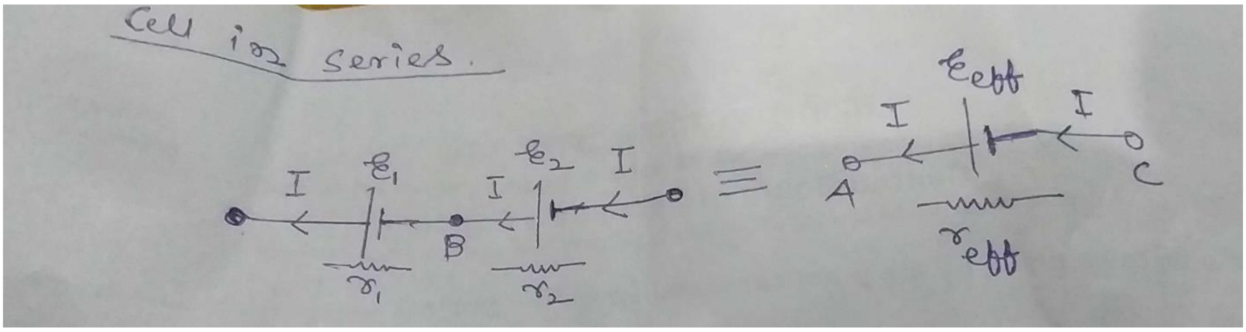
Cell in series with different emf and internal resistance



Let V_A, V_B, V_C be the potential at points A, B and C respectively

$V_{AB}= V_A-V_B = \varepsilon_1-I_{r1}$ and $V_{BC}= V_B-V_C=\varepsilon_2-I_{r2}$

Thus the P.D between the terminals A and C of the series combination

$V_{AC}=V_A-V_C= (V_A-V_B) + (VB-V_C) = (\varepsilon_1-I_{r1}) + (\varepsilon_2-I_{r2})$

$V_{AC} = (\varepsilon_1+\varepsilon_2)-I\ (r_1+r_2)$

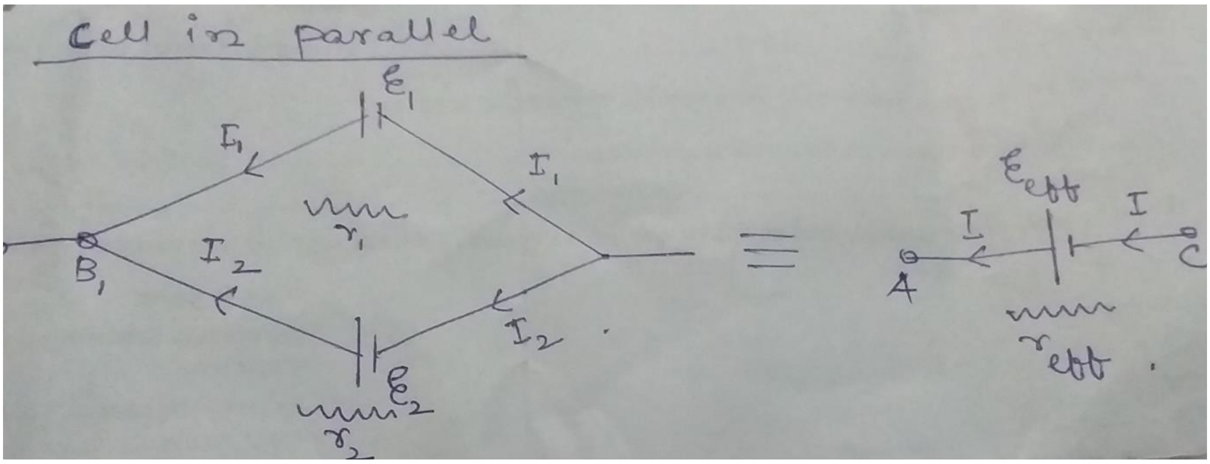
$V_{AC} = \varepsilon_{eff}-I_{reff}$

Where

$\varepsilon_{eff} = \varepsilon_1 +\varepsilon_2$

$R_{eff} = r_1+r_2$

Cell in parallel with different emf and internal resistance



As the two cells are connected in parallel between the same two points B1 and B2, the potential difference V across both cells must be same

