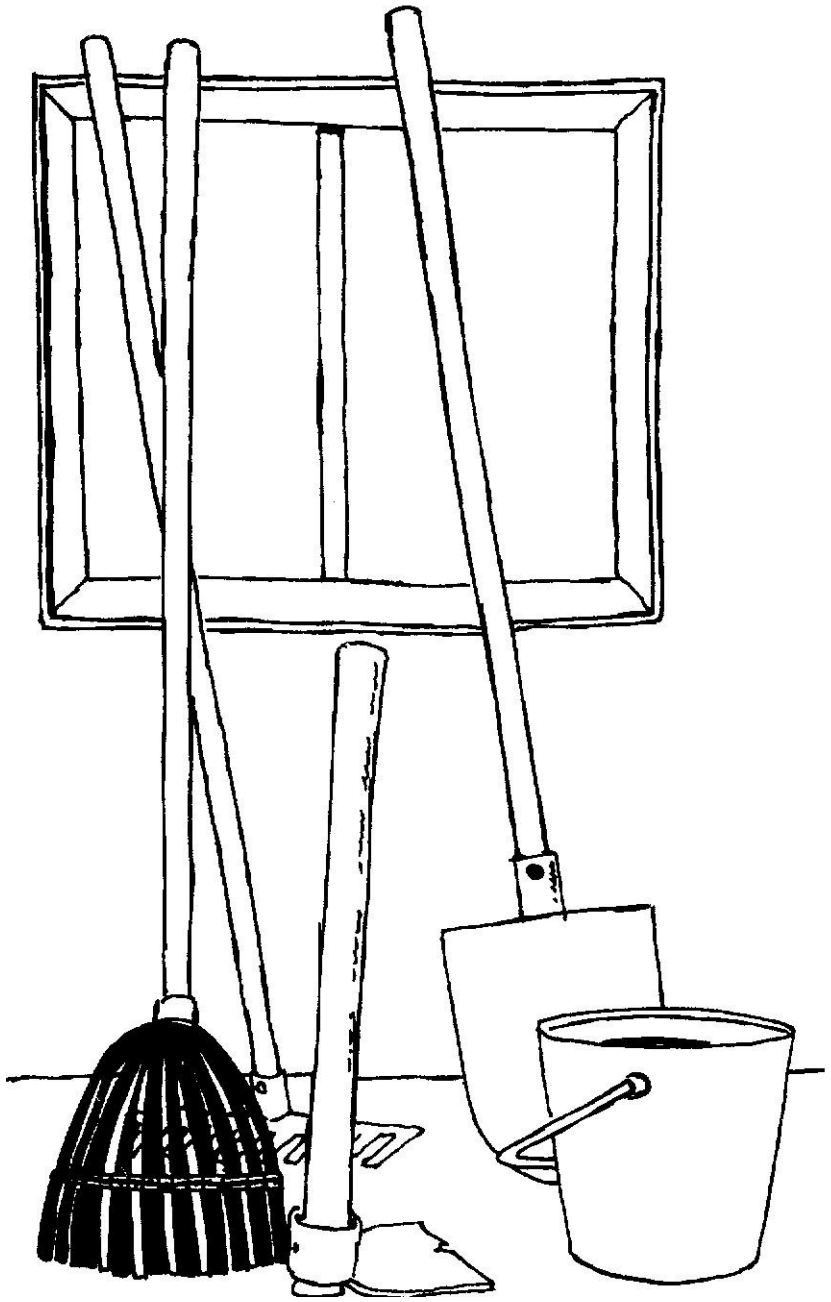
