Welcome to Physics 207
Lecture 01: Course Overview, recap of Units

I did not do very well in Physics in high school and honestly am very, very afraid of this class. I can do chemistry and biology but really have no idea what on earth I am getting myself into here. I don’t want this class to screw up my GPA.

"I’m really scared"

"I am very worried about doing poorly in this class.

My fear is falling behind

I have never been in a physics class before (even in high-school), so I’m a little nervous

http://www.physics.udel.edu/~nowak/phys207/05s/

Meet the Lecturer

1 Ed Nowak nowak@udel.edu / 228 SHL / x2676
1 Office Hours T, R 9:30-10:30am
R 2:00 – 3:00pm, and by appt.
1 Research
   2 Condensed Matter Experiment
Assessment

- Quizzes: 28%
- Exams (3 x 13%): 39%
- Cumulative Final Exam: 13%
- Lab: 20%
- Total: 100%
- Homework: 5% extra credit

Quizzes every week at END of DSC
See syllabus for exam dates

Tentative Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>A-</td>
<td>&gt; 87%</td>
</tr>
<tr>
<td>B+</td>
<td>&gt; 84%</td>
</tr>
<tr>
<td>B</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>B-</td>
<td>&gt; 77%</td>
</tr>
<tr>
<td>C</td>
<td>&gt; 74%</td>
</tr>
<tr>
<td>C-</td>
<td>&gt; 70%</td>
</tr>
<tr>
<td>C-</td>
<td>&gt; 67%</td>
</tr>
<tr>
<td>D</td>
<td>&gt; 64%</td>
</tr>
<tr>
<td>D-</td>
<td>&gt; 60%</td>
</tr>
<tr>
<td>D-</td>
<td>&gt; 57%</td>
</tr>
<tr>
<td>F</td>
<td>&lt; 57%</td>
</tr>
</tbody>
</table>

http://www.physics.udel.edu/~nowak/phys207/05s/
Phys207 Lectures

1. Participation is key!
   ² Come to lecture prepared!
1. Not everything you need for quizzes & exams!
   ² Concepts, Connections, Motivation
   ² Comprehensive Text
   ² Calculations       Homework + Discussion
   ² Hands-On       Lab

Phys207 Homework

1. Not graded! but . . .
1. Earn up to 5% extra credit if:
   ² at least 7/8 of problems are genuinely attempted
   ² Logical steps of solutions must be identifiable
   ² Must be handed in at BEGINNING of Monday lecture - FIRM
   ² No credit after that
1. ~ 10-12 hmwks will be assigned; ~1 per week
1. **First one is due Monday, February 14th!**
1. Solutions posted on website Thurs. mornings.
1. Advice: DO ALL THE HOMEWORK!!!
Discussion Sections

“I’m worried about it being such a large class.”

- We’ve got GOOD DSC TAs!
- DSC start on Monday, Feb. 14th!
- Multiple-choice quiz during last 15-20 minutes of section

Phys207 Labs

- One lab per week; rotation begins on Mondays
  - 11 labs total
  - Must complete a MINIMUM of 8 labs to pass this course!
- Labs start on Monday, Feb. 14th
- Check registration booklet for meeting times and place of your lab section
- Check syllabus for Lab TA contact info
Transferring lab scores

For students repeating this course

1. Can elect to transfer lab scores
   - All 10 (or 11) lab scores will be used to determine transferred lab points

1. Requirements:
   - Minimum of 8 labs completed
   - In your intent email specify: course, section, term, course instructor, and lab TA
   - Arrange for ALL lab scores, and average lab score for course to be sent to me by instructors.

Scheduling conflicts

1. ASAP – fill out a PINK add/drop form
1. Follow instruction on overhead projector
1. Give a 1st and 2nd choice
1. Must include justification and documentation, if applicable.
1. No guarantees! but we’ve done okay in the past
Physics Philosophy

“my biggest fear is taking this course...can you make it easy?”

1. Problem: You are too smart!

1. Physics is DIFFERENT

1. Describe large number of “complicated” observations with a few simple ideas

1. Exams don’t have same problems, but do have same IDEAS

Scope of Physics 207

1. Classical Mechanics:
   
   - Mechanics: How and why things work
   - Classical:
     - Not too fast $(v << c)$
     - Not too small $(d >> \text{atom})$

1. Most everyday situations can be described in these terms.
   - Path of baseball
   - Orbit of planets
   - etc...
Newton’s Laws of Motion

1. If the sum of all external forces on an object is zero, then its speed and direction will not change. Inertia

2. If a nonzero net force is applied to an object its motion will change $F = ma$

3. In an interaction between two objects, the forces that each exerts on the other are equal in magnitude and opposite in direction.

