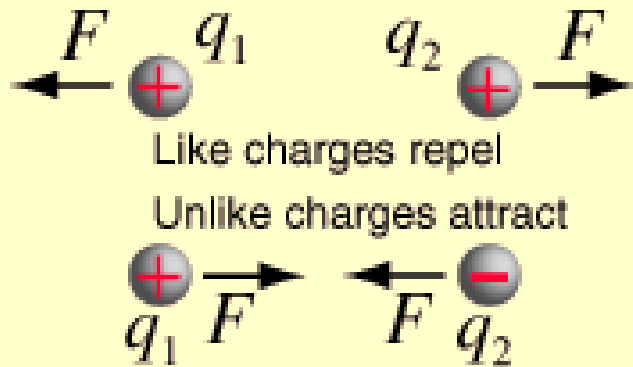
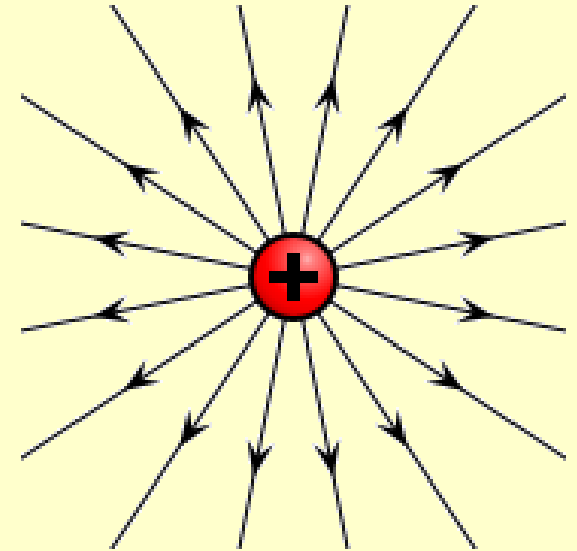




Physics 2208

Today:

- Electric charge
- Coulomb's law



$$F = \frac{kq_1q_2}{r^2} = \frac{q_1q_2}{4\pi\epsilon_0 r^2} \quad \text{Coulomb's Law}$$

Our Promise

We will teach you physics that matters to you.

We will treat you with respect.

We will help you.

Physics 2208:

- How does an EKG or EEG work?
- How do nerve cells transmit impulses?
- How does a touch screen work?
- Can frogs fly?
- What makes a rainbow?
- What makes a aurora borealis?
- What is light?

Physics 2208 Spring 2012

Lecturer: Matthias Liepe

Senior Staff: Glenn Case, Glenn Fletcher

Course Web Site:

www.blackboard.cornell.edu

- **Lecture notes**
- **Homework assignments and solutions**
- **...**

Please sign Sign-up Sheet if you can not access the page and need to be added to Blackboard

Texts:

- *Fundamentals of Physics*, 9th ed., Vol. 2, by Halliday, Resnick, and Walker
- P2208 Lab Manual 2012

I-Clicker:

- Please register your I-Clicker for this semester at <http://fit.cit.cornell.edu/atcsupport/pollsrvcl/> .

Academic Integrity:

- We take issues of academic integrity extremely seriously.

Homework assignments:

- Handed out/due every Wednesday. HW 1 due next week Wednesday. Grading based on effort.

Cooperative Learning Problems:

- Assigned in section. You'll work on them in teams.

Labs

- One during most weeks. No lab book is required. Turn in the completed lab manual pages. Labs start next week, in Rock B54. **You must attend all labs! You must attend the lab section you are signed up for!** There will be no make-up labs!

Quizzes:

- One each week, in recitation. Based on previous week's lectures, recitation and lab work. Start week of Feb. 6.

Participation:

- Lecture participation, recitation participation, lab part.

Exams:

- Prelim 1: Thursday, March 1
- Prelim 2: Thursday, April 5
- Final: Monday, May 14

Grading:

Exams: 65% (20% P1, P2, 25% Final)
Recitation, HW, Lab, part.: 35%

Exams will not be curved (unless we goof). Section grades will be adjusted for differences between TAs.

Help each other to learn, and no one will lose!

We will try our best to accommodate everyone who wants to take Physics 2208, but this class is very full.

Please see Rosemary French (121 Clark Hall) for help signing up.

Lectures on the same day are identical and you can attend either one, no matter which one you signed up for.

You must attend the section and labs you are signed up for! See Rosemary French if you need to change sections /labs because of direct conflicts.

Registration issues should be settled in the first two weeks.

Course Objective:

- To introduce you to the ideas and tools of physics relevant to careers in medicine, biology, and other science-related areas.

