

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,

$$\frac{E_1 + E_2}{E_1 - E_2} = \frac{L_1}{L_2} \text{ or } \frac{E_1}{E_2} = \frac{L_1 + L_2}{L_1 - L_2}.$$

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 than 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.