 Phys 1402 Lecture 1 8/27/2015

General Physics II
Dr. Spirko
Electricity & Magnetism

- Blackboard - Lecture section only
- WebAssign - Link from Bb.
- Web Folder - Syllabus
  - Class notes
  - Handouts

Require SMTE-0095

Topics

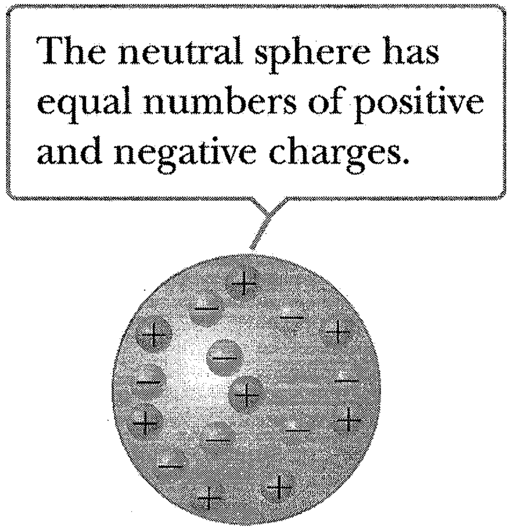
- I Static Elec & DC Circuits
  - Chap 15-18
- II Magnetism & AC Circuits
  - Chap 19-21
- III Waves, Light, Optics
  - Chap 13-14, 21, ~~[illegible]~~ 22-25

Why?

- Our society runs on electricity
  - energy
  - information tech
- Part of light & optics
- EM holds the world together.

What is our model of reality?

- Atoms with positive and negative charges.



- Like charges repel, opposites attract.
- Since atoms are neutral, there is a balance of attraction and repulsion, and we don't normally see electrical effects.
- All positive nuclei locked in place unless the object moves.
- Most negative electrons locked in place. Think orbitals, chemical bonds.
- Sometimes electrons can jump from atom to atom, but only if they are replaced. This allows a net flow of electrons which is an electrical current. Whether this happens determines the type of material:
    - Conductor: Electrons can move around (only if replaced)
    - Insulator: Virtually all electrons stuck to their respective atoms.
    - Semiconductor: Electrons moderately locked in place, can be ripped away. This allows us to control the electrical currents.
- I like thinking of materials like marbles in an egg crate.

To understand what's going on, we need some physics models.

Model 1: Coulomb's Law

If we have just **two small charges**, they will attract or repel.

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

$F_G = G\frac{Mm}{r^2}$

- F is the component of the force. Slightly more than just a magnitude (+ is repulsion, – is attraction)
- k is a physical constant, $k = 9 \times 10^9\ \mathrm{N \cdot m^2/C^2}$
- q_1 and q_2 are the amounts of charge involved. Measured in coulombs (which is actually a lot of charge). As an example, the charge of an electron is -1.6×10^{-19} C.
- r is the center-to-center distance between the charges.

Notice that this is a lot like the law of universal gravity.

For more than two charges, you have to focus on just one charge (your object) and figure out how much force each other charge (the sources of the forces) exerts. Add the forces as vectors.

1402 Can we feel the Coulomb force? Yes. Hair standing on end.

Model 2: Electric Fields

When we did gravity, we didn't use G M m / r^2 from the start. Instead, we used g*m. This allowed us to ignore the radius and mass of Earth and concentrate on our objects. We can do the same thing with electricity.

$$F = qE$$

$F_g = mg$

- F is the component of the force. Slightly more than just a magnitude (+ is repulsion, – is attraction)
- q is the amount of charge of our object. We don't need the charges of the sources.
- E is the Electric Field. Measured in N/C, it includes the effects of all of the source charges. We don't care about the details.

How do we create the electric field? It comes from the source charges.

- Point source:

$$E = k\frac{q}{r^2}$$

  Notice that this looks like part of Coulomb's Law. It is. This is also a vector component, and it points away from a positive charge and toward a negative charge. Notice also that it gets weaker as you get further from the source.
- For multiple sources, total up the electric field vectors caused by each. This can be a pain, so some sources have been done for us.

What kinds of charge can we analyze now?

- Free charge, flying through space.
- Mobile charge on a conductor.
- Charge on an insulator.