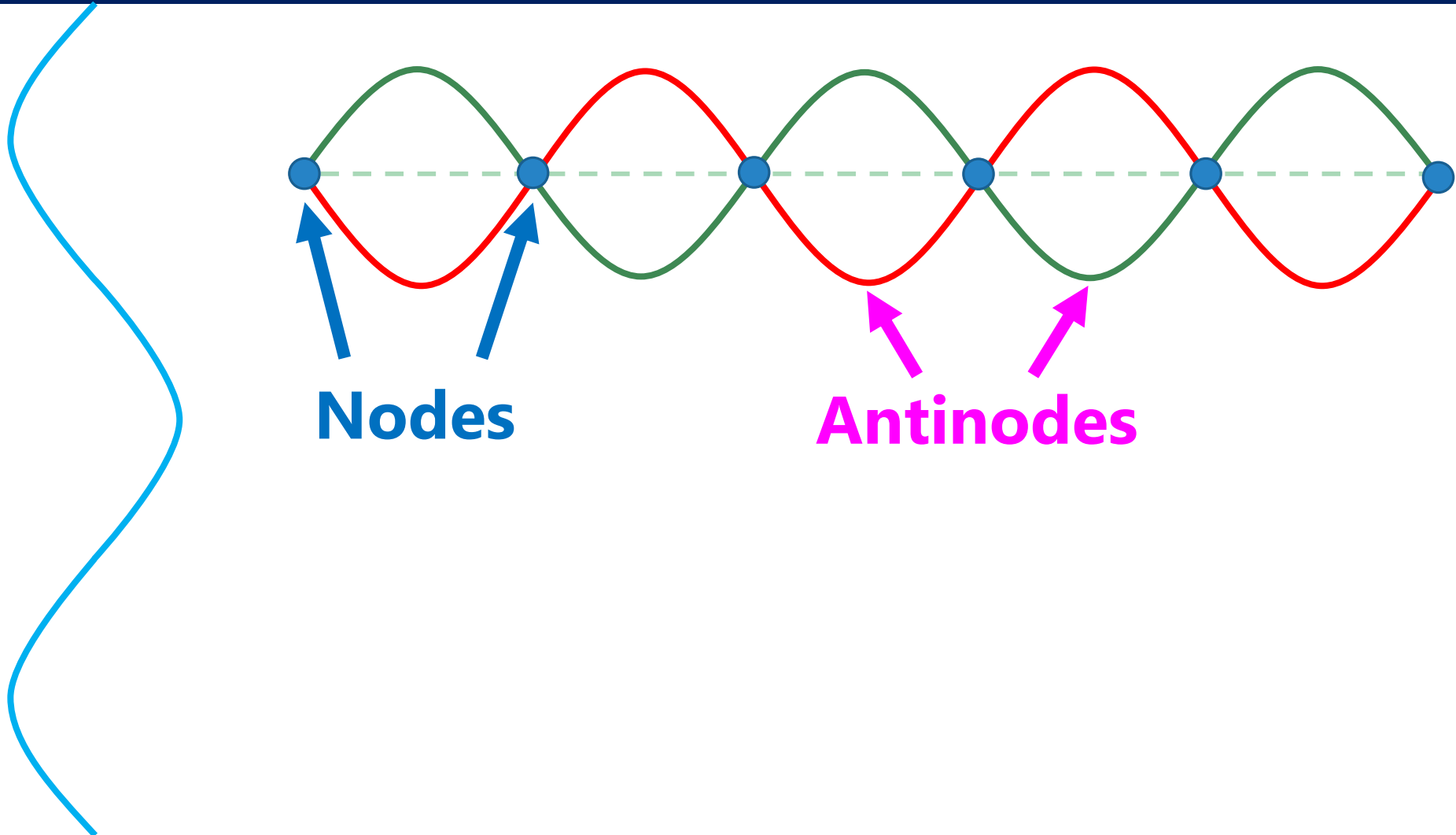


# Calculating Harmonics and Instruments

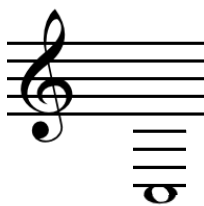
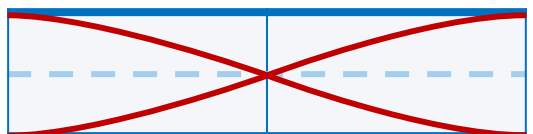
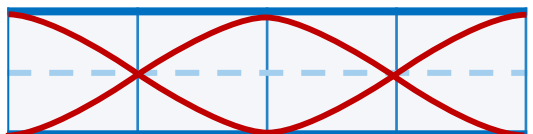
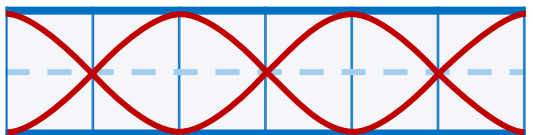
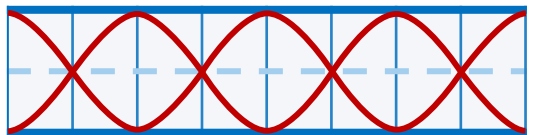
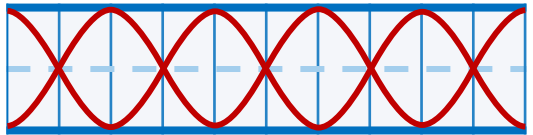
