Final

Physics 101: Lecture 21
Waves

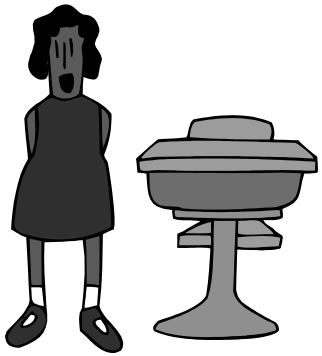
- Today's lecture will cover Textbook Chapter 11

Waves Overview

- Types

- Speed

- Harmonic
- Superposition
- Standing



Types of Waves

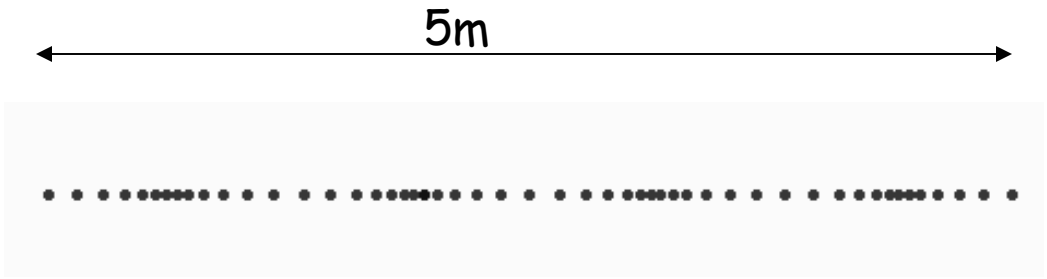
- **Transverse:** The medium oscillates perpendicular to the direction the wave is moving.
  - ➔Water (more or less)
  - ➔Slinky demo

- **Longitudinal:** The medium oscillates in the same direction as the wave is moving
  - ➔Sound
  - ➔Slinky demo

Longitudinal ACT

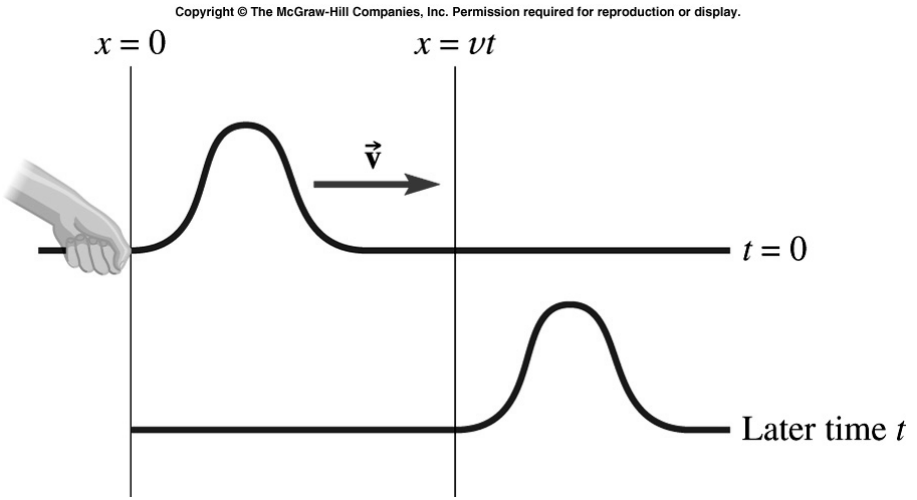
Suppose that a longitudinal wave moves along a Slinky at a speed of 5 m/s. Does one coil of the slinky move through a distance of five meters in one second?

1. Yes
2. No



Velocity of Waves Act

$$v = \sqrt{\frac{T}{m/L}} = \sqrt{\frac{T}{\mu}}$$



A spring and slinky are attached and stretched. Compare the speed of the wave pulse in the slinky with the speed of the wave pulse in the spring.

