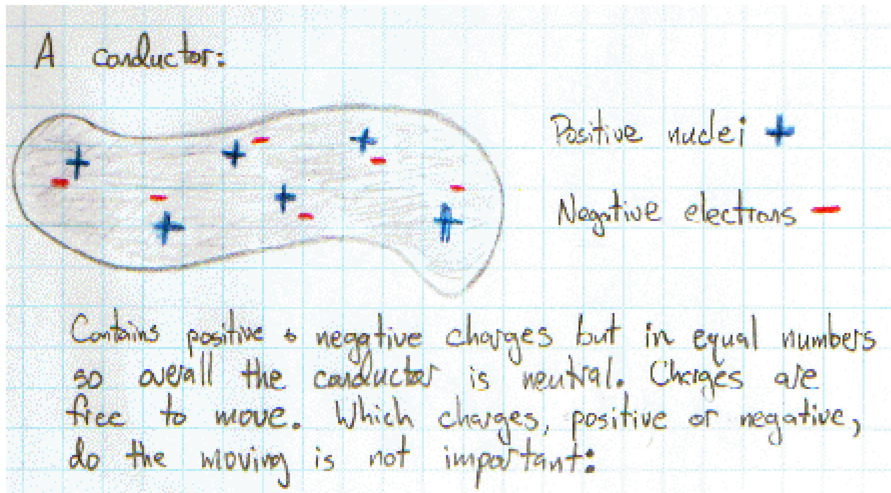
DAY 8

Summary of Topics Covered in Today's Lecture

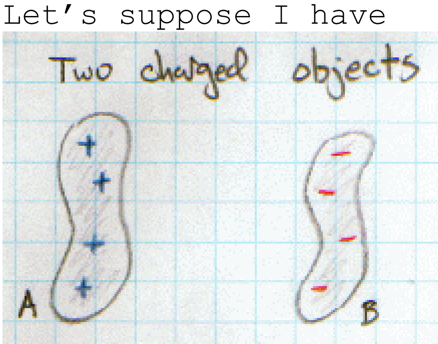
Conductors in Electrostatic Equilibrium

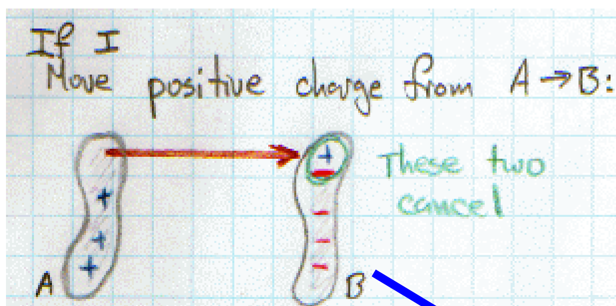
Electrostatic Equilibrium means that the conductor is in equilibrium, and there is no motion of charges.

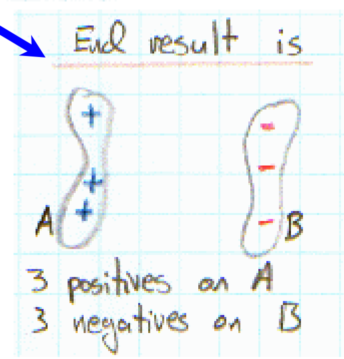


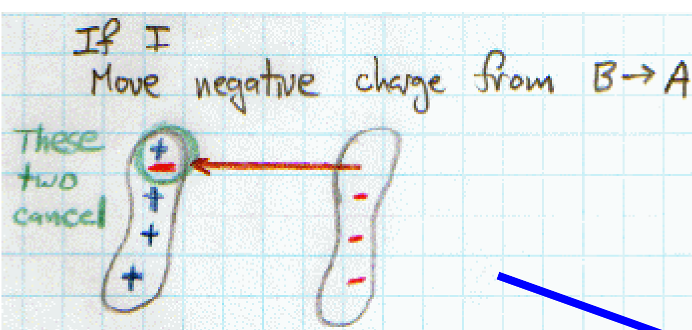
Why is it not important whether positive or negative charges are thought to be moving?

