Name _____

# Electrostatics Notes & Definitions

What are the four fundamental dimensions?

| Dimension | Symbol | Std. Unit |
|---|---|---|
| Length | L | meter (m) |
| Time | T | second (s) |
| Mass | M | kilogram (Kg) |
| Charge | Q | Coulomb (C) |

What are the dimensions of the following?

- Distance Length
- Velocity L/T $LT^{-1}$
- Area L x L $= L^2$

## Properties of charge:

Opposite charges Attract while like charges Repel .

What is the fundamental charge?

Smallest value of charge in the universe

$1.602 \times 10^{-19}$ Coulombs

How do objects become charged?

They loose or gain electrons

When we talk about the charge of an object, we are referring to the net charge or in other words, the overall charge.

- When an object is charged negative it has an excess of electrons.
- When an object is charged positive it has an deficit of electrons.
- Neutral objects have the same number of positives & negatives.

A hydrogen atom is 1 proton and 1 electron

## Atomic Particles:

### Electron

Negative Charge the value of the charge is -1 fundamental charge or $-1.6X10^{-19}$ Coulombs
Very little mass, Accounts for most of the atom's volume, and orbits the nucleus.

### Proton

Positive Charge the value of the charge is +1 fundamental charge.
Very large mass, Accounts for little of the atom's volume, and is in the nucleus.

### Neutron

No Charge, very large mass, accounts for little of the atom's volume, and is in the nucleus.

## Material Properties:

### Conductor

Materials that allow charge to pass through them easily be cause they have some mobile/free electrons in their atomic structure.

#### Examples:

Metals (Silver, Gold, Copper, Aluminum)
Wet wood, impure water.

### Insulator

Materials that do not allow charge to pass through them easily because their electrons are strongly bonded to the nucleus.

#### Examples:

Non metals, compounds(rubber, glass ceramic)
Air, pure water, dry wood.

### Semiconductor

Materials the can be either conductors or insulators based on certain conditions.

### Ground

The earth has the ability to accept or give electrons in order to make something neutral. The action is we say that we are grounding an object. To ground an object we giving it a a conducting path to the ground.

When a positive object is grounded, it attracts electrons from the earth making it neutral. When a negative object is grounded, it sends electrons to the ground making it neutral.

# Electrostatics

# What is Electrostatics?

Electric charges, electric fields, and the forces between them

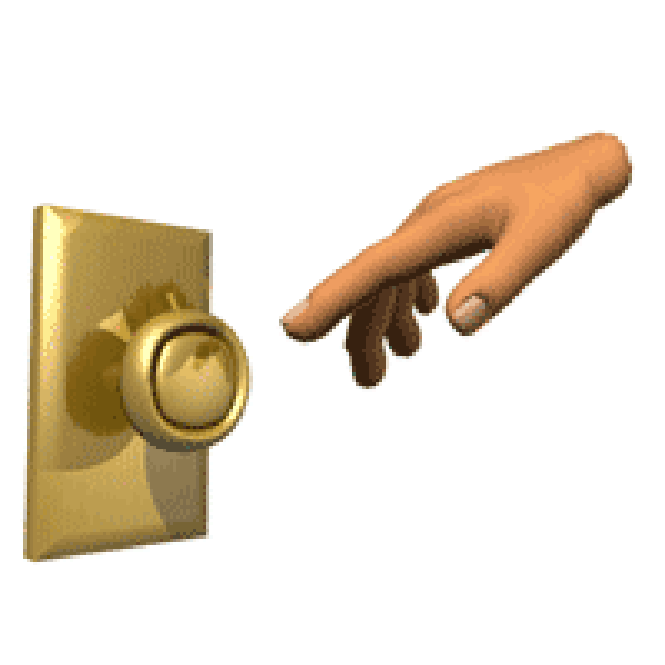
Electrostatics is electricity at rest.

Static electricity is the build up of charges on an object.

# Static Electricity

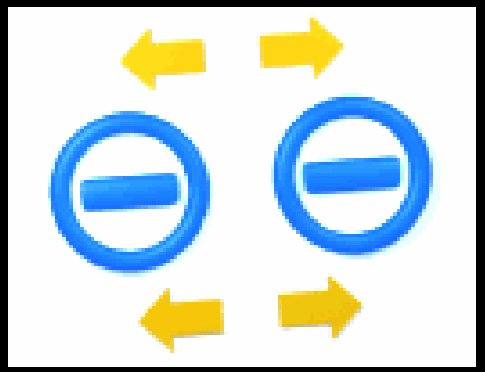
- Static Electricity is the build-up of charges upon an object.

