

## Plucked String

**example: pluck string at 1/4 point from end.  
which harmonics will be strong?  
which harmonics will be absent?**

**Answer:**

**2<sup>nd</sup> harmonic has belly where string is plucked: STRONGEST**

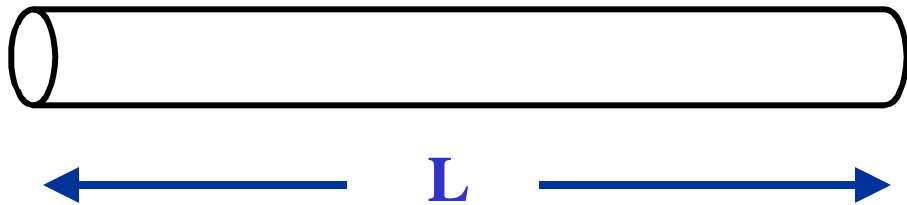
**4<sup>th</sup> harmonic has NODE where string is plucked: ABSENT**

**8<sup>th</sup> harmonic .... ABSENT**

other harmonics: more or less present, depending how much amplitude they have at pt. where plucked.

# Pipes

(woodwinds, brass, organ pipes)



an “open” pipe  
(open at both ends)

at open end, no pressure build-up because air is free to escape:

**OPEN END** is always a **PRESSURE NODE**

## Fundamental Oscillation:

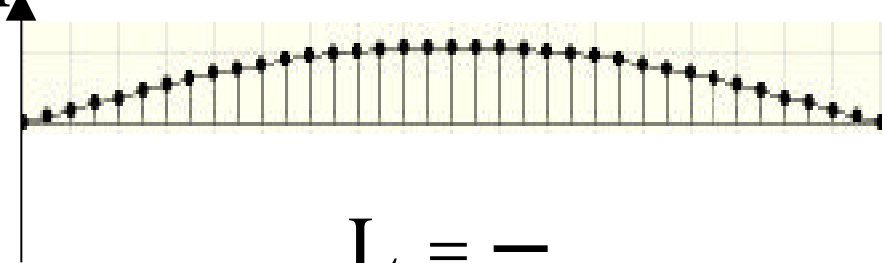


fundamental freq:

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

(T = round trip travel time)

air press.



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

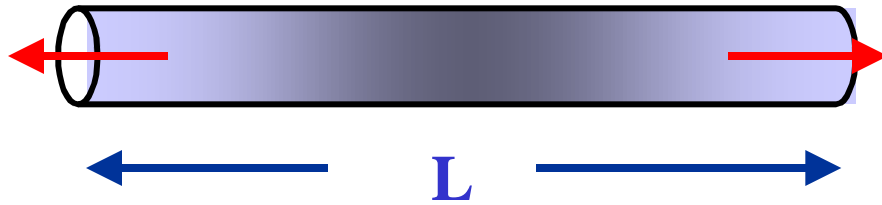
**Example: find length of flute  
of frequency C = 260 Hz**

$$L = \frac{v}{2f_1} = \frac{344 \frac{\text{m}}{\text{sec}}}{2 \times 260 \frac{1}{\text{sec}}} = 0.66 \text{ m}$$

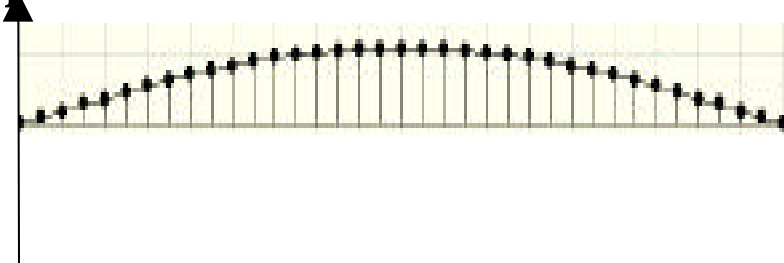
**demo: 1.25 m long pipe**

air flow 

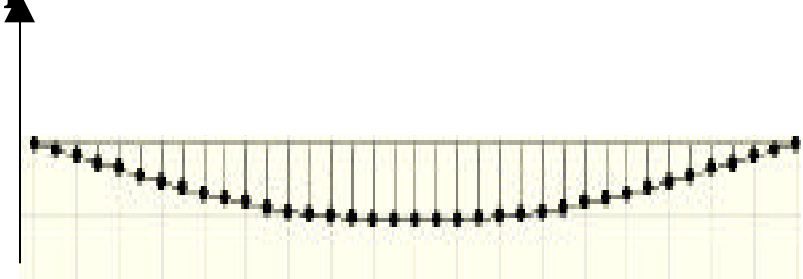
half a period later:



air press.



air press.



