Physics 201 – Lecture 1

Agenda:

- Course structure
- Course scope
- Ch. 1, Measurement

Course Homepage:
http://www.physics.wisc.edu/undergrads/courses/spring2012/201

Grading

- Homework Sets (12%), www.webassign.net (10-15 problems per week), expect to spend 6 to 10 hrs/week total), typically due 9 AM Thursdays
  HW1: Due Thurs. 2/2 at 9 AM (10%-50% off up to four days late)
- Exams:
  Three evening midterms (16%) and a final (24%)
  No make up (one or two early times; if a valid academic reason)
- Discussion section (6%)
  - Primarily participation/attendance based
- Labs (9%) Required
  - Generally: 1 absence, drop ½ grade, 2 absences drop 1 full grade, more…fail (Rare: Miss one lab with valid excuse)
- Lecture (Spot reading quizzes 1%)

Structure

- Lectures (2 per week) Tu, Th, 1:20-2:15 pm
  - Text: Serway & Jewitt, Physics for Scientists and Engineers, 8th Ed.
  - Reading Assignments (due BEFORE class)
  - For Thursday Jan 26th: Chapters 1 & 2.1-4

Structure, cont’d

- Labs
  - Rm. 4314 Chamberlin Hall, begin on Monday Jan. 30th
  - Lab notebook (TAs will provide more info)
- Honors students: E-mail later in the week
- Discussion Sections: Start Thursday
  - Thursday/Friday: centers on cooperative learning exercises
  - Tuesday/Wednesday: homework & class business
  - Remember that your TAs have other obligations
  - (They are NOT 24/7 tech support)
- Drop in tutoring: In room 2131 Chamberlain (shared with Physics 207)

Supplemental Instruction Program (SI)

- SI is an engineering supported program offering supplementary instruction to reinforce concepts, bridge gaps between teaching and learning.
- There will be meetings twice every week for 60 minutes per meeting, group discussions are facilitated by upper class engineering students.
- Our Physics 201 SI facilitator is Kevin Maddocks, he will be available after lecture to answer your questions about the SI.
  - http://studentservices.engr.wisc.edu/classes/tutoring/InterEGR150-SISchedule/

Lecture

- Three main components:
  - Discussion class material
    - Selected topics from text
  - Demonstrations of physical phenomenon
    - Physics is an experimental science
    - Example: Ping-pong ball bazooka
Lecture

Interactive exercises centered on conceptual “Active Learning” problems
- Critical thinking and problem solving
(physics requires very little memorization)

Understanding physics is more than rote or “appreciation”. You need to apply yourself.


A quick “quiz” on what not to do…

1. Please read and study the following paragraph for a minute or so.

”Last Fernday, George and Tony were in Donlon peppering gloopy samples and cleaning, burly greps. Suddenly, a ditty strezzle boofed into George’s grep. Tony blaired, “Oh George, that ditty strezzle is boofing your grep!“.

2. After reading and studying the paragraph, and without referring to the paragraph, please answer the following questions:

1. When were George and Tony in Donlon?
2. What did the ditty strezzle do to George’s grep?
3. What kind of samples did George and Tony pepper?
4. What was Tony’s reaction?
5. What do you imagine happened next?
6. Based on the incidents in this story, do you think George and Tony will want to return to Donlon? Why or why not?

So, do you think you did well on the quiz?
What do you think you actually “learned”?

Course Objectives

1. To begin to understand basic principles (e.g. Newton’s Laws) and their consequences (e.g. conservation of momentum, etc.)
2. To solve problems using both quantitative and qualitative applications of these physical principles
3. To develop an intuition of the physical world

Scope

1. Classical Mechanics:
   - Mechanics: How and why things work.
   - Motion (dynamics), balance (statics), energy, vibrations
   - Classical:
     - Not too fast (v << c), c = speed of light
     - Not too small (d >> atom), atoms ≅ 10⁻⁹ m
2. Most everyday situations can be described in these terms.
   - Path of baseball (or a ping pong ball)
   - Path of rubber ball bouncing against a wall
   - A clock pendulum
   (These reflect Newton’s Laws and forces)
Chapter 1

Position (where), Time (when) & Mass (how much)

- Time, Length, Mass are fundamental units from which other quantities are defined.
  - Time: time it takes for an electron in an atom to oscillate.
  - Length: how far light travels in vacuum for a specified time.
  - Mass: a block of Pt/Ir in France (not good...)

- Systems of units

- Relationships of M L T

- Dimensional Analysis

- Significant digits (home or discussion)

- Order of Magnitude calculations

Units

- SI (Système International) Units:
  - mks: L = meters (m), M = kilograms (kg), T = seconds (s)

- British Units:
  - L = inches, feet, miles, M = slugs (pounds is a unit of force), T = seconds

- We will use mostly SI units, but you may run across some problems using British units. You should know how to convert back & forth.

- Ask yourself, why do units matter?