The potential difference between the terminals of first cell is

$V= \mathcal{E}_1-I_1r_1$

$I_1=\mathcal{E}_1-V/r_1$

The potential difference between the terminals of the second cell is

$V=\mathcal{E}_2-I_2r_2$

$I_2 = \mathcal{E}_2-V/r_2$

Hence $I=I_1+I_2$

$= \mathcal{E}_1-V/r_1 \quad + \quad \mathcal{E}_2-V/r_2$

$= (\mathcal{E}_1/r_1 \quad + \quad \mathcal{E}_2/r_2) – V \ (1/r_1 \ +1/r_2)$

$V (r_1 +r_2/r_1r_2) =\mathcal{E}_1r_2 \ + \mathcal{E}_2r_1/r_1r_2 \quad -I$

$V= \mathcal{E}_1r_2 +\mathcal{E}_2r_1/r_1+r_2 \ - \ I (r_1r_2/r_1+r_2)$

$V= \mathcal{E}_{eq}-Ir_{eq}$

Where

$\mathcal{E}_{eq} = \mathcal{E}_1r_2 +\mathcal{E}_2r_1/r_1+r_2$

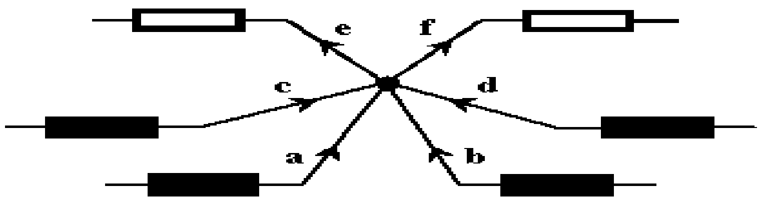
$r_{eq} = (r_1r_2/r_1+r_2)$

Kirchhoff’s Law

Kirchhoff’s first law of Junction rule : In an electric circuit, the algebraic sum of currents at any junction is zero

Or

The sum of current entering a junction is equal to the sum of currents leaving that junction



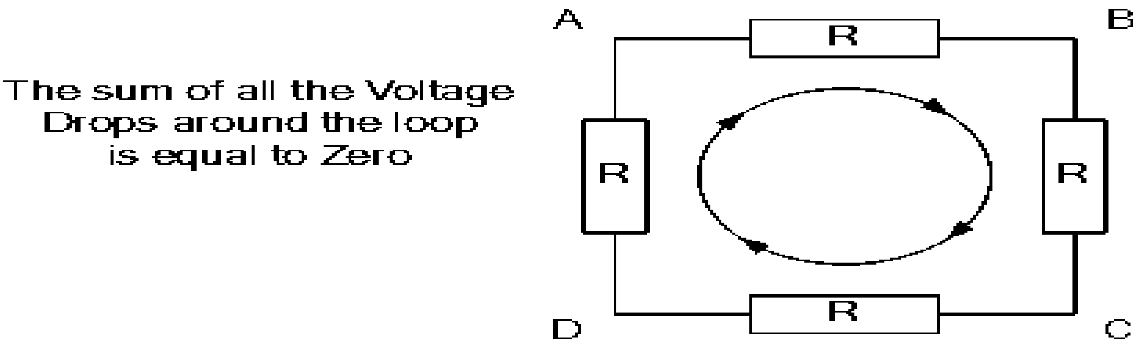
First Law

$a + b + c + d = e + f$

Its obey conservation of charge.