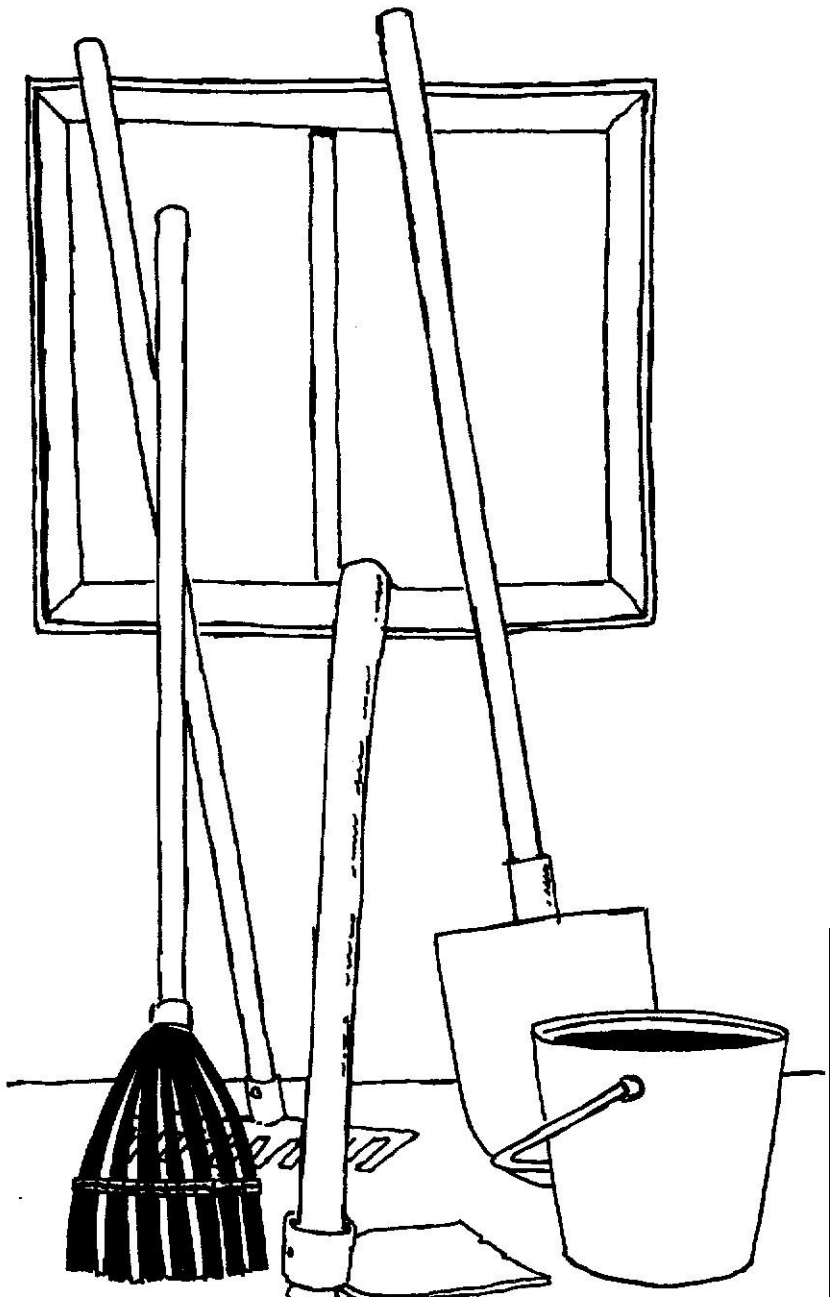
Day 3

