ELECTRICITY

Electric charge:

Inside each atom there is a nucleus with positively charges protons and chargeless neutrons and negatively charged electrons orbiting the nucleus.

If an electron is removed from the atom, the atom becomes positively charged. It is called positive ion. If an electron is added in excess to an atom then the atom is negatively charged and it is called negative ion.

It is measured in coulomb.

$q = 1.6 \times 10^{-19}$ C
$q = ne$
n → whole number
e – charge of an electron

Electric Force:

There are two types of electric force (F)
Attractive Force – Unlike charges are attract
Repulsive Force – like charges repel

The Force existing between the charges is called as 'electric force'.

Electric Field:

The region in which a charge experiences electric force forms the electric field around the charge. The lines representing the electric field are called 'electric lines of force'. They are imaginary lines.

Electrostatic force between two-point charges obeys Newton's third law. The force on one charge is the action and on the other is reaction and vice versa.

Electric Potential:

Electric potential is a measure of the work done on unit positive charge to bring it to that point against all electrical forces.

Electric Potential Difference:

It is the difference between two points and is defined as the amount of work done in moving a unit Positive charge from one point to another point against the electric force.

$$V = \frac{\text{Work done (W)}}{\text{Charge Q}}$$

SI unit is volt.

OHM's LAW:

At a constant temperature the steady current 'I' flowing through a conductor is directly proportional to the potential difference 'v' between the two ends of the conductor.

$I \alpha v, \quad \frac{I}{V} = \text{Constant}$

$$I = \frac{1}{R} V$$

$V = IR$ $\quad R \rightarrow$ Resistance of the conductor

Resistance of a material:

It is its property to oppose the flow of charges and hence the passage of current through it. It is different for different materials.

$$\frac{V}{I} = R \text{ Ohm (S.I Unit)}$$

Electrical Resistivity and Electrical Conductivity:

Resistance of any conductor 'R' is directly proportional to the length of the conductor 'L' and is inversely proportional to its area of cross section 'A'.

$R \alpha L, \quad R \alpha \frac{L}{A}$

$R = P\frac{L}{A}$, P = Constant called as electrical resistivity or specific resistance of the conductor

$$P = \frac{RA}{L}$$

Conductance of a material is mathematically defined as the reciprocal of its Resistance (R).

$G = \frac{1}{R}$ Unit is ohm^{-1}

The reciprocal of electrical resistivity of a material is called its electrical conductivity.

$\sigma = \frac{1}{P}$ Unit is $ohm^{-1}\ m^{-1}$,

Nichrome is a conductor with highest resistivity equal to $1.5 \times 10^{-6}\ \Omega$. Hence it is used in making heating elements.

Nature the material	Material	Resistivity
Conductor	Copper	1.62×10^{-8}
	Nickel	6.84×10^{-8}
	Chromium	12.9×10^{-8}
Insulator	Glass	10^{10} to 10^{14}
	Rubber	10^{13} to 10^{16}

System of Resistors:

i) Resistance in series

$$R_3 = R_1 + R_2 + R_3$$

ii) Resistance in Parallel

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Heating Effect of Current:

Generally, a source of electrical energy can develop a potential difference across a resistor which is connected to that source. This potential difference constitutes a current through the resistor. For continuous drawing of current, the source has to continuously spend its energy. A part of the energy from the source can be converted into useful work and the rest will be converted into heat energy. This effect is used in electric heater, electric iron, electric oven, toaster etc.,

Joule's law of heating:

$H = W = VQ$

$H = VIt$ $\quad (Q = It)$

$H = I^2Rt$ $\quad (V = IR)$

This is known as Joule's law of heating.

Applications:

i) Electric Heating device
ii) Fuse wire
iii) Filament in bulbs.

Electric Power - $\boxed{P = V \times I}$

S.I Unit is Watt

Practice Questions

1. A metal wire of resistance 5Ω was connected to a battery of 10v. Then the current through the wire and the power spent on the wire are
   5Ω மின்தடை கொண்ட உலோகக் கம்பியொன்று 10v மின்னியக்கு விசை கொண்ட மின்கலத்துடன் இணைக்கப்பட்டுள்ளது எனில், கம்பியில் பாயும் மின்னோட்டம் மற்றும் கம்பியில் செலவழிக்கப்பட்ட திறன்
   a. 0.5A, 5W b. 2.0A, 20W c. 5A, 0.5W d. 20A, 2W

2. Nickel has resistivity ____
   நிக்கல் என்ற பொருளின் மின்தடை எண்?
   a. 6.02×10^{-8} Ωm b. 6.14×10^{-7} Ωm
   c. 6.84×10^{-8} Ωm d. 6.84×10^{-7} Ωm

3. The resistance of a wire of length 10m is 2 ohm. If the area of cross section of the wire is 2×10^{-7} m^2 determine its resistivity.
   10 மீட்டர் நீளமும் மின்தடை 2Ω எனில் அதன் மின்தடை எண்-ஐ காண்க.
   a. 4×10^{8} Ωm b. 4×10^{-7} Ωm c. 4×10^{7} Ωm d. 6.84×10^{-8} Ωm

4. Filament in bulbs is based on the Principle of
   a. Charles law b. Newton's law of motion
   c. Joule's law of heating d. Newton's law of cooling
   மின் விளக்கில் உள்ள மின் இழை எந்த விதியின் அடிப்படையில் செயற்படுகிறது?
   a. சார்லஸ் விதி b. நியூட்டனின் இயக்க விதி
   c. ஜூல் வெப்ப விளைவு விதி d. நியூட்டனின் தளிர்வு விதி

5. In a simple circuit, why does the bulb glow when you close the switch?
   a. The switch produces electricity
   b. Closing the switch completes the circuit
   c. Closing the switch breaks the circuit
   d. The bulb is getting charged
   ஒரு எளிய மின்சுற்றில் சாவியை மூடியவுடன் மின்விளக்கு ஒளிர்வது ஏன்?
   a. சாவி மின்சாரத்தை தயாரிக்கிறது.
   b. சாவி மூடியிருக்கும் போது மின்சுற்றின் சுற்றுப்பாதையை மூடிவிடுகிறது.
   c. சாவி மூடியிருக்கும் போது மின்சுற்றின் சுற்றுப்பாதை திறக்கிறது.
   d. மின்விளக்கு மின்னேற்றமடையும்