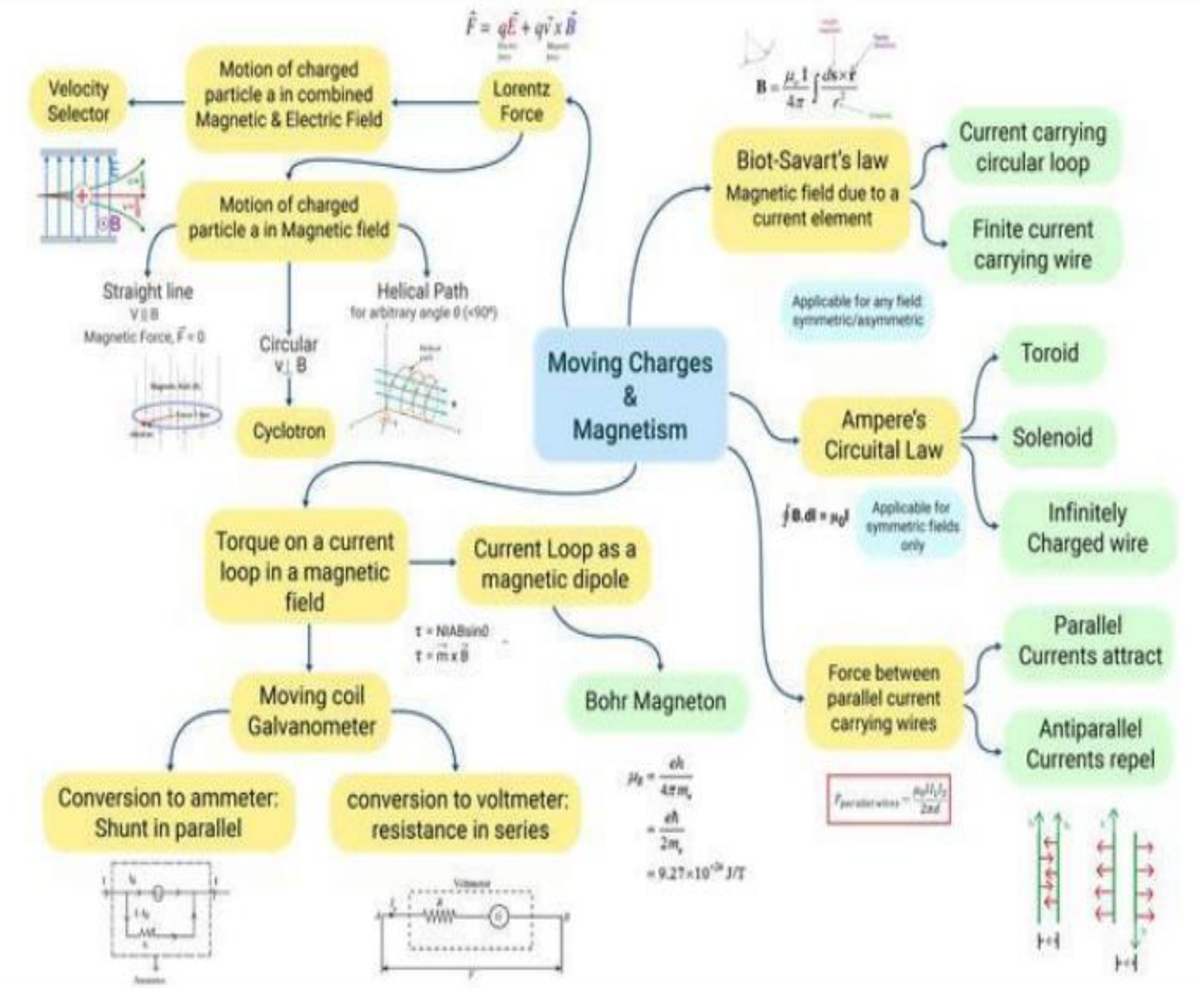
CBSE -Class 12-Physics
Chapter 4
MOVING CHARGES & MAGNETISM

MIND MAP



Sources and Fields

Just as **static charges produce an electric field,** the currents or moving charges produce (in addition) a ***magnetic field, denoted by B (r),*** again a vector field. It has several basic properties identical to the electric field.

The magnetic field of several sources is the vector addition of magnetic field of each individual source.

