4) POTENTIOMETER

1. Potentiometer :

i) It is a device which is used to
   a) compare the e.m.f.s of two cells,
   b) to determine the e.m.f of a cell
   c) determine the internal resistance of a cell
   d) calibrate a voltmeter and an ammeter
   e) determine the current in a circuit,
   f) determine unknown resistance,
   g) measure thermo emfs.

ii) A cell of E and internal resistance r in the primary circuit maintains uniform potential gradient along the length of its wire.

iii) Current through the potentiometer wire, $i = \frac{E}{r+R}$

iv) Potential gradient or potential drop per unit length = $\frac{iR}{\ell}$ where 'l' is the total length of potentiometer wire, 'R' is the total resistance of the wire and 'i' is the current through potentiometer wire due to primary circuit.

v) If a resistance R_s is connected in series with the potentiometer wire then $i = \frac{E}{r+R+R_S}$.

vi) potential drop per unit length $= \left(\frac{E}{r+R+R_S}\right)\frac{R}{\ell}$

vii) **Comparison of emfs using potentiometer :**

a) ℓ_1 and ℓ_2 are balancing lengths when two cells of emfs, E_1 and E_2 are connected in the secondary circuit. one after the other then, $\frac{E_1}{E_2} = \frac{\ell_1}{\ell_2}$

b) By sum and difference method,
$\frac{E_1+E_2}{E_1-E_2} = \frac{L_1}{L_2}$ or $\frac{E_1}{E_2} = \frac{L_1+L_2}{L_1-L_2}$.

viii) Internal resistance of a cell

$r = \left(\frac{E-V}{V}\right)R = \left(\frac{\ell_1-\ell_2}{\ell_2}\right)R$

When ℓ_1 = balancing length for the cell connected in the secondary circuit.

ℓ_2 = balancing length when a resistance R is connected in parallel to the cell.

E = emf of the cell in the secondary circuit

V = Terminal voltage

ix) The sensitivity of potentiometer can be increased by decreasing the potential gradient. i.e., by increasing the length of potentiometer wire for a given B.

x) The best instrument for accurate measurement of the e.m.f of cell is potentiometer because it does not draw current from cell.

xi) Potentiometer acts like a voltmeter of infinite resistance.

xii) E_b (emf of battery in the primary circuit) must be greater then E_c (emf of cell in the secondary circuit) otherwise e.m.f will not be balanced even over the complete length of wire.

xiii) + ve terminals of both battery and cell must be connected at same point otherwise I_b and I_c will be in same direction and null point is never obtained.