* Electric current: Charges in motion from one place to another
* Electric potential is transferred from one source to another (battery to light, etc)

**Current**

* Current: Motion of charge from one region to another
* Electrostatics: No net flow, electrons freely move but do not leave material
* Constant electric field being applied to particles results in a current
* **Drift velocity:** Very slow net motion of charge particles
* While drift velocity is very slow, the light will turn on instantaneously because an electric field is established immediately, ie soldiers listening to orders before they can start marching

Direction of Current Flow

* Electric field does work on moving charges
* Resulting kinetic energy transferred to material of conductor by means of collisions with ions
* Lots of energy goes into heating conductor as ions vibrate in equilibrium positions
* Moving charges in a metal are always negative
* Moving charges in a gas or ionic solution may be electrons or positively charged ions
* In semiconductors, motion is partly by electrons and partly by holes (missing electrons that act as positive charges)
* Whether it is positive or negative charges flowing, current is defined as net flow of positive charge, or **conventional current**
* **Ampere:** One colomb per second

Current, Drift Velocity, and Current Density

* Current can be expressed as drift velocity of moving charges
* Current dependent on both the drift velocity, concentration of particles, and volume of cross section
* Current density is charge flow at a certain point and contains information for direction
* Current describes how all the charges in an object such as a wire flow
* Current density varies around a loop of a circuit, current does not.
* Current flow can contain different types of charged particles and concentrations, such as in an ionic solution
* The current density would be the vector sum of all these particles
* Current can be steady only if there is a closed loop or complete circuit.

**Resistivity**

* Current density is directly dependent on both electric field and properties of material
* For some materials, current density is almost directly proportional to electric field (Ohms Law)
* Greater resistivity, greater the necessary field to cause a given current density
* Perfect conductor: Zero resistivity, Perfect Insulator: Infinite resistivity
* **Conductivity:** Reciprocal of resistivity
* Material that obeys Ohm’s law fairly well is Ohmic or linear conductor.

Resistivity and Temperature

* Resistivity always increases with temperature
* Alpha is **tempearature coefficient of resistivity**
* Superconductivity: at a certain temperature, resistivity suddenly drops to zero

Interpreting Resistance

* Resistance also varies with temperature
* Resistors that follows Ohm’s law will have a current vs. voltage graph that is linear
* Voltage vs. Current is nonlinear for a diode

**Electromotive Force and Circuits**

* If a circuit is not complete, a positive net charge will build at the end of the conductor and produce an opposing electric field to the one already established, causing current density to quickly approach zero
* Potential energy decreases as you move through a material with resistance

Electromotive Force

* In a circuit there must be a “pump” to go from lower to higher potential energy
* This device which makes current flow from lower to higher potential is an **electromotive force** or **emf**
* A circuit with steady current must have a **source of emf**
* Force Fn pushes charge against natural gradient from higher to lower potential
* Fn (force needed to move charge to higher potential) and Fe (natural electrostatic force) are in opposite directions and in equal in magnitude
* The total work done is zero

Internal Resistance

* Any battery will have its own internal resistance as well
* If it behaves according to Ohms law it will be constant and independent of current
* **Terminal voltage** is less than emf because there is a potential drop due to internal resistance
* Batteries DO NOT emit constant supply of current, the current depends on resistance, etc