Pearson
10.5

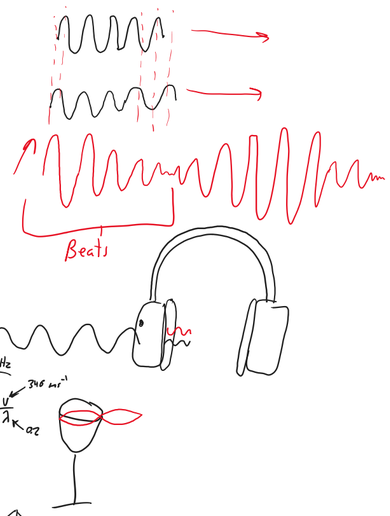
Standing Waves and Harmonics

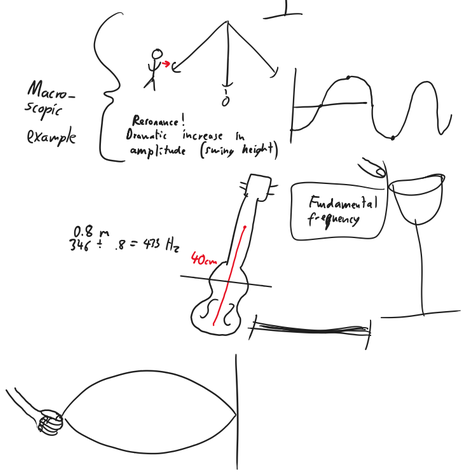
Standing Wave
- Super position of
- two waves with
  - similar amplitude
  - same frequency
  - opposite direction

(most of time due to reflection of perpendicular surface).

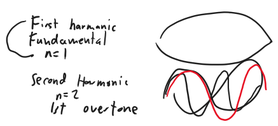
At the nodes
- destructive interference

At the antinodes
- Constructive interference.





Over-tone ≠ harmonic

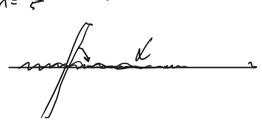


$l = \frac{\lambda_1}{2}$

$\lambda = \frac{2l}{1}$
$\lambda = \frac{2l}{2}$
$\lambda = \frac{2l}{3}$
$\lambda = \frac{2l}{4}$
$\lambda = \frac{2l}{5}$

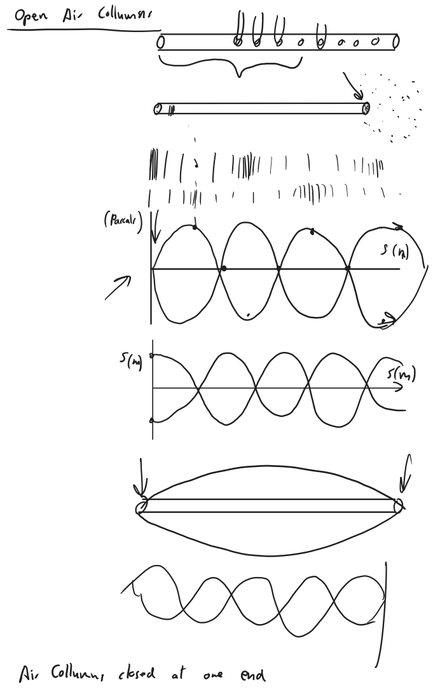
nth harmonic has wavelength $\lambda = \frac{2l}{n}$

$n \in \mathbb{I}$



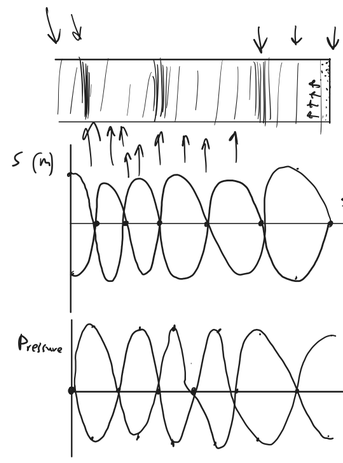
Air Columns

Open Air Columns



$\lambda = \frac{2l}{n}$

Air Columns closed at one end

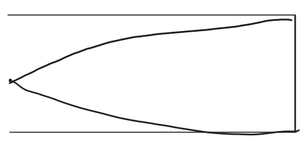


Open air columns
- resonant frequencies are natural number multiples of the fundamental frequency.

Closed air columns
- resonant frequencies are odd number multiples of the fundamental

Pressure

1st harmonic
1st Mode

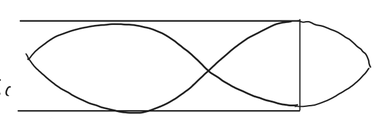


$\lambda = \frac{4l}{(2n-1)} \quad n \in \mathbb{N}$

$\lambda = 4 \cdot l$

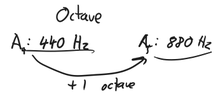
$\lambda = \frac{4l}{h}$ / h = harmonic

2nd mode
3rd harmonic
2nd overtone

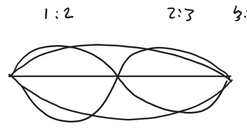


$\lambda = \frac{4l}{3}$

Octave



1:2 2:3 3:4



3rd mode
5th harmonic
4th Overtone

$\lambda = \frac{4l}{5}$