Physics Standard X: Sound Waves Chapter Answers

Comprehensive Solutions to All Questions and Activities

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1 Answers to Questions and Activities

1.1 Oscillatory Motion

1. **What type of motion does the swing have? (circular / oscillatory)**
   Answer: Oscillatory. A swing moves to and fro about its equilibrium position, not in a full circular path.

2. **What is the initial position of the swing when it starts oscillating from its free state (equilibrium position)? (A / O / B)**
   Answer: O. The swing starts from its equilibrium position (O) before moving to extremes A or B.

3. **In the figure, what is the maximum displacement to one side from the equilibrium position? (2a, a/2, a)**
   Answer: a. The maximum displacement from equilibrium to one side is the amplitude, denoted as a.

4. **When does the swing complete one oscillation? (when the pendulum starts from O, reaches A and returns to O / when the pendulum starts from O, reaches A, then to B and back to O)**
   Answer: When the pendulum starts from O, reaches A, then to B, and back to O. This completes one full cycle.

5. **What could be the reason that the number of oscillations counted by the child waiting for his turn to swing and the child on the swing were different? Discuss and find out.**
   Answer: The difference arises because the children may start counting from different points. The child on the swing might count from an extreme position (A to B to A), while the waiting child might count from the equilibrium (O to A to B to O). Accurate counting requires starting from the same point and completing a full cycle (O to A to B to O).

6. **Give more examples of oscillatory motion.**
   Answer:
   - Pendulum of a clock.
   - Vibrating guitar string.
   - Mass on a spring.
   - Tuning fork prongs.

7. **If a pendulum takes 1 minute to complete 30 oscillations, how long does it take to complete one oscillation?**
   Answer: Time for 30 oscillations = 1 minute = 60 s.
   Time for 1 oscillation $= \frac{60}{30} = 2\,\text{s}$.

8. **Find the number of oscillations the same pendulum completes in one second.**
   Answer: Number of oscillations in 60 s = 30.
   Number of oscillations in 1 s $= \frac{30}{60} = 0.5\,\text{oscillations}$.

9. **What is the change in frequency when the length of the pendulum increases? (increases / decreases)**
Answer: Decreases. A longer pendulum has a longer period, reducing frequency ($f = \frac{1}{T}$).

10. **What is the relation between period and frequency?**
Answer: Frequency (f) is the reciprocal of period (T): $f = \frac{1}{T}$.

11. **Complete table 1.1 by doing an experiment using a simple pendulum, meter scale, and a stopwatch.**
Answer: Set up a simple pendulum with lengths 25 cm, 60 cm, and 100 cm. Time 10 oscillations for accuracy, then calculate period ($T = \frac{\text{Time}}{10}$) and frequency ($f = \frac{10}{\text{Time}}$). Example:
(Note: Actual times depend on experimental conditions.)

Table 1: Simple Pendulum Experiment

Length (cm)	**Time for 10 Oscillations (s)**	**Period (s)**	**Frequency (Hz)**
25	10 (example)	$\frac{10}{10} = 1$	$\frac{10}{10} = 1$
60	14 (example)	$\frac{14}{10} = 1.4$	$\frac{10}{14} \approx 0.714$
100	20 (example)	$\frac{20}{10} = 2$	$\frac{10}{20} = 0.5$

12. **Observe various tuning forks and note down the markings on each of them with their units.**
Answer: Example markings: 256 Hz, 512 Hz. These indicate the natural frequency in Hertz (Hz).

13. **Do you feel any difference? (Excite tuning forks of different frequencies and listen to the sound.)**
Answer: Yes, different frequencies produce distinct pitches. Higher frequencies (e.g., 512 Hz) sound higher-pitched than lower ones (e.g., 256 Hz).

14. **Isn't the difference in frequency the reason for the difference in sound here?**
Answer: Yes, the frequency determines the pitch of the sound produced by the tuning fork.

15. **What is the change in the sound heard when the stem of the excited tuning fork is pressed on the table? What could be the reason for the sound being louder?**
Answer: The sound becomes louder. The table undergoes forced vibration, vibrating with the tuning fork, amplifying the sound energy.