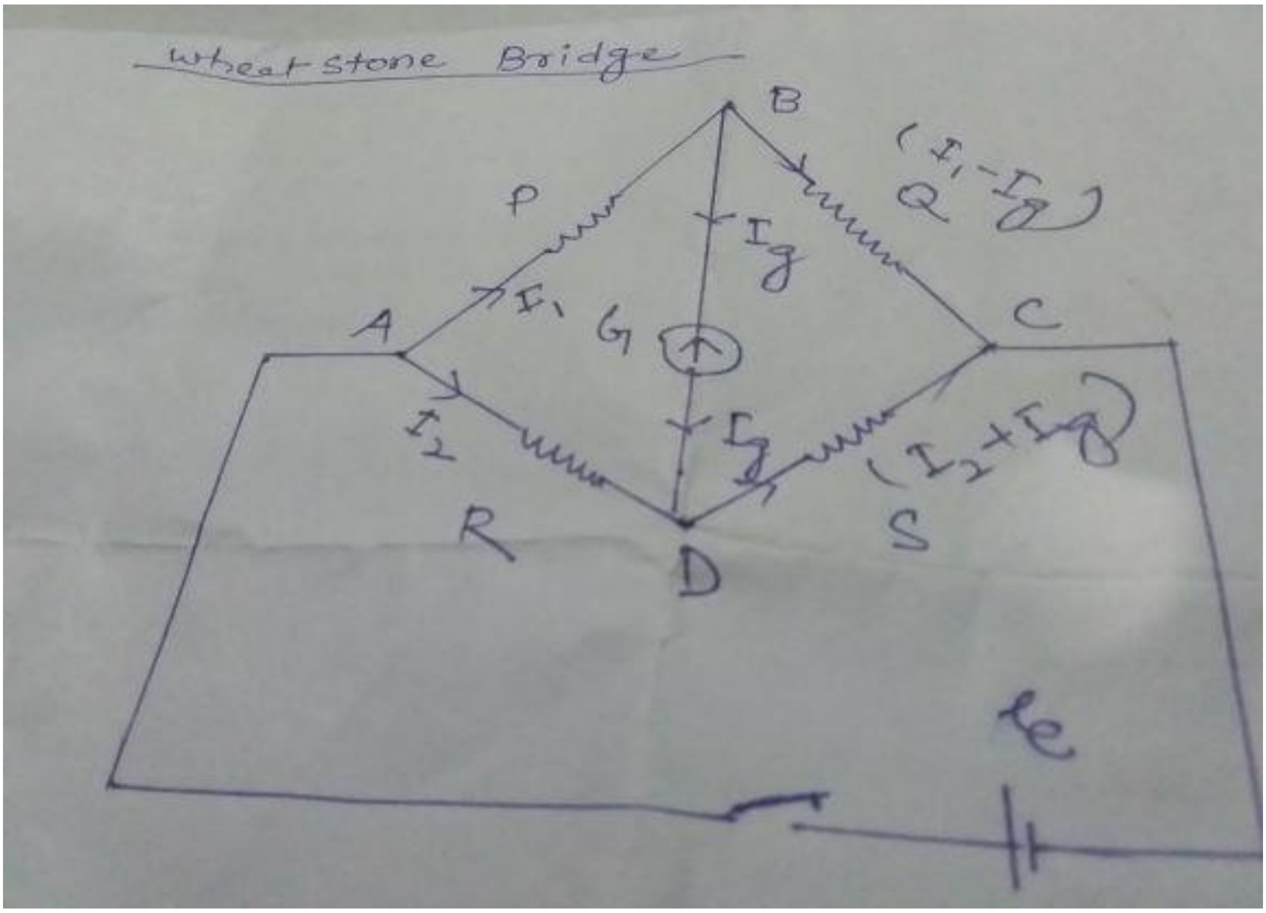
<u>Kirchhoff's Voltage Law</u> or KVL, states that "*in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop*" which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero. This idea by Kirchhoff is known as the **Conservation of Energy**.

Kirchhoff's Voltage Law



$$V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$$

<u>Wheatstone bridge</u>: It is a special type of resistance network, commonly used for comparing resistances or unknown resistance can be measured in terms of three unknown resistances. It consists of four resistances connected in the forms of a bridge.



