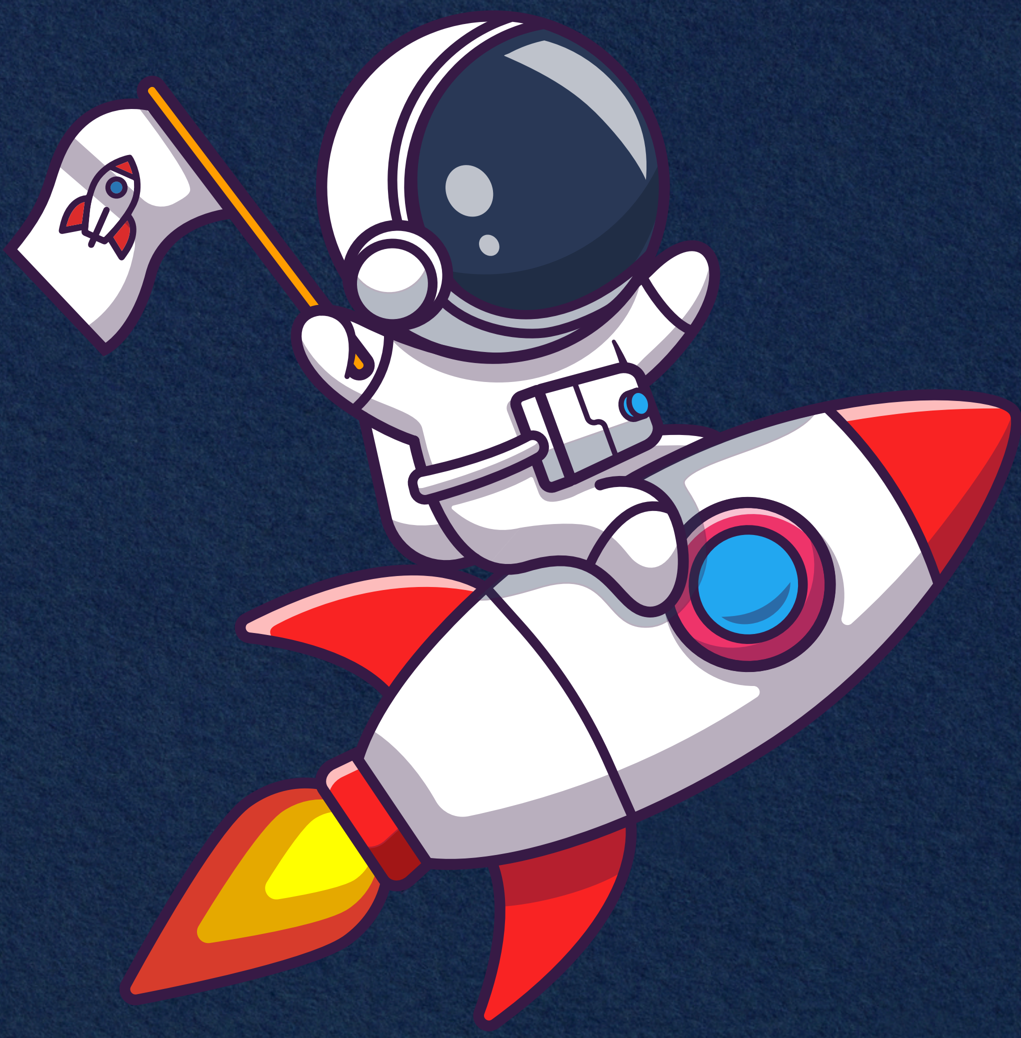
Class 12

PHYSICS

SHORT NOTES



Chapter-4
Moving Charges and Magnetism

★. Magnetic field :- ($\vec{B}$)

→ It is a vector quantity

→ Unit :- In MKS → Tesla, Wb/m^2, N/Am

In CGS → Gauss

$\boxed{1G = 10^{-4}\,T}$

→ Earth's Magnetic field is 3.6×10^{-5} T.