WAVES (standing waves/wave machine)



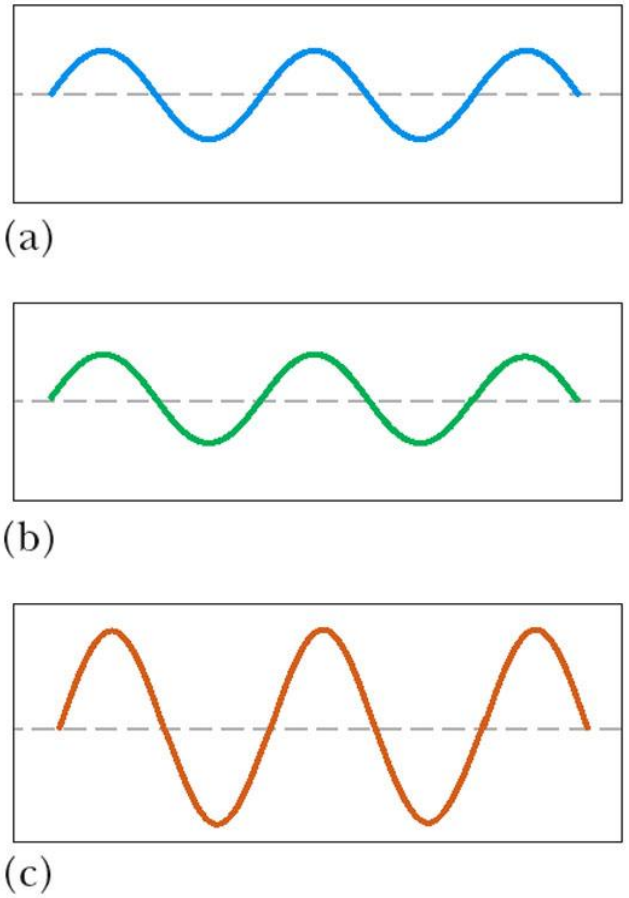


Interference of Waves

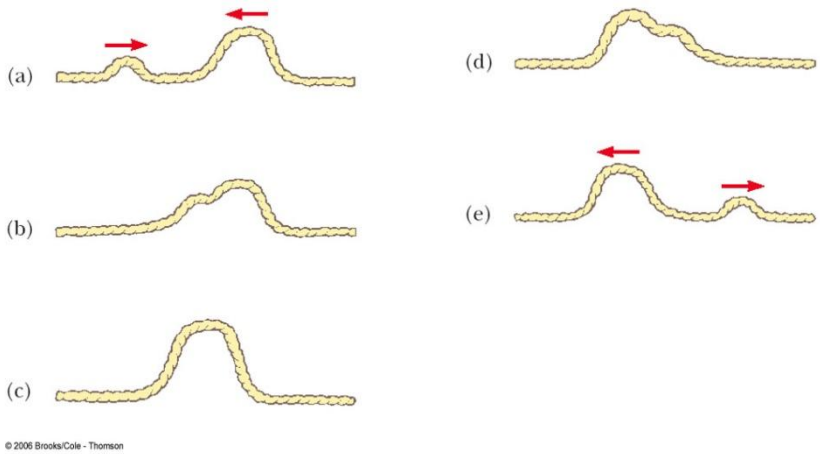
- Two traveling waves can meet and pass through each other without being destroyed or even altered
- Waves obey the *Superposition Principle*
  - If two or more traveling waves are moving through a medium, the resulting wave is found by adding together the displacements of the individual waves point by point
  - Actually only true for waves with small amplitudes

Constructive Interference

- Two waves, a and b, have the same frequency and amplitude
  - Are *in phase*
- The combined wave, c, has the same frequency and a greater amplitude



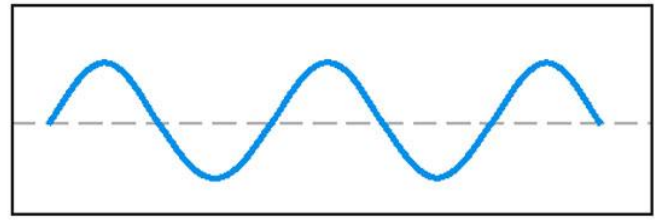
Constructive Interference in a String



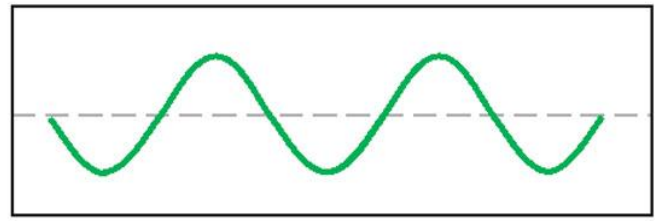
- Two pulses are traveling in opposite directions
- The net displacement when they overlap is the sum of the displacements of the pulses
- Note that the pulses are unchanged after the interference
- Put it in motion

Destructive Interference

- Two waves, a and b, have the same amplitude and frequency
- They are 180° out of phase
- When they combine, the waveforms cancel



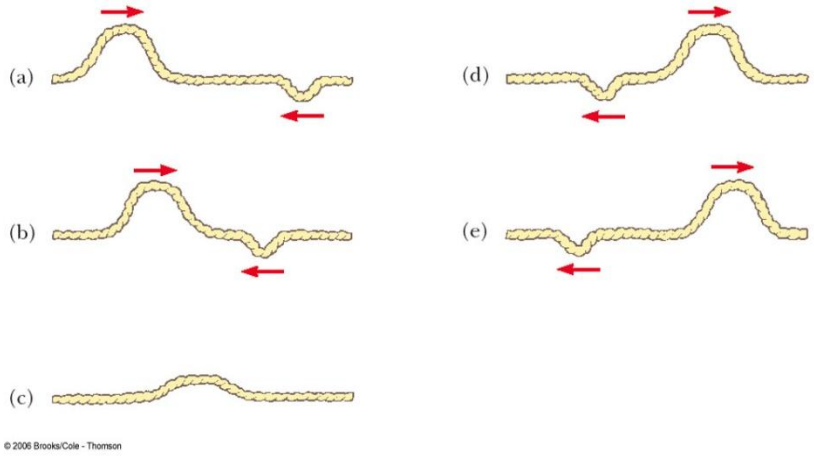
(a)



(b)