A) $v_{slinky} > v_{spring}$ B) $v_{slinky} = v_{spring}$ C) $v_{slinky} < v_{spring}$

Harmonic Waves

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

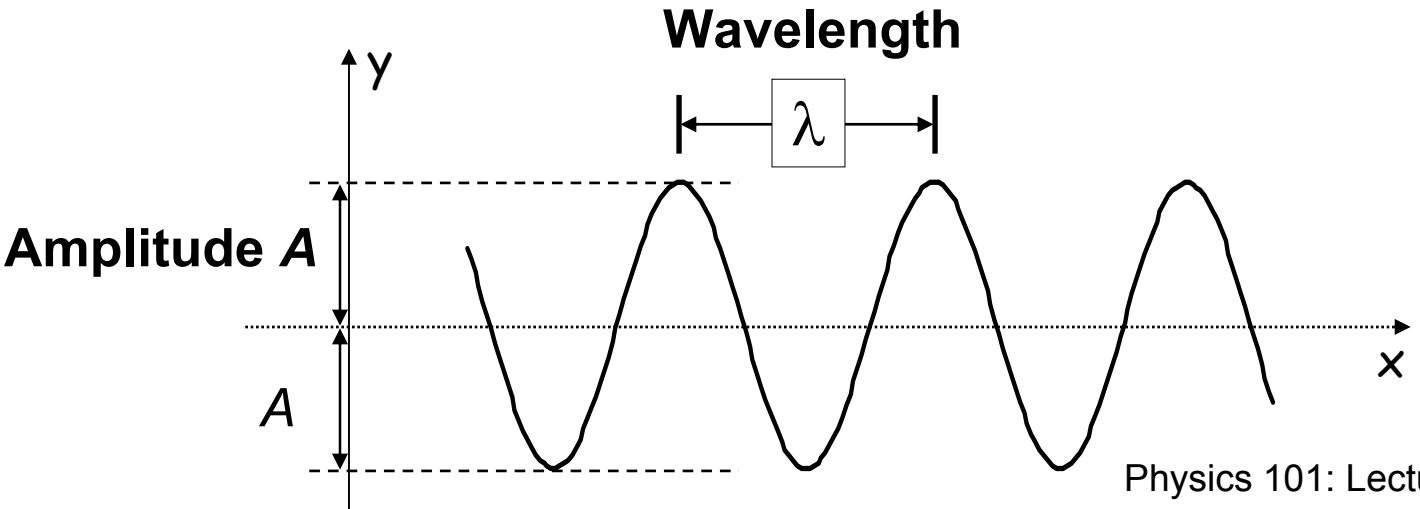
Wavelength: The distance λ between identical points on the wave.

Amplitude: The maximum displacement *A* of a point on the wave.

Angular Frequency ω: $\omega =$ _____

Wave Number k: k = _____

Recall: $f = v / \lambda$



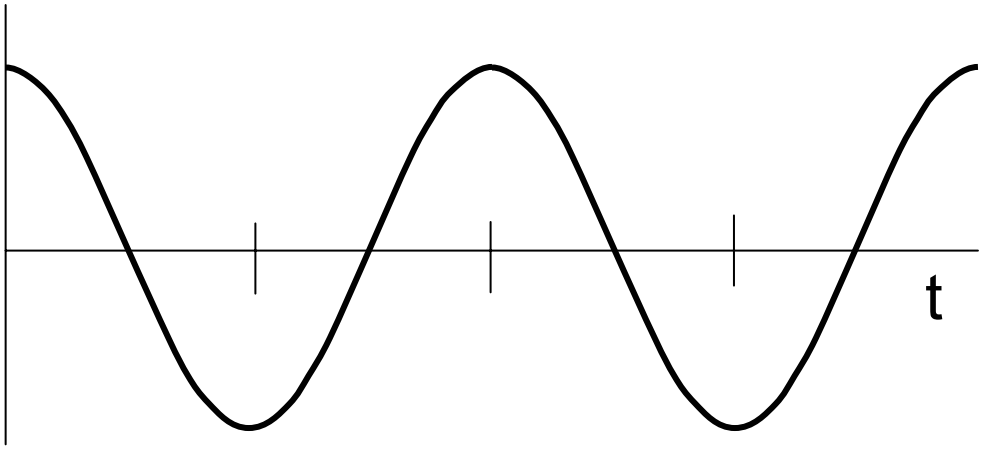
Harmonic Waves Exercise

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

Label axis and tic marks if the graph shows a snapshot of the wave

$y(x,t) = 2 \cos(4t - 2x)$ at $x=0$.

