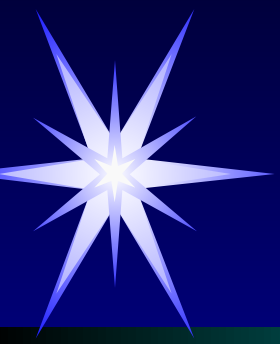


Electricity

You Light Up My Life!

Electricity and Magnetism

- The science of electricity has its roots in observation, known in 600 BC that a rubbed piece of amber will attract a bit of straw
- Study of magnetism goes back to the observation that certain naturally occurring stones attract iron
- The two sciences were separate until 1820 when Hans Christian Oersted saw the connection between them…an electric current in a wire will affect a compass needle

The Shocking History of Electricity

Around 600 BC Greeks found that by rubbing a hard fossilized resin (Amber) against a fur cloth, it would attract particles of straw. This strange effect remained a mystery for over 2000 years.

Two Thousand Years Later

Around 1600, William Gilbert, a physician who lived in London at the time of Queen Elizabeth I and Shakespeare, studied magnetic phenomena and demonstrated that the Earth itself was a huge magnet, by means of his "terrella" experiment. He also studied the attraction produced when materials were rubbed, and named it the "**electric**" attraction. From that came the word "electricity" and all others derived from it.

Birth of “Electronics”

- During the 1800s it became evident that electric charge had a natural unit, which could not be subdivided any further, and in 1891 Johnstone Stoney proposed to name it "**electron**."

- When J.J. Thomson discovered the particle which carried that charge, the name "electron" was applied to it. He won the Nobel Prize in 1906 for his discovery.

But, I Get Ahead of My Story

Benjamin Franklin

In 1752, Franklin proved that lightning and the spark from amber were one and the same thing. This story is a familiar one, in which Franklin fastened an iron spike to a silken kite, which he flew during a thunderstorm, while holding the end of the kite string by an iron key. When lightening flashed, a tiny spa
to his wrist. The experiment proved Franklin's theory, but was extremely dangerous - he could easily have been killed.

Galvani and Volta

In 1786, Luigi Galvani, an Italian professor of medicine, found that when the leg of a dead frog was touched by a metal knife, the leg twitched violently. Galvani thought that the muscles of the frog must contain electricity.

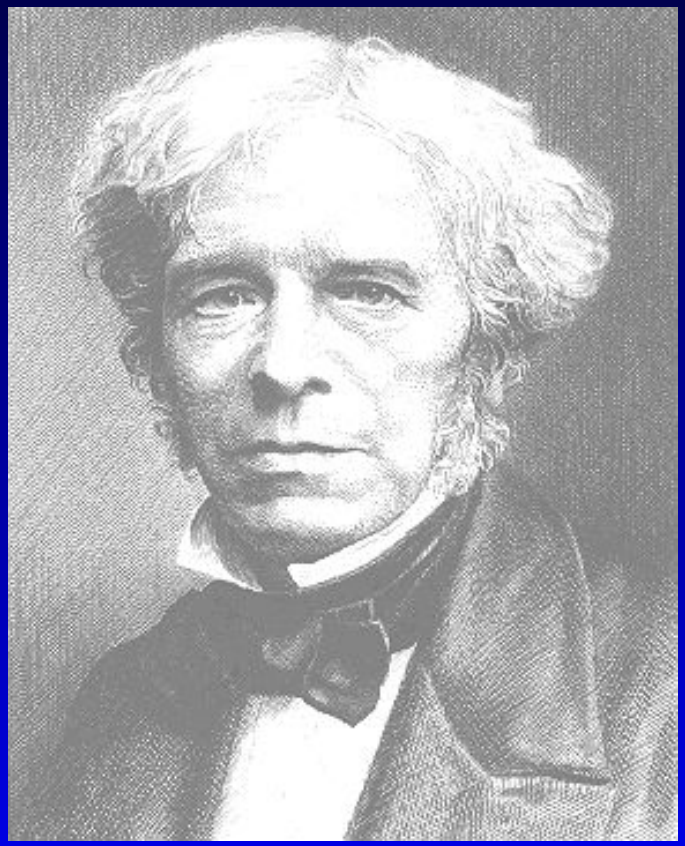
By 1792, another Italian scientist, Alessandro Volta, disagreed: he realized that the main factors in Galvani's discovery were the two different metals - the steel knife and the tin plate - upon which the frog was lying. Volta showed that when moisture comes between two different metals, electricity is created. This led him to invent the first electric battery, the voltaic pile, which he made from thin sheets of copper and zinc separated by moist pasteboard.

