Welcome to Physics 202

Today’s Topics

- The Physics 202 Team
- Course Formality and Course Overview
- Q&A
- Ch 23: Electric Charges

Physics 202 Homepage

Physics Department Homepage
http://www.physics.wisc.edu
The Physics 202 Team

Faculty (lectures):
- Prof. Tao Han, than@hep.wisc.edu 4223 CH. 262-8894
- Prof. Yibin Pan (me), pan@hep.wisc.edu 4283 CH. 262-9569

We both are High Energy physicists. Prof. Han is a theorist and I am an experimentalist.
- Heard of the “Big Bang” machine in Geneva?
  → That’s our Large Hadron Collider (LHC)

Teaching Assistants (labs, discussions):
- Matthew Ebert 301 302 mebert@wisc.edu
- Jianjia Fei 328 330 jfei@wisc.edu
- Joshua Isaacs 324 325 jaisaacs@wisc.edu
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- Xiao Wang 307 321 xwang235@wisc.edu
- Michael Wood 312 323 mpwood@wisc.edu
Physics 202 Course Composition

- Text: “Physics for Scientists and Engineers, 8th ed”. Serway/Jewett
- Lectures: TR 1:20pm (Lec. 1), 2:25pm (Lec. 2, repeats)
- Discussion Sessions: 2/week. (Grading: quizzes, participation, etc.)
- Labs: Mandatory. Each missing lab = -0.5 letter grade
- Homework: ~10 problems/week online by Webassign.net
- Exams: (3 middle-terms + final)
- Office Hours. (Faculty: by appointments, TAs: as scheduled)
- Your home time: > 5 hours/week + homework.

- Grading:
  - Homework: 100 pts
  - Laboratory: 50 pts (plus missing lab penalty)
  - Discussion: 50 pts
  - Midterm 1: 100 pts
  - Midterm 2: 100 pts
  - Midterm 3: 100 pts
  - Final Exam: 200 pts

  (Final grades are based on curved component scores)

Recent Phy202 grades (by Pan): 31% (A, AB), 27% B, 36% (BC,C), 8% D, (+1 F)
Lectures

- **Style:**
  - PPT + white board + demos
- **Subjects:**
  - Key concepts.
  - Tricky issues
  - Interactive problem solving

- **Lectures are NOT meant to be complete.**
  - It is a supplement to your own learning
  - Do read materials BEFORE the lecture.
    - Our lectures are designed with the assumption that you’ve read the corresponding sections!
  - Review materials after the lectures.
    - Lecture notes will be posted after each lecture

Effectiveness = Preview + Lecture + Review
Exams and Exam Policy

- **Exam Dates:**
  - Midterms (5:30-7:00 pm, rooms TBA)
    - Exam 1: Monday Sep 27
    - Exam 2: Monday Oct 25
    - Exam 3: Monday Nov 22
  - Final: Wednesday Dec 22 (7:45-9:45 am, rooms TBA), cumulative.

- If you have a conflict with above exam dates, inform your professors asap, normally at least 2 weeks before the scheduled date. Alternative exam arrangements are granted only for valid reasons. Given the size of the class, we do have limited flexibility.

- Popular excuses:
  - Academic/athletic conflicts: OK
  - Medical emergency: OK
  - Attending weddings/visiting friends/Thanksgiving plan: NOT OK.
Some Practical Issues

- **Course Web:**
  

- **When sending us emails:**
  
  - Include word “202” somewhere in the subject line. (“phy202”, “physics 202”, “p202”, or simply “202” will do)
  - Mentioning your section # is helpful.

- **Homework assignments are posted each Wednesday evening and due by 11 pm of the following Wednesday.**

- **Lecture notes will be posted after each lecture on the same day. A draft will be available the night before (can be late). Follow the links on course web.**

- **No discussion session, no labs this (first) Week**
- **No labs next week either. (First lab starts on week of Sep 12.)**
- **Please all sign up for WebAssign. (www.webassign.net)**
Physics 201 and 202

Light and Optics
Electro-Magnetism
Thermodynamics
Heat, Temperature, Pressure, Entropy,..
Oscillation and Waves
Classical Mechanics
Laws of motion
Force, Energy, Momentum,…

Cosmology
Sub-Sub-Atomic: Elementary Particles
Sub-Atomic: Nuclear Physics
Many-Atoms: Molecules, solids
Atomic Structure
Quantum Theory
Relativity

