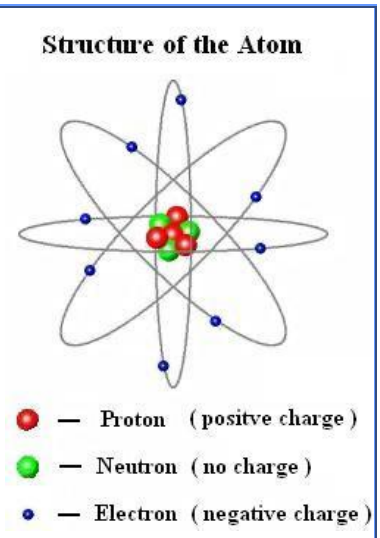
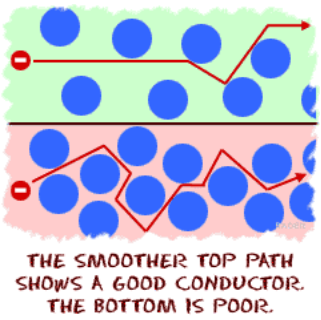
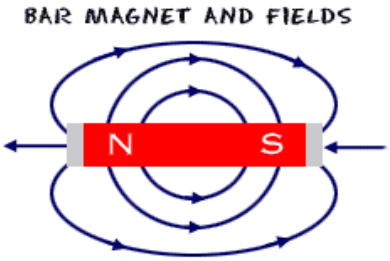
Electricity and Magnetism

Magnetism and **electricity** are closely related phenomena. An e**lectric charge** is a fundamental property of matter. Matter is made up of electrons, neutrons, and protons. Electrons have a negative electric charge, while protons have a positive electric charge; neutrons have no electric charge. These tiny particles are the building blocks of atoms. The objects around us contain billions and billions of atoms, and each atom contains many protons and electrons. The protons are located in the center of the atom, concentrated in a small area called the nucleus. The electrons are in motion outside of the **nucleus** in orbitals. The protons are basically trapped inside the nucleus and can't escape the nucleus. As a result, it is moving electrons that are primarily responsible for electricity.





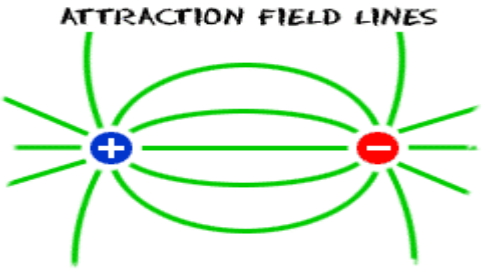
There are many materials that allow charges to move easily. They are called **conductors**. Conductors have the quality of **conductivity**. I guess that's not a lot of help for you. The reality is that you just need to understand the difference between those two words. The conductor is the object that allows charge to flow. Conductivity is a quality related to the conductor. A material that is a good conductor gives very little **resistance** to the flow of charge. This flow of charge is called an electric current. A good conductor has high conductivity.



A magnet is an object or a device that gives off an external magnetic field. Basically, it applies a force over a distance on other magnets. **Magnetism** can even be caused by electrical currents.

Magnetic fields are areas where an object exhibits a magnetic influence. The fields affect neighboring objects along things called magnetic field lines. A magnetic object can attract or push away another magnetic object. You also need to remember that magnetic forces are NOT related to gravity. The amount of gravity is based on an object's mass, while magnetic strength is based on the material that the object is made of.

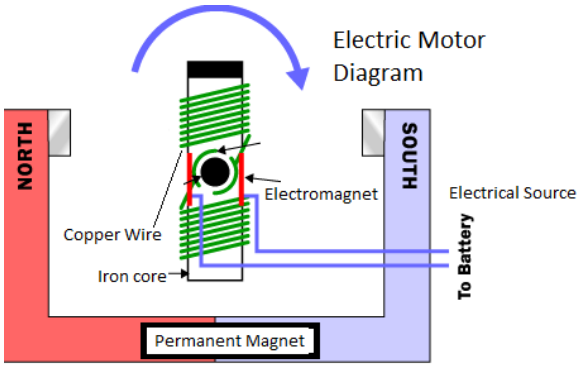
If you place an object in a magnetic field, it will be affected, and the effect will happen along field lines. Many classroom experiments watch small pieces of **iron** (Fe) line up around magnets along the field lines.

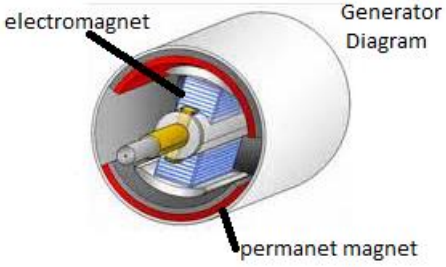


While you might think of metal magnets such as the ones you use in class, there are many different types of magnetic materials. Iron (Fe) is an easy material to use. Other elements such as neodymium (Nd) and samarium (Sm) are also used in magnets. Neodymium magnets are some of the strongest on Earth.

There are many different types of magnets. **Permanent magnets** never lose their magnetism. There are also **Electromagnets**. These magnets usually have iron or steel located inside of the coils of wire. The core is something that helps in producing magnetic effects, so electromagnets are typically stronger than a comparable magnet. Electromagnets can be turned on and off. They depend on currents of electricity to give them magnetic characteristics. Not only can they be turned on and off, but they can also be made much stronger than ordinary magnets. You might see an electromagnet at work in a junkyard lifting, moving, and dropping old cars off the ground.

An example of the relationship between electricity and magnetism is the electric motor and generator. In an **electric motor**, electrical energy from a battery is applied across a coil of wire (electromagnet). The voltage causes the electrons in the wire to move, which in turn generates a current. This electric current results in a magnetic field, which interacts with permanent magnets attached to the core of the motor, causing it to move resulting in mechanical energy.





In a **generator**, mechanical energy is applied to the electromagnet which spins inside a permanent magnet resulting in an electrical energy transformation. This is pushed through power lines that supply electrical energy for your everyday lives.

Without these two concepts working hand in hand, our world would not be the same.

Reading Comprehension Questions:

1. What are atoms made up of? _____
   _____
   _____
2. What part of an atom is responsible for electricity? _____
3. When electrons flow with little resistance through a conductor it is called a _____.
4. What is a magnetic field?
   _____
   _____
5. What is the strongest magnetic material? _____-
6. What is the difference between a permanent magnet and electromagnet?
   _____
   _____
7. How can you make an electromagnet stronger?
   _____
8. Both an electric motor and a generator spend an electromagnet inside of a permanent magnet. However, the input and output energies are different. Explain the differences.
   _____
   _____