Volta…continued

In this way, a new kind of electricity was discovered, electricity that flowed steadily like a current of water instead of discharging itself in a single spark or shock. Volta showed that electricity could be made to travel from one place to another by wire, thereby making an important contribution to the science of electricity. The unit of electrical potential, the Volt, is named after him.

Michael Faraday

The credit for generating electric current on a practical scale goes to the famous English scientist, Michael Faraday. Faraday was greatly interested in the invention of the electromagnet, but his brilliant mind took earlier experiments still further. If electricity could produce magnetism, why couldn't magnetism produce electricity?

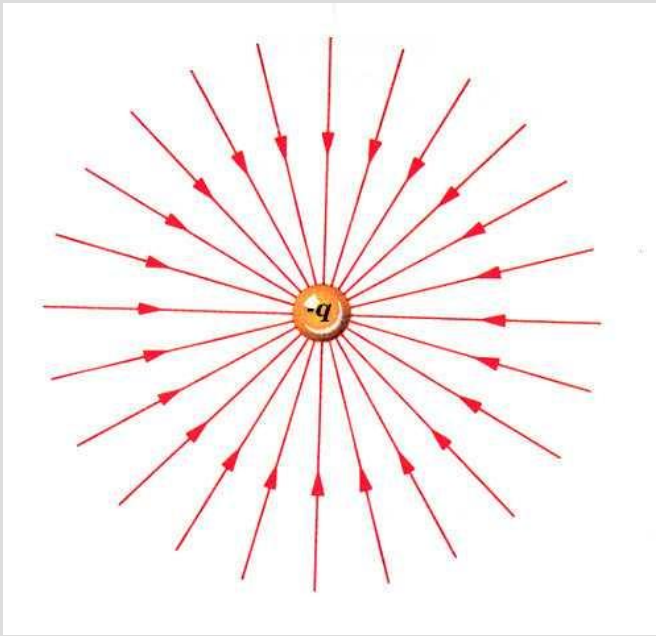


Faraday….continued

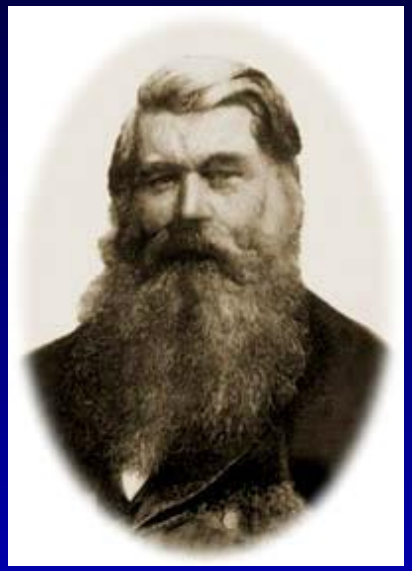
In 1831, Faraday found the solution. Electricity could be produced through magnetism by motion. He discovered that when a magnet was moved inside a coil of copper wire, a tiny electric current flows through the wire. Of course, by today's standards, Faraday's electric generator was crude (and provided only a small electric current), but he had discovered the first method of generating electricity by means of motion in a magnetic field.

Electric Interaction at a Distance

Faraday also realized that the electric force is transmitted by a electric field.



Edison and Swan



Nearly 40 years went by before a really practical DC (Direct Current) generator was built by Thomas Edison. In 1878 Joseph Swan, a British scientist, invented the incandescent filament lamp and within twelve months Edison made a similar discovery in America.