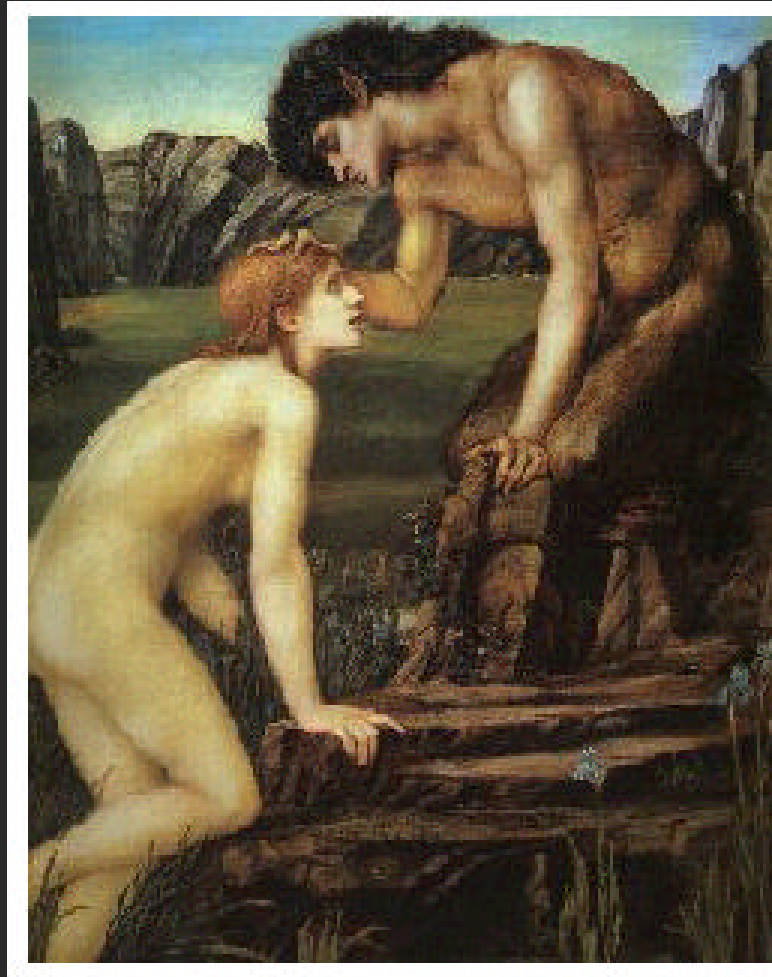
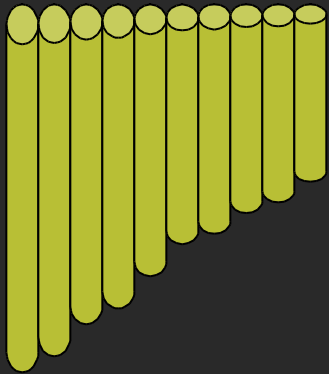
How change pitch of pipe?  $f = v/2L$

can **ONLY** change  $L$  (fingerholes on flute)

can't change speed of sound  $v$ !

diameter has (almost) no effect!

pan pipe



**Pan and Nymph**

## Higher modes of flute:

		example
$f_1$	first mode (fundamental)	260Hz
$f_2 = 2f_1$	second mode (first overtone)	520Hz
$f_3 = 3f_1$	third mode (second overtone)	780Hz
$f_n = nf_1$	<b>MODES ARE <u>HARMONICS</u></b>	

demo: modes of pipe - plastic tube

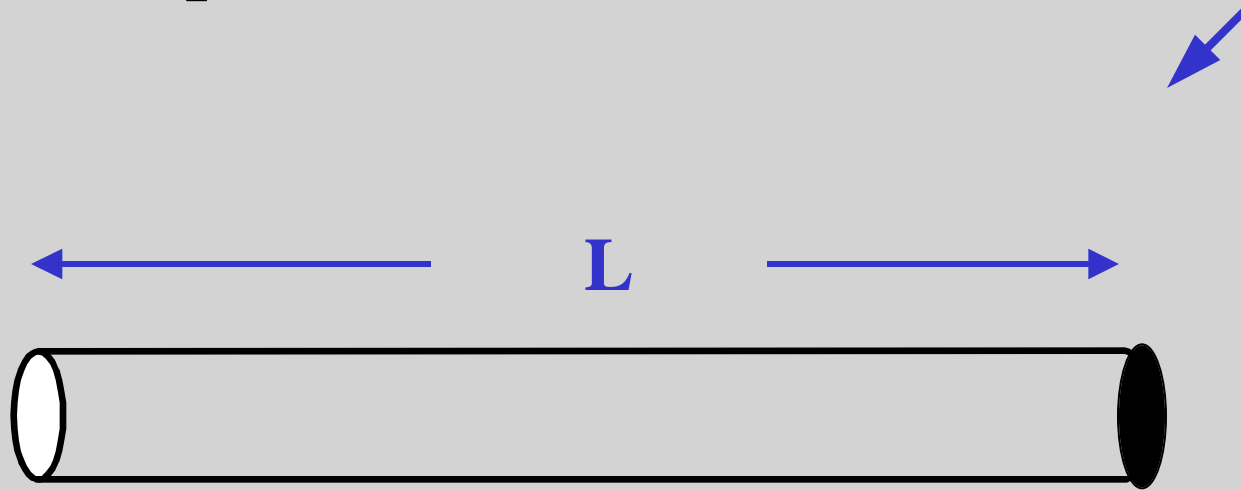
graphs of pressure and air velocity on blackboard

at pressure node air speed has antinode

at pressure antinode air speed had node **why?**

# Closed Pipe

Pipe closed at ONE end:



$$\leftarrow L = \frac{\lambda}{4} \rightarrow$$

**fundamental frequency of closed pipe:**

$$f_1 = \frac{v}{4L}$$

**note: this is half the frequency of an open pipe of same length (octave below)**

**open end: pressure **NODE** (motion antinode)  
closed end: pressure **antinode** (motion node)**