

Physics 1408-002 Principles of Physics

Lecture 25
– Chapter 15 & 16 –
April 21, 2009

Sung-Won Lee
Sungwon.Lee@ttu.edu

Announcement I

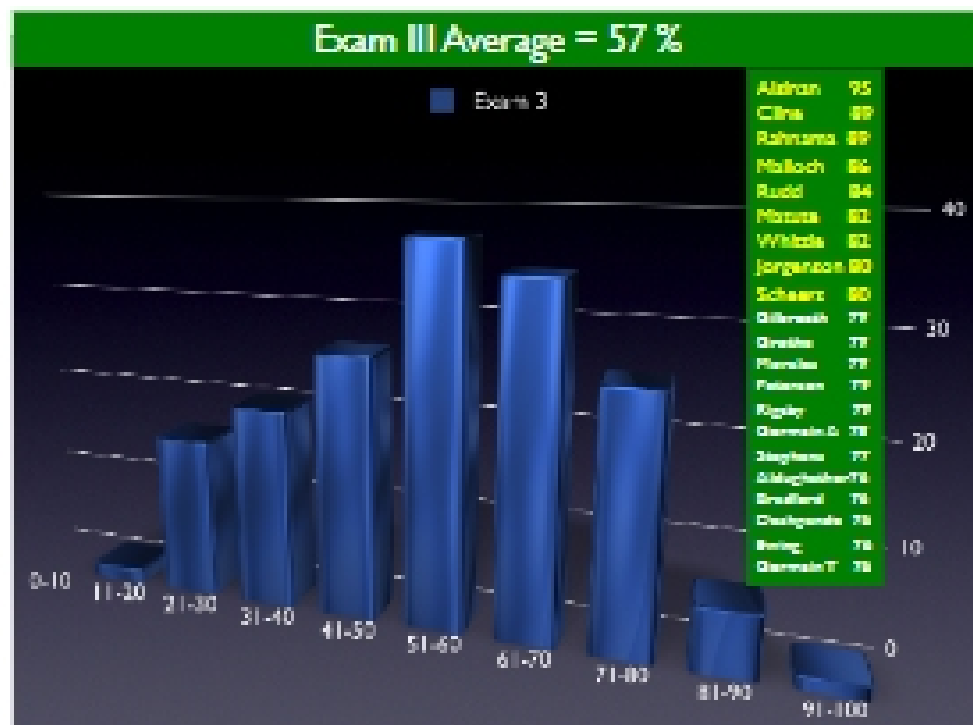
Lecture note is on the web

Handout (6 slides/page)

<http://highenergy.phys.ttu.edu/~slee/1408/>

*** Class attendance is strongly encouraged and will be taken randomly. Also it will be used for extra credits.

HW Assignment #10 (Ch. 14,15,16) is placed on MateringPHYSICS, and is due by 11:59pm on Wednesday, 4/29



Announcements II

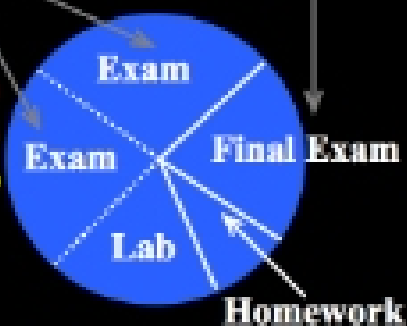
**Final Exam
(All Chapters)
4/30 Thursday @ Sci 7**

**7:30 am – 10:00 am
2.5 hours**

Grades

- The lowest exam grade (not the final) will be dropped since there are no makeup exams.
- Lab & Homework 25%, each exam 25%, and the final will count 25% towards your final course grade.

- Lab, Homework 25%
- 2(out of 3) in class exams 50%
- Final Exam 25%



- The grading scale is A=100-90%, B=89-80%, C=79-65% and D=64-50%, F=49 to 0.

8

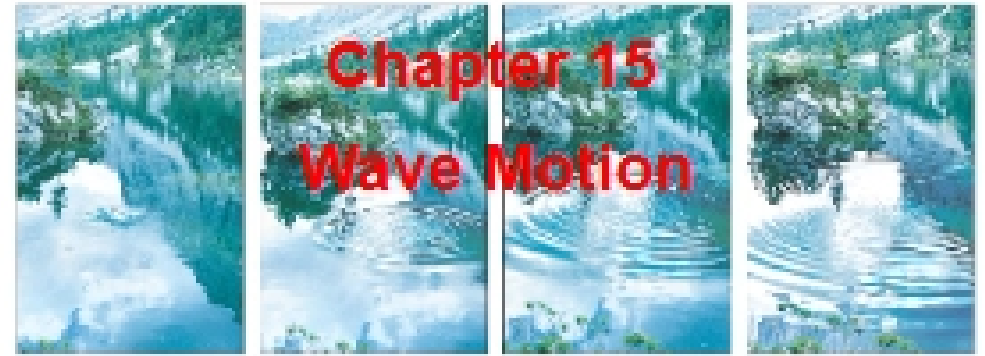
Exams - Overview

- The exams are closed book. You may bring **one hand-written 3" x 5" index card** with formulae, etc. Telephones, iPod and other gizmos are not allowed. Small **calculators are allowed**.
- The final exam is **comprehensive (3~5 min problems)** and is a common exam for all sections (~Total 20~25 problems: i.e. 1~2 / chapter) – YES, it's a **multiple choice** exam!!
- Please bring a **scantron sheet (orange)** for the exam!!