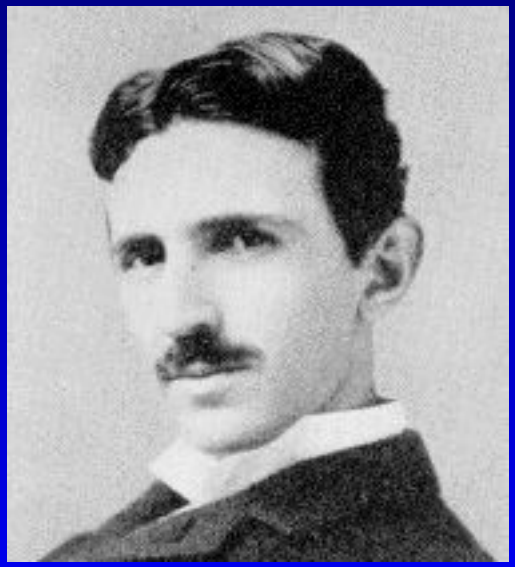
Edison and Swan…continued

Swan and Edison later set up a joint company to produce the first practical filament lamp. Prior to this, electric lighting had been crude arc lamps.

Edison used his DC generator to provide electricity to light his laboratory and later to illuminate the first New York street to be lit by electric lamps, in September 1882. Edison's successes were not without controversy, however - although he was convinced of the merits of DC for generating electricity, other scientists in Europe and America recognized that DC brought major disadvantages.

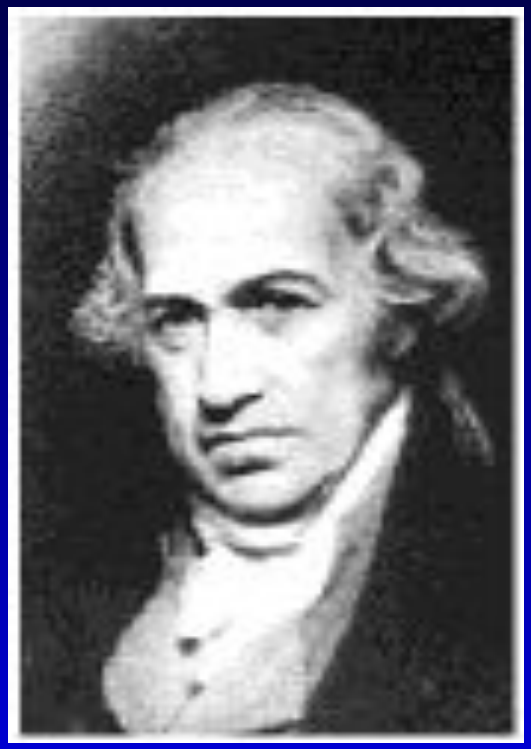
Westinghouse and Tesla

Westinghouse was a famous American inventor and industrialist who purchased and developed Nikola Tesla's patented motor for generating alternating current. The work of Westinghouse and Tesla gradually persuaded Americans that the future lay with AC rather than DC (Adoption of AC generation enabled the transmission of large blocks of electrical, power using higher voltages via transformers, which would have been impossible otherwise). Today the unit of measurement for magnetic fields commemorates Tesla's name.



James Watt

When Edison's generator was coupled with Watt's steam engine, large scale electricity generation became a practical proposition. James Watt, the Scottish inventor of the steam condensing engine, was born in 1736. His improvements to steam engines were patented over a period of 15 years, starting in 1769 and his name was given to the electric unit of power, the Watt.



Andre Marie Ampere

Andre Marie Ampere, a French mathematician who devoted himself to the study of electricity and magnetism, was the first to explain the electro-dynamic theory. A permanent memorial to Ampere is the use of his name for the unit of electric current.

Ohm

George Simon Ohm, a German mathematician and physicist, was a college teacher in Cologne when in 1827 he published, "The Galvanic Circuit Investigated Mathematically". His theories were coldly received by German scientists, but his research was recognized in Britain and he was awarded the Copley Medal in 1841. His name has been given to the unit of electrical resistance.

Voltage = Current x Resistance

Electromagnetism

- James Clerk Maxwell (1831 - 1879) developed the laws of electromagnetism in the form we know them today: Maxwell's Equations
- Maxwell's Equations are to electromagnetism what Newton's Laws are to gravity

Note: It was Maxwell who realized the light is electromagnetic in nature

What is “Electricity”?

- "Electricity" means electric charge.
Examples: CHARGES OF ELECTRICITY. COULOMBS OF ELECTRICITY.

- "Electricity" refers to the flowing motion of electric charge.
Examples: CURRENT ELECTRICITY. AMPERES OF ELECTRICITY.

