

Welcome to Physics 1161!

- Electricity & Magnetism (E&M)
- Optics
- Quantum Physics
- Atomic Physics
- Nuclear Physics
- Relativity

<http://smartphysics.com>

Instructor

- Cherie Bibo Lehman
- cblehman@eiu.edu
 - Please include course number in the Subject Line
- **1112 Physical Science – (c) 217.251.3734**
- **Office Hours**
 - T: 1:00 PM – 2:00 PM
 - W: 10:00 AM – 12:00 PM
 - R: 1:30 PM – 2:30 PM

<http://ux1.eiu.edu/~cblehman/>

Grade Components

• Prelectures	05%
• Checkpoints	05%
• Class Participation*	10%
• Homework & Quizzes	25%
• Hour Exams (highest 3 of 4)	30%
• Final Exam	<u>25%</u>
	100%

*Based on clicker responses

$grade = 0.05 \cdot PL + 0.05 \cdot ChkPt + 0.10 \cdot CP + 0.25 \cdot HW + 0.30 \cdot Exams + 0.25 \cdot Final$

Grading Scale

- 90-100 A
- 80-89 B
- 70-79 C
- 60-69 D
- <60 F

SmartPhysics

- <http://www.smartphysics.com>
- Online prelectures, checkpoints, and homework found there.
- You will setup your password when you register for an account. Your logon is your EIU email. For example, my logon is cblehman@eiu.edu
- Once you have set up an account, click on the **Enrollments** tab.
- Course access key: **lehman**
- The unique identifier can be your name.
- **DO NOT ever contact SmartPhysics for tech support. Always contact me.**

Pre-Lectures

- Completing the Pre-Lectures will be 5% of your grade.
- 24 hours prior to each class, I will post on the SmartPhysics schedule a link to a pre-lecture power point or movie.
- You should
 - go through the pre-lecture
 - read the relevant sections in the text before you move on to the **checkpoint**.

Checkpoints

- Complete the checkpoints - 5% of your grade
 - 2 points (full credit) for honest attempt at preflight.
 - Must do the entire preflight to earn any credit, including responding to questions about what you find most interesting or most difficult.
- Click on link from Schedule Page.
- Checkpoints are due by 6am the day of lecture – with the exception of checkpoint 1 which is due Tuesday night at 11pm

Homework

- Credit for a problem is awarded when you submit the correct answer.
- You can work a problem as many times as needed in order to obtain full credit.
- After the due date, you will have 7 days to submit the homework for 80% credit.
- Homework is due by 11pm on the due date.

Phy1161 Lectures

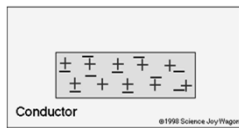
- Not everything you need!
 - Untangling and clarification of concepts & processes
 - Comprehensive Textbook
 - Calculations Homework + Discussion
 - Hands-On Lab
- Taking Notes
 - Lecture note handouts will be available online prior to class
 - Key pieces for you to fill in

Origin of Charge

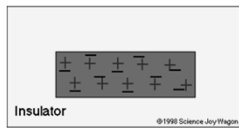
- Charge is an intrinsic property of matter
- Two types:
 - Positive Charge: Protons
 - Negative Charge: electrons
 - Opposites Attract! (likes repel)
- Atoms are neutral
 - Negatively charged electrons “orbit” $r \sim 10^{-10}$ m
 - Positively charged central nucleus $r \sim 10^{-15}$ m

Conductors and Insulators

Q: How do electrons behave in a perfect conductor?

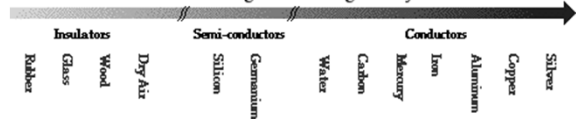


Q: How do electrons behave in a perfect insulator?



Most things are in between perfect conductor / insulator

Conductors & Insulators Increasing Conducting Ability



- Insulators: In these materials, once they are charged, the charges ARE NOT FREE TO MOVE. Plastics, glass, and other “bad conductors of electricity” are good examples of insulators.
- Conductors: In these materials, the charges ARE FREE TO MOVE. Metals are good examples of conductors.


