Kirchoff's Laws, Wheatstone Bridge, Meter Bridge

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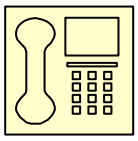

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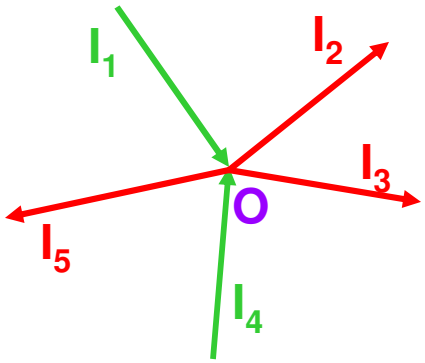
KIRCHHOFF'S LAWS:

I Law or Current Law or Junction Rule:

The algebraic sum of electric currents at a junction in any electrical network is always zero.



$$I_1 - I_2 - I_3 + I_4 - I_5 = 0$$

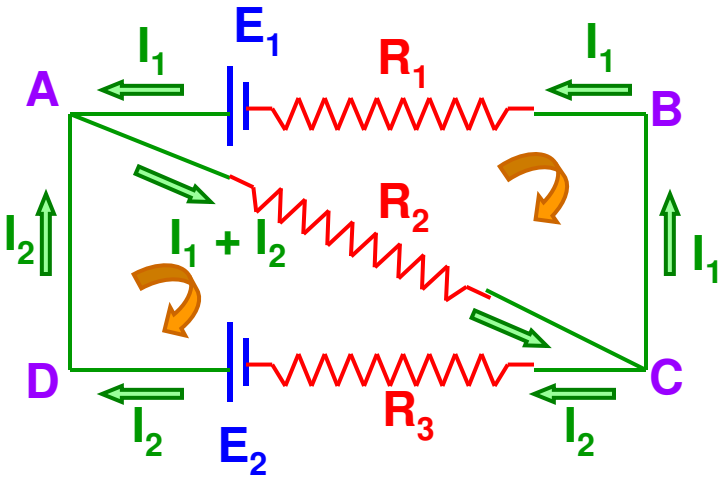
Sign Conventions:

1. The incoming currents towards the junction are taken positive.
2. The outgoing currents away from the junction are taken negative.

Note: The charges cannot accumulate at a junction. The number of charges that arrive at a junction in a given time must leave in the same time in accordance with conservation of charges.

II Law or Voltage Law or Loop Rule:

The algebraic sum of all the potential drops and emf's along any closed path in an electrical network is always zero.



Loop ABCA:

$$- E_1 + I_1.R_1 + (I_1 + I_2).R_2 = 0$$

Loop ACDA:

$$- (I_1 + I_2).R_2 - I_2.R_3 + E_2 = 0$$

Sign Conventions:

1. The emf is taken negative when we traverse from positive to negative terminal of the cell through the electrolyte.
2. The emf is taken positive when we traverse from negative to positive terminal of the cell through the electrolyte.

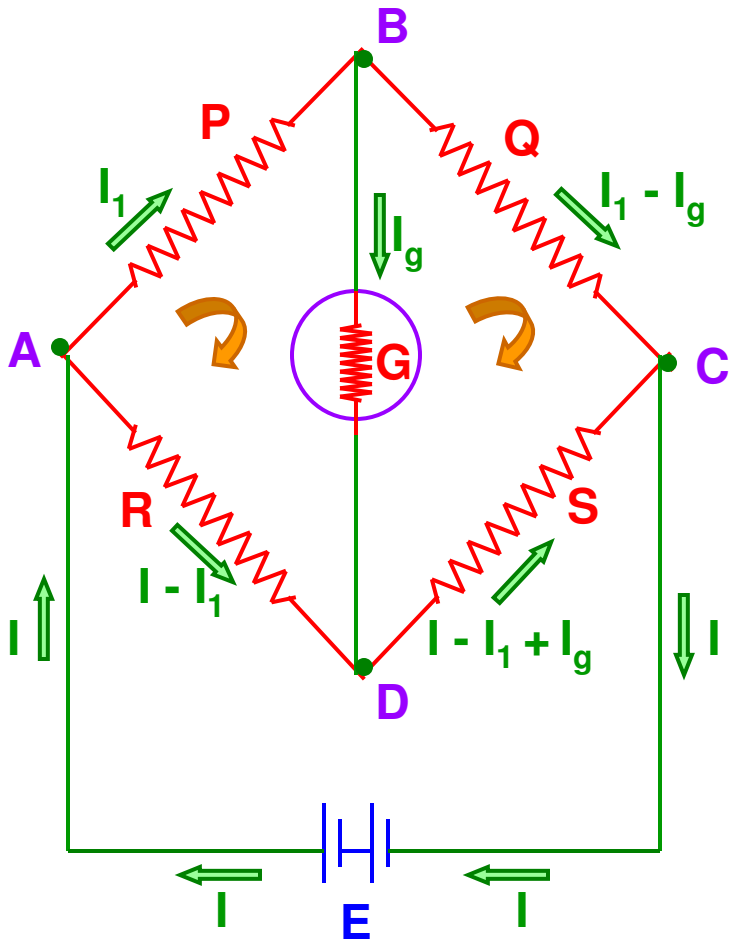
The potential falls along the direction of current in a current path and it rises along the direction opposite to the current path.

