Chapter 16

Electric Forces and Fields

Electric Charge

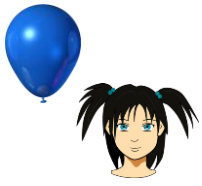
16.1

Objectives

- **Understand** the basic properties of electric charge.
- **Differentiate** between conductors and insulators.
- **Distinguish** between charging by contact, charging by induction, and charging by polarization.

Intro

- What happens when you rub a balloon on your head (hair) and then take it away?

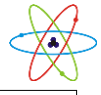
- Why does this happen?

Intro

- What would happen if you rubbed 2 balloons on your head (hair) and brought them near each other?


Properties of Electric Charge

- There are 2 types of charge
  - Positive (protons)
  - Negative (electrons)



Representations of charges and electric fields	
Positive Charge	+q
Negative Charge	-q
Electric Field Vector	E
Electric Field Lines	

Properties of Electric Charge

- Like charges repel each other

- Opposite charges are attracted to each other

How do you charge something

- The transfer of electrons
- Chem recap:
  - Neutrons and protons are in the nucleus
    - and pretty much stuck there
  - Electrons move around the nucleus
    - You can remove these
  - When charge is transferred, the electrons are transferred from one object to another
    - Your hair to a balloon
  - The charges atoms are called ions
    - Cation (+) and Anion (-)

Properties of Electric Charge

- Electric charge is *quantized.* Which means its charge is always a multiple of a *fundamental unit of charge*.
- The fundamental unit of charge, *e*, is the magnitude of the charge of a single electron or proton.

$$e = 1.602\ 176 \times 10^{-19}\ \text{C}$$

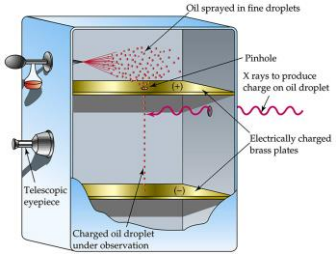
Charge is measured in coulombs (C).

Subatomic Info

Subatomic Particle	Charge (C)	Mass (kg)
Proton	1.602×10^{-19}	1.673×10^{-27}
Electron	-1.602×10^{-19}	9.109×10^{-31}
Neutron	0	1.675×10^{-27}

Millikan's Experiment

- So, he determined the charge of the electron!



Transfer of Electric Charge

- Why can you charge a balloon but you cannot charge a metal spoon?
- An **electrical conductor** is a material in which charges can move freely.
  - Spoon

- An **electrical insulator** is a material in which charges cannot move freely.
  - Balloon

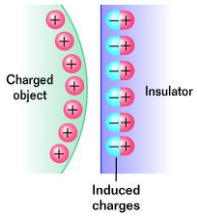
Transfer of Electric Charge

- Special Cases
- Semiconductors
  - They do not conduct electricity in their pure state
  - You can add "impurities" to change that
    - These are used in electronics (Si, Ge)
- Superconductors
  - They are ZERO electrical resistance
  - There must be below a particular temp.

Transfer of Electric Charge

- Insulators and conductors can be charged by contact.
- Conductors can be charged by **induction**.
- **Induction** is a process of charging a conductor by bringing it near another charged object and grounding the conductor.

Transfer of Electric Charge



- A surface charge can be induced on insulators by *polarization.*
- With polarization, the charges within individual molecules are realigned such that the molecule has a slight charge separation.