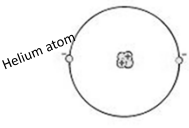
Charge

- Standard unit of charge
Coulomb (C)

Coulomb is a huge unit of charge

Charge on one electron or proton is:
 $1.602 \times 10^{-19} \text{C}$ – often given letter e

A small spark between your finger and a door knob on the order of microcoulombs
 $\mu\text{C} = 10^{-6} \text{C}$

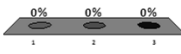



Electroscope

- Conduction**
 - Charged rod is brought near scope
 - Charged rod touches scope transferring some charge
 - Scope is left w/ same charge as rod
- Induction**
 - Charged rod is brought near scope
 - Scope is briefly grounded allowing charge to flow on (or off) scope
 - Scope is left w/ opposite charge as rod

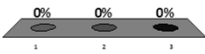
A negatively charged rod is used to charge an electroscope by induction. What is the resulting net charge on the electroscope?

- Positive
- Zero
- Negative




If the conducting electroscope were replaced by an insulating ball and then charged by induction as above, what would be the net charge on the ball.

- Positive
- Zero
- Negative

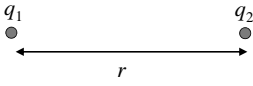


Law of Electrical Force

Charles-Augustin Coulomb
(1736 - 1806)

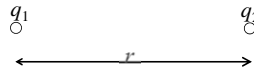


"The repulsive force between two small spheres charged with the same sort of electricity is in the inverse ratio of the squares of the distances between the centers of the spheres"



$$F \propto \frac{q_1 q_2}{r^2}$$

Coulomb's Law

$$F = k \frac{q_1 q_2}{r^2}$$


MKS Units:

- r in meters
- q in Coulombs
- F in Newtons

$k = 9 \cdot 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
 ↑
 Coulomb's constant

$k = \frac{1}{4\pi\epsilon_0}$
 ϵ_0 : permittivity of free space
 $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{N}\cdot\text{m}^2$

Summary

- Charges come in two varieties
 - ← negative and positive
 - ← in a conductor, *negative* charge means extra mobile electrons, and *positive* charge means a deficit of mobile electrons
- Coulomb Force**
$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2}$$
- Law of Superposition**
$$\vec{F} = \vec{F}_1 + \vec{F}_2$$

Gravitational vs. Electrical Force

$$F_{elec} = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2} \quad \longrightarrow \quad \frac{F_{elec}}{F_{grav}} = \frac{q_1q_2}{m_1m_2} \frac{4\pi\epsilon_0}{G}$$

$$F_{grav} = G \frac{m_1m_2}{r^2}$$

For an electron:

$$\begin{matrix} * |q| = 1.6 \times 10^{-19} \text{ C} \\ m = 9.1 \times 10^{-31} \text{ kg} \end{matrix} \quad \longrightarrow \quad \frac{F_{elec}}{F_{grav}} = 4.17 \times 10^{42}$$

* smallest charge seen in nature!

In the picture below, what is the direction of the force on the proton due to the electron?

- Left
- Right
- Zero

$Q_p = 1.6 \times 10^{-19} \text{ C}$ $Q_e = -1.6 \times 10^{-19} \text{ C}$

0% 0% 0%
 1 2 3

- What is the magnitude of the force on the proton due to the electron?

$q_p = 1.6 \times 10^{-19} \text{ C}$ $q_e = -1.6 \times 10^{-19} \text{ C}$

F = _____ N

A positive and a negative charge with equal magnitude are connected by a rigid rod, and placed near a large negative charge. What is the direction of the net force on the two connected charges?

- Left
- Zero
- Right

Positive charge is attracted (force to left)
 Negative charge is repelled (force to right)
 Positive charge is closer so force to left is larger.

0% 0% 0%
 1 2 3

To Do

- Purchase your clicker.
- Read Sections 19-1 -- 19-5
- Do checkpoint 1 before 6:00 AM 1/10/13.
- Watch PreLecture-2 before 6:00 AM 1/10/13.
- Do checkpoint 2 before 6:00 AM 1/10/13.

See you next time!