

Welcome to Physics 102!

- Electricity + Magnetism

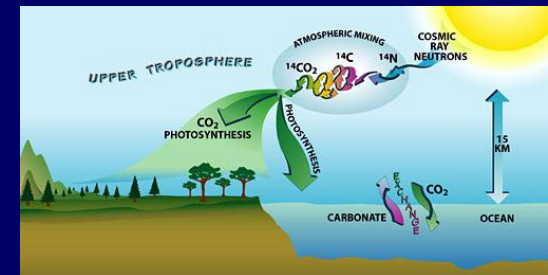
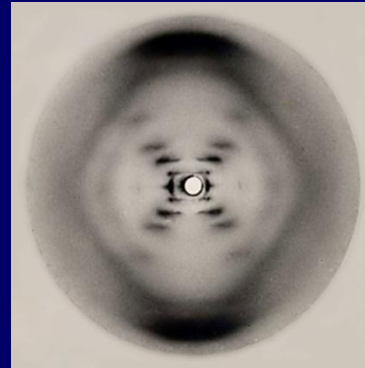
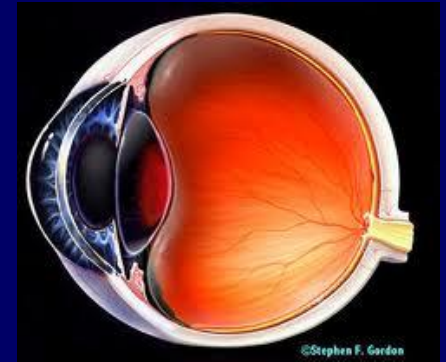
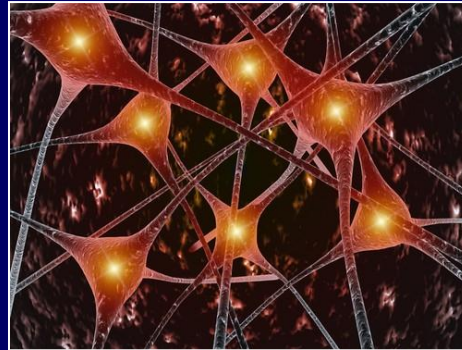
(at the heart of most processes around us:
...in atoms & molecules; living cells)

- Optics

- Atomic Physics

- Nuclear Physics

- Relativity



Meet the Lecturer

- Prof. _____

email:

- Research:

- Office Hours: _____

Course Website

- ---
- Daily Planner
 - what you should be doing and when you should be doing it
- Course Description
- Required Materials
 - Be sure to register your i-Clicker prior to lecture
- Lectures
 - posted after the lecture is given
- First Discussion:
- First Lab:
- Exam dates: 7 pm

Course Philosophy

- Read about it (textbook)
- Untangle it (lectures)
- Play with it (labs)
- Challenge yourself (homework)
- Close the loop (discussion/quiz)

The order is important!

Prerequisite!

Content

Physics 101

Macroscopic

- Kinematics
- Forces
- Energy
- Fluids
- Waves (Sound)