- "Electricity" means electrical energy.
Examples: PRICE OF ELECTRICITY. KILOWATT-HOURS OF ELECTRICITY.

- "Electricity" refers to the amount of imbalance between quantities of electrons and protons.
Example: STATIC ELECTRICITY.

- "Electricity" is a class of phenomena involving electric charges.
Examples: BIOELECTRICITY, PIEZOELECTRICITY, TRIBOELECTRICITY, THERMOELECTRICITY, ATMOSPHERIC ELECTRICITY ...ETC.

Electricity?

- Electricity is all about electrons, which are the fundamental cause of electricity
- Static Electricity - involves electrons that are moved from one place to another, usually by rubbing or brushing
- Current Electricity - involves the flow of electrons in a conductor

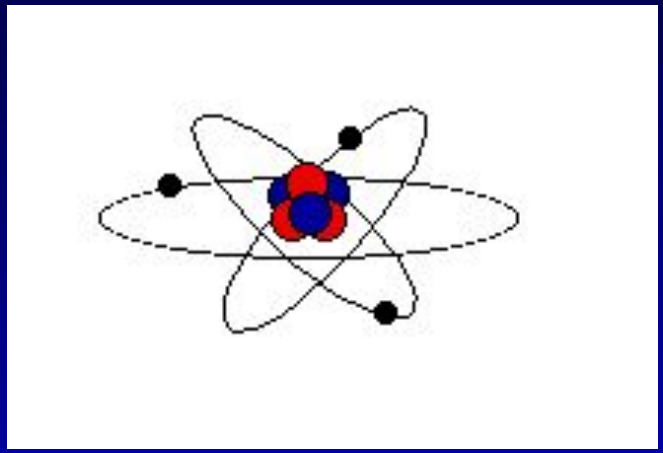
Electric Charge

- Two kinds: positive and negative (terms coined by Benjamin Franklin)
- When you rub a glass rod with silk, the charge that is left on the glass was called positive. If you rub a hard rubber rod with silk, the charge left on the rod was called negative.
- Like charges repel while unlike charges attract.

Quick Review of the Atom

- Matter is made up of atoms
- Atoms are made of nucleons (called protons and neutrons) and electrons
- Protons have a positive charge, neutrons have no charge, electrons have a negative charge
- The charges of protons and electrons are equal and opposite

Atoms Are Everywhere



- Electrons move in and out of fixed pathways around the nucleus
- Changing the number of electrons in a particular type of atom creates an ion of that atom

On the Move

- Electrons in the outer rings or shells of atoms are bound more loosely to the nucleus
- Such electrons tend to break free from the nucleus and wander around amongst other nearby atoms
- Such electrons are called free electrons

Current = Conduction

- Such movement of these free electrons creates an electric current
- Materials with large numbers of free electrons are called electrical conductors. They conduct electrical current.
- Movement of the electrons physically from one place to another is slow. Transfer of the energy from one electron to another happens fast.

Conductors and Insulators

- In conductors, electric charges are free to move through the material. In insulators, they are not.
- In conductors:
  - The charge carriers are called free electrons
  - Only negative charges are free to move
  - When isolated atoms are combined to form a metal, outer electrons of the atoms do not remain attached to individual atoms but become free to move throughout the volume of the material

Other Types of Conductors

- Electrolytes
  - Both negative and positive charges can move
- Semiconductors
  - In-between conductors and insulators in their ability to conduct electricity
  - Conductivity can be greatly enhanced by adding small amounts of other elements
  - Requires quantum physics to truly understand how they work

Simple Circuits

- Don't let the name fool you
- Bottom line: For electric current to flow, there has to be a complete pathway for it…a complete circuit.

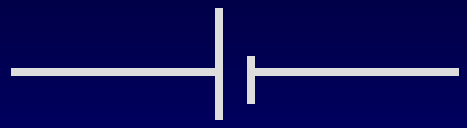
Closed and Open Circuits

- Closed Circuit - an unbroken path of conductors through which electric current flows
- Open Circuit - a circuit with a break in the conductive path, so no current flows

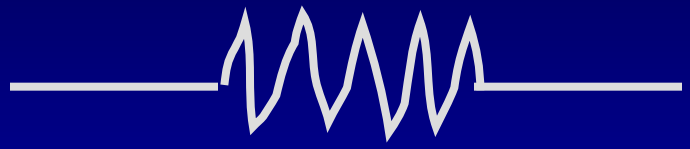
Now, let's play… "Know Your Electrical Symbols!"