16. **Excite the hacksaw blade A by tapping with your finger. What do you observe? (all blades vibrate / only A vibrates)**
Answer: Only A vibrates initially, as it is directly tapped.

17. **Are all the blades vibrating with the same amplitude?**
Answer: No, only blades with the same natural frequency as A (e.g., C and E) vibrate significantly due to resonance.

18. **Which of them vibrates with maximum amplitude?**
Answer: Blades C and E, which share the same natural frequency as A, vibrate with maximum amplitude due to resonance.

19. **After all the blades have stopped vibrating, excite B and record the observation in the science diary.**
Answer: Exciting blade B causes it to vibrate. Blades D and F (same length as B, 17 cm) vibrate with maximum amplitude due to resonance, while others vibrate minimally or not at all.

20. **When blade A vibrates, why would the hacksaw blades C and E vibrate with maximum amplitude?**
Answer: Blades C and E have the same natural frequency as A (same length, 13 cm), causing resonance and maximum amplitude.

21. **Immerse in water a PVC pipe of about 50 cm length and 4 cm diameter. Excite a tuning fork of frequency 512 Hz and hold it close to the mouth of the pipe. Vary the length of the air column inside the pipe by gradually raising both the tuning fork and the pipe. Don't you hear a louder sound at a particular stage? What could be the reason for this? Record in your science diary.**
Answer: A louder sound is heard when the air column's length matches the frequency of the tuning fork (512 Hz), causing resonance. The air column vibrates with maximum amplitude, amplifying the sound.

22. **Stretch both ends of a slinky placed on a table. Compress and release a few coils at one end of the slinky. Notice the disturbance formed in the slinky.**
Answer: A compression wave travels along the slinky, with coils bunching up and spreading out, forming a longitudinal wave.

23. **Move one end of the slinky back and forth. What do you observe?**
Answer: A transverse wave forms, with coils moving up and down, creating crests and troughs that travel along the slinky.

24. **Are the coils in the slinky moving towards the other end along with the disturbances?**
Answer: No, the coils oscillate locally; only the disturbance (wave) travels to the other end.

25. **In figure 1.8 (b), did the coils in the slinky move parallel or perpendicular to the direction of propagation of the wave?**
Answer: Perpendicular. The slinky in this setup forms a transverse wave.

26. **Do all these waves require a medium to travel? Complete table 1.2 appropriately.**
Answer:

27. **In figure 1.9, as the prong of the tuning fork moves from the equilibrium position to the side A, the air pressure on that side (increases / decreases).**
Answer: Increases. The prong compresses air molecules, forming a compression.

Table 2: Waves and Medium Requirements

Waves Requiring Medium	Waves Not Requiring Medium
Sound waves	Radio waves
Seismic waves	Light waves
Ripples on water	Microwaves
	Ultraviolet rays
	X-rays
	Gamma rays

28. **What about the air pressure on side A when the same prong moves to side B?**
Answer: Decreases. The prong moves away, creating a rarefaction.

29. **When the prongs of the tuning fork vibrate continuously, aren't regions of high and low pressure formed intermittently in the air?**
Answer: Yes, continuous vibration creates alternating compressions (high pressure) and rarefactions (low pressure).

30. **Compare the wave produced in the slinky with the wave produced by the tuning fork in the air.**
Answer: The slinky wave (figure 1.8b) is transverse, with coils moving perpendicular to the wave direction, forming crests and troughs. The tuning fork wave is longitudinal, with air molecules vibrating parallel, forming compressions and rarefactions.

31. **Press and release the spring continuously. What do you observe?**
Answer: A transverse wave forms, with the string moving up and down, creating crests and troughs that propagate.

32. **What is the direction of motion of the particles in the string, with respect to the equilibrium position? (parallel / perpendicular)**
Answer: Perpendicular. The string particles move up and down relative to the wave's horizontal propagation.

33. **Does each point on the string move parallel or perpendicular to the direction of propagation of the wave formed in the string?**
Answer: Perpendicular. The wave is transverse.

34. **Do the particles on the string undergo resultant translatory motion other than moving vertically up and down from their equilibrium position?**
Answer: No, particles oscillate vertically without net displacement along the wave's direction.

35. **Are the coils moving parallel or perpendicular to the waveform created on the slinky?**
Answer: Perpendicular. The slinky forms a transverse wave.

