Restless Electrons

Vehicles for Transfer of Charge

- ***Friction*** **: rubbing two electrically neutral objects together can charge both objects – they will gain O**

When two insulators are rubbed together – the one with greater *RESISTIVITY* will tend to gain *ELECTRONS* while the other one loses them.

Conductors

Do NOT hold onto a charge well because it flows through them very easily

High Conductivity

Insulators

Readily hold onto a charge because it's difficult for the charge to flow through them

High Resistivity

Conductors and Insulators

Conductor:

- Allows flow of electricity by having free roaming electrons.

Examples:
Metals, water, humid air, ionized gas, plasma, graphite, wet wood

Insulator:

- Hinders flow of electricity by having tightly bound electrons.

Examples:
Glass, ceramics, dry wood, rubbers, plastics, cloth, air.

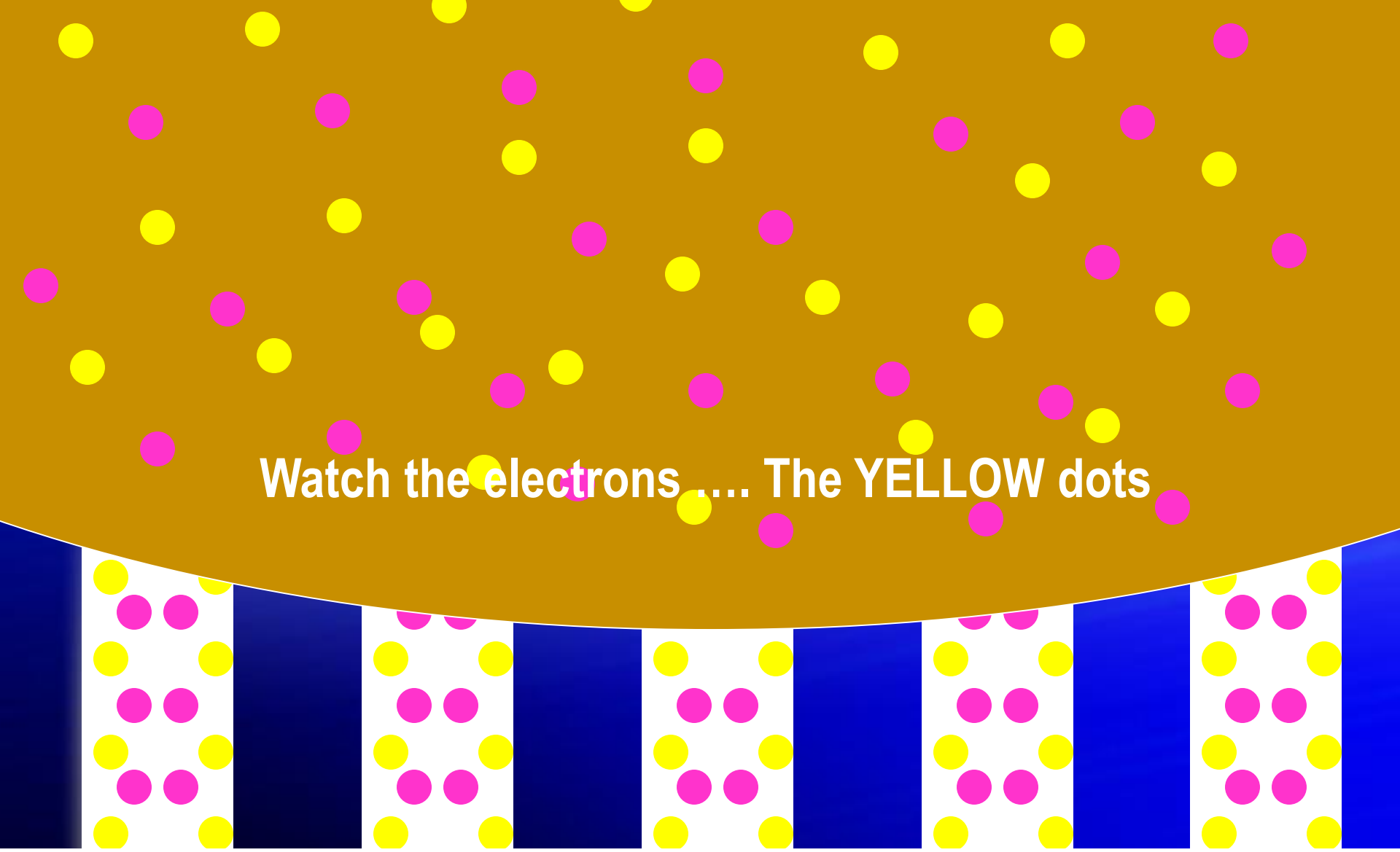
So … What is Static Electricity?

- **Definition: A buildup of excess electrical charge on an object**
- ***Electricity at rest (stationary)***

What is Static Electricity?

Imagine rubbing a balloon against your hair.