Announcement III

SI session by
Reginald Tuvilla

Next week, final exam review will be on
Monday 04/06 from 4:30 - 7:30.
(Room: HH 28)

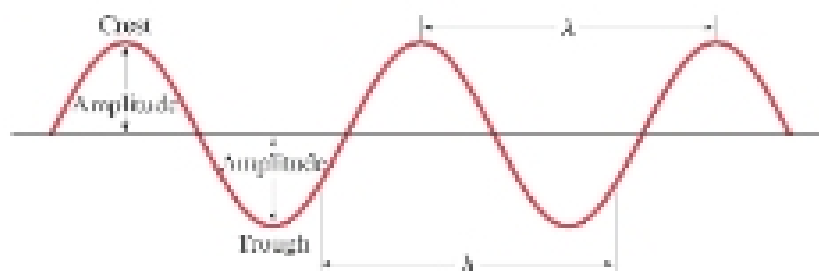


- Characteristics & Types of Wave Motion
- Energy Transported by Waves
- Mathematical Representation of a Traveling Wave
- The Principle of Superposition, Reflection and Transmission
- Interference & Standing Waves

15-1 Characteristics of Wave Motion

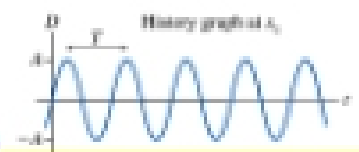
Characteristics of continuous wave moving through space:

- Amplitude, A
- Wavelength, λ
- Frequency, f and period, T
- Wave velocity, $v = \lambda f$



Wave Equations

$$D(x, t) = A \sin \left[2\pi \left(\frac{x}{\lambda} - \frac{t}{T} \right) + \phi_0 \right]$$



$$\omega = 2\pi f = \frac{2\pi}{T} = \text{angular frequency (rad/s)}$$

$$k \equiv \frac{2\pi}{\lambda} = \text{wave number (rad/m)}$$

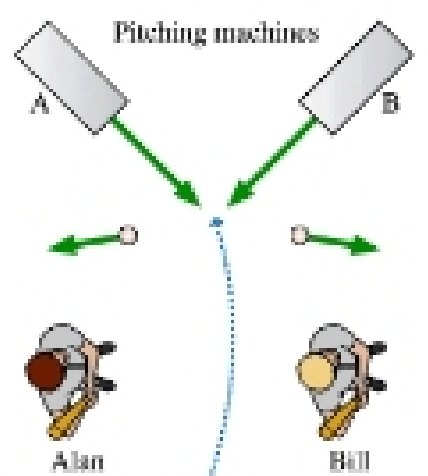
$$v = \lambda f = \left(\frac{2\pi}{k} \right) \left(\frac{\omega}{2\pi} \right) = \omega / k \text{ or } \omega = vk$$

If x is fixed, $D(x_0, t) = A \sin (\omega t_0 - \omega t + \phi)$ gives a sinusoidal history graph at one point in space, x_0 . It repeats every T .

$$D(x, t) = A \sin [kx - \omega t + \phi_0]$$

Note that: $D(0, 0) = A \sin \phi_0$

Waves vs. Particles

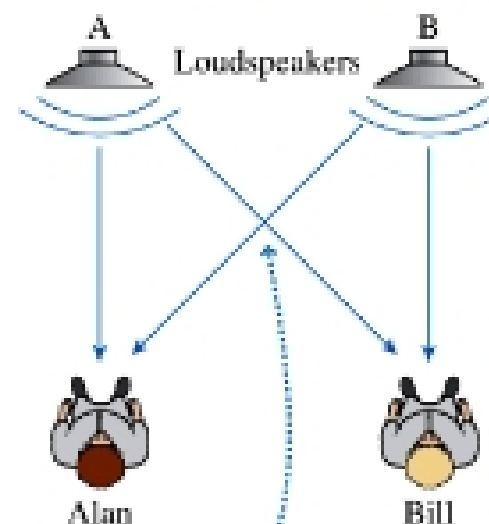


If two pitching machines simultaneously throw baseballs, they will collide and bounce.

Two particles **cannot** occupy the same space point at the same time.

The balls collide and bounce apart.
Two particles cannot occupy the same point of space at the same time.

