Electric Current

➔ Any conductor has one or more electrons that are bound to the nucleus with very little force; they are called a free election.

➔ These free electrons can easily pass from one part to another.

➔ This free electron also carries a negative charge.

➔ An electric charge flowing over a period of time through a conductor is called 'electric current'.

$$I = \frac{Q}{t}$$

$$I = Ampere\ (A)$$

$$Q = Coulomb(C)$$

$$I = Time(t)$$

- ➔ Here, $Coulomb(C)$is the unit of electric charge.
- ➔ The amount of charge carried by a conductor when 1 ampere current flows through a conductor for 1 coulomb. I.e. $1C = 1A\ X\ 1s$

Potential Difference

- ➔ Lightning strikes from the sky to the ground, meaning the sky has more potential, while the earth has less potential. The potential difference generated in this process is $10^7 Volt$.
- ➔ Electric potential is the level of electricity near a point on a conductor. If there is a difference in the electric potential level between the two ends of the conductor, then only current flows.
- ➔ The action that takes place when a certain charge is moving from one point to another is called potential difference.
  $V(Voltage) = W\ (Joule)\ /\ Q\ (C)$
- ➔ Voltmeter is used to measure potential.
  Note - Voltmeter is connected parallel to the circuit.

Resistance

- ➔ When the electrons in a conductor move from one end to the other, the free electrons collide with the other closed electrons. This interference with the flow of electrons is called Resistance.

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$$R = V / I$$

$$R \alpha V \quad R \alpha 1 / I$$

- ➔ Resistance and current are inversely proportional to each other. As the resistance increases, the current decreases. Vice Versa, when the resistance is reduced, the current increases.
- ➔ The potential and resistance are directly proportional to each other. As the potential increases, the resistance increases, but the rate of current increase is greater than the resistance.

Types of Conductors

A. Conductor

It has a high number of free electrons, so the resistance is low.

Eg. Aluminium, Copper, etc.

B. Semiconductor

- ➔ A substance which shows the properties of both a conductor and an insulator is called a semi-conductor.
- ➔ When the temperature is increased in the semiconductor, it shows the properties of the conductor, while when the temperature is reduced, it shows the properties of the conductor.
- ➔ Eg. Silicon, Germanium, etc.

C. Super Conductor

- ➔ Substances in which the temperature is reduced, the resistance is reduced; and if the resistance is zero at a certain temperature, then the substance is called Super Conductor.
- ➔ Eg. Mercury, Fullerene (C-60), etc.

D. Insulator

- ➔ It lacks / does not have free electrons, so current does not flow through it.
- ➔ Eg. Plastic, Wood, etc.

Ohm's law

- ➔ When the physical condition (temperature, area, etc.) of the conductor is maintained, the current flowing through the conductor is proportional to the potential difference between the two ends of the conductor.

$$V = I$$

$$V \alpha I$$

- ➔ As the potential difference increases in conductors like silver, aluminium, copper, etc so does the current. Hence, these Conductors are called Ohmic Conductors.

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➔ Some carriers do not follow Ohm's law. In them, the more the potential difference in those conductors increases, the current does not increase in that proportion.
E.g. Diodes, thermistors, etc.

Resistivity

➔ Resistivity is a property of a substance, and the resistance of different substances is different.
➔ Resistivity is defined as the electrical resistance of a conductor of unit cross-sectional area and unit length.

$$R = \rho \frac{l}{A}$$

$$R \propto l , R \propto \frac{1}{A} \& R \propto \rho$$

Where, ρ is known as the resistivity of the conductor.

