Welcome to Physics 202

Today’s Topics

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

Meet the Physics 202 Team

Faculty (lectures):
• Prof. Bruce Mellado, bmellado@wisc.edu 4223 CH. 262-8894
• Prof. Yibin Pan (me), pan@hep.wisc.edu 4283 CH. 262-9569

We both are experimental High Energy physicists working at LHC/CERN

That’s our “Big Bang” machine in Geneva!

Teaching Assistants (labs, discussions):
• Jinlu Miao jmiao@wisc.edu 301 322
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Physics 202 Course Composition

• Text: “Physics for Scientists and Engineers, 7th ed”, Serway/Jewett
• Lectures: TR 8:50am (Lec. 1), 9:55am (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
• Discussion: 50 pts
• Midterm 1: 100 pts
• Midterm 2: 100 pts
• Midterm 3: 100 pts
• Final Exam: 200 pts

(Grades are based on curved component scores)

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 Feb 16
    - Exam 2: Friday Mar 13
    - Exam 3: Monday April 13
  - Final: Monday May 11 (7:45-9:45 am, rooms TBA), cumulative.

- If you have a conflict with the exam dates, inform professors and your TA ASAP, normally at least 2 weeks before the scheduled date. Alternative exam arrangements are granted only for valid reasons.
  - Exemplary excuses:
    - Academic conflicts: OK
    - Medical emergency: OK
    - Attending weddings/visiting friends: NOT OK.

Some Practical Issues

- Course Web:

- When sending us emails:
  - Include word “202” somewhere in the subject line.
  - Mentioning your section # is helpful.

- Homework assignments are posted each Wednesday evening and expected 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.

- This (first) Week:
  - No labs
  - Only one discussion session (the 2nd one of the week)
  - HW 1 will be assigned but due in two weeks.
**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)

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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 = ±ne, e = 1.602x10^{-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 = 1.602x10^{-19}</td>
<td>9.11x10^{-31}</td>
</tr>
<tr>
<td>Proton</td>
<td>+e = 1.602x10^{-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 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

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

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A Repeated Message

Lectures supplement but do not substitute for reading!

Lecture Effectiveness = Preview + Lectures + Review

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Before This 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...

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

Coulomb Constant: \( k = 8.987 \times 10^9 \text{Nm}^2/\text{C}^2 = 1/(4\pi\varepsilon_0) \)
\( \varepsilon_0 \): permittivity of free space (Ch. 26)