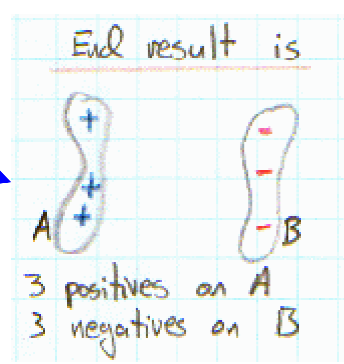
Let's suppose I have







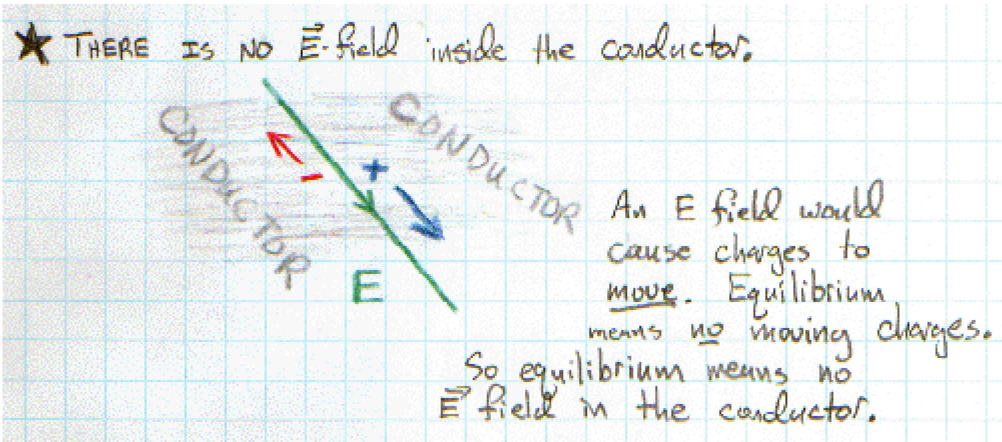




So whether positive charges move or negative charges move, the result is the same.

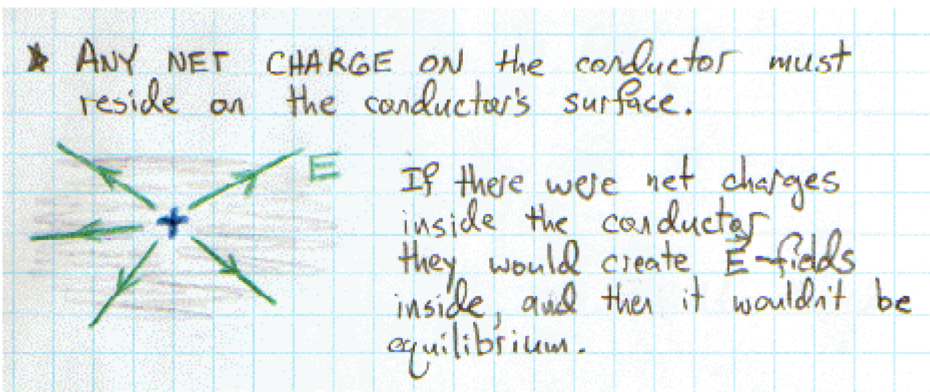
When a conductor is in electrostatic equilibrium, certain rules apply:

#1



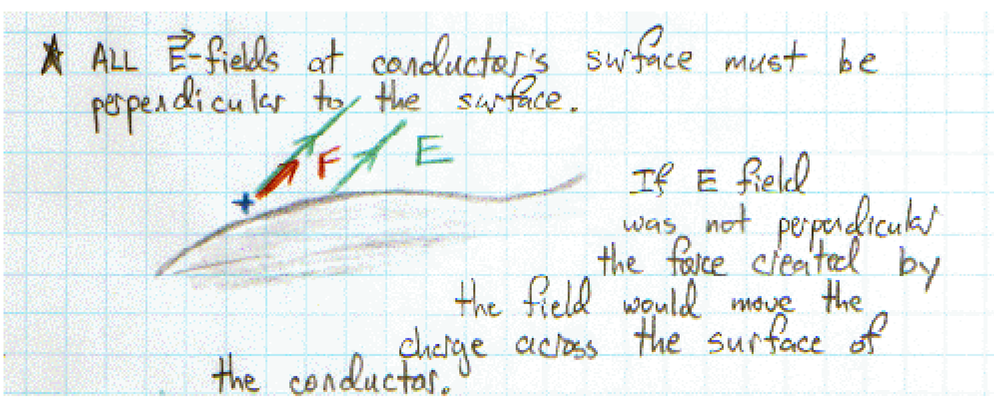
No E-field inside conductor.

#2



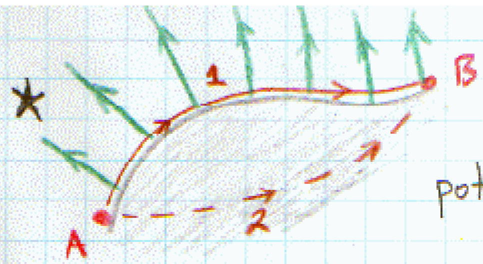
Any net charge is on conductor's surface.

#3



E-fields are perpendicular to conductor's surface.

#4



All points on a conductor are at the same potential.

If I want to find the potential difference between A & B, I use

$\Delta U_{AB} = -\vec{E} \cdot \vec{r}$

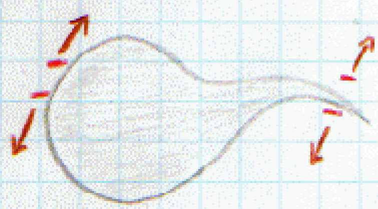
But if I go from A → B via path 1, $\vec{E}$ & $\vec{r}$ are always perpendicular. If I go via path 2, E = 0.

Either way, $\Delta U_{AB} = 0$, meaning $U_A = U_B$. A & B have same potential.

All points on conductors are at the same potential (voltage).

#5

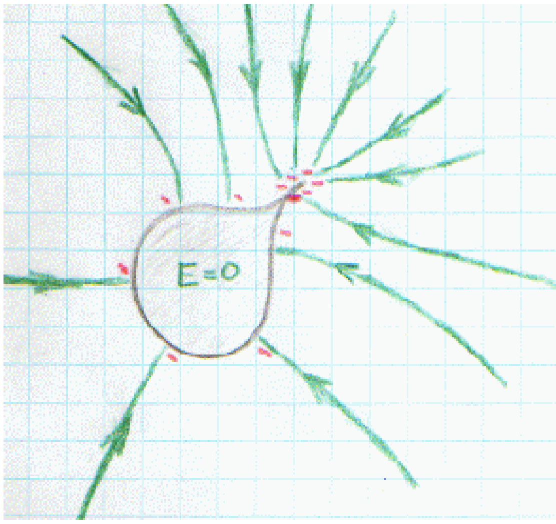
★ CHARGE is densest, and $\vec{E}$-field strongest, around sharp points on a conductor



The forces between these two cause them to move away from each other

The forces between these two try to push the charge off the conductor. That can't happen unless the insulator that surrounds the conductor (air, vacuum, etc) breaks down. The forces do not cause the charges to move away from each other.

Charge is densest and E-field strongest near points.



A conductor in equilibrium.

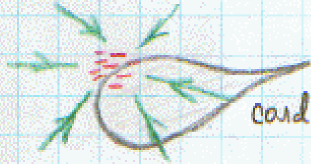
The conductor is carrying a net negative charge.

