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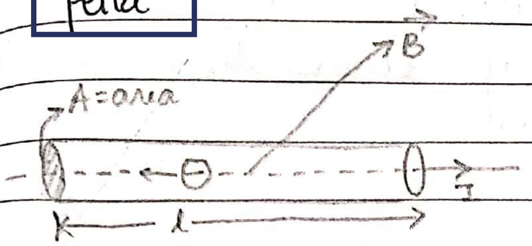
Force on current carrying conductor placed in a uniform magnetic feild



Let n = number of free electrons per unit volume.

$\vec{f}$ = force on moving electron

$\vec{f} = -e(\vec{v}_d \times \vec{B})$

Total no: of free electron

= free electron density x volume of the conductor

$= nAl$

$\therefore$ Net force on the conductor

$\vec{F} = (nAl)\vec{f}$

$\vec{F} = -nAle(\vec{v}_d \times \vec{B})$ —(i)

Direction of Magnetic force is given by Fleming's Left Hand Rule.

$I = neAv_d$.

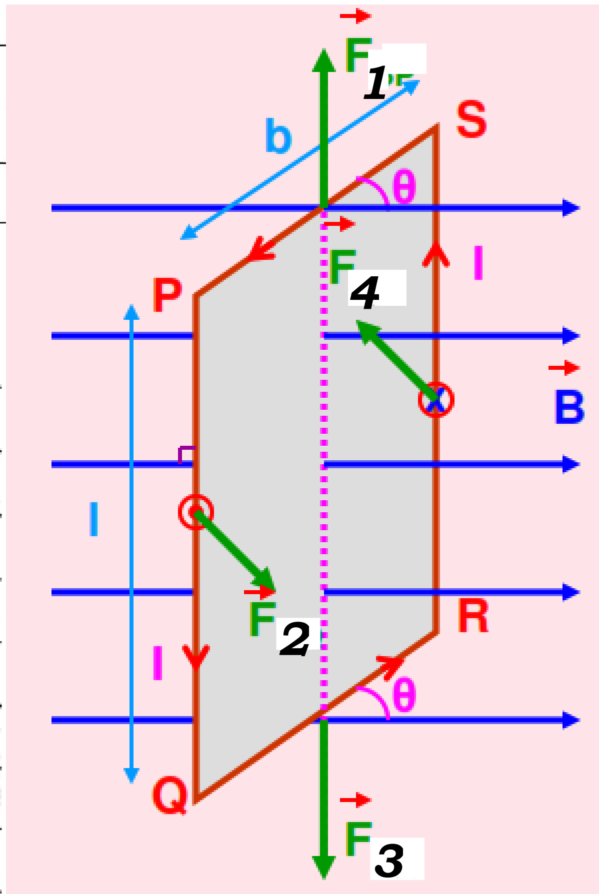
$I\vec{l} = -neAl\vec{v}_d$ —(ii)

from eqn (i) and (ii)

$$\boxed{\vec{F} = I\vec{l} \times \vec{B}}$$

$$\boxed{F = IBl\sin\theta}$$

Torque on Current Carrying Rectangular Coil placed in Uniform Magnetic Field:



B = uniform M.F

I = current

l & B = Dimension of rectangular coil

$F_1 = IBb\sin(180-\theta)$

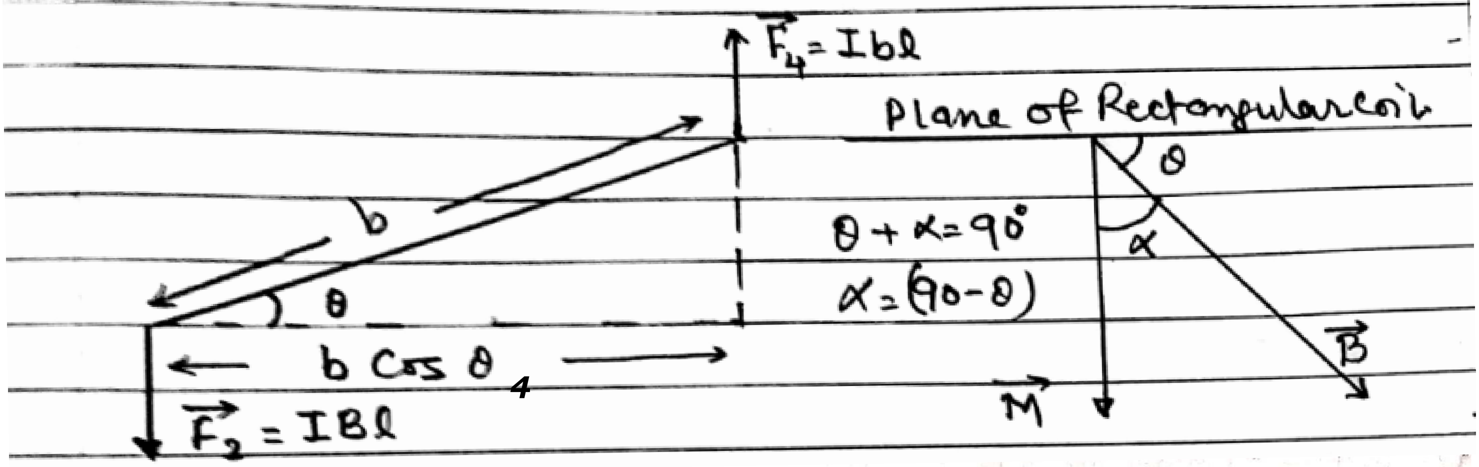
$F_1 = IBb\sin\theta$.

