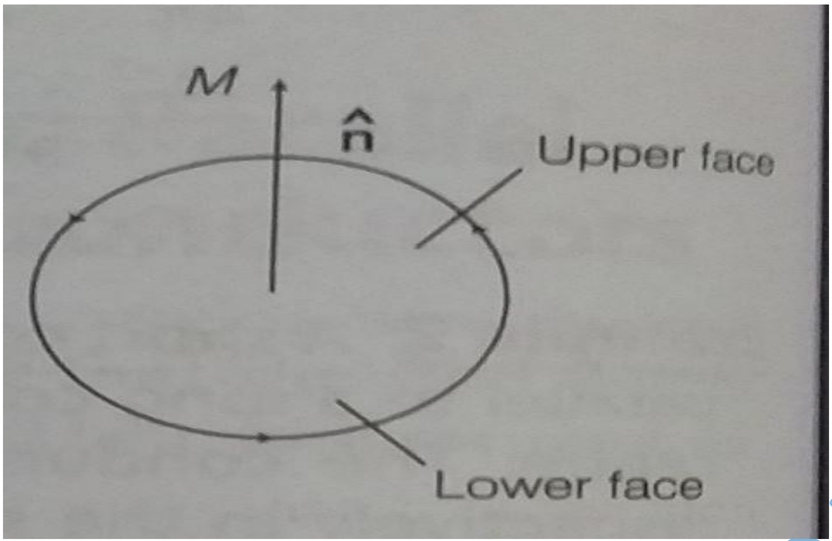
Circular current loop as a magnetic dipole: *A current loop behaves as a magnetic dipole. If we look at the upper face, current is anticlockwise so it has north polarity*

And the lower face, current is clockwise. So it has south polarity. Its mean current loop behaves as a system of two equal and opposite magnetic poles hence it behaves like magnetic dipole.



Magnetic dipole moment of loop $M = NIA$

The magnitude of magnetic field on the axis of a circular loop of radius R carrying a current I is given by

$B = \mu_0 I R^2/2(x^2 + R^2)$

$x >> R$

$B = \mu_0 I R^2/2x^3$

As $A = \pi R^2$

So $R^2 = A/\pi$

$B = \mu_0 IA/2\pi x^3$

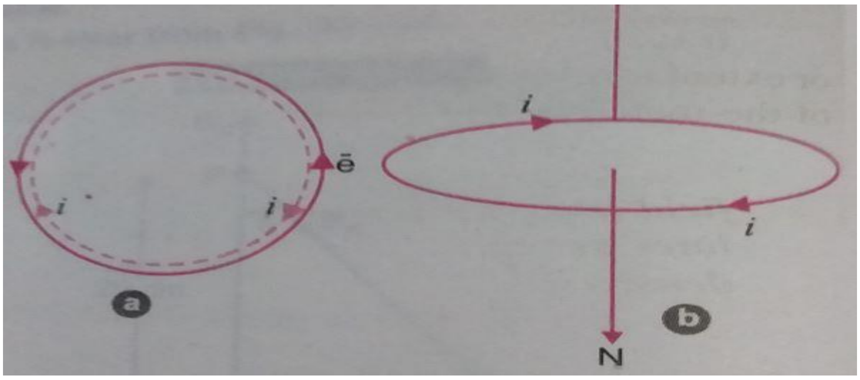
$M = IA$

$B = \mu_0 M/2\pi x^3$

Magnetic dipole moment of an atom due to revolving electron (Bohr magnetron): *A revolving electron is like a loop of current which has a definite magnetic dipole moment*

As $i = e/T$

As $T = 2\pi/\omega$



As $i = \omega e/2\pi$

$A = \pi r^2$

$M = iA = \omega e/2\pi \times \pi r^2$

$M = e\omega r^2/2$ ------------------------------------- (1)

According to Bohr theory , an electron in an atom can revolve only in certain stationary orbit in which angular momentum of electron is an integral multiple of h/2π

