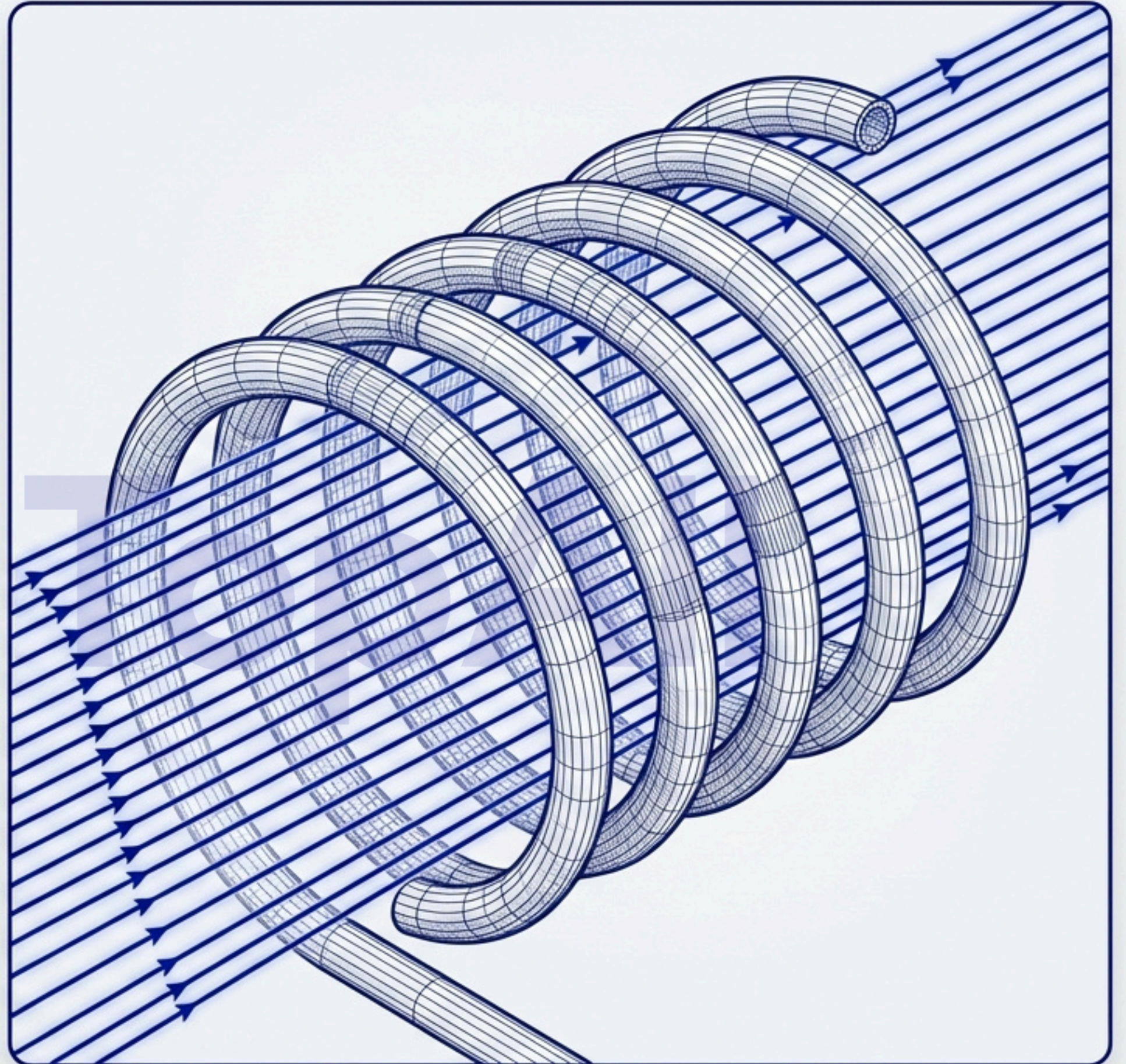


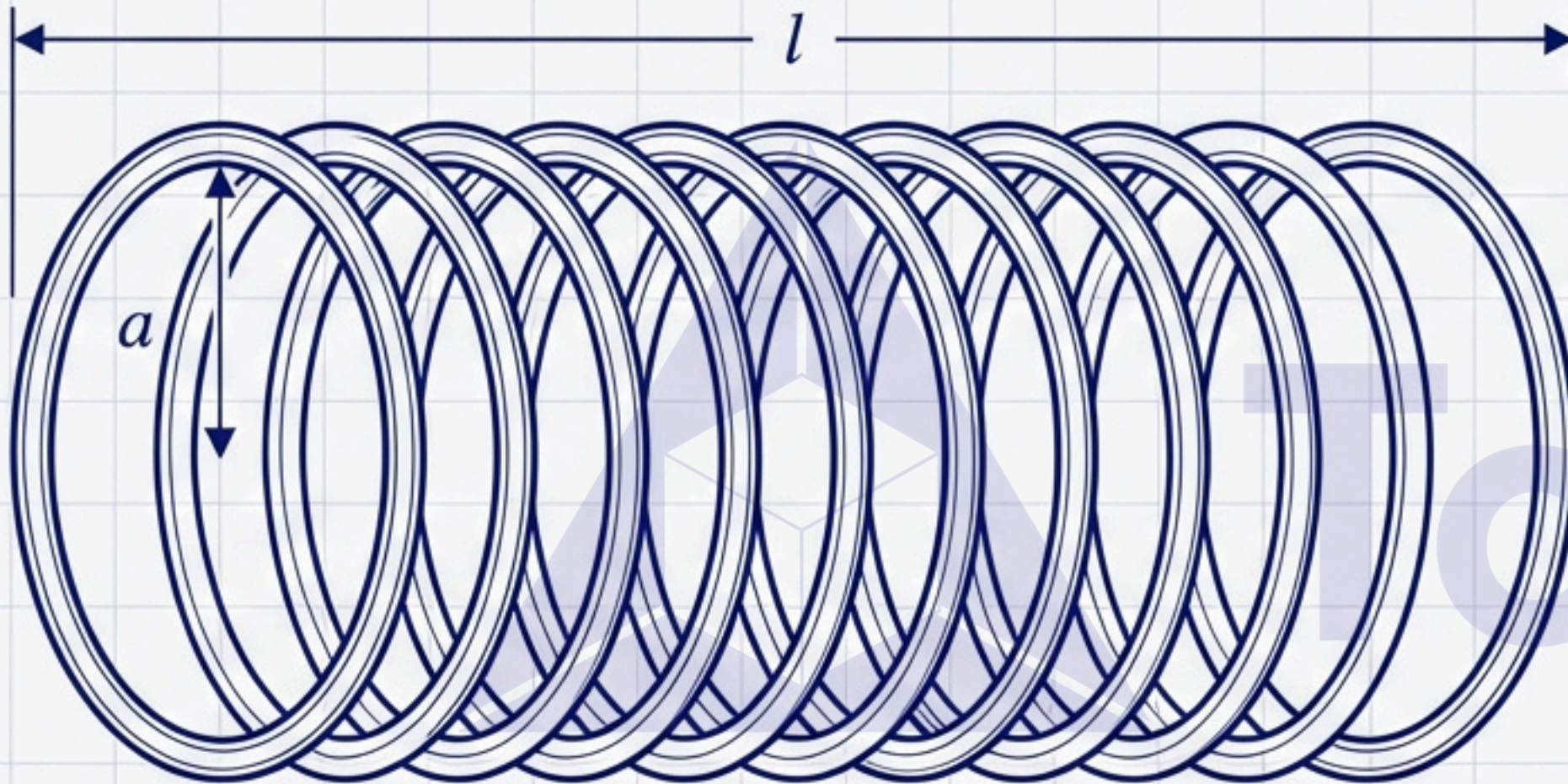


CHAPTER 4 • MOVING CHARGES AND MAGNETISM

The Solenoid

Generating Strong, Uniform
Magnetic Fields.





Definition

A long wire wound in the form of a helix with closely spaced, insulated turns.

