Moving Charges and Magnetism Class 12 Formula Sheet

CBSE Class 12 Physics · NCERT · for boards, NEET and JEE revision

ChapterNotes

Magnetic Force on a Moving Charge

$$F = q\,v\,B\sin\theta$$

θ is the angle between v and B; a charge at rest feels no magnetic force.

- Maximum F = qvB when v ⊥ B; zero when v ∥ B
- Force ⊥ to both v and B → does no work, speed unchanged
- Direction from right-hand rule for q v × B (reverse for negative q)

The Lorentz Force

$$F = q\,(E + v \times B)$$

For a straight wire of length L: F = B I L sin θ.

- Electric part qE acts even on a stationary charge
- Magnetic part q(v × B) acts only on a moving charge
- A current-carrying wire is just many moving charges → F = BIL sin θ

Circular Motion in a Field

$$r = m\,v / (q\,B)\,,\; T = 2\pi\,m / (q\,B)$$

T and frequency are independent of speed and radius.

- r = √(2mK) / (qB), so r ∝ √K
- If v has a part along B → path is a helix
- Pitch = v cos θ · T (distance advanced per turn)

The Cyclotron

$$f = q\,B / (2\pi\,m)\,,\; K_{max} = q^2\,B^2\,R^2 / (2m)$$

R = dee radius; the alternating voltage runs at the cyclotron frequency f.

- Constant period lets the field flip in sync each half-circle
- Energy is gained only in the gap between the dees
- Cannot accelerate neutral particles or (relativistically) electrons well

Biot-Savart & Ampere's Law

$$dB = (\mu_0/4\pi)\cdot I\,dl\sin\theta / r^2\;;\; \oint B\cdot dl = \mu_0\,I_{enc}$$

$\mu_0/4\pi = 10^{-7}$ T·m/A; Ampere's law works for symmetric cases.

- Long straight wire: B = μ_0 I / (2π a), so B ∝ 1/a
- Field circles the wire by the right-hand grip rule
- Currents outside the chosen loop add zero to $\oint$ B · dl

Loops, Solenoids & Toroids

$$\text{Loop centre: } B = \mu_0\,N\,I / (2R)\;;\; \text{Solenoid: } B = \mu_0\,n\,I$$

Solenoid uses n (turns per metre); toroid uses total N.

- On loop axis: B = μ_0 N I R^2 / [2(R^2+x^2)^(3/2)]
- Solenoid field is uniform inside, ~zero outside; half (μ_0nI/2) at the end
- Toroid: B = μ_0 N I / (2π r), field only inside the ring

Force Between Parallel Currents

$$F / L = \mu_0\,I_1\,I_2 / (2\pi\,d)$$

1 A gives 2 × 10^{-7} N/m for wires 1 m apart in vacuum.

- Parallel (same-direction) currents attract
- Antiparallel (opposite-direction) currents repel
- Force is mutual and equal even when $I_1 \neq I_2$ (Newton's 3rd law)

Torque, Magnetic Moment & Galvanometer

$$m = N\,I\,A\,,\; \tau = m\,B\sin\theta = N\,I\,A\,B\sin\theta\,,\; U = -m\cdot B$$

θ = angle between the loop's normal and B.

- τ max when loop plane ∥ B; τ = 0 (stable) when plane ⊥ B
- Galvanometer (radial field): ϕ ∝ I, sensitivity = N A B / k
- Ammeter = shunt in parallel; voltmeter = high resistance in series

Quick revision

- F = qvB sin θ; magnetic force ⊥ velocity → does no work
- Circular path: r = mv/(qB); T = 2πm/(qB) - independent of v
- Biot-Savart: dB = (μ_0/4π)(Idl sin θ)/r^2
- Centre of loop: B = μ_0I/(2R); Straight wire: B = μ_0I/(2πr)
- Solenoid: B = μ_0nI; Toroid: B = μ_0NI/(2πr)
- Ampere's law: $\oint$B·dl = μ_0I_enc
- F between wires: F/l = $\mu_0 I_1 I_2$/(2πd); same direction → attract
- Cyclotron: v = qB/(2πm); can't accelerate electrons or neutrals

Full chapter notes with solved examples and practice questions: https://chapternotes.in/cbse/class-12-physics/moving-charges-and-magnetism-class-12-notes/