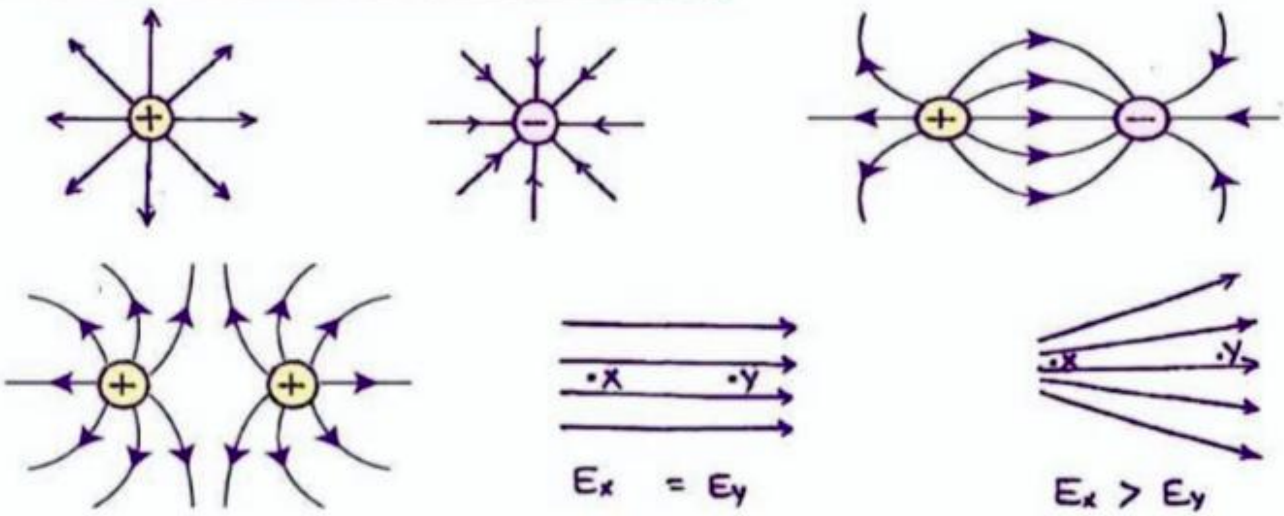
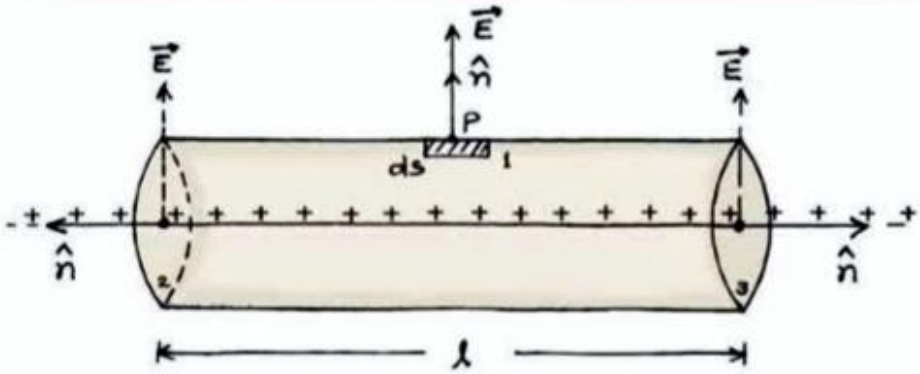
Chapter–1: Electric Charges and Fields

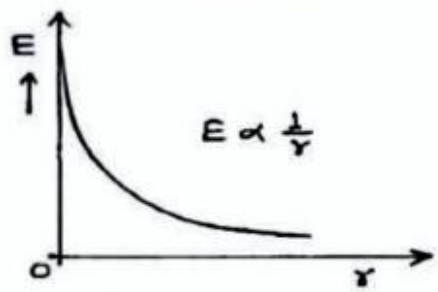
Properties of Electric Field Lines



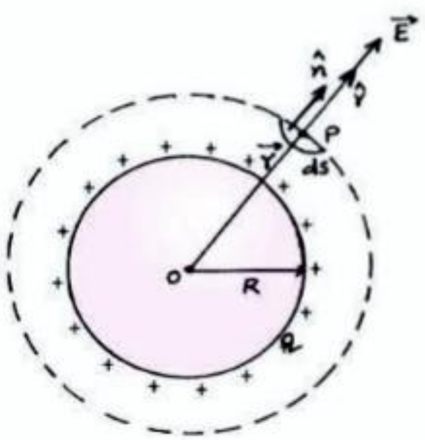
(1) Field due to an infinitely Long straight Uniformly charged wire



$$\vec{E} = \frac{\lambda}{2\pi \epsilon_0 r}\hat{n}$$



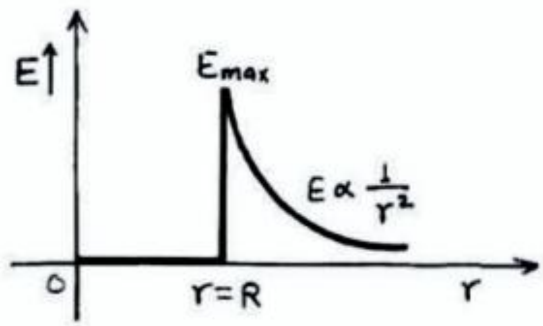
(2) Electric Field Intensity due to a Uniformly Charged spherical shell -



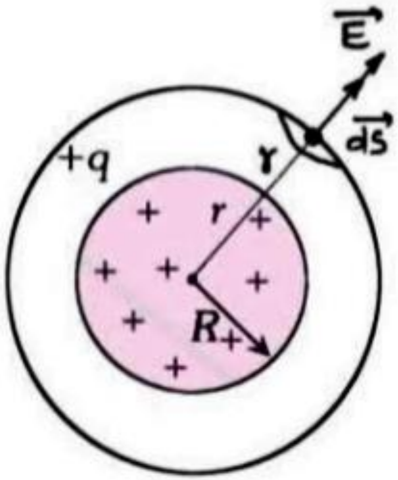
$$E_{out} = \frac{q}{4\pi \epsilon_0 r^2}$$

$$E_s = \frac{q}{4\pi \epsilon_0 R^2}$$

$$E_{in} = 0$$



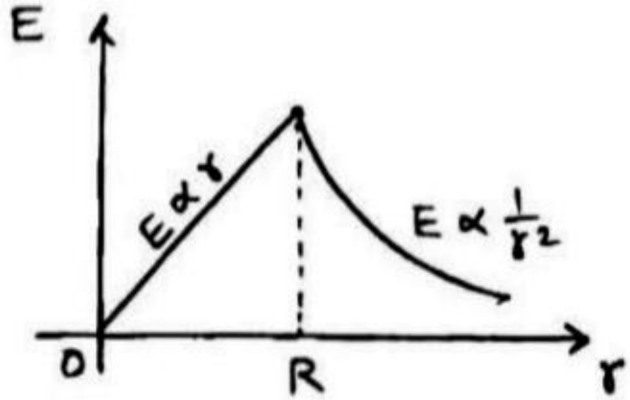
(3) Electric Field due to uniformly charged Non-Conducting sphere -



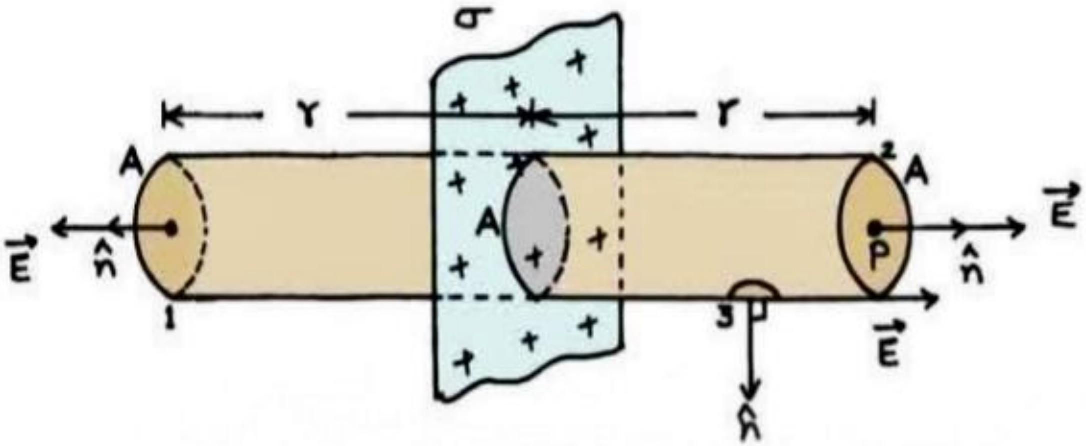
$$E_{out} = \frac{q}{4\pi \epsilon_0 r^2}$$

$$E_s = \frac{q}{4\pi \epsilon_0 R^2}$$

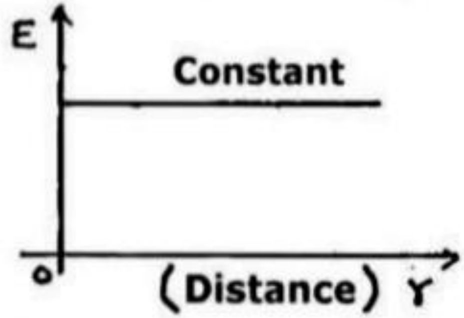
$$E = \frac{1}{4\pi \epsilon_0} \frac{q}{R^3}$$



(4) Electric Field intensity due to a thin infinite plane sheet of charge



$$\vec{E} = \frac{\sigma}{2\epsilon_0} \hat{n}$$

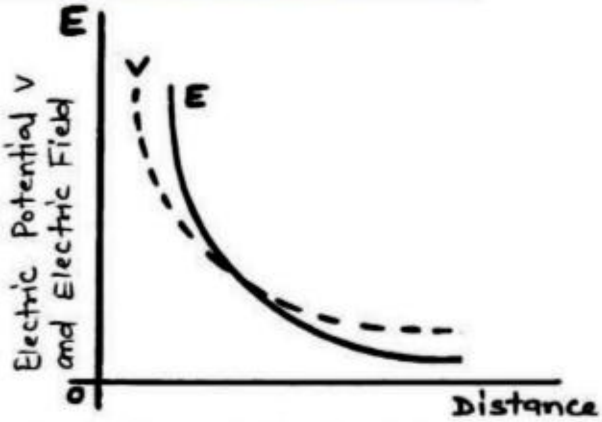


$$V = \frac{q}{4\pi\epsilon_0 r}$$

$$V \propto \frac{1}{r}$$

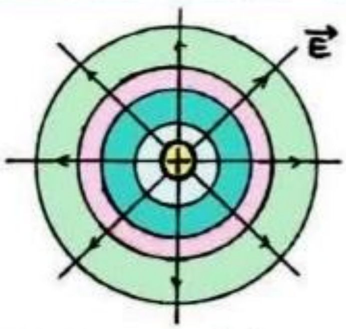
$$E = \frac{q}{4\pi\epsilon_0 r^2}$$

$$E \propto \frac{1}{r^2}$$

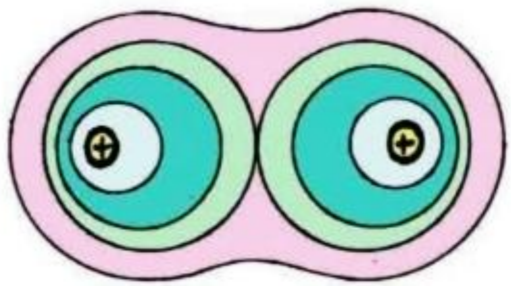


Variation of Electrostatic Potential and Electric field with distance

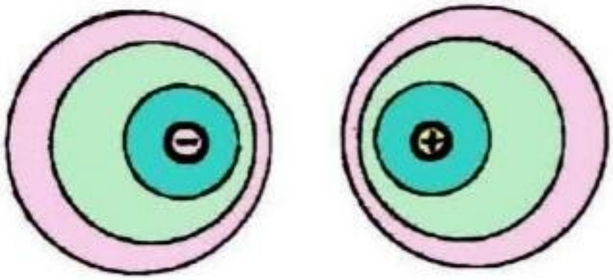
Some equipotential surfaces are shown in figures.



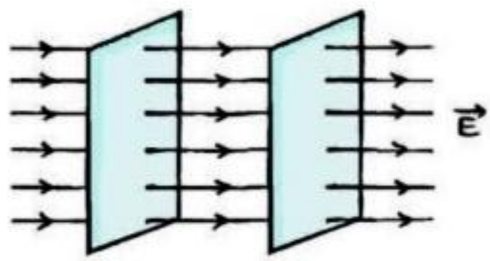
(a) For a point charge



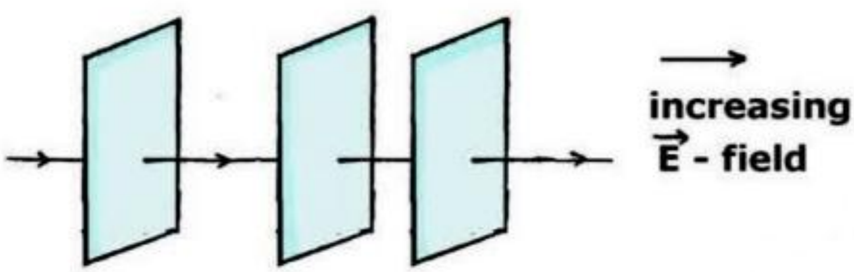
(b) For two identical Positive charges



(c) For an electric dipole

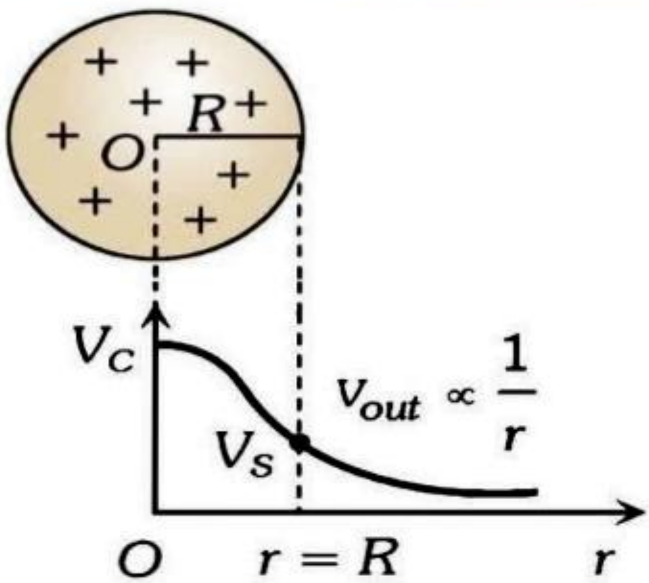


(d) For uniform electric field



(e) For nonuniform electric field.

Electric Potential due to an insulating sphere



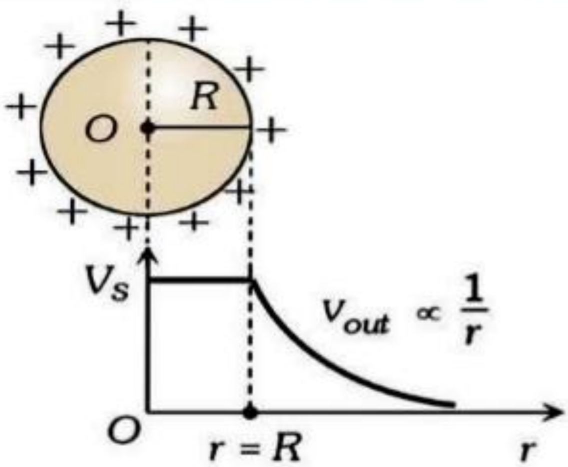
$$V_{out} = \frac{q}{4\pi\epsilon_0 r}$$

$$V_s = \frac{q}{4\pi\epsilon_0 R}$$

$$V_{in} = \frac{q}{4\pi\epsilon_0}\left[\frac{3R^2 - r^2}{2R^3}\right]$$

$$V_c = \frac{q}{4\pi\epsilon_0}\left(\frac{3}{2R}\right)$$

Electric Potential due to hollow or conducting sphere

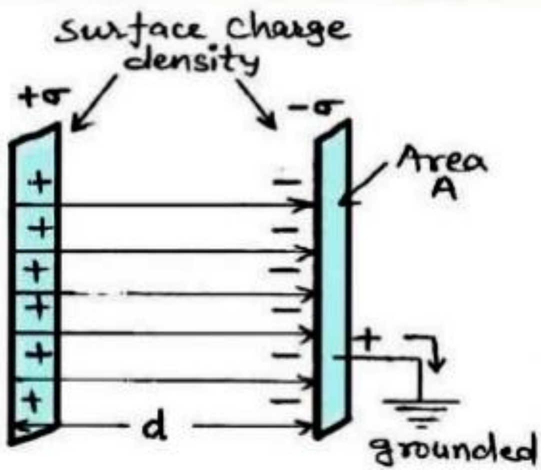


$$V_{out} = \frac{q}{4\pi\epsilon_0 r}$$

$$V_s = \frac{q}{4\pi\epsilon_0 R}$$

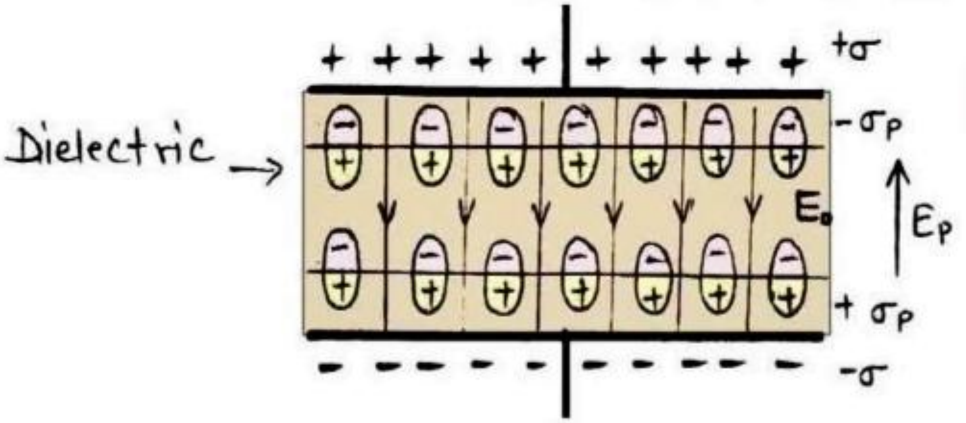
$$V_{in} = \frac{q}{4\pi\epsilon_0 R}$$

Parallel Plate Capacitor



$$C = \frac{\epsilon_0 A}{d}$$

Effect of Dielectric on Capacitance

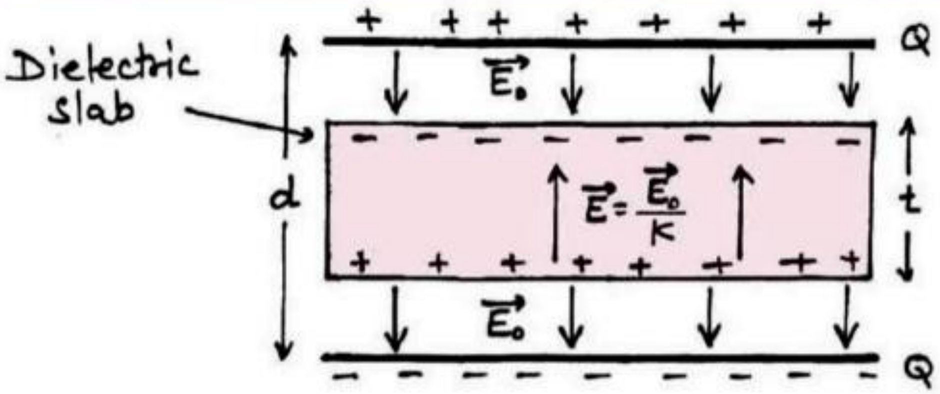


$$C = \frac{K \epsilon_0 A}{d}$$

$$K = \frac{\epsilon}{\epsilon_0}$$

$$C = K C_0$$

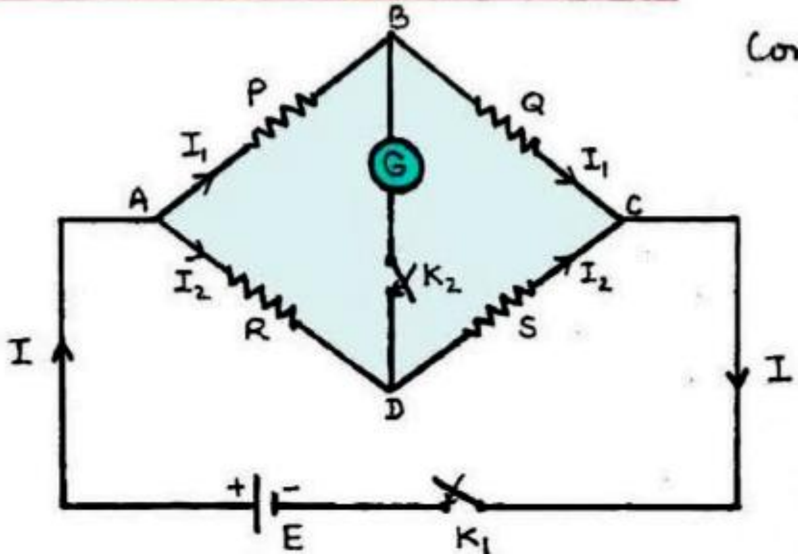
Capacitance of a Parallel plate capacitor with a dielectric slab -



$$C = \frac{\epsilon_0 A}{d - t + \frac{t}{K}}$$

Chapter-3: Current Electricity

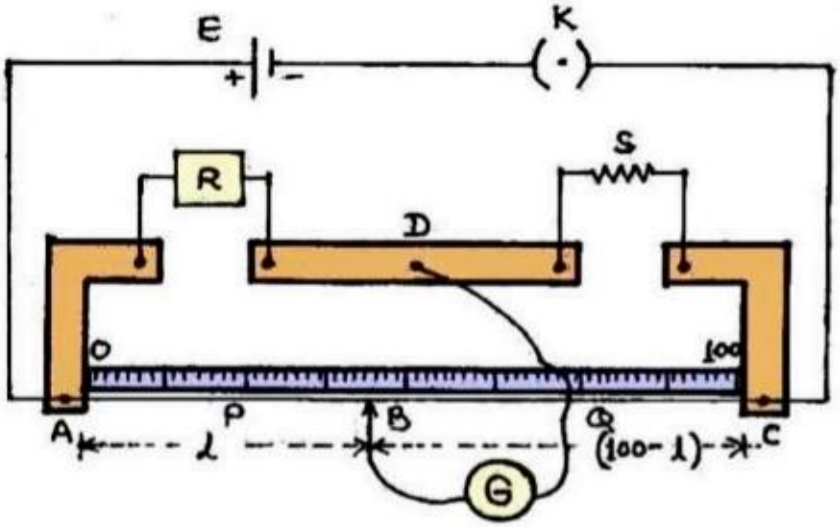
Wheatstone Bridge Principle



Condition for the balanced wheatstone bridge.

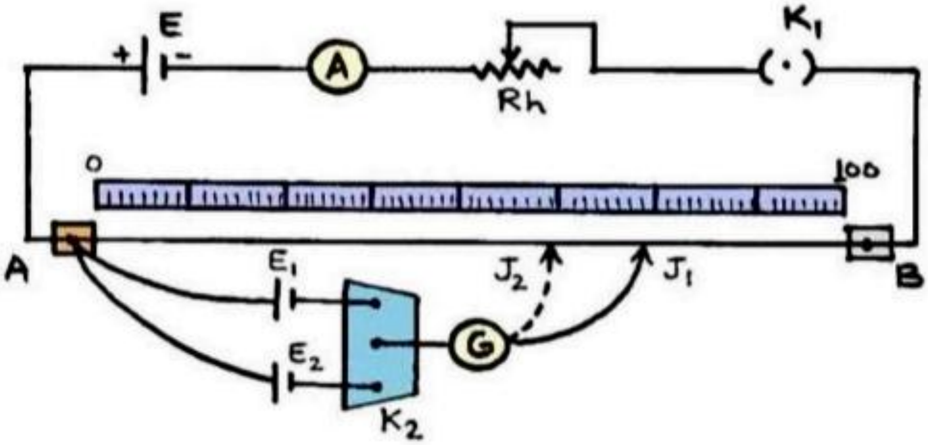
$$\frac{P}{Q} = \frac{R}{S}$$

Meter Bridge



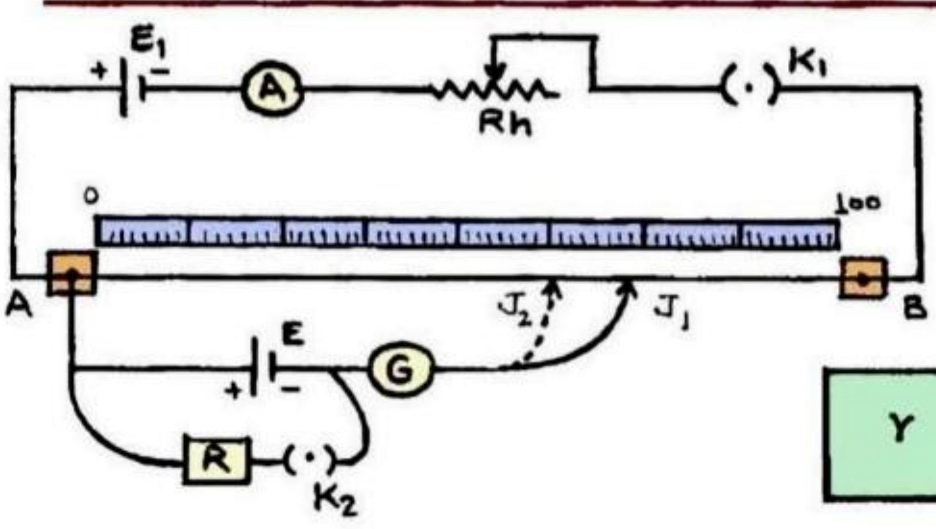
$$S = \left(\frac{100 - l}{l}\right) \times R$$

(i) Comparison of EMF's of two cells using potentiometer –



$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

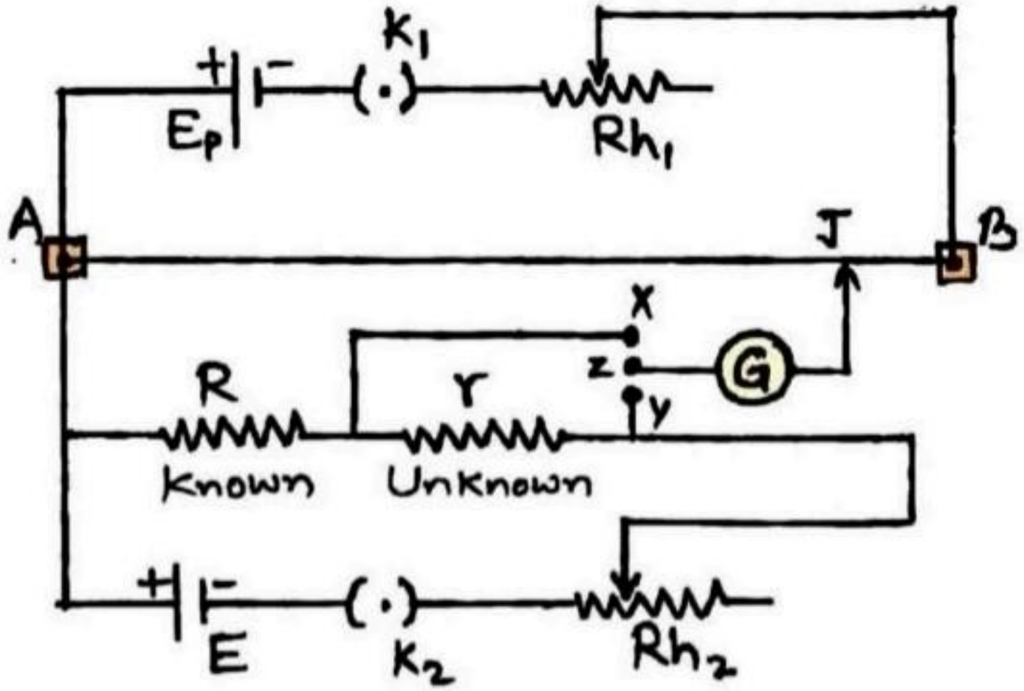
(ii) Determination of internal resistance of the cell



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

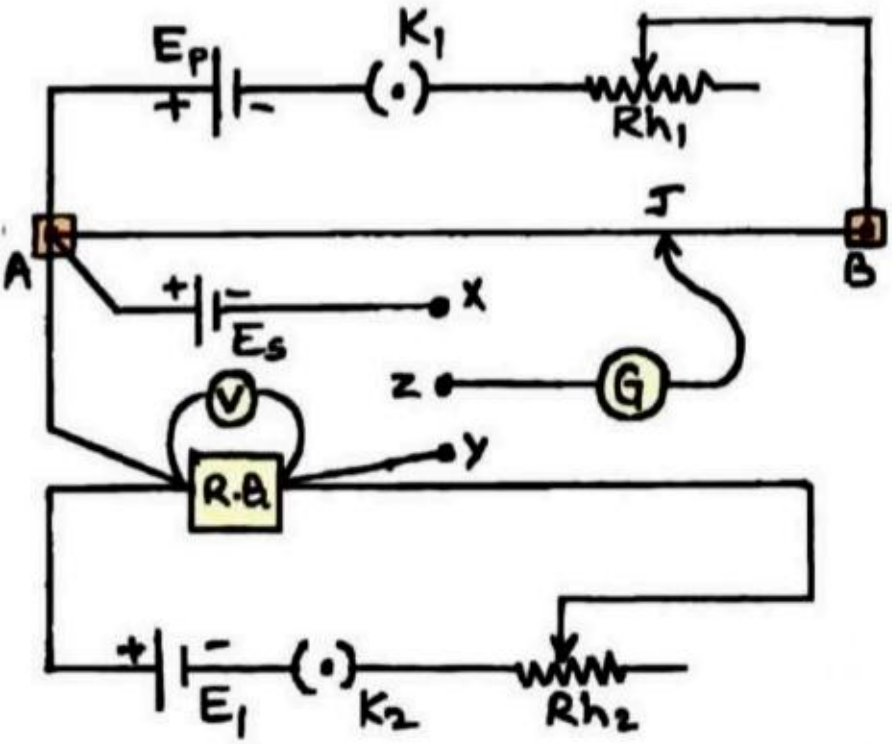
$$r = \left(\frac{l_1}{l_2} - 1\right) R$$

(iii) Determination of a small resistance by Potentiometer



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

(iv) Calibration of a voltmeter by Potentiometer

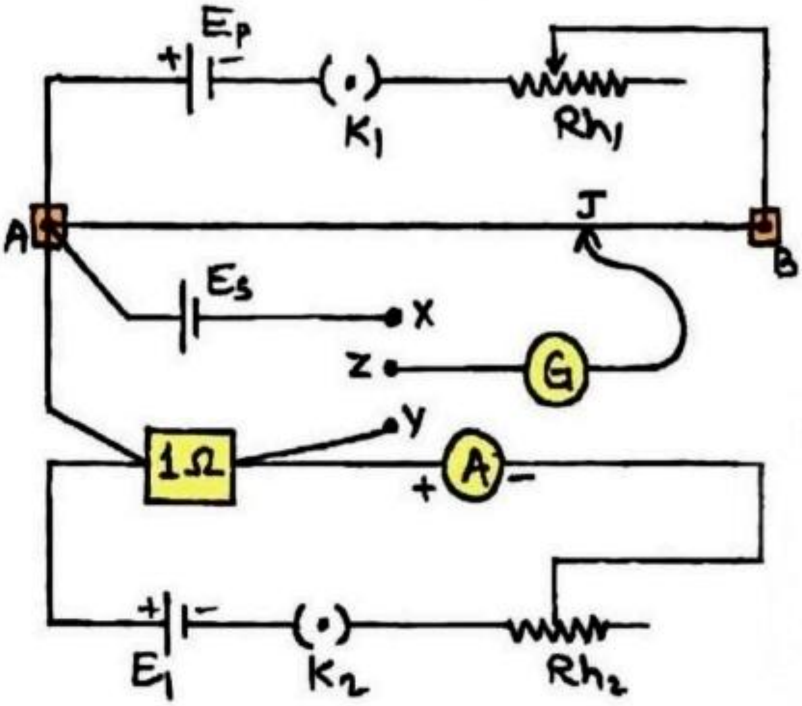


$$V' = \frac{E_s}{l_1} \times l_2$$

V = voltmeter reading

Error in Voltmeter reading $\Delta V = V - V'$

(V) Calibration of a ammeter by Potentiometer



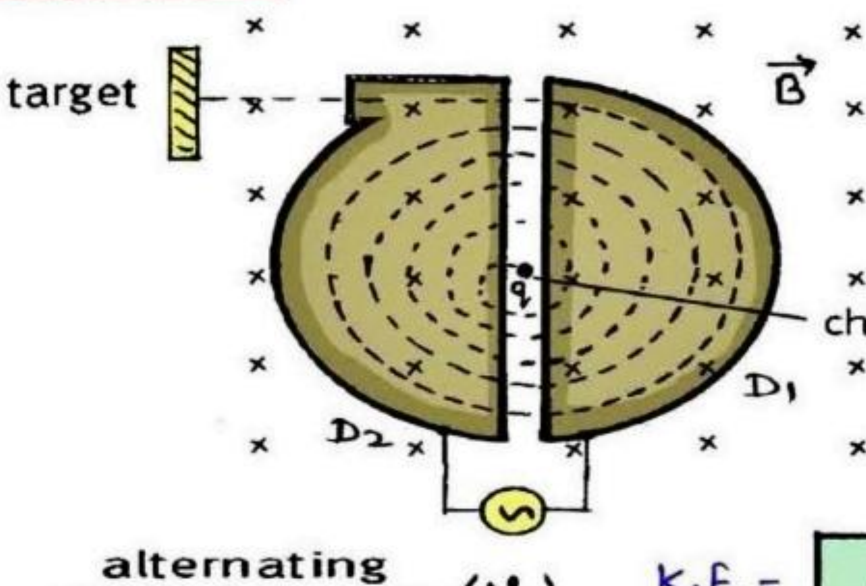
I = ammeter reading

$$I' = \frac{E_s}{l_1} \times l_2$$

Error in ammeter reading $\Delta I = I - I'$

Chapter–4: Moving Charges and Magnetism

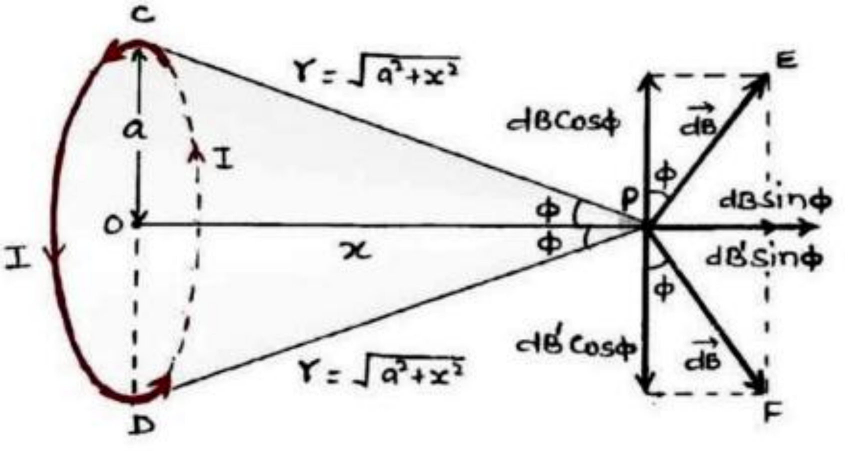
Cyclotron



$$\nu_c = \frac{qB}{2\pi m}$$

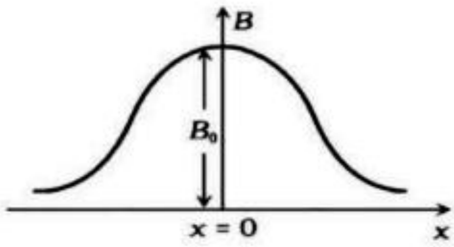
$$K.E. = \frac{1}{2}mv^2 = \frac{q^2B^2R^2}{2m}$$

Magnetic Field on the axis of a Circular Current Loop -

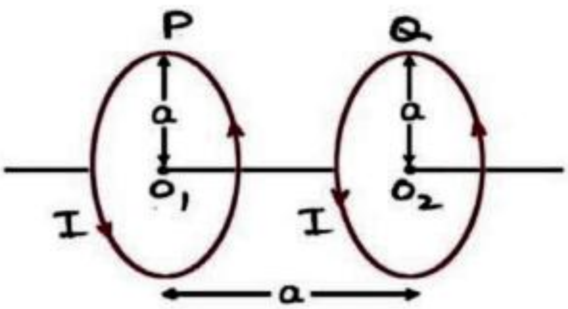


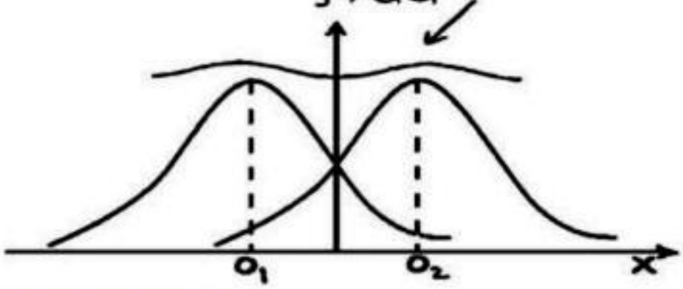
$$B = \frac{\mu_0}{4\pi} \frac{2\pi n I a^2}{(a^2+x^2)^{3/2}}$$

$$B_0 = \frac{\mu_0 n I}{2a}$$



Helmholtz Coils

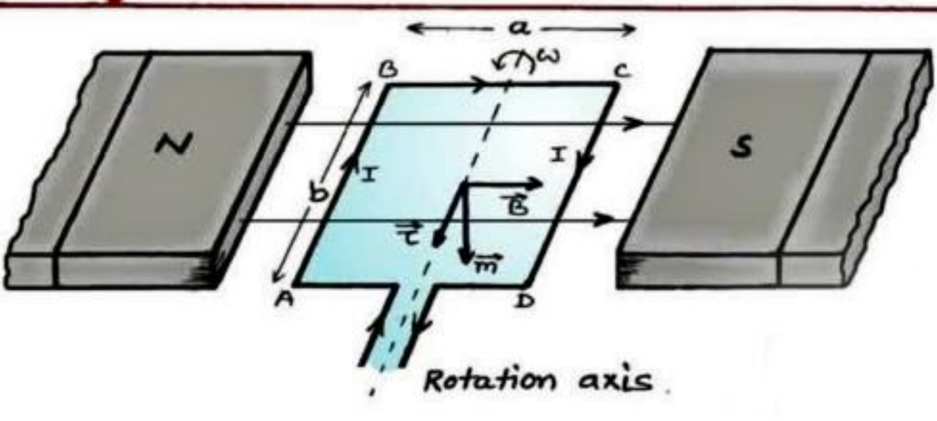




$$B = 0.716 \frac{\mu_0 N I}{a}$$

$$B = 1.432 \, B_{centre} \qquad \left[\because B_{centre} = \frac{\mu_0 N I}{2a}\right]$$

