Physical Science
Lecture Notes
Chapter 13

I. Section 13-1 Electricity, Magnetism & Motion

A. Electrical & mechanical energy

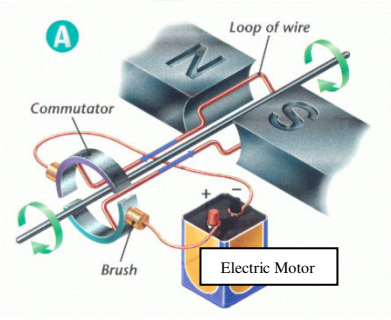
1. Magnetic forces repel when alike and attract when opposite
2. Electric current in a wire produces a magnetic field
3. Therefore a magnet can move a wire when it is charged just as it moves a magnet
4. Energy is the ability to do work (force applied over a distance)
    a. **Electrical energy** – energy associated w/ electrical current
    b. **Mechanical energy** – energy associated w/ movement (kinetic) or position (potential)
    c. Energy is changed from one form to another
        i. When a current carrying wire is placed in a magnetic field, electrical energy is converted into mechanical energy (a **motor** is made)

B. Galvanometers


Galvanometer

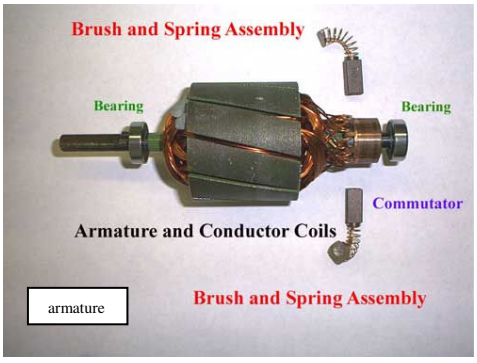
1. Tool used to measure small currents
2. A **coil of wire** in a **magnetic field** causes a torque when a current passes thru it.
3. The coil is attached to a pointer and a spring so as the current increases the amount of deflection is proportional to the current.

C. Electric motors



Electric Motor

1. **Converts electrical energy into mechanical energy**
2. How they work:
    a. The current induces a magnetic field in the wire.
    b. As the motor turns the forces push up on one side and down on the other
    c. The side that was pushed down on the right is now pushed up on the left and it begins to cycle over and over.
3. Parts of a motor
    a. **Commutator** – device that reverses the flow of current thru an electric motor
        i. Two parts of a ring each attached to one end of the wire loop
        ii. When the loop rotates, so does the Commutator
        iii. As it rotates, the Commutator slides past two contact points called brushes
    b. **Brushes** – contact point between the Commutator and the power source
    c. **Armature** – instead of a single loop of wire most electric motors have dozens or hundreds of loops of wire wrapped around a metal core



d. **Permanent magnet**- attracts & repels the coils w/in the armature thus allowing the motor to spin rapidly
e. **Current source** – supplies the electrical energy needed to the brushes which transfers to the commutator

II. Section 13-2: **Generating Electric Current**

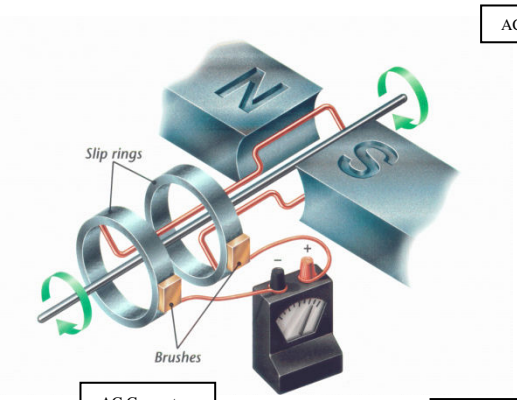
A. **Induction of electric current** – making a current flow in a wire
   1. Moving a coil of wire up and down in a magnetic field or
   2. Moving a magnetic field up and down through a coil of wire

B. Alternating & direct current
   1. The flow of an induced current may be constant or may change direction
   2. **Alternating current** – **AC** – as a coil is moved up & down on a magnet repeatedly the current would reverse direction each time
      a. A current that changes direction
      b. The electricity in our homes is AC
   3. **Direct current** – **DC –** the current resulting in electrons flowing from high potential to lower potential
      a. Therefore it moves in one direction only
      b. The electricity stored in batteries is DC

