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PHY2053 Health, Summer C 2016

Quiz 7

Date: Thursday, July 28, 2016

Problem 1: An organ pipe is closed at one end. When a particular key on the organ is pressed, the pipe resonates with a frequency of 870 Hz. If you are told that this frequency is the *second* overtone of the pipe, what is the pipe's length? Assume that the temperature in the organ room is 10° Celsius.

Second overtone is the 3^{rd} harmonic

For pipe open at one end and closed at the other,

this corresponds to $n = 5$

$$\lambda_5 = \frac{4L}{5}$$

$$f_5 = \frac{v}{\lambda_5} = \frac{5v}{4L}$$

$f_5 = 870$ Hz

$v = (331 + 0.606 \times 10)$ m/s

$= 337$ m/s

Find L

$$L = \frac{5v}{4f_5} = \frac{5 \times 337}{4 \times 870} \text{ m} = 0.48 \text{ m}$$

$$\boxed{L = 48 \text{ cm}}$$

(Problem 2 on the next page)

Problem 2: You stand in a room full of clocks. Whenever a new hour begins, all of the clocks start to chime, with each clock producing sound with the same intensity $I = 4.0 \times 10^{-4}\ \mathrm{W/m^2}$. Assume the threshold of human hearing is $I_0 = 10^{-12}\ \mathrm{W/m^2}$.

(a) What is the intensity level of the sound produced by one chiming clock?

(b) How many clocks would need to chime to produce an intensity level of 130 dB (the intensity level you would experience standing 30 m away from a jet engine). Round your answer *up* to the nearest integer. [Hint: it's a lot of clocks!]

a) $\beta = 10\,\mathrm{dB}\,\log_{10}\left(\frac{I}{I_0}\right)$

$= 10\,\mathrm{dB}\,\log_{10}\left(\frac{4\times10^{-4}}{10^{-12}}\right)$

$= 10\,\mathrm{dB} \times 8.60 = 86.0\,\mathrm{dB}$

b) $I_{tot} = n \times I$ (since the waves are incoherent, intensities add up).
where n is the number of clocks

$\beta_{tot} = 130\,\mathrm{dB} = 10\,\mathrm{dB}\,\log_{10}\left(\frac{I_{tot}}{I_0}\right)$

So, $\log_{10}\left(\frac{I_{tot}}{I_0}\right) = 13$

(or) $I_{tot} = I_0 \times 10^{13} = 10^{-12}\ \mathrm{W/m^2} \times 10^{13}$

$= 10\ \mathrm{W/m^2}$.

$I = 4\times10^{-4}\ \mathrm{W/m^2}$.

$\Rightarrow n = \frac{I_{tot}}{I} = \frac{10}{4\times10^{-4}} = 25{,}000$

25000 clocks 86 dB each only produce 130 dB. That's how loud 130 dB is

25,000 clocks will be needed to produce a 130dB noise. Sound intensity level doesn't add up!