36. **What type of waveform is formed in the slinky?**
Answer: Transverse waveform, with crests and troughs.

37. **Some of the characteristics related to transverse waves and longitudinal waves are given below. Classify them and complete the table.**

Answer:

Table 3: Longitudinal vs. Transverse Waves

Longitudinal Waves	**Transverse Waves**
Particles vibrate parallel	Particles vibrate perpendicular
Compressions and rarefactions	Crests and troughs
Pressure variations occur	No pressure variations

38. **In the figure, which are the points with maximum displacement from the equilibrium position of the wave? (A, B, C, D, E)**
Answer: Points A and B. These represent the crests and troughs with maximum amplitude.

39. **What is the amplitude of this wave?**
Answer: The maximum displacement from equilibrium to A or B, denoted as a, in meters.

40. **In figure 1.11, what is the time taken by the particle in the medium to complete one vibration?**
Answer: The period (T), the time from one crest (or trough) to the next identical point on the graph, in seconds.

41. **What is the period of the wave in the figure?**
Answer: The time for one complete cycle, as shown on the displacement-time graph, in seconds.

42. **If the wave shown in figure 1.11 takes 1 s to travel from O to D, find the frequency of the wave.**
Answer: Assuming the distance O to D represents one wavelength (λ), frequency $= \frac{\text{Speed}}{\lambda}$. Without specific distances, frequency depends on the number of cycles in 1 s, determined from the graph (e.g., if 2 cycles, $f = 2\,\text{Hz}$).

43. **In figure 1.13 (a), which particle is in the same phase of vibration as particle A? (B, C, D, E)**
Answer: Particle D (assuming D is one wavelength from A, in the same phase).

44. **In the case of particle P?**
Answer: The particle one wavelength from P, in the same phase (depends on figure specifics).

45. **In the case of particle B?**
Answer: The particle one wavelength from B, in the same phase (depends on figure specifics).

46. **In figure 1.13 (b), which represents the wavelength (λ)? (CR, RR)**
Answer: CR. In longitudinal waves, wavelength is the distance between consecutive compressions (C to C) or rarefactions (R to R).

47. **Here CR represents ($\lambda, \frac{\lambda}{2}, \frac{\lambda}{4}$)?**
Answer: λ. CR is the distance between consecutive compressions, equal to one wavelength.

48. **If a wave travels 700 m in 2 s, what is the speed of the wave?**
Answer: Speed $= \frac{700}{2} = 350\,\text{m/s}$.

49. **If the frequency of the wave is changed, will the wavelength change?**
Answer: Yes, for constant speed, wavelength is inversely proportional to frequency ($v = f\lambda$).

50. **In figure 1.14 (a), what is the wavelength of the wave?**
Answer: The distance between two consecutive crests or troughs, measured from the figure (e.g., 4 m, depending on specifics).

51. **What is the wavelength of the wave in figure 1.14 (b)?**
Answer: The distance between consecutive crests or troughs, typically shorter or longer than figure 1.14 (a) based on visual comparison (e.g., 2 m).

52. **In figure 1.14 (a), if both the waves take 1 s to travel a distance of 12 m, what is the frequency of the wave?**
Answer: Speed $= \frac{12}{1} = 12\,\text{m/s}$. If wavelength = 4 m (example), frequency $= \frac{12}{4} = 3\,\text{Hz}$.

53. **In figure 1.14 (b), what is the frequency of the wave?**
Answer: Speed = 12 m/s. If wavelength = 2 m (example), frequency $= \frac{12}{2} = 6\,\text{Hz}$.

54. **Which wave has a longer wavelength?**
Answer: Figure 1.14 (a), as it typically shows fewer cycles, indicating a longer wavelength.

55. **Which wave has a higher frequency?**
Answer: Figure 1.14 (b), as shorter wavelength implies higher frequency for the same speed.

56. **What is the relation between wavelength and frequency?**
Answer: Inversely proportional: $f \propto \frac{1}{\lambda}$ when speed is constant.

57. **What is the wavelength (λ)?**
Answer: The distance between consecutive points in the same phase, e.g., crest to crest, in meters.

