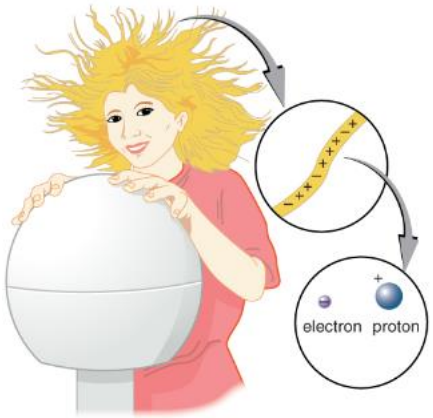
Electricity

A form of energy resulting from the existence of charged particles (such as electrons or protons).

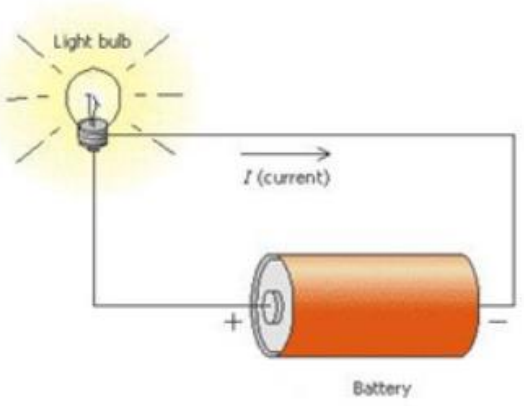
Two main types of electricity

1) Static Electricity - generally defined as the build-up of electric charge on the surface of a material.

- It is called <u>static</u> electricity because the charges don't move.



2) Current Electricity - defined as the controlled flow of an electric charge.



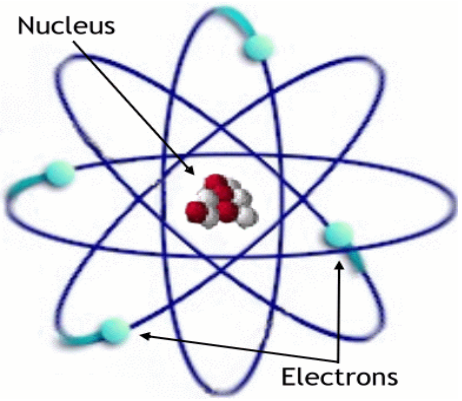
Static Charges

- Can you think of some instances when you have been affected by static charges?
  - Clothes coming out of a dryer
  - Rubbing your feet on the carpet
  - Touching a lock with a key and seeing a spark
  - Lightening
    - when a static charge builds up in the ground during a thunderstorm

Positive and Negative Charge in Atoms

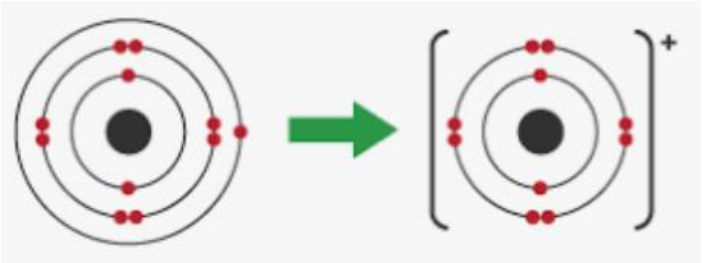
All matter is made of atoms which contain:

- Protons (positively charged)
- Neutrons (no charge)
- Electrons (negatively charged)



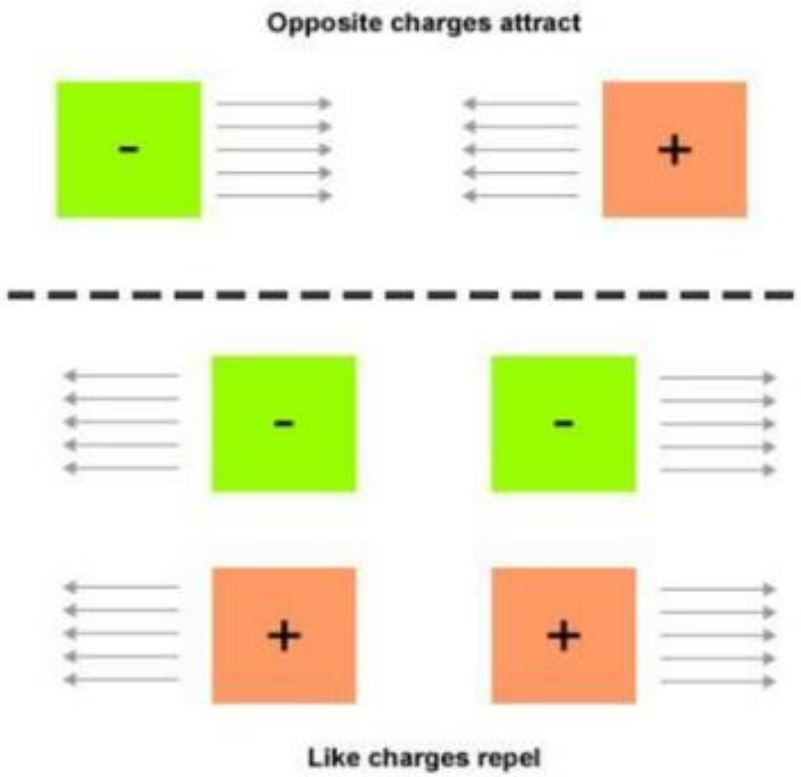
Atoms have a neutral charge, but if they lose an electron they become positively charged and if they gain an electron they become negatively charged.

