Physics

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(Unit 2)(Current Electricity)

(Class 12)

Key Points and Revision Notes

- **Current carriers:** The charge particles which flow in a definite direction constitutes the electric current are called current carriers. E.g.: Electrons in conductors, Ions in electrolytes, Electrons and holes in semi-conductors.
- Electric current is defined as the amount of charge flowing through any cross section of the conductor in unit time. $I = Q/t$.
- Current density $\vec{J} = I/A$.
- **Ohm's law:** Current through a conductor is proportional to the potential difference across the ends of the conductor provided the physical conditions such as temperature, pressure etc. Remain constant. $V \alpha I$ i.e. $V = IR$, Where R is the resistance of the conductor. Resistance R is the ratio of V & I
- Resistance is the opposition offered by the conductor to the flow of current.
- Resistance $R = \rho l/A$ where ρ is the resistivity of the material of the conductor-length and A area of cross section of the conductor. If l is increased n times, new resistance becomes n^2R. If A is increased n times, new resistance becomes $\frac{1}{n^2}R$
- Resistivity $\rho = m/ne^2\tau$, Where m, n, e are mass, number density and charge of electron respectively, τ-relaxation time of electrons. ρ is independent of geometric dimensions.
- Relaxation time is the average time interval between two successive collisions
- Conductance of the material G =1/R and conductivity σ=1/ρ
- Drift velocity is the average velocity of all electrons in the conductor under the influence of applied electric field.
  Drift velocity $V_d = (eE/m)\tau$ also $I = neAv_d$
- Mobility (μ) of a current carrier is the ratio of its drift velocity to the applied field $\mu = \frac{V_d}{E}$

- Effect of temperature on resistance: Resistance of a conductor increase with the increase of temperature of conductor $R_T = R_o(1+\alpha T)$, where α is the temperature coefficient of resistance of the conductor. α is slightly positive for metal and conductor, negative for semiconductors and insulators and highly positive for alloys.
- **Combination of resistors:** $R_{series} = R_1 + R_2 + ...R_n$, $\frac{1}{R_{Parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + ... \frac{1}{R_n}$
- **Cells:** E.M.F of a cell is defined as the potential difference between its terminals in an open circuit. Terminal potential difference of a cell is defined as the p.d between its ends in a closed circuit.
- Internal resistance *r* of a cell is defined as the opposition offered by the cell to the flow of current. $r = \left(\frac{E}{V} - 1\right)R$ where R is external resistances.
- **Grouping of cells :**
  - ✓ In series grouping circuit current is given by $I_s = \frac{nE}{R+nr}$,
  - ✓ In parallel grouping circuit current is given by $I_p = \frac{mE}{r+mR}$ where n, m are number of cells in series and parallel connection respectively.
- **Kirchhoff's Rule:**
  - ✓ **Junction Rule:**-The algebraic sum of currents meeting at a point is zero. $\sum I = 0$
  - ✓ **Loop rule:**-The algebraic sum of potential difference around a closed loop is zero $\sum V = o$
- Wheatstone bridge is an arrangement of four resistors arranged in four arms of the bridge and is used to determine the unknown resistance in terms of other three resistances. For balanced Wheatstone Bridge, $\frac{P}{Q} = \frac{R}{S}$

- Slide Wire Bridge or Metre Bridge is based on Wheatstone bridge and is used to measure unknown resistance. If unknown resistance S is in the right gap, $s=\left(\frac{100-l}{l}\right)R$
- Potentiometer is considered as an ideal voltmeter of infinite resistance.
- **Principle of potentiometer:** The potential drop across any portion of the uniform wire is proportional to the length of that portion of the wire provided steady current is maintained in it i.e. $v\ \alpha\ l$
- Potentiometer is used to
  - ✓ compare the e.m.f.s of two cells
  - ✓ determine the internal resistance of a cell and
  - ✓ measure small potential differences.
- Expression for comparison of e.m.f of two cells by using potentiometer, $\frac{\varepsilon_1}{\varepsilon_2}=\frac{l_1}{l_2}$ where l_1, l_2 are the balancing lengths of potentiometer wire for e.m.fs ε_1 and ε_2 of two cells.
- Expression for the determination of internal resistance of a cell I is given by $\left(\frac{l_1-l_2}{l_2}\right)R$

  Where l_1 is the balancing length of potentiometer wire corresponding to e.m.f of the cell, l_2 that of terminal potential difference of the cell when a resistance R is connected in series with the cell whose internal resistance is to be determined
- Expression for determination of potential difference $V=\varepsilon\left(\frac{\varepsilon}{R+r}\right)\frac{rl}{L}$.

  Where L is the length of the potentiometer wire, l is balancing length, r is the resistance of potentiometer wire, R is the resistance included in the primary circuit.

- Joule's law of heating states that the amount of heat produced in a conductor is proportional to (i) square of the current flowing through the conductor,(ii) resistance of the conductor and (iii) time for which the current is passed. Heat produced is given by the relation $H=I^2Rt$
- Electric power: It is defined `as the rate at which work is done in maintaining the current in electric circuit. $P = VI = I^2R = V^2/R$. Power P is the product of V & I
- **Electrical energy:** The electrical energy consumed in a circuit is defined as the total work done in maintaining the current in an electrical circuit for a given time. Electrical energy = $VIt = I^2Rt = (V^2/R)t = Pt$
- Commercial unit of energy $1KWh = 3.6\times10^6J$
- Colour coding :

Black **B**rown **R**ed **O**range **Y**ellow **G**reen **B**lue **V**iolet **G**ray **W**hite

0 1 2 3 4 5 6 7 8 9

Tolerance

(i) Gold 5% (ii) Silver 10% (iii) No Color 20%

Example:

If colour code on carbon resister is Red Yellow and Orange with tolerance colour as silver, the resistance of the give resister is $(24\times10^3 \pm 10\%)\ \Omega$.