

Solutions

These allocations are for the original questions on this sheet. B1 = one standalone point, M1 = one method point, A1 = one accuracy point.

2.1 They have the same frequency and a constant phase difference. No: that constant phase difference can be non-zero.

2.2 $\Delta\phi = (\Delta x/\lambda)360^\circ = (0.90/0.60)360^\circ = 540^\circ$, equivalent to 180° . Destructive interference. Equal arriving amplitudes are also needed for complete cancellation.

2.3 The second harmonic has two half-wavelengths in L : $\lambda = L = 0.80$ m. $v = f\lambda = 150 \times 0.80 = 120$ m s⁻¹. Node separation = $\lambda/2 = 0.40$ m. Neighbouring loops vibrate in opposite phase.

3.1 For the fundamental, $\lambda = 2L$. $v = \sqrt{T/\mu} = \sqrt{18/0.002} = 94.9$ m s⁻¹. $f = v/(2L) = 94.9$ Hz. Quadrupling tension doubles f to 190 Hz. Keep string linear density, vibrating length and harmonic number fixed while varying tension.

3.2 Connect a generator reference and microphone output to separate channels; the generator drives a speaker. Move the microphone along a measured line and identify repeated in-phase positions. Separation of consecutive in-phase positions gives λ . Read period from divisions and time base, then $f = 1/T$. Calculate $v = f\lambda$. Measure across several wavelengths and divide by their count, reducing percentage distance uncertainty.

3.3 Length investigation: vary vibrating length and tune to the fundamental each time, keeping tension and string linear density fixed. Plot f against $1/L$ for a straight line through the origin. Density investigation: use strings with different measured $\mu = m/l$ and tune each to the fundamental, keeping tension and vibrating length fixed. Plot f^2 against $1/\mu$ for a straight line through the origin.