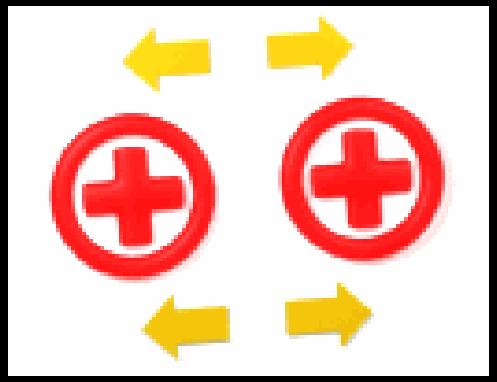
- The spark was the electrons moving from your hand to the doorknob!



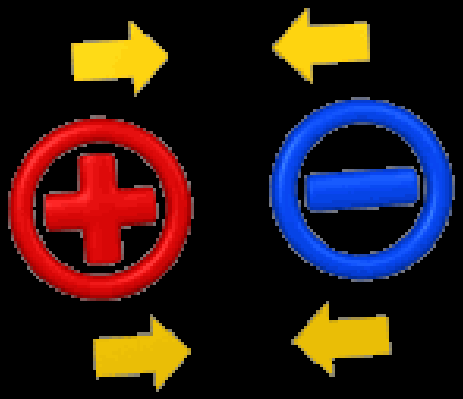
# Rules for Charge Interaction

- Like charges repel!!





- Opposite (unlike) charges attract!



# What is the fundamental charge?

Fundamental charge is the smallest charge possible. Electrons & protons carry a fundamental charge of -1 and +1

The value of the fundamental charge is $1.602 \times 10^{-19}$ Coulombs.

- The electron ($e^-$) charge is $-1.602 \times 10^{-19}$ C.
- The proton ($p^+$) charge is $+1.602 \times 10^{-19}$ C.
- A proton ($p^+$) combined with an electron ($e^-$) have a net charge of zero.

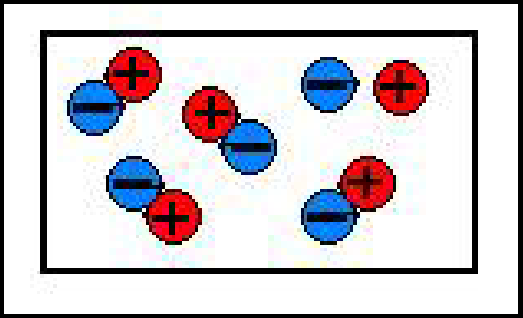
# How do objects become charged?

A negatively charged object has excess electrons

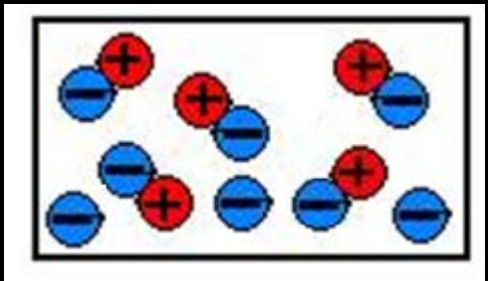
A positively charged object has an electron deficit (too few electrons)

# The Charge of Objects

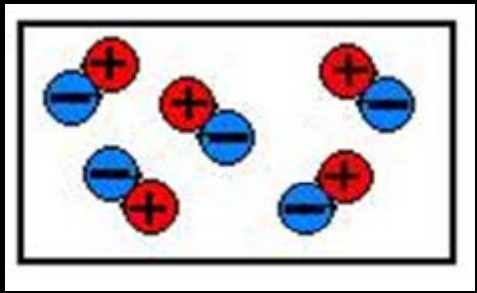
Neutral objects have a balanced amount of Positive and Negative charges.



