Ch 17 - Standing Waves and Interference

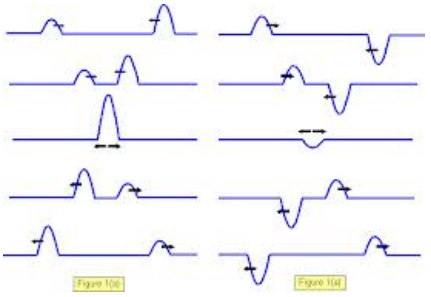
/www.physicsclassroom.com/mmedia/waves/swf.cfm

Standing wave animation

- Constructive Interference
- Destructive Interference
- Standing Waves

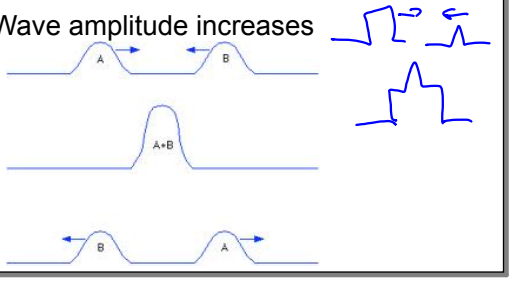
Principle of Linear Superposition

- When 2 or more waves are present simultaneously at the same place, the resultant disturbance is the sum of the disturbances from the individual waves.



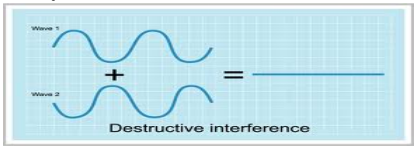
Constructive interference

- Waves on "same" side
- trough + trough OR crest + crest
- Wave amplitude increases

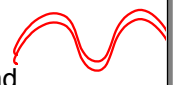


Destructive Interference

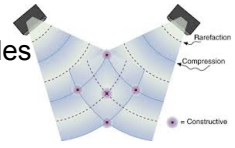
- Waves on "opposite" sides
- crest + trough
- amplitude decreases



If two waves of SAME frequency and IN PHASE are emitted from TWO speakers



- creates pattern of destructive and constructive interference
- hear loud and soft
- creates nodes and antinodes
- creates max's and min's

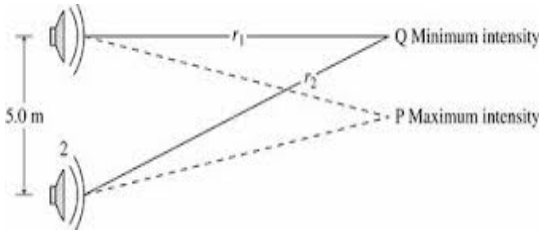


path length difference = difference between distances sounds travel (r_1- r_2 in pictures) = Δd

if Δd= mλ then = max, antinode, LOUD

if Δd = (m-1/2)λ = min, node, NO SOUND

m = integer = 1, 2, 3... so multiple places where you have loud or soft sounds P or Q

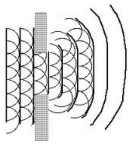


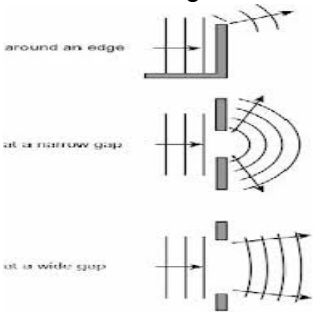
Diffraction of sound

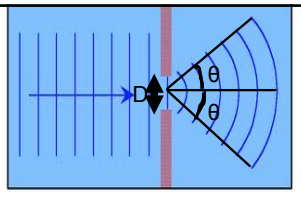
Huygen's Principle: Waves can be broken down into smaller waves

Diffraction -bending as wave goes through or around a barrier

- allows one of the small waves to pass through
- causes wave to "bend" into single wave







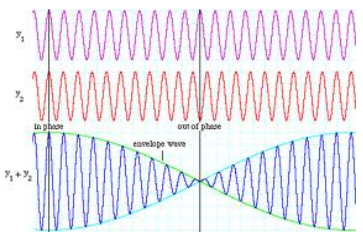
Amount of diffraction (bending) depends on wavelength and opening