Lorentz Force Law

Both the electric field and magnetic field can be defined from the Lorentz force law:

Force on a moving charge

i) Force on a charge in an electric field,

$$\vec{F}_E = q\vec{E} \cdots\cdots\cdots\cdots \text{(Electric Lorentz force)}$$

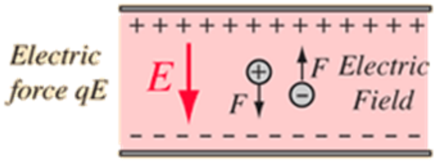
ii) Force on a charge in a magnetic field,

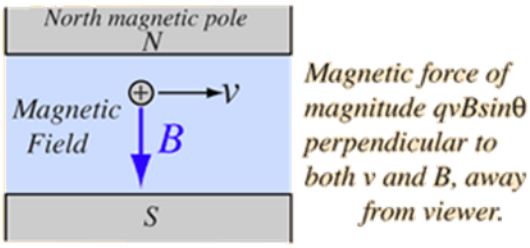
$\vec{F}_E = q\times(\vec{v}\times\vec{B})$ ………………………… (Magnetic Lorentz Force)

iii) **Lorentz force** –
The total force experienced by a charged particle moving in a region where both electric and magnetic fields are present,

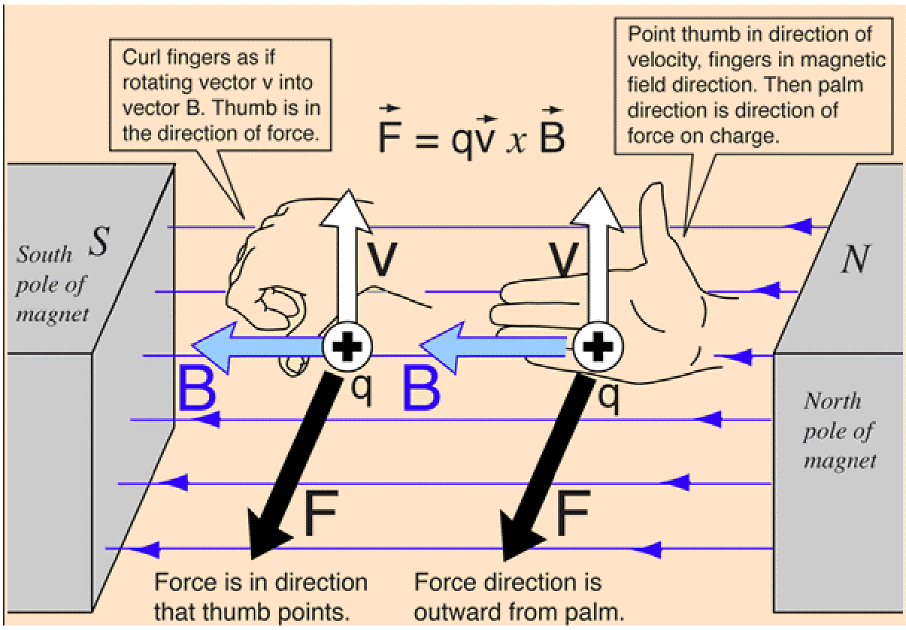
$$\vec{F} = q\vec{E} + q(\vec{v}\times\vec{B})$$

The electric force is straightforward, being in the direction of the electric field if the charge q is positive, but the direction of the magnetic part of the force is given by the right hand rule.





Right Hand Rule



https://javalab.org/en/lorentzs_force_3d_en/

Shape of the path of the charged particle moving inside the field
Charged particle entering perpendicular to the magnetic field moves in a circular path.
$Centripetal\ \ force\ = Magnetic\ \ Lorentz\ \ force$

$$\frac{\boldsymbol{mv^2}}{\boldsymbol{r}} = \boldsymbol{qvB}$$

$Radius\ \ of\ \ the\ \ path\ \ r = \frac{mv}{qB}$

$Speed\ \ of\ \ the\ \ particle\ v = \frac{Bqr}{m}$

$Time\ \ period\ \ T = \frac{2\pi r}{v} = \frac{2\pi r}{\frac{Bqr}{m}} = \frac{2\pi m}{Bq}$

$$\boldsymbol{T} = \frac{2\pi m}{Bq}$$

$Frequency\ \ f = \frac{1}{T} = \frac{Bq}{2\pi m}$

https://ophysics.com/em7.html

A charged particle is *entering* **a magnetic field making an angle with it (inclined)** will ***move in helical path.***

https://ophysics.com/em8.html

A charged particle is *entering* ***perpendicular to an electric field moves in a parabolic path***

Equation of the path is $x^2 = \left(\frac{2\pi m v^2}{qE}\right) \times y$

https://ophysics.com/em6.html

Force experienced by a current carrying conductor placed in an external magnetic field

$\vec{F} = (I\vec{l} \times \vec{B})$
For finding the direction of this force Fleming's Left Hand Rule can be Used

Force per unit length between two infinitely long straight parallel current carrying wires.

$$f_1 = \frac{F_1}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

- If the currents are in the same direction, the force is *attractive.*
- If the currents are in the opposite direction, the force is *repulsive*

https://www.olabs.edu.in/?sub=74&brch=9&sim=241&cnt=4

https://javalab.org/en/magnetic_field_around_a_wire_en/

https://www.geogebra.org/m/JSrCbknr

Torque acting on a current carrying loop suspended in a uniform magnetic field.

$$\tau = NIAB = k\phi$$
$$\vec{\tau} = \vec{m} \times \vec{B}$$

magnetic dipole moment

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