Waves and Sound Review

Thurs May 30th

Today's Plan

1. review the key concepts and formulas

2. work on the three sample problems (answers to be provided)

3. start to work through the assigned textbook problems

Unit 4 : Review Notes - Key concepts:

1. Periodic Motion

2. Wave Motion

3. Reflections and Interference

4. Standing Waves

5. Sound
5.1 Sound as a pressure wave
5.2 Speed of sound
5.3 Sound Intensity
5.4 Pitch and Sound Quality
5.5 Air columns
5.6 Doppler Effect

Unit 4 : Review Notes - Key concepts:

1. periodic motion

electromagnetic waves → transverse

- transverse across axis of equilibrium ex→pendulum
- longitudinal - along axis of equilibrium ex→ Sound wave.

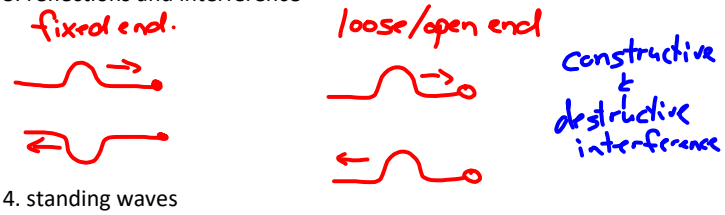
frequency = $\frac{1}{\text{period}}$ ⇒ $f = \frac{1}{T}$

if period(T) is in sec. $f = \frac{1}{s} = Hz$.

2. wave motion

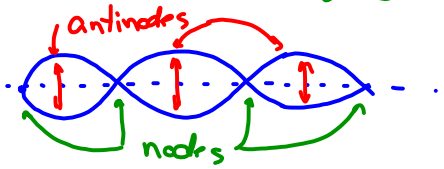
$V = f\lambda$ "universal wave equation

3. reflections and interference



4. standing waves

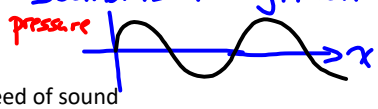
special case of interference (waves moving in opposite directions with same frequency & wavelength)



5. sound

5.1 Sound as a wave

Sound is a longitudinal wave



5.2 Speed of sound

$V_{sound} = 332 m/s$ (at 0°C, sea level)

$V_{sound} = 332 + 0.59T$ (at temperature changes).

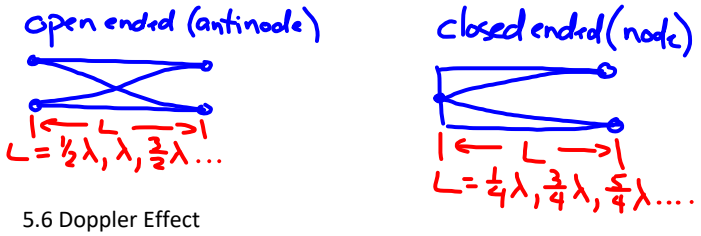
5.4 / 5.5 Sound Intensity and Pitch

* frequency range 20 Hz → 20 kHz.
* intensity range $10^{-12} W/m^2 \rightarrow 1 W/m^2$

0 dB → 120 dB

threshold of human hearing

5.5 Air columns



5.6 Doppler Effect

The apparent change in frequency due to the relative velocity between the source of sound and the receiver. The Doppler effect will be noticed if the source is moving or the receiver is moving.

Practice Problem #1

Some species of hummingbirds beat their wings 6000 times per minute. This helps to create "humming" sound that is associated with humming birds. If the temperature on a warm summer day is 28°C and the hummingbird beats her wings at 6000 times per minute, what is the wavelength of the sound waves generated by the beating wings? (assume 2 sig figs in your answer).

① find V_{sound} $V = 332 + 0.59(T)$

$= 332 + 0.59(28)$

$= 348.5\ m/s$

② find f $f = 6000\ beats/min \times \frac{1}{60}\ min/sec.$

$= 100 Hz$

③ find λ $\lambda = \frac{V}{f} = \frac{348.5\ m/s}{100 Hz}$

$= 3.485\ m$

$\therefore \lambda = 3.5\ m$ 2 sig figs.

Practice Problem #2

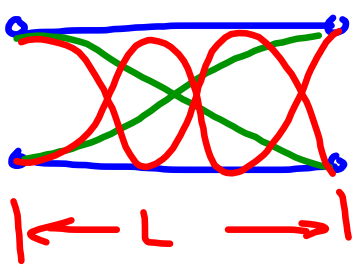
You want to design a musical instrument that will create sounds at both 224 and 672 Hz. If the speed of sound is 336 m/s, what are two different ways that you could design this instrument?

First determine what wavelengths you need to design for:

$\lambda = \frac{v}{f} = \frac{336\ m/s}{224\ Hz} = 1.5\ m$

$\lambda = \frac{v}{f} = \frac{336\ m/s}{672\ Hz} = 0.5\ m$

Design #1 - Open Ended Air Column



$\lambda_{green} = 1.5\ m$

$\lambda_{red} = 0.5\ m$

Shortest length that will allow $\lambda = 1.5$ to resonate.