$\sin\theta = \lambda/D$ --- slit opening

$\sin\theta = 1.22(\lambda/D)$ -- circular opening (like a speaker)

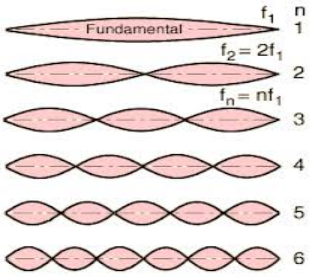
Beat frequency - due to difference between two closely sounded frequency interfering with each other

$f_b = |f_1 - f_2|$



Standing Waves

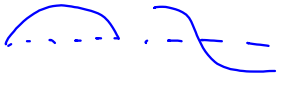
Demo - wave generator



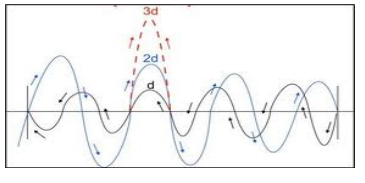
Demo - tuning fork on board, music box

Demo - wine glass and bridge

Forced vibration - forcing an object to vibrate, causes more molecules to vibrate and increases amplitude = louder

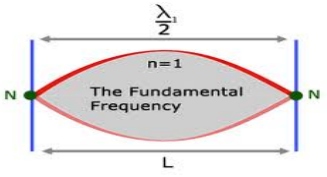


Resonance = forcing an object to vibrate at its natural frequency = causes HUGE increase in amplitude



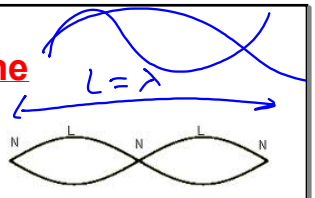
Fundamental frequency

- Biggest wave
- smallest frequency $f_1 = v/\lambda = v/2L$
- f_1



First Overtone

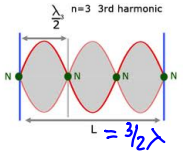
- 2nd Harmonic
- $f_2 = 2f_1$



$f_2 = v/\lambda = v/L$

Second Overtone

- 3rd Harmonic
- $f_3 = 3f_1$



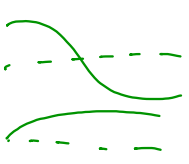
$f_3 = v/\lambda = v/(2/3)L = 3v/2L$

What's the pattern???

$f_1 = v/2L = (1)v/2L$

$f_2 = v/L = (2)v/2L$

$f_3 = 3v/2L = (3)v/2L$

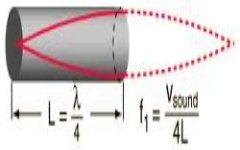


closed/closed OR open/open

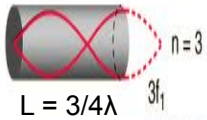
That was for closed/closed ends...but what about closed open??

Demo..soda bottle

Figure 29.1

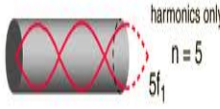


$f_1 = v/\lambda = v/4L$



L = 3/4λ

Produces odd harmonics only!



L = 5/4λ

$f_3 = v/\lambda = v/(4/3)L = 3v/4L$

$f_5 = v/\lambda = v/(4/5)L = 5v/4L$

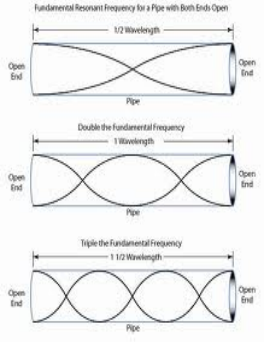
So for close/open system

$f_n = nv/4L$ ..but n=1,3,5,.....

Careful when reading questions...2nd frequency is 3rd and 3rd frequency is 5th...just read what they are asking....

Open/Open system is the same as closed/ closed

Demo - singing rod



L = λ/2

L = λ

L = 3λ/2