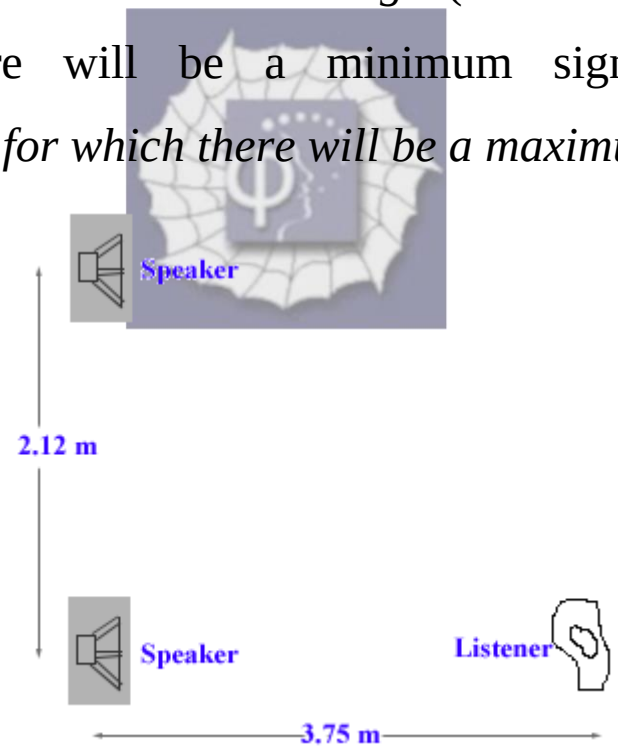
147.

Problem 20.31 (RHK)

Two stereo loud speakers are separated by a distance of 2.12 m. *We may assume that the amplitude of the sound from each speaker is approximately the same at the position of a listener, who is* 3.75 m *directly in front of one of the speakers. We have to find* (a) *the frequencies in the audible range* (20 – 20,000 Hz) for which there will be a minimum signal; (b) *the frequencies for which there will be a maximum signal.*



Solution:

The stereo speakers are separated as shown in the figure. It is assumed that the amplitude of the sound from each speaker is approximately the same at the position of the

listener, who is 3.75 m directly in front of one of the speakers.

The distance x_2 from the second speaker to the listener is

$$x_2 = \sqrt{3.75^2 + 2.12^2}\ \text{m} = 4.308\ \text{m}.$$

The distance x_1 from the first speaker to the listener is

$$x_1 = 3.75\ \text{m}.$$

The condition for minimum at the position of the listener is

$$\frac{2\pi\left(\left(x_2 - x_1\right)\right)/2}{\lambda} = \frac{n\pi}{2}, \quad n = 1,3,5,7,...$$

As, $x_2 - x_1 = \left(4.308 - 3.75\right)\ \text{m} = 0.558\ \text{m}$,

$$\lambda = \frac{2 \times 0.558}{n}\ \text{m} = \frac{1.116}{n}\ \text{m}.$$

Frequencies that will produce a minimum will therefore be

$$f_{\min} = \frac{v}{\lambda} = \frac{343 \times n}{1.116}\ \text{Hz} = 307n\ \text{Hz}.$$

As,

$$\frac{20,000}{307} = 65.1,$$

frequencies in the audible range that will produce a minimum are

$$f_{\min} = 307n\ \text{Hz},\ n = 1,3,5,7,...,65.$$

The condition for maximum at the position of the listener is

$$\frac{2\pi\left(x_2 - x_1\right)/2}{\lambda} = n\pi,\ n = 1, 2, 3, \ldots$$

or

$$\lambda = \frac{0.559}{n}\ \text{m},$$

and

$$f_{\max} = \frac{v_s}{\lambda} = \frac{343n}{0.558}\ \text{Hz} = 615n\ \text{Hz}.$$

As,

$$\frac{20,000}{615} = 32.5,$$

frequencies in the audible range that will produce a maximum are

$$f_{\max} = 615n\ \text{Hz},\ n = 1, 2, 3, \ldots 32.$$