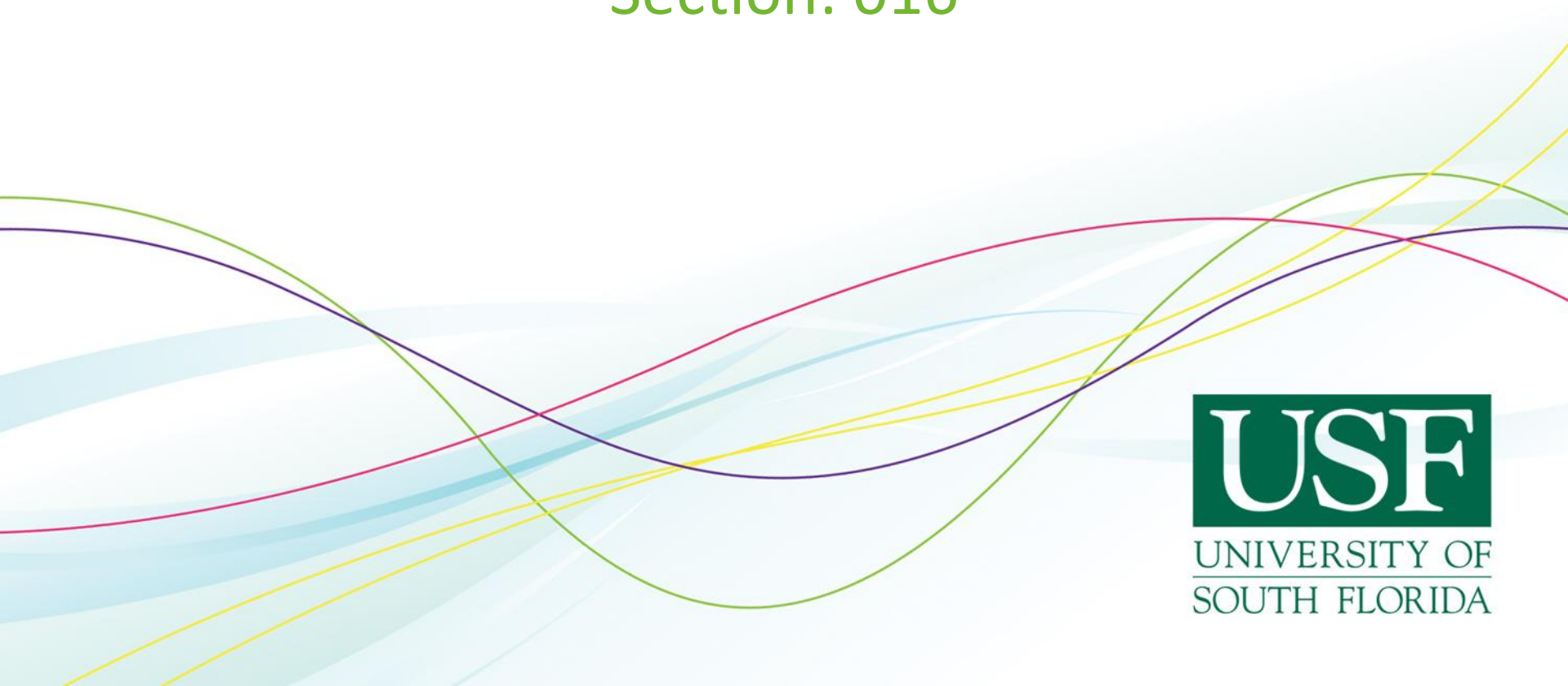
Lab 2: Sound Waves

PHY2049L

Section: 016



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Learning Outcomes

- Students will demonstrate the experimental relationship between the speed of sound, wavelength and frequency for a standing wave in a stopped tube.
- Students will also learn the effect of air temperature on the speed of sound.