$L = \frac{1}{2}\lambda = 0.75\ m\ (\lambda = 1.5\ m)$

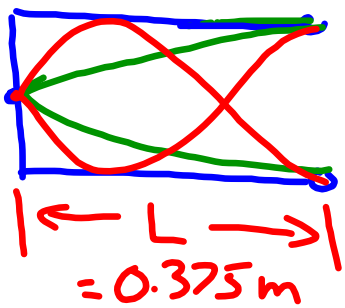
also

$L = \frac{3}{2}\lambda = 0.75\ m\ (\text{if } \lambda = 0.5)$

*this is the 3rd harmonic

(both $\lambda = 1.5\ m$ & $0.5\ m$ will resonate in an air column of $L = 0.75\ m$).

Design #2 - Closed Ended Air Column



$\lambda_{green} = 1.5\ m$

$\lambda_{red} = 0.5\ m$

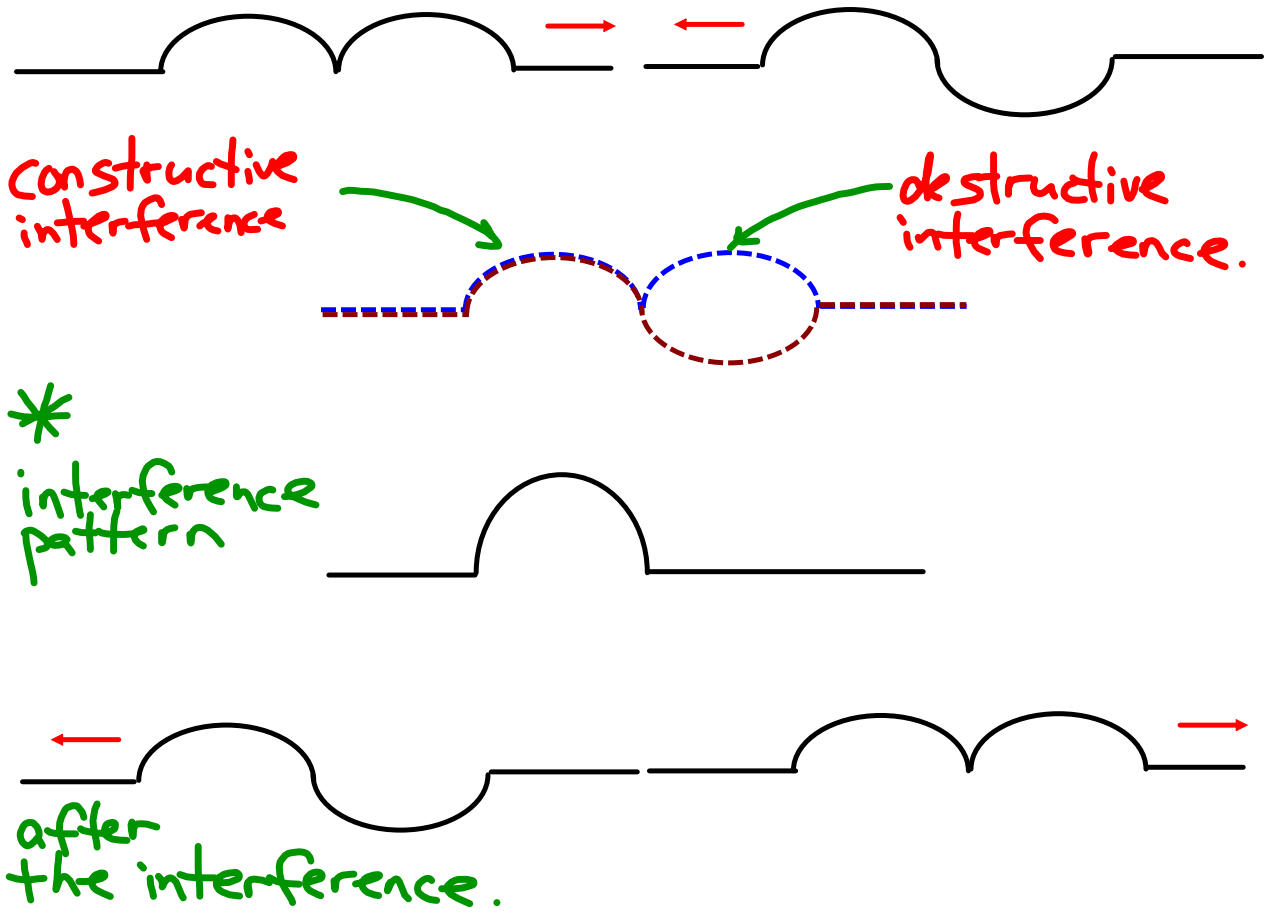
Shortest length (L) that will allow $\lambda = 1.5\ m$ to resonate.

$L = \frac{1}{4}\lambda = 0.375\ m\ (\lambda = 1.5\ m)$

$L = \frac{3}{4}\lambda = 0.375\ m\ (\lambda = 0.5\ m)$

Practice Problem #3

Show the resulting wave pattern when the two waves pulses below interfere. (show the interference pattern when the center of the two waves align).



Review

Go Over your Quiz

Do the following text book problems:

Standing waves - page 229 #1-3
(#1 - answer is wrong in book - should be 4.75cm)
Speed of Sound - page 246 # 1, 2, 5
Speed of Sound - page 270 #3, 5
Sound Intensity - page 249, #2, 3
Doppler Effect – page 272 #1, 6
Harmonics & Air Columns- page 312 #13, 14, 15

Extra Review (answers are in the back of the text)
- Page 316 - #1, 3, 4, 5, 8, 12, 13, 14, 16, 31, 38a.b., 40,

Test - May 31st