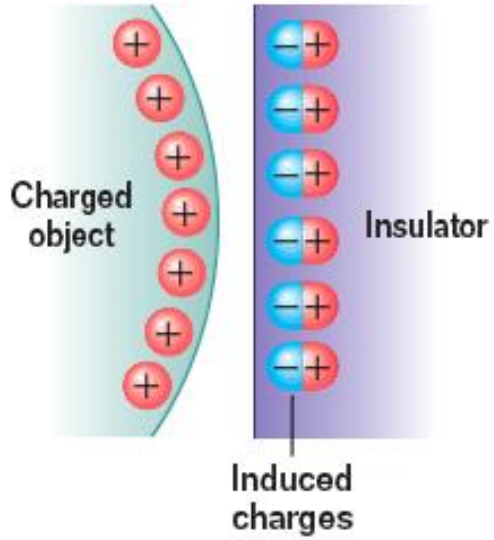
But this will also work with almost ANY insulator



Many moved to the balloon because it has greater resistance to electron flow

Polarization of Charge

Electrical Polarization



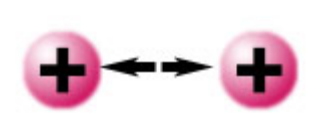
Da-da da-da da-da, Charge!

- An object that has electrical interactions with its surroundings is said to be **CHARGED**.

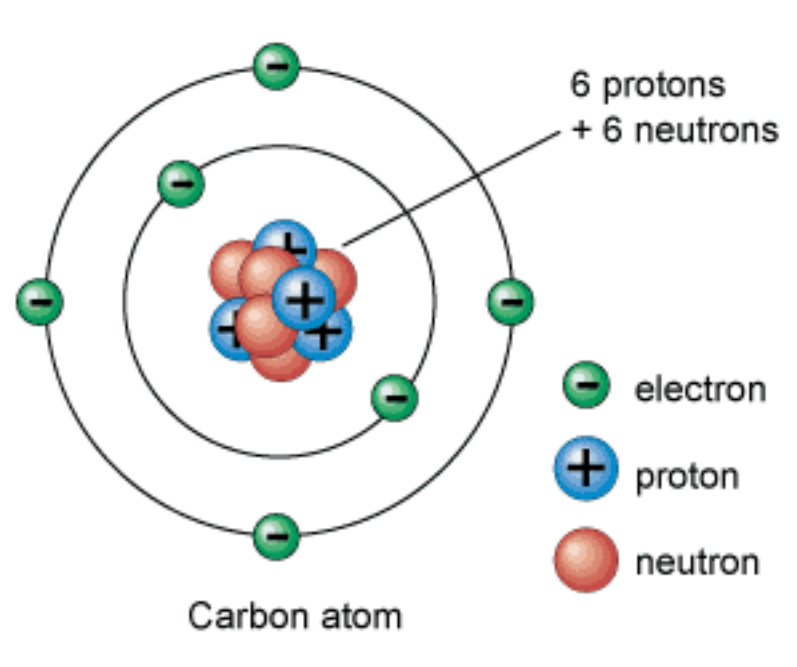
- There are "positive" and "negative" charges.
- Like charges repel (+&+; -&-)
- Opposites attract (+&-).

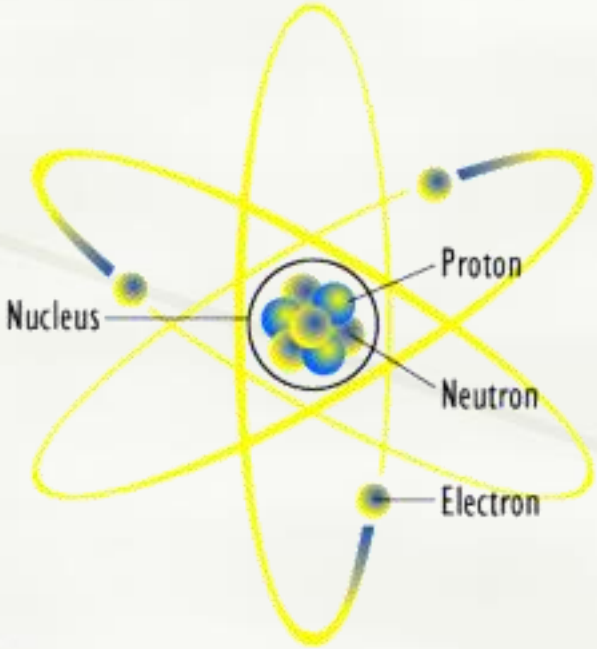
Electrical Forces

- Charge: Positive (+) and Negative (-)
- Protons (+) are attracted to Electrons (-). Neutrons have neutral (no) charge.
- Like charges repel; opposite charges attract.



Remember our Model of the Atom?





Protons are POSITIVELY charged; electrons are NEGATIVE!

