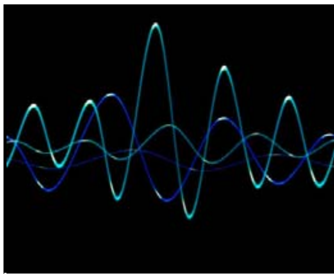
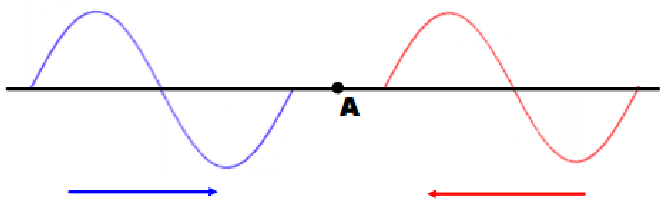


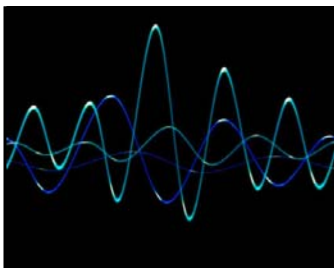
Unit 4: Oscillatory Motion and Mechanical Waves

4.6 Acoustic Resonance

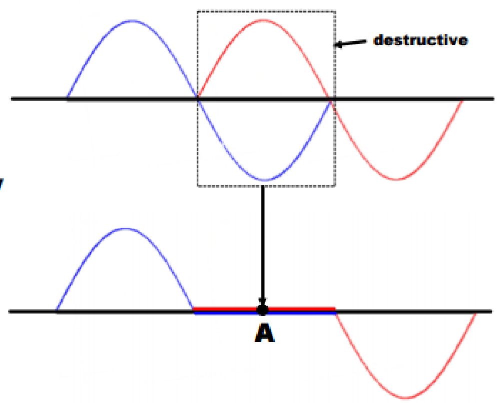
Let's look at what happens when we have a group of pulses (a wave train) interfering:

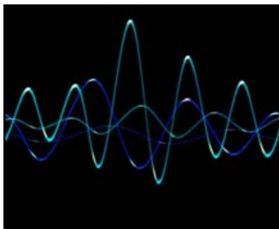


1) The pulses move towards each other and the point A on the spring/string/medium.

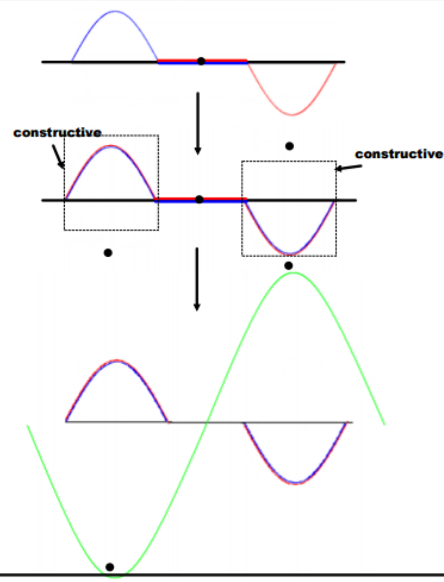


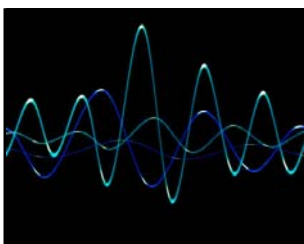
2) The first pulses destructively interfere:



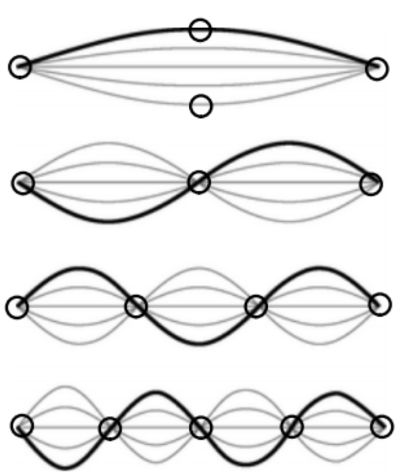


3) But as the waves pass, the pulses then constructively interfere:

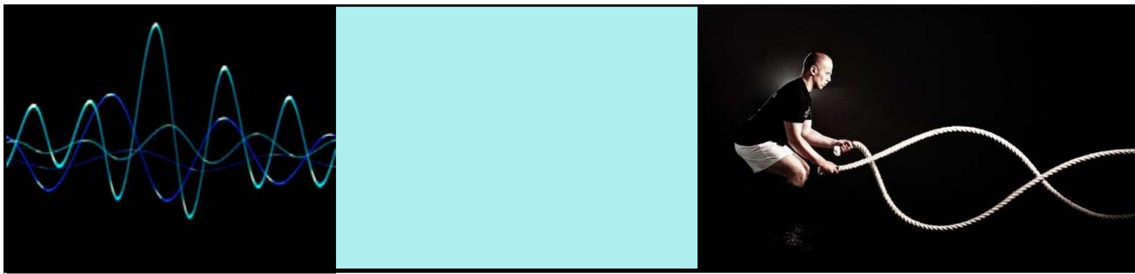




The resulting pattern is called a <u>standing wave</u>. A standing wave appears to ascillate about set points called nodes.



- nodes (don't move)
- antinodes (the regions of maximum displacement)



The Sound of Resonance

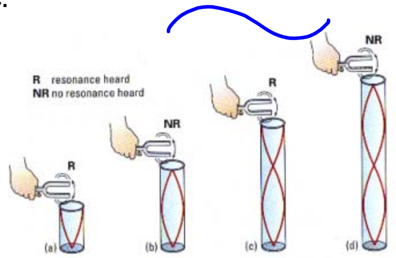
Resonance - when a vibrating system drives another system to oscillate with greater amplitude

▲ **Figure 8.32** The tone produced when you blow across the top of an open bottle depends on the length of the air column.

Wind instruments take advantage of resonance to produce music. The air vibrates as a standing wave, producing and antinode in the mouth of the instrument and a node at the bottom of the intrument.

Resonance only occurs in air in an open cylinder if the open end of the cylinder has an antinode and the closed end has a node.

Resonance in air results in a greatly amplified sound wave that you can hear called a harmonic.



antinodes: $L = \frac{1}{4}\lambda$ $L = \frac{3}{4}\lambda$ $L = \frac{5}{4}\lambda$ $L = \frac{7}{4}\lambda$

nodes: $L = \frac{1}{2}\lambda$ $L = \frac{2}{2}\lambda$ $L = \frac{3}{2}\lambda$ $L = \frac{4}{2}\lambda$

As resonance is easily detected, and occurs when antinodes are at the open end of a cylinder, we can use an open ended air column to determine the speed of sound in air.

Remember: antinodes occur at 1/4λ and every 1/2λ after that (1/4λ, 3/4λ, 5/4λ, etc.)

Ex.) A tuning fork tuned to middle C (440 Hz) is held at the end of a 1.00 m closed at one end cylinder. The second harmonic heard in the cylinder. What is the speed of the sound waves around this cylinder?

$L = \frac{1}{4}\lambda$	$L = \frac{3}{4}\lambda$	$L = \frac{5}{4}\lambda$
$1.00 = \frac{1}{4}\lambda$	$1.00 = \frac{3}{4}\lambda$	$1.00 = \frac{5}{4}\lambda$
$\lambda = 4.00\text{ m}$	$1.\overline{3} = \lambda$	$\lambda = 0.8$
$v = f\lambda$	$v = f\lambda$	$v = f\lambda$
$v = (440)(4.00)$	$v = (440)(1.\overline{3})$	$v = (440)(0.8)$
~~$v = 1760\text{ m/s}$~~	~~$v = 587\text{ m/s}$~~	$\boxed{v = 352\text{ m/s}}$

Questions: Pg. 420 # 1-4.

Steps: Assume $L = \frac{1}{4}\lambda$ and look at the magnitude of the speed of sound, if it's realistic (~343 m/s) stop, if not try $L = \frac{3}{4}\lambda$, $L = \frac{5}{4}\lambda$, and so on.