CLASS 9 SCIENCE

CHAPTER 10 • SOUND WAVES: CHARACTERISTICS AND APPLICATIONS

NUMERICAL PROBLEMS • Practice + Answers

Formula Sheet: ν = number of oscillations/time | $T = 1/\nu$ | $v = \lambda\nu$ | $\lambda = v/\nu$ | distance = vt | Echo/SONAR one-way distance = vt/2

1. A sound wave has 10 density oscillations in 2 s. Find its frequency and time period.

Answer: $\nu = 10/2 =$ **5 Hz**; $T = 1/\nu =$ **0.2 s**.

2. A sound wave has a frequency of 20 Hz. How many oscillations does it complete in 1 minute?

Answer: Oscillations = $\nu t = 20 \times 60 =$ **1200 oscillations**.

3. A sound wave has a frequency of 50 Hz. Calculate its time period.

Answer: $T = 1/\nu = 1/50 =$ **0.02 s**.

4. A sound wave has a time period of 0.005 s. Find its frequency.

Answer: $\nu = 1/T = 1/0.005 =$ **200 Hz**.

5. A sound wave travels at 344 m/s and has a frequency of 20 Hz. Calculate its wavelength.

Answer: $\lambda = v/\nu = 344/20 =$ **17.2 m**.

6. A sound wave travels at 344 m/s and has a frequency of 20 kHz. Calculate its wavelength in metres and centimetres.

Answer: 20 kHz = 20,000 Hz. $\lambda = 344/20{,}000 = 0.0172$ m = **1.72 cm**.

7. A sound wave has a wavelength of 2 m and frequency of 170 Hz. Calculate its speed.

Answer: $v = \lambda\nu = 2 \times 170 =$ **340 m/s**.

8. A sound wave travels at 340 m/s and has a wavelength of 0.5 m. Find its frequency.

Answer: $\nu = v/\lambda = 340/0.5 =$ **680 Hz**.

9. A sound wave has a wavelength of 3.44 m and travels at 344 m/s. Find its frequency and time period.

Answer: $\nu = 344/3.44 =$ **100 Hz**; $T = 1/100 =$ **0.01 s**.

10. A sound wave travels in steel at 5000 m/s and has a wavelength of 50 m. Find its frequency and time period.

Answer: $\nu = 5000/50 =$ **100 Hz**; $T = 1/100 =$ **0.01 s**.

11. Sound travels at 340 m/s in air and 1500 m/s in water. Find the ratio of its speed in water to its speed in air.

Answer: Ratio = 1500:340 = **75:17** ≈ 4.41:1.

12. Sound travels at 5000 m/s in steel and 1500 m/s in water. Find the ratio of its speed in steel to its speed in water.

Answer: Ratio = 5000:1500 = **10:3** ≈ 3.33:1.

13. During a thunderstorm, the delay between seeing lightning and hearing thunder is 5 s. Take speed of sound as 340 m/s. Estimate the distance of the lightning strike.

Answer: Distance = vt = 340 × 5 = **1700 m = 1.7 km**.

14. An echo is heard 0.5 s after a clap. If the speed of sound is 340 m/s, calculate the distance from the wall.

Answer: Sound travels to the wall and back. d = vt/2 = 340×0.5/2 = **85 m**.

15. An experiment requires an echo to arrive at least 0.2 s after sound is emitted. If the speed of sound is 343 m/s, what minimum distance should the reflecting surface be placed at?

Answer: d = vt/2 = 343×0.2/2 = **34.3 m**.

16. An echo is heard 0.8 s after a sound is produced. Take speed of sound as 340 m/s. Find the distance of the reflecting surface.

Answer: $d = vt/2 = 340 \times 0.8/2 =$ **136 m**.

17. A sonar signal sent into seawater returns after 0.90 s. If sound travels at 1530 m/s in seawater, how far is the object?

Answer: One-way time $= 0.90/2 = 0.45$ s. $d = 1530 \times 0.45 =$ **688.5 m**.

18. A sonar signal sent to find the depth of the ocean takes 4 s to return. If the speed of sound in seawater is 1500 m/s, find the depth.

Answer: Depth $= vt/2 = 1500 \times 4/2 =$ **3000 m = 3 km**.

