PHY138 – Waves, Lecture 5

Today's overview

- The Principle of Superposition
- Standing Waves
- The Guitar: Stringed Instruments
- The Trumpet: Wind Instruments

Message from Dr. Savaria….

- If you have a conflict at 6:00-7:30 PM on Dec.5 and wish to write Test 2 at an alternate time:
  - Send an email to phy138y@physics.utoronto.ca confirming that you wish to re-register, if you registered for the alternate sitting of Test 1.

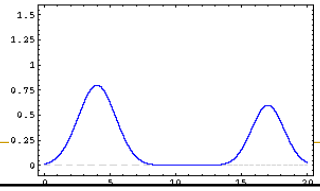
  or
  - Visit April Seeley in MP129 or MP302 to register for the first time you will write in an alternate time.
- The deadline for confirming / registering is Nov.27 by 5:00PM.

Reading Assignment

- This week's reading assignment from the text by Knight is: **Chapter 21**, Sections 21.1-21.8
- Suggested Chapter 21 Exercises and Problems for Practice: 7, 19, 25, 31, 49, 65, 71, 83 (skip part b – just use result)
- Waves Quarter **Written Team Problem Set** is due Friday by 5:00 PM in T.A. drop box. – You must work in the teams assigned to you in tutorial.

Chapter 21: Principle of Superposition

- If two or more waves combine at a given point, the resulting disturbance is the *sum* of the disturbances of the individual waves.
- Two traveling waves can pass through each other without being destroyed or even altered!



Some *Results* of Superposition:

- 21.2-21.4: Two waves, same wavelength and frequency, opposite direction:

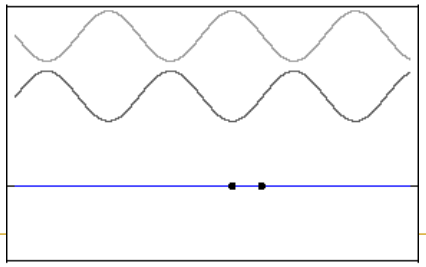
  Standing Wave
- 21.5-21.7: Two waves, same wavelength and frequency, similar direction, different phase:

  Interference
- 21.8: Two waves, same direction, slightly different frequency and wavelength:

  Beats!

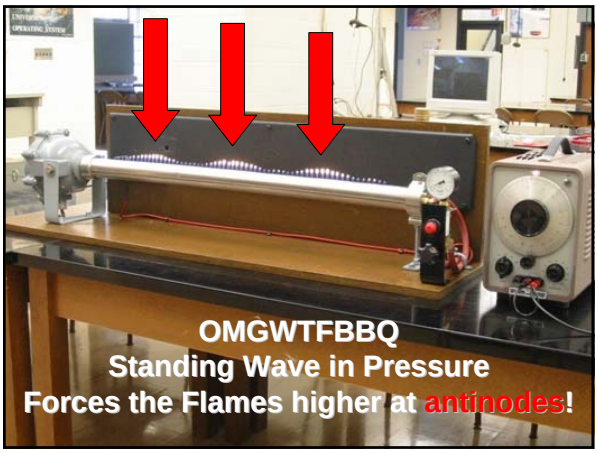
Standing Wave:

The superposition of two 1-D sinusoidal waves traveling in opposite directions.



Standing Waves

- Are a form of “resonance”
- There are multiple resonant frequencies called harmonics
- The boundary conditions and speed of waves determine which frequencies are allowed.
- The ends of the resonant cavity have forced nodes or antinodes
- With a wave on a string, it is possible to force an intermediate node



Harmonic frequencies

Transverse standing wave on a string clamped at both ends: there are nodes in displacement at both ends.

$$f_m = m\frac{v}{2L} \qquad (m = 1,2,3,...)$$

Standing sound wave in a tube open at both ends: there are nodes in pressure both ends.

$$f_m = m\frac{v}{2L} \qquad (m = 1,2,3,...)$$

Harmonic frequencies

Standing sound wave in a tube closed at one end: there is a node in pressure at the open end, and an anti-node at the closed end.

$$f_m = m\frac{v}{4L} \qquad (m = 1,3,5,...)$$