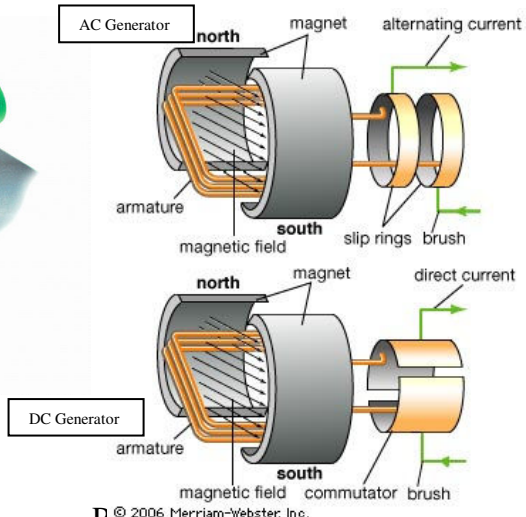
C. Generators
   1. Converts mechanical energy into electrical energy
   2. An electric motor uses electricity to produce motion
   3. A generator uses motion to produce electricity
   4. **AC generators**- simply a backwards motor
      a. requires a mechanical source to spin the axle
      b. which in turn spins the loop/armature which will induce a current.
      c. Attached to each end of the coil loop are Slip Rings – which spin &
      d. transfers the electricity to the brushes & the rest of the circuit
   5. DC generators
      a. Similar to an AC generator but has a single Commutator instead of two slip rings

D. **Turbines** – the "fins attached to the axle of a generator that act as a "propeller"

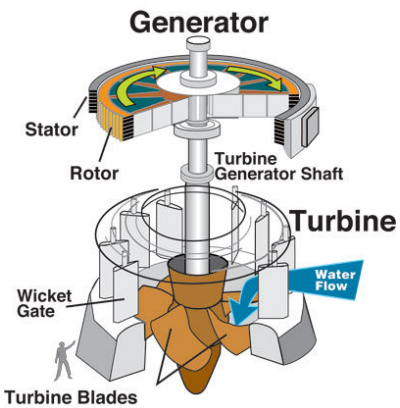
E. **Generating electricity** – turbines attached to many different devices to help generate electricity from mechanical energy: Wind turbines, steam turbines, water (hydroelectric dams) tides, nuclear (San Onofre)
   1. Also Solar electric cells and chemical reactions (dry cell batteries and wet cell batteries



AC Generator



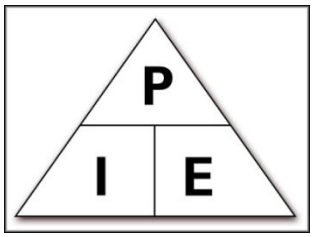
DC Generator

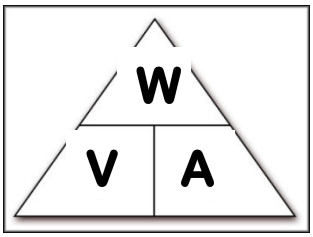


III. Section 13-3: Using Electric Power

A. Electric power – Remember that **Power is the rate at which work is done** and the unit of power is the **Watt.**

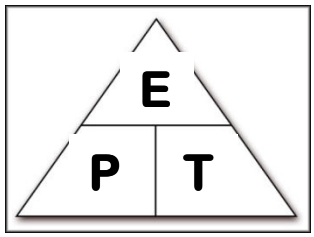
1. Formula is: **Power = Voltage x Current**
2. Formula is: **Watts = Volts x Amps**
3. Or **Amps = Watts / Volts**
4. Or **Volts = Watts / Amps**