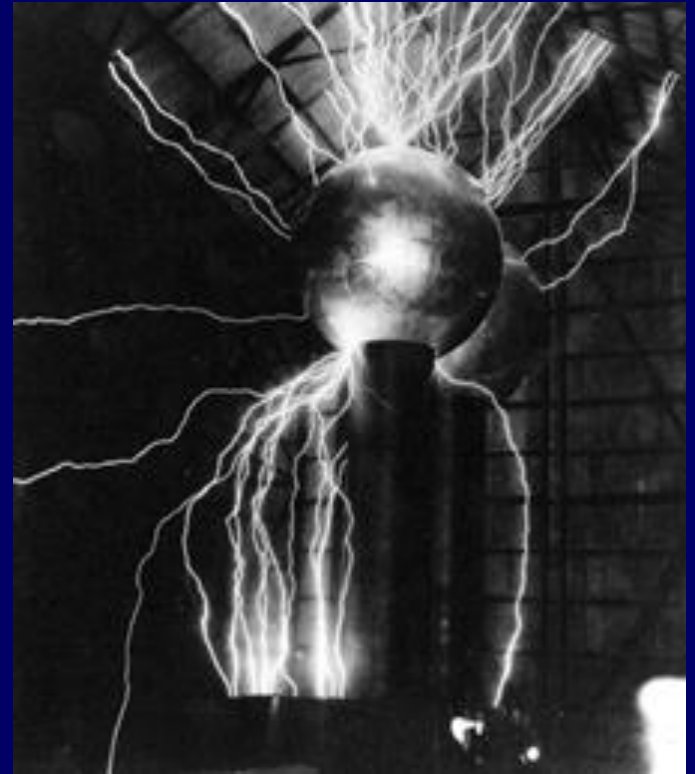
Physics 102

Microscopic

- Electricity+Magnetism
- Circuits
- Optics
- Modern
 - Atomic
 - Nuclear
 - Relativity

Physics 102: Lecture 01

Electric charge & Coulomb's Law

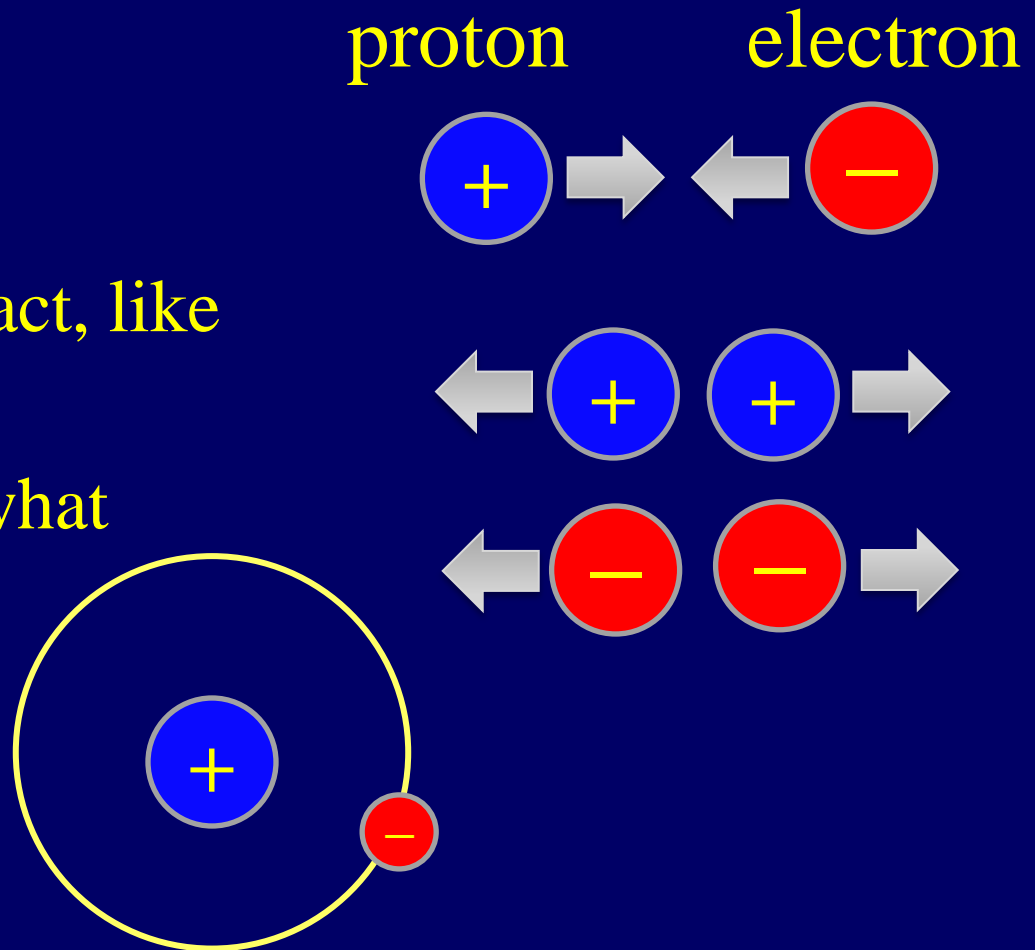


Origin of Charge

Charge is an intrinsic property of matter

- Two types:
 - Positive Charge
 - Negative Charge
 - Opposite charges attract, like charges repel.
 - The electric force is what holds stuff together