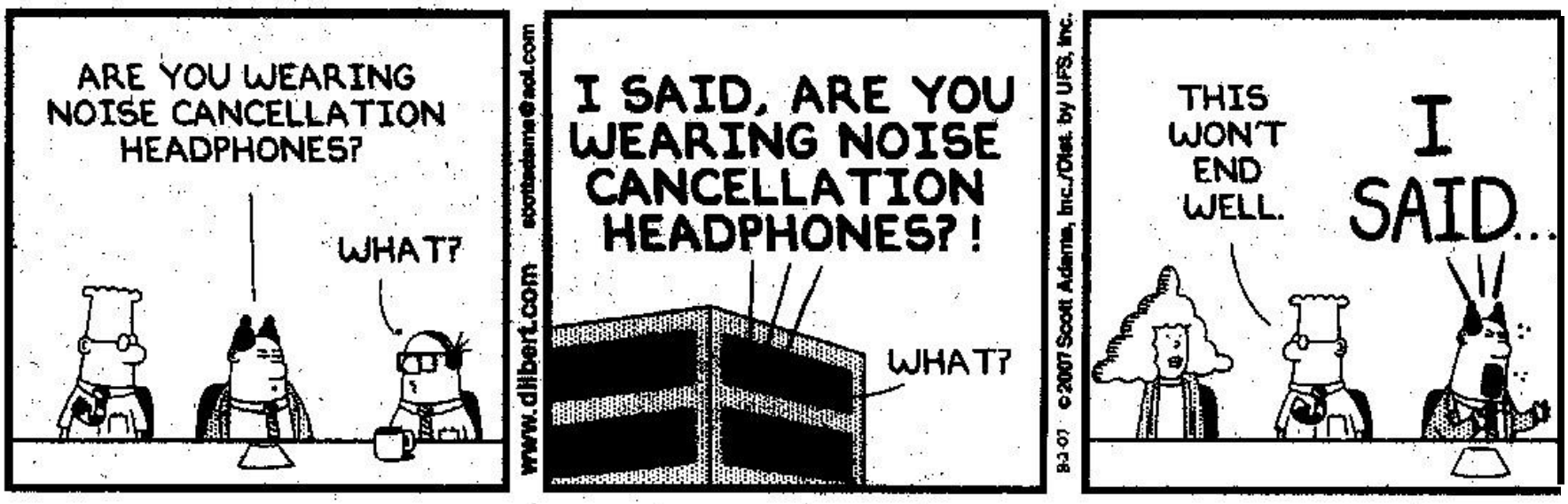
(c)

Destructive Interference in a String



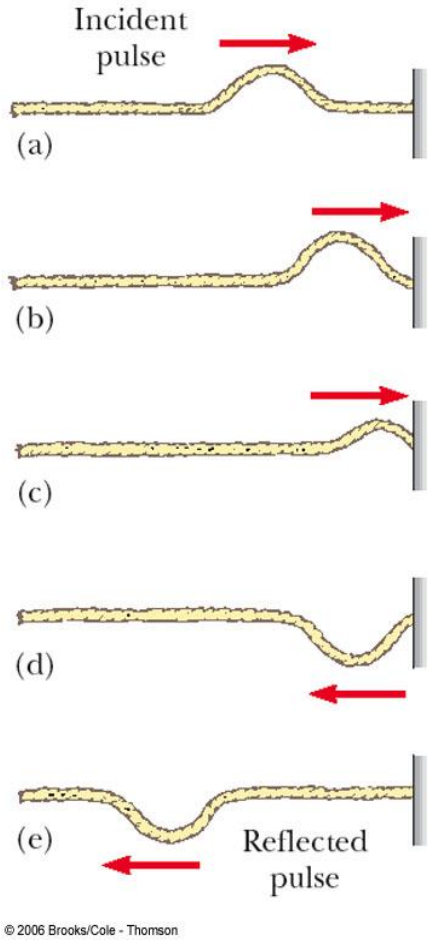
- Two pulses are traveling in opposite directions
- The net displacement when they overlap is decreased since the displacements of the pulses subtract
- Note that the pulses are unchanged after the interference
- In motion