Electroscopes Detect Charges

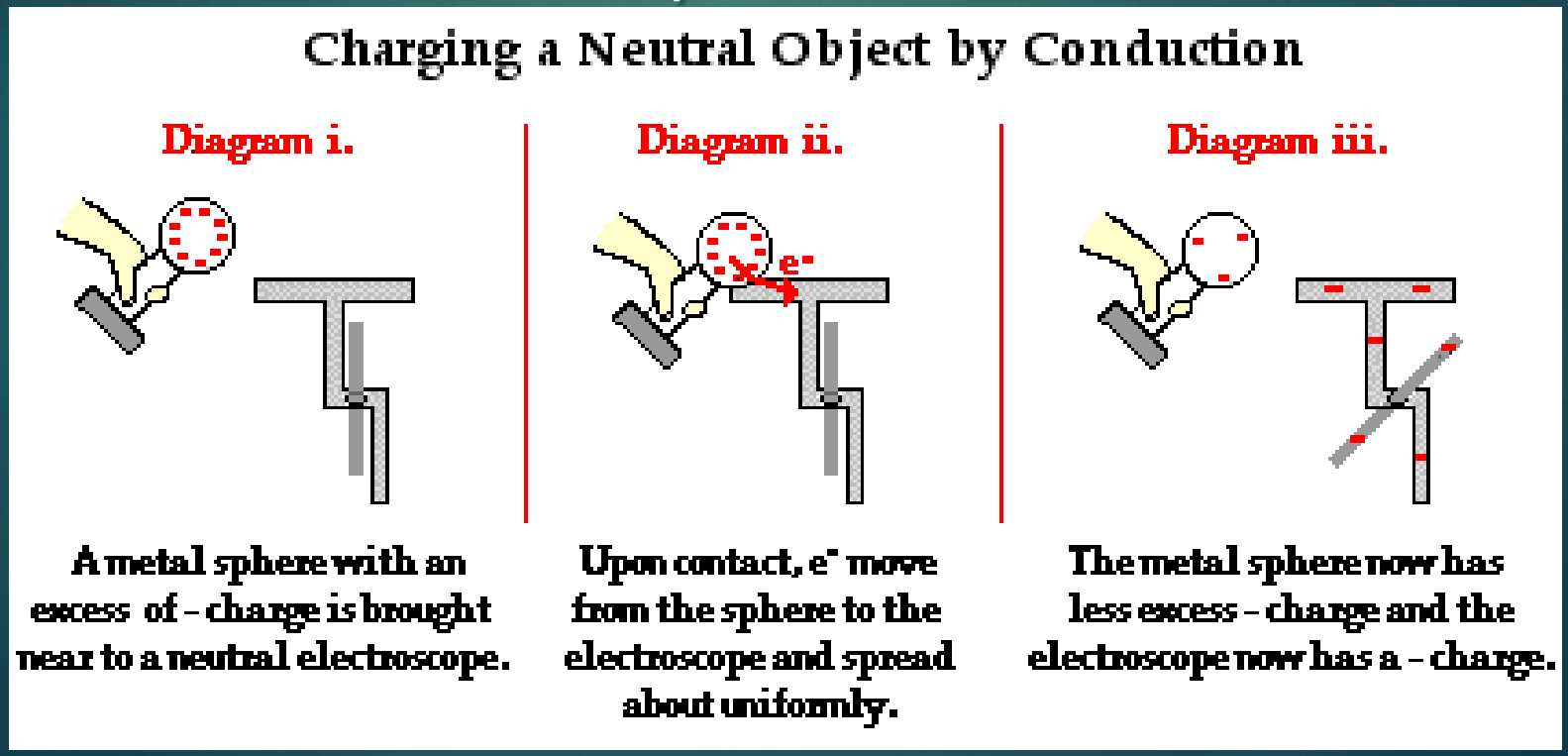
The test sample touches external ball or other metal part. Charges spread out onto foil leaves. Since all charges are the same the leaves separate by ***repulsion*** - either positive and positive, or negative and negative.

Induction versus Conduction

Charging by Conduction:

Transferring charges by ***touching*** a charged object to an uncharged one.

Examples: An electroscope charged by a conductor; rubbing your socks on carpet and your body is charged because it is TOUCHING your socks

