Reminders 03-05-08:
-Chapter 16 Homework Monday Night
-Next Exam Wed March 12.
-POW 5 Due Mon March 10

Outline:

-Intensity Level
-Doppler Effect
-Standing Waves and Resonance
-Beats
-Complex Waves

- 100dB corresponds to an intensity of…
- If the intensity of a siren changes from 0.90 W/m² to 0.055 W/m², what is the change in β?
- What is the change in β when the intensity of a sound doubles?

$\beta = 10\log\frac{I}{I_0}$ $\quad I_0 = 10^{-12}\ \frac{W}{m^2}$

$100 = 10\log\frac{I}{10^{-12}}$; $10 = \log\frac{I}{10^{-12}}$

$10^{10} = \frac{I}{10^{-12}}$ $\quad I = 10^{-2}\ W/m^2$

$\Delta\beta = 10\log\frac{I_2}{I_0} - 10\log\frac{I_1}{I_0}$

$= 10\log\frac{I_2}{I_1} = 10\log\frac{.055}{.90}$

$= -12\,dB$

$\Delta\beta = 10\log\frac{2I}{I} = 10\log 2 = 3\,dB$

- Federal regulations have set β_{max} at 90 dB for the workplace (no ear protection). An office of 128 typewriters was found to have a maximum reading of 92 dB's by a federal inspector when all were in operation. How many typewriters must be removed to be in compliance ?

$$\Delta\beta = -2 = 10\log\frac{I_f}{I_i} = 10\log\frac{nI}{128I}$$

$$-2 = 10\log\frac{n}{128}$$

$$-.2 = \log\frac{n}{128}; \quad 10^{(-.2)} = \frac{n}{128}$$

$$n = 81$$

removed is $128 - 81 = 47$

Source moves toward observer

$$\lambda' = \lambda - v_s T$$

$$v = f\lambda$$

$$f' = \frac{v}{\lambda'} = \frac{v}{\lambda - v_s T} = \frac{v}{\lambda - \frac{v_s}{f}}$$

$$= \frac{v}{\frac{v}{f} - \frac{v_s}{f}} = \frac{v}{\frac{1}{f}(v - v_s)}$$

$$f' = f\left(\frac{v}{v - v_s}\right)$$

In general

$$f' = f\left(\frac{v}{v \pm v_s}\right)$$

Observer moves

What is the # of waves that go from source to observer in time T?

$$\frac{vT}{\lambda} = fT$$

# of extra waves observed

$$\frac{v_o T}{\lambda}$$

the total number of observed waves is

$$N = \frac{vT}{\lambda} + \frac{v_o T}{\lambda} = \frac{(v + v_o)T}{\lambda}$$

$$f' = \frac{N}{t} = \frac{(v + v_o)}{\lambda} = \frac{(v + v_o)}{\frac{v}{f}}$$

$$f' = f\left(\frac{(v + v_o)}{v}\right)$$

In general

$$f' = f\left(\frac{v \pm v_o}{v}\right)$$

- Hovering over the pit from hell, the devil observes that as a student falls past (at terminal velocity), the frequency of his scream decreases from 842Hz to 820Hz.
  - What is the speed of the student?
  - The student's scream reflects from the bottom of the pit. Find the frequency of the echo as observed by the student.
  - Find the frequency of the echo observed by the devil.

$$842\,Hz = f\left(\frac{v}{v - v_s}\right)$$

$$820\,Hz = f = \left(\frac{v}{v + v_s}\right)$$

$$\frac{842}{820} = \frac{v + v_s}{v - v_s}$$

$$842(v - v_s) = 820(v + v_s)$$

$$22v = 1662 v_s$$

Say $v = 340$ m/s

$$v = \frac{22(340)}{1662} = 4.50 \text{ m/s}$$

Plug v_s into one of the equations to find f.

$f = 831$ Hz

$$f' = 831\text{Hz}\left(\frac{v + v_o}{v - v_s}\right)$$

$$= 831\left(\frac{340 + 4.5}{340 - 4.5}\right) \approx 853\text{Hz}$$

$$f' = 831\left(\frac{340}{340 - 4.5}\right) \approx 842\text{Hz}$$