Syllabus:

- Electric charge, field, and forces
- Electric potential
- Electric currents and circuits
- Magnetic fields and forces
- Sources of magnetic fields
- Electromagnetic waves
- Geometrical optics
- Interference and diffraction
- Relativity
- Quantum mechanics
- Nuclear and particle physics

Concepts will be illustrated with applications.

Math Skills for Physics 2208

- Unlike **1101**, **2208** is officially **calculus-based**.
- However, **you need only understand the basic notions of a derivative and an integral**.

Getting Help in P2208

1. Study room/ Office Hours

All office hours will be held in Clark Hall, second floor, next to room 282.

- **The study room is open:**

- **Mondays: 1 – 6 PM**
- **Tuesdays: 1 – 9 PM**
- **Wednesdays: 1 – 6 PM**
- **Thursdays: 1 – 6 PM**
- **Fridays: 1 – 6 PM**
- **Saturdays: 1 – 6 PM**
- **Sundays: study room closed**

- **Phys2208 staff will be present during most of the time the study room is open (see detailed schedule on study room door)**

Getting Help in P2208

2. Prof. Liepe's "Help me!" Office Hours

Wednesdays, 3- 4 PM in
302 PSB.

***See me if you feel
overwhelmed by the
material, need study
tips, are concerned
about your
performance...***



Getting Help in P2208

3. The Learning Strategies Center - B14 Rock

- **Focused on those students needing remedial help in math and physics**

LSC office hours:

Mon-Thurs: 2:30-5:30 pm and 6:30-9:30 pm

Friday: 2:30-5:30 pm

Saturday: closed

Sunday: noon - 9 pm

Getting Help in P2208

4. Counseling and Psychological Services (CAPS) - Gannett Health Center

- Where to go if you are feeling unusually anxious, stressed or depressed, and especially if these feelings are interfering with your ability to perform in the course.
- **Don't dismiss this option:** Psychological issues are one of the most important **controllable** factors affecting student performance in challenging courses.

Keys to Success in Physics 2208

1. You can't learn how to do physics by reading the text or the solutions manual!

Do lots and lots of problems, both on your own and in groups.

Your ability to solve problems on your own is the gold standard against which to assess your understanding.

