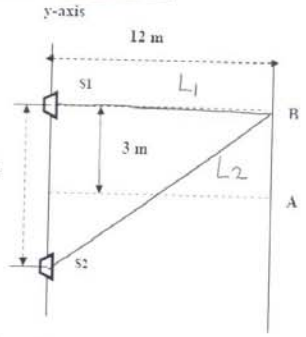
KING FAHD UNIVERSITY OF PERTOLEUM & MINERALS
PHYSICS DEPARTMENT
QUIZ #2- CHAPTER 17

NAME: Key ID# SECTION#

Two speakers S1 and S2 are placed on the y-axis as shown in the figure. The speakers are in phase and emit identical sound waves with a given frequency. Speed of sound = 343 m/s.




(a) Does an observer, standing at point A, hears a sound of minimum or maximum intensity? Explain.

at point A $L_1 = L_2 \Rightarrow \Delta L = 0$

$\Rightarrow$ maximum intensity

for max. intensity: $\Delta L = 0, \lambda, 2\lambda, \ldots$

(b) As the observer moves along a straight line parallel to the y-axis and reaches point B, he hears a maximum of sound intensity. What is the frequency of sound emitted by the speakers?

at point B $L_1 = 12\,m$ $L_2 = \sqrt{12^2+6^2} = 13.4\,m$

max. intensity $\Delta L = \lambda = \frac{v}{f} \Rightarrow f = \frac{v}{\Delta L} = \frac{343}{1.4}$

$f = 245\,Hz$

(c) While the observer is at point B, the frequency of the speakers is changed. What is the frequency for the lowest minimum of sound intensity at point B?

at point B $\Delta L = 1.4\,m$

lowest min. $\Delta L = \frac{\lambda}{2} = \frac{v}{2f}$

$f = \frac{v}{2\Delta L} = \frac{343}{2 \times 1.4} = 122.5\,Hz$

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Pipe A of length 1.6 m, open at both ends, oscillates at its fourth resonant frequency. Pipe B, closed at one end, oscillates in its third resonant frequency. This frequency of pipe B happens to match the frequency of pipe A. Take speed of sound = 340 m/s.

(a) What is the length of pipe B?

$$f_{A,4} = 4\frac{v}{2L_A} \qquad f_{B,5} = 5\frac{v}{4L_B}$$

$$4\frac{v}{2L_A} = 5\frac{v}{4L_B} \qquad \frac{4}{2\times 1.6} = \frac{5}{4L_B}$$

$$\boxed{L_B = 1.0\ m}$$

(b) What is the second resonant frequency of pipe B?

$$f_{B,3} = 3\frac{v}{4L_B} = \frac{3\times 340}{4\times 1.0} = \boxed{255\,Hz}$$

(c) What is the sixth harmonic of pipe B?

$f_{B,6}$ does NOT exist.

It is forbidden!

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The power output from a point source is 100 W.

(a) What is the sound level 5.00 m from the source?

$$I = \frac{P_s}{4\pi r^2} = \frac{100}{4\pi (5)^2} = 0.318 \ w/m^2$$

$$\beta = 10 \log \frac{I}{I_0} = 10 \log \left( \frac{0.318}{10^{-12}} \right) = \boxed{115 \ dB}$$

(b) At what distance from the source is the sound level 80 dB?

$$I_1 = \frac{P_s}{4\pi r_1^2}, \quad I_2 = \frac{P_s}{4\pi r_2^2} \Rightarrow \frac{I_2}{I_1} = \left( \frac{r_1}{r_2} \right)^2 \quad \text{also} \quad \frac{I_1}{I_2} = 10^{\frac{\beta_1 - \beta_2}{10}} = 10^{3.5}$$

$$r_2 = r_1 \sqrt{\frac{I_1}{I_2}} \Rightarrow r_2 = 5m \sqrt{10^{3.5}} = \boxed{281 \ m}$$

(c) What is the displacement amplitude of the sound wave at 5.0 m from the source if the frequency of the source is 2000 Hz? (density of air = 1.2 kg/m$^3$, v = 343 m/s)

$$I = \frac{1}{2} \rho v \omega^2 S_m^2$$

$$S_m = \sqrt{\frac{2I}{\rho v \omega^2}} = \sqrt{\frac{2I}{\rho v 4\pi^2 f^2}}$$

$$S_m = \sqrt{\frac{2 \times 0.318}{1.2 \times 343 \times 4 \times \pi^2 \times (2000)^2}} = \boxed{3.1 \times 10^{-6} \ m}$$