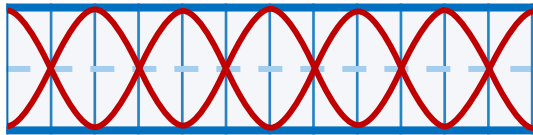
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IB PHYSICS | WAVES - SOUND

# Standing Waves Review



# Harmonics



## Taps

$\text{♩} = 40$



## Reveille (US)

Traditional

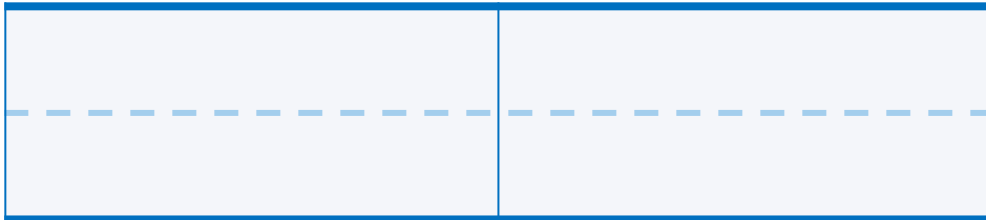
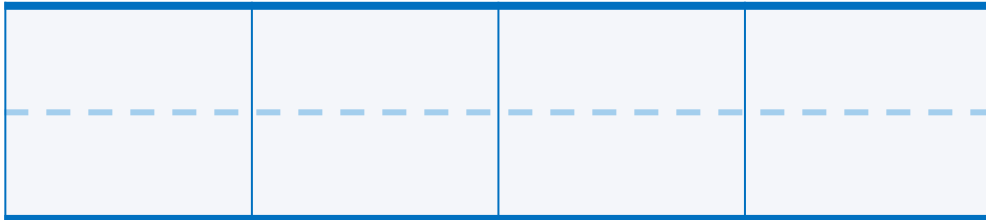
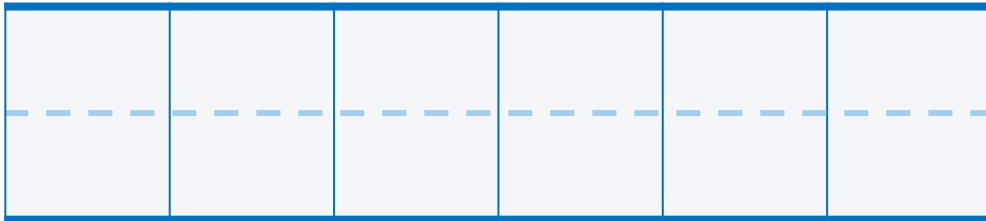
5