Charged atoms are called ions.



Laws of Static Electricity

- Opposite charges attract.
- Like charges repel.
- Neutral objects are attracted to charged objects.



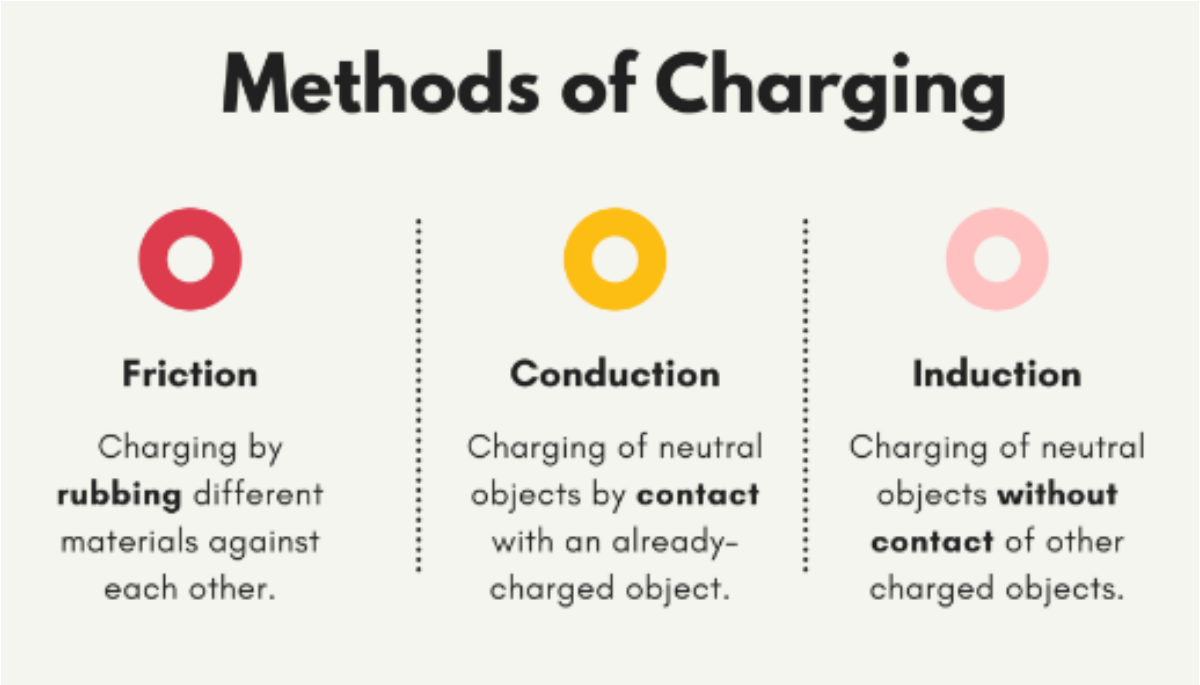
How Can You Charge Objects?

There are 3 ways objects can be charged.

