5 (a) Fig. 5.1 shows two small loudspeakers, L_1 and L_2, separated by 15 cm. A microphone is moved along a line XY parallel to the line joining the two loudspeakers and at a perpendicular distance of 1.2 m away.

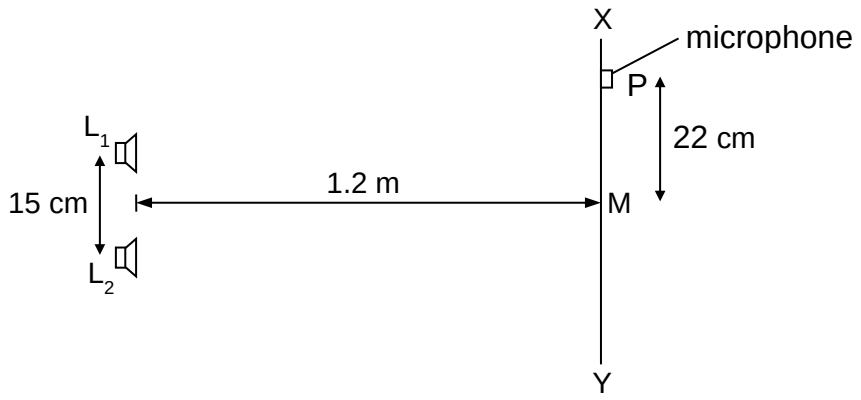

Fig. 5.1

The centre of the interference pattern formed along XY is at point M. When the microphone is moved from M to P by a distance of 22 cm, it detects three intensity maxima including the ones at M and P.

Given that the speed of sound in air is 330 m s^{-1}, determine the approximate frequency at which the speakers were driven. Express your answer to 2 significant figures.

frequency = ... Hz [3]

(b) Fig. 5.2 shows a microwave transmitter T and a microwave receiver R placed at the same angle θ to the normal of a horizontal board A, which partially reflects and transmits microwaves. A similar horizontal board B is placed a distance d below board A, such that a high intensity signal is detected by receiver R. A metal sheet is placed between T and R to prevent microwaves from reaching R directly from T.

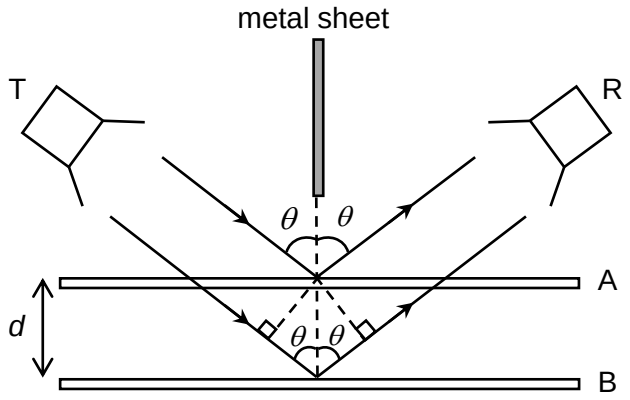

Fig. 5.2

The path difference between the two waves reflected off boards A and B is given by

$$2d \cos \theta$$

When a high intensity signal is detected by R,

$$2d \cos \theta = m\lambda$$

where m is a positive integer and refers to the order of constructive interference (m = 1, 2, 3, …) and λ is the wavelength of the microwaves.

(i) State the phase difference, in radians, between the reflected microwaves from A and B at a point where a high intensity signal is detected.

phase difference = ... rad [1]

(ii) When distance d is increased by lowering board B, alternating low and high intensity signals are detected by receiver R. Explain these observations.

[3]

(iii) Transmitter T and receiver R are now placed side-by-side and facing the boards normally, meaning that $\theta = 0°$.

As board B is moved 140 mm downwards at a constant speed, receiver R goes from the initial high intensity signal through nine high intensity signals and then to a final high intensity signal.

Determine the wavelength of these microwaves.

wavelength = ... m [2]

[Total: 9]

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