Unit 6 · Wave Motion

HARDER PRACTICE QUESTIONS

Full marks 29

Write your answers on separate paper. Show your working.

1 Spot the error [3]

Find the mistake in the working and correct it.

For the wave $y = 0.06\sin(36t + 3x)$ (SI units), Suraj writes:
"$\omega = 36$ rad/s and k = 3 rad/m, so v = ω/k = 12 m/s. The wave travels along the **+x** direction."

2 Show that [3]

For the progressive wave $y = a\sin(\omega t - kx)$, show that the greatest speed of a particle divided by the speed of the wave is $\frac{2\pi a}{\lambda}$. What does this say about a wave whose amplitude is much smaller than its wavelength?

3 Predict, then explain [3]

Write your prediction first, then explain it.

A crest of height 2 cm and a trough of depth 2 cm, of the same shape, run towards each other on a rope. At one instant they overlap exactly.

i. Predict: what does the rope look like at that instant?
ii. Has the energy of the two pulses disappeared? Explain.

4 Read the data [3]

Answer from the data.

Sabina sets up a stationary wave on a string with a vibrator of frequency 125 Hz, and marks the nodes she sees, measured from one end:

Node	1st	2nd	3rd	4th
Position (m)	0.15	0.47	0.79	1.11

i. Find the wavelength.
ii. Find the speed of the waves on the string.
iii. Where would she find the antinodes between them?

5 A real setting [3]

A sitar string vibrates between two fixed points 0.90 m apart, and waves travel along it at 270 m/s. Find the wavelength and frequency when it vibrates in one loop, and the frequency when it vibrates in three loops.

6 What if? [3]

A stationary wave needs two waves of the **same** amplitude traveling in opposite directions. What if one wave had amplitude 5 mm and the other 3 mm (same frequency and wavelength)? What would the amplitude be at the places where the nodes would have been, and at the antinodes? Would energy now be carried along?

7 Measure it [3]

The numbers are made up.

Ripples spread across a pond. A floating leaf bobs up and down 20 times in 16 s, and the crests are 0.40 m apart. Find the frequency, the speed of the ripples, and how far a crest travels while the leaf makes one bob.

8 Work backwards [2]

A wave of amplitude 5 mm and frequency 40 Hz travels along the −x direction at 32 m/s. Write its equation in SI units, taking $y = 0$ and moving up at $x = 0$, $t = 0$.

9 Correct the misconceptions [3]

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

Anil wrote: “In a stationary wave, all the particles between two nodes vibrate with the same amplitude, and energy flows steadily from one loop into the next. The free end of a rope is always a node, because the wave turns back there.”

10 Make your own [3]

Write the equations of two progressive waves that would form a stationary wave whose nodes are 0.25 m apart and whose antinodes swing up to 6 mm either side. Choose any frequency you like.