(1) Friction

(2) Conduction

(3) Induction



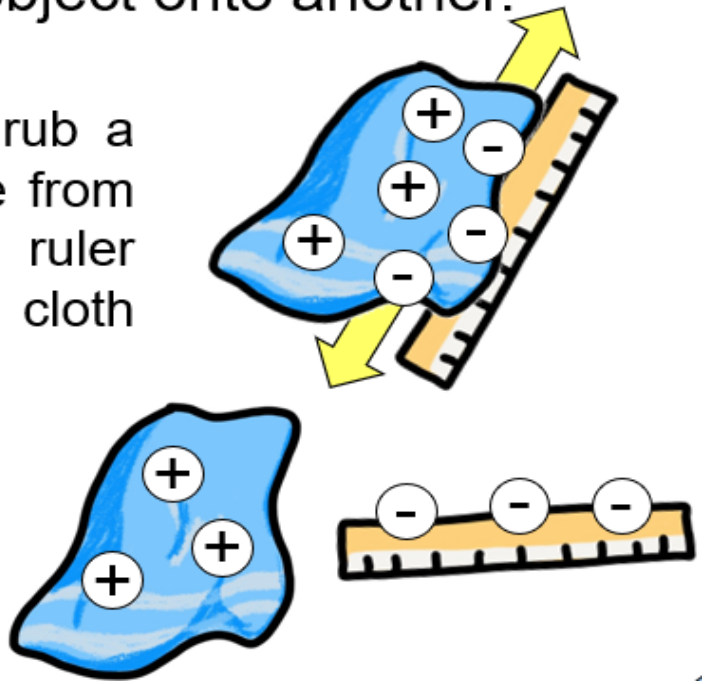
In each of these, only the electrons move.

The protons stay in the nucleus

(1) Friction

- Charging by friction occurs when electrons are "wiped" from one object onto another.

e.g., If you use a cloth to rub a plastic ruler, electrons move from the cloth to the ruler. The ruler gains electrons and the cloth loses electrons.



Electrons are most often transferred through friction, when objects rub against each other.

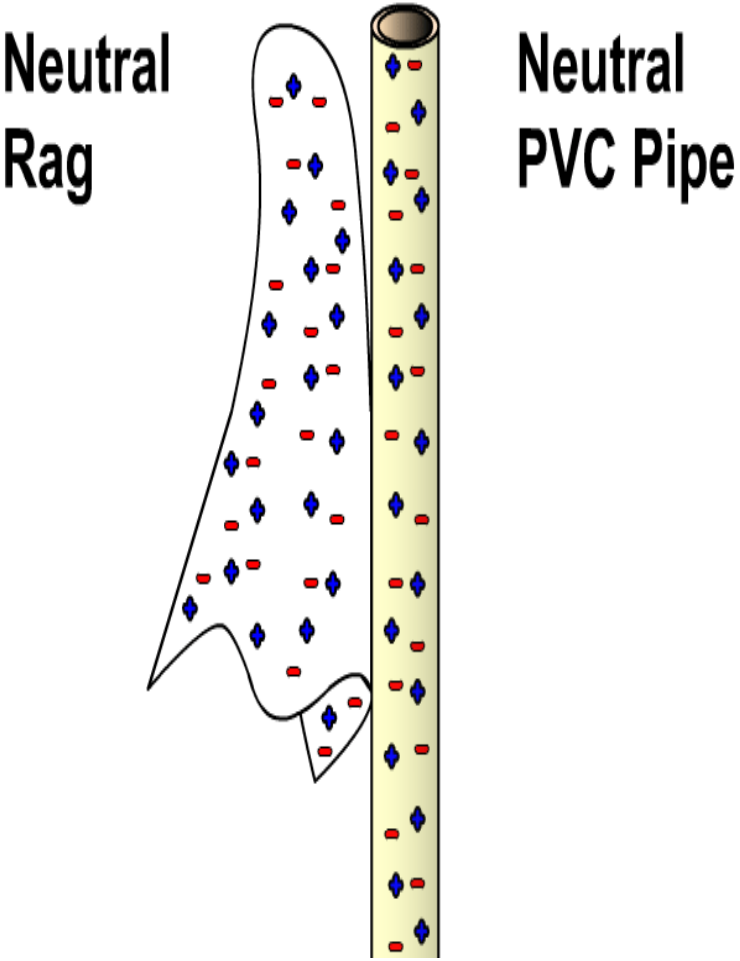
Friction results in losing electrons or gaining electrons.

Charging By Friction

- Different materials have a different **affinity for electrons**. Some hold on to their electrons tighter than others.

