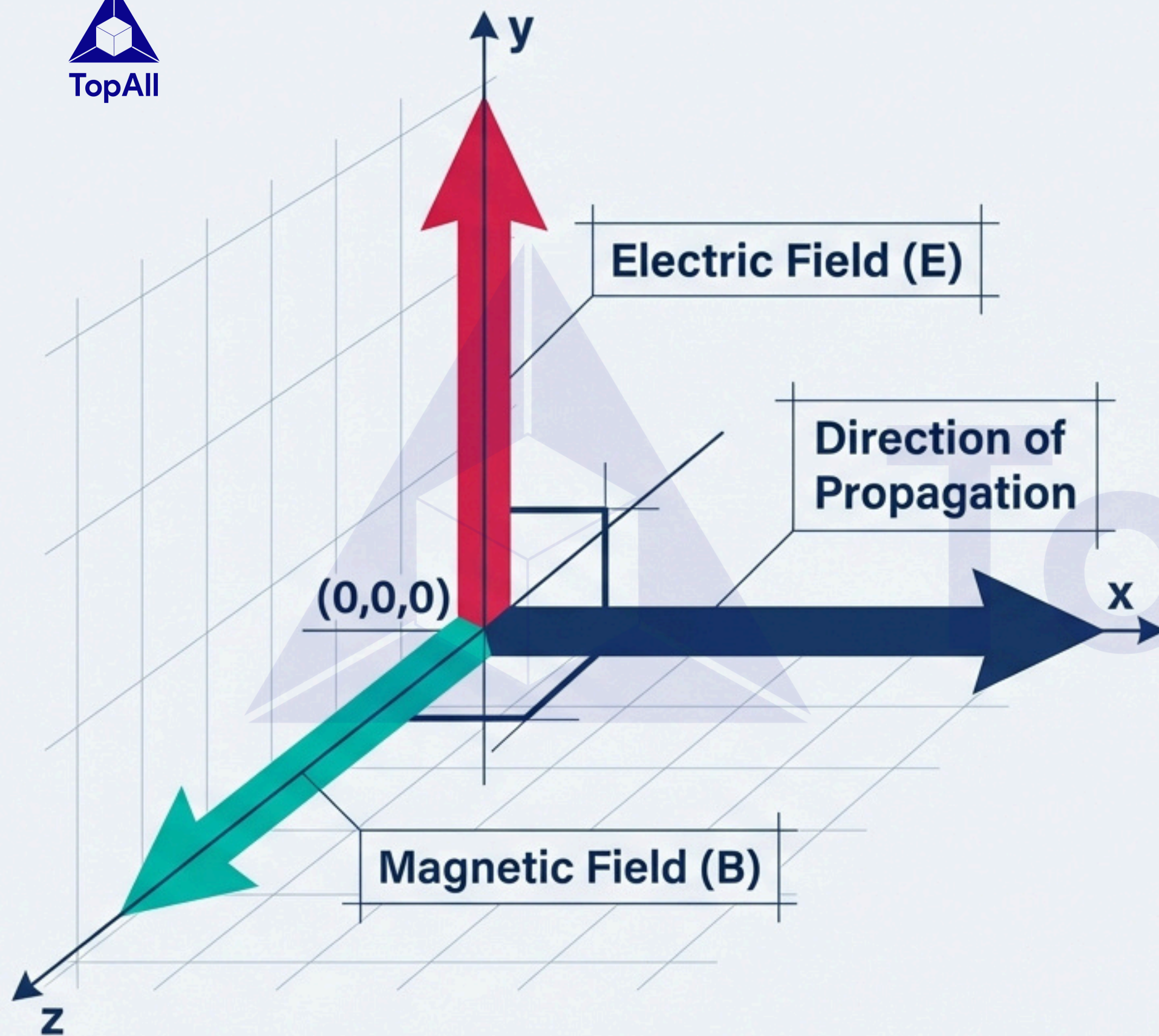


The 3-D Geometry of an Electromagnetic Wave

Visualizing the fields, propagation, and equations of light.



The Foundation: Mutual Perpendicularity

The defining feature of an electromagnetic wave is its 3D geometry. The electric field and magnetic field are always mutually perpendicular to each other AND perpendicular to the direction of propagation.