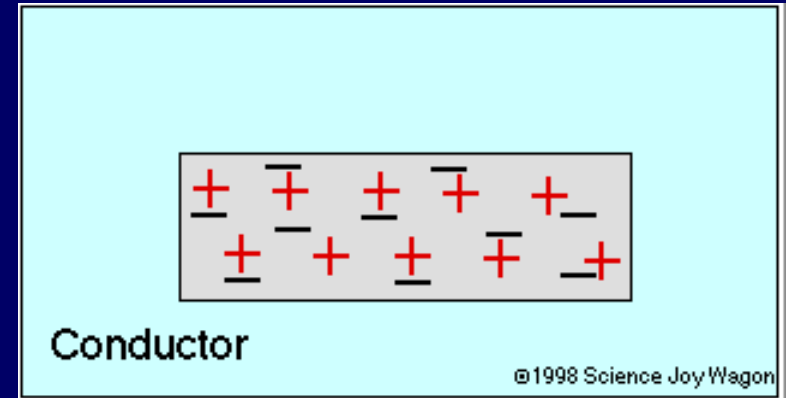
- Atoms are neutral
 - electron “orbits” the positive nucleus



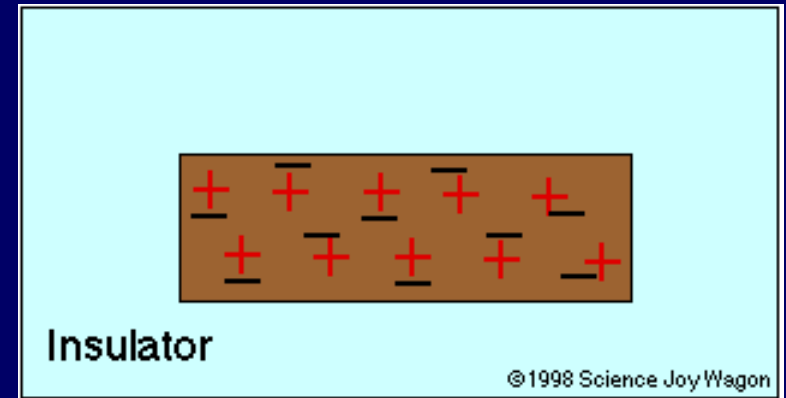
Conductors and Insulators



Q: How do electrons behave in a perfect conductor?



Q: How do electrons behave in a perfect insulator?