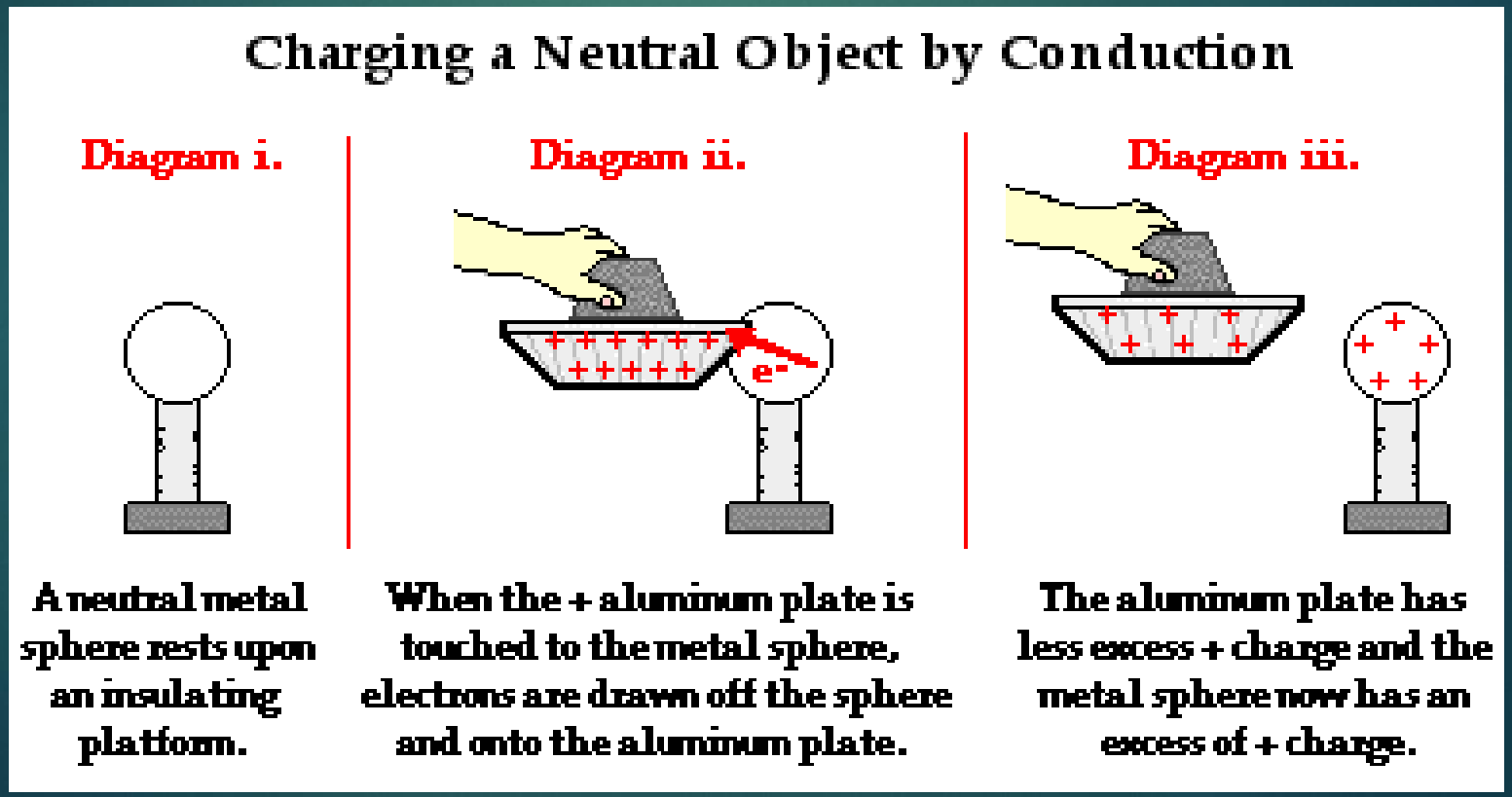


Induction versus Conduction

Charging by Conduction:

Transferring charges by ***touching*** a charged object to an uncharged one.

Practical application: copy machines (paper is charged so toner can be applied)

