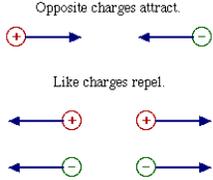


Static Electricity

When you get 'shocked', or see a 'spark', you are experiencing the same electrical effect that makes lightning. Most objects have the same number of positive (**proton**) and negative (**electron**) charges. This makes them **neutral** (no charge). Static electricity happens when there is an imbalance of electrons (which have negative charges).

The Laws of Electrical Charges



Van de Graaff Generators (VDG) build up an excess of static charge using friction. A rubber belt rubs a piece of metal and transfers the charge to a sphere. When you touch the sphere the charge builds up on you.

Charge separation occurs, when a **charged** object is brought close to a **neutral** object. The charged electrons repel the electrons in the neutral object and the charged object is then attracted to the protons of the neutral object.

Electrical Discharge is the movement of charges whenever an imbalance of charges occurs. The action results in neutralizing the objects. The over-charged electrons repel the electrons in the object and the positive protons attract the charged electrons causing a discharge or 'miniature lightning bolt'. Certain animals like an electric eel, can produce electric shock, to kill or stun prey. They have a special organ that contains specialized muscle cells called **electroplaques**. Each cell produces a small amount of electricity. When all the cells work together, a large amount of electricity is produced and used to help the eel survive. This type of electricity is like static electricity, which builds up and then discharges. **It does not flow continuously.**

Current Electricity

Electrical devices need a steady flow of electricity. The steady flow of charged particles is called **electrical current**. The flow continues until the energy source is used up, or disconnected.

Amperes - The **rate** at which an electrical current flows is measured in **amperes** (A). This flow varies from a fraction of an ampere to many thousands of amperes, depending on the device. Conductors are used to allow the flow of electrical charges from where they are produced to where they are needed. These conductors are materials (often wires), which allow the flow of electrical charges easily.

Circuits - A circuit is a **pathway** that allows the flow of electricity. Most electrical circuits use wires (as conductors), although others may use gases, other fluids or materials. A circuit consists of a conductor, an energy source, a load and often a switch (to control the flow).

Electrical Energy and Voltage

Electrical energy is the energy carried by charged particles. **Voltage** is a measure of how much electrical energy each charged particle carries. The higher the energy of each charged particle, the greater the potential energy. Also called '**potential difference**', the energy delivered by a flow of charged particles is equal to the voltage times the number of particles. Voltage units are **volts** (V), and for safety purposes, the voltage of most everyday devices we commonly use is relatively low, while industries and transmission lines are **relatively high**. The simplest way to measure voltage is with a **voltmeter**. Some voltmeters can measure a wide range of voltages. **Multi-meters** should be used with caution, so that the sensitive needle is not damaged (by testing a low range with high voltage).

Measuring Voltage with Computers

A voltmeter can also be hooked up to a computer. Hook-up the red and black lead in the same way as you would for a voltmeter.

Electrical Safety

Coming in contact with a power transmission line can be deadly. By touching it, a short circuit can occur, because the electricity is trying to find a path to the ground - you can complete the circuit. Amperage is more important to consider. 0.001A will likely not be felt at all, 0.015A to 0.020A will cause a painful shock and loss of muscle control (which means you will not be able to let go of the line). Current as low as 0.1A can be fatal. When current can flow easily, it is more dangerous. Insulators (such as wood, rubber and air) hamper the flow of electricity.

The Danger of Lightning - A lightning strike can have 30,000A - more than enough to kill you. Lightning can also do a lot of damage to a building. Metal lightning rods that are connected to the ground with a grounding wire are fixed on the roof of many buildings to prevent damage to the building during an electrical storm.



Underwriters Laboratory issues labels to identify the amount of voltage required to operate electrical devices and the maximum current they use.



Plugs, Fuses and Breakers

The third prong of a 3 prong plug is a **ground** wire, connected to the ground wire of the building, in case of a short circuit. Fuses and circuit breakers interrupt a circuit when there is too much current flowing through it. Fuses contain a thin piece of metal designed to melt if the current is too high. Circuit breakers, on the other hand, trip a spring mechanism, which shuts off the flow of electricity through the circuit, when there is too much current. It can be reused over and over (provided the cause of the increased flow is corrected).

Electrical Safety Actions

- Never handle electrical devices if you are wet or near water
- Don't use devices that have a frayed or exposed power cord
- Always unplug an electrical device before disassembling it
- Don't put anything into an electrical outlet - except a proper plug for an electrical device
- Don't overload an electrical circuit, by trying to operate too many devices at once
- Avoid power lines
- Don't bypass safety precautions when you are in a hurry
- Pull on the plug, not the wire
- Never remove the third prong from a 3 prong plug
- Avoid being the target of a lightning strike, by staying low to the ground (horizon) and away from trees.
- Moisture is a good conductor of electricity, so avoid water when working with electricity.

Cells and Batteries

Electrochemical cells produce small amounts of electricity from chemical reactions within the cell.

Dry Cells - The electricity-producing cells, which are referred to as 'batteries', are called **dry cells**. They are 'dry' because the chemicals used are in a paste. The chemical reaction in a cell releases free electrons, which travel from the negative terminal of the cell, through the device, which uses the electricity, and back to the positive terminal of the cell. The dry cell is made up of two different metals, called **electrodes** in an electrolyte. An **electrolyte** is a paste or liquid that conducts electricity because it contains chemicals that form ions. An ion is an atom or group of atoms that has become electrically charged through the loss or gain of electrons from one atom to another. The electrolyte reacts with the electrodes, making one electrode positive and the other negative. These electrodes are connected to the terminals

Wet Cells

Wet cells are 'wet' because the **electrolyte** is a liquid (usually an acid). Each **electrode** (zinc and copper) reacts differently in the electrolyte. The acidic electrolyte eats away the zinc electrode, leaving behind electrons that give it a negative charge. The copper electrode is positive, but it is not eaten away. Electrons travel from the negative terminal (attached to the zinc electrode) through the device and on to the positive terminal (attached to the copper electrode).



A car battery is made up of wet cells. Each battery has 6 lead-acid wet cells containing alternating positive and negative metal plated (**electrodes**) in a sulfuric acid **electrolyte**.