Physics 5B: Sound Waves II

by Kameron Gill

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- For Friday: read Ch 16.6 $\Rightarrow$16.9
- Intensiy $I = 10^{-4}\frac{W}{m^2} \Rightarrow \delta = 10\log\left(\frac{I}{I_0}\right)$=10log($\frac{10^{-4}}{10^{-12}}$)=80 dB

  $I = 10^{-5}\frac{W}{m^2} \Rightarrow 70\,\text{dB}$

  $\frac{1}{10}I \Rightarrow 10\,\text{dB}$ increase

  $\frac{1}{100}I \Rightarrow 20\,\text{dB}$ decrease
- What about double Intensity? $I_2 = I_1$

  $B_1 = 10\log\left(\frac{1_1}{I_0}\right)$ $\qquad$ $B_2 = 10\log\left(\frac{I_2}{I_0}\right)$

  $B_2 - B_1 = 10\log\left(\frac{I_2}{I_0}\right) - 10\log\left(\frac{I_1}{I_0}\right) = 10(\log\left(\frac{I_2}{I_0}\right) - \log\left(\frac{I_1}{I_0}\right))$

  $=10\log\left(\frac{I_2}{I_1}\right) = 10\log(2) = 3.010\,\text{dB}$
- Vibrating Strings:

  I. Frequency (Pitch)

  Strings fixed at both ends:

  Fundamental:

  λ=2L $\qquad$ L=$\frac{1}{2}\lambda$

  2nd. Harmonic:

  L=λ $\qquad$ λ=L

  $f_n = \text{nf}_1 = n\frac{v}{\lambda_1} = n\frac{v}{2L}$ $\qquad$ Frequency Equation

  $f_{1=\frac{v}{2l}}$ $\qquad$ $f_{2=\frac{v}{L}}$

  To get different Frequencies: we need to change properties of strings!

  $v = \sqrt{\frac{F_T}{\mu}}$ via stretching $\qquad$ or length by fingering

  EXAMPLE:

  Guitar string .73m long, tuned to E 330(Hz) Where should you put your finger to play A4 (440Hz)?

  $f_E = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{F_T}{\mu}}$

  $f_A = \frac{1}{2L'} = \sqrt{\frac{F_T}{\mu}}$

  $f_A L' = f_E L \Rightarrow L' = \frac{f_E}{f_A}L = \frac{330}{440}(.73m)$

$L' = .548\text{cm}$

II. Vibrating columns of Air

Two cases: At least one is open and stadning wave is formed

Case 1: tube open at both ends

At open ends, air moves freely, but gauge pressure is 0

Anti-node for displacement wave, Node for pressure wave

$f_1 = \frac{v}{2L}$ $f_2 = \frac{v}{L}$ for the 2nd Harmonics

Case 2: tube closed at ends

$f_1 = \frac{v}{4L} = \frac{v}{\lambda_1}$

EXAMPLE: What is length of base clarinet (closed at one end) that plays the low D (72.4Hz)?

Fundamental freequency at one end: $f_1 = \frac{v}{4L}$

$L = \frac{v}{4f_1} \Rightarrow \frac{343}{4(72.4)} = 1.18m$

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