

1 A vertical tube of length 0.60 m is open at both ends, as shown in Fig. 1.1.

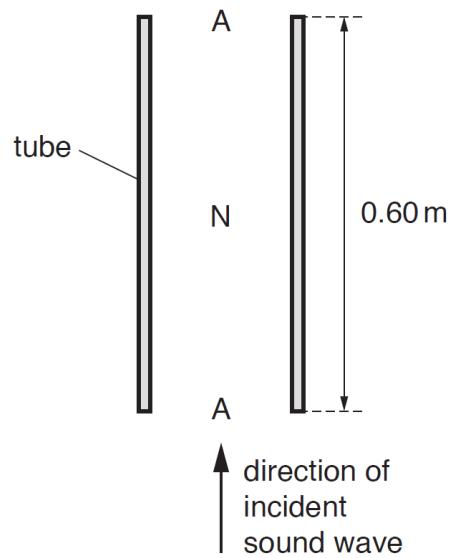


Fig. 1.1

An incident sinusoidal sound wave of a single frequency travels up the tube. A stationary wave is then formed in the air column in the tube with antinodes A at both ends and a node N at the midpoint.

- (a) Explain how the stationary wave is formed from the incident sound wave.

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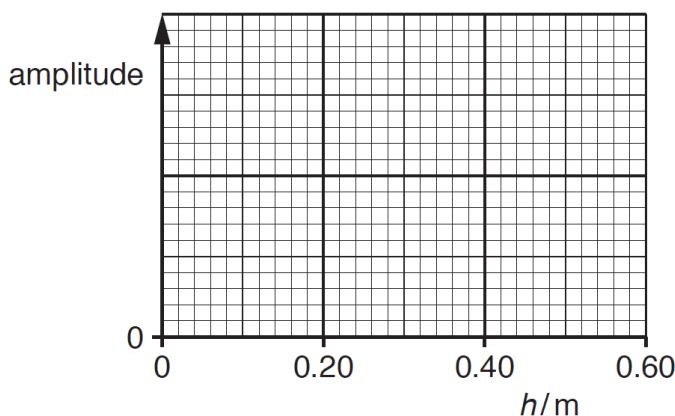
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[3]

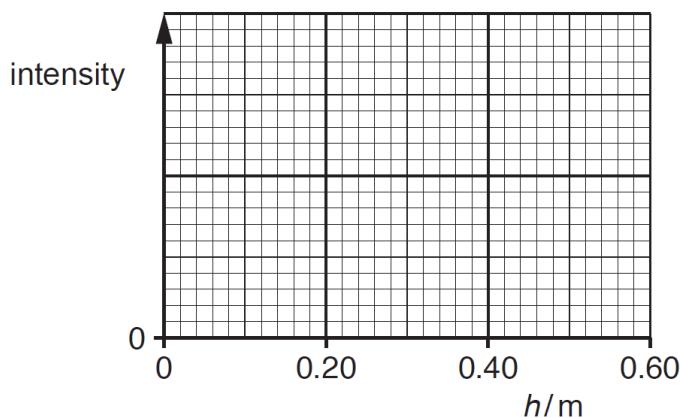
- (b) (i) On Fig. 1.2, sketch a graph to show the variation of the amplitude of the stationary wave with height h above the bottom of the tube.

[2]

**Fig. 1.2**

- (ii) On Fig. 1.3, sketch a graph to show the variation of the intensity of the stationary wave with height h above the bottom of the tube.

[1]

**Fig. 1.3**

- (c) For the stationary wave, state:

- (i) the direction of the oscillations of an air particle at a height of 0.15 m above the bottom of the tube.

..... [1]

- (ii) the phase difference between the oscillations of a particle at a height of 0.10 m and a particle at a height of 0.20 m above the bottom of the tube.

phase difference = ° [1]

- (iii) the phase difference between the oscillations of a particle at the top of the tube and a particle at the bottom of the tube.

phase difference = ° [1]

- (d) The speed of the sound wave is 340 m s^{-1} .

Calculate the frequency of the sound wave.

$$\text{frequency} = \dots \text{ Hz} [2]$$

- (e) The frequency of the sound wave is gradually increased until a stationary wave is next formed.

- (i) Determine the frequency of this stationary wave.

$$\text{frequency} = \dots \text{ Hz} [1]$$

- (ii) The microphone is initially placed at the bottom of the tube and moved upwards.

Determine the shortest distance from bottom of the tube when the microphone detects a displacement node.

$$\text{distance} = \dots \text{ m} [1]$$