

Waves Lec. 5 - PHY 138 Nov. 20 2006

Standing Waves : result of Principle of superposition.

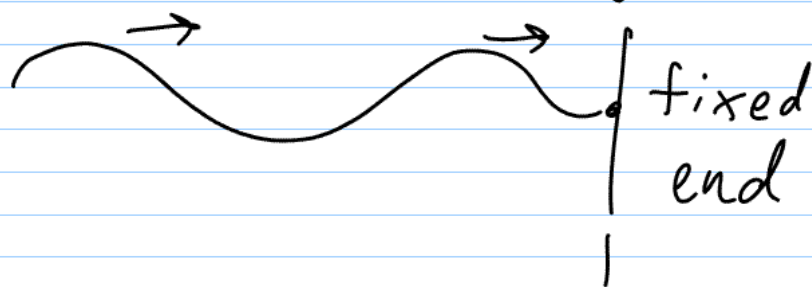
↑ (also interference & beats)

- If one or more waves occur at the same time & place the resulting disturbance is the sum of the disturbances of the individual waves

this sum : can be constructive or destructive

Standing Wave can form naturally from a wave and its echo.

ie) wave on a string:



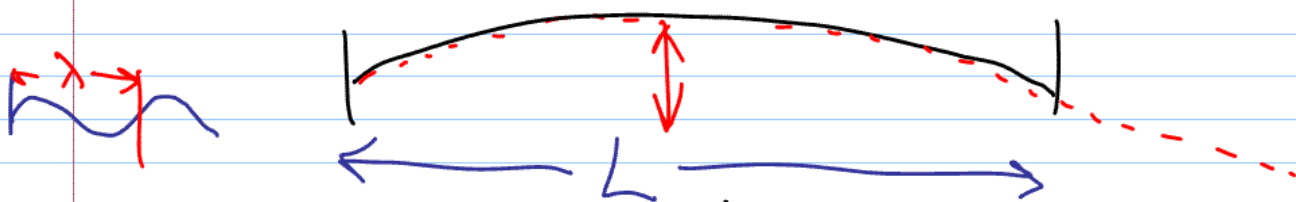
creates:



sum: standing wave.

→ fixed end doesn't move:  
forced node.

Fundamental Mode:



one antinode,  $\lambda = 2L$

$L = \frac{1}{2}$  wavelength.

→ Wavelength = 2 × distance between nodes.

$m =$  harmonic number (integer)

$$f_m = \frac{mv}{2L}$$

$v =$  wave speed

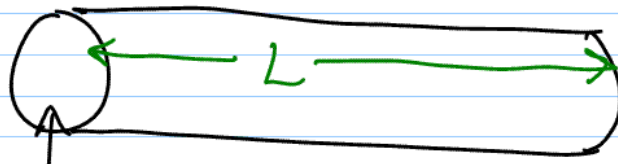
$L =$  distance between fixed ends.

Subscript labels mode freq. i.e.  $f_1, f_2, f_3$  ends.

Musical Instruments:

string: creates a standing wave, usually fundamental mode of transverse waves on string, speed  $v = \sqrt{\frac{T}{\mu}}$   
 $T, \mu, L$  determine frequency.

wind: form a cavity of air



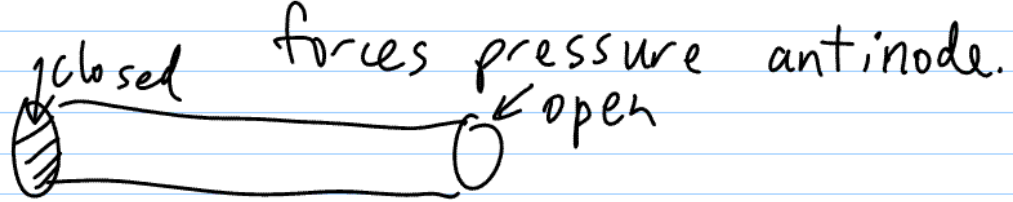
sound waves can travel along cavity in air, at

open end: pressure = outside air pressure = constant. speed of sound ( $v = 344 \text{ m/s}$ )

→ this is a forced node.

For a tube with open end, pressure is constant at end.

- closed end: longitudinal displacement of air molecules is constant.



different eq:

$$f_m = \frac{m v}{4L}$$

$m = \text{odd integers only.}$   
 $m \neq 0$

$$m = 1, 3, 5, \dots$$