

L 25 Electricity & Magnetism [2]

- static electricity
 - the van de Graff generator
 - electrostatic shielding
- lightning
- batteries and frogs legs
- electric circuits
 - what conducts electricity
 - what doesn't conduct electricity



review – electric charge

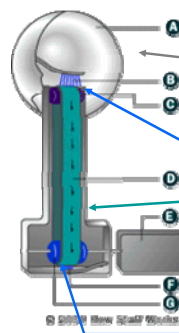
- Matter (stuff) has two basic properties
 - mass → gravitational force
 - charge → electric and magnetic forces
 - positive charge
 - negative charge
- electric forces
 - like charges repel $+/+$ or $-/-$
 - unlike charges attract $+/-$
- charge is measured in **Coulombs [C]**



Where is the charge?

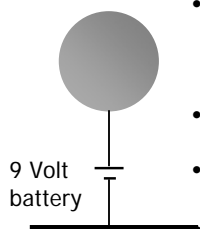
- the charge is in atoms
 - positive → protons
 - negative → electrons
- matter is usually electrically neutral → it has the same amount of positive and negative charge
- electrons can be transferred from one object to another by rubbing (friction)

Making Sparks: The Van de Graff Generator



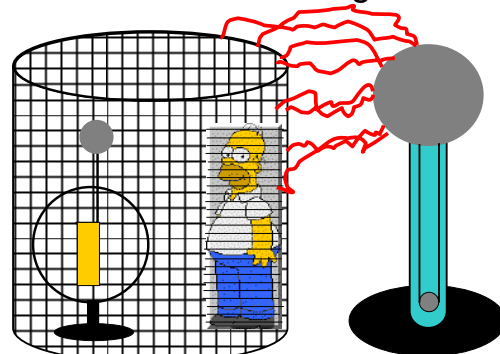
- The van de Graff generator is a device for building up a large electrical charge on a metal sphere
- The charge is generated by friction between a rubber belt and a roller.
- the charge on the belt is transferred to the sphere by a brush.

Electric Potential → voltage



- The amount of charge on a charged sphere can be measured in terms of its electric potential or voltage
 - the more charge that is on the sphere, the higher its voltage
 - electric potential is measured in **VOLTS**
- if I connect a 9 V battery to the sphere and the ground, it will have a potential of 9 V

Electrostatic shielding



Electrostatic shielding

- The effect of the high voltage on the van de Graff generator stops on the outside of the metal cage → **Homer is SAFE!**
- Being inside your car during a lightning storm offers you some protection
- radio signals cannot penetrate through a metal enclosure
- the metal bars (rebar) that reinforce the concrete in walls can interfere also

Lightning- outdoor spark



- causes 80 million dollars in damage each year in the US
- On average, kills 85 people a year in the US
- is all over in a thousandth of a second
- carries up to 200,000 A
- causes the thunder!

development of a lightning bolt

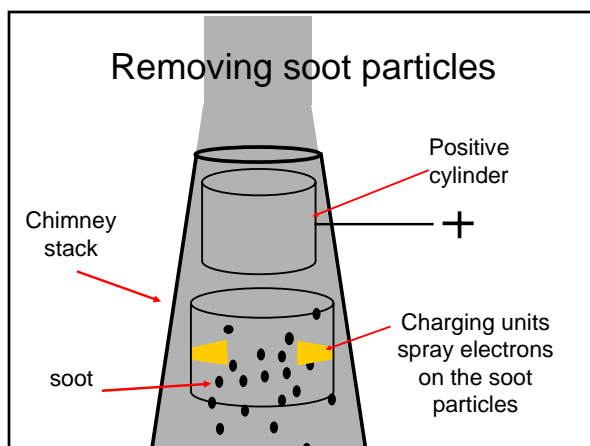
charge separation stepped leader leader & streamer leader meets streamer lightning bolt

applications of electrostatics

- Xerox copiers use electrostatic attraction to put the ink droplets on the paper
- electrostatic precipitators use the attraction of charged dust to remove dust particles from smoke.
- can be used to hold balloons on your head