TWO THINGS TO REMEMBER:

1 There is charge inside the conductor, but it all cancels out + thus has no effect.

2 The rules for conductors in Electrostatic Equilibrium are the result of equilibrium. The rules don't create the equilibrium.

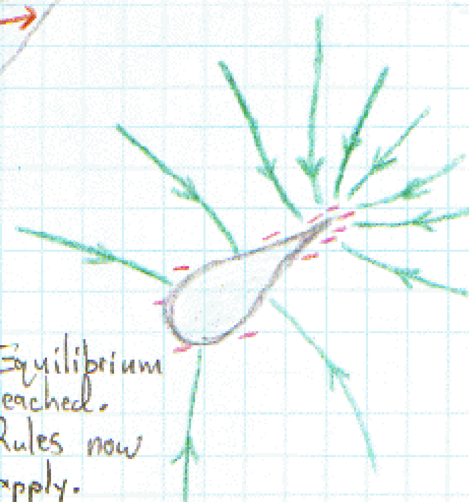
For instance, if a bunch of negative charge is placed on a conductor, there is not equilibrium and the rules don't apply; but very quickly the charge will spread itself out + reach equilibrium.



Charge placed on conductor.

Charge spreads out.

This process happens very rapidly in most cases.



Equilibrium reached. Rules now apply.

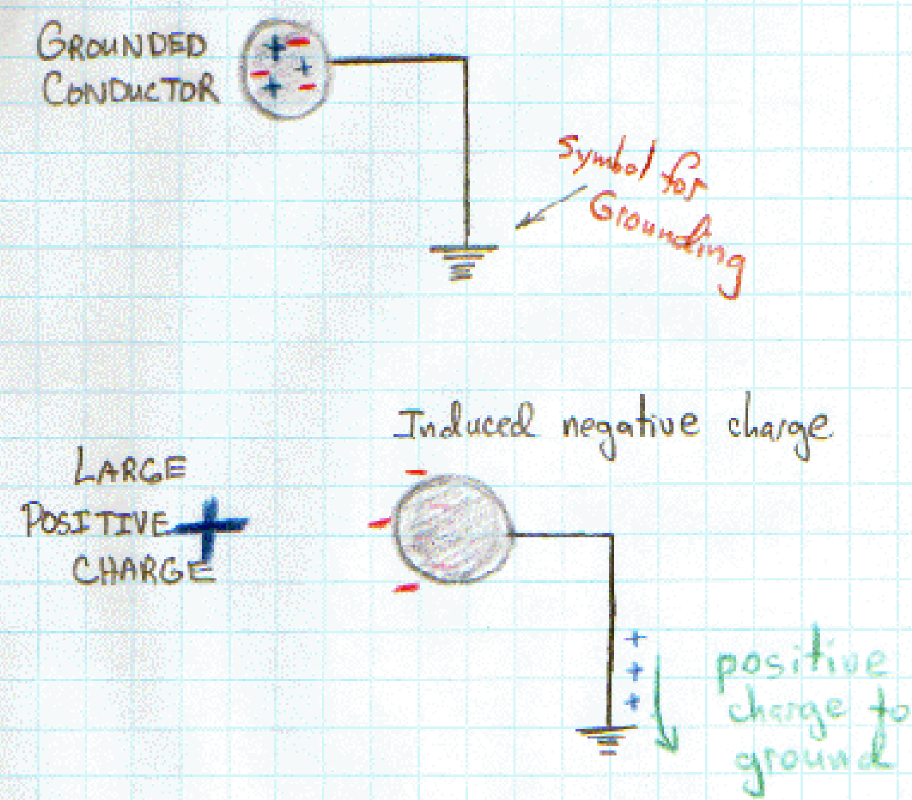
Grounding

GROUNDING is simply connecting a conductor to the Earth. The Earth is so large it can accept or give up large amounts of charge without becoming charged itself.