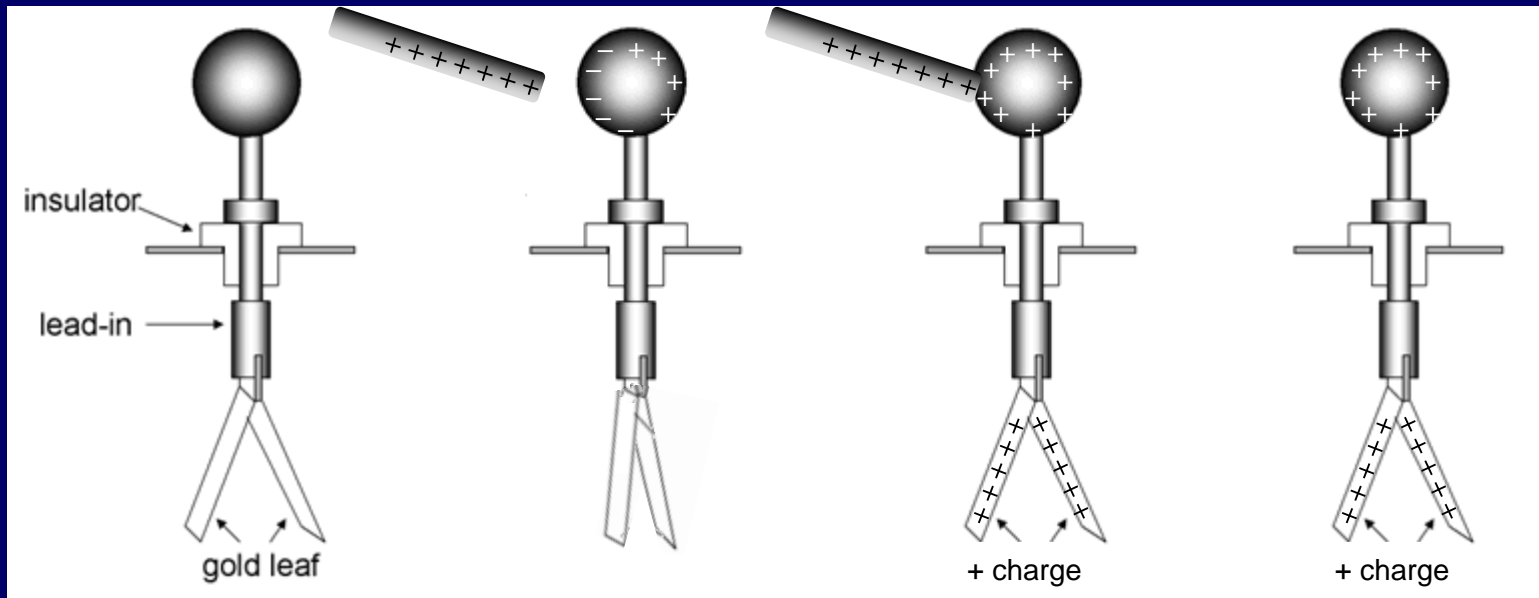


Most things are in between perfect conductor / insulator



Electroscope (+demo)

- Conduction
 - Charged rod is brought near scope
 - Charged rod touches scope transferring some charge
 - Scope is left w/ same charge as rod

