World of Electronics Study
Electronics Study from basic to advanced

Basic Electronics Series
Lesson Two: Atomic Structure

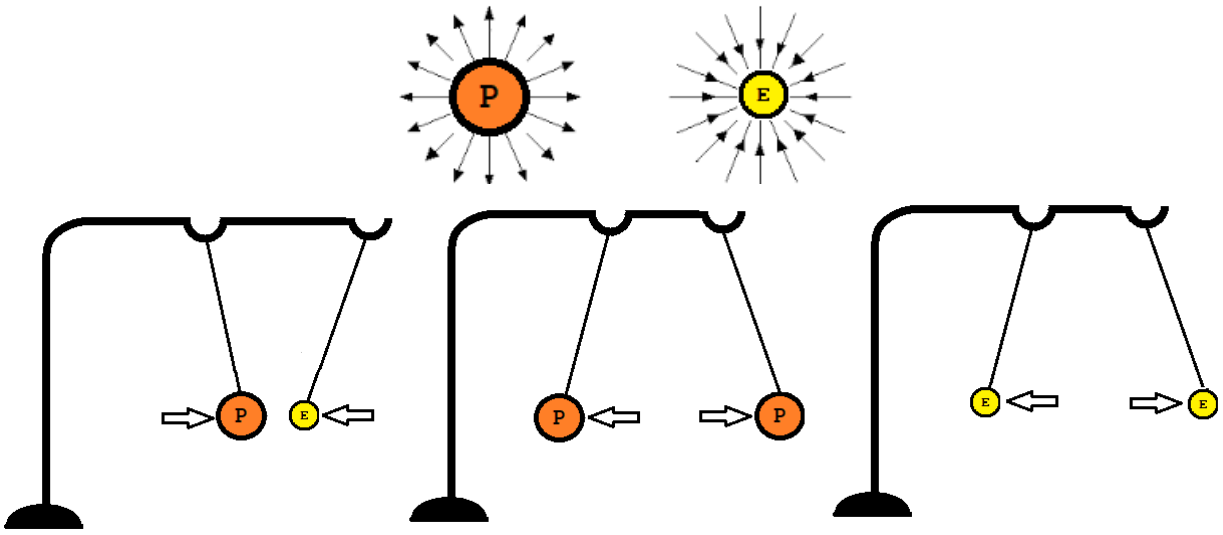
Let's begin with a review of basic terms regarding matter.

Matter is anything that has mass and takes up space. The fundamental building block of matter is the atom. Although there are many types of atoms, all atoms are made up of various combinations of three basic particles, the neutron, proton and electron. The Electrons and Protons each possess static charges.

Due to these charges, the particles exert force upon one another. The force is what holds the structure of the atom together. The center of the atom is called the nucleus and contains protons and neutrons. Orbiting the nucleus are electrons.

Polarity

The electrostatic charge of the Proton is classified as positive. Neutrons are considered neutral. Electrons have a negative charge. The concept of an electric field is used to explain why charged particles exert forces on each other. Like charges repel each other and opposite charges attract. In the drawings, the arrows represent the direction of the force exerted by the surrounding field.



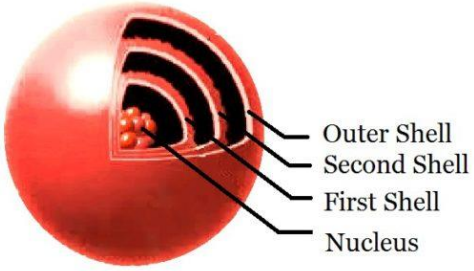
Electrostatic charge is measured in Coulombs. One coulomb is equal to the amount of negative charge of $6.25x10^{18}$ electrons or the positive charge created on a material with a deficiency of $6.25x10^{18}$ electrons. The letter G is used to indicate charge.

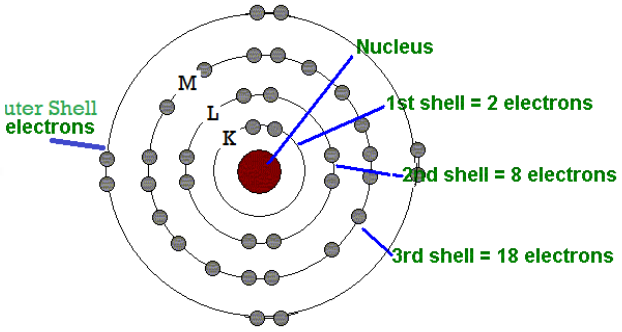
The electrons orbiting the nucleus of an atom contain enough energy to maintain their orbits. Each electron must maintain a discrete and very specific distance from the nucleus to avoid collisions.

