CLASS 9 SCIENCE

CHAPTER 10

SOUND WAVES: CHARACTERISTICS AND APPLICATIONS

IMPORTANT QUESTIONS

Purpose: Exam-focused questions covering Chapter 10 of the Class 9 Science Exploration textbook: production and propagation of sound, mechanical and longitudinal waves, energy transfer, graphical representation, wavelength, frequency, time period, amplitude, intensity, speed, pitch, loudness, audible/infrasonic/ultrasonic sound, reflection, echo, reverberation, echolocation and SONAR.

Name: __________________________ **Class:** ______ **Date:** __________

Suggested use: Attempt Sections A–F before checking the answer key.

SECTION A — VERY SHORT ANSWER QUESTIONS

Answer in 1–2 sentences.

1. What is a vibration?
2. What produces sound?
3. What is a source of sound?
4. What is a tuning fork?
5. What are the prongs of a tuning fork?
6. What is meant by a medium?
7. Can sound travel through solids, liquids and gases?
8. Can sound travel through vacuum?
9. What is a sound wave?
10. What is a compression?
11. What is a rarefaction?
12. What is a longitudinal wave?
13. Why is sound called a mechanical wave?
14. What is wavelength?
15. What is frequency?
16. What is time period?
17. What is amplitude of a sound wave in the chapter’s density description?
18. What is intensity of sound?
19. What is the relation between speed, wavelength and frequency?
20. What is pitch?

SECTION B — SHORT ANSWER QUESTIONS

Answer in about 3–5 sentences.

21. Explain how a vibrating rubber band produces sound.
22. Explain how the tuning fork activity demonstrates vibration.
23. How is sound produced in human beings?
24. Give examples of vibrating parts in different musical instruments.
25. Explain how sound travels through a solid and through a liquid.
26. Describe the vacuum bell jar experiment and its conclusion.
27. Why can astronauts in spacewalks not directly hear one another?
28. Explain how compressions and rarefactions are produced by an oscillating piston.
29. Why do the particles of the medium not travel along with a sound wave?
30. Differentiate between a longitudinal wave and a transverse wave.
31. Explain why sound is a form of energy.
32. How does a microphone convert sound energy into electrical energy?
33. How does a speaker convert electrical energy into sound?
34. Explain the graphical representation of a sound wave using density and distance.
35. Define frequency and time period and state their relationship.
36. Explain how amplitude is related to the energy carried by a sound wave.
37. Why does sound intensity decrease as the distance from the source increases?
38. Explain how temperature and humidity affect the speed of sound in air.
39. Differentiate between pitch and loudness.
40. What are infrasonic, audible and ultrasonic sound ranges?

SECTION C — LONG ANSWER & DIFFERENTIATION

Answer in about 5–8 sentences. Use examples where appropriate.

41. Describe the complete process of sound production and propagation from a vibrating source to a listener.

42. Explain the vacuum bell jar experiment and why it establishes that sound needs a material medium.

43. Explain the formation and movement of compressions and rarefactions in air.

44. Why is sound a longitudinal mechanical wave? Compare it with a transverse wave.

45. Explain how sound energy is transferred through a medium without the medium’s particles travelling with the wave.

46. Explain wavelength, frequency, time period, amplitude and intensity as characteristics of sound.

47. Explain the equation $v = \lambda\nu$ and the significance of each quantity.

48. Discuss how the speed of sound differs in solids, liquids and gases, with the values given in the chapter.

49. Explain human perception of sound in terms of pitch, loudness and the audible range.

50. Explain reflection of sound and the conditions required to hear a distinct echo.

51. Differentiate between echo and reverberation.

52. Explain echolocation and its importance to bats and other animals.

53. Explain the working principle of SONAR and one major application.

54. Explain how the human ear converts sound vibrations into signals perceived by the brain.

55. Write a detailed note on noise, noise pollution and the possible effects of prolonged exposure to loud sound.

SECTION D — NUMERICAL & APPLICATION QUESTIONS

Show formula, substitution and final answer.