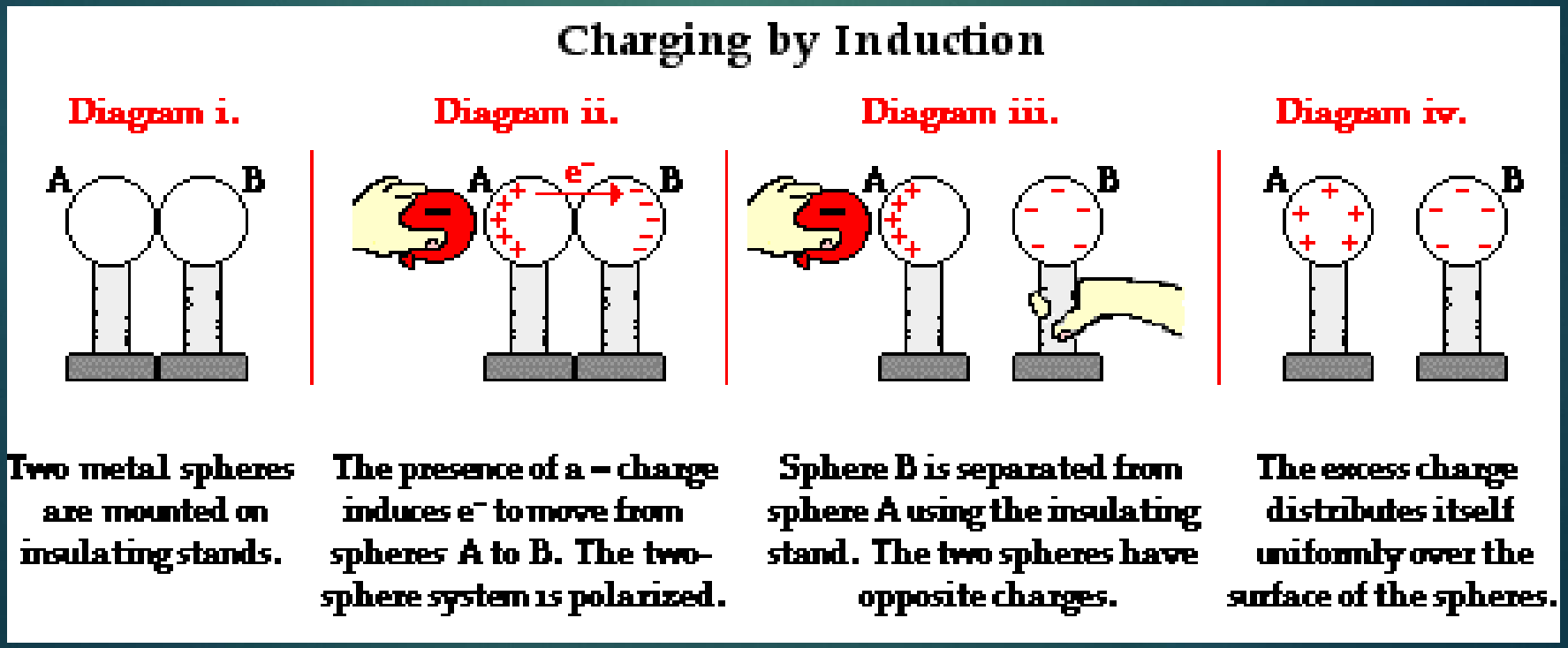


Induction versus Conduction

Charging by Induction:

Transferring charges *without* touching a charged object to an uncharged one.

Example: Large amounts of negative charges in storm clouds *induces* separation of charge on ground … sometimes with lightning as a result.

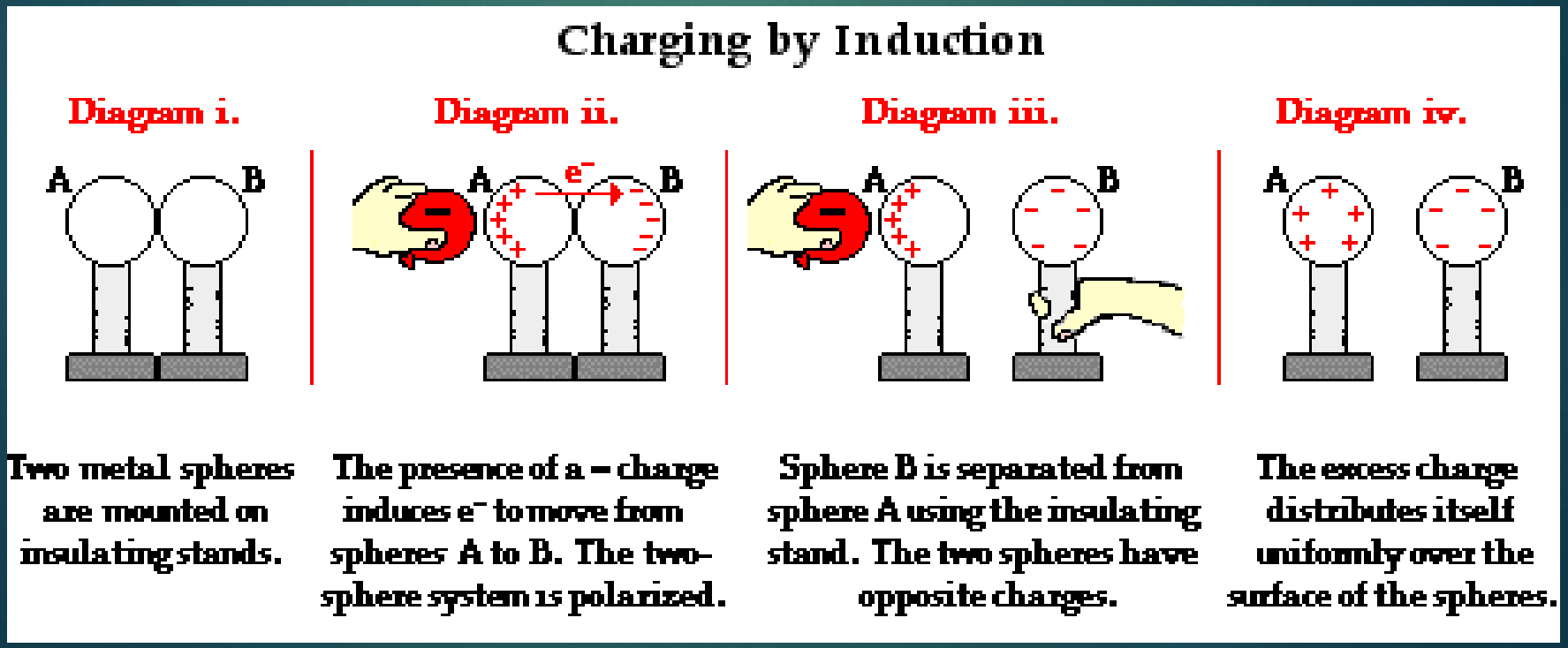


Induction versus Conduction

Charging by Induction:

Transferring charges *without* touching a charged object to an uncharged one.

Electroscopes can also be charged this way when a charged insulator is placed close to the receiver ball (or other metal part outside the electroscope)



Induction versus Conduction

Charging by Induction or Conduction:

A balloon is charged negatively and sticks to the wall. Is it charging the wall by induction, conduction or something else?

