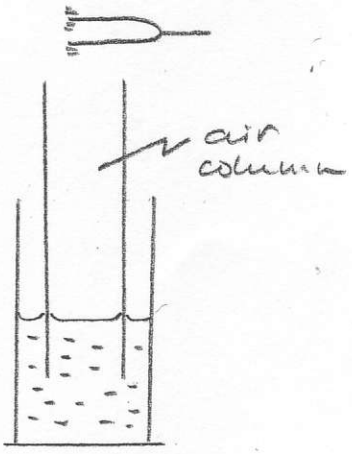
Waves - Standing Waves (3) A Physics

A Sound

1. A student is measuring the velocity of sound by resonance tube. She gets the air column vibrating in its fundamental mode with a frequency of 256 Hz, and a length of 32 cm.

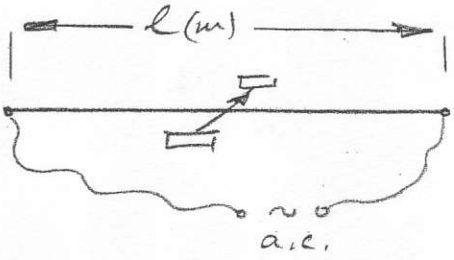


(a) Explain the underlined phrase, with a labelled diagram, Calculate the speed of sound in air

(b) The student gets another resonant length of 97 cm for the same frequency. Explain, with a diagram, how this can happen, and calculate the velocity of sound from this.

B Stretched Strings

You will need $f = \frac{1}{2\pi}\sqrt{\frac{T}{\mu}}$ — T – Tension, N; μ – mass/unit length, kg/m.



1. A metal wire is set vibrating by passing alternating current down it, in a magnetic field

(a) explain how this sets the wire vibrating.

(b) The wire vibrates in its fundamental mode, with $f = 40$ Hz, and wire length 76 cm. Draw the wire's fundamental mode.

(c) The standing wave can be regarded as 2 progressive waves passing along the wire. Calculate the velocity of the progressive waves.

(d) Draw the first two harmonics above the fundamental, and calculate the frequencies at which they will appear.

(e) If the wire tension for the fundamental standing wave is 2.0 N, calculate the mass per metre of the wire.

TN
3.98

Standing Waves - Answers

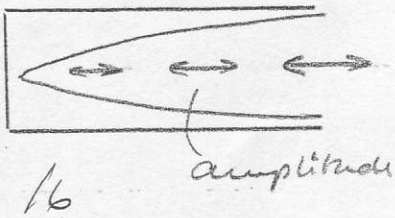
1A Physics Standing waves

A Sound

1.(a) Fundamental mode – lowest frequency standing wave possible – tube holds ¼ of a wavelength (2)

$l = \lambda/4$ (1) so $\lambda = 1.28$ m (1)

so $V_{air} = f\lambda$ (1) $= 256 \times 1.28 = 328$ m/s (1)



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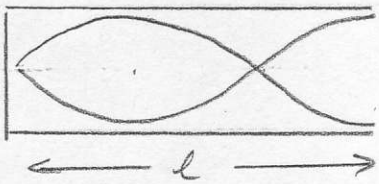
(b) Now the air column vibrates with the first harmonic frequency. (1) + (1)

Now $l = \frac{3}{4}\lambda \rightarrow \lambda = 0.97 \times \frac{4}{3} = 1.29$ m (1)

so $V_{sound} = 256 \times 1.29 = 331$ m/s (1)

↑ same frequency



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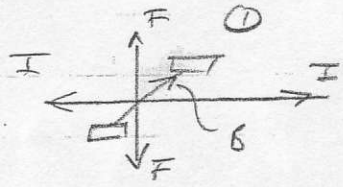
B Stretched string

1 (a) Current passing in the wire at right angles to magnetic field will produce a motor force (1) on the wire at right angles to both A.C. will produce oscillating / reversing (1) force – the wire will vibrate



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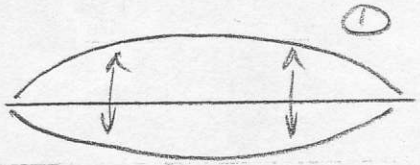
(b) fundamental mode: frequency 40 Hz (1)

(c) length $l = \lambda/2 \rightarrow \lambda = 1.52$ m (1)

$V = f\lambda$ (1) $= 40 \times 1.52 = 60.8$ m/s (1) /3



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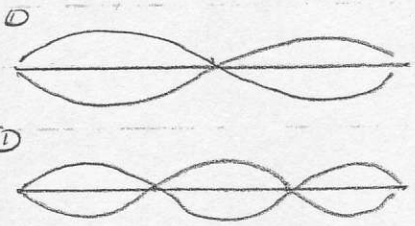
(d) 1st harmonic

$f_1 = 2 \times f_0 = 80$ Hz (1)

$f_2 = 3 \times f_0 = 120$ Hz (1)



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(e) use $f = \frac{1}{2\pi}\sqrt{\frac{T}{\mu}}$

$\sqrt{\frac{T}{\mu}} = 2\pi f = 251$

$T/\mu = 63{,}165$

so mass/m, $\mu = T/63{,}165 = 3.2 \times 10^{-5}$ kg/m (2) $= 0.03$ g/m rather light!

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TDW 3.98