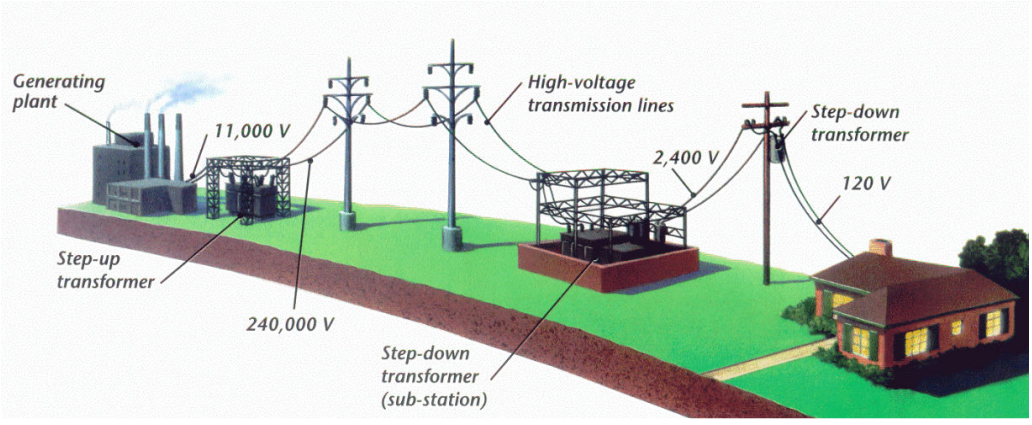
B. Paying for energy – we are charged by the electric company for the power we use. It is calculated and billed to us by the kilowatt hour.

1. The formula used is **Energy = Power x Time**
2. The formula used is **Kilowatt hours = Kilowatts x Hours**

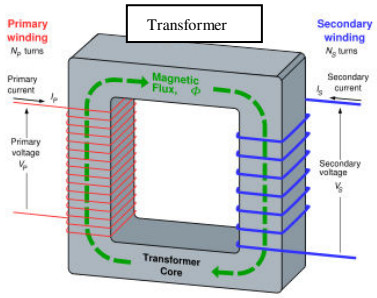


C. Transformers

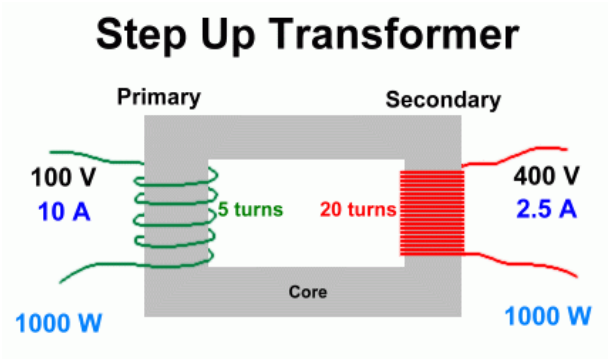
1. Remember resistance occurs anytime current is sent thru a wire.
2. Power companies have found that **very high voltages can travel more efficiently thru the wires**
3. Once electricity is generated, it is transformed (in a **step up transformer**) to a very high voltage (up to 750,000 volts) then sent along the transmission lines
4. Voltage is then reduced at a substation at a **step-down transformer** to a lower voltage (between 2,000 & 5,000 volts)
5. Electricity is then sent throughout the neighborhood and as it comes into the home it is step-downed one more time to the **110 volts required** for our household appliances and tools

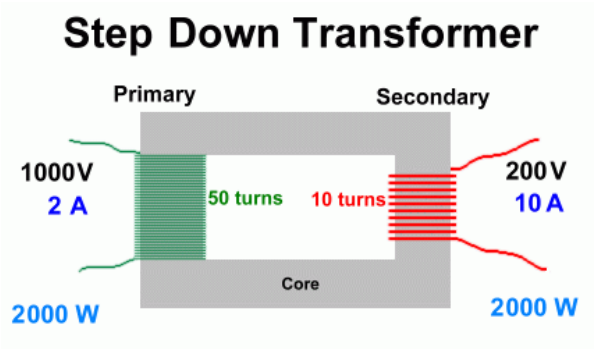


D. Changing voltage with a transformer



1. **Transformer** – piece of iron with two wires coiled around it. The coils do not come into contact w/ each other
2. Transformers work **only with AC currents**, not DC currents and is accomplished by Induction
3. The loops are labeled **primary coil**/winding, electricity coming into the transformer; the **secondary coil** is the loop/winding coming out.
4. If the number of loops in both the primary & secondary coils are the same, there is no change in voltage or current
5. If the primary coils are greater than the secondary coils, the voltage **steps down**
6. If the primary coils are fewer than the secondary coils, the voltage is **stepped u**p
7. If volts go up; the amps go down, if volts go down, amps go up. **Watts will always remain the same**
8. Step-up or step-down voltage is directly proportional to the number of coils present
    a. If **primary has 10 coils & secondary has 50 coils**: voltage increases **5x**
    b. If **primary has 100 coils and secondary has10 coils**: voltage decreases by **10x**
    c. **watts= volts x amps**, Since watts on both sides of the transformer stays the same:
        i. when voltage goes up on the secondary side the amps will have to go down
        ii. when voltage goes down on the secondary side the amps will have to go up!