Answer:

Neither. Even though it touches the wall, it's more like induction than conduction. Few charges are transferred to the wall since the wall is an insulator. Notice how the balloon STICKS to the wall … evidence that the balloon remains charged and doesn't allow electrons to flow. If the electrons moved, both would be equally charged and the balloon would not stick to the wall.

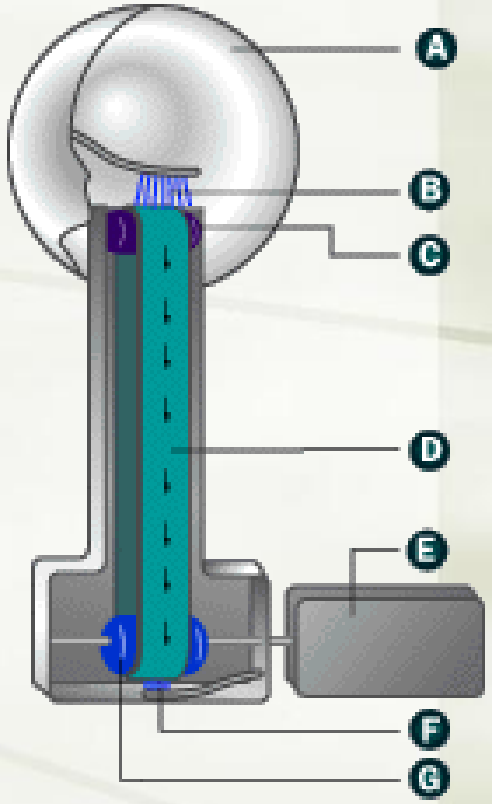
Van de Graaff Generator

The American physicist Robert Jemison Van de Graaff invented the Van de Graaff generator in 1931.

Charge transferred onto moving belt and up to the metal dome on top.

Silicon tape on lower roller and rubber belt cause charges to build up on belt that are taken up and collected on the dome.

The results are shocking!



A Output terminal — An aluminum or steel sphere
B Upper brush — A piece of fine metal wire
C Upper roller — A piece of nylon
D Belt — A piece of surgical tubing
E Motor
F Lower brush
G Lower roller — A piece of nylon covered with silicon tape