$F_2 = IBl\sin 90^\circ = IBl$.

$F_3 = IBb\sin\theta$.

$F_4 = IBl\sin 90^\circ = IBl$.

F_1 and F_3 being equal and opposite acting along the same line of action will produce on effect on the coil. But F_2 and F_4 are equal and opposite but form a couple because diff. line



Torque = Force × $\perp$ distance between them

$F = IBl \times b\cos\theta$

$= IB(lb)\cos\theta$

$= IBA\cos\theta$ [$\because A = l \times b$]

If there are n turns in the coil then $\tau = (nIA)B\cos\theta$.

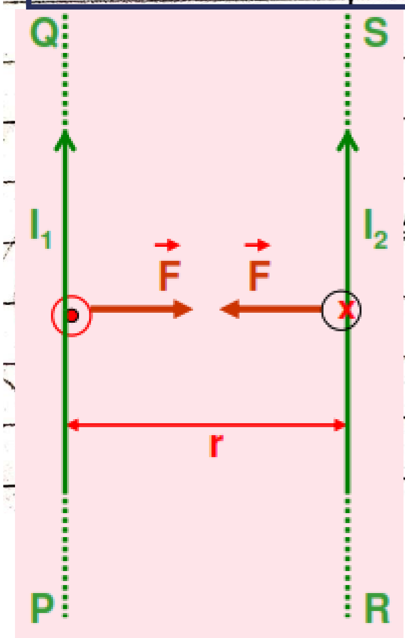
$\tau = MB\cos\theta$

$\tau = MB\cos(90 - \alpha)$

$\tau = MB\sin\alpha$

$\boxed{\vec{\tau} = \vec{M} \times \vec{B}}$

* **Force b/w two parallel current carrying straight wire.**



Considering two parallel conductor carrying current I_1 & I_2 placed r distance apart.

Magnetic feild at P due Ist conductor

$$B_1 = \frac{\mu_0 I_1}{2\pi r}$$

Now force on conductor 2 due to B_1

$F = I_2 B_1 l \sin 90^\circ$

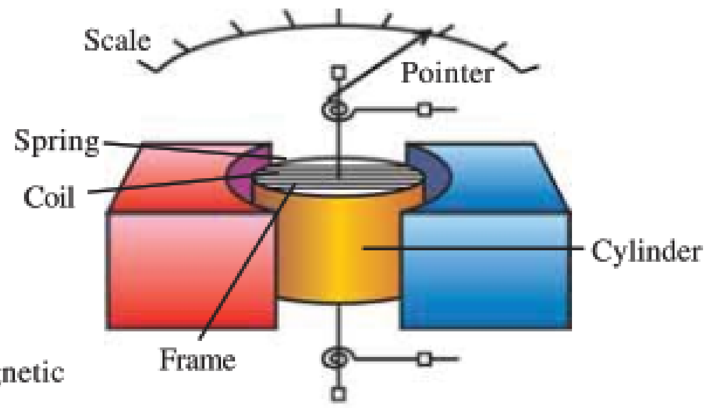
$\therefore f = \frac{F}{l} = I_2 \frac{\mu_0 I_1}{2\pi r}$ = force / length.

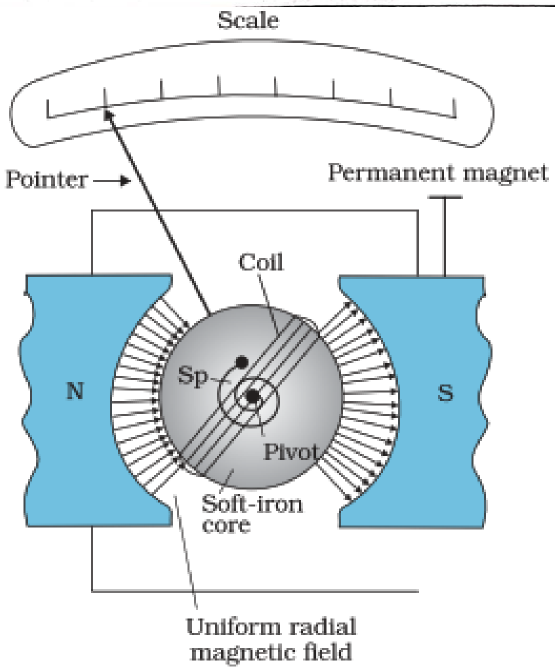
$$\boxed{f = 2\times 10^{-7}\frac{I_1 I_2}{r} \text{ N/metre.}}$$

If the currents are ∥ there will be force of attraction and if anti-parallel there will be force of repulsion.