➔ The ascending order of a material's resistance Or the descending order of an electric current
1) Silver (Ag)

2) Copper (Cu)

3) Aluminium (Al)

4) Tungsten (Tn)

5) Iron (Fe)

6) Chromium (Cr)

7) Manganese (Mg)

Que. धातुंमधील विद्युत चालकता कमी ते जास्त क्रमानुसार (MPSC Subordinate Combine **Prelim 2017**)

(1) Al, Ag, Cu (2) Al, Cu, Ag (3) Cu, Al, Ag (4)Al, Cu, Al

From metals electrical conductivity increases in the order of

(1) Al, Ag, Cu (2) Al, Cu, Ag (3) Cu, Al, Ag (4)Al, Cu, Al

Internal Resistance

$$R + r = V / I$$

Where, r = internal resistance

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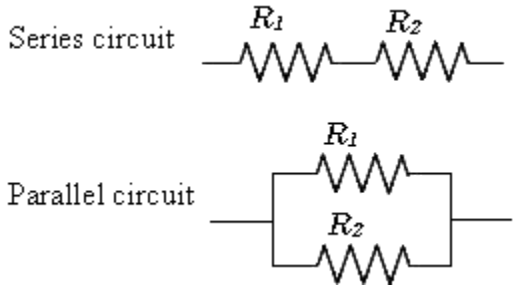
Resistors in Series and Parallel



A. Series circuit

➔ The same current flows through each part of the circuit.

➔ The potential difference is different for each resistor in the Series circuit.

➔ This connection is used to increase the resistance in the circuit and to reduce the current.

➔ The resulting resistance in a series circuit is the sum of the independent resistances in that connection

$$Rs = R_1 + R_2 + R_3 \ldots$$

➔ The resulting resistance in a series circuit is greater than the independent resistance in that connection.

B. Parallel circuit

➔ The same potential difference flows through each part of the circuit.

➔ In a parallel circuit, the current is different for each resistor.

➔ This connection is used to reduce the resistance in the circuit and to increase the current.

➔ The resulting resistance of a parallel circuit is less than the sum of the independent resistors

$$1/Rp = 1/R_1 + 1/R_2 + 1/R_3 \ldots$$

➔ The resulting resistance in a parallel connection is less than that of each individual resistance in the connection.

Thermal effects of electric current

➔ When an electric current flow through a conductor, the free electrons from the conductor begin to travel from the high potential to the low potential.

➔ The free electrons in this movement affect the other electrons and ions in the carrier.

➔ At each stroke, some of the kinetic and potential energy of the electron is converted into heat energy, so that the temperature of the conductor gradually increases.

➔ The process by which heat energy is generated when current flows through a conductor is called the thermal effect of current.

Joule's Law

The current flowing through the conductor 'I' by letting it pass through a conductor with 'R' resistance for a period of 't', the head generated is

1) Square of current (I^2)

2) Resistance (R)

3) Potential Difference (v)

4) time period (t)

directly proportional to all of these. This is called Joule's Law.

So,

$$V = W/Q$$

$$W = V\ X\ Q$$

$$H = V\ X\ Q$$

But, $I = Q/t$

$$H = V\ X\ I\ X\ t$$

But, $V = IR$

$$\boldsymbol{H = I^2\ X\ R\ X\ t\ Joules}$$

$$\boldsymbol{H = I^2\ X\ R\ X\ t\ /\ 4.18\ Cal}$$

Que. जर 0.3A इतकी विद्युतधारा 418Ω रोध असलेल्या तारेच्या कुंडलातून एका मिनिटासाठी प्रवाहित केली तर किती कॅलरी उष्मा निर्माण होईल ? (MPSC Subordinate Combine **Prelim 2018**)

(1) 240

(2) 540

(3) 418

(4) 60

Find the heat generated in calories if a current of 0.3A is passed through a coil of resistance 418Ω for one minute.

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(1) 240

(2) 540

(3) 418

(4) 60

AC and DC (Alternating & Direct Current)

A. AC

➔ When electrons are transported in up and down manner, the current that flows at that time is called AC. or A current that changes its magnitude and polarity at regular intervals of time is called AC

➔ electrons' ups and downs occur 50 times in India, so the AC frequency in India is 50Hz.

➔ AC is used in home appliances.

➔ Rectifier is used to convert AC to DC.

B. DC

➔ Electrons move in only one direction. I.e. A current which has a constant magnitude and same direction, is called DC.

➔ Electrons do not move up and down in any way. So, the frequency of Direct Current is zero.

➔ DC is used for industrial purposes.

➔ Oscillator is used to convert DC to AC.

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