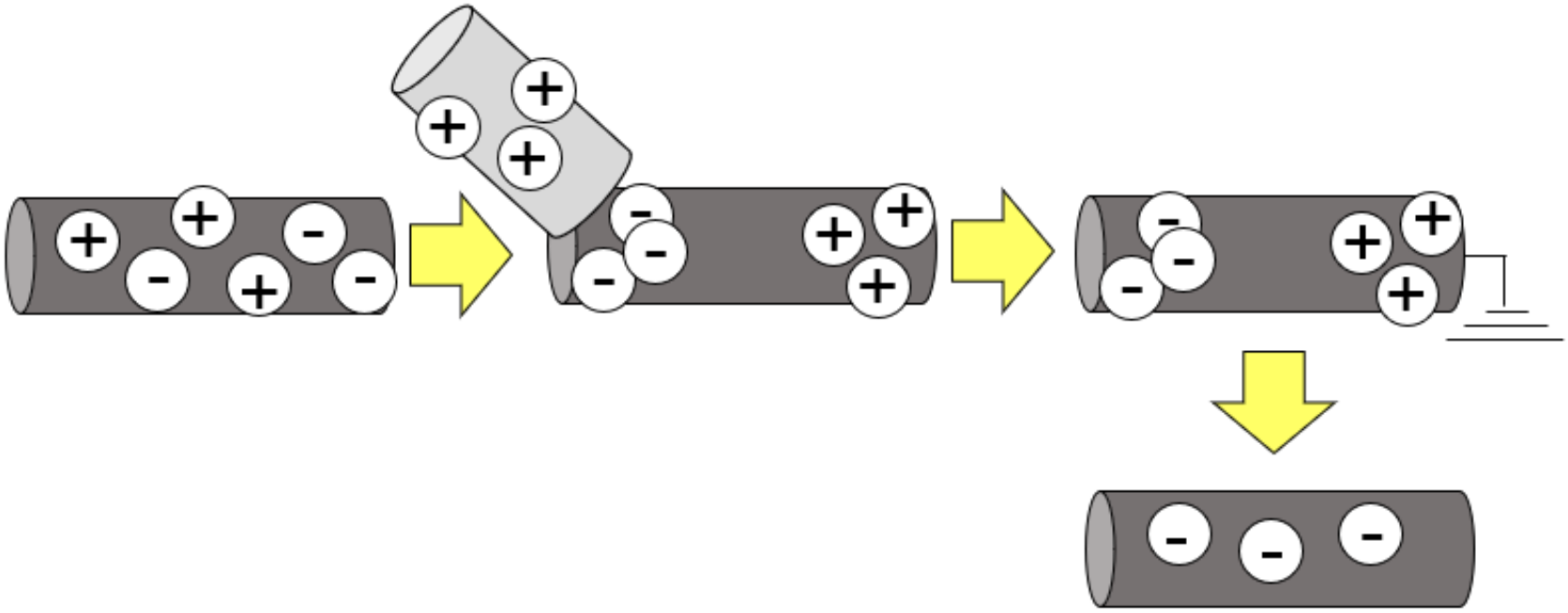
- **Greater affinity for electrons**: hold electrons stronger and often gain electrons by friction and **become negative**.

- **Less affinity for electrons**: hold electrons weaker and often loose more electrons by friction and **become positive**.



(2) Conduction

- Charging by conduction happens when electrons move from one object to another through direct contact (touching).



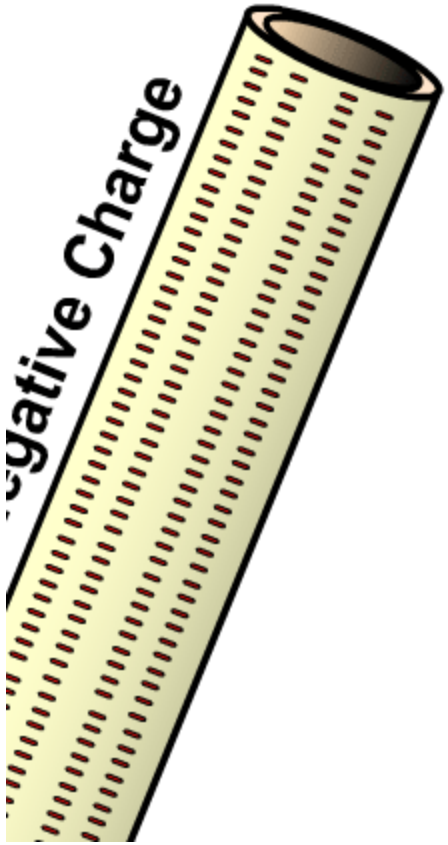
Charging By Conduction:

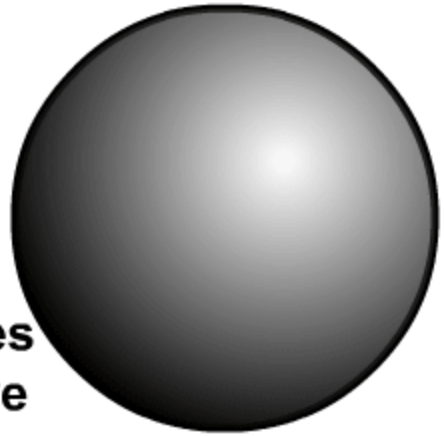
- Contact
- Same charge
- Permanent (with electron transfer)

Charge When Charged By Conduction:

- Negative creates negative
- Positive creates positive

Conduction





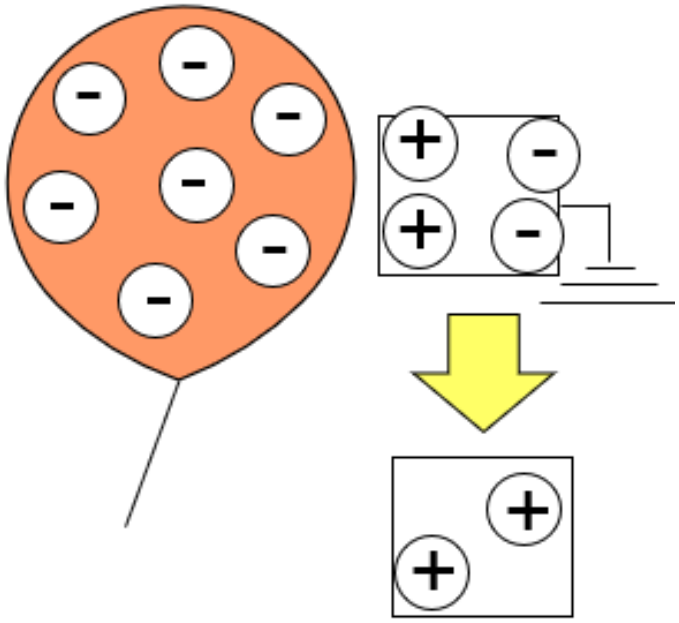
Becomes
Negative

Electrons transfer to the object
making it the same charge

(3) Induction

- Charging by induction happens when charges in an uncharged object are rearranged without direct contact with a charged object.

e.g., If you charge up a balloon through friction and place the balloon near pieces of paper, the charges of the paper will be rearranged, and the paper will be attracted to the balloon.



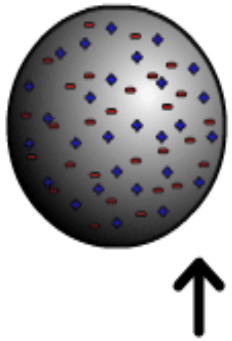
Charging By Induction:

- No contact
- Opposite charge
- Temporary (no electron transfer)

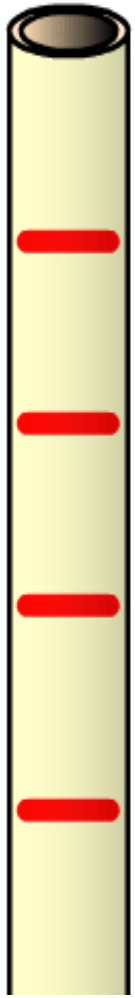
Charge When Charged By Induction:

- Positive induces negative
- Negative induces positive

Positive Induction



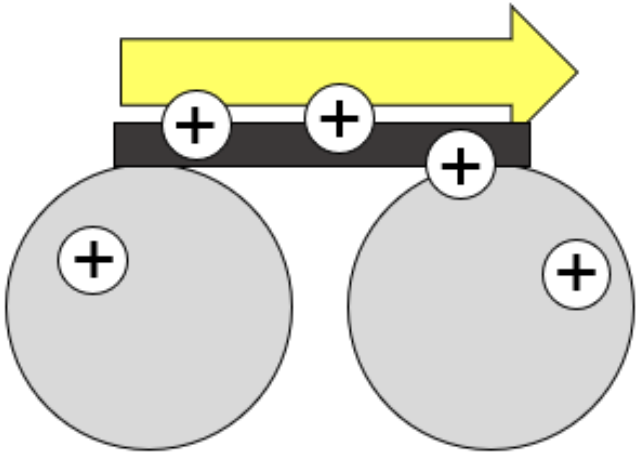
Electrons Move Away
Side Becomes Positive