Ampere :- 1 Ampere is that current which when flows through 2 parallel infinitely long conductors placed in vaccum at ~~1m~~ 1m apart. Then they will experience a force 2×10^{-7} N/m

Moving coil Galvanometer





Purpose :- It is used to detect and measure small current in an electrical circuit.

Principle :- When a current carrying rectangular **coil** is placed in an magnetic feild. It experiences a ~~curre~~ torque which is directly proportional to current flowing through it.

Working :- In MCG radial magnetic feild is used in order to obtain max. torque.

For radial Magnetic feild $\alpha = 90°$

$\tau \Rightarrow \tau_{max}$

when strong magnetic feild is produced using concave magnet and soft iron cylindrical core.

$\tau = NIAB$.

where N = no: of turns.
A = Area of coil
B = magnetic feild.

when coil rotates recoil spring produces restoring torque

$\tau' = K\theta$.

under equilibrium condition

$\tau = \tau'$

$nIAB = K\theta$.

$I = \frac{K}{NAB}\theta$.

$I = G\theta$.

where G = galvanometer constant $= \left(\frac{K}{NAB}\right)$ K = torque perunit twist. ***(Torsional Constant)***

$= I \propto \theta$.

Restoring spring is made up of ***PhosphorBronze*** as it has very very small torque per unit twist and very high tensile strength. As a result very small current can be measured.

Current sensitivity :- It is defined as the angle of twist perunit current flowing through galvanometer.

$$\boxed{I_S = \frac{\theta}{I} = \frac{1}{G} = \frac{NAB}{K}}$$ Rad / Ampere.

Voltage sensitivity :- It is defined as the angle of twist per unit potential diff. applied across galvanometer.

$$\boxed{V_S = \frac{\theta}{V} = \frac{\theta}{IR} = \frac{1}{GR} = \frac{NAB}{KR}}$$ Rad /volt

Conversion of Galvanometer in to ~~Amp~~ Ameter

To convert galvanometer into Ameter a very small resistence which is known as shunt is connected parallel to galvanometer coil.

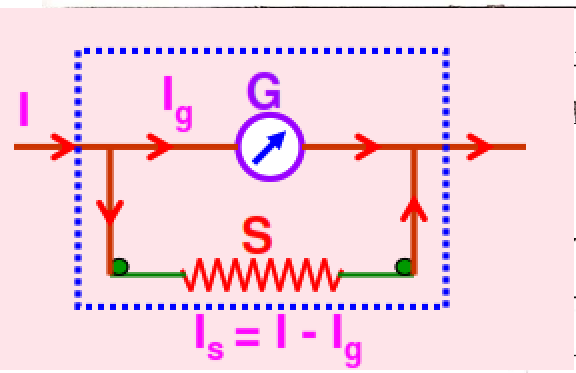
~~Purpo~~.

Purpose of shunt :- It converts galvanometer into Ameter.

→ It protect galvanometer from strong current

→ It is used to increase range of Ameter.

R_g = ***Resistance of Galvanometer***



P.D across GM & Shunt is same

$I_g . R_g = (I - I_g) S$

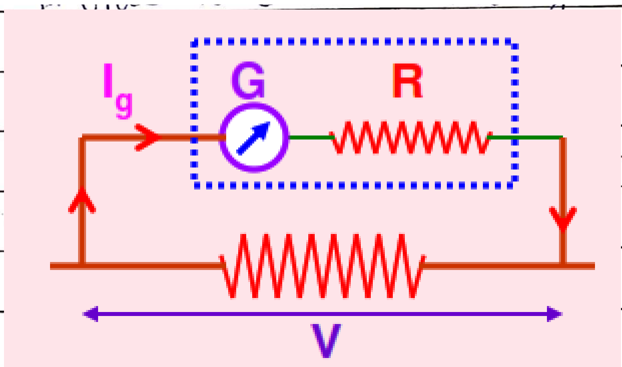
$$\boxed{S = \frac{I_g . R_g}{(I - I_g)}}$$

I_g = max^m current that can flow through GM.

I = Max^m current that can be measured by AM.

Conversion of Galvanometer into Voltmeter.

In order to convert Galvanometer into Voltmeter a large resistance is connected in series with GM.



$\therefore V = I_g (R_g + R)$

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

Figure of Merit :- It is defined as the amount of current flowing through galvanometer per division

Let n = no: of division in GM. dial.

$\therefore I_g = nf$.

$$\boxed{f = \frac{I_g}{n}}$$ $\frac{\text{Amp}}{\text{division}}$.