10

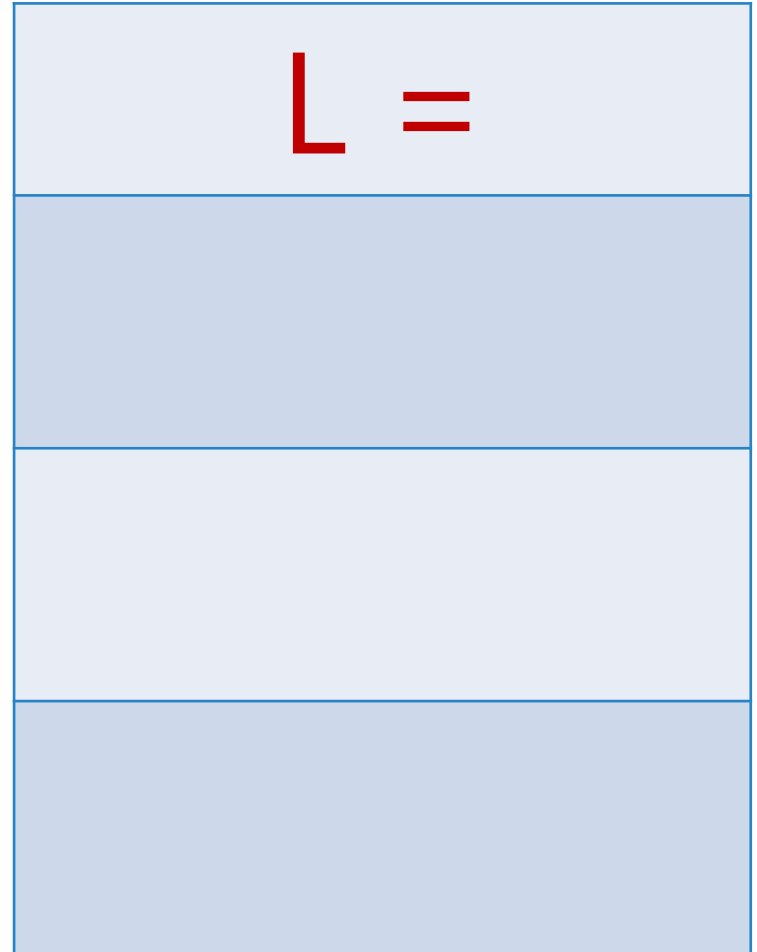
16

21

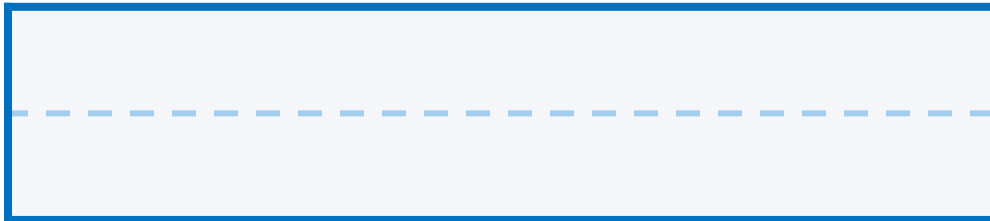
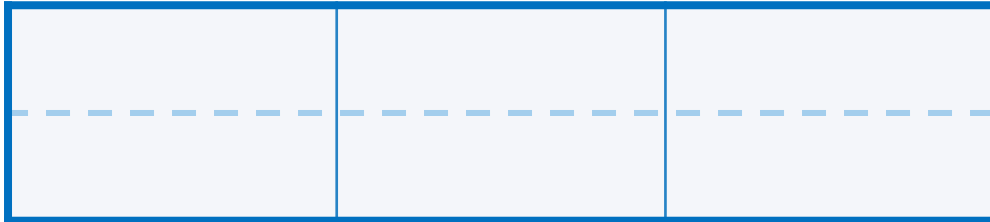
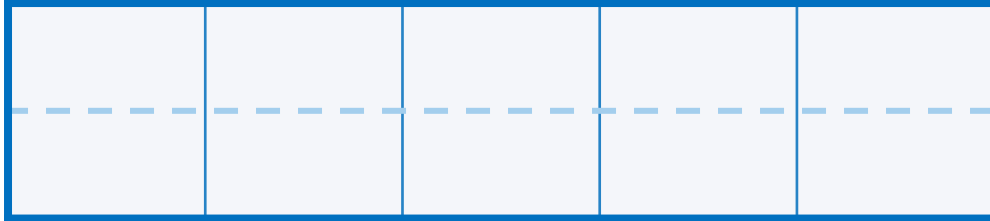
# Open Pipe Resonance