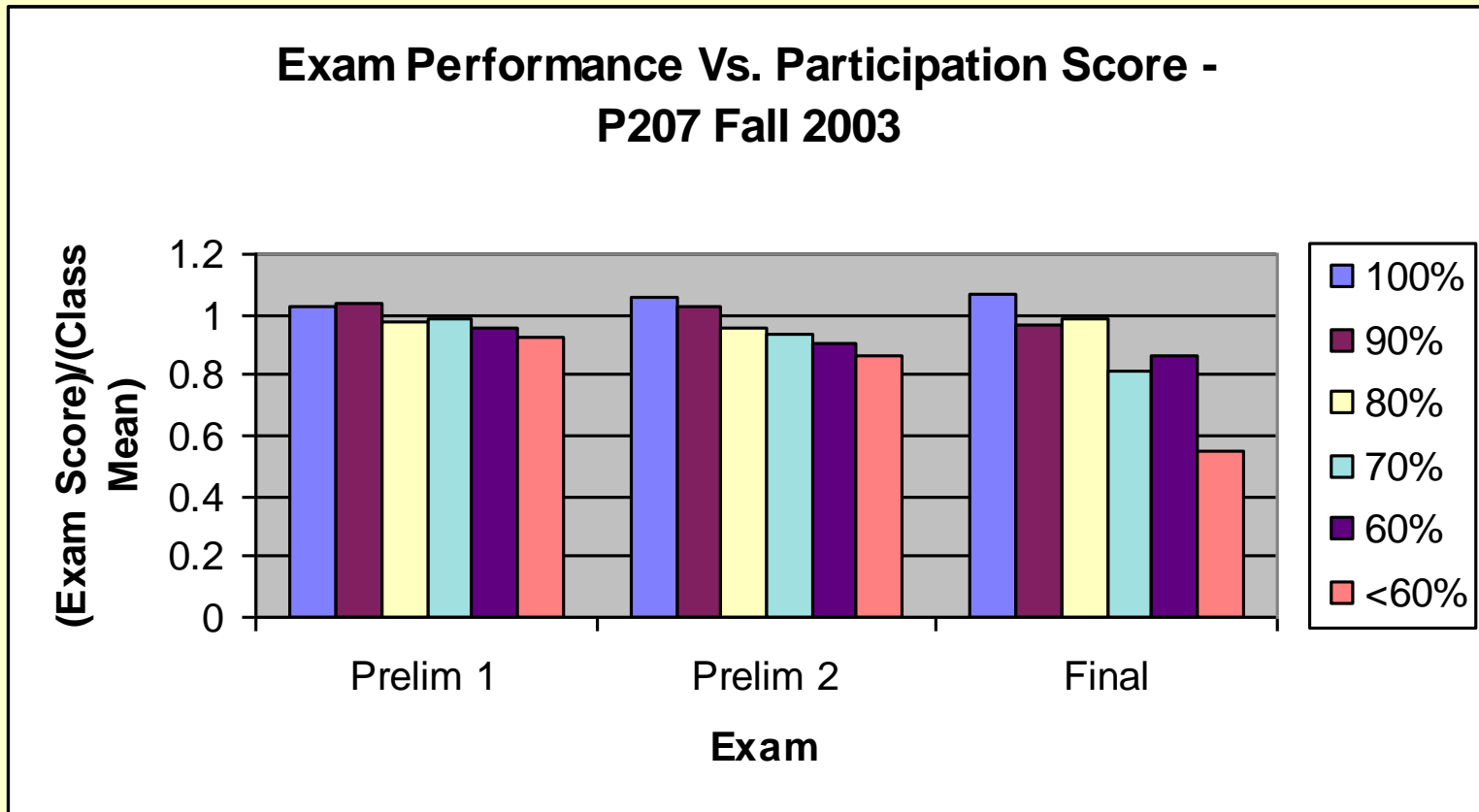
Keys to Success in Physics 2208

2. You get most of the points in recitation, lab and HW for showing up and making a good effort. **Don't throw these points away!** Missed work carries a huge grade penalty: missing half the homework is roughly equivalent to the difference between getting an "A" and a "C" on a prelim!

Do all the assigned work.

Keys to Success in Physics 2208

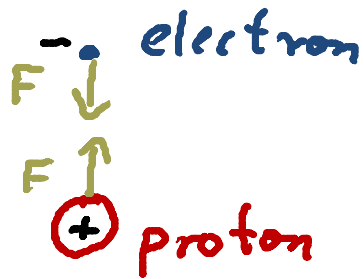
3. Maintain a consistent effort.



Attend lectures, recitations and labs throughout the semester.

Electric charge:

Hydrogen Atom:



$$q_e = -1.602 \cdot 10^{-19} \text{ C}$$

$$q_p = +1.602 \cdot 10^{-19} \text{ C}$$

→ Units of charge:

Coulomb : C

What keeps the electron and proton together?

• Gravity??

$$F_{\text{grav}} = G \frac{m_p m_e}{r^2}$$

$$G = 6.67 \cdot 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$$

$$r_H = 50 \text{ pm} \approx 5 \cdot 10^{-11} \text{ m}$$

$$\Rightarrow F_{\text{grav}} \approx 4 \cdot 10^{-47} \text{ N}$$

} strength determined by mass

↑
property of object

$$m_p = 1.7 \cdot 10^{-27} \text{ kg}$$

$$m_e = 9.1 \cdot 10^{-31} \text{ kg}$$

\Rightarrow tiny!

\Rightarrow far too small!

• Electrostatic force:

strength of force is determined by "new" property: electric charge q

↑
intrinsic character of fundamental particles

Electric Charge:

- can be positive or negative
- is conserved: The net charge of a closed system never changes!
- is quantized: comes in discrete amounts

particle	symbol	charge
proton	p	+e
electron	e, or e ⁻	-e
neutron	n	0

elementary charge
 $e = 1.602 \cdot 10^{-19} \text{ C}$

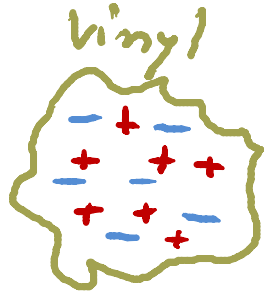
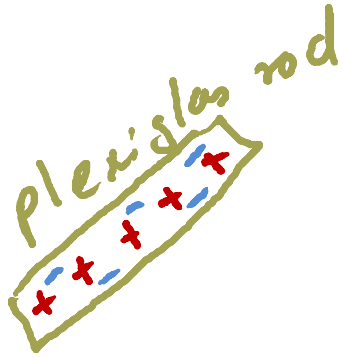
smallest, non-zero, individually obtainable charge

=> charge of objects: $q = n \cdot e$

- charged particles (usually electron) can be transferred from one object to another with $n = 0, \pm 1, \pm 2, \pm 3 \dots$

