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 ygong5@wisc.edu
😊 Minho Kwon 306 322 mkwon22@wisc.edu
😊 Gregory Lau 308 328 glau@wisc.edu
😊 Andrew Loveridge 327 330 loveridge@wisc.edu
😊 Tao Peng 303 313 tpeng23@wisc.edu
😊 Benjamin Stefanek 304 329 stefanek@wisc.edu
😊 Gandhari Wattal 307 321 gwattal@wisc.edu
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)
- Discussion Sessions: 2/week. (Grading: quizzes, participation, etc.)
- Labs: Mandatory. Each missing lab = -1 letter grade level (A→AB, AB→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)
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
Before Physics 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.
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: $q = \pm Ne$, $e = 1.602 \times 10^{-19}$ 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 ↔ 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 → 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
A Repeated Message

Lectures supplement but do not substitute for reading!

Lecture Effectiveness = Preview + Lectures + Review
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….
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: \( k_e = 8.987 \times 10^9 \text{Nm}^2/\text{C}^2 = 1/(4\pi\varepsilon_0) \)

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