$$L =$$



# Closed Pipe Resonance



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

# Strings make sound too!



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changes depending  
on the string tension

Two ways to increase frequency in string:

# String Resonance

- 

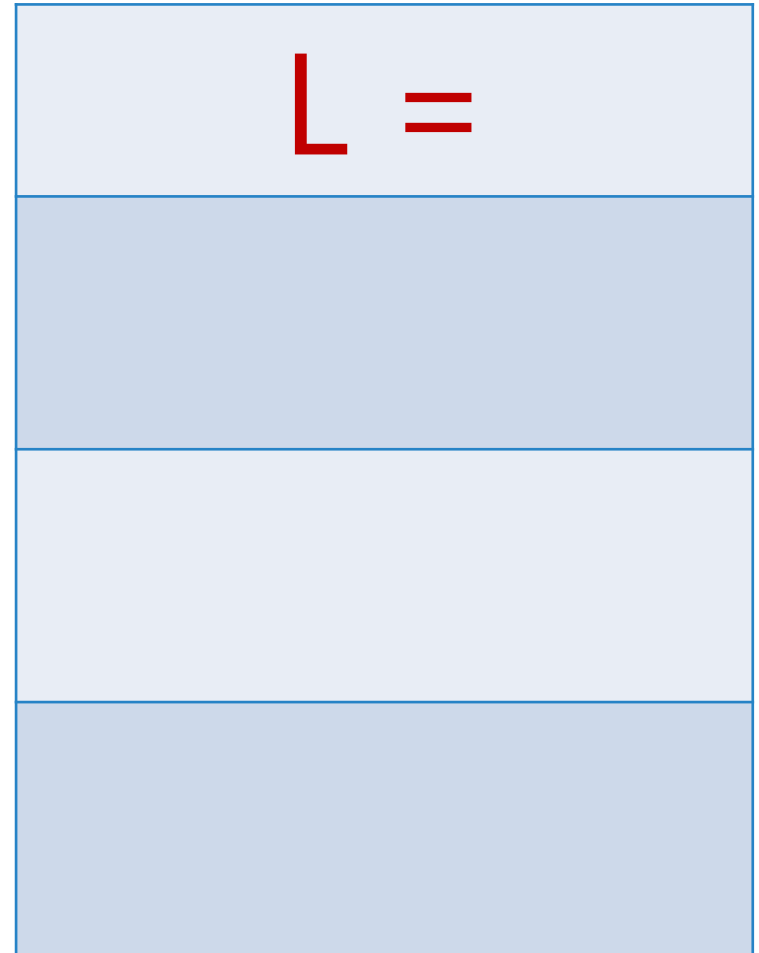
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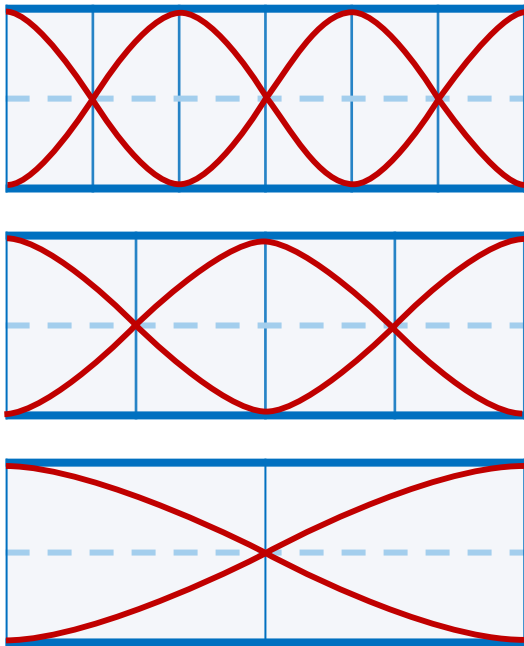
# Review of End Conditions

