Electrostatics

What is Electrostatics?

Electric charges, electric fields, and the forces between them

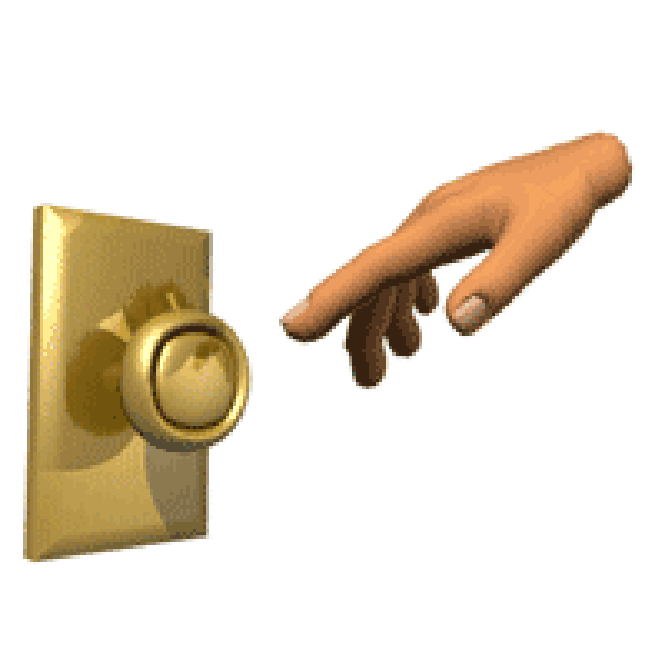
Static electricity is the build up of charges at rest upon an object.

Objects become charged when they lose or gain electrons.

Static Electricity

- Static Electricity is the build-up of charges upon an object.

- The spark was the electrons moving from your hand to the doorknob!



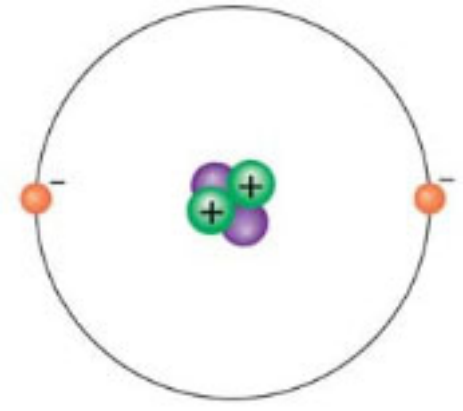
A little Chem (or is it Physics) lesson

The particles that compose atoms:

-Protons

-Neutrons

-Electrons

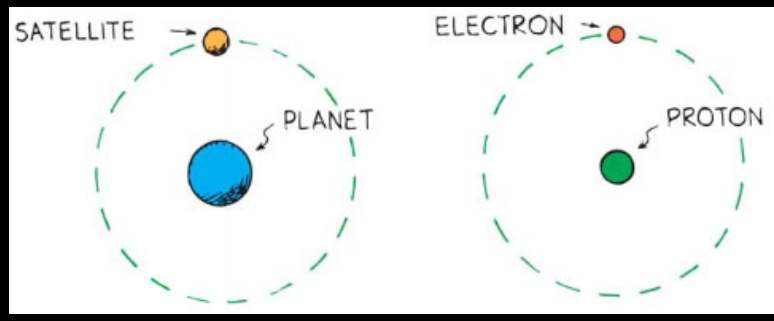


Particle:	**Charge:**	**Relative Mass:**	**Location:**
Proton	Positive (+)	big	Nucleus of the atom
Neutron	Neutral (+/-)	big	Nucleus of the atom
Electron	Negative (-)	Teeny tiny	Orbit around the nucleus

Electrons

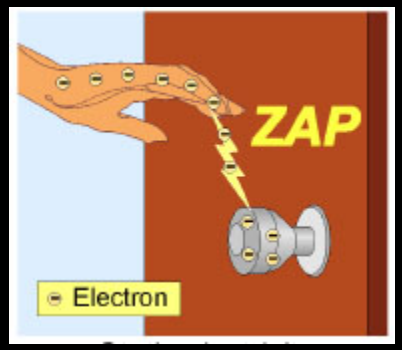
Electrons orbit the nucleus of the atom.

They are the only particles that MOVE around!



Electrons in some materials move more easily than electrons in other materials

Electricity is electrons on the move.