Dilbert

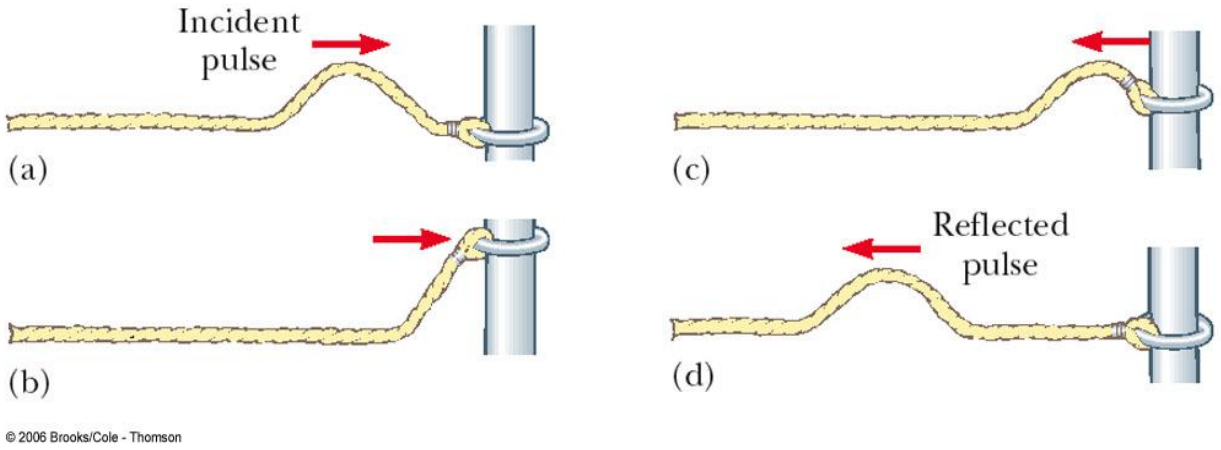

ARE YOU WEARING NOISE CANCELLATION HEADPHONES?
WHAT?
www.dilbert.com scottadams@aol.com
I SAID, ARE YOU WEARING NOISE CANCELLATION HEADPHONES?!
WHAT?
8-3-07 ©2007 Scott Adams, Inc./Dist. by UFS, Inc.
THIS WON'T END WELL.
I SAID...

Reflection of Waves – Fixed End

- Whenever a traveling wave reaches a boundary, some or all of the wave is reflected
- When it is reflected from a fixed end, the wave is inverted
- The shape remains the same
- example



Reflected Wave – Free End



- When a traveling wave reaches a boundary, all or part of it is reflected
- When reflected from a free end, the pulse is not inverted
- example

Waves

- Story

  Laser engraving table for Artec in our basement. Taking the wiggle out of the huge metal beam table by bracing and why bracing actually works.

Standing Waves/Wave Machine

- Wave Machine

1). Fixed end with alligator clip rod with larger rod machine.

(How does the wave reflect from a fixed end?) inverted or erect

2). Free end reflection: Unhook the alligator clip

(How does the wave reflect from free end?) inverted or erect

3). How could you remove some energy before reflecting?

4). Hook the two size rod wave machines together and fix at far end. (How do the speed of the wave in each machine compare?) (Note reflection and transmission at boundary. Note how much transmits)

5). How could one transmit more energy between different media? (Add device necessary to do this.)

Standing Waves/Wave Machine

- Wave Machine (cont.)

  6). Story of painting ceiling at 3M and loosing acoustics of room. Jail tutor room. Etc.

  7). Megaphone: Why it works! Use one.

Problem 52

- A series of pulses of amplitude 0.15 m is sent down a string that is attached to a post at one end. The pulses are reflected at the post and travel back along the string without loss of amplitude. What is the amplitude at a point on the string where two pulses are crossing (a) if the string is rigidly attached to the post? (b) if the end at which reflection occurs is free to slide up and down?

- If the end is fixed, there is inversion of the pulse upon reflection. Thus, when they meet, they cancel and the amplitude is

- If the end is free there is no inversion on reflection. When they meet the amplitude is

Problem 53

- A wave of amplitude 0.30 m interferes with a second wave of amplitude 0.20 m traveling in the same direction. What are (a) the largest and (b) the smallest resultant amplitudes that can occur, and under what conditions will these maxima and minima arise?