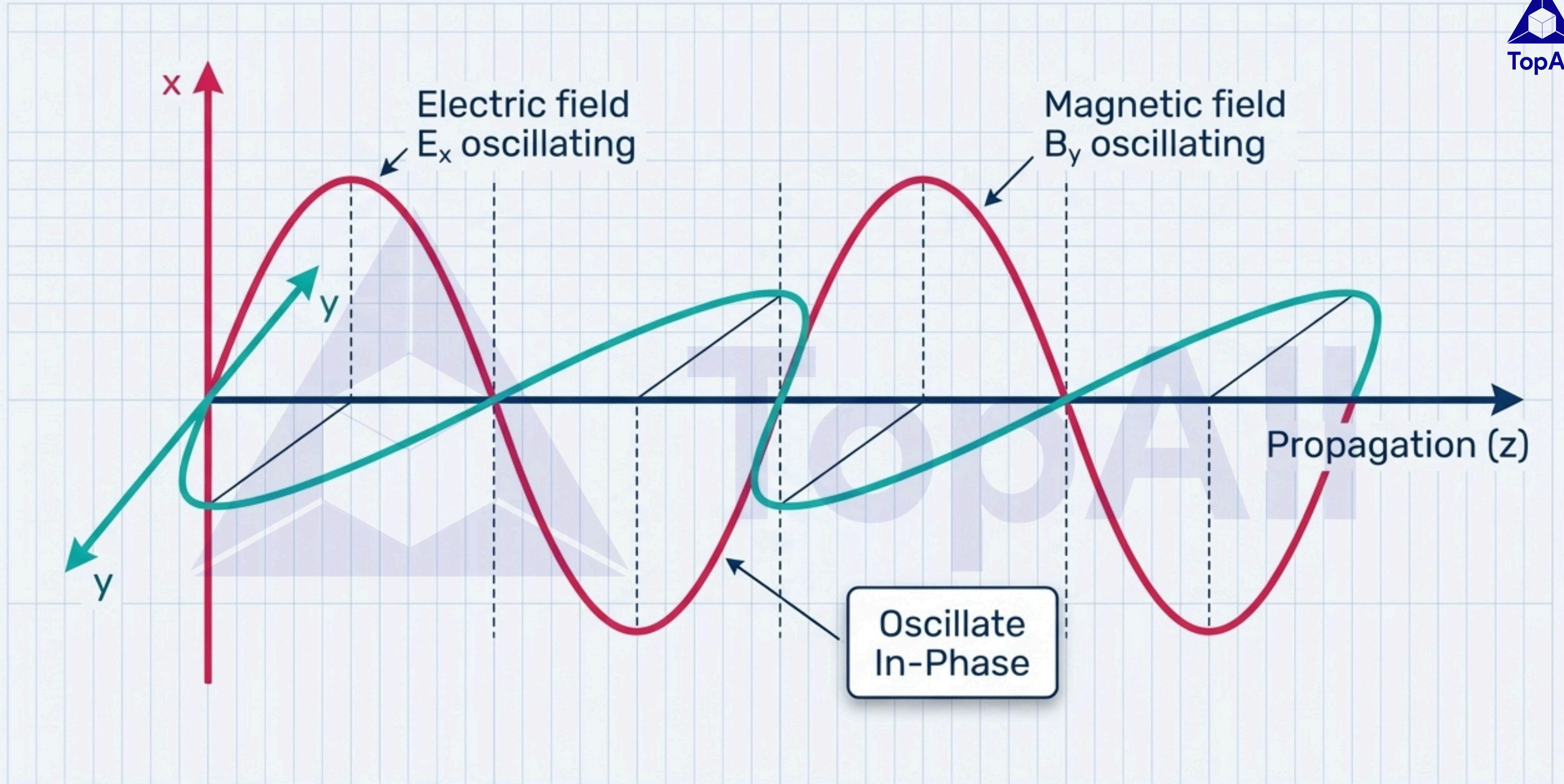


FIG 8.3: LINEARLY POLARISED EM WAVE



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



At prep.topall.app

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



The Anatomy of the Wave Equations

$$E_x = E_0 \sin(kz - \omega t)$$

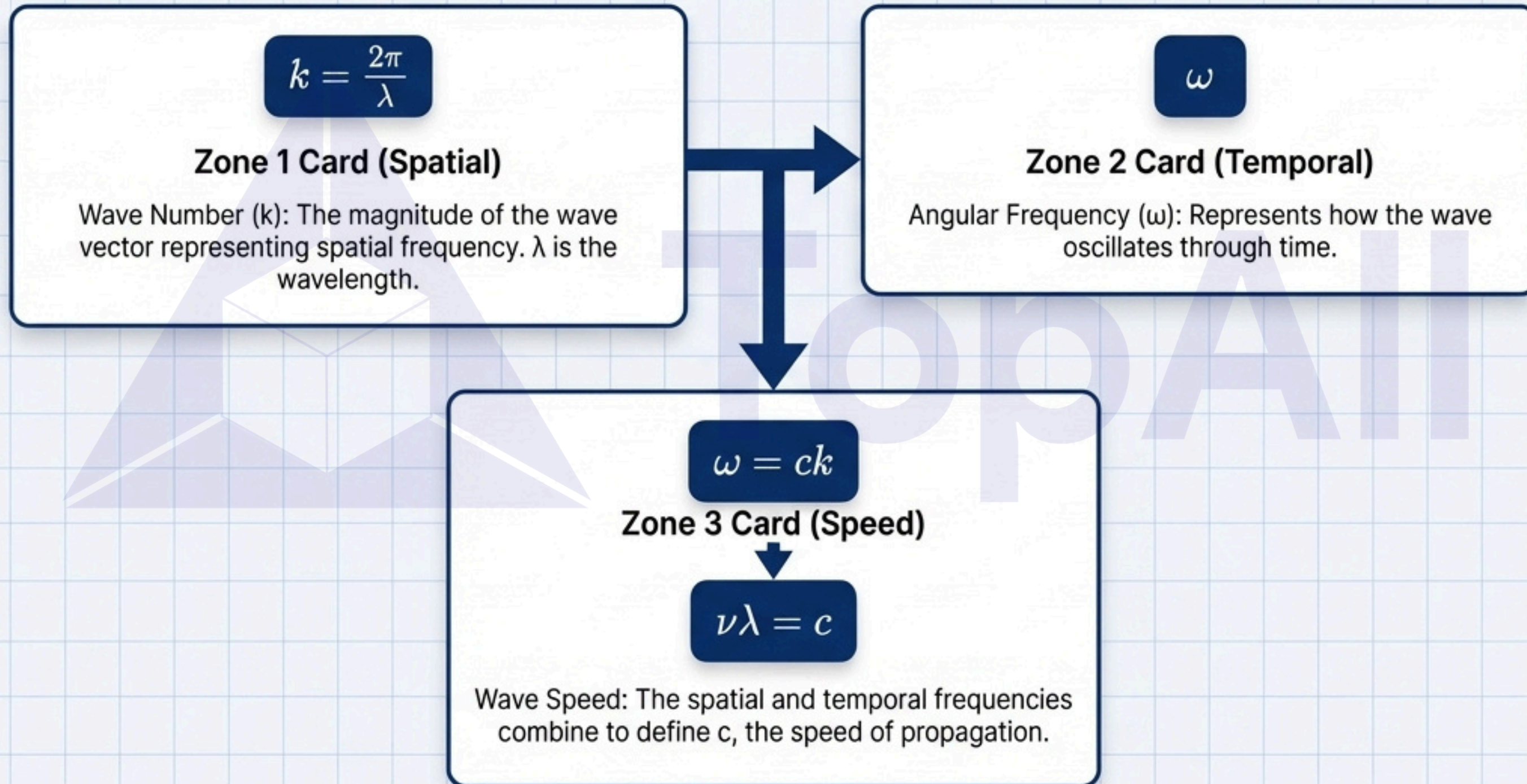
[Eq. 8.7(a)]

$$B_y = B_0 \sin(kz - \omega t)$$

[Eq. 8.7(b)]

The shared phase factor mathematically proves what we see visually:
the fields oscillate together in space (z) and time (t).

Defining the Wave Parameters



Amplitude Relation and Speed Comparison

$$B_0 = \frac{E_0}{c}$$

The magnitudes of the fields are intrinsically linked, separated only by the massive constant of the speed of light (c).

Speed in Vacuum

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

Calculated using constants for free space permeability (μ_0) and permittivity (ϵ_0).

Speed in Material Medium

$$v = \frac{1}{\sqrt{\mu \epsilon}}$$

Velocity drops based on the specific electric (ϵ) and magnetic (μ) properties of the surrounding medium.

Key Takeaways

1. E-field (Crimson), B-field (Teal), and propagation direction (Navy) are always mutually perpendicular.
2. Both fields are described by in-phase sinusoidal equations sharing the same $(kz - \omega t)$ phase.
3. Wave speed is fundamentally determined by the electric (ϵ) and magnetic (μ) properties of the medium.

Knowledge Check



If a plane EM wave travels in the +x direction, and the Electric field oscillates in the +y direction, what is the direction of the Magnetic field?

Answer: +z direction.

Determined by the vector cross product rule $E \times B$.



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis