Physics Standard X: Sound Waves Short Answer Questions

Comprehensive Question Bank with Answers for Examinations

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1 Short Answer Questions and Answers

1.1 Oscillatory Motion

1. **What type of motion does a swing exhibit? Why is it not considered circular motion?**
   - **Answer**: A swing exhibits oscillatory motion because it moves to and fro about its equilibrium position at regular intervals. It is not circular motion as it does not complete a full circular path but oscillates between two extreme positions (e.g., A and B around O).
2. **Define amplitude in the context of a swing's motion. What is its SI unit?**
   - **Answer**: Amplitude is the maximum displacement of the swing from its equilibrium position to one side (e.g., from O to A). Its SI unit is the meter (m).
3. **When does a swing complete one oscillation if it starts from the equilibrium position (O)?**
   - **Answer**: A swing completes one oscillation when it starts from O, moves to A, then to B, and returns to O.
4. **If a pendulum takes 1 minute to complete 30 oscillations, calculate the time for one oscillation.**
   - **Answer**: Time for 30 oscillations = 60 s. Time for 1 oscillation = $\frac{60}{30} = 2\,\text{s}$.
5. **What is the frequency of a pendulum that completes 30 oscillations in 60 seconds?**
   - **Answer**: Frequency = $\frac{\text{Number of oscillations}}{\text{Time}} = \frac{30}{60} = 0.5\,\text{Hz}$.

1.2 Period and Frequency

1. **Define the period of a pendulum and state its SI unit.**
   - **Answer**: The period (T) is the time taken to complete one oscillation, measured in seconds (s).
2. **What is the relationship between the period and frequency of a pendulum?**
   - **Answer**: Frequency (f) is the reciprocal of the period (T): $f = \frac{1}{T}$. If the period increases, the frequency decreases.
3. **How does the frequency of a simple pendulum change when its length increases?**
   - **Answer**: As the length of the pendulum increases, the frequency decreases because the period increases.
4. **Convert 1 MHz to Hz and explain its relevance in sound applications.**
   - **Answer**: $1\,\text{MHz} = 10^6\,\text{Hz} = 1,000,000\,\text{Hz}$. This unit is used in radio and television transmissions to denote high-frequency signals.

1.3 Tuning Forks and Natural Frequency

1. **What does the marking on a tuning fork (e.g., 256 Hz) indicate?**
   - **Answer**: The marking indicates the natural frequency of the tuning fork, i.e., the number of vibrations it produces per second (256 vibrations per second).
2. **List two factors that influence the natural frequency of an object.**
   - **Answer**: Length of the object and elasticity of the material.

1.4 Forced Vibration and Resonance

1. **What is forced vibration? Provide an example.**
   - **Answer**: Forced vibration occurs when an object vibrates due to an external vibrating source. Example: A table vibrates when a tuning fork is pressed against it.
2. **Explain resonance with an example from the chapter.**
   - **Answer**: Resonance occurs when the natural frequency of a forced object matches that of the forcing object, resulting in maximum amplitude. Example: Hacksaw blades C and E vibrate with maximum amplitude when blade A (with the same natural frequency) is excited.
3. **How does a stethoscope utilize forced vibration and resonance?**
   - **Answer**: A stethoscope amplifies faint sounds (e.g., heartbeats) by transferring vibrations from the body to the diaphragm, which resonates to produce a louder sound.

1.5 Wave Motion

1. **What is wave motion? How does it differ from particle motion in a medium?**
   - **Answer**: Wave motion is the transfer of energy through a medium via oscillations without permanent displacement of particles. Particles oscillate locally, while the wave propagates energy across the medium.
2. **Differentiate between longitudinal and transverse waves with examples.**
   - **Answer**: Longitudinal waves have particles vibrating parallel to the wave's direction (e.g., sound waves). Transverse waves have particles vibrating perpendicular to the wave's direction (e.g., light waves or waves on a string).

1.6 Wave Characteristics

1. **Define wavelength and state its unit.**
   - **Answer**: Wavelength (λ) is the distance between two consecutive particles in the same phase of vibration (e.g., two crests or compressions), measured in meters (m).

2. **What is the relationship between the speed, frequency, and wavelength of a wave?**
   - **Answer**: The speed of a wave (v) is the product of its frequency (f) and wavelength (λ): $v = f\lambda$.
3. **A wave travels 700 m in 2 s. Calculate its speed.**
   - **Answer**: Speed $= \frac{\text{Distance}}{\text{Time}} = \frac{700}{2} = 350\,\text{m/s}$.
4. **A sound wave has a frequency of 175 Hz and a wavelength of 2 m. Calculate its speed.**
   - **Answer**: Speed $= f\lambda = 175 \times 2 = 350\,\text{m/s}$.

1.7 Reflection of Sound

1. **Why is the reflected sound louder on a smooth surface compared to a rough surface?**
   - **Answer**: Smooth surfaces reflect sound waves more effectively, preserving more energy, while rough surfaces scatter sound, reducing loudness.
2. **What is an echo, and what is the minimum distance required to hear it in air (speed of sound = 350 m/s)?**
   - **Answer**: An echo is the distinct reflection of the initial sound after a delay. Minimum distance $= \frac{350 \times 0.1}{2} = 17.5\,\text{m}$, based on the persistence of hearing (0.1 s).
3. **If an echo is heard 1 s after a firecracker is burst, how far is the reflecting surface (speed of sound = 350 m/s)?**
   - **Answer**: Distance $= \frac{350 \times 1}{2} = 175\,\text{m}$.

1.8 Reverberation and Audibility

1. **What is reverberation, and why are cinema hall walls made rough?**
   - **Answer**: Reverberation is the lingering of sound due to multiple reflections. Rough walls scatter sound, reducing reverberation for clearer audio.
2. **What are the human audible frequency limits, and why can't humans hear a galton whistle?**
   - **Answer**: Humans hear frequencies between 20 Hz and 20 kHz. A galton whistle (30 kHz) is ultrasonic, above the human hearing range.

1.9 Ultrasonic Waves

1. **List two uses of ultrasonic waves in the medical field.**
   - **Answer**: Ultrasonography (imaging organs) and crushing kidney stones.
2. **How does SONAR use ultrasonic waves to measure underwater distances?**

- **Answer**: SONAR emits ultrasonic waves, which reflect off underwater objects. The time taken for the echo to return is used to calculate distance using the speed of sound in water.

3. **If an ultrasonic wave in seawater (speed = 1522 m/s) returns after 0.2 s, calculate the distance to the object.**

   - **Answer**: Distance $= \frac{1522 \times 0.2}{2} = 152.2\,\mathrm{m}$.

1.10 Application-Based Questions

1. **A tuning fork of 512 Hz is pressed on a table, causing it to vibrate. What phenomenon is this, and why is the sound louder?**

   - **Answer**: This is forced vibration. The sound is louder because the table vibrates with the tuning fork, amplifying the sound energy.

2. **A longitudinal wave has a frequency of 35 Hz and travels at 350 m/s. What is the distance between two consecutive compressions?**

   - **Answer**: Wavelength $= \frac{v}{f} = \frac{350}{35} = 10\,\mathrm{m}$. This is the distance between two consecutive compressions.

3. **Why don't we hear an echo in a small room?**

   - **Answer**: In a small room, the reflecting surface is closer than 17.5 m, so the reflected sound arrives within 0.1 s, merging with the original sound due to persistence of hearing.

4. **A wave produces 50 crests and 50 troughs in 0.5 s. Calculate its frequency.**

   - **Answer**: Total cycles = 50 (since 50 crests correspond to 50 cycles). Frequency $= \frac{50}{0.5} = 100\,\mathrm{Hz}$.

5. **A transverse wave has a wavelength of 2 m and a speed of 20 m/s. What is its frequency?**

   - **Answer**: Frequency $= \frac{v}{\lambda} = \frac{20}{2} = 10\,\mathrm{Hz}$.

6. **Explain how resonance is used in a guitar.**

   - **Answer**: When a guitar string is plucked, it vibrates at its natural frequency, causing the guitar's body to resonate at the same frequency, amplifying the sound.