Electron

Negatively Charged

Located Around the Nucleus

Very small mass

Account for most of the space in an atom

Proton

Positively Charged

Located in the Nucleus

Very large mass

Account for little of the space in an atom

Neutrons

Not Charged

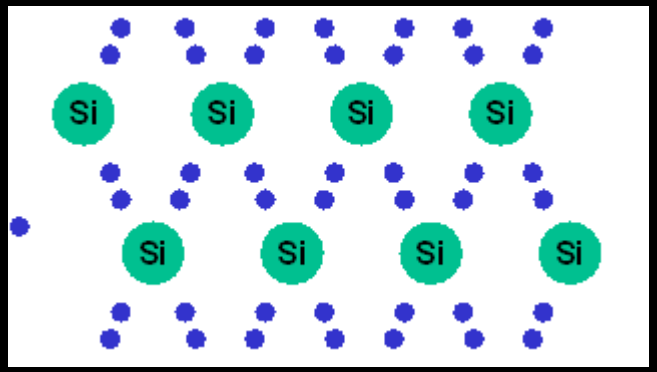
Located in the Nucleus

Very large mass

Account for little of the space in an atom

Conservation of Charge

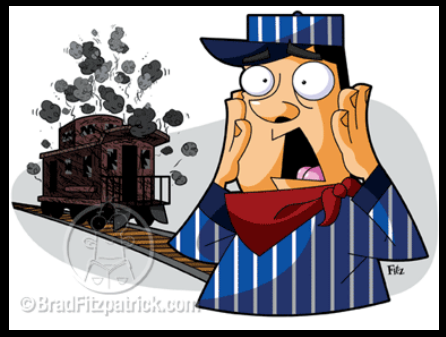
Since matter is neither created nor destroyed, electrons are neither created nor destroyed, simply TRANSFERRED.



Conductors

Electrons in conductors roam throughout the material easily. Conductors allow electric charge to flow easily through them. For the same reason, they are also good conductors of heat.

Examples: Copper, Aluminum, Iron, Gold, Silver



Conductors

Materials that have the ability to transfer charge.

Some electrons are mobile and free to move through the atomic structure.

Conductor Examples

Metals (copper, aluminum, silver, gold)

Impure water.

Wet wood.

Periodic Table of Elements

Group Number → 13
Atomic Number → 13
Name → aluminum
Atomic Mass → 26.98
Symbol → Al
Electronegativity (Pauling) → 1.61

Alkali metals
Alkaline earth metals
Transition metals
Metalloids
Other metals
Nonmetals
Noble gases
C Solid
Hg Liquid
H Gas
Tc Synthetic

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008 2.20 hydrogen																	2 He 4.003 helium
3 Li 6.941 0.98 lithium	4 Be 9.012 1.57 beryllium											5 B 10.81 2.04 boron	6 C 12.01 2.55 carbon	7 N 14.01 3.04 nitrogen	8 O 16.00 3.44 oxygen	9 F 19.00 3.98 fluorine	10 Ne 20.18 neon
11 Na 22.99 0.93 sodium	12 Mg 24.31 1.31 magnesium											13 Al 26.98 1.61 aluminum	14 Si 28.09 1.90 silicon	15 P 30.97 2.19 phosphorus	16 S 32.07 2.58 sulfur	17 Cl 35.45 3.16 chlorine	18 Ar 39.95 argon
19 K 39.10 0.82 potassium	20 Ca 40.08 1.00 calcium	21 Sc 44.96 1.36 scandium	22 Ti 47.87 1.54 titanium	23 V 50.94 1.63 vanadium	24 Cr 52.00 1.66 chromium	25 Mn 54.94 1.55 manganese	26 Fe 55.85 1.83 iron	27 Co 58.93 1.88 cobalt	28 Ni 58.69 1.91 nickel	29 Cu 63.55 1.90 copper	30 Zn 65.38 1.65 zinc	31 Ga 69.72 1.81 gallium	32 Ge 72.63 2.01 germanium	33 As 74.92 2.18 arsenic	34 Se 78.96 2.55 selenium	35 Br 79.90 2.96 bromine	36 Kr 83.80 krypton
37 Rb 85.47 0.82 rubidium	38 Sr 87.62 0.95 strontium	39 Y 88.91 1.22 yttrium	40 Zr 91.22 1.33 zirconium	41 Nb 92.91 1.6 niobium	42 Mo 95.96 2.16 molybdenum	43 Tc 1.9 technetium	44 Ru 101.1 2.2 ruthenium	45 Rh 102.9 2.28 rhodium	46 Pd 106.4 2.2 palladium	47 Ag 107.9 1.93 silver	48 Cd 112.4 1.69 cadmium	49 In 114.8 1.78 indium	50 Sn 118.7 1.96 tin	51 Sb 121.8 2.05 antimony	52 Te 127.6 2.1 tellurium	53 I 126.9 2.66 iodine	54 Xe 131.3 2.6 xenon
55 Cs 132.9 0.79 cesium	56 Ba 137.3 0.89 barium	57-71 lanthanoids	72 Hf 178.5 1.3 hafnium	73 Ta 180.9 1.5 tantalum	74 W 183.8 2.36 tungsten	75 Re 186.2 1.9 rhenium	76 Os 190.2 2.2 osmium	77 Ir 192.2 2.2 iridium	78 Pt 195.1 2.28 platinum	79 Au 197.0 2.54 gold	80 Hg 200.6 2.0 mercury	81 Tl 204.4 2.04 thalium	82 Pb 207.2 2.33 lead	83 Bi 209.0 2.02 bismuth	84 Po 2.0 polonium	85 At 2.2 astatine	86 Rn radon
87 Fr 0.7 francium	88 Ra 0.89 radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstatdtium	111 Rg roentgenium	112 Cn copernicium	113 Unnamed	114 Fl flerovium	115 Unnamed	116 Lv livermorium	117 Unnamed	118 Unnamed

