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. Bruce Bmellado@wisc.edu, 4223 Chamberlin, 262-8894
  ● Prof. Yibin Pan (me), pan@hep.wisc.edu 4283 Ch. 262-9569
  ➢ We both are Experimental High Energy physicists.
  ➢ Heard of the “Big Bang” machine in Geneva?
  ➢ That’s our Large Hadron Collider (LHC)

➢ Teaching Assistants (labs, discussions):
  ● James Buchanan 301 325 jjbuchanan@wisc.edu
  ● Diptaranjan Das 302 305 ddas5@wisc.edu
  ● Ross Devol 312 324 devol@wisc.edu
  ● Yutao Gong 311 323 ygong@wisc.edu
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Physics 202 Course Composition

✓ Text: "Physics for Scientists and Engineers, 8th ed." Serway/Jewett
✓ Lectures: TR 1:20am(Lec. 1), 2:25am (Lec. 2, repeats)
✓ Labs: Mandatory. Each missing lab = -1 letter grade level (A à⇒ AB, AB à⇒ B…)
✓ 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.
✓ Honor credit: read email announcement (to be sent)
✓ Grading:
  • Homework: 100 pts
  • Laboratory: 50 pts (plus missing lab penalty)
  • Discussion: 50 pts (quizzes:35 + attendance: 15)
  • Midterm 1: 100 pts
  • Midterm 2: 100 pts
  • Midterm 3: 100 pts
  • Final Exam: 200 pts

(Final grades are curved based on component scores)
Recent Phy202 grades (by Pan): 35% (A, AB), 21% B, 40% (BC,C), 4% 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: Tuesday Oct 2
    - Exam 2: Tuesday Oct 30
    - Exam 3: Tuesday Nov 27
  - Final: (Wed. Dec 19, 2:25-4:25 pm, 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 will have very limited flexibility.

- **Popular excuses:**
  - Academic/official 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.**

- **One discussion session, no labs this (first) Week**
- **No labs next week either. (First lab starts on week of Sept 16.)**
- **Please all sign up for WebAssign.** [www.webassign.net](http://www.webassign.net)

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Physics 201 and 202

- **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.

- **Cosmology**
- **Sub-Sub-Atomic:**
  - Elementary Particles
- **Sub-Atomic:**
  - Nuclear Physics
- **Many-Atoms:**
  - Molecules, solids
- **Atomic Structure**
- **Quantum Theory**
- **Relativity**
- **Thermodynamics**
- **Waves**
- **Gravitation**
- **Mechanics**

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Before Physics 202

- **Classical**
- **Modern**
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)

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**Properties of Electric Charges**

- 2+1 types: positive, negative (+neutral).
- Unit: Coulomb (C). 1 C= charge of 6.24x10^18 protons.
- Electric charge is quantized: \( q = n e \), \( e = 1.602 \times 10^{-19} \text{ C} \)
- 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>9.11x10^{-31}</td>
</tr>
<tr>
<td>Proton</td>
<td>(+e = 1.602 \times 10^{-19})</td>
<td>1.673x10^{-27}</td>
</tr>
<tr>
<td>Neutron</td>
<td>0</td>
<td>1.675x10^{-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?

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**Demo: Two Types of Electric Charges**

Opposite signs attract Like signs repel

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**What Are Happening in Previous Demo**

- Initially both the rod and the fur are neutral
  - Neutral ➔ 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 object to another. The result is that the rod (and the fur) now have un-equal mount of +,- charges ➔ they are charged (charge by friction)
  - rubber rods tend to acquire more electron ➔ negative
  - glass/acrylic rods tends to lose electron ➔ 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

Conductivity of matter:
- Conductors (metals): electrons free to move (protons do not move)
- Insulators (glass, plastic, most fabric): charges can not move
- Semi-conductors: charges have limited mobility, future topics

Remember:
Like signs attract, opposite signs repel

Before Thursday (Read Ch. 23)

- 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...

A Repeated Message

Lectures supplement but do not substitute for reading!

Lecture Effectiveness =
Preview + Lectures + Review

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

\[ F_{12} = F_{21} = k \frac{|q_1 q_2|}{r^2} \]  
(Coulomb’s Law)

Coulomb Constant: \( k_q = 8.987 \times 10^9 \text{Nm}^2/\text{C}^2 = 1/(4\pi\epsilon_0) \)
\( \epsilon_0 \): permittivity of free space (Ch. 26)