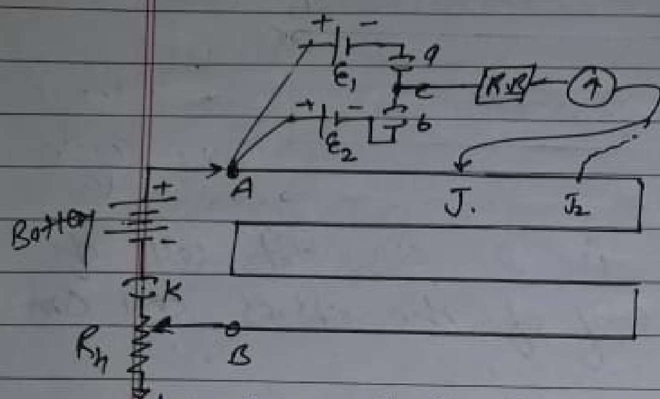
Application of potentiometer :-

Comparision of emfs of two primary cells :-

The circuit diagram for comparing the emfs as shown below fig.



let ε_1 and ε_2 be the emfs of two primary cells which are to be compared. The positive terminals of these cells are connected to the end A of the potentiometer wire and their negative terminals are connected to a high resistance box R.B., a galvanometer G and jockey J through a two way key.

If the plug is inserted b/w 'a' and 'c' the cell ε_1 get introduced in the circuit. The jockey J is moved along wire AB till the Galvanometer shows no deflection.

let the position of the jockey is J_1 and length of wire l_1. then according to principle of potentiometer

$$\varepsilon_1 = K \cdot l_1 \quad \text{——} (1)$$

If the plug is inserted b/w b and c the null point again obtained for cell ε_2.

let the balancing length l_2, then

$$\varepsilon_2 = K l_2 \quad \text{—(2)}$$

Hence,

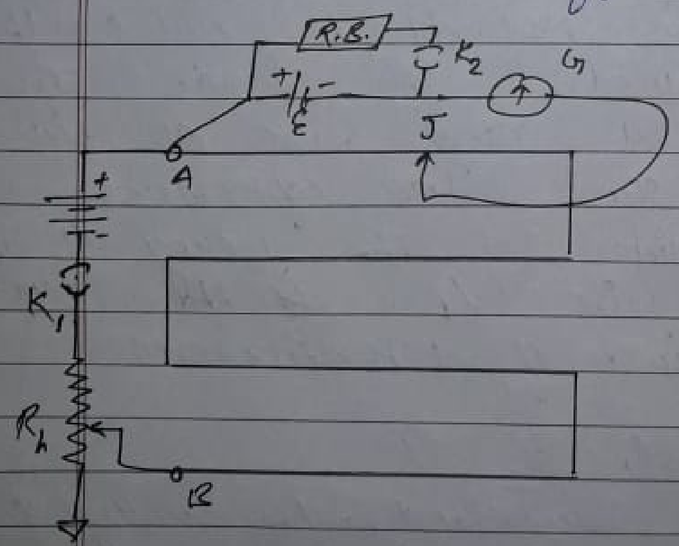
$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{K l_1}{K l_2}$$

$$\boxed{\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}}$$

if one of the two cell is a standard cell of known emf, the emf of the other cell can be determined.

$$\boxed{\varepsilon_2 = \varepsilon_1 \cdot \frac{l_2}{l_1}}$$

2. Internal resistance of a primary cell by a potentiometer:- The circuit diagram shown in below fig.



The positive terminal of the cell of emf ε whose internal resistance r is to be measured is connected to the end A of the potentio-meter wire and its negative terminal to a galvanometer G and Jockey J. A R.B. Resistance box connected across the cell through the key. K_2.

If close the key K_1. and K_2 kept open. move the jockey along wire AB till it balances the emf ε of the cell. let l_1 is the balancing length of wire then

$$\varepsilon = k l_1 \quad \text{—(1)}$$

If close the key K_2 ~~find the~~ If l_2 is the balancing length then

$$V = k l_2 \quad \text{—(2)}$$

Thus

$$\frac{\varepsilon}{V} = \frac{l_1}{l_2}$$

If current I flows through the cell when it is shunted with Resistance R then by ohm's law

$$\varepsilon = I(R + r) \quad \& \quad V = IR$$

$$\frac{I(R+r)}{IR} = \frac{l_1}{l_2}$$

$$1 + \frac{r}{R} = \frac{l_1}{l_2}$$

$$\frac{r}{R} = \frac{l_1}{l_2} - 1$$

Hence

$$\boxed{r = R\left(\frac{l_1}{l_2} - 1\right)}$$

Sensitivity of a potentiometer :-

A potentiometer is sensitive if

(i) it is capable of measuring very small potential differences

(ii) it shows a significant change in balancing length for a small change in the potential difference being measured.

Note :- Smaller the potential gradient, Greater will be the sensitivity of the potentiometer.