57 La 138.9 1.1 lanthanum	58 Ce 140.1 1.12 cerium	59 Pr 140.9 1.13 praseodymium	60 Nd 144.2 1.14 neodymium	61 Pm 1.17 promethium	62 Sm 150.4 1.17 samarium	63 Eu 152.0 europium	64 Gd 157.3 1.2 gadolinium	65 Tb 158.9 1.3 terbium	66 Dy 162.5 1.22 dysprosium	67 Ho 164.9 1.23 holmium	68 Er 167.3 1.24 erbium	69 Tm 168.9 1.25 thulium	70 Yb 173.1 ytterbium	71 Lu 175.0 1.27 lutetium
89 Ac 1.1 actinium	90 Th 232.0 1.3 thorium	91 Pa 231.0 1.5 protactinium	92 U 238.0 1.38 uranium	93 Np 1.36 neptunium	94 Pu 1.28 plutonium	95 Am 1.3 americium	96 Cm 1.3 curium	97 Bk 1.3 berkelium	98 Cf 1.3 californium	99 Es 1.3 einsteinium	100 Fm 1.3 fermium	101 Md 1.3 mendelevium	102 No 1.3 nobelium	103 Lr 1.3 lawrencium

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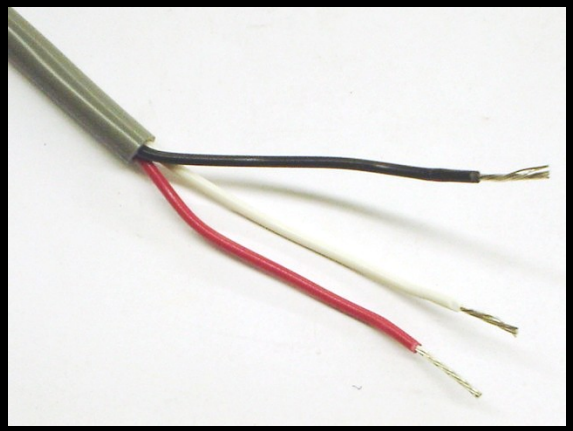
Insulators

Electrons are tightly bound to the atoms of materials called insulators. Electrons are not free to wander about. For the same reason, they are also poor conductors of heat.

Examples: Rubber, Plastic, Wood, Glass, Air



Insulators

Materials that don’t transfer charge easily.

Electrons are not very mobile and are tightly bound to the atomic structure.

