:** c) mechanical transverse waves can propagate through solids only

**Explanation:** Mechanical transverse waves require a medium that can support shear stress, which only solids can provide. Liquids and gases cannot support shear stress, so they cannot transmit mechanical transverse waves.

**7. A sound wave is passing through air column in the form of compression and rarefaction.**

**In consecutive compressions and rarefactions:**

- a) density remains constant
- b) Boyle's law is obeyed
- c) bulk modulus of air oscillates
- d) there is no transfer of heat

**Answer:** d) there is no transfer of heat

**Explanation:** Sound waves in air are adiabatic processes (no heat transfer) because the compressions and rarefactions occur so rapidly that there's insufficient time for heat exchange.

**8. Equation of a plane progressive wave is given by  $y = 0.6 \sin 2\pi(t-x/2)$ . On reflection from a denser medium its amplitude becomes  $2/3$  of the amplitude of the incident wave:**

- a)  $y = 0.6 \sin 2\pi(t+x/2)$
- b)  $y = -0.4 \sin 2\pi(t+x/2)$

c)  $y = 0.4 \sin 2\pi(t+x/2)$

d)  $y = -0.4 \sin 2\pi(t-x/2)$

Answer: b)  $y = -0.4 \sin 2\pi(t+x/2)$

Explanation:

- Reflected amplitude =  $(2/3) \times 0.6 = 0.4$
- Reflection from denser medium causes phase change of  $\pi$  (negative sign)
- Direction reverses:  $(t-x/2)$  becomes  $(t+x/2)$

9. A string of mass 2.5 kg is under a tension of 200 N. The length of the stretched string is 20.0 m. If the transverse jerk is struck at one end of the string, the disturbance will reach the other end in:

a) one second

b) 0.5 second

c) 2 seconds

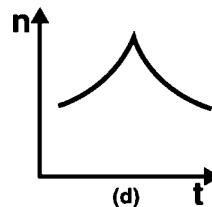
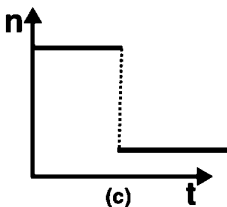
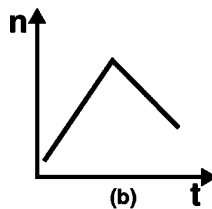
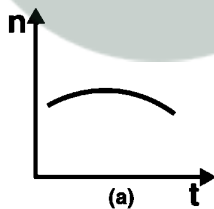
d) data given is insufficient

Answer: b) 0.5 second

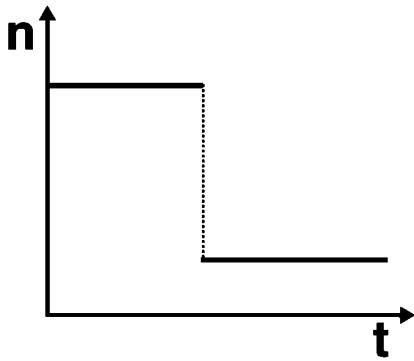
Explanation:

- Linear mass density:  $\mu = m/L = 2.5/20 = 0.125 \text{ kg/m}$
- Wave speed:  $v = \sqrt{T/\mu} = \sqrt{200/0.125} = \sqrt{1600} = 40 \text{ m/s}$
- Time =  $L/v = 20/40 = 0.5 \text{ s}$

10. A train whistling at constant frequency is moving towards a station at a constant speed  $V$ . The train goes past a stationary observer on the station. The frequency  $n'$  of the sound as heard by the observer is plotted as a function of time  $t$ . Identify the expected curve:



Answer: c)



**Explanation:** The graph shows a step-like change in frequency. When the train approaches, the observed frequency is higher due to the Doppler effect. When it passes and moves away, the frequency drops to a lower value. The transition is abrupt as the train passes the observer.

### Multiple Choice Questions II

**11. A transverse harmonic wave on a string is described by  $y(x,t) = 3.0 \sin(36t + 0.018x + \pi/4)$  where  $x$  and  $y$  are in cm and  $t$  is in s. The positive direction of  $x$  is from left to right:**

- the wave is travelling from right to left
- the speed of the wave is 20 m/s
- frequency of the wave is 5.7 Hz
- the least distance between two successive crests in the wave is 2.5 cm

