DC Circuits

Electromotive Force

➜ It is the energy transformed from chemical to electrical energy per unit charge
➜ It is measured in Volts
➜ It is also the potential difference across a battery when no current is flowing

Internal Resistance

➜ All power supplies have resistance between their terminals, known as internal resistance
➜ It causes some electrical energy to dissipate from the power supply
➜ It causes a loss of voltage
➜ Terminal potential difference (V_R) is the voltage across the components of a circuit
➜ $V_R = IR$
➜ When current passes through the cell, voltage produces across the internal resistance
➜ The voltage is not available to the rest of the circuit and is known as lost volts (V_r)
➜ $V_r = Ir$
➜ $V_r = E - V_R$
➜ $E = IR + Ir$

Kirchhoff's First Law

➜ The sum of currents entering a junction is equal to the sum of currents leaving the junction
➜ This is due to the conservation of charge

Kirchhoff's Second Law

➜ The sum of e.m.f.s in a closed circuit is equal to the sum of potential differences across individual components
➜ This is due to the conservation of energy
➜ In series circuit, voltage splits across components depending on the resistance
➜ The total e.m.f. is equal to the sum of voltages
➜ In a parallel circuit, the voltage across each loop is same
➜ The sum of voltages in each closed loop is equal to the total e.m.f.

Resistors in Series

➜ In series circuist, the total resistance is the sum of all individual resistances
➜ The equation is derived through Kirchhoff's laws

$V = V_1 + V_2$

$IR = IR_1 + IR_2$

$R = R_1 + R_2$ …

Resistors in Parallel

➜ In parallel circuits, the reciprocal of the total resistance is equal to the sum of the reciprocal of the individual resistances

➜ The equation is derived through Kirchhof's laws

$I = I_1 + I_2$

$V/R = V/R_1 + V/R_2$

$1/R = 1/R_1 = 1/R_2 \ldots$

For two resistors: $R = R_1R_2/(R_1+R_2)$

Potential Dividers

➜ Potential difference is divided across two resistors connected in series

➜ Potential dividers produce an output voltage as a fraction of the input voltage

➜ $V_{out} = \frac{R_2}{R_1+R_2}V_{in}$

➜ The V_{out} is measured across R_2

➜ The resistor with the larger resistance will have greater potential difference

➜ If a resistor's resistance is increased, it will get more potential difference and the other will get lesser

➜ Variable resistors such as LDRs and thermistors can be used to vary the output voltage

Potentiometer

➜ It is a variable resistor

➜ It is used in potential dividers to give variable output voltages

➜ The symbol has an arrow with the resistor

➜ It consists of a coil of wire with a sliding contact

➜ Moving the slider changes the length of the coil the current passes through and thus, the resistance

Galvanometer

➜ It is a sensitive instrument to detect electric current

➜ It is used in a potentiometer to measure the e.m.f. between two points

➜ It has an arrow/needle which deflects in the direction of the current

➜ If the arrow is facing upwards, there is no current, or null deflection

➜ According to Ohm's law, there will be no current when there is no voltage

➜ The potential difference across the galvanometer will be zero when the potential on both sides of it is equal

➜ This occurs when the position of the sliding contact produces a voltage equal to the e.m.f.

➜ The potential of the cell should oppose the e.m.f. in the circuit

➜ Positive terminals should be connected together

➜ The sliding contact is adjusted till the galvanometer gives null reading

➜ There is no current due to the opposing equal voltage and e.m.f.

➜ $V_1/L_1 = V_2/L_2$