Periodic Table of Elements

Group Number → 13
Atomic Number → 13
Name → aluminum
Atomic Mass → 26.98
Symbol → Al
Electronegativity (Pauling) → 1.61

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Insulator Examples

Non metals

Compounds (rubber, plastics, ceramics)

Dry wood

Pure water

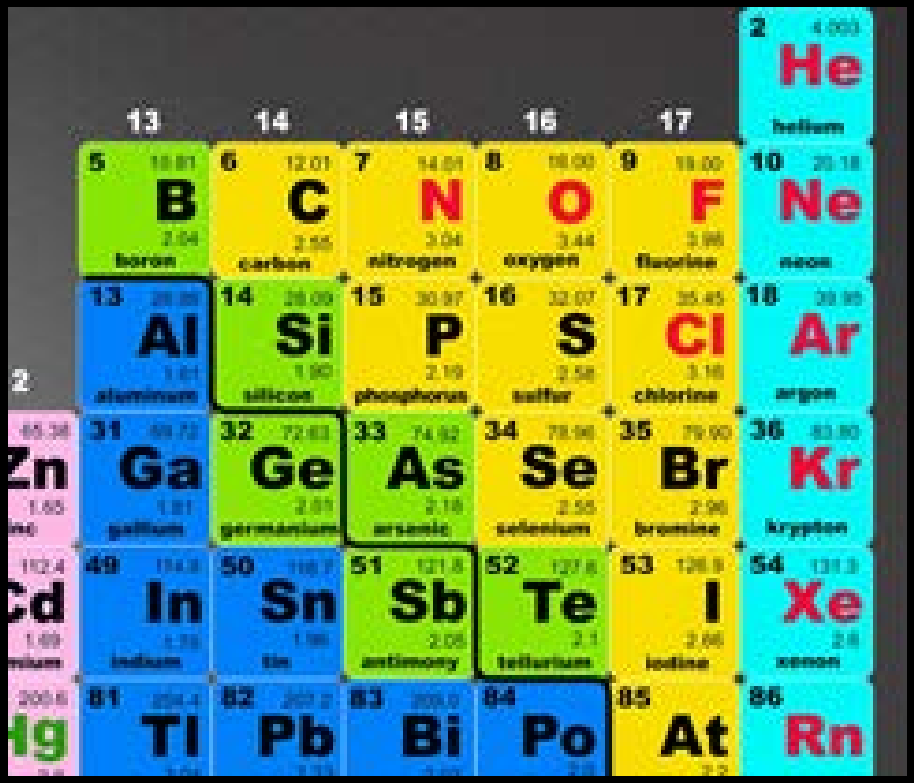
Semiconductors

Semiconductors can act as a conductor or an insulators.

Examples: Germanium and Silicon

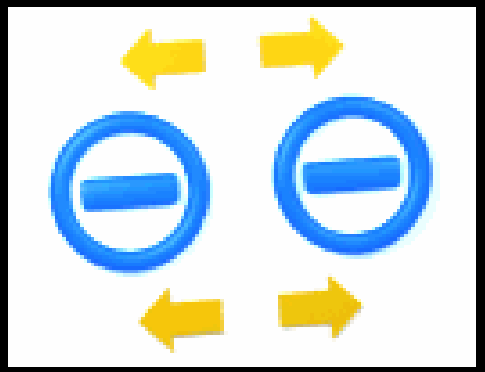
Semi Conductors

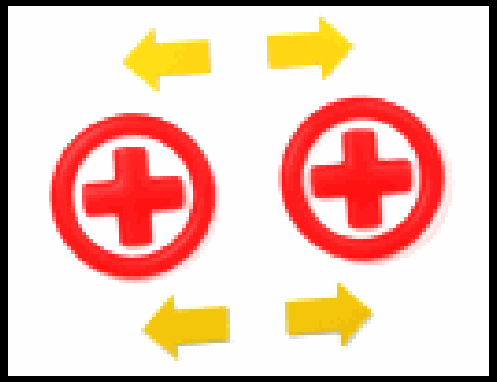
Materials that are generally insulators but can become conductors under conditions.



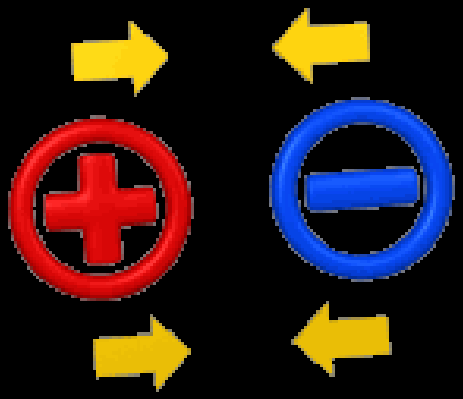
Fundamental Rules of Charge Interaction

- Like charges repel!!