Forces in Phys207

1. Non-Contact ---- Gravity ($F = G \frac{m \cdot M}{r^2}$)
   - $G = 6.7 \times 10^{-11}$ m$^3$/(kg s$^2$)
   - Earth: Mass = 6x10$^{24}$ kg, radius = 6.4 x10$^6$ m.

1. Contact (fundamentally E+M)
   - Normal: Perpendicular to surface
   - Friction: Parallel to surface
   - Anything touching the object
     » Rope: Tension
     » Spring $F = -kx$
Free Body Diagrams

1. Choose Object (book)
2. Label coordinate axis
3. Identify All Forces
   a. Hand (to right)
   b. Gravity (down)
   c. Normal (table, up)
   d. Friction (table, left)

Units

1. How we measure things!
   1. All things in classical mechanics can be expressed in terms of the fundamental units:
      a. Length  L
      b. Mass     M
      c. Time     T

1. For example:
   a. Speed has units of L / T (i.e. miles per hour).
   b. Force has units of ML / T² etc... (as you will learn).
### Length:

<table>
<thead>
<tr>
<th>Distance</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radius of visible universe</td>
<td>$1 \times 10^{26}$</td>
</tr>
<tr>
<td>To Andromeda Galaxy</td>
<td>$2 \times 10^{22}$</td>
</tr>
<tr>
<td>To nearest star</td>
<td>$4 \times 10^{16}$</td>
</tr>
<tr>
<td>Earth to Sun</td>
<td>$1.5 \times 10^{11}$</td>
</tr>
<tr>
<td>Radius of Earth</td>
<td>$6.4 \times 10^6$</td>
</tr>
<tr>
<td>Sears Tower</td>
<td>$4.5 \times 10^2$</td>
</tr>
<tr>
<td>Football field</td>
<td>$1.0 \times 10^2$</td>
</tr>
<tr>
<td>Tall person</td>
<td>$2 \times 10^0$</td>
</tr>
<tr>
<td>Thickness of paper</td>
<td>$1 \times 10^{-4}$</td>
</tr>
<tr>
<td>Wavelength of blue light</td>
<td>$4 \times 10^{-7}$</td>
</tr>
<tr>
<td>Diameter of hydrogen atom</td>
<td>$1 \times 10^{-10}$</td>
</tr>
<tr>
<td>Diameter of proton</td>
<td>$1 \times 10^{-15}$</td>
</tr>
</tbody>
</table>

### Time:

<table>
<thead>
<tr>
<th>Interval</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of universe</td>
<td>$5 \times 10^{17}$</td>
</tr>
<tr>
<td>Age of Grand Canyon</td>
<td>$3 \times 10^{14}$</td>
</tr>
<tr>
<td>32 years</td>
<td>$1 \times 10^9$</td>
</tr>
<tr>
<td>One year</td>
<td>$3.2 \times 10^7$</td>
</tr>
<tr>
<td>One hour</td>
<td>$3.6 \times 10^3$</td>
</tr>
<tr>
<td>Light travel from Earth to Moon</td>
<td>$1.3 \times 10^0$</td>
</tr>
<tr>
<td>One cycle of guitar A string</td>
<td>$2 \times 10^{-3}$</td>
</tr>
<tr>
<td>One cycle of FM radio wave</td>
<td>$6 \times 10^{-8}$</td>
</tr>
<tr>
<td>Lifetime of neutral pi meson</td>
<td>$1 \times 10^{-16}$</td>
</tr>
<tr>
<td>Lifetime of top quark</td>
<td>$4 \times 10^{-25}$</td>
</tr>
</tbody>
</table>
## Mass:

<table>
<thead>
<tr>
<th>Object</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milky Way Galaxy</td>
<td>$4 \times 10^{41}$</td>
</tr>
<tr>
<td>Sun</td>
<td>$2 \times 10^{30}$</td>
</tr>
<tr>
<td>Earth</td>
<td>$6 \times 10^{24}$</td>
</tr>
<tr>
<td>Boeing 747</td>
<td>$4 \times 10^{5}$</td>
</tr>
<tr>
<td>Car</td>
<td>$1 \times 10^{3}$</td>
</tr>
<tr>
<td>Student</td>
<td>$7 \times 10^{1}$</td>
</tr>
<tr>
<td>Dust particle</td>
<td>$1 \times 10^{-9}$</td>
</tr>
<tr>
<td>Top quark</td>
<td>$3 \times 10^{-25}$</td>
</tr>
<tr>
<td>Proton</td>
<td>$2 \times 10^{-27}$</td>
</tr>
<tr>
<td>Electron</td>
<td>$9 \times 10^{-31}$</td>
</tr>
<tr>
<td>Neutrino</td>
<td>$1 \times 10^{-38}$</td>
</tr>
</tbody>
</table>

### Units...

1. **SI (Système International) Units:**
   - **mks:** $L =$ meters (m), $M =$ kilograms (kg), $T =$ seconds (s)
   - **cgs:** $L =$ centimeters (cm), $M =$ grams (gm), $T =$ seconds (s)

1. **British Units:**
   - Inches, feet, miles, pounds, slugs...

1. We will use mostly SI units, but you may run across some problems using British units. You should know how to convert back & forth.
Converting between different systems of units

Useful Conversion factors:

- 1 inch = 2.54 cm
- 1 m = 3.28 ft
- 1 mile = 5280 ft
- 1 mile = 1.61 km

Example: convert miles per hour to meters per second:

\[
\frac{1 \text{ mi}}{1 \text{ hr}} = \frac{1 \text{ mi}}{1 \text{ hr}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{1 \text{ m}}{3.28 \text{ ft}} \times \frac{1 \text{ hr}}{3600 \text{ s}} = 0.447 \frac{\text{m}}{\text{s}}
\]

This is a very important tool to check your work. It’s also very easy!

Example:

Doing a problem you get the answer distance \( d = vt^2 \) (velocity x time squared)

Units on left side = L
Units on right side = L / T x T = L x T

Left units and right units don’t match, so answer must be wrong!!

Dimensional Analysis
Lecture 1, Act 1
Dimensional Analysis

1. The period $P$ of a swinging pendulum depends only on the length of the pendulum $d$ and the acceleration of gravity $g$.

2. Which of the following formulas for $P$ could be correct?

\[
\begin{align*}
(a) \quad P &= 2\pi (dg)^2 \\
(b) \quad P &= \frac{2\pi d}{g} \\
(c) \quad P &= 2\pi \sqrt{\frac{d}{g}}
\end{align*}
\]

Given: $d$ has units of length ($L$) and $g$ has units of ($L / T^2$).

Lecture 1, Act 1
Solution

1. Realize that the left hand side $P$ has units of time ($T$)

1. Try the first equation

\[
\begin{align*}
(a) \quad \left( L \cdot \frac{L}{T^2} \right)^{\frac{1}{2}} &= \frac{L}{T} \neq T \\
(b) \quad P &= \frac{2\pi d}{g} \\
(c) \quad P &= 2\pi \sqrt{\frac{d}{g}}
\end{align*}
\]

Not Right!!

$P = 2\pi (dg)^2$
Lecture 1, Act 1
Solution

1 Try the second equation

\[
\frac{L}{LT^2} = T^2 \neq T
\]

Not Right!!

(a) \( P = 2\pi(dg)^2 \)  (b) \( P = 2\pi \frac{d}{g} \)  (c) \( P = 2\pi \sqrt{\frac{d}{g}} \)

Lecture 1, Act 1
Solution

1 Try the third equation

\[
\sqrt{\frac{L}{LT^2}} = \sqrt{T^2} = T
\]

This has the correct units!!
This must be the answer!!

(a) \( P = 2\pi(dg)^2 \)  (b) \( P = 2\pi \frac{d}{g} \)  (c) \( P = 2\pi \sqrt{\frac{d}{g}} \)
To Do

1. Discussions and Labs START NEXT WEEK, ON MONDAY

1. 1ST HOMEWORK DUE ON MONDAY, FEB. 14TH.
   - Ch. 1: 15, 17, 22, 23, 40, and 62
   - Ch. 2: 16, 24, 32
   - Reading assignment:
     Ch.1, Ch. 2 thru section 2.5