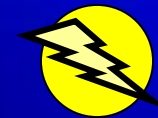




Restless Electrons

Vehicles for Transfer of Charge



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

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)***



A wireframe sphere is visible in the top-left corner of the slide, partially cut off by the edge.

What is Static Electricity?



**Imagine rubbing a balloon
against your hair.**

**But this will also work with
almost ANY insulator**



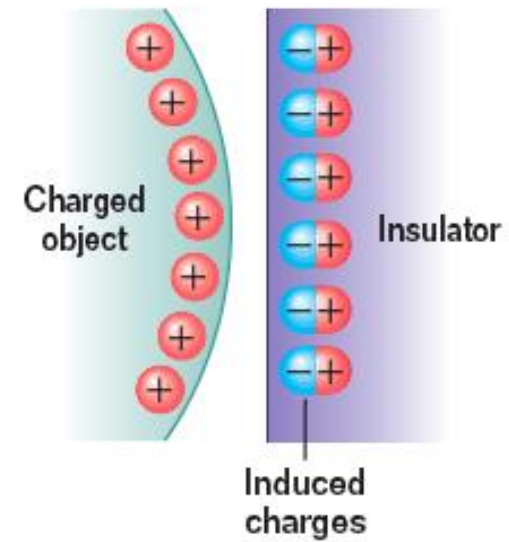
The diagram illustrates the attraction of electrons to a charged object. A large, curved, orange-brown shape at the top represents a balloon, which is densely populated with small dots. These dots are colored yellow and pink. Below the balloon, a series of vertical bars represent a table. The bars alternate in color between dark blue and a lighter blue. The white spaces between these bars are also filled with yellow and pink dots. The text 'Watch the electrons The YELLOW dots' is written in white across the middle of the image, pointing towards the yellow dots. At the bottom, a solid dark blue banner contains white text explaining the reason for the electron movement.

Watch the electrons The YELLOW dots


**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!

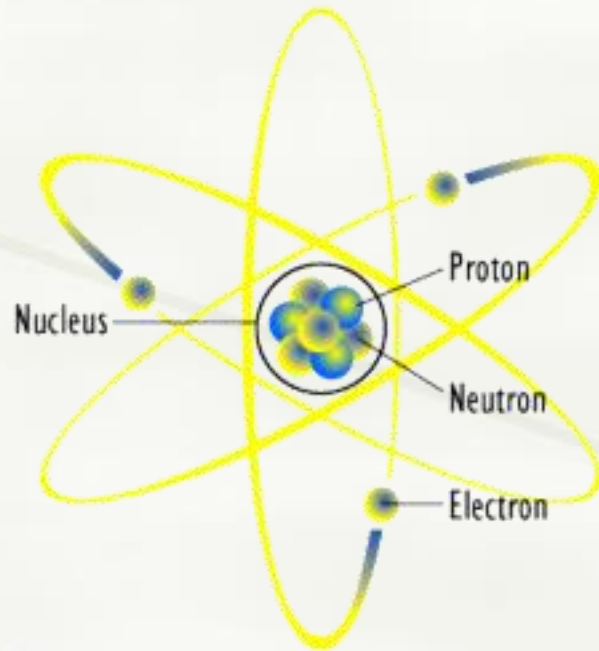
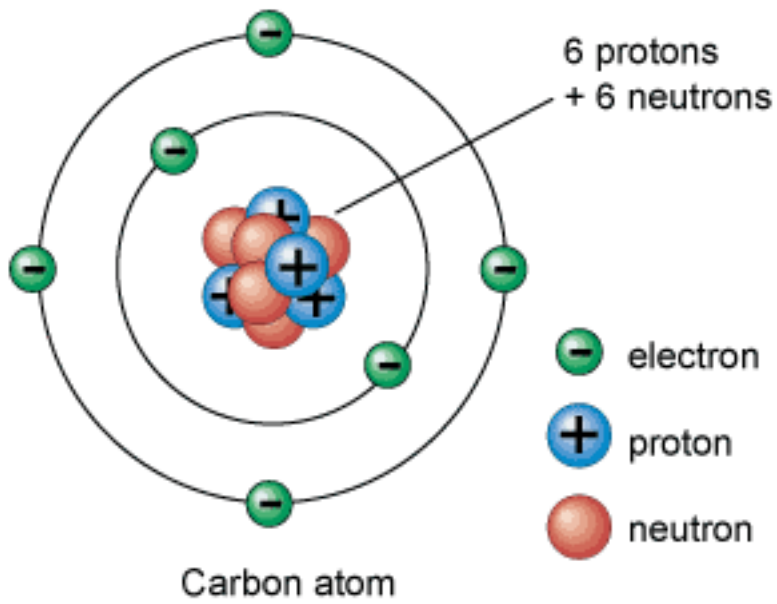
- 
- An object that has electrical interactions with its surroundings is said to be **CHARGED**.
 - There are “positive” and “negative” charges.
 - **Like charges repel** (+&+; -&-)
 - **Opposites attract** (+&-).