**Answer:** a), b), c)

**Explanation:**

- Standard form:  $y = A \sin(\omega t \pm kx + \phi)$
- Here:  $\omega = 36 \text{ rad/s}$ ,  $k = 0.018 \text{ rad/cm} = 1.8 \text{ rad/m}$
- Since coefficient of  $x$  is positive, wave travels in  $-x$  direction (right to left)
- Speed:  $v = \omega/k = 36/1.8 = 20 \text{ m/s}$
- Frequency:  $f = \omega/2\pi = 36/2\pi \approx 5.7 \text{ Hz}$
- Wavelength:  $\lambda = 2\pi/k = 2\pi/1.8 \approx 3.49 \text{ m}$  (not 2.5 cm)

**12. The displacement of a string is given by  $y(x,t) = 0.06 \sin(2\pi x/3) \cos(120\pi t)$  where  $x$  and  $y$  are in m and  $t$  in s. The length of the string is 1.5 m and its mass is  $3.0 \times 10^{-2} \text{ kg}$ :**

- it represents a progressive wave of frequency 60 Hz
- it represents a stationary wave of frequency 60 Hz
- it is the result of superposition of two waves of wavelength 3 m, frequency 60 Hz each travelling with a speed of 180 m/s in opposite directions
- amplitude of this wave is constant

**Answer:** b), c)

**Explanation:**

- Form  $y = A \sin(kx) \cos(\omega t)$  represents a stationary wave

- $\omega = 120\pi$ , so  $f = \omega/2\pi = 60$  Hz
- $k = 2\pi/3$ , so  $\lambda = 2\pi/k = 3$  m
- Wave speed:  $v = f\lambda = 60 \times 3 = 180$  m/s
- Amplitude varies with position:  $A(x) = 0.06 \sin(2\pi x/3)$

**13. Speed of sound waves in a fluid depends upon:**

- directly on density of the medium
- square of bulk modulus of the medium
- inversely on the square root of density
- directly on the square root of bulk modulus of the medium

Answer: c), d)

Explanation: Newton-Laplace equation:  $v = \sqrt{B/\rho}$

- $v \propto 1/\sqrt{\rho}$  (inversely proportional to square root of density)
- $v \propto \sqrt{B}$  (directly proportional to square root of bulk modulus)

**14. During propagation of a plane progressive mechanical wave:**

- all the particles are vibrating in the same phase
- amplitude of all the particles is equal
- particles of the medium execute SHM
- wave velocity depends upon the nature of the medium

Answer: b), c), d)

Explanation:

- Particles at different positions have different phases
- All particles have the same amplitude in a plane progressive wave
- Each particle executes simple harmonic motion about its equilibrium position
- Wave velocity depends on medium properties (density, elasticity, etc.)

**15. The transverse displacement of a string is given by  $y(x,t) = 0.06 \sin(2\pi x/3) \cos(120\pi t)$ .**

All the points on the string between two consecutive nodes vibrate with:

- same frequency
- same phase
- same energy
- different amplitude

Answer: a), b), d)

Explanation: In a stationary wave between consecutive nodes:

- All points vibrate with the same frequency ( $120\pi/2\pi = 60$  Hz)
- All points are in the same phase (all reach maximum displacement simultaneously)
- Amplitude varies with position:  $|0.06 \sin(2\pi x/3)|$
- Energy is not the same at all points

16. A train, standing in a station yard, blows a whistle of frequency 400 Hz in still air. The wind starts blowing in the direction from the yard to the station with a speed of 10 m/s. Given that the speed of sound in still air is 340 m/s:

- a) the frequency of sound as heard by an observer standing on the platform is 400 Hz
- b) the speed of sound for the observer standing on the platform is 350 m/s
- c) the frequency of sound as heard by the observer standing on the platform will increase
- d) the frequency of sound as heard by the observer standing on the platform will decrease

Answer: a), b)

Explanation:

- Since both source and observer are stationary relative to each other, frequency remains 400 Hz
- Wind increases the effective speed of sound:  $v_{\text{eff}} = 340 + 10 = 350$  m/s
- Wind affects the speed of sound propagation but not the frequency when source and observer are both stationary

17. Which of the following statements are true for a stationary wave?

- a) every particle has a fixed amplitude which is different from the amplitude of its nearest particle
- b) all the particles cross their mean position at the same time
- c) all the particles are oscillating with same amplitude
- d) there is no net transfer of energy across any plane
- e) there are some particles which are always at rest

Answer: a), b), d), e)

Explanation:

- Amplitude varies with position:  $A(x) = 2A_0 |\sin(kx)|$
- Between nodes, all particles cross mean position simultaneously
- Particles have different amplitudes depending on their position
- No net energy transfer in stationary waves
- Nodes are points that remain permanently at rest