Constructive interference

- produces the maximum amplitude

$$A'_{max} = A_1 + A_2 = \boxed{0.50\ \text{m}}$$

Destructive interference

- produces the minimum amplitude

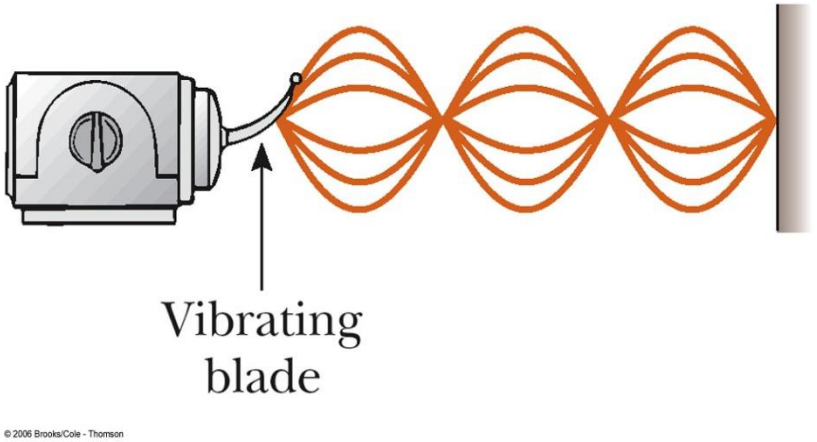
$$A'_{min} = A_1 - A_2 = \boxed{0.10\ \text{m}}$$

Standing Waves

- When a traveling wave reflects back on itself, it creates traveling waves in both directions
- The wave and its reflection interfere according to the superposition principle
- With exactly the right frequency, the wave will appear to stand still
  - This is called a *standing wave*

Standing Waves, cont

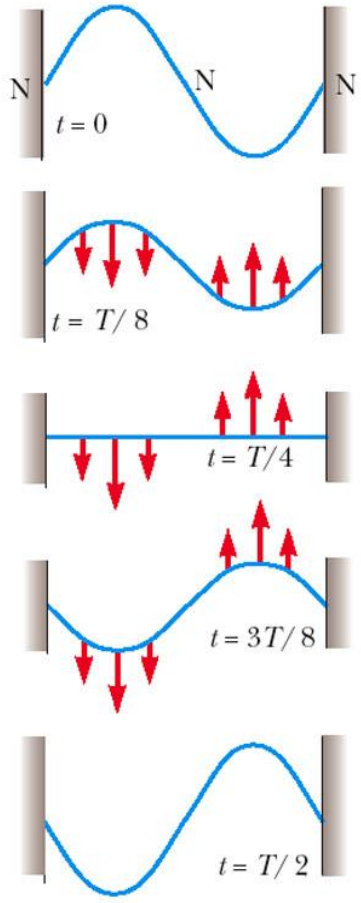
- A *node* occu waves have the same m ut the displacemer s
  - Net displa
  - The distan



- An *antinode* occurs where the standing wave vibrates at maximum amplitude

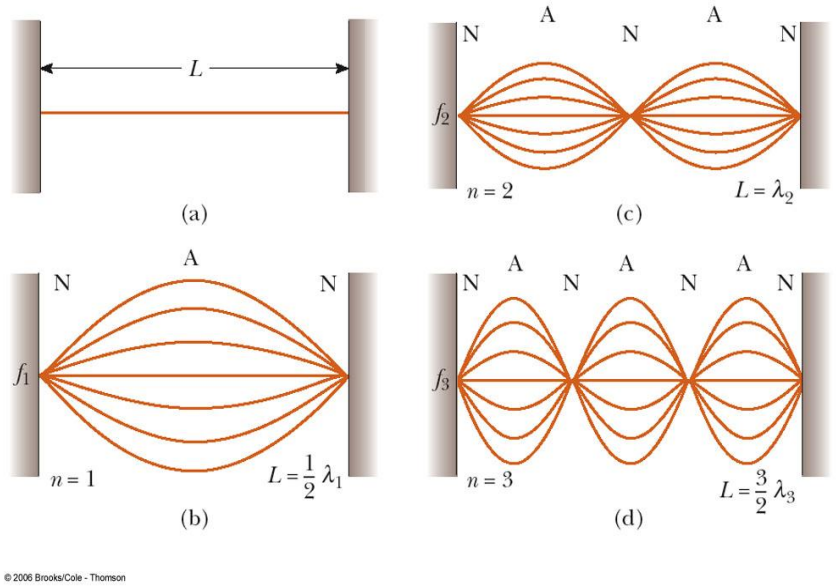
Standing Waves, cont.

- The pink arrows indicate the direction of motion of the parts of the string
- All points on the string oscillate together vertically with the same frequency, but different points have different amplitudes of motion



Standing Waves on a String, final

- The lowest frequency of vibration (b) is called the *fundamental frequency*



Standing Waves/Wave Machine

- http://phet.colorado.edu/sims/wave-on-a-string/wave-on-a-string_en.html

Wave Interference

- If time permits.
- http://phet.colorado.edu/en/simulation/wave-interference
- The end