Removing soot particles

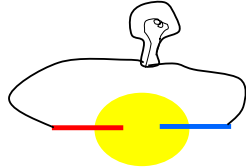


Frog's leg Batteries

- in 18th century Luigi Galvani a professor of anatomy at the University of Bologna found that a freshly dissected frog leg hung on a copper hook twitched when touched by an iron scalpel.
- The two metals had to be different.
- Galvani thought that he had discovered the secret life force

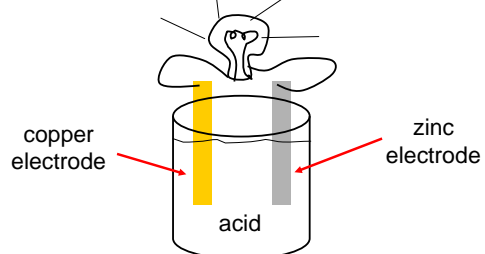
Alessandro Volta

- Professor of Physics at the University of Pavia realized that the electricity was not in the frog's leg but the twitching was the result of touching it with two different metals
- Volta had discovered the first battery.
- Lemon battery

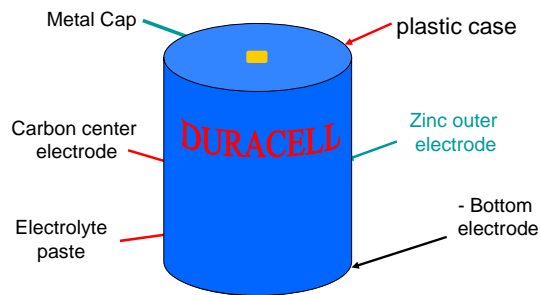


Batteries → use chemical energy to produce electricity

- two dissimilar metals immersed in a conducting fluid (like an acid for example) cause a chemical reaction which can produce electric current.

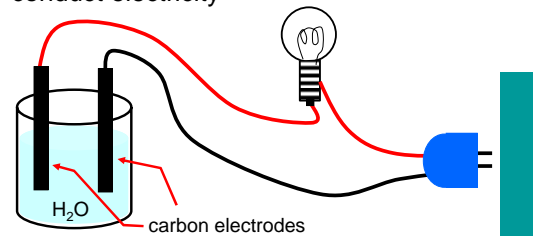


Inside a Duracell 1.5 Volt battery



Pure water is non-conducting

- clean water will not conduct electricity
- if salt or acid is added, however, it will conduct electricity

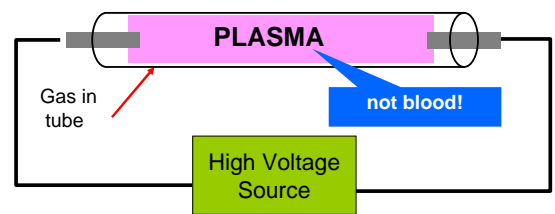


A salt water solution is a conductor

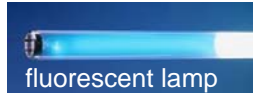
- When salt NaCl (sodium chloride) is added to water H₂O, the NaCl molecule dissociates into a positive ion Na⁺, and a negative ion Cl⁻.
- Thus the solutions contains both positive and negative ions, both of which can conduct electricity.
- Electric current can pass through dirty bath water and through you also!

Gas discharges

When a high voltage is applied to a gas-filled tube, the gas can become ionized, one or more electrons are separated from each atom. Since positive and negative charges are present the ionized gas conducts electricity. The gas atoms are excited and emit light of a color characteristic of the gas.



examples of electrical discharges



Current– flow of electric charge

If I connect a battery to the ends of the copper bar the electrons in the copper will be pulled toward the positive side of the battery and will flow around and around.

→ this is called **current** – flow of charge

