QUIZ#2- CHAPTER 17
DATE: 6/02/20

Name: Key Id#: Sect.#: Serial#:

1. A stationary train passenger hears a frequency of 500 Hz as a train approaches a bell on a trackside safety gate. After the train passes the gate the passenger hears a frequency of 420 Hz for the bell sound. What is the speed of the train? (speed of sound in air = 343 m/s)

$$f' = f\,\frac{V+V_D}{V} \qquad f'' = f\,\frac{V-V_D}{V}$$

$$\frac{f'}{f''} = \frac{V+V_D}{V-V_D} \Rightarrow \frac{500}{420} = \frac{343+V_D}{343-V_D} = 1.19$$

$$1.19(343-V_D) = 343+V_D \Rightarrow V_D = \frac{65.17}{2.19} = \boxed{29.8\ m/s}$$

2. Tube A (open at both ends) has the same length as tube B (open at one end). What is the ratio of their ~~fundamental frequencies (f_{1A}/f_{1B})~~? second resonance frequencies?

Open pipe $f_n = n\,\frac{v}{2L}$ $n = 1, 2, 3, \ldots$

Closed at one end pipe $f_n = n\,\frac{v}{4L}$ $n = 1, 3, 5, \ldots$

Open pipe 2nd resonance $n = 2$ $f_{2A} = 2\,\frac{v}{2L}$

Closed pipe 2nd resonance $n = 3$ $f_{3B} = 3\,\frac{v}{4L}$

$$\frac{f_{2A}}{f_{3B}} = \frac{2\,\frac{v}{2L}}{3\,\frac{v}{4L}} = \boxed{\frac{4}{3}}$$

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1. The average output power of a speaker is 550 watts. The sound level that reaches to a detector is 105 dB, how far is the detector from the source? Assume the source of sound is isotropic and point source.

$$I = \frac{P_s}{Area} = \frac{P_s}{4\pi r^2}$$

$$I = I_0 10^{\beta/10} = 10^{-12} \times 10^{10.5} = 0.032\ W/m^2$$

$$r = \sqrt{\frac{P_s}{4\pi I}} = \sqrt{\frac{550}{4\pi \times 0.032}} = \boxed{37.2\ m}$$

2. The displacement of a sound wave in a material is given by: s (x,t) = (7.00×10^{-6}) cos(5.23x – 7845t), where and s are in meters and t is in seconds. Write the equation of the pressure variation wave [The density of air is 1.21 kg/m^3]

water = 1000 kg/m^3 $\Delta P(x,t) = \Delta P_m \sin(5.23x - 7845t)$

$$\Delta P_m = \rho v \omega s_m$$

$$v = \frac{\omega}{k} = 1500\ m/s$$ speed of sound in water

water density = 1000 kg/m^3

$$\Delta P_m = (1.21) \times 1500 \times 7845 \times 7 \times 10^{-6} = 99.67\ Pa$$

$$\boxed{\Delta P(x,t) = 99.67 \sin(5.23x - 7845t)}$$

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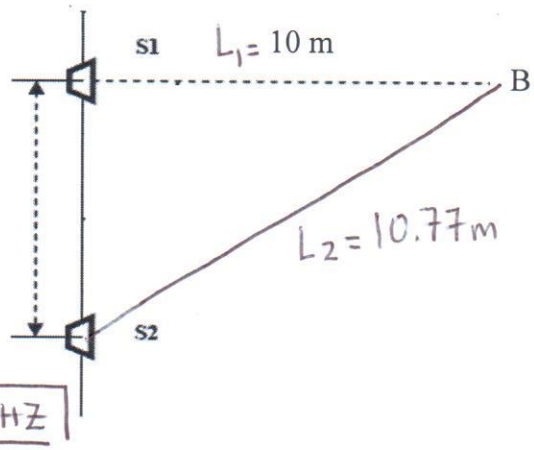
1. Two speakers S_1 and S_2 are placed on the y-axis as shown in the figure. The speakers are in phase and emit identical sound waves at the same time.
What are three lowest frequencies that will produce minimum sound at point B? (speed of sound in air = 343 m/s).



$\Delta L = L_2 - L_1 = 10.77 - 10$

$= 0.77$ m

minimum sound $\Delta L = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \ldots$

lowest freq: $\Delta L = \frac{\lambda}{2} = \frac{v}{2f_1}$

$f_1 = \frac{v}{2\Delta L} = \frac{343}{2 \times 0.77} =$ **222.7 HZ**

$f_3 = 3\frac{v}{2\Delta L} = 3f_1 =$ **668.2 HZ**

$f_5 = 5\frac{v}{2\Delta L} = 5f_1 =$ **1113.6 HZ**

2. A certain sound source is increased in sound level by 50 dB. By what factor is its intensity increased?

$\beta_2 = \beta_1 + 50 \Rightarrow \beta_2 - \beta_1 = 50$

$\beta = 10 \log \frac{I}{I_0}$ $\quad \beta_2 - \beta_1 = 10 \log \frac{I_2}{I_1}$

$\frac{I_2}{I_1} = 10^{\frac{\beta_2 - \beta_1}{10}} = 10^{\frac{50}{10}} = 10^5$

$$I_2 = 10^5 I_1$$