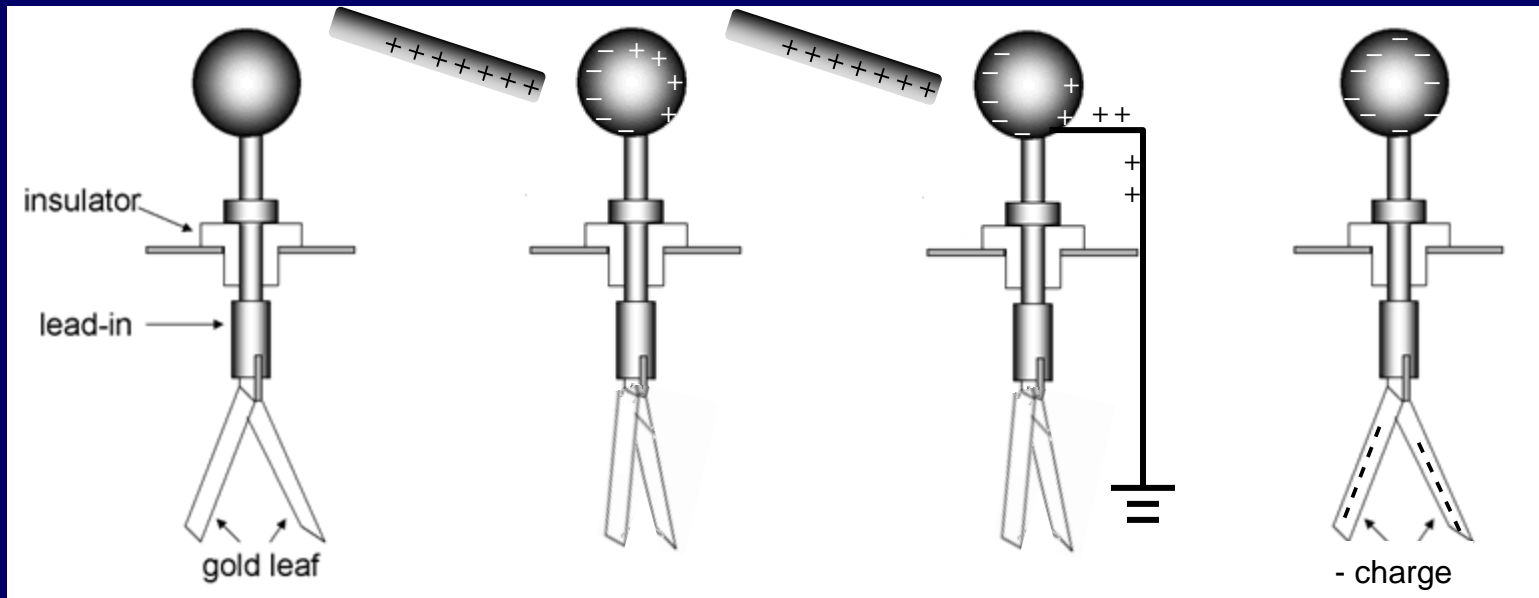




Electroscope (+demo)

- 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



ACTS



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

A) positive B) zero C) 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.

A) positive B) zero C) negative

Coulomb's Law



Force between charges q_1 and q_2 separated a distance r :

Magnitude

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

“Coulomb constant”

$$k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$$

Or: $F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$

“Permittivity of free space”

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$$

Direction

Opposite charges attract, like charges repel

Example

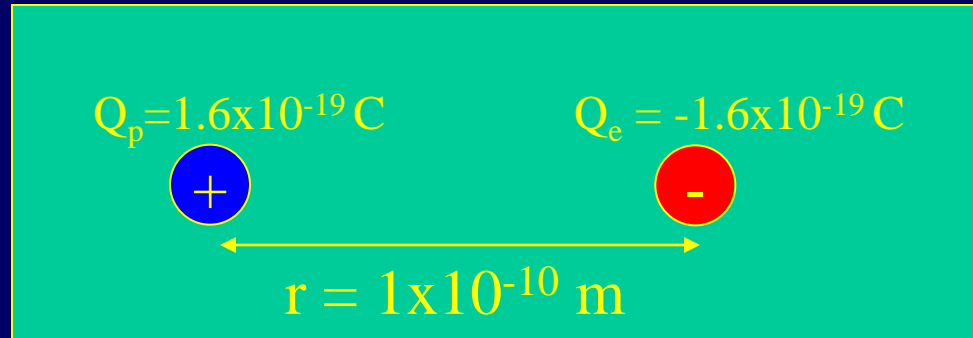


Coulomb's Law

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

$$F = k q_1 q_2 / r^2$$

$$k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$$



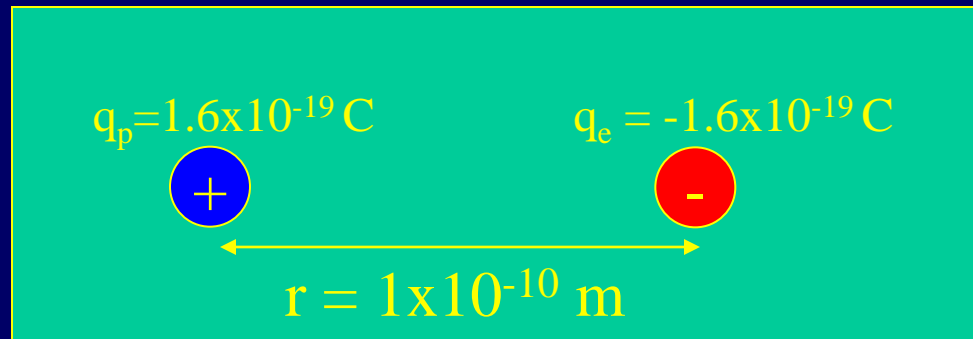
$$F = 9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2} \frac{(1.6 \times 10^{-19} \text{ C})(1.6 \times 10^{-19} \text{ C})}{(1 \times 10^{-10} \text{ m})^2} = 2.3 \times 10^{-8} \text{ N}$$