Closed Pipe		
Open Pipe		
String		

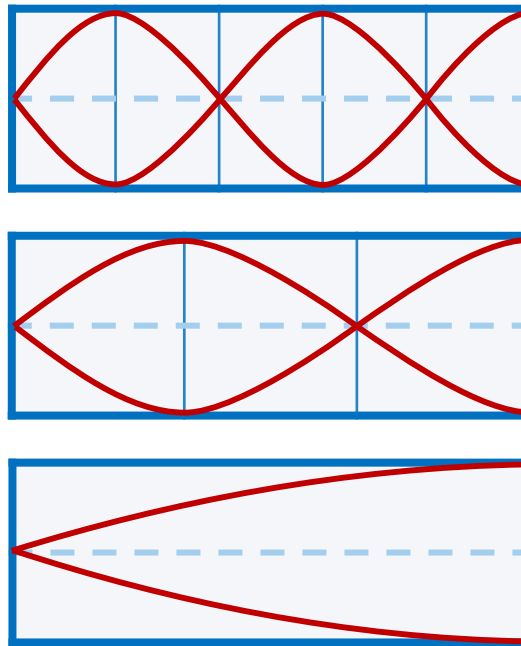


# All the Harmonics!

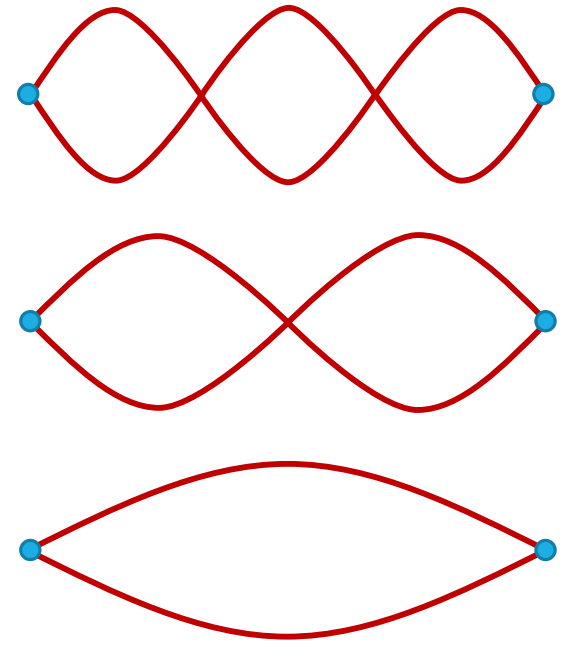
Open



Closed

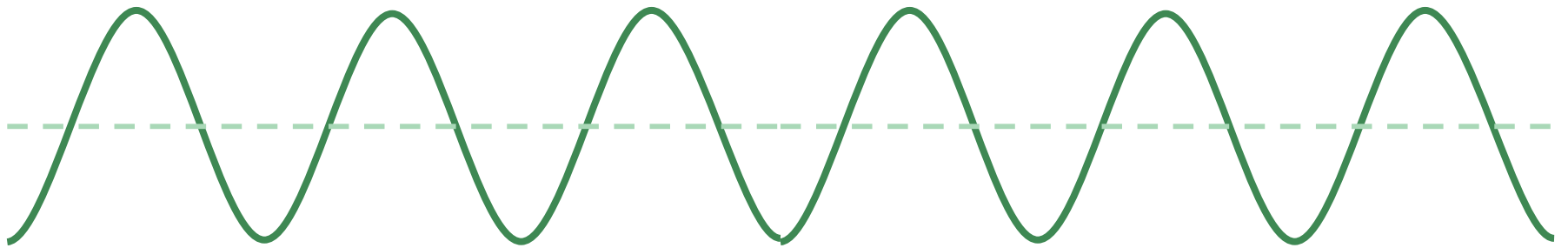


String