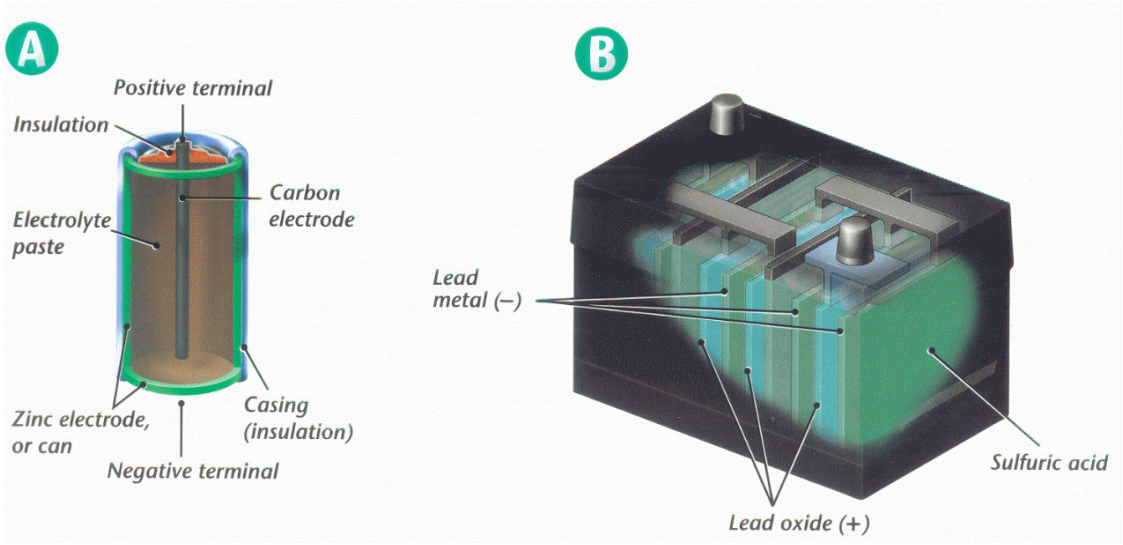


IV. Section 13-4: **Batteries**

A. Electrochemical cells

1. **Converts chemical energy into electrical energy**
2. Consists of two different metals – **the electrodes**
3. Electrodes immersed in a chemical "bath" that conducts electricity called the **electrolyte**
4. The part of the electrodes above the electrolyte is the **terminal** and used to connect the battery to the circuit.
5. There is a chemical reaction between the electrodes and the electrolyte resulting in a buildup of electrons on one of the terminals (it becomes the **"-" terminal**)
6. The other terminal gives up its electrons and becomes the **"+" terminal**.
7. This difference sets up the electrical potential of the system **= Volts**
8. When cells are connected in series the voltages of the cells are **added together**
9. Two main types of electrochemical batteries: **dry cell & wet cell**

a. **Wet Cell** – the electrolyte is a liquid (car battery)
    i. In a car battery, Electrolyte is sulfuric acid the "+" terminal is lead oxide and the "-" terminal is lead metal
b. **Dry Cell** – the electrolyte is not really dry; but is a paste
    i. Standard AA, C, D type batteries, electrolyte is a paste. The "+" terminal is the "Button" on top the battery case itself is the negative terminal.



V. Worksheet vocabulary

A. **Alternating** – current that changes direction
B. **Amplifies** – magnification of a small electrical signal
C. **Ammeter** – Tool used to measure the current flowing in a circuit
D. **Cathode** Ray Tube– old fashion TV or computer monitor that uses electrons to produce images on a screen
E. **Generator** – produces electrical current simply by moving a magnetic field across a wire
F. **Integrated** Circuit- A complicated electrical circuit that can contain thousands of tiny transistors – a computer
G. Electric **Motor**- device that converts electrical energy into kinetic (mechanical) energy
H. **Rectifier** – Device that will change alternating current into direct current
I. **Silicon** – A semiconductor material used in the construction of small/micro electrical circuits
J. **Transistor** – made from semiconductors (like Silicon) allowing the miniaturization of electrical circuits. Allows for smaller & smaller electrical devices
K. **Voltmeter** – measures the potential energy of a circuit, the volts in the system