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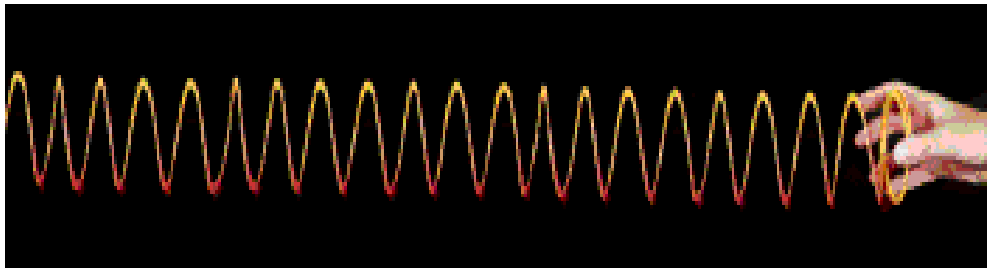
Defining Sound Waves

- Sound waves are longitudinal waves: particles will be displaced parallel to the direction the wave travels, think of a slinky:



- These waves can also be described by:

$$y(x,t) = A\cos(kx - \omega t)$$

For a sound wave travelling in the +x direction.

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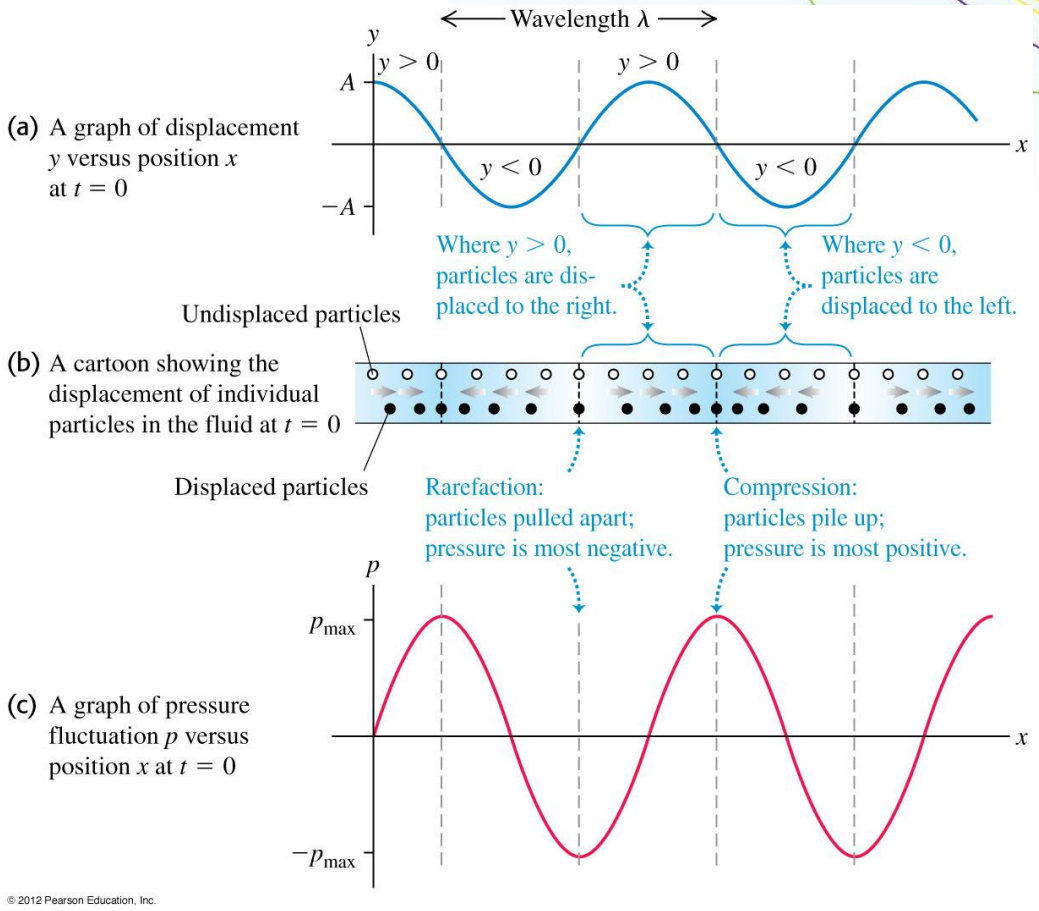
Pressure Waves

- Sound waves are Pressure waves.
- When particles are pushed together, the pressure reaches a maximum.
- When particles spread apart, the pressure reaches a minimum.