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

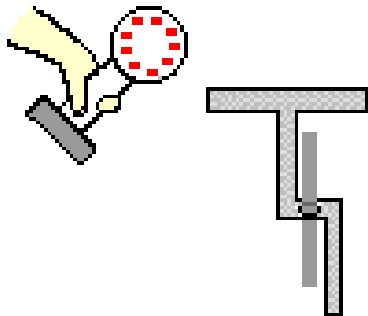
Charging by Conduction:

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

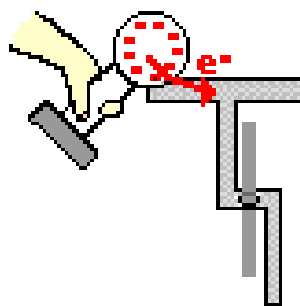
Charging a Neutral Object by Conduction

Diagram i.



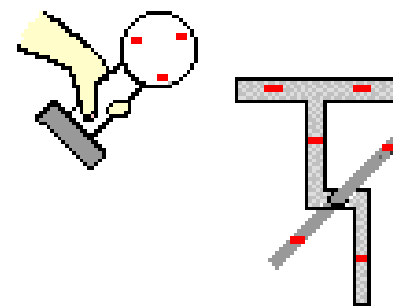
A metal sphere with an excess of - charge is brought near to a neutral electroscope.

Diagram ii.



Upon contact, e^- move from the sphere to the electroscope and spread about uniformly.

Diagram iii.



The metal sphere now has less excess - charge and the electroscope now has a - charge.

Induction versus Conduction

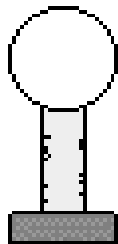
Charging by Conduction:

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

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

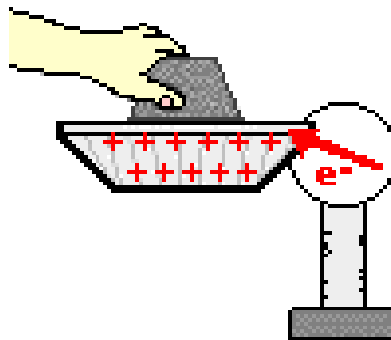
Charging a Neutral Object by Conduction

Diagram i.



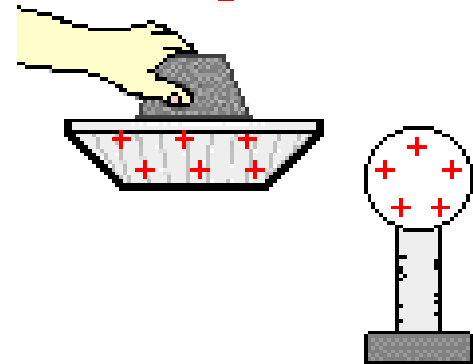
A neutral metal sphere rests upon an insulating platform.

Diagram ii.



When the + aluminum plate is touched to the metal sphere, electrons are drawn off the sphere and onto the aluminum plate.

Diagram iii.



The aluminum plate has less excess + charge and the metal sphere now has an excess of + charge.

Induction versus Conduction

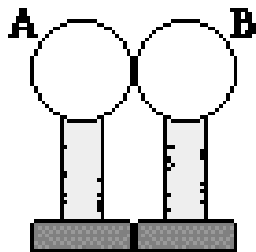
Charging by Induction:

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.