56. 10 density oscillations occur in 2 s. Find the frequency and time period.
57. A sound wave has frequency 20 Hz. How many oscillations occur in 1 minute?
58. A sound wave has a wavelength of 3.44 m and travels at 344 m/s. Find its frequency and time period.
59. Calculate the wavelength in air for a 20 Hz sound when speed is 344 m/s.
60. Calculate the wavelength in air for a 20,000 Hz sound when speed is 344 m/s.
61. Lightning is seen 5 s before thunder is heard. Using 340 m/s for sound, estimate the distance of the lightning strike.
62. Sound travels at 5000 m/s in steel and 1500 m/s in water. Find the ratio of the speeds in steel and water.
63. Find the ratio of the speed of sound in water (1500 m/s) to air (340 m/s).
64. A sound wave travels in steel at 5000 m/s and has wavelength 50 m. Find its frequency and time period.
65. A reflected sound is heard after 0.5 s. If speed of sound is 340 m/s, find the distance of the reflecting wall.
66. An echo is required after 0.2 s. If sound travels at 343 m/s, find the minimum distance of the reflecting surface.
67. A SONAR signal returns after 0.90 s in seawater where sound speed is 1530 m/s. Find the distance of the underwater object.
68. A SONAR signal returns after 4 s in seawater where speed is 1500 m/s. Find the depth of the ocean.
69. A parking sensor is 1.2 m from an obstacle. If ultrasonic sound travels at 345 m/s, find the round-trip time.
70. At 22 °C sound travels at 344 m/s; at 0 °C it travels at 331 m/s. For 1720 m, calculate the difference in travel time.
71. Two sounds travel 340 m through air and steel at 340 m/s and 5000 m/s respectively. Find the time taken in each medium.
72. A wave has speed 345 m/s and frequency 500 Hz. Find its wavelength.
73. A wave has wavelength 0.5 m and frequency 600 Hz. Find its speed.
74. A source produces 80 compressions in 4 s. Find its frequency and time period.
75. A sound has frequency 2 kHz and travels at 344 m/s. Find its wavelength.

SECTION E — APPLICATION, HOTS & CASE-BASED QUESTIONS

Use reasoning and scientific concepts.

76. During a spacewalk, an astronaut sees a tool strike metal but cannot hear the sound directly. Explain why.

77. A rubber band stops vibrating but the observer still thinks the sound should continue. Explain why the sound stops.

78. A student says that air particles travel from a speaker all the way to the listener. Correct the statement scientifically.

79. A slinky shows closely spaced and widely spaced regions moving forward while a marked turn oscillates in place. What do these regions represent and what does the observation show?

80. A sound wave has a larger density amplitude than another wave. Which carries more energy and why?

81. Two sound sources have the same frequency but different amplitudes. How would their pitch and loudness compare?

82. Two waves travel in the same medium with different frequencies. Which has the shorter wavelength, assuming the speed is the same? Explain.

83. A hall has many hard reflecting surfaces and speech becomes unclear because sound persists after the source stops. Identify the phenomenon and suggest a way to reduce it.

84. Why does a distinct echo require a minimum time gap between the original and reflected sound?

85. A soft curtain produces a weaker echo than a hard wall. Explain using reflection and absorption.

86. A bat emits ultrasound and detects its reflection. Explain how it can locate prey.

87. Why is SONAR suitable for locating underwater objects?

88. A student claims that higher frequency always means higher speed of sound in the same medium. Evaluate the claim.

89. Why is thunder heard after lightning is seen even though both events occur almost simultaneously?

90. A sound wave is inaudible to humans but detectable by an elephant. What frequency range could it belong to? Explain.

91. A person moves farther from a sound source and notices it becomes less loud. Explain using intensity and spreading of energy.

92. Why can two instruments playing the same note at the same loudness still sound different?

93. Explain why the same musical note can be produced by different sources but have different sound quality.

94. Why does a supersonic aircraft produce a sonic boom?

95. Explain why an increase in temperature of air increases the speed of sound according to the chapter.

SECTION F — EXAM-STYLE CHALLENGE QUESTIONS

Integrated questions for school-exam preparation.

96. Explain the chain: vibration → medium disturbance → compressions/rarefactions → sound wave → energy transfer → hearing.

97. A wave has wavelength 2 m and frequency 170 Hz. Calculate its speed and time period.

98. A wave travels at 340 m/s and has a frequency of 100 Hz. Calculate wavelength and time period.

99. A student observes two sound-wave graphs with the same axis scales. One has wider spacing between successive crests and the other has larger vertical variation. Identify which has greater wavelength and which has greater amplitude.

100. A sound wave has frequency 50 Hz. Is it audible to a healthy human according to the chapter? What type of wave is it?

101. Explain why increasing frequency increases the number of compressions per second but does not necessarily increase sound speed in the same medium.

102. A ship uses SONAR and receives an echo 5 s after sending the signal. If speed in seawater is 1525 m/s, calculate the depth of the wreckage.

103. A steel fence is 340 m long. Compare the arrival times of a sound travelling through steel at 5000 m/s and through air at 340 m/s, and determine whether the two sounds can be distinguished if a 0.1 s gap is required.

104. Explain the difference between a tone, a musical note and timbre as described in the chapter.

105. Write a complete chapter-revision answer covering sound production, propagation, wave characteristics, human perception, reflection, echo, reverberation, ultrasound, infrasound and SONAR.