★. Note :-

- q = rest → Electric field
- q = uniform motion → Electric field & Magnetic field
- q = accelerated motion → $\vec{E}$ & $\vec{B}$ both are in motion (Electromagnetic waves)

★. Direction of $\vec{B}$:- ① Right Hand thumb rule

② Right Hand Palm rule

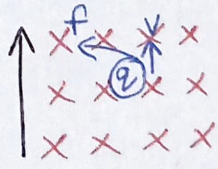
★. Note :- Inward $\vec{B}$ → × (Cross)

Outward $\vec{B}$ → • (Dot)

★. Magnetic force :-

If q at rest, then I = 0, B = 0

If q ~~at~~ in motion then I ≠ 0, B ≠ 0.



★ Direction of Magnetic force :- ① Fleming Left Hand Rule

② Right Hand Palm Rule

☆. Magnetic force on a moving charge in Magnetic field:-

$$\boxed{f = qVB\sin\theta}$$

$$\boxed{\vec{f} = q(\vec{V} \times \vec{B})}$$

Here, θ = angle between $\vec{V}$ and $\vec{B}$ and direction is perpendicular to $\vec{V} \times \vec{B}$ plane.

Imp.
☆. Note:-
When charge move parallel or antiparallel to $\vec{B}$, then force on charge is $0°$ and at $90°$ to $\vec{B}$, the force becomes Maximum.

Imp ☆ Magnetic force on a current carrying conductor:-

$$\boxed{f = IlB\sin\theta}$$

$$\boxed{\vec{f} = I(\vec{l} \times \vec{B})}$$

Here, $\vec{l}$ is always in direction of current.

☆. Motion of Charge in a Magnetic field:-

• Case-I:- When charge moving along or in opposite to $\vec{B}$.

$$\boxed{f = 0}$$

Path of Particle → Linear (Straight line)

• Case-II:- When charge moves at right angle to $\vec{B}$.

force → $\boxed{f = qVB}$

radius of path → $\boxed{r = \frac{MV}{qB}}$

Time Period → $\boxed{T = \frac{2\pi M}{qB}}$

Path of Particle → Circular.

Case-III:- When charge moves at any angle to $\vec{B}$.

Radius → $\boxed{R = \frac{MV\sin\theta}{qB}}$

Time Period → $\boxed{T = \frac{2\pi M}{qB}}$

Pitch → $\boxed{P = \frac{2\pi MV\cos\theta}{qB}}$

Path of Particle → Helical Path.

☆. Biot Savart Law:- (For magnitude of $\vec{B}$ around a current carrying wire)

Scalar form:- $\boxed{dB = \frac{K_m I\, dl \sin\theta}{r^2} \text{ or } \frac{\mu_0}{4\pi}\frac{I\, dl \sin\theta}{r^2}}$

Vector form:- $\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\, d\vec{l} \times \vec{r}}{r^3}}$

$\boxed{K_m = 10^{-7} \frac{Tm}{A} = \frac{\mu_0}{4\pi}}$

$\mu_0 \rightarrow$ Permeability of free space.

☆. Similarity / Dissimilarity b/w Coulomb's law & Biot Savart law:-

Similarity

→ to get field at long range

→ follow inverse square law

→ follow superposition principle

Dissimilarity

→ Coulomb's law = independent of angle.

Biot Savart law = depend on angle

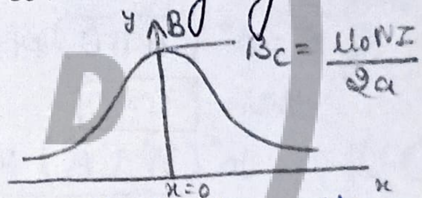
→ $\vec{E}$ act along displacement vector

$\vec{B}$ act along ⊥ to $(d\vec{l} \times \vec{r})$ plane.