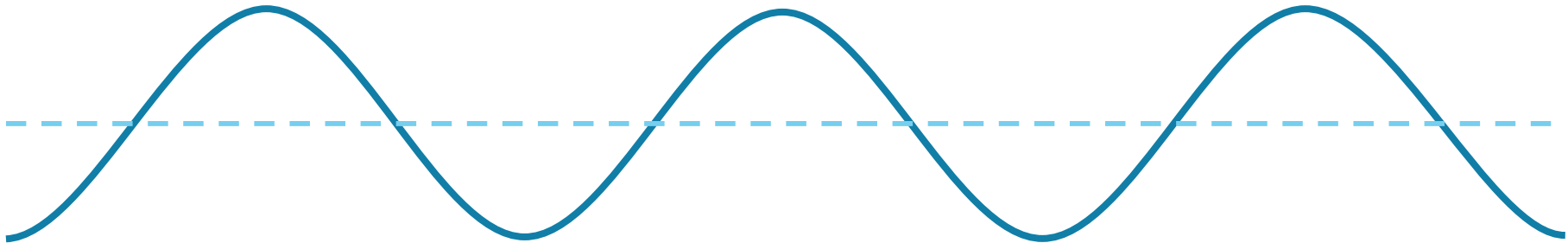


# Remember Pitch and Frequency

High pitched sounds have high frequencies



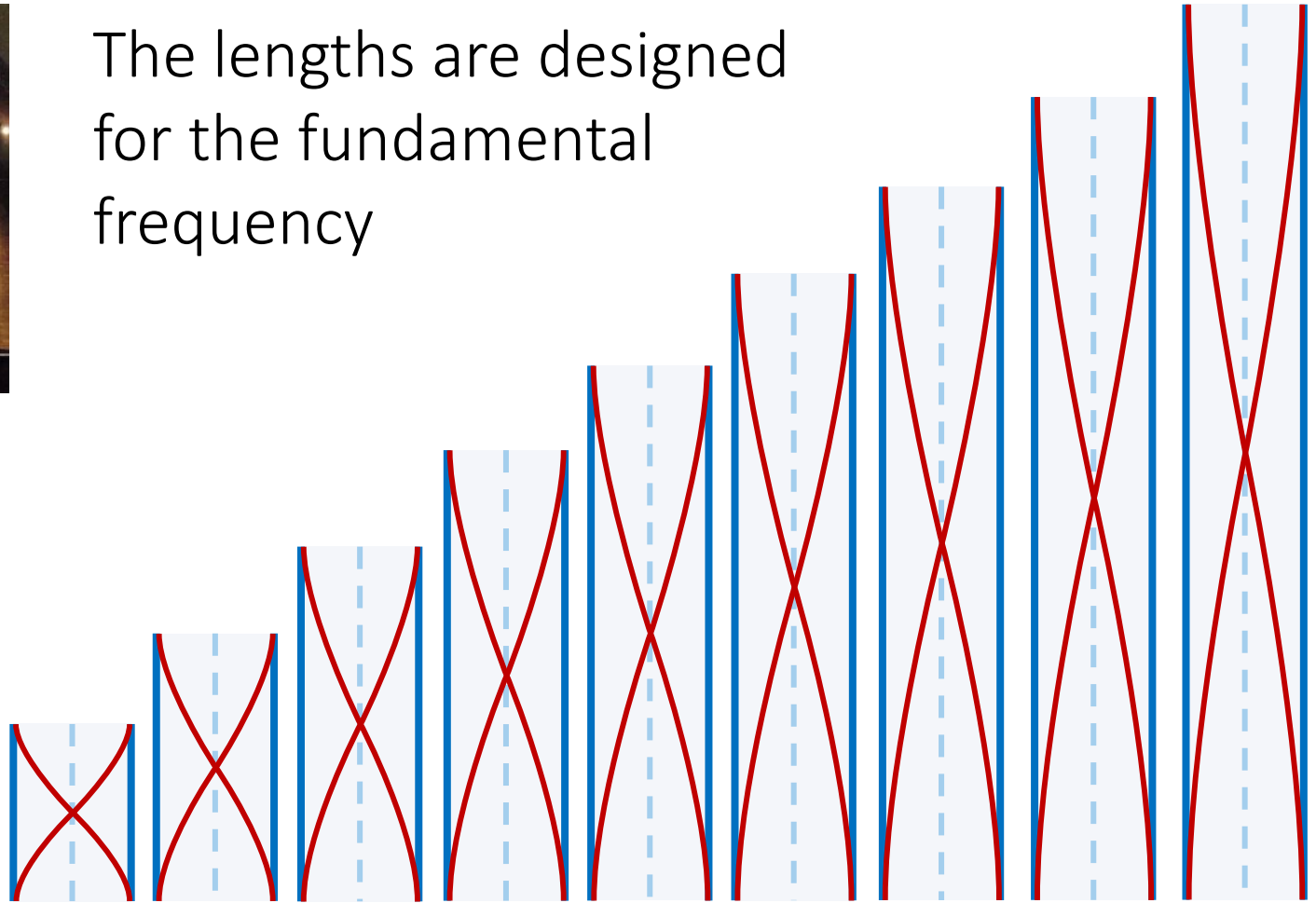
Low pitched sounds have low frequencies



# Making Different Pitches



The lengths are designed for the fundamental frequency



# Calculating Frequency | Open Pipes



An open organ pipe is 2.1 m long and the speed of sound in the pipe is 341 m/s. What is the fundamental frequency of the pipe?