19. A ship detects a sonar echo after 5 s. If the ultrasonic wave travels at 1525 m/s in seawater, approximately how far down is the wreckage?

Answer: Depth $= vt/2 = 1525 \times 5/2 =$ **3812.5 m** $\approx$ **3.81 km**.

20. A vehicle's ultrasonic parking sensor detects an obstacle 1.2 m away. If the speed of ultrasound in air is 345 m/s, how much time does the wave take to travel to the obstacle and return?

Answer: Total distance $= 2 \times 1.2 = 2.4$ m. $t = d/v = 2.4/345 =$ **0.00696 s** $\approx$ **6.96 ms**.

21. A sound wave has a frequency of 1000 Hz and travels at 340 m/s. Calculate its wavelength and time period.

Answer: $\lambda = 340/1000 =$ **0.34 m**; $T = 1/1000 =$ **0.001 s**.

22. A sound wave has wavelength 0.25 m and travels at 5000 m/s in steel. Find its frequency.

Answer: $\nu = v/\lambda = 5000/0.25 =$ **20,000 Hz**.

23. A sound wave travels 1020 m in 3 s. Calculate its speed.

Answer: v = distance/time = 1020/3 = **340 m/s**.

24. A sound wave travels at 346 m/s for 2.5 s. Calculate the distance travelled.

Answer: $d = vt = 346 \times 2.5 =$ **865 m**.

25. A sound wave has frequency 250 Hz and speed 340 m/s. Calculate its wavelength and time period.

Answer: $\lambda = 340/250 =$ **1.36 m**; $T = 1/250 =$ **0.004 s**.

ANSWER CHECKLIST

Chapter 10 • Sound Waves: Characteristics and Applications

Problem	Final Answer	Problem	Final Answer
1	ν = 10/2 = 5 Hz; T = 1/ν = 0.2 s.	13	Distance = vt = 340 × 5 = 1700 m = 1.7 km.
2	Oscillations = νt = 20 × 60 = 1200 oscillations.	14	Sound travels to the wall and back. d = vt/2 = 340×0.5/2
3	T = 1/ν = 1/50 = 0.02 s.	15	d = vt/2 = 343×0.2/2 = 34.3 m.
4	ν = 1/T = 1/0.005 = 200 Hz.	16	d = vt/2 = 340×0.8/2 = 136 m.
5	λ = v/ν = 344/20 = 17.2 m.	17	One-way time = 0.90/2 = 0.45 s. d = 1530×0.45 = 688.5 m
6	20 kHz = 20,000 Hz. λ = 344/20,000 = 0.0172 m = 1.72 cm.	18	Depth = vt/2 = 1500×4/2 = 3000 m = 3 km.
7	v = λν = 2 × 170 = 340 m/s.	19	Depth = vt/2 = 1525×5/2 = 3812.5 m ≈ 3.81 km.
8	ν = v/λ = 340/0.5 = 680 Hz.	20	Total distance = 2×1.2 = 2.4 m. t = d/v = 2.4/345 = 0.0069
9	ν = 344/3.44 = 100 Hz; T = 1/100 = 0.01 s.	21	λ = 340/1000 = 0.34 m; T = 1/1000 = 0.001 s.
10	ν = 5000/50 = 100 Hz; T = 1/100 = 0.01 s.	22	ν = v/λ = 5000/0.25 = 20,000 Hz.
11	Ratio = 1500:340 = 75:17 ≈ 4.41:1.	23	v = distance/time = 1020/3 = 340 m/s.
12	Ratio = 5000:1500 = 10:3 ≈ 3.33:1.	24	d = vt = 346×2.5 = 865 m.
25	λ = 340/250 = 1.36 m; T = 1/250 = 0.004 s.		

Source alignment: Chapter 10 explicitly covers frequency, time period, wavelength, speed of sound, amplitude/intensity, echo, reverberation and sonar. The textbook worked examples include 10 oscillations in 2 s, wavelength calculations at 20 Hz and 20 kHz, the 5 s lightning delay, the 50 m wavelength graph in steel, the 0.5 s echo, and the 0.90 s sonar calculation. ■filecite■turn223file0■L26-L43■ ■filecite■turn223file3■L213-L242■ ■filecite■turn223file4■L275-L325■ ■filecite■turn223file1■L83-L114■ ■filecite■turn223file7■L475-L506■