In balanced condition

P/Q =R/S

Applying Kirchhoff's second law to the loop ABDA, we get

$I_1P+I_gG-I_2R=0$

Where G is the resistance of the galvanometer.

In loop BCDB

$(I_1-I_g)Q-(I_2+I_g)S-Gi_g=0$

In the balanced condition of the bridge $I_g = 0$

So,

$I_1P-I_2S=0$

$I_1P = I_2R$ --(1)

And $I_1Q - I_2S = 0$

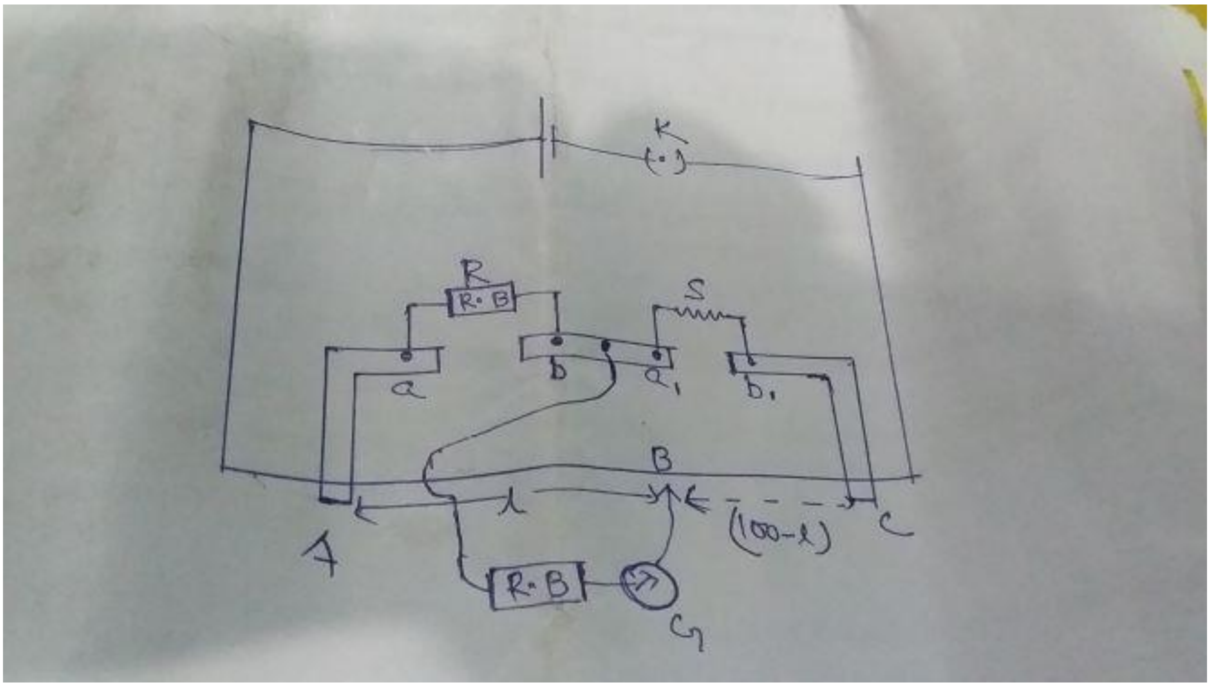
$I_1Q = I_2S$ ______________________________(2)

Equation ½ we get

P/Q =R/S

Metre Bridge or slide Wire Bridge: It is the practical application of Wheatstone bridge.it is used to measure an unknown resistance.

Working principle: P/Q =R/S



If P and Q are the resistances of the part AB and BC of the wire, then for the balanced condition of the bridge, we have

P/Q =R/S

As,

AC= 100 cm and AB =l cm then BC = (100-l) cm

Since the resistance wire of uniform cross section, therefore

Resistance of the wire ∝ length of wire

P/Q = resistance of AB/resistance of BC = lr/(100-l)r

So, l/(100-l) cm

R/S = l/ 100 –L

Or

S = R (100-l)/l