- Opposite (unlike) charges attract!



Ground

The ground (earth) can give or take electrons from an object to make it neutral.

When you “ground” an object you make a conducting path to the ground allowing the object to become neutral.

How do objects become charged?

All objects have both negative and positive charges, electrons and protons.

When an object is said to be charged, we are referring to the net charge on an object.

A neutral object has the same number of electrons and protons.

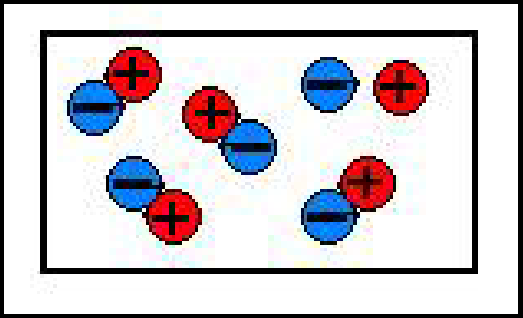
How do objects become charged?

A negatively charged object has excess electrons

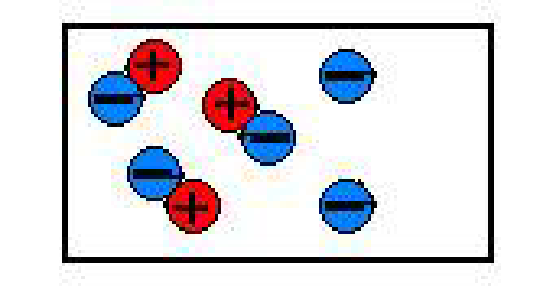
A positively charged object has an electron
deficit (too few electrons)

The Charge of Objects

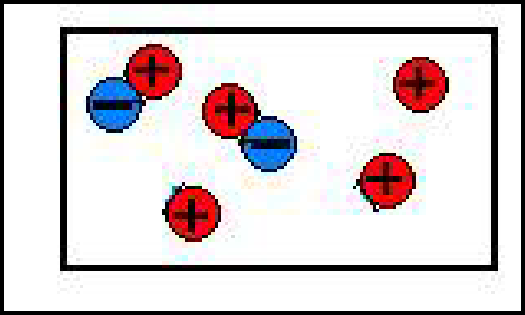
Neutral objects have a balanced amount of Positive and Negative charges.



When an object GAINS electrons it has a net negative charge.



When an object LOSES electrons it has a net positive charge.



Methods to Charge Objects

Friction: Electrons are rubbed off one object and onto another.

Conduction: Once <u>contact</u> is made, electrons flow from one object to the other.

Induction: A charged object comes NEAR a neutral one and charges are rearranged (polarized).