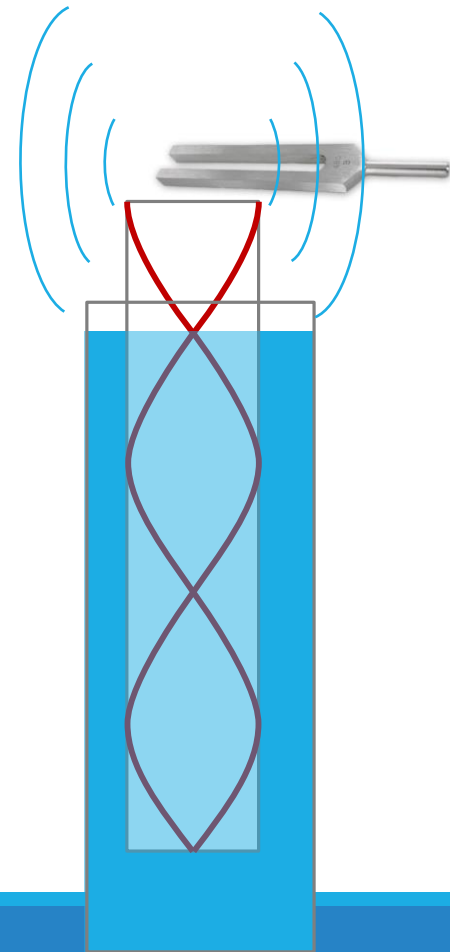
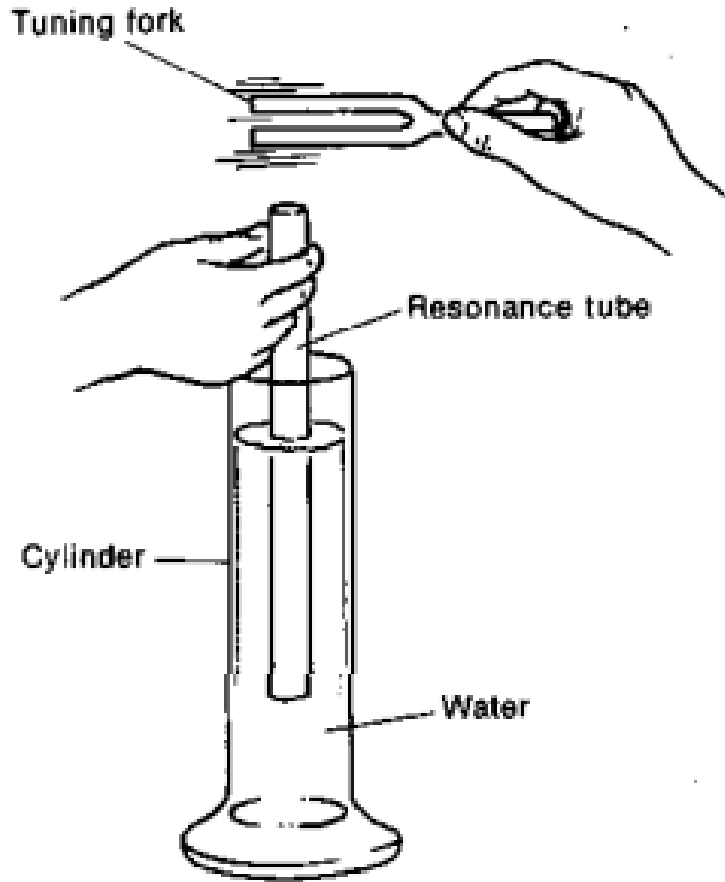

# Resonant String Practice



The note produced on a violin string of length 40 cm produces a wave speed of 250 m/s. What is the first harmonic of this note?



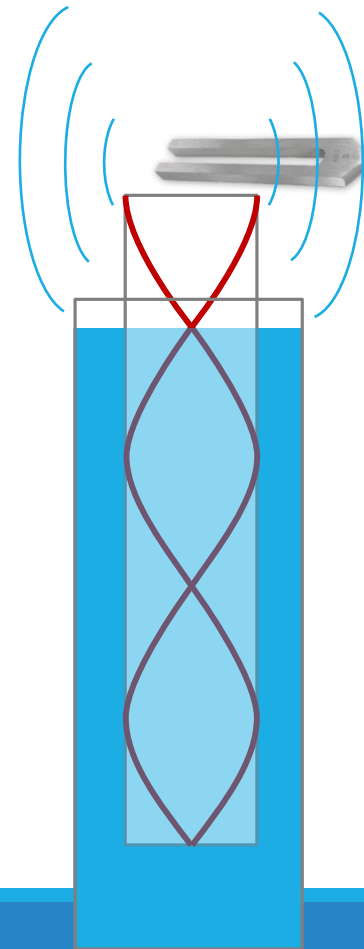
# Finding Resonance



# Calculating Frequency | Closed Pipes

You found an unmarked tuning fork in your collection. You notice that the smallest length for resonance is **12 cm**. If the speed of sound is **345 m/s**, what is the tuning fork frequency?

What should the length of the tube be for the 2<sup>nd</sup> resonant position?



# Lesson Takeaways

- I can identify and label the node and antinodes on a standing wave diagram
- I can describe the end conditions and nodes/antinodes for open/closed pipes and vibrating strings
- I can calculate the wavelength or instrument length of a standing wave for different harmonics