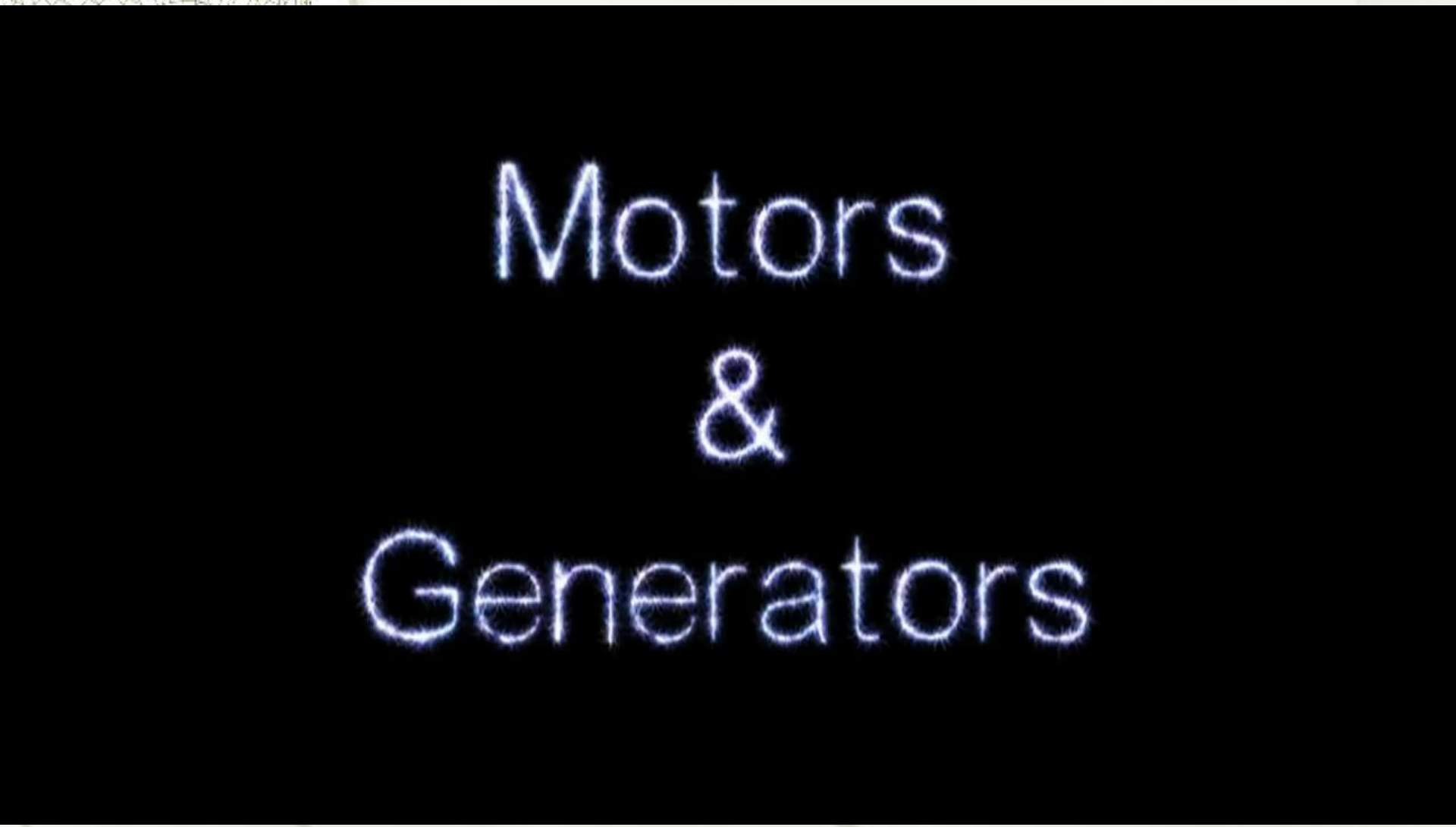
Van de Graaff Generator

Remember when we talked about electric motors and generators?

Electricity can be used to generate mechanical motion … with an electric motor.

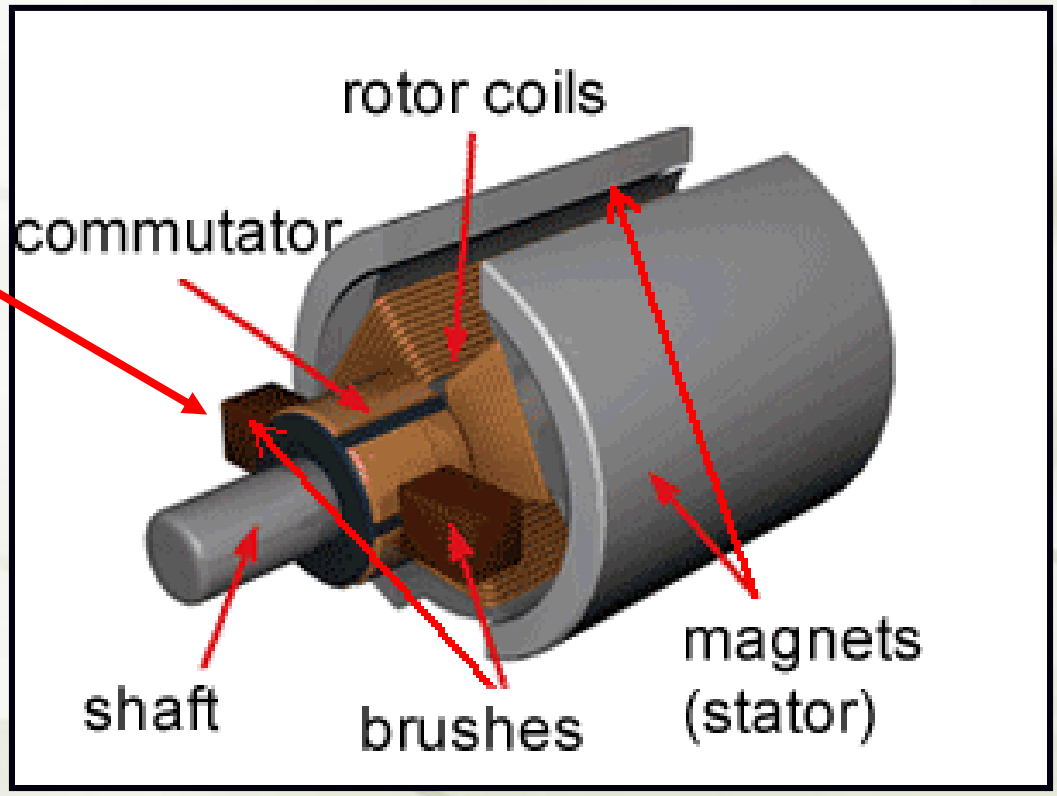
AND … when reversed … the system becomes a generator that produces electricity.

Electric Motors and Generators



Electric Motors and Generators

When a motor or a generator has BRUSHES, the electrons are transferred by CONDUCTION (thru the brushes)



