Sound Waves: Characteristics and Applications

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. A sound has frequency 220 Hz and wavelength 1.5 m. Its speed is:
(a) 146.67 m/s **(b)** 165 m/s **(c)** 660 m/s **(d)** 330 m/s

2. The time period of a sound wave is 0.4 ms. Its frequency is:
(a) 2,500 Hz **(b)** 25,000 Hz **(c)** 1,250 Hz **(d)** 5,000 Hz

3. Sound cannot travel through:
(a) steel **(b)** water **(c)** a vacuum **(d)** air

4. A person claps near a cliff and hears the echo 2.5 s later. If sound travels at 330 m/s, the cliff is:
(a) 206.25 m away **(b)** 132 m away **(c)** 825 m away **(d)** 412.5 m away

5. A sound of frequency 50,000 Hz is:
(a) ultrasound **(b)** infrasound **(c)** audible sound **(d)** a light wave

6. In which of these does sound travel slowest (at 25 °C)?
(a) Distilled water **(b)** Sulphur dioxide
(c) Helium **(d)** Sea water

7. Sound travels at 5,960 m/s in steel. How long does it take to travel 2,980 m in steel?
(a) 5 s **(b)** 1 s **(c)** 0.25 s **(d)** 0.5 s

8. Assertion (A): An echo heard 2.5 s after a shout means the wall is 430 m away (speed of sound 344 m/s).
Reason (R): Sound needs a material medium to travel.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. A sound of frequency 100 Hz travels through air at 344 m/s. Find its wavelength and its time period.

10. A boy stands 196 m from a tall building and claps. After how long will he hear the echo? (Speed of sound = 344 m/s)

11. A ship's SONAR sends an ultrasonic pulse to the sea bed and receives the echo 1.5 s later. If sound travels at 1,531 m/s in sea water, how deep is the sea?

12. Why do we see the lightning before we hear the thunder?

13. A tuning fork vibrates at 100 Hz. Find its time period, and the number of vibrations it makes in 30 s.

14. Thunder is heard 2 s after a flash of lightning is seen. How far away is the storm? (Speed of sound = 346 m/s; light arrives almost instantly.) Give the answer in km.

15. To hear a distinct echo, the reflected sound must arrive at least 0.1 s after the original. What is the minimum distance of the reflecting surface if sound travels at 346 m/s?

16. A hammer strikes one end of a 500 m long brass rail. Sound reaches the other end through the brass (4,700 m/s) and through the air (346 m/s). Find both times and the gap between them, in milliseconds.

Section C — Word problems — 4 × 4 = 16 marks

17. Describe an experiment to show that sound needs a medium to travel.

18. A person stands between two cliffs and fires a cracker. The first echo is heard after 2 s and the second after 3.5 s. If sound travels at 346 m/s, find (a) the distance to each cliff and (b) the distance between the cliffs.

19. A SONAR sends ultrasound of frequency 50,000 Hz into sea water (speed 1,531 m/s). The echo from a shoal of fish returns after 3 s. (a) How far away are the fish? (b) What is the wavelength of the ultrasound in water, in cm? (c) Why is ultrasound used and not audible sound?

20. A sound of frequency 5,000 Hz travels through methanol, where its speed is 1,103 m/s. Find (a) its wavelength, (b) its time period, (c) the distance it travels in 0.5 s, and (d) say whether a human can hear it.

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Answer key

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Q	Answer	Working
1	**(d) 330 m/s**	v = fλ
2	**(a) 2,500 Hz**	f = 1 ÷ T
3	**(c) a vacuum**	it needs a medium
4	**(d) 412.5 m away**	2d = vt, d = 330 × 2.5 ÷ 2
5	**(a) ultrasound**	humans hear 20 Hz to 20,000 Hz
6	**(b) Sulphur dioxide**	helium 965 m/s, sea water 1,531 m/s, sulphur dioxide 213 m/s, distilled water 1,498 m/s
7	**(d) 0.5 s**	t = d ÷ v
8	**(b) Both A and R are true, but R is not the correct explanation of A.**	A is true: d = 344 × 2.5 ÷ 2 = 430 m. R is true but does not explain A.
9	**λ = 3.44 m; T = 10 ms**	λ = v ÷ f; T = 1 ÷ f
10	**1.14 s**	t = 2d ÷ v = 392 ÷ 344
11	**1,148.25 m**	d = vt ÷ 2 = 1531 × 1.5 ÷ 2
12	**Light travels at about 3 × 10^8 m/s, far faster than sound (about 340 m/s in air), so the flash reaches us almost at once while the sound takes longer.**	—
13	**10 ms; 3,000 vibrations**	T = 1 ÷ 100; 100 × 30
14	**692 m = 0.69 km**	d = 346 × 2
15	**17.3 m**	sound travels 346 × 0.1 = 34.6 m there and back; ÷ 2
16	**brass: 106.38 ms; air: 1,445.09 ms; gap 1,338.70 ms**	t = d ÷ v for each
17	**Hang an electric bell inside an airtight glass jar connected to a vacuum pump. Ring the bell: you hear it. Pump the air out slowly: the sound becomes fainter and almost stops, though the bell can still be seen ringing. So sound cannot travel through a vacuum.**	—
18	**(a) 346 m and 605.5 m. (b) 951.5 m**	d = vt ÷ 2 for each echo; add
19	**(a) 2,296.5 m. (b) 3.06 cm. (c) Ultrasound has a very high frequency and short wavelength, so it travels in a narrow beam without spreading much and is reflected well by small objects; it also cannot be heard, so it does not disturb people.**	d = vt ÷ 2; λ = v ÷ f

Q	Answer	Working
20	**(a) 0.22 m. (b) 0.2 ms. (c) 551.5 m. (d) Yes, it is in the audible range (20 Hz to 20,000 Hz).**	λ = v ÷ f; T = 1 ÷ f; d = v × 0.5