

### 3) KIRCHHOFF'S LAWS AND BRIDGES

#### 1. Kirchhoff's laws :

##### a) First law :

i) The algebraic sum of electric currents meeting at a junction is zero.

for the junction 'P' ;

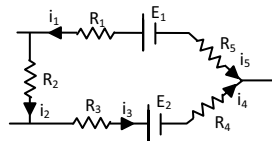
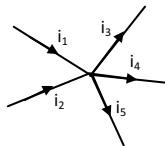
$$i_1 + i_2 - i_3 - i_4 - i_5 = 0 \text{ (or) } i_1 + i_2 = i_3 + i_4 + i_5$$

ii) Kirchhoff's first law is known as junction law or point law of kirchhoff's current law

iii) Kirchhoff's first law obeys law of conservation of electric charge.

##### b) Second Law :

i) the algebraic sum of emfs or potential differences around a closed circuit is zero.



For the closed circuit ABCDEA

$$+ E_1 - i_1 R_1 - i_1 R_2 - i_3 R_3 - E_2 - i_4 R_4 + i_5 R_5 = 0$$

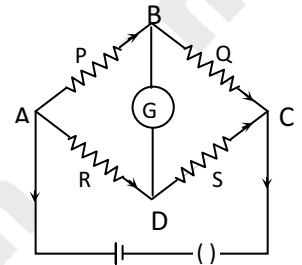
- ii) Second law is known as loop theorem or Kirchhoff's voltage law.
- iii) Kirchhoff's second law obeys law of conservation of energy.

c) **Sign convention in Kirchhoff's laws:**

- i) While going from +ve of a battery to the negative through a cell, emf is negative.
- ii) While going in the direction of the current through a conductor, potential difference is negative.

2. **Wheatstone bridge :**

- i) Wheatstone bridge is a circuit used to compare the ratio of nearly equal resistance. It consists of four arms, each consisting a resistor.
- ii) If two of the resistors of the four are known, the other two can be compared.
- iii) If three resistances are known the fourth one can be calculated.
- iv) If the current through the galvanometer in a Wheatstone bridge is made zero, then the bridge is balanced.



v) **Under balanced condition :**

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

- b) The same current passes through the P & Q.
- c) The same current passes through the R & S
- d) The P.D. across the ends of the galvanometer is zero.
- e) When galvanometer and cell are interchanged, the balance point is not effected.

f) The effective resistance =  $\frac{(P+Q)(R+S)}{P+Q+R+S}$

- vi) Whetstone's bridge is more sensitive if  $P = Q = R = S$
- vii) The number of closed circuits in bridge = 7.

3. **Meter bridge :**

- i) It works on the principle of Wheatstone Bridge. It is the simplified form of Wheatstone Bridge.
- ii) It is used to find
  - a) unknown resistance of a wire
  - b) specific resistance of the wire
  - c) and also to compare resistances.

iii) When the Meter bridge is balanced then  $\frac{\text{resistance in the left gap}}{\text{resistance in the right gap}} = \frac{\ell}{100 - \ell}$

Where  $\ell$  is the balancing length from the left end.

- iv) A high resistance box is connected in series to the galvanometer to protect it from higher currents.
- v) The bridge wire (manganin wire) ha low  $\alpha$ -value.
- vi) Meter bridge is more sensitive if  $\ell_1 = 50$  cm
- vii) The resistance of copper strip is called end resistance.
- viii) The resistance in two gaps (x and R) are interchanged to reduce the effect of end resistance.
- ix) If a conductor is connected in the left gap and it is heated then blanching point shifts towards right.
- x) If a semiconductor is connected in the left gap and it is heated then balancing point shifts towards left.