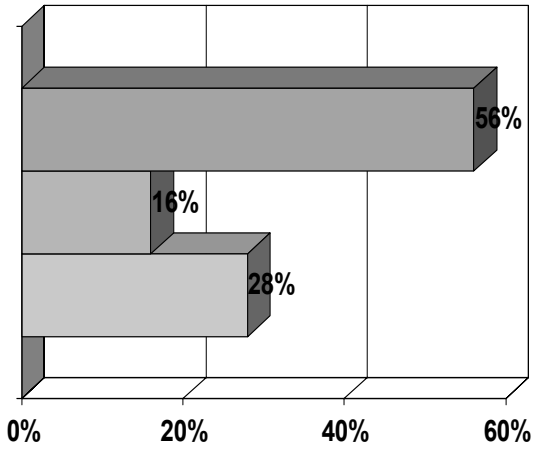
Recall: $T = 2\pi/\omega$



ACT

Suppose a periodic wave moves through some medium. If the period of the wave is increased, what happens to the wavelength of the wave assuming the speed of the wave remains the same?

1. The wavelength increases
2. The wavelength remains the same
3. The wavelength decreases



ACT

- The wavelength of microwaves generated by a microwave oven is about *3 cm*. At what frequency do these waves cause the water molecules in your burrito to vibrate ?