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



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



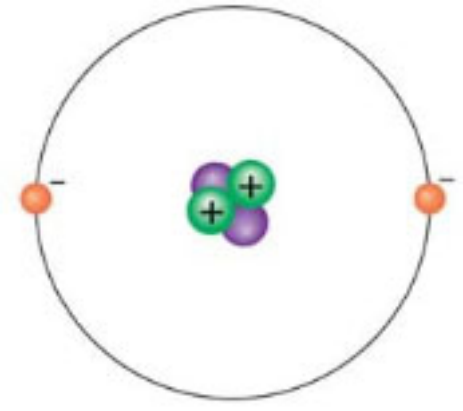
# A little Chem (or is it Physics) lesson

The particles that compose atoms:

-Protons

-Neutrons

-Electrons

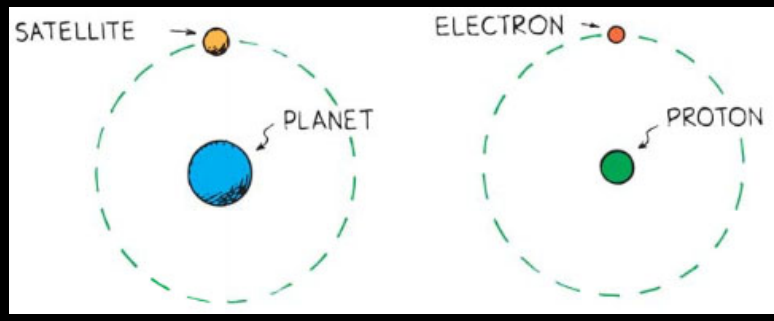



| **Particle:** | **Charge:** | **Relative Mass:** | **Location:** |
|---|---|---|---|
| Proton | Positive (+) | big | Nucleus of the atom |
| Neutron | Neutral (+/-) | big | Nucleus of the atom |
| Electron | Negative (-) | Teeny tiny | Orbit around the nucleus |

# Electrons

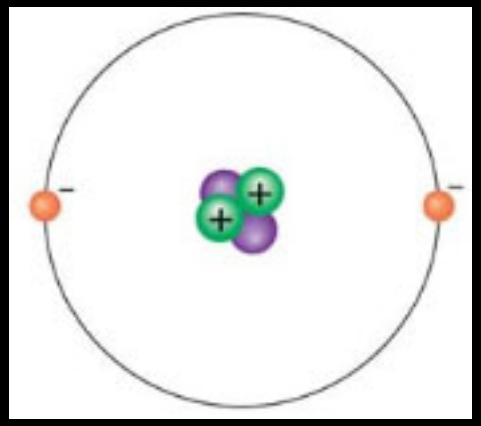
Electrons orbit the nucleus of the atom.

They are the only particles that MOVE around!