ANSWER KEY

Concise exam-ready answers based on Chapter 10 content.

Note: Equivalent scientifically correct wording should be accepted. Numerical answers use the values stated in the chapter questions/examples.

1–20

1. Periodic to-and-fro motion/oscillation. 2. Vibrating objects. 3. Object that produces sound. 4. U-shaped metal bar with a stem used in sound experiments. 5. The two sides/tines of the U-shaped fork. 6. Material through which sound propagates. 7. Yes. 8. No; sound needs a material medium. 9. A disturbance of alternating compressions and rarefactions propagating through a medium without actual flow of the medium particles. 10. Region of higher-than-average density. 11. Region of lower-than-average density. 12. Wave in which particles vibrate parallel to propagation. 13. It requires a material medium. 14. Distance between consecutive crests or troughs. 15. Number of density oscillations per unit time. 16. Time for one complete oscillation. 17. Maximum change in density from average density. 18. Sound energy passing through unit area perpendicular to propagation per unit time. 19. $v = \lambda\nu$. 20. Human perception of frequency.

21–40

21. Plucking makes the band vibrate; while it vibrates sound is produced. 22. Vibrating prongs produce sound and create water-surface waves, demonstrating vibration. 23. Vocal cords in the larynx vibrate; mouth, tongue, lips and nasal cavity shape the sound. 24. Strings in string instruments, air columns in flutes, membranes in drums, etc. 25. Sound reaches the listener through the vibrating particles of the solid/liquid medium. 26. As air is removed, the bell becomes fainter although it still vibrates; near vacuum produces almost no audible sound, proving sound needs a medium. 27. Space is near vacuum, so sound cannot directly propagate; astronauts use communication devices. 28. Forward piston motion compresses air; backward motion creates rarefaction; repeated oscillation produces alternating C and R. 29. Particles oscillate about mean positions; the disturbance and energy travel. 30. Longitudinal: parallel vibration; transverse: perpendicular vibration. 31. Sound can transfer energy and do work, e.g., make grains move. 32. A microphone diaphragm vibrates and converts sound energy into an electrical signal. 33. Electrical signal makes speaker diaphragm/cone vibrate, producing sound. 34. Plot density against distance or time; higher density gives crest and lower density gives trough. 35. Frequency is oscillations per second; T is time for one oscillation; $\nu=1/T$. 36. Larger amplitude means larger density variation and more energy. 37. Energy spreads over a larger area as the wave moves away, so intensity decreases. 38. Higher temperature/humidity increase speed of sound in air. 39. Pitch depends mainly on perceived frequency; loudness depends on perceived amplitude. 40. Audible: 20 Hz–20 kHz; infrasound below 20 Hz; ultrasound above 20 kHz.

41–55

41. A vibrating source creates disturbances; particles of the medium oscillate and pass the disturbance through compressions/rarefactions until it reaches the listener. 42. The bell remains visible but sound fades as air is removed, showing a material medium is necessary. 43. Forward piston motion increases density (C); backward motion decreases density (R); repeated motion produces alternating regions. 44. Sound is longitudinal because particle vibration is parallel to propagation, and mechanical because it needs a medium. 45. Particles transfer energy by collisions while oscillating about mean positions; they do not travel with the wave. 46. λ measures spatial repetition, ν measures oscillations per second, T measures one oscillation time, amplitude measures maximum density variation, and intensity measures energy passing through unit area per unit time. 47. $v=\lambda/T$ and since $\nu=1/T$, $v=\lambda\nu$. 48. Sound is fastest in solids, slower in liquids and slowest in gases; chapter values: steel 5000 m/s, water 1500 m/s, air 340 m/s at 15 °C. 49. Pitch is related to frequency; loudness to amplitude; human hearing is roughly 20 Hz–20 kHz. 50. Reflection is bouncing from a surface; distinct echo requires at least 0.1 s separation. 51. Echo is a distinct reflected sound; reverberation is persistence caused by multiple reflections, especially in halls. 52. Bats emit ultrasound and use returning echoes to determine positions of prey/obstacles. 53. SONAR sends ultrasonic pulses underwater and analyses returning echoes to determine distance/direction of objects. 54. Eardrum vibrates; tiny bones amplify vibrations; cochlea converts them into electrical signals interpreted by the brain. 55. Noise is unwanted/harmful sound; prolonged loud exposure can affect sleep, health and hearing and may cause hearing loss.