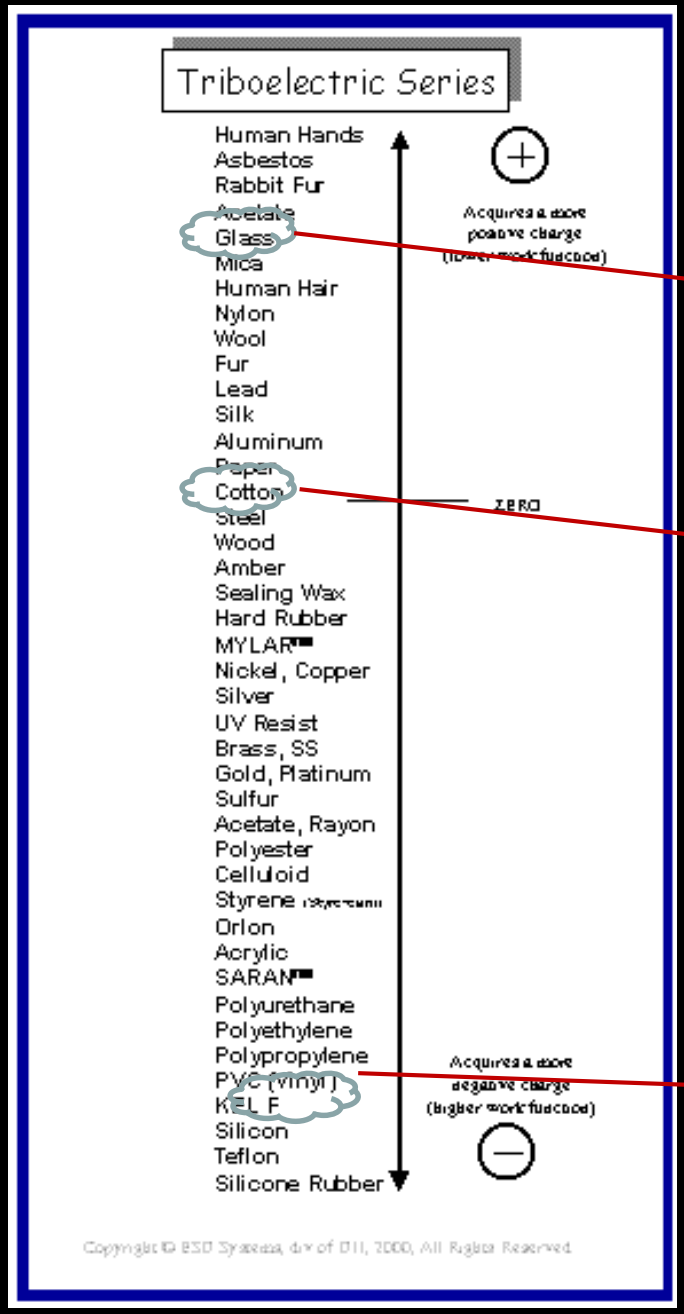
Charging by Friction

Start with two insulators

Friction strips electrons from one object to the other.

End with two equal and oppositely charged objects.

Electrostatic Series



Acetate

Paper

Vinyl

Charging by contact (conduction)

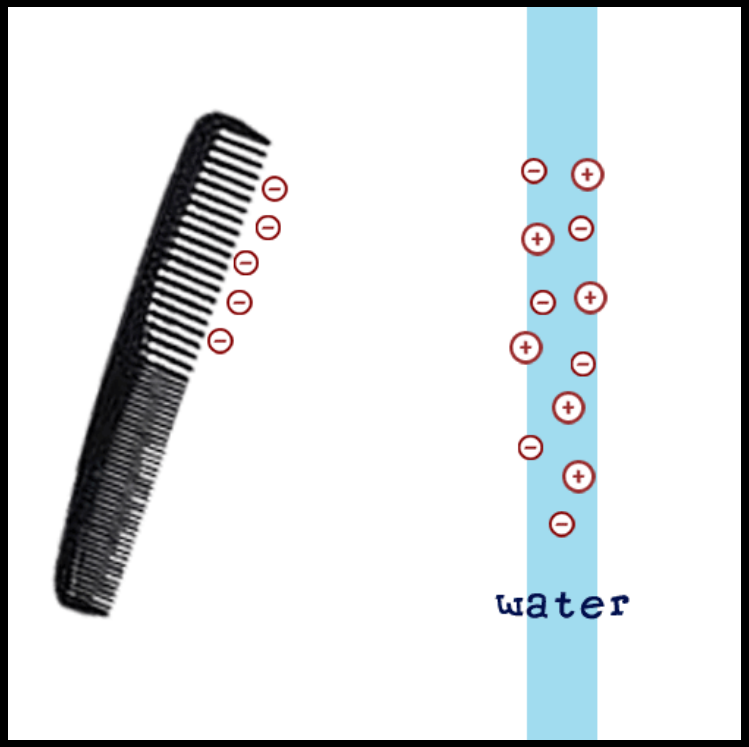
Start 1 charged object & a Neutral Conductor

