G482 Revision Notes

- **Electric current** - flow of charge

- **Conventional Current** - flow of current from the positive to negative terminal
- **Electron Flow** - flow of electrons from the negative to the positive terminal

- **Electrolyte** - a solution that conducts and contains both positive and negative ions

- **Charge carriers** - any charged particle that contributes to an electric current (eg. electrons, protons or neutrons)

- **Charge = Current x Time (Q=It)**
- **Current** - measured in amperes (A)
- **Charge** - measured in coulombs (C)

- **One coulomb is the amount of charge which flows past a point in a circuit in a time of 1s when the current is 1A**

- **Elementary charge** - the magnitude of the charge (e=1.6x10^(-19))

- **Kirchhoff's first law: The sum of the currents entering any point in a circuit is equal to the sum of the currents leaving that same point**
  - Kirchhoff's first law is an expression of the **conservation of energy**

- **Current = Cross-sectional area x Number Density x Elementary Charge x Mean-drift velocity (I=Anev)**
- **Number density** - the number of conduction electrons per unit volume
- **Mean-drift velocity** - in a metal the electrons collide with vibrating ions (haphazard journey) which causes it to have a drift-velocity
- **Velocity ∝ Current**
- **Velocity ∝ 1/Area**
- **Velocity ∝ 1/Number-density**

- **Resistance = Voltage/Current (R=V/I)**
- **Resistance** - measured in ohm

- **1 Ohm = 1VA^(-1)**
- **The ohm is the resistance of a component when a p.d of 1V is produced per ampere of current**

- **Ammeter** - connected in series, should have a low resistance (e.g. Digital ammeter) so as little energy as possible is transferred into the ammeter itself.
- **Voltmeter** - connected in parallel, should have a very high resistance so it takes as little current as possible.

- On a **I-V Characteristic graph**: **Resistance = 1/Gradient** (BUT only if it is a *straight line* that passes through the *origin*)
- **Ohm's law: for a metallic conductor at a constant temperature, the current in the conductor is directly proportional to the potential difference across its ends.**

- **Ohmic component** - e.g. resistor and wire at constant temperature
- **Non-ohmic conductor**: does not obey Ohm's law; e.g. semiconductor diodes (LEARN SYMBOL) (Only allows current through in one direction) or light-emitting diodes (LEDS) (LEARN SYMBOL)

- And **LED** only starts to conduct at its threshold voltage which is usually 2V (so it depends on the p.d. across it - non-ohmic conductor)

- **Thermistors** (thermal resistors): components with a resistance that changes rapidly with temperature. The two types are:
  - **Negative temperature coefficient (NTC)** - resistance decreases as the temperature increases
  - **Positive temperature coefficient (PTC)** - resistance increases abruptly at around 100-150*C
  - Thermistors are used for: water temperature sensors, baby alarms, fire sensors etc

- The 2 factors which affect the resistance of a metal are: the temperature and the presence of impurities

- At a *constant temperature*:
  -**Resistance ∝ Length**
  -**Resistance ∝ 1/Cross-sectional Area**

- **Resistance = (Resistivity x Length)/Cross-sectional area (R=pL/A)**
- **Resistivity** - measured in ohm metres
- For a metal resistivity increases as the temperature increases but for a semiconductor resistivity decrease with temperature

- **Potential Difference: when charges lose energy by transferring electrical energy to other forms of energy in a component. P.d is defined as the energy transferred per unit charge.**

- **Potential Difference = (Energy lost by charge)/Charge (V=W/Q)**

- **Electromotive Force: when charges gain energy from a power supply of a battery. E.m.f. is defined as the energy transferred per unit charge.**

- **Electromotive force = (Energy gained by charge)/Charge (E=W/Q)**

- **1 volt = 1 joule per coulomb (JC^(-1))**

- **Power**: rate at which energy is transferred

- **Power = Energy transferred/Time taken (P=W/t)**
- **Power = Potential difference x Current (P=VI)**
- **Power = (Current)^2 x Resistance (P=I^2 x R)**
- **Power = (Velocity)^2/Resistance (P=V^2/R)**

- **Fuse**: 'blows' when the current is too high – has a rating which is slightly higher than the normal operating current of the device which it is protecting

- **Energy transferred = Current x Voltage x Time (W=IVt)**
- **Energy transferred (kWh) = Power (kW) x Time (h)**
- **1 kWh = 3.6 MJ**

- **Cost (p) = Number of kWh x Cost of each kWh (p)**

- For a *series circuit*:
-The resistances add up: **R = R(1) + R(2) + R(3)...**
-The **current is the same** at all points around the circuit
-The **p.d.s add up**
-The **e.m.f.s add up**

- When components are connected in *parallel*:
-All have the **same p.d.** across their ends
-The **current is shared** between them
-We use the reciprocal formula to calculate their combined resistances: **1/R = 1/R(1) + 1/R(2) +...**

- **Internal resistance**: the resistance of an e.m.f source. The internal resistance of a battery is due to its chemicals

- **Electromotive force = (Current x Resistance) + (Current x Internal resistance) (E=IR+Ir)**

- **Terminal p.d** : the potential difference across the external resistor connected by an e.m.f source
- **Terminal p.d. = e.m.f. – 'lost volts' (V=E-Ir)**

- On a *V against I graph*, the y-axis intercept = E and the gradient = -r

- **Maximum power dissipated when: R=r**

- **Potential divider**: a circuit in which two or more components are connected in series to a supply. The output voltage from the circuit is taken across one of the components.
- A *potential divider circuit* consists of two or more resistors connected in series to a supply. The output voltage V(out) across the resistor of resistance R(2) is given by:
- **V (out) = R(2)/[R(1) +R(2)] x V(in)**

- The resistance of a **light-dependent resistor** (LDR) decreases as the intensity of the light falling on it increases
- **Thermistors** and **LDR**s can be used in potential divider circuits to provide output voltages that are dependent on the temperature and light intensity, respectively.

- **Kirchhoff's second law: The sum of the e.m.f.s around any loop in a circuit is equal to the sum of the p.d.s around the loop.**

- **E.m.f of battery = sum of p.d.s across the resistors (E=IR(1)+IR(2))**

- Kirchhoff's second law is a consequence of the **principle of conservation of energy**; e.g. A charge of 1C gains energy when it passes through each e.m.f and losses energy as it passes through each p.d so when it gets back to way it started, the energy has to be the same.
- **Energy gained passing through sources of e.m.f = energy lost through passing components with p.d.s.**
- **Energy gained per coulomb around the loop = energy lost per coulomb around the loop.**