Some Prefixes for Power of Ten

<table>
<thead>
<tr>
<th>Power</th>
<th>Prefix</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>10⁻¹²</td>
<td>pico</td>
<td>p</td>
</tr>
<tr>
<td>10⁻⁹</td>
<td>nano</td>
<td>n</td>
</tr>
<tr>
<td>10⁻⁶</td>
<td>micro</td>
<td>µ</td>
</tr>
<tr>
<td>10⁻³</td>
<td>milli</td>
<td>m</td>
</tr>
<tr>
<td>10⁻¹</td>
<td>kilo</td>
<td>k</td>
</tr>
<tr>
<td>10¹</td>
<td>mega</td>
<td>M</td>
</tr>
<tr>
<td>10⁶</td>
<td>giga</td>
<td>G</td>
</tr>
<tr>
<td>10¹²</td>
<td>tera</td>
<td>T</td>
</tr>
<tr>
<td>10¹⁵</td>
<td>peta</td>
<td>P</td>
</tr>
<tr>
<td>10¹⁸</td>
<td>exa</td>
<td>E</td>
</tr>
</tbody>
</table>

Converting between different systems of units

- 1 inch = 2.54 cm
  - 1 inch / 2.54 cm = 1

- 1 m = 3.28 ft
  - 1 m / 3.28 ft = 1

- 1 mile = 5280 ft
  - 5280 ft / 1 mile = 1

- 1 hr = 60 min = 3600 s
  - 1 hr / 3600 s = 1

- Example: Convert miles per hour to meters per second:

  \[
  \frac{1 \text{ mi}}{1 \text{ hr}} = \frac{1 \text{ mi}}{1 \text{ hr}} \times \frac{1 \times 1 \times 1}{5280 \text{ ft}} \times \frac{1 \text{ mi}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{3600 \text{ s}} = 0.447 \text{ m/s} = \frac{1 \text{ m}}{2 \text{ s}}
  \]

Home Exercise 1

Converting between different systems of units

- When on travel in Europe you rent a small car which consumes 6 liters of gasoline per 100 km. What is the MPG of the car?
  - (There are 3.8 liters per gallon.)

  \[
  \frac{100 \text{ km}}{6 \text{ l}} \times \frac{1 \text{ mi}}{1.6 \text{ km}} \times \frac{3.8 \text{ l}}{\text{ gal}} = 39.6 \text{ mi/gal} = 40 \text{ mi/gal}
  \]

M L T relationships

- Some examples
  - Density has the quantity of M/L³
  - Speed has the quantity of L/T (i.e. miles per hour)
  - Acceleration has the quantity of L/T²
  - Force has the quantity of M L/T²

Question:

Can the left hand side of an expression A = B have different units than the right hand side?
Dimensional Analysis (reality check)

- This is a very important tool to check your work
- Provides a reality check (if dimensional analysis fails then there is no sense in putting in numbers)

Example
- When working a problem you get an expression for distance
  \[ d = v t^2 \] (velocity \cdot time)²

Quantity on left side: \( d \) □ \( L \) □ length (also \( T \) □ time and \( v \) □ \( m/s \) □ \( L / T \))

Quantity on right side: \( L / T \) \( \times \) \( T \)² = \( L \times T \)

Left units and right units don’t match, so answer is nonsense

Exercise 1

Dimensional Analysis

The force (F) to keep an object moving in a circle can be described in terms of:
- velocity (\( v \), dimension \( L / T \)) of the object
- mass (\( m \), dimension \( M \))
- radius of the circle (\( R \), dimension \( L \))

Which of the following formulas for \( F \) could be correct?

Note: Force has dimensions of \( ML/T^2 \) or \( kg\cdot m/s^2 \)

(a) \( F = mvR \)
(b) \( F = m \left( \frac{v}{R} \right)^2 \)
(c) \( F = \frac{mv^2}{R} \)

Significant Figures

- The number of digits that have merit in a measurement or calculation.
- When writing a number, all non-zero digits are significant.
- Zeros may or may not be significant:
  - those used to position the decimal point are not significant (unless followed by a decimal point)
  - those used to position powers of ten ordinals may or may not be significant.
- In scientific notation all digits are significant
- Examples:
  - 2 1 sig fig
  - 40 ambiguous, could be 1 or 2 sig figs
  - (use scientific notations)
  - \( 4.0 \times 10^3 \) 2 significant figures
  - 0.0031 2 significant figures
  - 3.03 3 significant figures

Order of Magnitude Calculations / Estimates

Question: If you were to eat one french fry per second, estimate how many years would it take you to eat a linear chain of trans-fat free french fries, placed end to end, that reach from the Earth to the moon?

- Need to know something from your experience:
  - Average length of french fry: 3 inches or 8 cm, 0.08 m
  - Earth to moon distance: 250,000 miles
  - In meters: \( 2.5 \times 10^8 \) mi \( \times \) \( 1.6 \times 10^3 \) m/mi = \( 4 \times 10^8 \) m
  - 1 yr \( \times \) \( 365 \) d/yr \( \times \) \( 24 \) hr/d \( \times \) \( 60 \) min/hr \( \times \) \( 60 \) s/min = \( 3 \times 10^7 \) sec

\[ \text{fries} = \frac{4 \times 10^8 \text{m}}{8 \times 10^{-10} \text{m}} = 0.5 \times 10^{10} \text{ (french fries to the moon)} \]

\[ 0.5 \times 10^{10} \text{ sec.} = \frac{5 \times 10^7 \text{s}}{3 \times 10^9 \text{s/yr}} = 200 \text{ years} \]
Recap

1. For Thursday's class
   - Read Chapters 1 & 2 (through section 2.4)