ACT: Coulomb's Law

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

(A) Left (B) Right (C) Zero

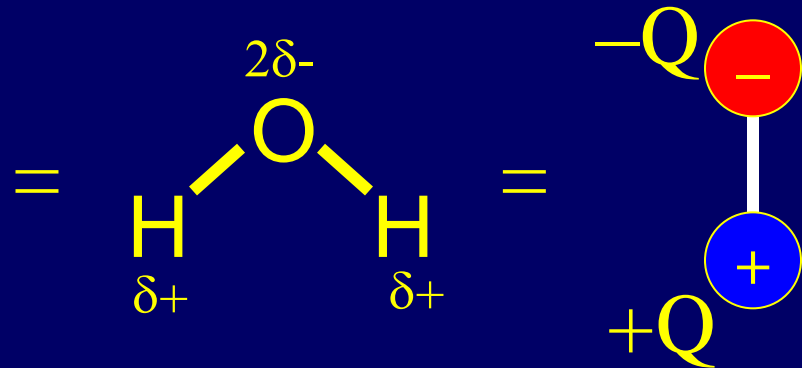
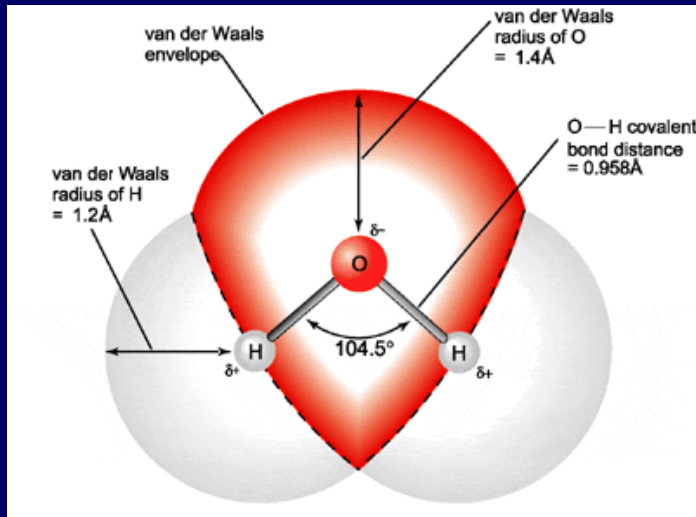


- What is the direction of the force on the electron due to the proton?

Electric dipole

A positive and negative charge of equal magnitude separated by a (usually small) distance

Ex: water





ACT

An electric dipole is placed near a large negative charge.
What is the net force on the two connected charges?

A) Left

B) Zero

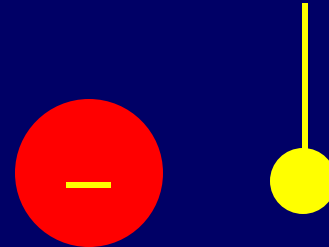
C) Right



ACT: Induced Dipole

- An uncharged conducting sphere is hung next to a charged sphere. What happens when the uncharged sphere is released?

- 1) Nothing
- 2) Attracted to charged sphere.
- 3) Repelled from charged sphere.



Summary of Today's Lecture

- The concept of charge
- Conductors and insulators
- Coulomb's Law for the force between charges

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

- Much more on Coulomb's Law in next lecture
- Electric dipoles (permanent & induced)

Prior to next lecture....

- Do your CheckPoint
before _____ AM on the day of lecture.