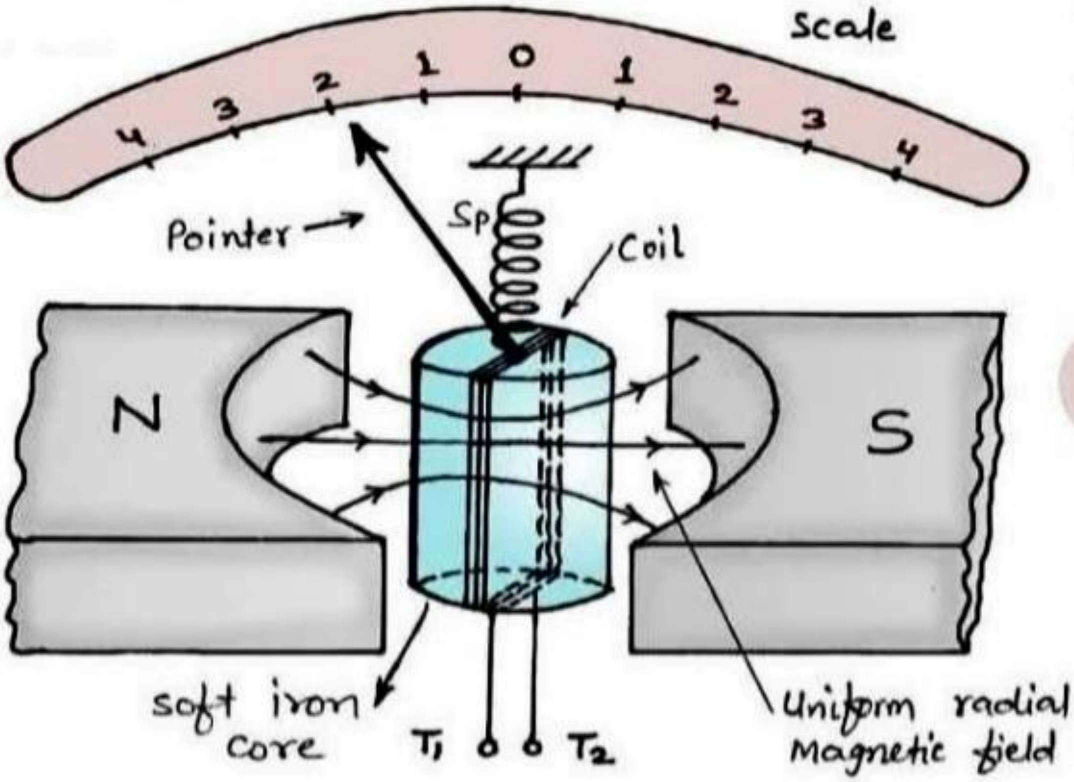
Torque on a current Carrying Coil in a Magnetic Field -



$$\vec{\tau} = NI(\vec{A} \times \vec{B})$$

$$\vec{M} = NI\vec{A}$$

Moving Coil GALVANOMETER



$$\phi = \left(\frac{NBA}{K}\right) I$$

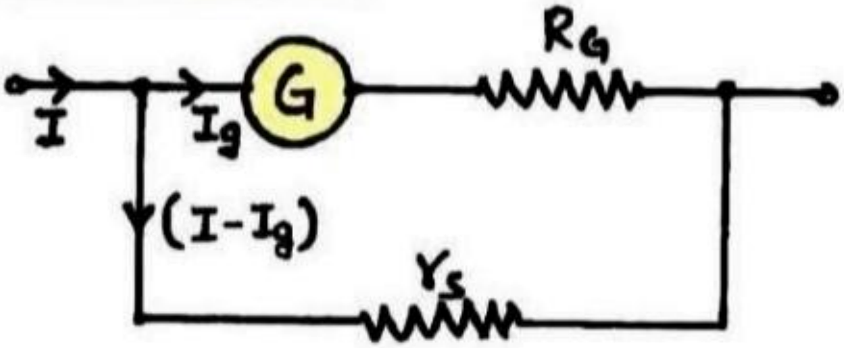
Current Senitivity

$$I_s = \frac{\phi}{I} = \frac{NBA}{K}$$

Voltage Sensitivity

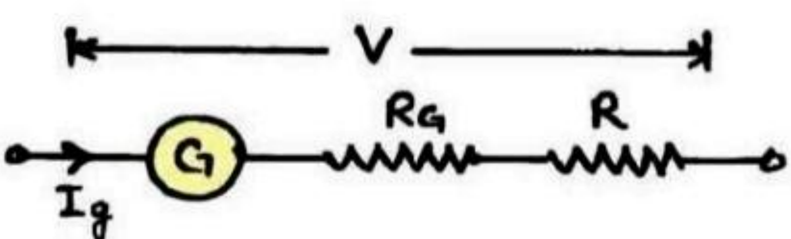
$$V_s = \frac{\phi}{IR} = \frac{NBA}{KR}$$

Ammeter



$$r_s = \frac{I_g}{(I-I_g)} R_G$$

Voltmeter



$$R = \frac{V}{I_g} - R_G$$