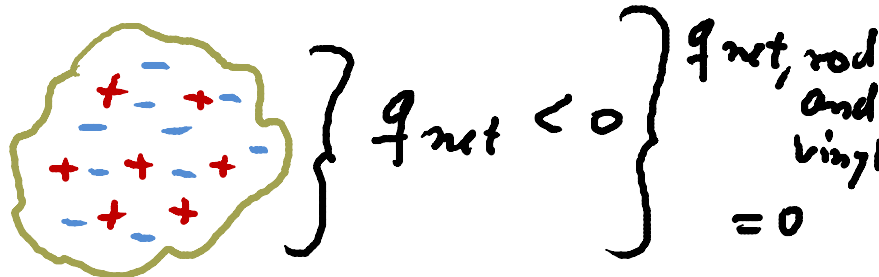
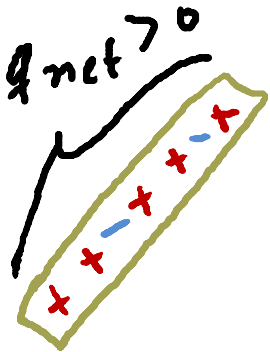
Triboelectricity - separation of charge by contact between two different materials.

The Triboelectric Series



initially: electrically neutral
(net charge = 0)

⇓ rub rod with vinyl
⇒ e^- move from rod to vinyl



objects become charged
(net charge $\neq 0$)

More **positive (+)** ↑
(Tend to donate electrons.)

More **negative (-)** ↓
(Tend to accept electrons.)

- Rabbit's fur
- Acetate
- Human hair
- Lucite (plexiglass)
- Wool
- Glass
- Quartz
- Mica
- Nylon
- Cat's fur
- Silk
- Aluminum
- Paper
- Cotton
- Wood
- Sealing wax
- Amber
- Rubber
- Metals (Ni, Cu, Ag)
- Polyester
- Polystyrene
- Saran wrap
- Polyethylene
- Sulfur
- Vinyl & PVC
- Teflon

After the PVC rod is rubbed with wool does the rod have a positive (+) or a negative (−) electric charge?

A. Positive

B. Negative

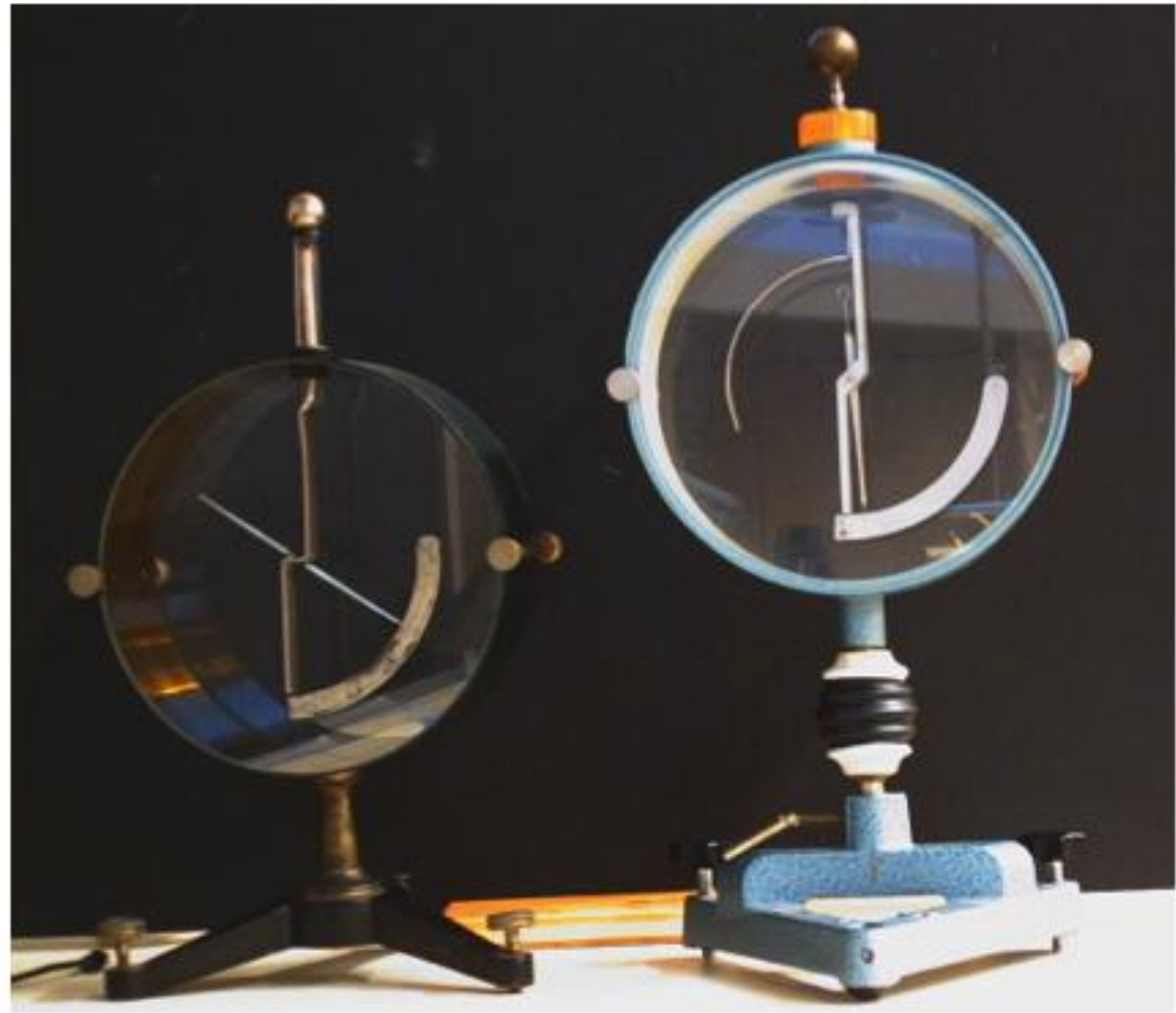
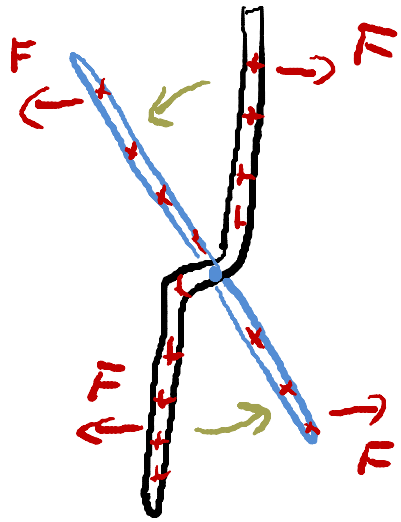
C. Neither, it is electrically neutral.

