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

NAME: Key ID# SECTION#

1. Two sound waves, from two different sources with the same frequency travel at a speed of 330 m/s. The sources are in phase.

   (a) What is the second lowest frequency of the source that will produce a maximum sound at the listener at point P that is 5.0 m from one source and 4.0 m from the other? (The waves are traveling in the same direction.)

$$\Delta L = n\lambda = n\frac{v}{f} \Rightarrow \boxed{f_n = n\frac{v}{\Delta L}} \quad n = 1, 2, 3, \ldots$$

$$\Delta L = 5 - 4 = 1.0\,m$$

$$f_n = n\frac{330}{1} = 330\,n \qquad n = 1, 2, 3, \ldots$$

2nd lowest frequency $\Rightarrow n = 2$ $\quad f_2 = 2 \times 330 = \boxed{660\,Hz}$

   (b) What is the third lowest frequency of the source that will produce a minimum sound at the listener at point P?

$$\Delta L = n\frac{\lambda}{2} = n\frac{v}{2f} \Rightarrow \boxed{f_n = n\frac{v}{2\Delta L}} \quad n = 1, 3, 5, \ldots$$

$$\Delta L = 1.0\,m$$

$$f_n = n\frac{330}{2} = 165\,n$$

3rd lowest frequency $\Rightarrow n = 5$

$$f_5 = 165 \times 5 = \boxed{825\,Hz}$$

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1. A 1.5×10^{-6} W point source emits sound waves isotropically. What is the sound level 2.5 m from the source?

$$I = \frac{P_s}{A} = \frac{P_s}{4\pi r^2} \quad \text{(For point source)}$$

$$= \frac{1.5\times10^{-6}}{4\pi(2.5)^2} = 1.9\times10^{-8}\ \text{W/m}^2$$

$$\beta = 10 \log \frac{I}{I_0} = 10 \log \frac{1.9\times10^{-8}}{10^{-12}} = \boxed{42.8\ \text{dB}}$$

2. (a) What is the ratio of the intensity of sound (I_2/I_1) when the sound level is increased by 40 dB?

$$\beta_2 - \beta_1 = 40\ \text{dB} = 10 \log \frac{I_2}{I_0} - 10 \log \frac{I_1}{I_0}$$

$$= 10 \log \frac{I_2}{I_1}$$

$$10 \log \frac{I_2}{I_1} = 40 \Rightarrow \log \frac{I_2}{I_1} = 4$$

$$\boxed{\frac{I_2}{I_1} = 10^4}$$

(b) What is the ratio of the distances from the source (r_2/r_1) in this case?

$$I_1 = \frac{P_s}{4\pi r_1^2} \qquad I_2 = \frac{P_s}{4\pi r_2^2}$$

$$\frac{I_1}{I_2} = \left(\frac{r_2}{r_1}\right)^2 \Rightarrow \frac{r_2}{r_1} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{1}{10^4}} = \frac{1}{100}$$

$$\boxed{\frac{r_2}{r_1} = \frac{1}{100}}$$

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An ambulance is approaching a stationary observer at 50 m/s with its siren emitting a frequency of 600 Hz.

(a) What is the frequency heard by the observer in still air? [Speed of sound in air = 343 m/s].

$\vec{v}_S = 50$ m/s (S) $\quad v_D = 0$ (D)

$$f' = f\frac{v}{v - v_S} = 600\ \frac{343}{343-50} = \boxed{702\ \text{Hz}}$$

(b) What is the frequency heard by the observer if there is a wind blowing at a speed of 20 m/s in the opposite direction to the ambulance?

$\vec{v}_S = 50$ m/s (S) $\quad \overleftarrow{v}_W = 20$ m/s (D)

In this case $v_S = 50 + 20$ m/s $= 70$ m/s

$v_D = -20$ m/s

$$f' = f\ \frac{v - v_D}{v - v_S} = 600\left(\frac{343 - 20}{343 - 70}\right)$$

$$= \boxed{710\ \text{Hz}}$$