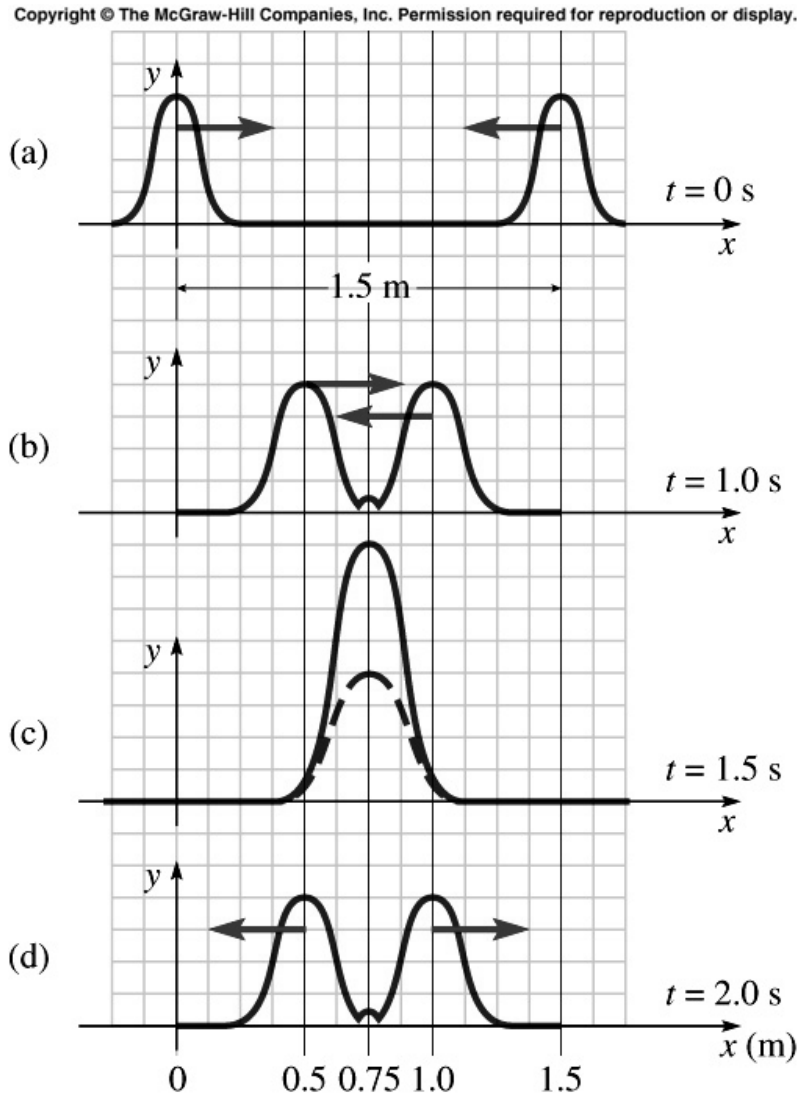
(a) *1 GHz* (b) *10 GHz* (c) *100 GHz*

1 GHz = 10^9 cycles/sec

The speed of light is $c = 3x10^8$ *m/s*

Interference and Superposition

- When too waves overlap, the amplitudes add.
  - ➔Constructive: increases amplitude
  - ➔Destructive: decreases amplitude