Classical
Modern
Physics 201

<table>
<thead>
<tr>
<th>Mechanics</th>
<th>Gravitation</th>
<th>Waves</th>
<th>Thermodynamics</th>
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</thead>
</table>

- **Mechanics: Motion and Force**
  - Fundamental Laws:
    - Newton’s laws of motion (Classical view)
    - Energy/Momentum/Angular Momentum conservation (modern view)

- **Gravitation: One of the four fundamental forces**

- **Waves: Coherent phenomena over space and time**
  - Fundamental Law: Superposition Principle

- **Thermodynamics: Statistical behavior of large quantity**
  - Fundamental Laws:
    - Laws of Probability (average, entropy,...)
    - + Laws of Physics.
Physics 202

Electro-Magnetism

- Electric force, electric charge, electric fields → Ch. 23, 24
- Electric potential → Ch. 25
- Current, capacitance & resistance → Ch. 26, 27
- Magnetic fields and magnetic force → Ch. 29, 30, 31, 32
- Electromagnetic waves → Ch. 34
- DC and AC Circuits → Ch. 28, 33

Light & Optics

- Optics: Physics of lights
  - Lights as rays: Geometric optics, imaging → Ch. 35, 36
  - Lights as (electromagnetic) waves, interference → Ch. 37, 38
  - Lights as group of photons (Future Topic)
Demo: Two Types of Electric Charges

Opposite signs attract  Like signs repel
Properties of Electric Charges

- 2+1 types: positive, negative (+neutral).
- Unit: Coulomb (C). 1 C = charge of $6.24 \times 10^{18}$ protons.
- Electric charge is quantized: $q = \pm N e$, $e = 1.602 \times 10^{-19}$ C
- Building blocks of matters:

<table>
<thead>
<tr>
<th></th>
<th>Charge (C)</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron</td>
<td>$-e = -1.602 \times 10^{-19}$</td>
<td>$9.11 \times 10^{-31}$</td>
</tr>
<tr>
<td>Proton</td>
<td>$+e = +1.602 \times 10^{-19}$</td>
<td>$1.673 \times 10^{-27}$</td>
</tr>
<tr>
<td>Neutron</td>
<td>0</td>
<td>$1.675 \times 10^{-27}$</td>
</tr>
</tbody>
</table>

- Electric charge is conserved: charges can be moved around, but the total charge remains the same.

☑️ For very deep thinkers: Why electrons and protons have the same electric charge?
What Are Happening in Previous Demo

- Initially both the rod and the fur are neutral
  - Neutral $\leftrightarrow$ the object carries equal amount of negative (electron) and positive (protons) charges.

- When the rod is rubbed against the fur, electrons are separated from the protons and transferred from one objects to another. The result is that the rod (and the fur) now have un-equal mount of charges $\rightarrow$ they are charged (charge by friction)
  - rubber rods tend to acquire more electron $\rightarrow$ negative
  - glass/acrylic rods tends to lose electron $\rightarrow$ positive

- Attraction/repel behavior can be explained by the rules:
  - Like sign charges repel each other
  - Opposite sign charges attract each other.
One More Demo:
Electroscope, Charge by Induction

Remember:
Like signs attract, opposite signs repel

Further reading: Conductivity of matter
- Conductors (metals): electrons are free to move
- Insulators (glass, plastic, most fabric): charges can not move
- Semi-conductors: charges have limited mobility, future topics
A Repeated Message

Lectures supplement but do not substitute for reading!

Lecture Effectiveness = Preview + Lectures + Review
Review:
- Electric charge is an intrinsic property of matter.
- There are two types of charges: positive and negative.
- A particle (an object) can have three charge states:
  - positive, negative, neutral
- Electric forces exist between two charged particles
  - Like sign changes repel one another
  - Opposite sign charges attract one another.

Preview:
- Electric forces are quantified by Coulomb’s Law
- A charged particle creates an electric field around it.
- Electric field exerts electric forces on charged particles.
- General ideas on how to calculate electric field....
Electric Force And Coulomb’s Law

- Electric forces exist between two charged particles
- The direction of electric force depends on the signs of the charges:
  - forces between opposite sign charges are attractive
  - forces between like sign charges are repulsive

The magnitude of the electric forces for point charges

\[ F_{12} = F_{21} = k_e \frac{|q_1||q_2|}{r^2} \]  

(Coulomb’s Law)

Coulomb Constant: \( k_e = 8.987 \times 10^9 \text{Nm}^2/\text{C}^2 = 1/(4\pi\varepsilon_0) \)

\( \varepsilon_0 \): permitivity of free space (Ch. 26)