A PVC rod is rubbed with wool to charge the rod **negative** and then brought near a floating He-balloon, which has a net **negative** charge. The electrostatic force between the rod and the balloon will...

Like charges repel
one another

- A. Push the balloon away
- B. Attract the balloon
- C. Nothing will happen.

Electroscopes



The electroscope on the left is charged.

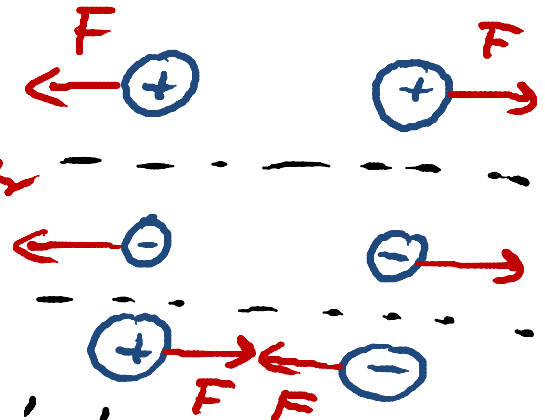
A Plexiglas rod is rubbed with vinyl to charge the rod **positive** and then brought near a floating He-balloon, which has a net **negative** charge. The electrostatic force between the rod and the balloon will...

*Unlike charges
attract one another!*

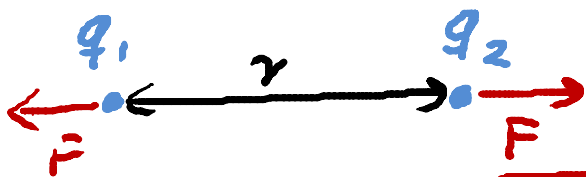
- A. Push the balloon away
- B. Attract the balloon
- C. Nothing will happen.

- charge determines strength and direction of electrostatic force:

Like charges repel one another
 Unlike " attract " "



Magnitude of force: Coulomb's Law:



for two point charges, separated by distance r

F_a H-Atom

$F_{\text{electric}} = 9 \cdot 10^{-8} \text{ N}$
 between e^- and p

$\Rightarrow \frac{F_{\text{elec}}}{F_{\text{grav}}} \approx 2 \cdot 10^{39}$

$\Rightarrow F_{\text{el}}$ keeps atoms together!

$$|F_{1 \rightarrow 2}| = |F_{2 \rightarrow 1}| = k \frac{|q_1| \cdot |q_2|}{r^2}$$

k : electrostatic constant

$$k = 8.99 \cdot 10^9 \frac{\text{Nm}^2}{\text{C}^2}$$

\vec{F} always points along "axis" passing through the two particles

