Welcome to Physics 202

Today’s Topics

- The Physics 202 Team
- Course Formality and Overview
- Ch. 21.1-21.5: Electric Charge, Coulomb's Law

Text: Giancoli, Physics for Scientists and Engineers, 4th ed., Volume II.

Physics 202 Homepage

http://www.physics.wisc.edu/undergrads/courses/fall08/202/
Meet the Physics 202 Team

Faculty (lectures):

😊 Prof. Yibin Pan  pan@hep.wisc.edu

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

😊 Prof. Bruce Mellado  bmellado@wisc.edu

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/fall08/202/consult.htm
Physics 202 Course Composition

- **Lectures:** TR 1:20 pm (Lec. 1), 2:25 pm (Lec. 2)
  Honors: F 8:50 am (w/ Physics 208)

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

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

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

- **Homework:** ~10 problems/week, web-based
  
  Online homework system: MasteringPhysics
  http://www.masteringphysics.com
  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 29
  - Exam 2: Monday Oct 27
  - Exam 3: Monday Nov 24

- **Final:**
  Wednesday Dec 17 *(7:25-9:25 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

Electromagnetism
Light and Optics
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
Relativity
Quantum theory

Classical  Modern
Physics 202

**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 21: Electric Charge and Field

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

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

Please read Ch. 21 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*
  (phenomenon: polarization)

Electroscope (next lab)
Charging by conduction (touching)

Positively charged rod (too few electrons)

Neutral metal

electron flow

Less positively charged rod

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

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

\( \varepsilon_0 \): 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 $q_1$

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

>2 charges: force on charge $i$

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

principle of linear superposition

Examples: 21.13, 21.18, 21.20