Physics 100
Electricity Notes, Part I

I. General Principles

A. Matter is made of atoms

B. Atoms are made of protons, neutrons and electrons

C. These particles that make up the atom have an electric charge.

Proton +

Neutron 0 (neutral)

Electron −

D. Electric charges exert a force on one another.

Two positive charges will repel each other.

Two negative charges will repel each other.

A positive charge and a negative charge will attract each other.

E. If an object is "charged" we know that it has either an excess of electrons or a lack of electrons.

F. A neutral object may have positive and negative charges, but its net charge is zero.

II. Units

A. Force Newton N

B. Charge Coulomb C

C. Charge on 1 electron -1.6×10^{-19} C

D. Charge on 1 proton 1.6×10^{-19} C

E. 1 Coulomb (6.25×10^{18} electrons) the amount of charge passing through a 100 watt bulb in about 1 second.

-0.000000000000000016 C

III. Coulomb's Law

$9 \times 10^9 \frac{Nm^2}{C^2}$

A. $F = k \frac{q_1 q_2}{d^2}$ (q_1, q_2 ← separated charges; d ← distance between charges)

$\left(\frac{1}{2}\right)^2$ $\left(\frac{1}{3}\right)^2$

B. Coulomb's Law is an inverse square law

If the distance between two charges doubles, the force ~~decreases by~~ becomes 1/4.

If the distance between two charges triples, the force ~~decreases by~~ becomes 1/9.

IV. Conservation of Charge

A. Electrons are neither created nor destroyed.

B. Within a system, the net charge does not change.

Example: A closed system comprises object A (charge = 2C) and object B (charge =-3C)

1. What is the net charge in the system? $2C + (-3C) = -1C$
2. ~~Which object has more electrons? B~~
3. If object A's charge changes to 4C, what is object B's new charge?

$4C + x = -1C \quad x = -5C$

V. Conductors and Insulators

A. In some kinds of matter, electrons are not anchored to their atoms' nuclei; they can "roam around" to some extent. These materials are called conductors. Metals are typically good conductors.

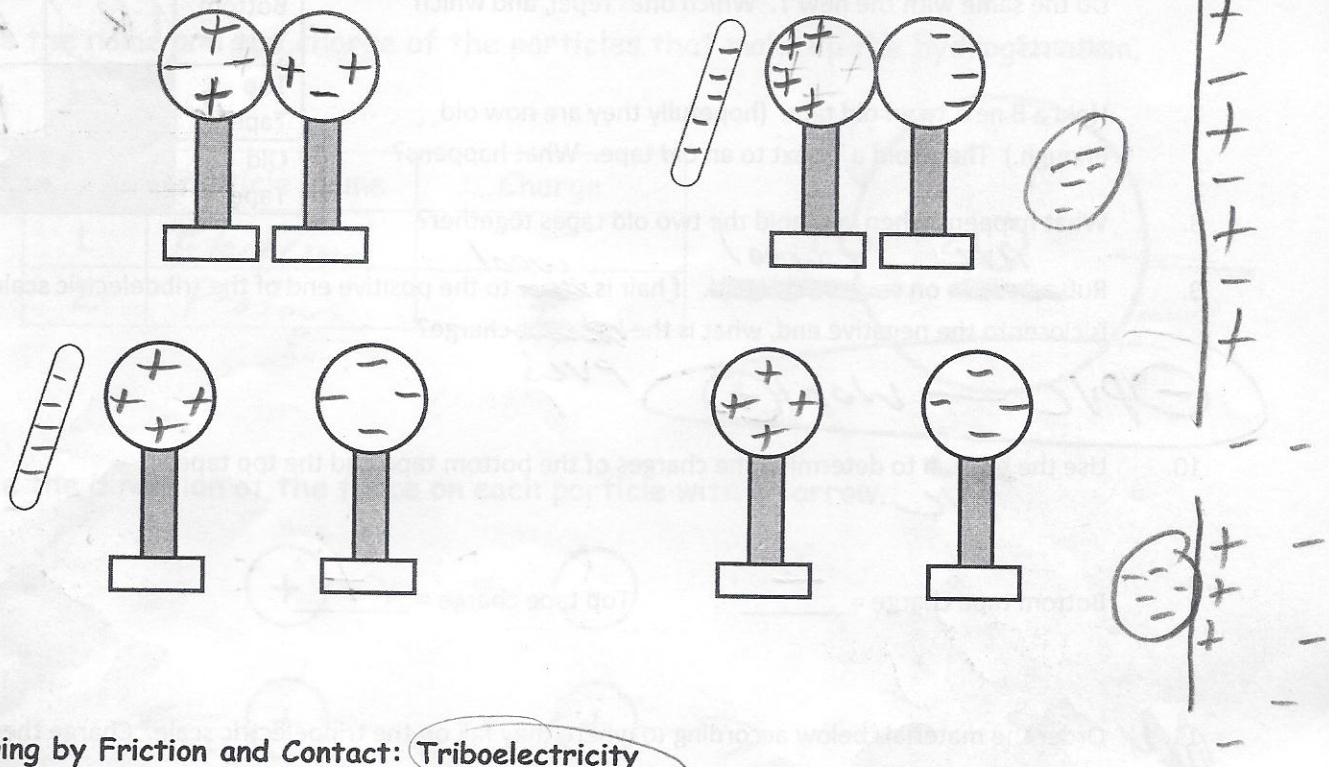
B. In some kinds of matter, the outer electrons can barely move at all. These materials are called insulators. Glass and rubber are typically good insulators.

C. Semiconductors are materials that be made to sometimes behave as insulators and other times behave as conductors.

D. Superconductors are materials whose electrons may (at low temperatures, for example) roam entirely free, with no resistance whatsoever.

VI. Induction

When a charged object is brought near a neutral object, the neutral object will undergo "separation of charges". This is called charging by ___induction___.



VII. Charging by Friction and Contact: Triboelectricity

For reasons that are not entirely understood, when two materials are brought into contact and then separated, one may become positively charged, while the other becomes negatively charged. Electricity created in this way is called ___triboelectricity___.

The separated charges that result are often called ___static electricity___, because they do not move (until they are brought into contact with another object of different charge).

Activity: "Sticky Tape" and Triboelectricity

1. Hang two pieces of tape from the edge of the table. Let them hang there and age. These will be called the "old tapes."

2. Attach a "base tape" to the table. Then stick another tape on top of it, folding over one end as a handle. Label it "B" (for bottom) or remember that it's the "b" tape.

3. Stick another tape on top of the "b" tape. Make a handle on the same end as the "b" tape handle. Label this one "T" (top).

4. Grab the B tape and pull up both tapes. Then pull them apart. Hold them back to back so they don't stick. What happens? Do they attract or repel? Fill in each open cell in the table on the right with "A" for "attract" or "R" for "repel."