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Standing Sound Waves

- Standing waves occur when two identical travelling waves (travelling in opposite directions) interfere.
- This is very similar to the case of standing waves on a string.
  - Now we have displacement nodes N (where particles in the fluid have zero displacement).
  - Displacement anti-nodes A (where particles in the fluid have maximum displacement).

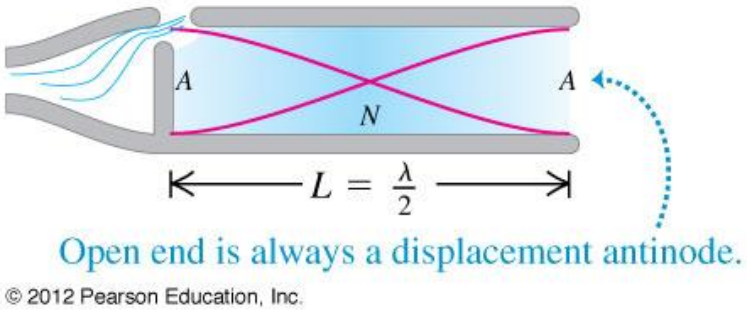
Standing Waves in Tube

- Velocity of the waves are still described by:

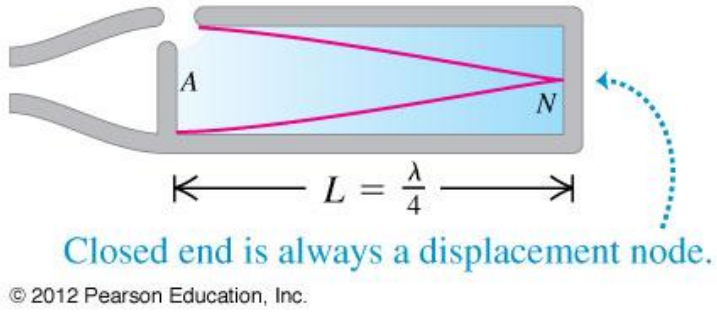
$$v = \lambda f$$

- There exist two cases for a standing sound wave to form in a tube:
  1. Tube with two open ends.
  2. Tube with one closed end and one open end.

1) Fundamental: $f_1 = \frac{v}{2L}$



2) Fundamental: $f_1 = \frac{v}{4L}$



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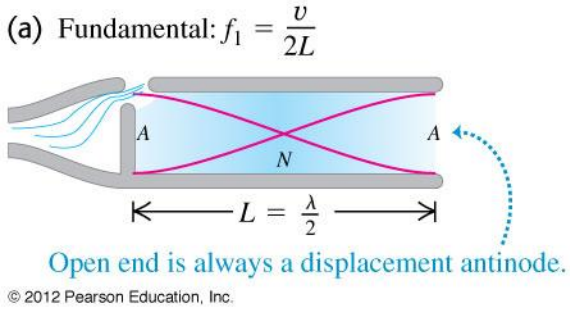
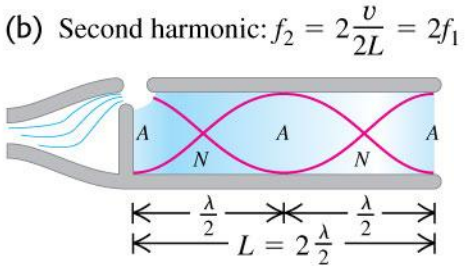
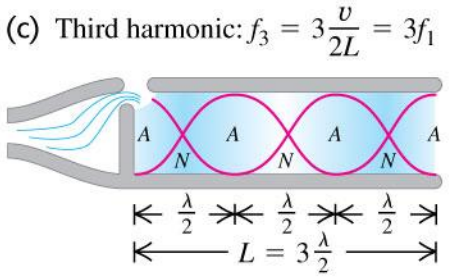
Fundamental Modes (1)

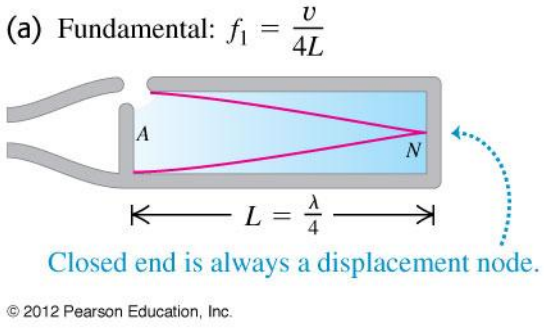
An Antinode always exists at a tube opening.