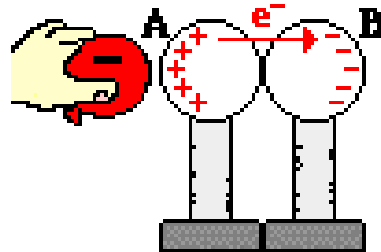
Charging by Induction

Diagram i.



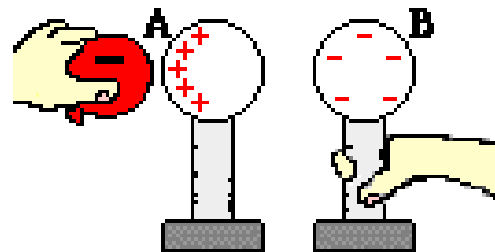
Two metal spheres are mounted on insulating stands.

Diagram ii.



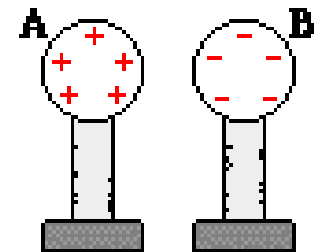
The presence of a $-$ charge induces e^- to move from spheres A to B. The two-sphere system is polarized.

Diagram iii.



Sphere B is separated from sphere A using the insulating stand. The two spheres have opposite charges.

Diagram iv.



The excess charge distributes itself uniformly over the surface of the spheres.

Induction versus Conduction

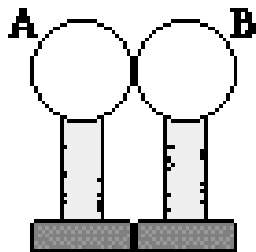
Charging by Induction:

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)

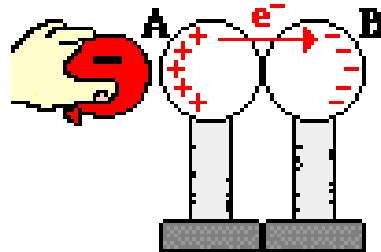
Charging by Induction

Diagram i.



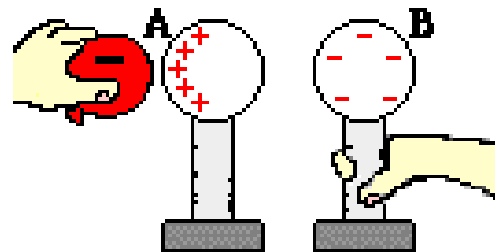
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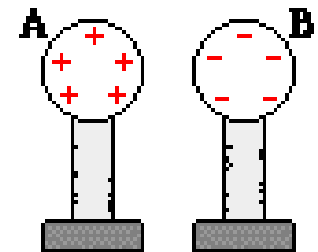
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Diagram iv.



The excess charge distributes itself uniformly over the surface of the spheres.



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.

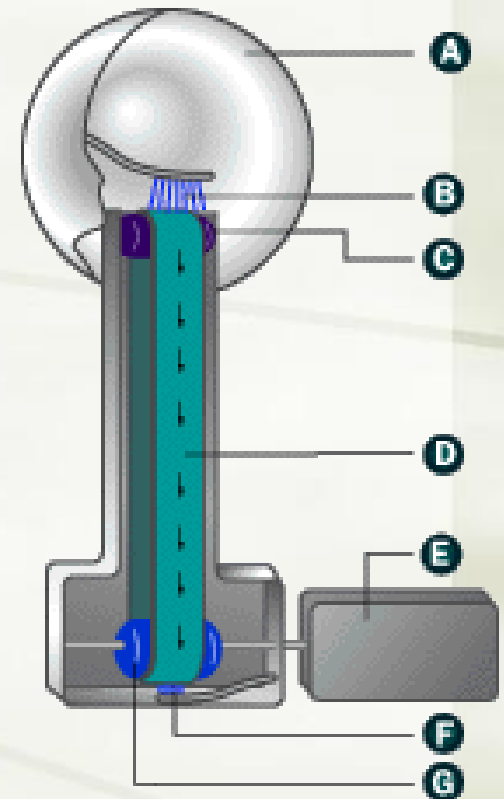
Van de Graaff Generator

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!



