Unit 9 · Acoustic Phenomena

HARDER PRACTICE QUESTIONS

Full marks 28

Write your answers on separate paper. Show your working. Take the speed of sound in air as 340 m/s and the threshold of hearing as 10^{-12} W/m^2.

1 Spot the error [3]

Find the mistake in the working and correct it.

Sanjana stands 5 m from a speaker and hears 84 dB. She works out the level 20 m away:
"The distance is 4 times, so the intensity is 1/4. The level falls by $10 \log_{10} 4 = 6$ dB, to **78 dB**."

2 Show that [2]

Show that, for a source sending sound equally in all directions in the open, the intensity level falls by about 6 dB each time the distance is doubled, whatever the distance.

3 Predict, then explain [3]

Write your prediction first, then explain it.

A siren at rest sounds at 500 Hz, and a listener stands still 200 m away. A steady wind blows at 10 m/s from the siren towards the listener. Predict: does she hear a frequency above 500 Hz? Then explain what the wind changes and what it doesn't.

4 Read the data [4]

Answer from the data.

Puja measures the level from a small speaker in an open field:

Distance (m)	2	4	8	16
Level (dB)	86	80	74	68

i. Show that the data follow the inverse square law.
ii. Find the intensity 2 m from the speaker.
iii. Find the sound power the speaker sends out.

5 A real setting [3]

A Doppler ultrasound probe sends 2.0 MHz into the body, where sound travels at 1540 m/s. Blood flows straight towards the probe at 0.30 m/s and reflects the wave. Find the frequency of the echo and the shift.

6 Estimate it [3]

A jet flies level at Mach 1.5, 3.0 km above you. When you first hear its boom, how far ahead of you is the jet (measured along its path)?

7 Check the claim [2]

Kabita reads that a busy road (80 dB) is "four times as loud as a whisper (20 dB)", and takes it to mean that the road's sound has four times the intensity. Check her meaning.

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Aashish wrote: “A source moving towards you at 30 m/s and you moving towards it at 30 m/s give exactly the same Doppler shift, since only the relative speed matters. In a sound wave the pressure is greatest where the air is displaced most. And a 3 dB rise means the intensity has tripled.”

9 Work backwards [3]

A train’s whistle is heard at 380 Hz as the train comes towards a person on a platform, and at 320 Hz after it has passed. Find the train’s speed and the whistle’s real frequency.

10 Make your own [2]

Choose the power of a speaker, sending sound equally in all directions, that would give an intensity level of 90 dB at 10 m.