56–75

56. $\nu=10/2=5$ Hz; $T=1/5=0.2$ s. 57. $20\times60=1200$ oscillations. 58. $\nu=v/\lambda=344/3.44=100$ Hz; $T=0.01$ s. 59. $\lambda=344/20=17.2$ m. 60. $\lambda=344/20000=0.0172$ m$=1.72$ cm. 61. $d=340\times5=1700$ m$=1.7$ km. 62. $5000:1500=10:3\approx3.33:1$. 63. $1500:340\approx4.41:1$. 64. $\nu=5000/50=100$ Hz; $T=0.01$ s. 65. Distance$=340\times0.5/2=85$ m. 66. Minimum distance$=343\times0.2/2=34.3$ m. 67. One-way time$=0.90/2=0.45$ s; $d=1530\times0.45=688.5$ m. 68. Depth$=1500\times4/2=3000$ m. 69. Round trip time$=2\times1.2/345\approx0.00696$ s (6.96 ms). 70. At 22 °C: $1720/344=5$ s; at 0 °C: $1720/331\approx5.197$ s; extra ≈0.197 s. 71. Air: $340/340=1$ s; steel: $340/5000=0.068$ s. 72. $\lambda=345/500=0.69$ m. 73. $v=0.5\times600=300$ m/s. 74. $\nu=80/4=20$ Hz; $T=0.05$ s. 75. $\lambda=344/2000=0.172$ m$=17.2$ cm.

76–95

76. Sound cannot travel directly through vacuum; the astronaut sees the event but needs a medium for sound. 77. Sound is produced while the source vibrates; when vibration stops, sound production stops. 78. Air particles only oscillate about mean positions; energy/disturbance travels. 79. Closely spaced regions are compressions, spread regions are rarefactions; the disturbance travels while marked particles oscillate locally. 80. The larger-amplitude wave carries more energy. 81. Same pitch because frequency is same; larger amplitude is perceived as louder. 82. Higher frequency gives shorter wavelength when speed is unchanged. 83. Reverberation; use sound-absorbing panels, curtains, upholstered seats or other soft porous materials. 84. The original and reflected sounds must be separated by at least about 0.1 s for the brain to distinguish them. 85. Hard surfaces reflect strongly; soft curtains absorb more sound and produce weaker echoes. 86. Bat emits ultrasonic pulses; reflections reveal location/distance of prey. 87. SONAR uses reflected ultrasonic pulses effectively in water to locate underwater objects. 88. False. In a given medium, sound speed generally depends on the medium, not frequency; wavelength changes when frequency changes. 89. Light travels much faster than sound, so the visual flash arrives first. 90. Below 20 Hz, i.e., infrasound. 91. Energy spreads over a larger area, so intensity and perceived loudness decrease with distance. 92. Their timbre differs because the pattern and intensity of overtones depend on shape, material and construction. 93. A supersonic aircraft creates a strong pressure disturbance/sonic boom while moving faster than sound. 94. The chapter states that increasing temperature or humidity increases sound speed in air. 95. The chain shows vibration at the source, disturbance of the medium, C/R propagation, energy transfer and finally vibration of the listener's hearing system.

96–105

96. $v=\lambda\nu=2\times170=340$ m/s; $T=1/170\approx0.00588$ s. 97. $\lambda=v/\nu=340/100=3.4$ m; $T=0.01$ s. 98. The graph with wider horizontal spacing has greater wavelength; the graph with larger vertical variation has greater amplitude. 99. 50 Hz lies within the human audible range, so it is audible. 100. Frequency increases the number of oscillations/compressions per second; in the same medium speed generally remains constant while wavelength changes. 101. Depth$=1525\times5/2=3812.5$ m. 102. Steel time$=340/5000=0.068$ s; air time$=340/340=1$ s; difference$=0.932$ s, so they can be distinguished because it exceeds 0.1 s. 103. A tone has a single frequency; a musical note contains a fundamental plus overtones; timbre is the quality that makes different instruments sound different even for the same note and loudness. 104. Sound is produced by vibration; needs a medium; travels as longitudinal C/R disturbances; transfers energy; is described by λ, ν, T, amplitude and intensity; speed depends on medium; human perception includes pitch/loudness; reflection causes echo/reverberation; frequencies below 20 Hz are infrasonic and above 20 kHz ultrasonic; ultrasound is used in echolocation and SONAR.

Chapter 10 final checklist: Production of Sound • Tuning Fork • Propagation • Medium & Vacuum • Compressions & Rarefactions • Longitudinal/Mechanical Waves • Sound Energy • Graphs • Wavelength • Frequency • Time Period • Amplitude • Intensity • Speed • Pitch • Loudness • Audible/Infrasonic/Ultrasonic • Human Ear • Reflection • Echo • Reverberation • Echolocation • SONAR.