58. **If the wave takes 1 s to reach A from O, what is the frequency (f)?**
Answer: If O to A is one wavelength, frequency $= \frac{\text{Speed}}{\lambda}$. Without specific values, frequency depends on the figure's scale.

59. **What is the speed of the wave (v)?**
Answer: Speed $= \frac{\text{Distance from O to A}}{1} = f\lambda$, calculated from the figure's specifics.

60. **Find the relation between wavelength, frequency, and speed of a wave.**
Answer: $v = f\lambda$.

61. **How many crests are there in the figure?**
Answer: Count the elevated portions in the transverse wave (depends on figure, e.g., 3 crests).

62. **How many troughs are there?**
Answer: Count the lowest portions (e.g., 3 troughs, depending on figure).

63. **What is the wavelength?**
Answer: Distance between consecutive crests or troughs, measured from the figure.

64. **If the frequency of a longitudinal wave travelling at a speed of 350 m/s in the air is 35 Hz, what is the distance between two consecutive compressions of this wave?**
Answer: Wavelength $= \frac{v}{f} = \frac{350}{35} = 10\,\text{m}$.

65. **What about the distance between two consecutive rarefactions?**
Answer: Also 10 m, as the distance between consecutive rarefactions equals the wavelength.

66. **A sound wave with a frequency of 175 Hz has a wavelength of 2 m. Calculate the speed of sound.**
Answer: Speed $= f\lambda = 175 \times 2 = 350\,\text{m/s}$.

67. **Adjust the pipe B at different angles and listen to the ticking sound from the clock. What could be the reason for the ticking sound being heard from the clock through the pipe B?**
Answer: The sound reflects off the glass plate into pipe B, allowing it to be heard.

68. **Don't you feel a decrease in the loudness of the reflecting sound? What is the reason? (Using rough surfaces instead of glass)**
Answer: Yes, loudness decreases. Rough surfaces scatter sound, reducing reflection intensity.

69. **Does sound from a source always travel directly to the listener?**
Answer: No, sound can reflect off surfaces, reaching the listener indirectly.

70. **How long will it take to hear the echo distinctly after hearing the first sound?**
Answer: 0.1 s, due to the persistence of hearing.

71. **How far does the sound travel during this time? (Speed of sound = 350 m/s)**
ascended **Answer**: Distance $= 350 \times \frac{1}{10} = 35\,\text{m}$.

72. **The echo of fire cracker is heard after 1 s by the person who burst it. How far is the reflecting surface? (Speed = 350 m/s)**
Answer: Distance $= \frac{350\times1}{2} = 175\,\text{m}$.

73. **What should be the minimum distance between the source and the reflecting surface to hear the echo in water? (Speed = 1480 m/s)**
Answer: Distance $= \frac{1480\times0.1}{2} = 74\,\text{m}$.

74. **If an ultrasonic wave emitted by a transmitter on a ship returns after 0.2 s, what is the distance to the rock? (Speed = 1522 m/s)**
Answer: Distance $= \frac{1522\times0.2}{2} = 152.2\,\text{m}$.

75. **What measures can be taken to safeguard against tsunamis? Discuss and make notes.**
Answer: Follow tsunami warning center instructions, evacuate to higher ground, avoid coastal areas, and prepare emergency kits.

76. **The frequency of a simple pendulum is 1 Hz. What is its period?**
Answer: Period $= \frac{1}{f} = \frac{1}{1} = 1\,\text{s}$.

77. **If a pendulum takes 0.5 s to complete one oscillation, what is its frequency?**
Answer: Frequency $= \frac{1}{T} = \frac{1}{0.5} = 2\,\text{Hz}$.

78. **A tuning fork of frequency 512 Hz is excited and its stem is pressed on a table. Does the table vibrate? What is this phenomenon called?**
Answer: Yes, the table vibrates. This is forced vibration.

79. **How does the air near a 256 Hz tuning fork vibrate?**
Answer: The air vibrates 256 times per second, forming longitudinal waves with compressions and rarefactions.

2 Assessment Questions

1. **Which of the following statements is correct?**

   a) Sound and light are transverse waves.

   b) Sound and light are longitudinal waves.

   c) Sound is a longitudinal wave and light is a transverse wave.

   d) Sound is a transverse wave and light is a longitudinal wave.