☆. Lorentz force:- $\boxed{\vec{F} = q(\vec{E} + \vec{V} \times \vec{B})}$

☆. Magnetic field on the axis of a current carrying circular loop:-

$$\boxed{B = \frac{\mu_0 I N a^2}{2(a^2 + x^2)^{3/2}}}$$



→ at center of coil:- $\boxed{B = \frac{\mu_0 NI}{2a}}$

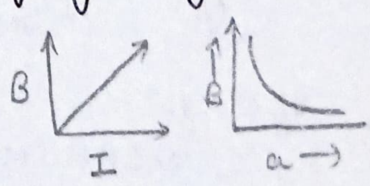
→ at semi circular coil:- $\boxed{B = \frac{\mu_0 NI}{4a}}$

☆. Ampere's Circuital Law:-

$$\boxed{\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{Total}}$$

☆. Magnetic field around a current carrying long and straight wire:-

$$\boxed{B = \frac{\mu_0 I}{2\pi a} \text{ or } \frac{\mu_0}{4\pi}\frac{2I}{a}}$$



☆. Note:-

Outside solenoid → $\vec{B} = 0$

Inside solenoid → $\vec{B}$ = strong & uniform.

☆. Magnetic field inside a solenoid:-

$$\boxed{B = \frac{\mu_0 NI}{l} \text{ or } \mu_0 n I}$$

N → No. of turns in coil.

→ Magnetic field at ends of solenoid :-

$$\boxed{B = \frac{\mu_0 n I}{2}}$$

☆. Magnetic force betⁿ two parallel current carrying conductor :-

$$\boxed{f = \frac{\mu_0 I_1 I_2}{2\pi r}}$$ (per unit length)

→ One wire must be of infinite length

☆. Note :-

$I_1 \uparrow \quad \uparrow I_2$ → attract

$I_1 \uparrow \quad \downarrow I_2$ → Repel.

→ Net force for a regular closed loop is 0.

☆. Force and torque on a current carrying coil in Magnetic field :-

$$\boxed{\tau = NIAB\sin\theta} \quad \text{or} \quad \boxed{\vec{\tau} = NI(\vec{A} \times \vec{B})}$$

$$\boxed{\tau = MB\sin\theta} \quad \text{or} \quad \boxed{\vec{\tau} = (\vec{M} \times \vec{B})}$$

☆. Note :-

① If $\theta = 0°$ $(\vec{A} \parallel \vec{B})$ or (coil $\perp \vec{B}$)
then $\boxed{\tau = 0}$

② If $\theta = 90°$ $(\vec{A} \perp \vec{B})$ or (coil $\parallel \vec{B}$)
then $\boxed{\tau = \text{Max.}}$

☆. Magnetic Dipole Moment :- unit → Am^2

$$\boxed{\vec{M} = I\vec{A}}$$ where $\vec{A}$ = Area Vector

☆. Galvenometer :- (device used to detect the current)

→ Converted into ammeter & voltmeter

☆. Moving Coil Galvenometer :-

Torque :- $\boxed{\tau = NIAB\sin\theta}$

If $\theta = 90°$

$\tau_m = NIAB$ (Max.)

$$\boxed{\phi = \left(\frac{NBA}{K}\right) I}$$ ← Angular deflection

$$\boxed{\phi \propto I}$$

• Current Sensitivity :-

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

Unit → $\frac{rad}{A}$ or $\frac{division}{A}$

• Voltage Sensitivity :-

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

Unit → rad/V or $\frac{division}{V}$

☆ Ammeter :-

$$\boxed{R_{eff} = \frac{R_g R_s}{R_g + R_s}}$$

Shunt Resistance :- $\boxed{R_s = \frac{I_g R_g}{I - I_g}}$

→ An ideal ammeter has zero resistance.

☆. Voltmeter :-

$$\boxed{R_{eff} = R_g + R}$$

Shunt Resistance (High) :- $\boxed{R = \frac{V}{I_g} - R_g}$

→ Resistance of an ideal voltmeter is infinity.

* BOARD ZONE *