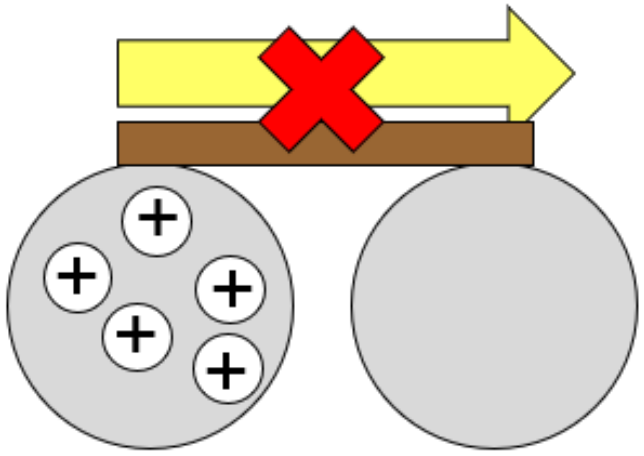
Conductors and Insulators

Conductors VS **Insulators**

- Charge flows freely
  e.g., metals, seawater, iron



- Almost no charge flows
  e.g., rubber, glass, wood



Grounding

The removal of a charge by producing a conductive path to the ground.

- The earth both accepts and gives electrons to neutralize objects.

- If an object with a positive charge is grounded, electrons will flow up from the ground to neutralize it.

- If an object with a negative charge is grounded, electrons will flow down to the ground to neutralize it.

Lightening

During a rainstorm, clouds develop regions of positive and negative charge due to the movement of air molecules, water drops, and ice particles.

The negative charges are concentrated at the base of the clouds, and the positive charges are concentrated at the top.

The negative charges repel electrons on the ground beneath them, so the ground below the clouds becomes positively charged.

As more charges build up, the air between the oppositely charged areas also becomes charged. When this happens, static electricity is discharged as bolts of lightning.

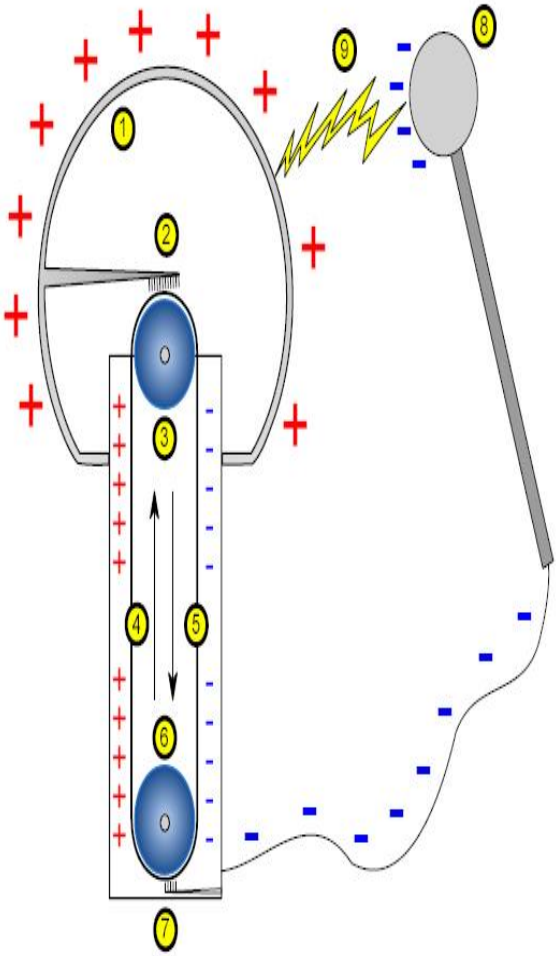
Lightening

Measuring Charge

- Unit of electric charge is called a Coulomb (C)
  - named after the French physicist Charles Augustin de Coulomb

- 1 C of charge is equal to the removal or addition of 6.25×10^{18} electrons
- That is 6250000000000000000 electrons !!
- A typical lightning bolt carries 5 – 25 C

Generating Static Charge



A **Van de Graaff generator** uses friction to produce a large static charge on a metal dome. The moving belt produces a static charge at the base, and this is carried to the top of the dome where it is collected.

Some Applications of Static Electricity

Plastic sandwich wrap clings due to static charges.

Static devices are used in industry to remove pollutants from chimney stacks.

Air ionizers in homes.

Static charges are used in painting automobiles.

Some Dangers of Static Electricity

When static charge builds up it can discharge and cause serious shocks, explosions or fires.

Those pumping flammables must ensure objects are grounded (connected to the Earth so that static charge is discharged).

Lightning is especially dangerous – buildings can be protected with lightning rods.