The theory is that the electron orbit is in all plains forming shells around the nucleus. Moving outward from the nucleus, the first shell (the K shell) can contain up to only two electrons. Moving on out to the next shell (the L shell) can have up to eight electrons.

The drawings below show the number of electrons aloud in each shell. Also shown is the letter designation assigned to each shell. The number of electrons in each specific shell is divided into subshells. (To explain why electrons don't collide). Electrons can't exist between shells.

Energy Level	Shell Letter	Electron Capacity
1	K	2
2	L	8
3	M	18
4	N	32
5	O	50
6	P	72





The elements of "main" interest to your studies are classified as conductors, semiconductors, and insulators. The number of electrons in the outer shell (valence shell) of a materiel's atoms determines its electrical properties. The maximum number of valence electrons is up to eight (In the K shell only two). Conductors have three or less valence electronics. Semiconductors have four and insulators have five or more.

Common Insulators (Valence 5-8)		Conductors			Semiconductors
Material	Material		Material	Electrons	Valence
Oil	Plastic	☆	Silver	47	1
Fur	Wood	☆	Copper	29	1
Silk	Paper	☆	Gold	79	1
Wool	Wax	☆	Aluminum	13	3
Rubber	Ebonite	☆	Silicon	14	4
Porcelain, Glass	Pure Water	☆	Germanium	32	4
		☆	Lead	82	4

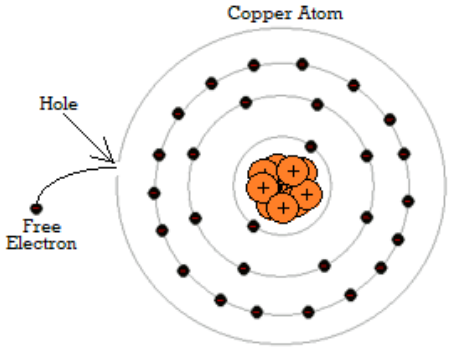
Let's pick up the discussion with what is significant about these materials.

First, we'll start with insulators that have anywhere from five to eight valence electrons. The fact that the outer shell has lots of valence electrons means that they are tightly bound by the attraction of the protons in the nucleus. To add or dislodge electrons from the valence shell of insulators is difficult.

Unlike insulators, conductors only have from one to three valence electrons which are only loosely bound to the nucleus. Electric and electronics applications have to do with controlling electrons. An important part of controlling electrons is to have individual electrons to control.

Ions

By adding a little energy to loosely bound conductor valence electrons they can be liberated from their parent atom. Once a valence electron is broken free the parent atom is left with more protons than electrons. The atom then has a net positive charge. Charged Atoms (Atoms with less or more valence electrons than normal) are called "Ions". The liberated electron is called a "free electron".



Here are a few ways that energy can be added to a valence electron:

--> Friction
--> Heat
-->Magnetism
--> Light

Unlike the volatility of the valence shell of the conductor atom, the valence shell of the insulator atom cannot easily gain or lose electrons. Although, it is possible for free electrons to build up on the surface of an insulated material.

Dielectric

A material that can hold a static charge on its outer surface is termed a "Dielectric". A static charge refers to a charge that is motionless. The minute electrostatic charge of a single electron or ion is insignificant. But, when a large number of these charged particles collect the resulting Static Charge can be useful or harmful.

- Useful in applications such as electrostatic painting or laser printing.
- Harmful when handling static sensitive electronic components.

The study of electrostatics might be useful at some point. But, currently you need to understand electrons in motion along with their control and application.
Before starting on the next major topic, there are three electrical quantities that need defining.
First, "Voltage" which is the electrical pressure that causes electrons to flow.
Next, "Electrical Current" which is charge in motion.
And last but not least, "Electrical Resistance" which is the opposition to current.

Dynamic Electricity

When an electron moves the theory is that it absorbs energy from the electrostatic field. When in motion a magnetic field appears around the electron. This complex electrostatic and magnetic field is the foundation for everything electrical.

The next lesson will cover a few major formulas and equations used in design, prototyping and troubleshooting.