Welcome to Physics 202

Today’s Topics

- The Physics 202 Team
- Course Formality and Overview
- Electric Charge, Coulomb's Law

Text: Serway/Jewett, Physics for Scientists & Engineers Vol II, 7th ed

Physics 202 Homepage (under construction)
http://www.physics.wisc.edu/undergrads/courses/fall09/202/
Meet the Physics 202 Team

Faculty (lectures):

😊 Prof. Yibin Pan  
pan@hep.wisc.edu

Research: experimental high energy physics
Office hrs: by appointment, 4283 CH, 262-9569

😊 Prof. Bruce Mellado  
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Research: experimental high energy physics
Office hrs: by appointment, 4223 CH, 262-8894
Meet the Physics 202 Team

➢ Teaching Assistants (labs, discussion):

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Office hours: in 2307 CH (starting Sep 8). Schedule (TBA):
http://www.physics.wisc.edu/undergrads/courses/fall09/202/consult.htm
Physics 202 Course Composition

- **Lectures:** TR 1:20 pm (Lec. 1), 2:25 pm (Lec. 2)

- **Labs:** Mandatory. Each missing lab = - 0.5 grade pt. 10 labs total. grading: weekly lab quizzes, 2 lab reports
  - **Start on September 14th**

- **Discussion Sections:** 2/week. grading: discussion quizzes (5 total during the semester), participation,…
  - **Start on September 8th**

- **Exams:** 3 midterms + final (word problem format)

- **Homework:** ~10 problems/week, web-based
  
  Online homework system: Webassign
  http://webassign.net/
  tutorial + end-of-chapter problems (not aligned with our text yet)
Exams and Exam Policy

Exam Dates

– Midterms: (5:30-7 PM, rooms TBA)
  • Exam 1: Monday Sep 28
  • Exam 2: Monday Oct 26
  • Exam 3: Monday Nov 23

– Final:
  Friday Dec 18 (5:05-7:05 PM, rooms TBA) Cumulative

If you have an academic conflict with the exam dates, inform the professors and your TA ASAP (at latest: 2 weeks before the exam period) so that we can accommodate you.

(Exam policy details on course website)
Physics 201, 202 and 249

Classical Mechanics
Laws of motion
Force, Energy, Momentum,…

Electromagnetism

Light and Optics

Oscillation and Waves

Cosmology
Sub-Sub-Atomic: Elementary Particles
Sub-Atomic: Nuclear Physics
Many-Atoms: Molecules, solids
Atomic Structure
Relativity
Quantum theory
• Electromagnetism
  – Electric force, field, and potential: stationary charges (electrostatics)
  – Current, capacitance & resistance
  – Magnetic force and field: steady currents (magnetostatics)
  – Time-dependent fields: Maxwell’s equations
  – Electromagnetic waves, wave motion, superposition
  – DC and AC Circuits

• Light and Optics
  – Light as rays: Geometric optics, imaging
  – Light as electromagnetic waves, interference
Chapter 23: Electric Charge and Field

Today:
- Electric charges
  - Fundamental units of charge
  - Conductors and insulators
- Electrostatic force: Coulomb’s Law

Next Tuesday:
- Electric Field
  - Calculating electric fields from charge distributions
  - Motion of charged particle in external electric field

⚠️ Please read Ch. 23 before Thursday’s lecture
Properties of Electric Charge

- 2 types: positive or negative
- SI Unit: Coulomb (C). 1 C = chg of $6.24 \times 10^{18}$ protons
- Building blocks of matter:

<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 quantized: $q = \pm Ne$  ($e = 1.602 \times 10^{-19}$ C)
- Electric charge of isolated system is conserved

*neutral objects: no charge or equal amount of + and -
Conductors v. Insulators

Consider how charge is carried on macroscopic objects. In Physics 202, we are concerned with only 2 types:

**Insulators** (glass, plastic, rubber...):
charges NOT free to move

**Conductors** (metals...):
charges free to move
charge also by induction!

Electroscope (next lab)
Charging by conduction (touching)

- Positively charged rod (too few electrons)
  - Electron flow
- Less positively charged rod
- Neat neutral metal
- Positively charged metal
Charging conductors by Induction

- Charging by induction requires no contact with the object inducing the charge

a) We start with a neutral metallic sphere

b) The rod does not touch the sphere. The electrons in the neutral sphere are redistributed

b) charged rubber rod
Coulomb’s Law

Electric Force b/w 2 stationary point charges:

\[ F = \frac{kq_1q_2}{r^2} \]

(Coulomb’s Law)

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

\( \varepsilon_0 \): permitivity of free space = \( 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2 \)

Attractive (opp sign charges), repulsive (like sign charges)

❖ Four fundamental forces:

**Strong > Electromagnetic > Weak >> Gravitation**
Coulomb’s Law: Vector Form

2 charges: force on $q_2$ by $q_1$

$$\vec{F}_{12} = k \frac{q_1 q_2}{r^2} \hat{r}_{12} = -\vec{F}_{21}$$

>2 charges: force on charge $i$

$$\vec{F}_i = \vec{F}_{1i} + \vec{F}_{2i} + \vec{F}_{3i} + \ldots$$

principle of linear superposition