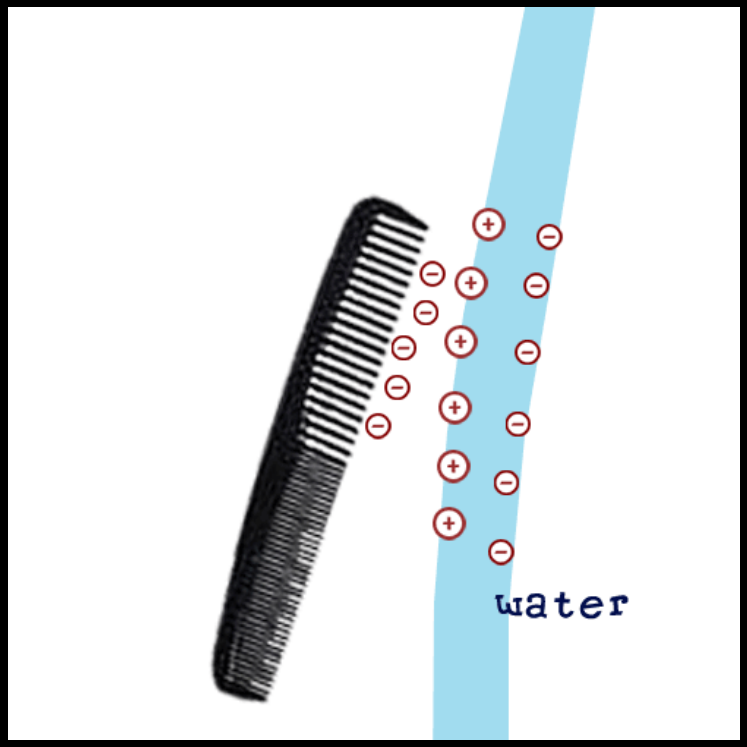
During contact electrons move to or from the conductor.

Two Like charged objects

Interactions of Charged Objects

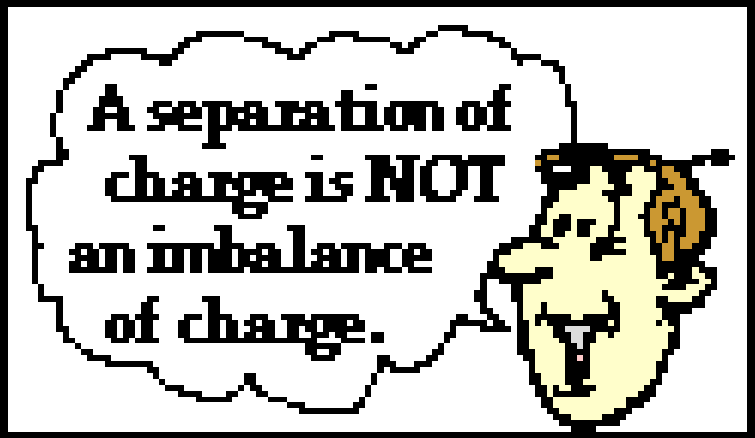
Bending water:



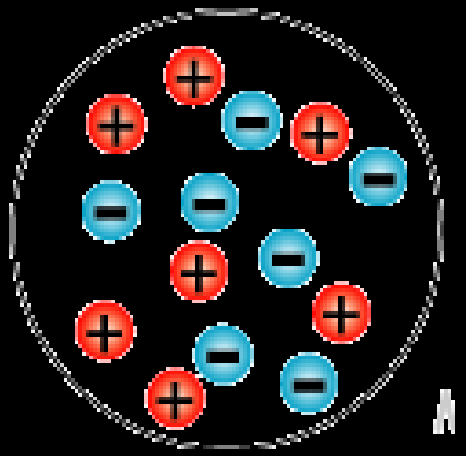


Polarization

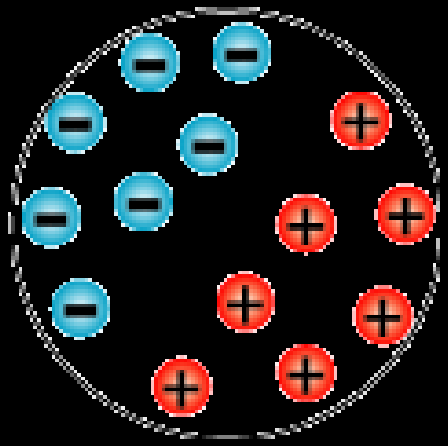
Polarization is the process of separating charges within an object.



unpolarized



polarized



Polarization (no net charge)

