Interference due to Superposition

Constructive - total displacement of medium is larger than each seperate wave.

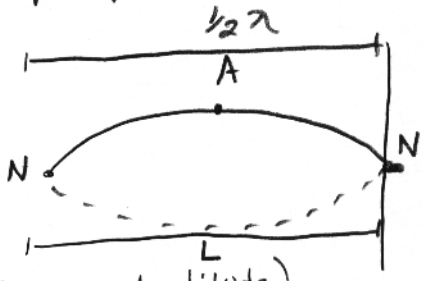
Destructive - total displacement of medium is smaller than each seperate wave.

Standing Waves

- Waves that form in between boundaries.
  - The wave no longer travels
  - remains in fixed position.

- Caused by superposition.

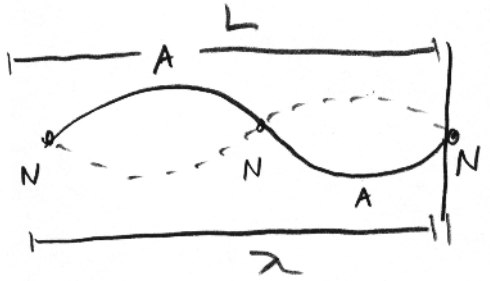
Strings



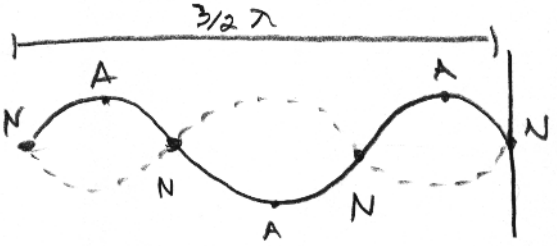
$L = \frac{1}{2}\lambda$

N = nodes (destructive, zero Amplitude)

A = antinode (constructive, max amplitude)



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



$L = 3(\frac{1}{2}\lambda)$

$$L = n\left(\tfrac{1}{2}\lambda\right)$$

$$\boxed{\lambda_n = \frac{2L}{n}}$$

n = harmonic (resonant) numbers

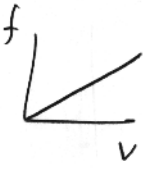
n for strings is any positive whole # 1, 2, 3, 4.....

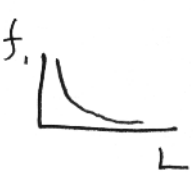
In terms of frequency. $\lambda = \frac{v}{f}$ $\frac{v}{f} = \frac{2L}{n}$

$$\boxed{f_n = \frac{nv}{2L}}$$ ← harmonic frequencies

When $n=1$ this is called the fundemental frequency. "lowest possible"

$$f_1 = \frac{v}{2L}$$





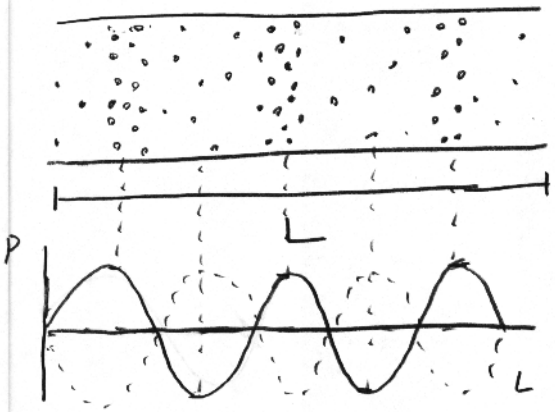
For stringed musical instruments

$$v = \sqrt{\frac{T}{\mu}}$$

$$\boxed{f_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}}$$

Standing Sound Waves

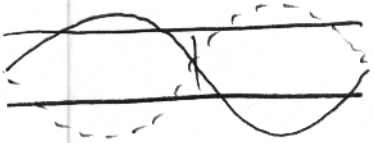
In a column of air.



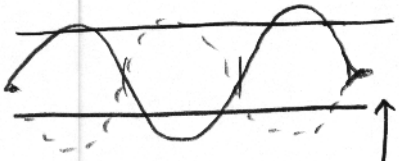
← as standing wave forms the air molecules form compressions that are the Antinodes of the standing wave.

Open - Open

n = 1



n = 2



n = 3

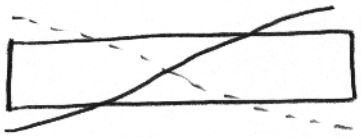
Nodes form at open ends

$$L = \left(\frac{1}{2}\lambda\right)n$$

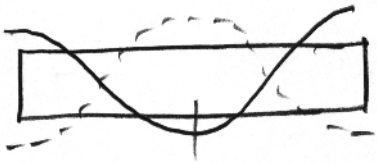
$$\lambda_n = \frac{2L}{n} \qquad f_n = n\left(\frac{V}{2L}\right)$$

$n = 1, 2, 3 \ldots$

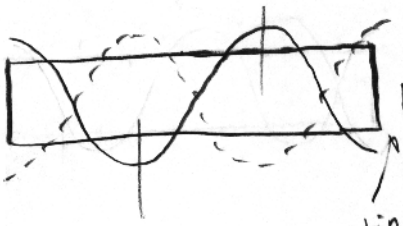
closed - closed



n = 1



n = 2

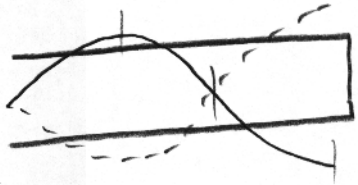


n = 3

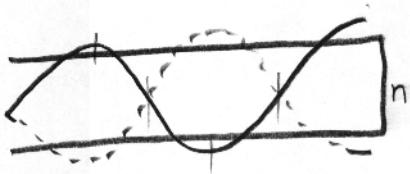
antinodes form at closed ends

open - closed

n = 1



n = 3



n = 5

$$L = \left(\frac{1}{4}\lambda\right)n$$

$$\lambda_n = \frac{4L}{n} \qquad f_n = n\left(\frac{V}{4L}\right)$$

$n = 1, 3, 5 \ldots$