Waves vs. Particles



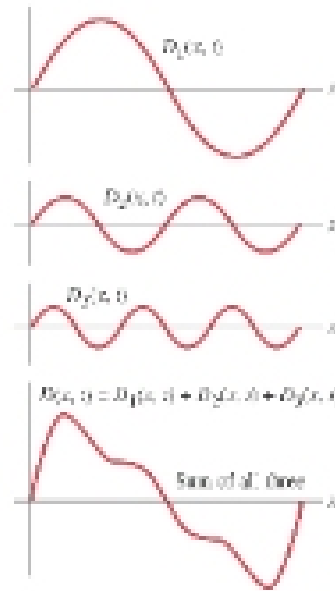
On the other hand, if two loud speakers make sound waves at the same time, they will pass through each other w/o collision.

Two waves **can** occupy the same space point at the same time.

The waves pass through each other.

15-6 The Principle of Superposition

- If two or more traveling waves are moving through a medium, the resultant wave function is the algebraic sum of the wave functions of the individual waves



Superposition of Sinusoidal Waves

- Assume two waves are traveling in the same direction, with the same frequency, wavelength and amplitude

- The waves differ in phase

$$y_1 = A \sin(kx - \omega t)$$

$$y_2 = A \sin(kx - \omega t + \phi)$$

$$y = y_1 + y_2$$

$$= 2A \cos(\phi/2) \sin(kx - \omega t + \phi/2)$$

amplitude

How?
see next page

A Useful Trigonometric Identity

$$\sin a + \sin b = 2 \cos((a-b)/2) \sin((a+b)/2)$$

$$y_1 = A \sin(kx - \omega t) \quad y_2 = A \sin(kx - \omega t + \phi)$$

$$a = kx - \omega t$$

$$b = kx - \omega t + \phi$$

$$y = y_1 + y_2$$

$$= 2A \cos(\phi/2) \sin(kx - \omega t + \phi/2)$$

amplitude

Superposition Example

- Two pulses are traveling in opposite directions; (a). The pulses have the same speed but different shapes



- When the waves start to overlap (b), the resultant wave function is $y_1 + y_2$
- When crest meets crest (c) the resultant wave has a larger amplitude than either of the original waves

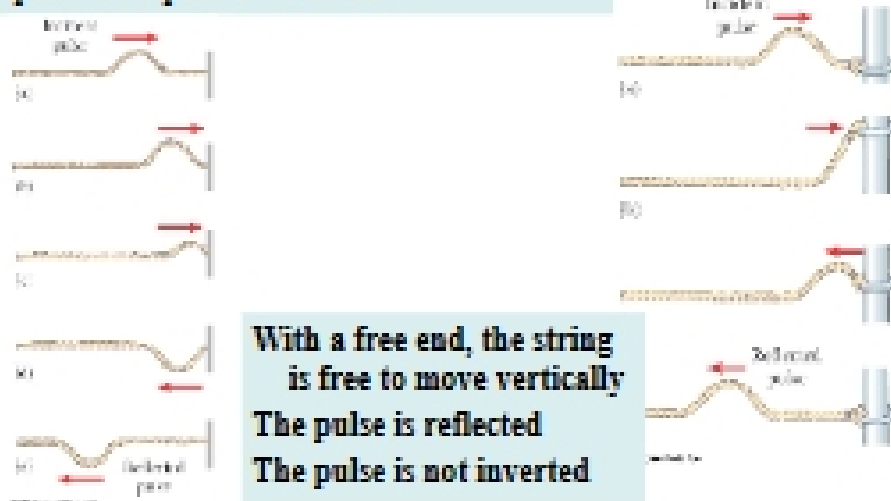


- The two pulses separate. They continue moving in their original directions. The shapes of the pulses remain unchanged; (d)



15-7 Reflection and Transmission

When the pulse reaches the support, the pulse moves back along the string in the opposite direction. This is the **reflection** of the pulse. The pulse is inverted



With a free end, the string is free to move vertically
The pulse is reflected
The pulse is not inverted

15-7 Reflection and Transmission

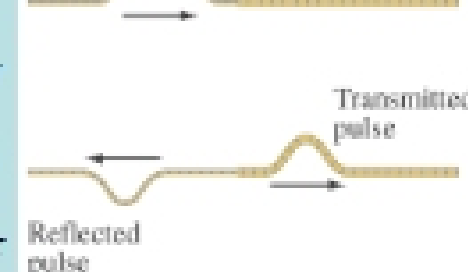
- Assume a light string is attached to a heavier string (see Fig.)



- Pulse travels through the light string and reaches the boundary

- The part of the pulse is inverted

- The reflected pulse has a smaller amplitude



A wave encountering a denser medium will be partly reflected and partly **transmitted**; if the wave speed is less in the denser medium, the wavelength will be shorter.