Two loudspeakers emit sound waves along the x-axis. The intensity of sound is maximum when the speakers are 25-cm apart. The intensity of sound decreases as the distance between the speakers is increased and reaches zero at a separation of 45-cm.

a) Determine the wavelength of the sound waves?
b) The distance between the speakers is increased further. At what separation will the sound intensity again be a maximum?

Given:

Distance between loudspeakers for maximum sound intensity $d_{max} = 0.25$ m
Distance between loudspeakers for minimum sound intensity $d_{min} = 0.45$ m

Determine:

a) Wavelength of sound waves: λ

(i) When sound intensity is maximum, the waves from the two loudspeakers are in constructive interference. Constructive interference happens when the path length difference travelled by the two waves is $n\lambda$, where n =0.1,2.3….

$$d_{max} = n\lambda \text{ ---------------------------------------(1)}$$

(ii) When sound intensity is minimum, the waves from the two loudspeakers are in destructive interference. Destructive interference happens when the path length difference travelled by the two waves is $(n+½)\lambda$, where n =0.1,2.3….

$$d_{min} = (n+½)\lambda \text{ ---------------------------------(2)}$$

When $d_{max} = 0.25$ m, the sound intensity is maximum. When distance is increased by $\lambda/2$, to $d_{min} = 0.45$ m, the sound intensity falls to zero.

From (1) & (2):

$$\Delta d = d_{max} - d_{min} = 0.45 - 0.25 = 0.20 \text{ m}$$

Also, from (1) & (2):

$$\Delta d = \lambda/2 \text{ ------------------------------------(3)}$$

Substituting for Δd in (3):

$$\mathbf{\lambda = 2 \times \Delta d = 2 \times 0.2 = 0.4 \text{ m} = 40 \text{ cm}}$$

b) Distance between speakers when sound intensity is maximum again: d'_{max}

For intensity of the sound to be maximum again, path length difference has to be $(n+1)\lambda = (n+½)\lambda + \lambda/2$

Then

$$\mathbf{d'_{max} = d_{min} + \lambda / 2 = 0.45 + (0.4 / 2) = 0.65 \text{ m} = 65 \text{ cm}}$$