$mvr = n\, h/2\pi$

$m(r\omega)r = n\, h/2\pi$

$\omega r^2 = nh/2\pi m$ --(2)

put such value in equation (1)

$M = enh/4\pi m = n \times (eh/4\pi m) = n(\mu_B)$

$\mu_B = eh/4\pi m$ = Bohr magnetron = 9.27×10^{-24} ampere metre^2

Bohr magnetron as the minimum dipole moment associated with an atom due to orbital motion of an electron in the first stationary orbit of the atom

Gyromagnetic ratio of electron = magnetic moment/ angular momentum = $e\omega r^2/2 \; / \; mr\omega^2$

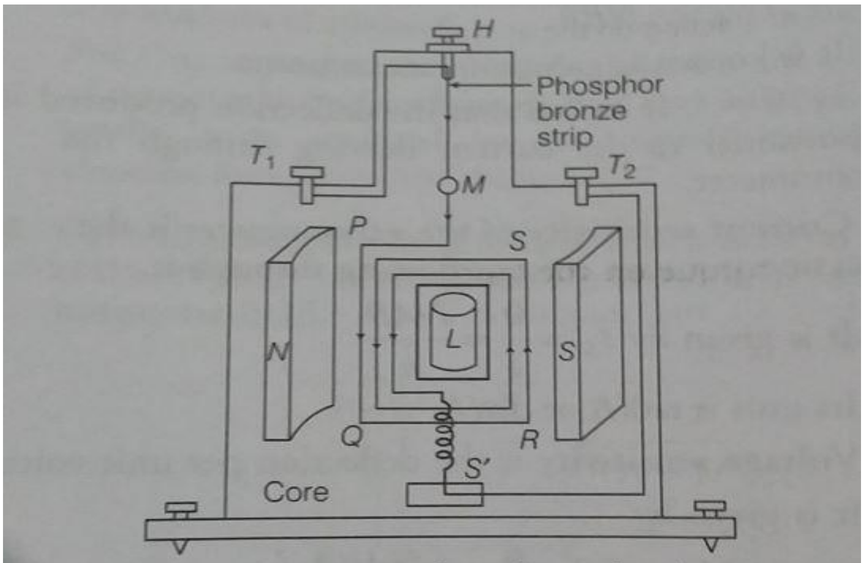
= $e/2\pi$ = 8.8×10^{10} C/kg

Moving coil galvanometer

Moving coil galvanometer is a device used for measuring the current in a circuit.

Principle: *Moving coil galvanometer works on the principle that a current carrying coil placed in a magnetic field experiences a torque*

Construction: *It consists of a rectangular coil of a large number of turns of thin insulated copper wire wound over a light metallic frame. The coil is suspended between the pole pieces of a horse-shoe magnet by a fine phosphor bronze strip from a movable torsion head. The lower end of the coil is connected to a hair spring (HS) of phosphor bronze having only a few turns. The other end of the spring is connected to a binding screw. A soft iron cylinder is placed symmetrically inside the coil.*



Schematic arrangement of moving coil galvanometer

<u>Theory and working :</u> *As the field is radial , the plane of the coil always remain parallel to the field B . When the current flows through the coil ,a torque act on it*

τ = force x perpendicular distance

= NIbB x asin90^0 = NIB (ab) = NIBA

The restoring torque is also set up

$\tau_{restoring}$ = kα

Restoring torque = deflecting torque

Kα = NIBA

α = NIBA/K

α = I/G

Where G = K/NBA = galvanometer constant or figure of merit

Sensitivity of a galvanometer: *A galvanometer said to be sensitive if it shows large scale deflection even when a small current is passed through it or a small voltage is applied across it*

Current sensitivity*:: The deflection produced in the galvanometer when a unit current flow through it*

Current sensitivity I_s = α/I = NBA/ K

Voltage sensitivity: *The deflection produced in the galvanometer when a unit P.D is applied across it.*

Voltage sensitivity Vs = α/V = NBA/KR