© 2000 How Stuff Works

- 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

Motors
&
Generators

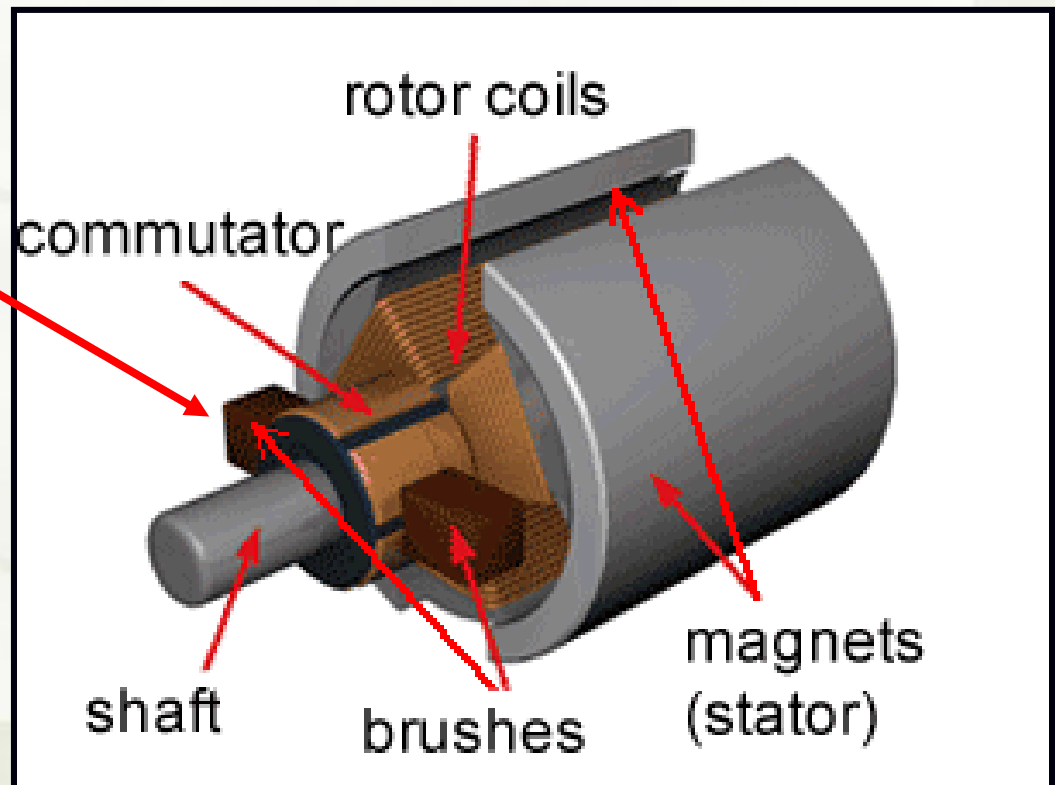
Electric Motors and Generators

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

Note:

Motor: electricity in,
mechanical motion out

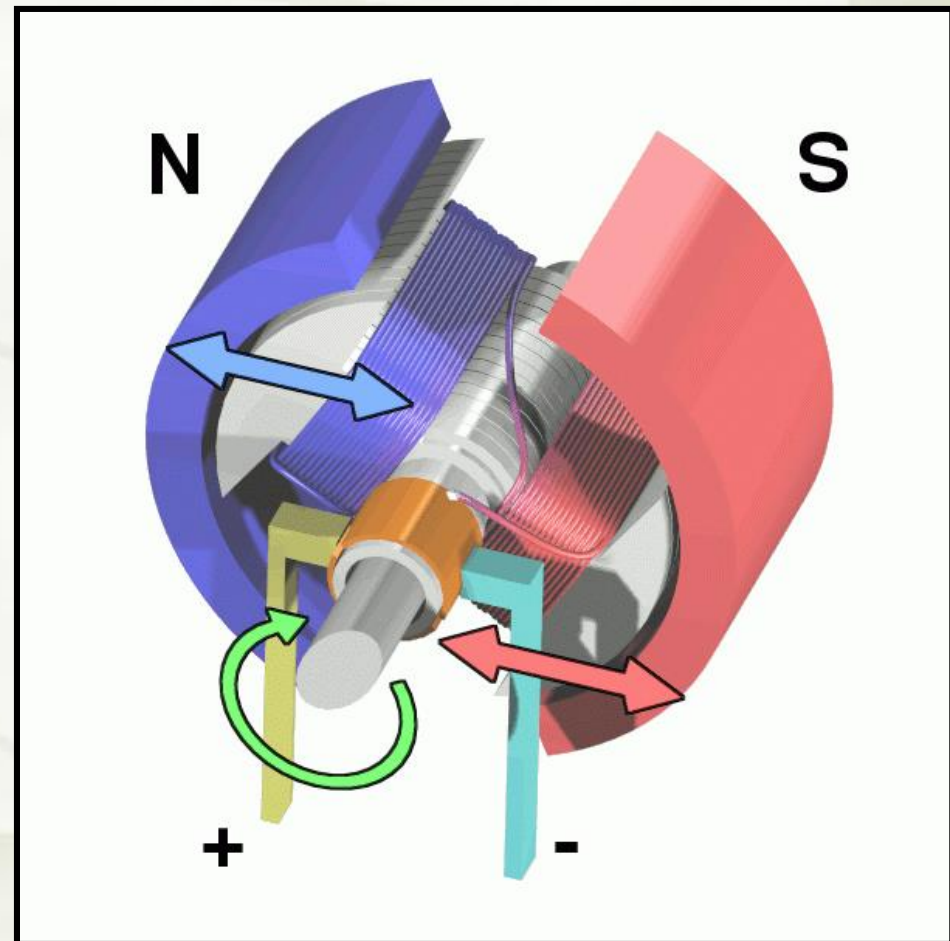
Generator: mechanical
motion in, electricity
out