The Earth is often defined as being at potential of 0 Volts. Any conductor connected by a conductor to ground is at 0 Volts, too.

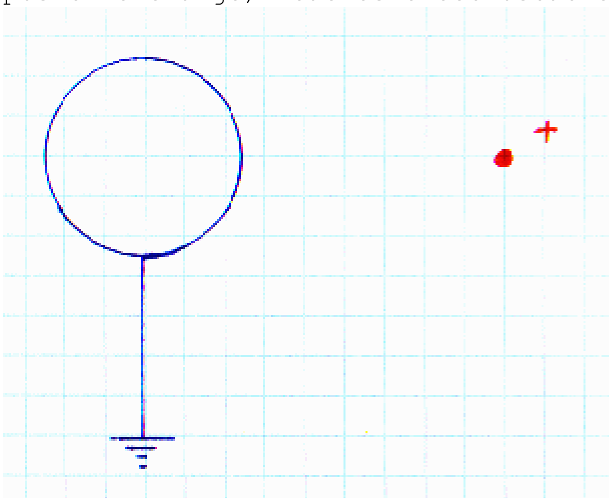
Induction

INDUCTION occurs when a large charge "induces" charge on a conductor:

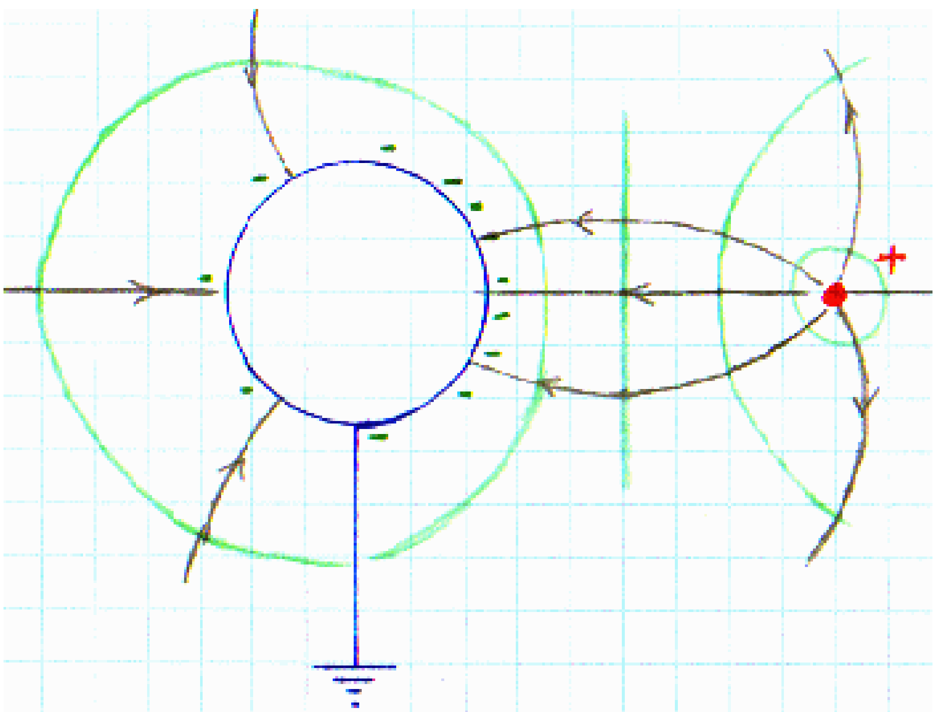


Example Problem #1

Sketch the field, distribution of charge, and equipotential surfaces when the system below (consisting of a grounded spherical conductor and a large positive charge) reaches electrostatic equilibrium.



Solution:



The positive charge has induced a negative charge on the sphere – the sphere's positive charges have gone to ground. The negative charges are attracted to the positive charge and therefore are a little denser on the side of the sphere nearest the positive charge. Note the field lines are perpendicular to the conductor. The equipotential surfaces (light green) are perpendicular to the field lines.