Key Assumption

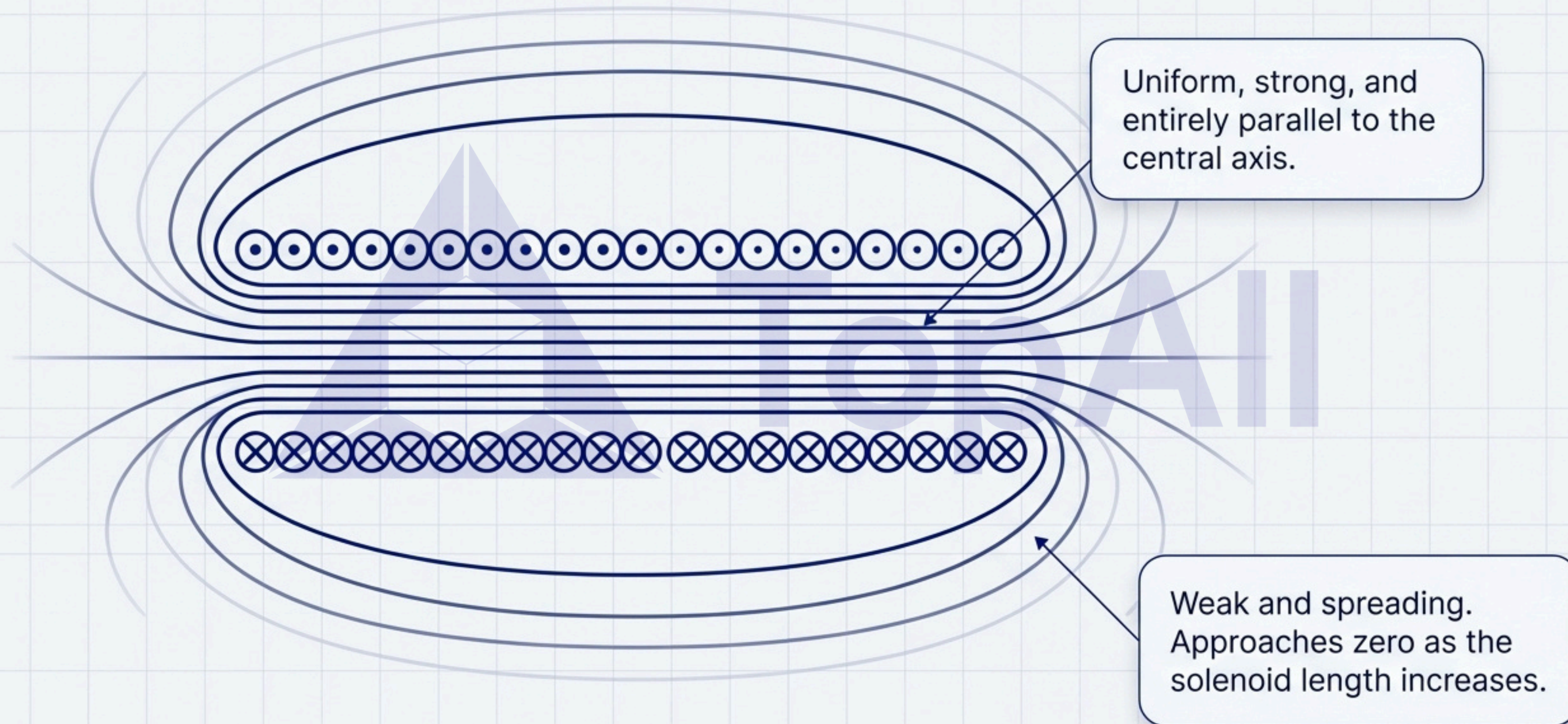
Ideal Long Solenoid: Length is significantly larger than its radius ($l \gg a$).

Turns per unit length (n)

$$n = \frac{N}{l}$$

Do not confuse n with total turns (N).

Field Pattern of a Finite Solenoid





**You've Learned the Theory.
Let's Test Them Now.**

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

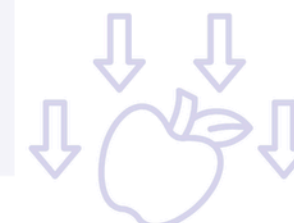
Practice Now



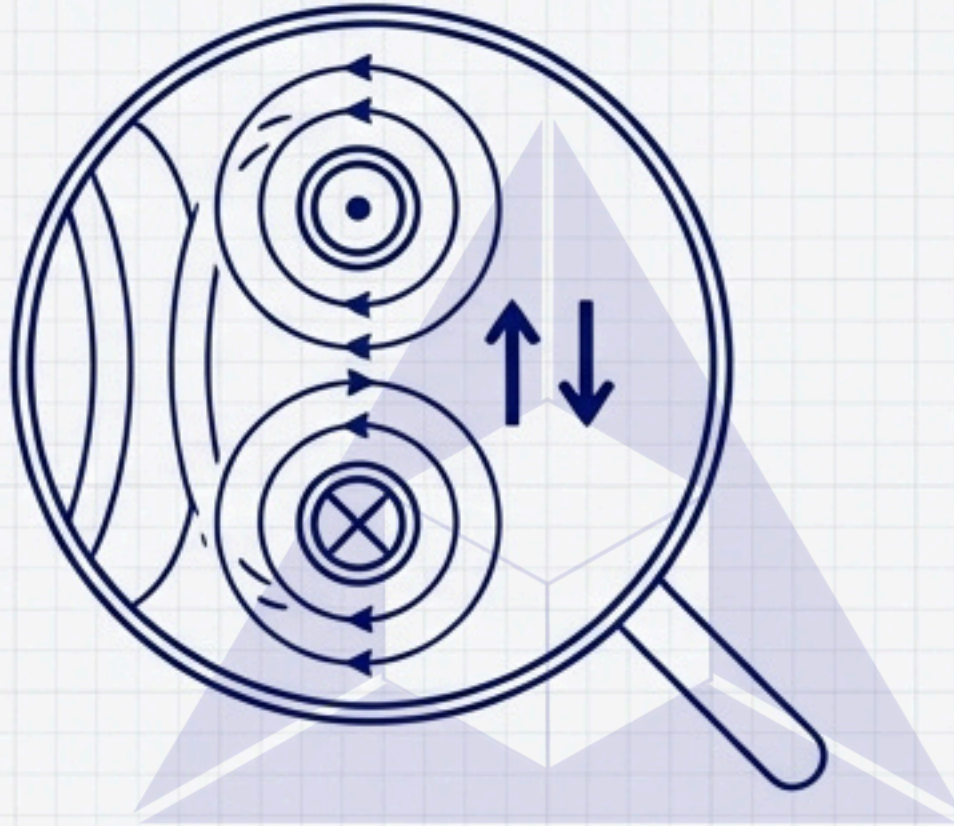
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Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter

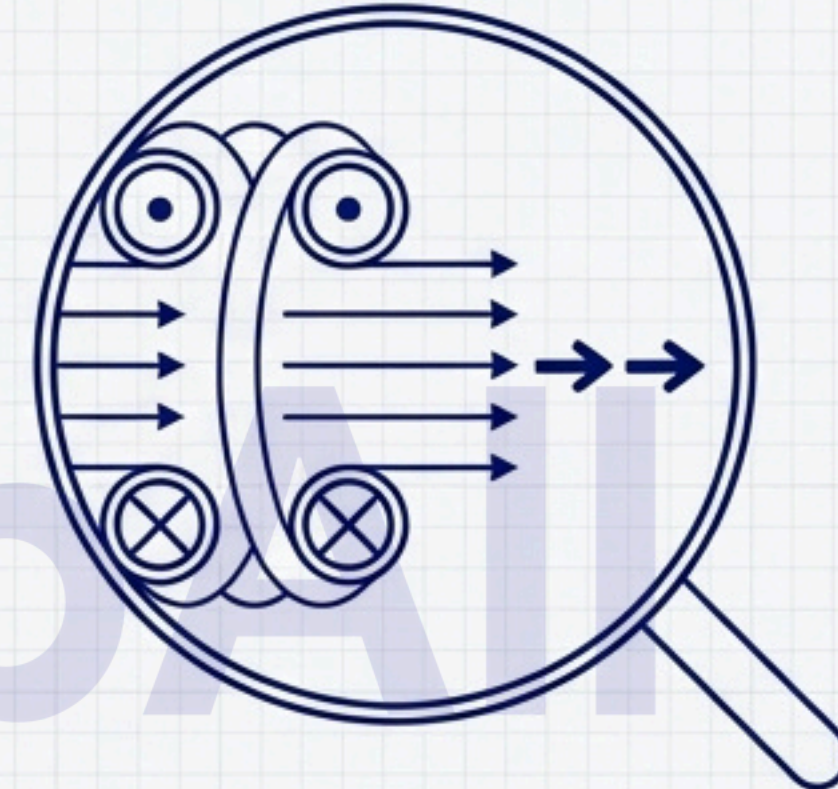


Vector Addition & Cancellation



Transverse Components CANCEL

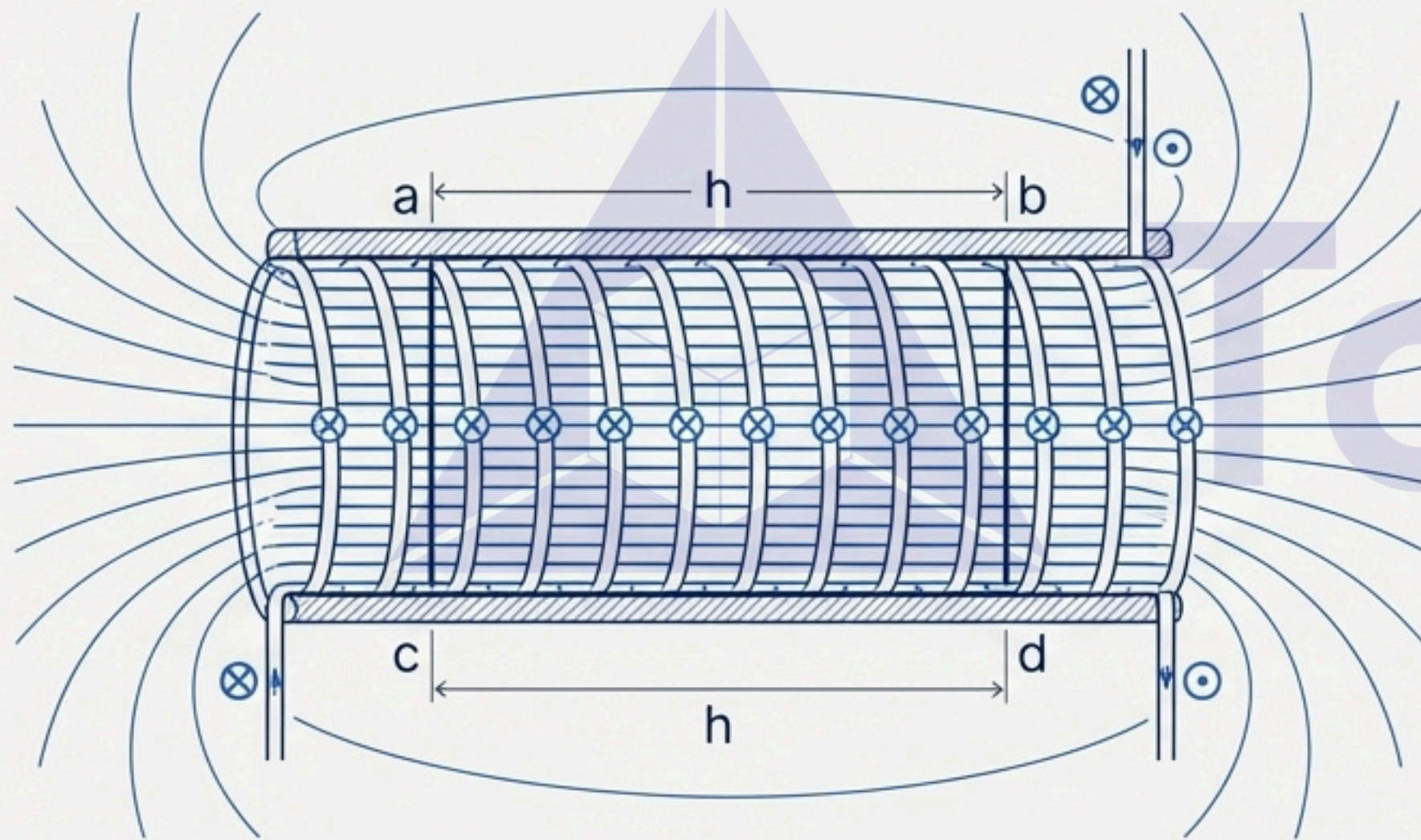
Circular fields from neighboring loops point in opposite directions ($\uparrow\downarrow$), neutralizing the field outside the axis.



Axial Components ADD UP

Field components from all individual loops point in the exact same direction ($\rightarrow\rightarrow$), creating a powerful uniform field.

Ampere's Law Derivation



1. Path c-d (outside):

$$\text{Field } \mathbf{B} \approx 0 \Rightarrow \int \vec{\mathbf{B}} \cdot d\vec{\mathbf{l}} = 0$$



2. Paths b-c & a-d (perpendicular):

$$\mathbf{B} \perp d\vec{\mathbf{l}} \Rightarrow \int \vec{\mathbf{B}} \cdot d\vec{\mathbf{l}} = 0$$



3. Path a-b (inside):

$$\mathbf{B} \parallel d\vec{\mathbf{l}}, \text{ length } h \Rightarrow \int \vec{\mathbf{B}} \cdot d\vec{\mathbf{l}} = Bh$$



$$\text{Enclosed Current: } I_e = I(nh)$$

$$Bh = \mu_0 (nh) I$$

$$\text{Result: } B = \mu_0 n I$$

EXAM ESSENTIALS

$$\pi \int_{-\infty}^{\infty}$$

The Formula

$$B = \mu_0 n I$$

Magnitude of the uniform field inside an ideal long solenoid.



The Dependencies

- Depends strictly on current (I), turns per unit length (n), and core permeability (μ_0).
- Crucial Trap: It does NOT depend on the solenoid's radius or total length independently.



Directional Rule

Right-Hand Rule: Grasp the solenoid. Fingers curl with the current; the extended thumb points to the North pole (direction of B).



You've Learned the Theory.

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