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

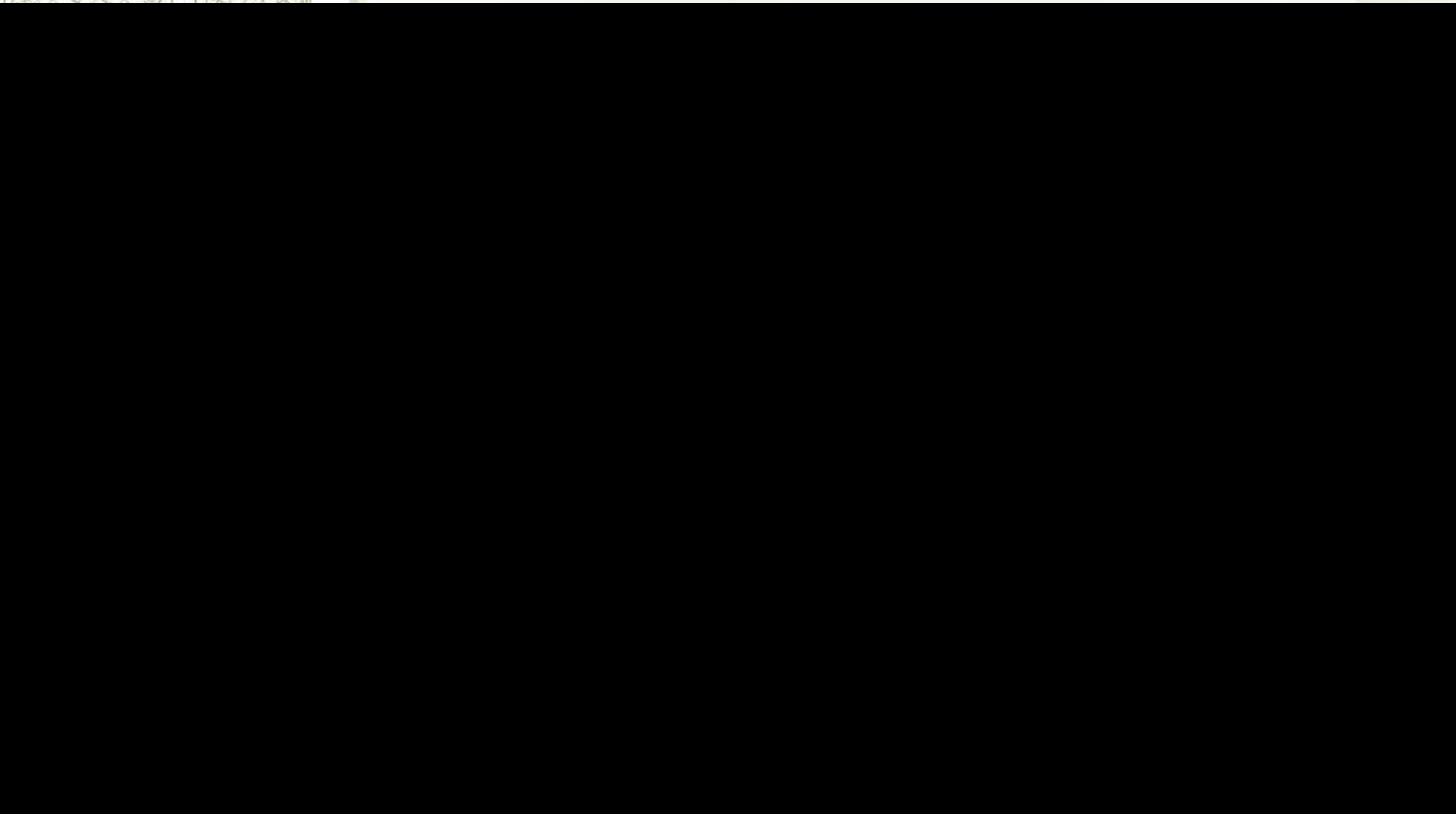




Diagram i.

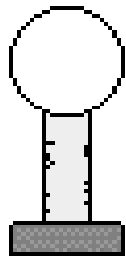


Diagram ii.

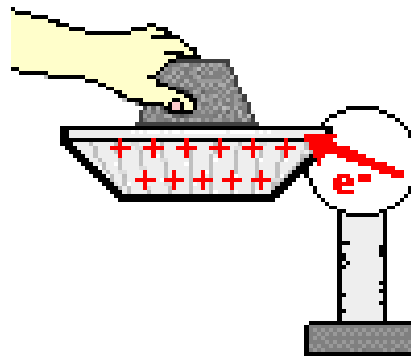


Diagram iii.

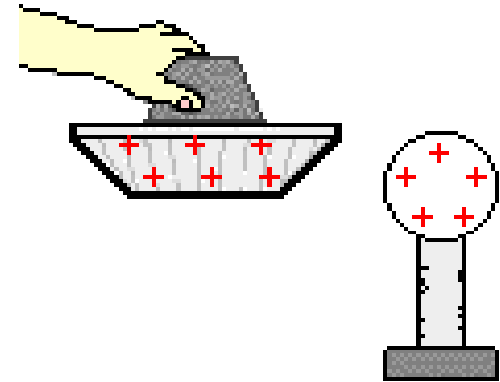


Diagram i.

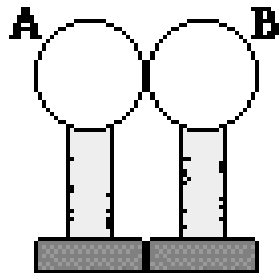


Diagram ii.

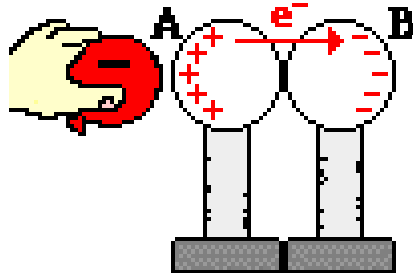


Diagram iii.

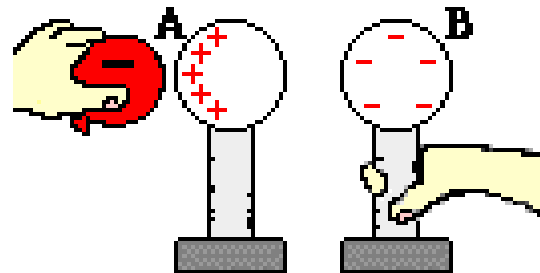


Diagram iv.