   Answer: c) Sound is a longitudinal wave and light is a transverse wave.
   Explanation: Sound involves parallel vibrations; light involves perpendicular vibrations.

2. **The upper limit of frequency of sound that a bat can hear is 120 kHz. What is the maximum wavelength? (Speed = 350 m/s)**
   Answer: Wavelength $= \frac{v}{f} = \frac{350}{120\times10^3} = 0.00292\,\text{m} = 2.92\,\text{mm}$.

3. **Find the frequency, period, and wavelength of each wave. (Two waves at 3.2 m/s)**
   Answer: Without specific figure data, assume example wavelengths (e.g., 1.6 m and 0.8 m).
   Wave 1: $f = \frac{3.2}{1.6} = 2\,\text{Hz}$, $T = \frac{1}{2} = 0.5\,\text{s}$, $\lambda = 1.6\,\text{m}$.
   Wave 2: $f = \frac{3.2}{0.8} = 4\,\text{Hz}$, $T = \frac{1}{4} = 0.25\,\text{s}$, $\lambda = 0.8\,\text{m}$.

4. **Which frequency can be heard by humans?**

   a) 5 Hz

   b) 2000 Hz

   c) 200 kHz

   d) 50 kHz

Answer: b) 2000 Hz.
Explanation: Human hearing range is 20 Hz to 20 kHz.

5. **A wave has a frequency of 2 kHz and a wavelength of 35 cm. How far does it travel in 0.5 s?**
   Answer: Speed $= 2000 \times 0.35 = 700\,\text{m/s}$.
   Distance $= 700 \times 0.5 = 350\,\text{m}$.

6. **What is the frequency of a wave that produces 50 crests and 50 troughs in 0.5 s?**
   Answer: Frequency $= \frac{50}{0.5} = 100\,\text{Hz}$.

7. **Which of the following is different regarding the waves given in the figures 1.31 (a) and 1.31 (b)? (frequency, amplitude, wavelength)**
   Answer: Wavelength.
   Explanation: Different wavelengths are indicated by different crest spacing in the figures.

8. **The distance between two adjacent troughs of a transverse wave is 2 m. Find the frequency if its speed is 20 m/s.**
   Answer: Frequency $= \frac{v}{\lambda} = \frac{20}{2} = 10\,\text{Hz}$.

9. **When sound passes through a medium, what travels?**

   a) The particles in the medium
   b) The wave
   c) The source of sound
   d) The medium

   Answer: b) The wave.
   Explanation: The wave transfers energy, not the medium or source.

10. **Two pith balls near a tuning fork move slightly when a piano is played. What is the reason? (forced vibration / echo)**
    Answer: Forced vibration. The piano's vibrations cause the pith balls to vibrate.

11. **While playing certain notes on the piano, the pith balls are thrown to a maximum distance. Which phenomenon is responsible? (reverberation / resonance)**
    Answer: Resonance. Matching frequencies cause maximum amplitude.

3 Extended Activities

1. **Plan an activity that illustrates the resonance of sound.**
   Answer: Set up two tuning forks of 512 Hz on stands. Excite one fork by striking it, then place it near the second fork. The second fork vibrates loudly due to resonance, as their natural frequencies match, amplifying the sound. Record observations in a science diary, noting the increased loudness when frequencies align.

2. **Prepare and present a seminar paper on the topic: 'Ultrasonic Waves and their Applications.'**
   Answer: **Seminar Paper Outline**:
   Title: Ultrasonic Waves and Their Applications
   Introduction: Ultrasonic waves (>20 kHz) are inaudible, used in various fields.
   Medical Applications:

   - Ultrasonography: Imaging organs via reflected waves.
   - Kidney stone crushing: High-intensity waves break stones.
   - Physiotherapy: Promotes tissue healing.

   Industrial Applications: Cleaning intricate parts (e.g., electronics) using ultrasonic vibrations in fluid.
   Navigation: SONAR measures underwater distances (e.g., 1522 m/s wave returns in 0.2 s: distance = 152.2 m).
   Conclusion: Ultrasonic waves enhance precision in medicine, industry, and navigation, showcasing physics' practical impact.