Q1 M1-122-06

The pressure in a travelling sound wave is given by the equation

$$\Delta p = (1.00\ \text{Pa}) \sin \pi [(0.900\ \text{m}^{-1})\, x - (315\ \text{s}^{-1})\, t]$$

Find the sound level of the wave (Take the density of air $\rho_{air} = 1.21\ \text{kg/m}^3$).

A) 90.7 dB
B) 100 dB
C) 85.0 dB
D) 75.0 dB
E) 120 dB

$\beta = 10 \log \frac{I}{I_0}$ and $I = \frac{1}{2} \rho v \omega^2 s_m^2$

$\Delta p_m = v \rho \omega s_m \Rightarrow I = \frac{1}{2} \frac{\Delta p_m^2}{v\rho}$

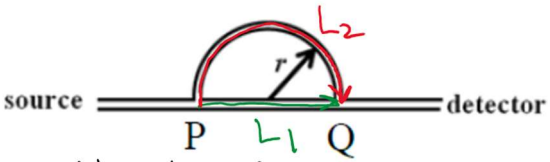
$\beta = 10 \log \frac{\frac{1}{2} \frac{\Delta p_m^2}{v\rho}}{I_0} = 10 \log \frac{1}{2} \frac{1^2}{343(1.21)(10^{-12})}$

$\beta = 90.8\ \text{dB}$

Q2 M1-112-05

A sound wave enters a tube at the source end, as shown in figure 1. At point P, the sound wave splits into two waves that recombine at point Q. The radius of the semicircle is varied until the first minimum is observed at the detector when *r* = 50.0 cm. What is the wavelength of sound?

A) 114 cm
B) 228 cm
C) 456 cm
D) 152 cm
E) 304 cm



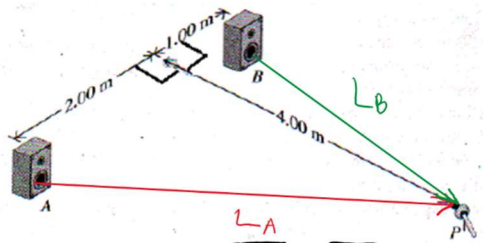
$\Delta L = L_2 - L_1 = \pi r - 2r = \frac{\lambda}{2}$

$\Rightarrow \lambda = 2\pi r - 4r = 114\ \text{cm}$

Q3 M1-132-07

waves in phase as shown in **Figure 2**. What is the first frequency at which destructive interference occurs and the first frequency at which constructive interference occurs at point P, respectively? Speed of sound = 350 m/s.

A) 500 Hz, 1000 Hz
B) 500 Hz, 1500 Hz
C) 1500 Hz, 500 Hz
D) 1000 Hz, 500 Hz
E) 1000 Hz, 1500 Hz



$\Delta L = L_A - L_B = \sqrt{2^2+4^2} - \sqrt{1^2+4^2} = 0.349\ \text{m}$

Destructive interference $\Delta L = \frac{\lambda}{2} \Rightarrow f = \frac{v}{2\Delta L} = 500\ \text{Hz}$

Constructive interference $\Delta L = \lambda \Rightarrow f = \frac{v}{\Delta L} = 1000\ \text{Hz}$

Q4 M1-132-05

A point sound source, emitting sound waves isotropically with constant power, is located at a distance *d* from you. If you move the source to position at a distance of *2d* from you, by how many decibel (dB) the sound intensity level will drop at your position?

A) 6
B) 4
C) 2
D) 8
E) 10

$$\beta_1 = 10\log\frac{I_1}{I_0} = 10\log\frac{\frac{P_s}{4\pi d^2}}{I_0}$$

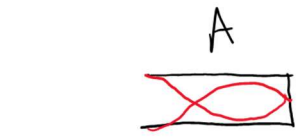
$$\beta_2 = 10\log\frac{I_2}{I_0} = 10\log\frac{\frac{P_s}{4\pi(2d)^2}}{I_0} = 10\log\frac{\frac{P_s}{4\pi d^2}}{I_0} - 10\log 4$$

$$\beta_2 - \beta_1 = -10\log 4 = 6\ dB$$

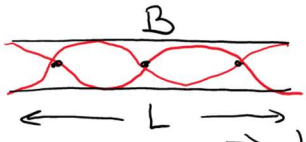
Q5 M1-132-06

Organ pipe A, with one open end, has a fundamental frequency of 220 Hz. The next-highest harmonic of pipe A has the same frequency as the third harmonic of a pipe B which has both ends open. How long is pipe B? The speed of sound = 345 m/s.

A) 0.784 m
B) 0.321 m
C) 0.732 m
D) 0.214 m
E) 0.136 m



$f_3 = 3f_1 = 660\ Hz$



$$f_3 = 3\frac{v}{2L} = 660\ Hz$$

$$\Rightarrow L = \frac{3}{2}\frac{345}{660} = 0.784\ m$$

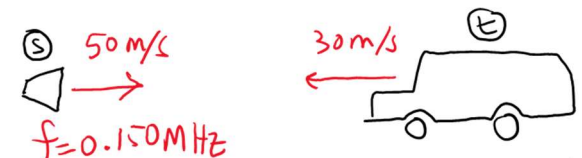
Q6 M1-122-08

Q8.

A sound source and a truck are approaching each other with speeds of 50.0 m/s and 30.0 m/s respectively. The source emits sound waves at a frequency of 0.150 MHz. Find the wavelength of the sound waves reflected back to the source.

(The speed of sound in air is 340 m/s)

A) 0.141 cm
B) 1.20 cm
C) 0.213 cm
D) 0.532 cm
E) 0.921 cm



Detected by truck $f' = f\frac{v+v_t}{v-v_s} = 0.191\ MHz$

Detected by source $f'' = f'\frac{v+v_s}{v-v_t} = 0.241\ MHz$

$$\lambda'' = \frac{v}{f''} = 0.141\ cm$$