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

# Electron $e^-$



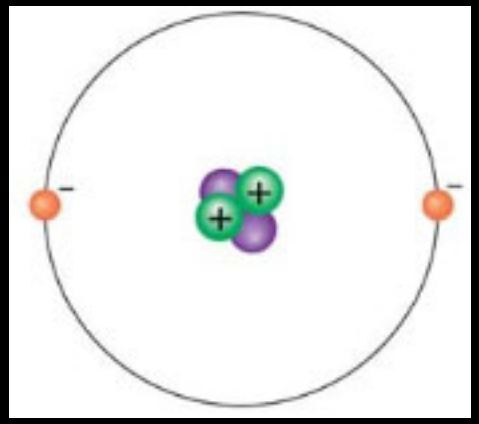

Negatively Charged

Located Around the Nucleus

Very small mass

Account for most of the space in an atom

# Proton $p^+$




Positively Charged

Located in the Nucleus

Very large mass

Account for little of the space in an atom

# Neutrons

Not Charged

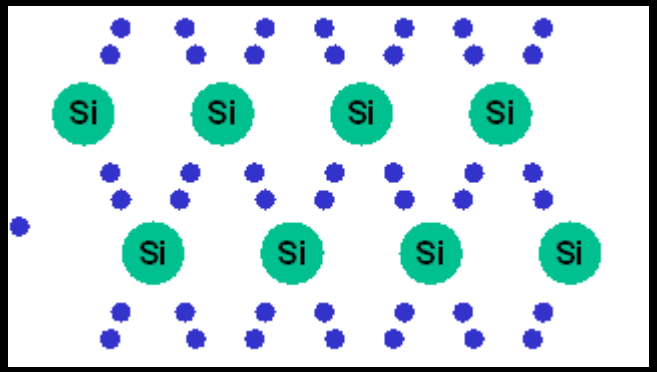
Located in the Nucleus

Very large mass

Account for little of the space in an atom

# Conservation of Charge

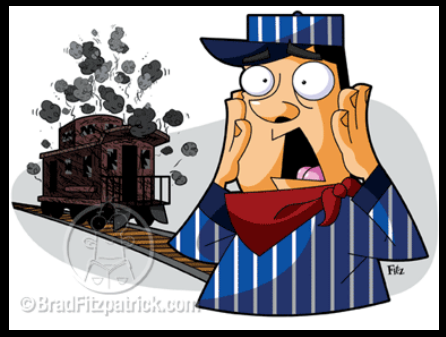
Since matter is neither created nor destroyed, electrons are neither created nor destroyed, simply TRANSFERRED.



# 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 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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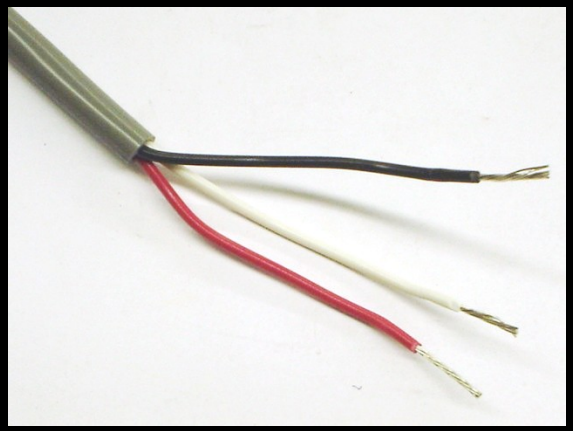
# Insulators

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

Alkali metals
Alkaline earth metals
Transition metals
Metalloids
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Nonmetals
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Hg Liquid
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Tc Synthetic

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# Insulator Examples

Non metals

Compounds (rubber, plastics, ceramics)

Dry wood

Pure water

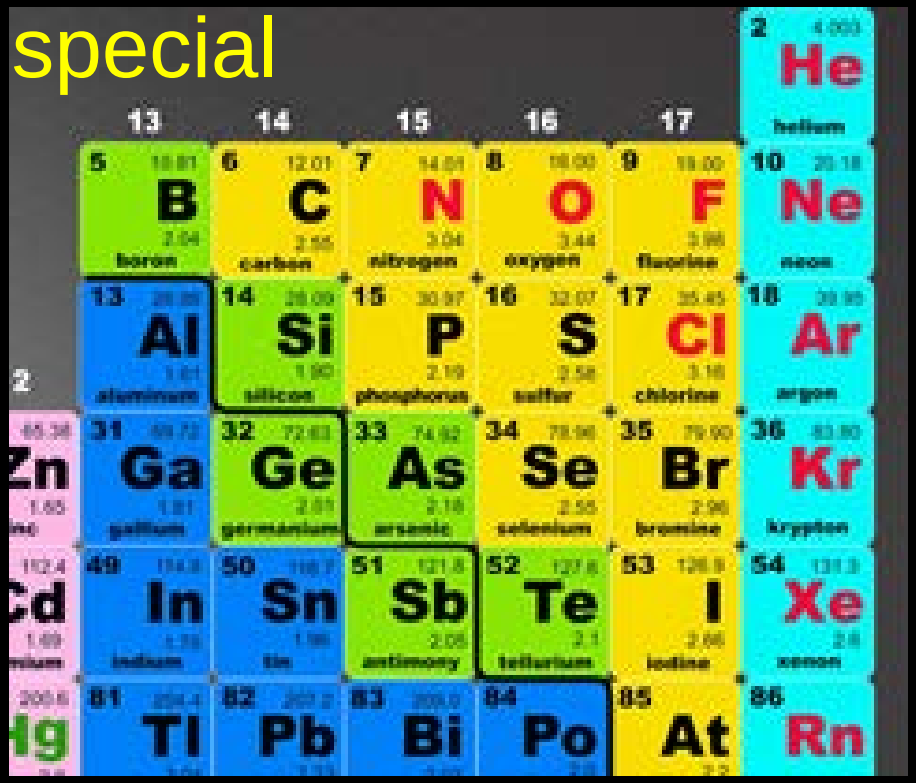
# Semiconductors

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 special conditions.



# 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.