3. The potential fall is taken negative.
4. The potential rise is taken positive.

Note: The path can be traversed in clockwise or anticlockwise direction of the loop.

Wheatstone Bridge:

Currents through the arms are assumed by applying Kirchhoff's Junction Rule.



Applying Kirchhoff's Loop Rule for:

Loop ABDA:

$-I_1.P - I_g.G + (I - I_1).R = 0$

Loop BCDB:

$-(I_1 - I_g).Q + (I - I_1 + I_g).S + I_g.G = 0$

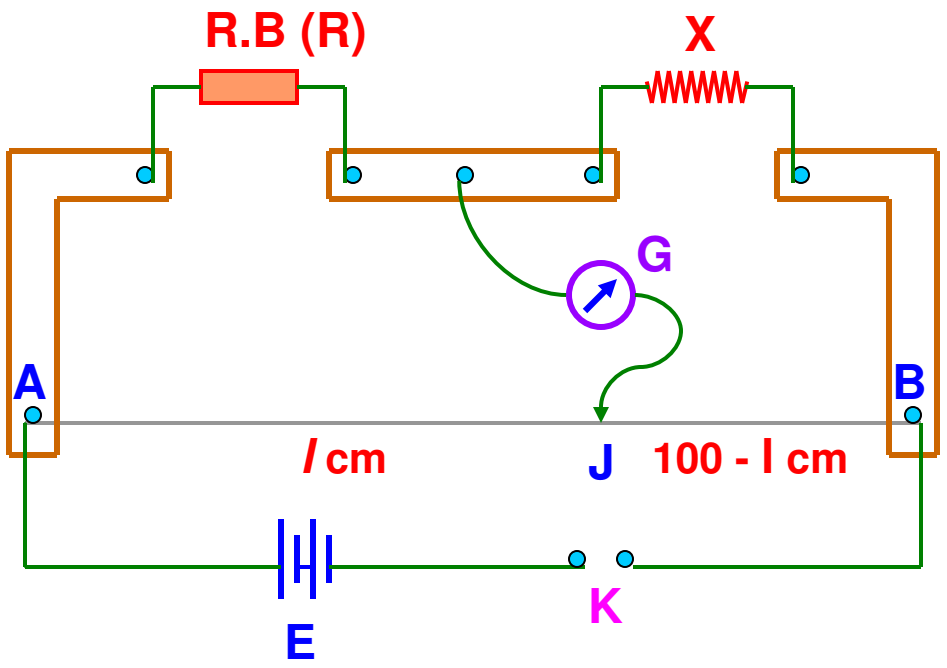
When $I_g = 0$, the bridge is said to balanced.

By manipulating the above equations, we get

$$\frac{P}{Q} = \frac{R}{S}$$

Metre Bridge:

Metre Bridge is based on the principle of Wheatstone Bridge.



When the galvanometer current is made zero by adjusting the jockey position on the metre-bridge wire for the given values of known and unknown resistances,

$$\frac{R}{X} = \frac{R_{AJ}}{R_{JB}} \rightarrow \frac{R}{X} = \frac{AJ}{JB} \rightarrow \frac{R}{X} = \frac{l}{100 - l}$$

(Since, Resistance α length)

Therefore, $X = R\,(100 - l)\,/\,l$