Know Your Symbols

- Battery or Power Supply



- Resistor



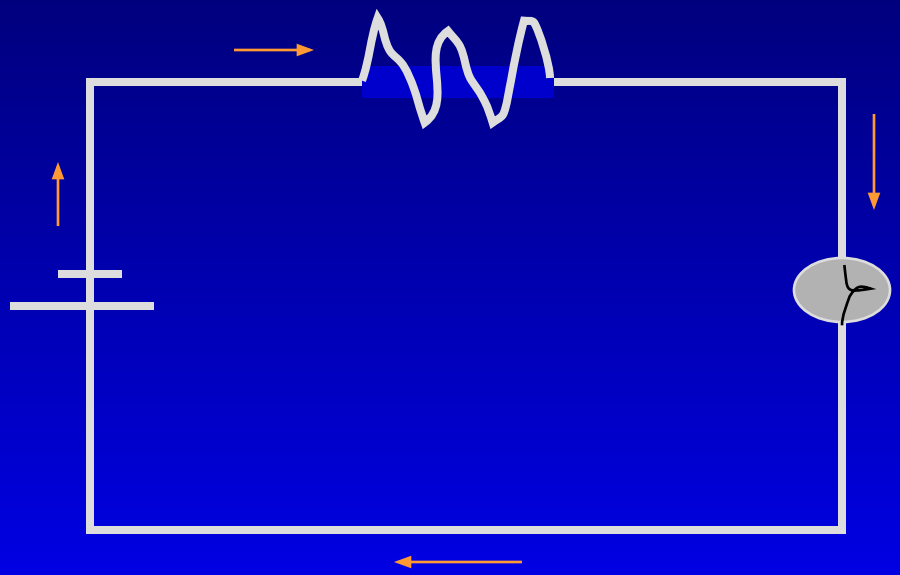
- Capacitor

- Switch

- Conductive Wire

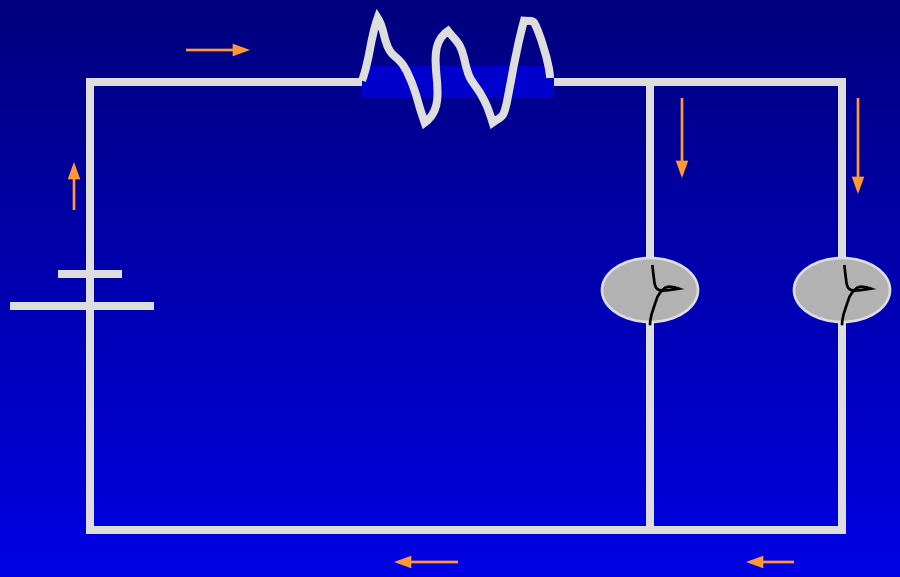
Series Circuits

- An electrical circuit with only one path for the electrical current to follow



Parallel Circuits

- An electrical circuit that provides more than one path for the electrical current to follow.



Static Electricity

Who hasn't rubbed a balloon on their hair and stuck it to the wall?

- Buildup of charge (static, not moving) in one place.
- Charge can be either positive or negative

Beware of Door Knobs That Bite

More apt to happen in dry weather…why?