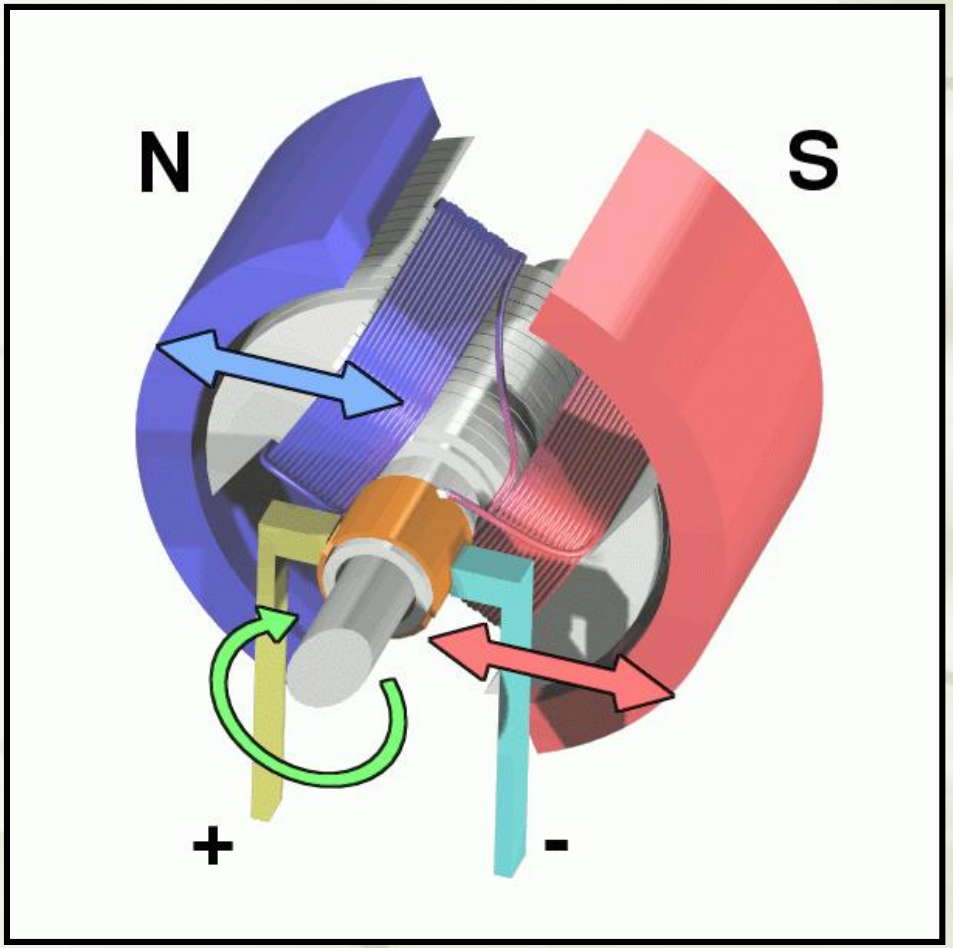
Note:

Motor: electricity in, mechanical motion out

Generator: mechanical motion in, electricity out

Electric Motors and Generators

When a generator uses INDUCTION, the electrons are moved without any direct contact.



The fast spinning motion of the magnet causes electrons to move in the coil of wire … and electricity is generated!

Faraday – Electromagnetic Induction

Diagram i.

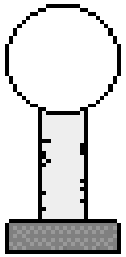


Diagram ii.

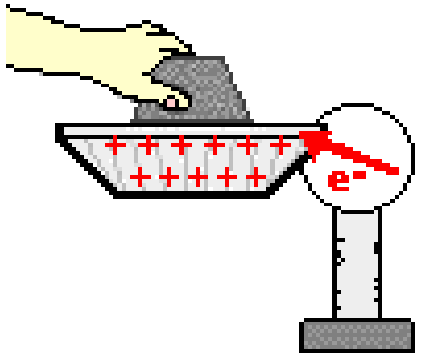


Diagram iii.

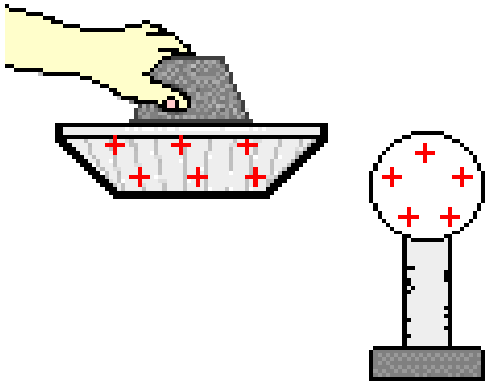


Diagram i.

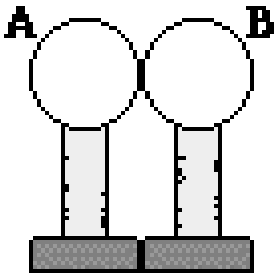


Diagram ii.

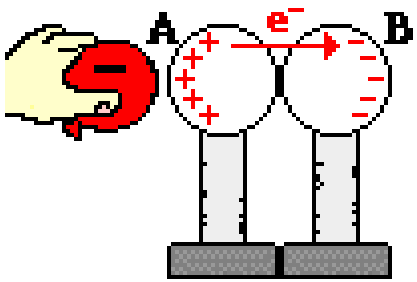


Diagram iii.

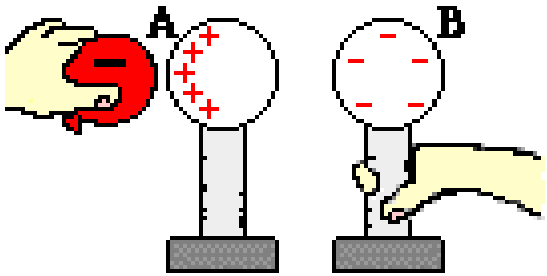


Diagram iv.