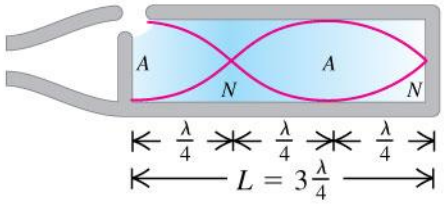


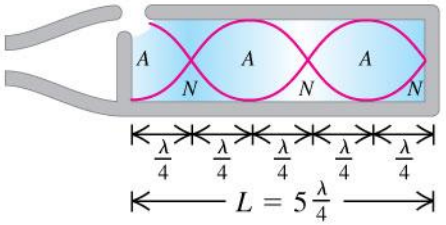




A closed end is always a Node.







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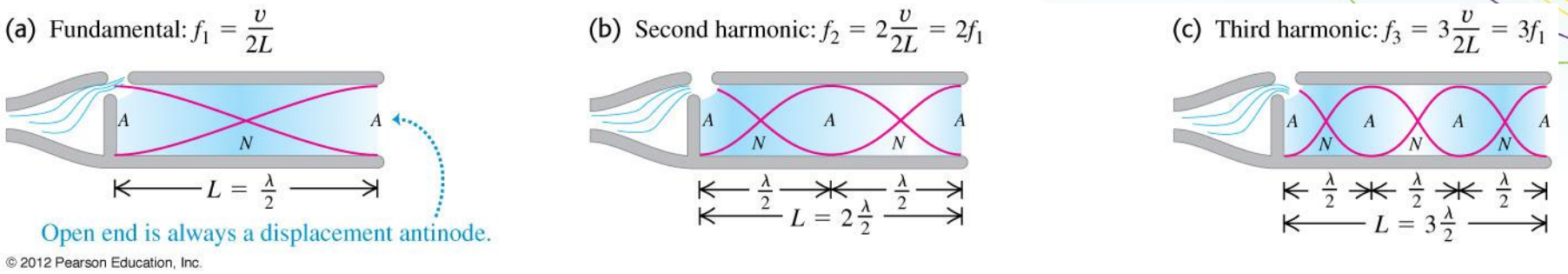
Fundamental Modes - Open Pipe



- From the above we can see that the frequency/wavelength for a pipe with two open ends is given for various modes by:

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

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

n = 1, 2, 3…

v is the speed of the wave.

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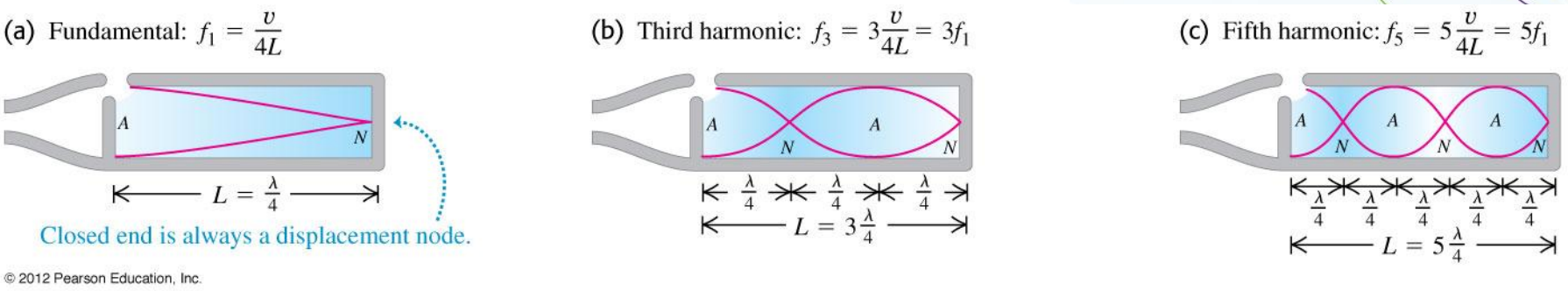
Fundamental Modes - Stopped Pipe



- For a stopped by, only odd modes can exist as stading waves.

$$\lambda_n = \frac{4L}{n}$$

$$f_n = \frac{nv}{4L}$$

n = 1, 3, 5…

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