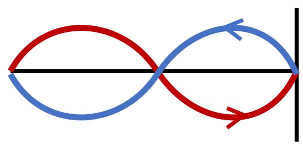
CONCEPT: STANDING SOUND WAVES

● Longitudinal & Transverse Standing Waves are <u>very similar</u>. Best example: Sound waves in an **open** or **closed** pipe.

TRANSVERSE STANDING WAVE



● Both ends are **[Nodes | Antinodes]**

$$f_n = \frac{nv}{2L}$$

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

For n = 1, 2, 3…

LONGITUDINAL STANDING (SOUND) WAVE

OPEN PIPE

● Both ends are **[Open | Closed]**
● Both ends are **[Nodes | Antinodes]**

$f_n =$ ——

$\lambda_n =$ ——

n = 1, 2, 3…

CLOSED / "STOPPED" PIPE

● 1 end is open, other end **[Open | Closed]**
● Open end is Antinode, closed end **[Node | Antinode]**

$f_n =$ ——

$\lambda_n =$ ——

n = 1, 3, 5…

● For sound waves, *always* assume the speed of sound v = 343 m/s unless otherwise stated.

<u>EXAMPLE</u>: For a particular musical instrument, the pipe which sound travels through is 5m long. **a)** Calculate the fundamental frequency if the pipe is open at both ends. **b)** Calculate the 4rd overtone if the pipe is open at 1end, closed at the other.

PROBLEM: The fundamental frequency of your *closed* organ pipe is 200 Hz. The second overtone of this pipe has the same frequency as the 3rd harmonic of an *open* pipe. What is the length of this open pipe?

- **A)** 0.85 m
- **B)** 0.51 m
- **C)** 0.69 m
- **D)** 0.43 m

STANDING WAVES

$v = \sqrt{\frac{F_T}{\mu}}$ (for *strings only*)

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

$f_n = nf_1 = \frac{nv}{2L}$ (open pipe)

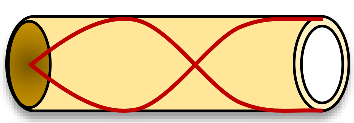
$\lambda_n = \frac{2L}{n}$ (open pipe)

$f_n = nf_1 = \frac{nv}{4L}$ (closed pipe)

$\lambda_n = \frac{4L}{n}$ (closed pipe)

n^{th} Overtone = $(n+1)^{th}$ Harmonic

PROBLEM: The length of the closed pipe shown below is 2.75 m long. **a)** Calculate the frequency of the standing wave shown. **b)** Calculate the fundamental frequency of the pipe.



STANDING WAVES

$v = \sqrt{\frac{F_T}{\mu}}$ (for *strings only*)

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

$f_n = nf_1 = \frac{nv}{2L}$ (open pipe)

$\lambda_n = \frac{2L}{n}$ (open pipe)

$f_n = nf_1 = \frac{nv}{4L}$ (closed pipe)

$\lambda_n = \frac{4L}{n}$ (closed pipe)

n^{th} Overtone = $(n+1)^{th}$ Harmonic