Start 1 charged object & a Neutral object

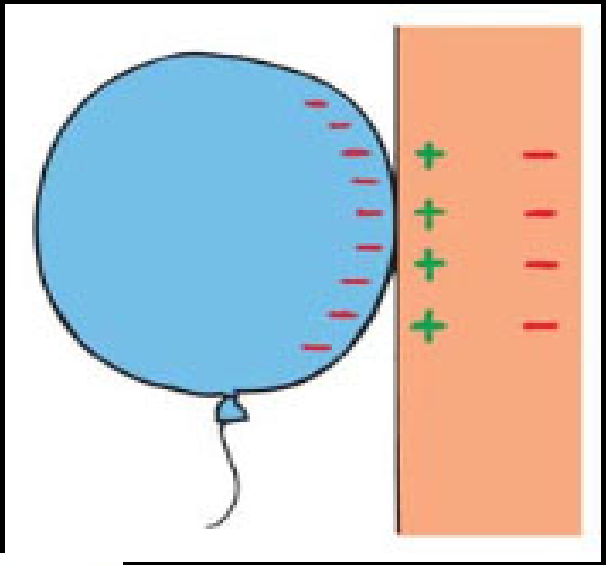
Charges in the neutral object separate while in the presence of the charged object.

Leaving one side of the neutral positive and the other negative.

Interactions of Charged Objects

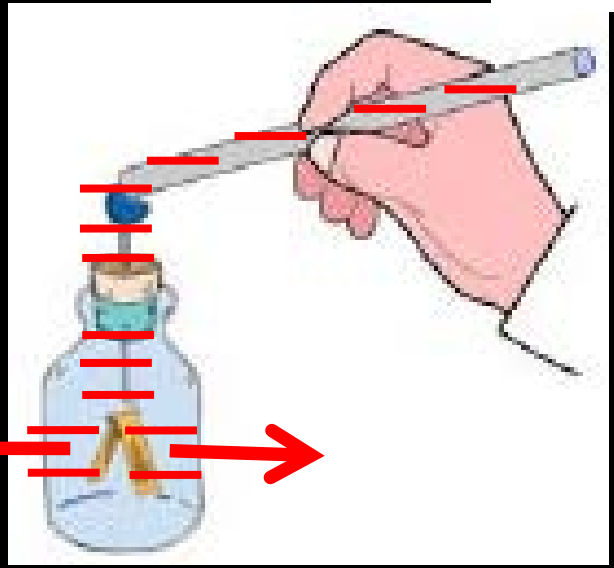
Balloon sticking to a wall:

The charges in the wall are polarized



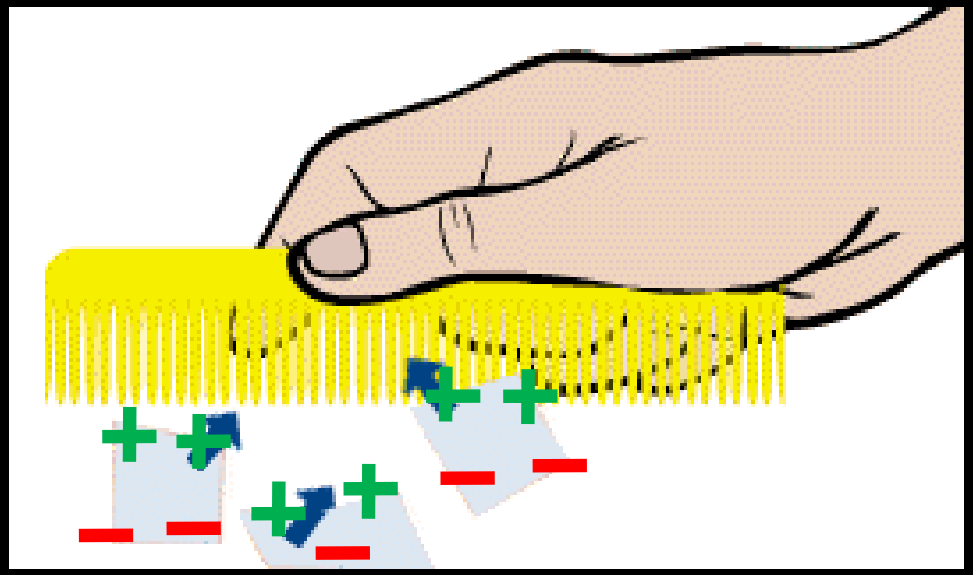
Electroscope:

(The electroscope Is charged by Conduction)



Interactions of Charged Objects

Paper pieces sticking to a charged comb:



Induction

Start charged object & 2 Neutral Conductors in contact with one another.

Polarize the conductors and split apart

Two equal and oppositely charged objects

Induction with Grounding

Start with a Neutral Conductor.

Polarize the conductor and ground it to remove electrons.

Finish with a charged object