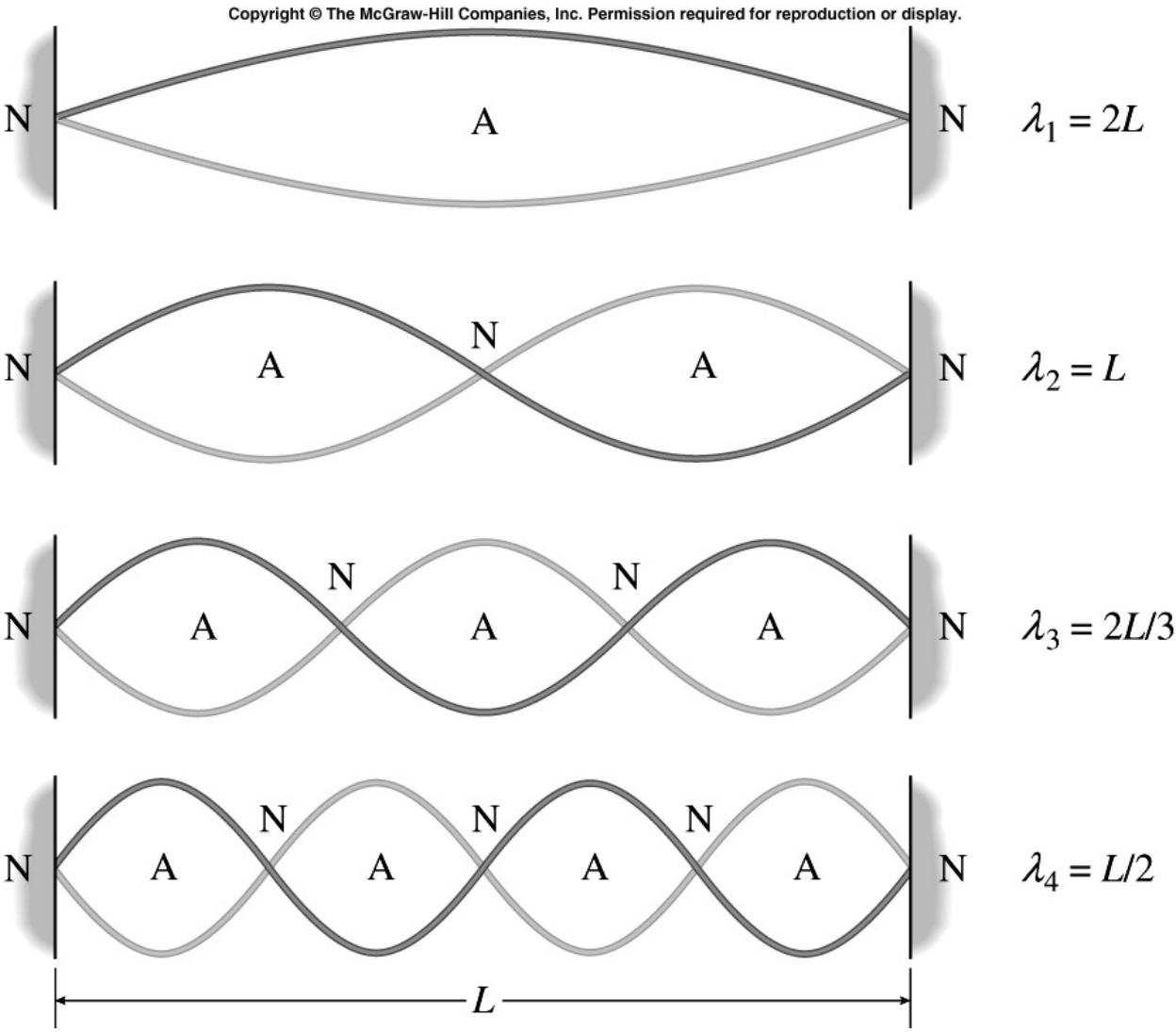
Reflection Act

- A slinky is connected to a wall at one end. A pulse travels to the right, hits the wall and is reflected back to the left. The reflected wave is

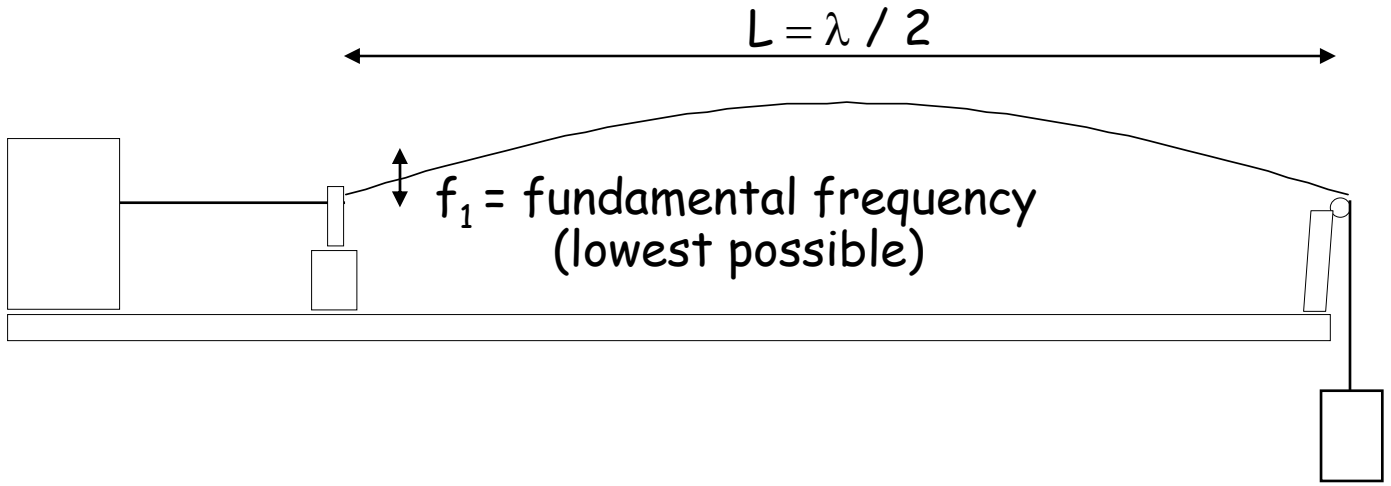
A) Inverted B) Upright

Standing Waves Fixed Endpoints

- Fundamental n=1
- $\lambda_n = 2L/n$
- $f_n = n\ v\ /\ (2L)$



Standing Waves:



A guitar's E-string has a length of 65 cm and is stretched to a tension of 82N. If it vibrates with a fundamental frequency of 329.63 Hz, what is the mass of the string?

$$v = \sqrt{\frac{F}{\mu}}$$

f = v / λ tells us f if we know v and λ

Summary

- Wave Types
  - ➔Transverse (eg pulse on string, water)
  - ➔ Longitudinal (sound, slinky)
- Harmonic
  - ➔$y(x,t) = A \cos(\omega t - kx)$ or $A \sin(\omega t - kx)$
- Superposition
  - ➔Just add amplitudes
- Reflection (fixed point inverts wave)
- Standing Waves (fixed ends)
  - ➔$\lambda_n = 2L/n$
  - ➔$f_n = n\, v / 2L$