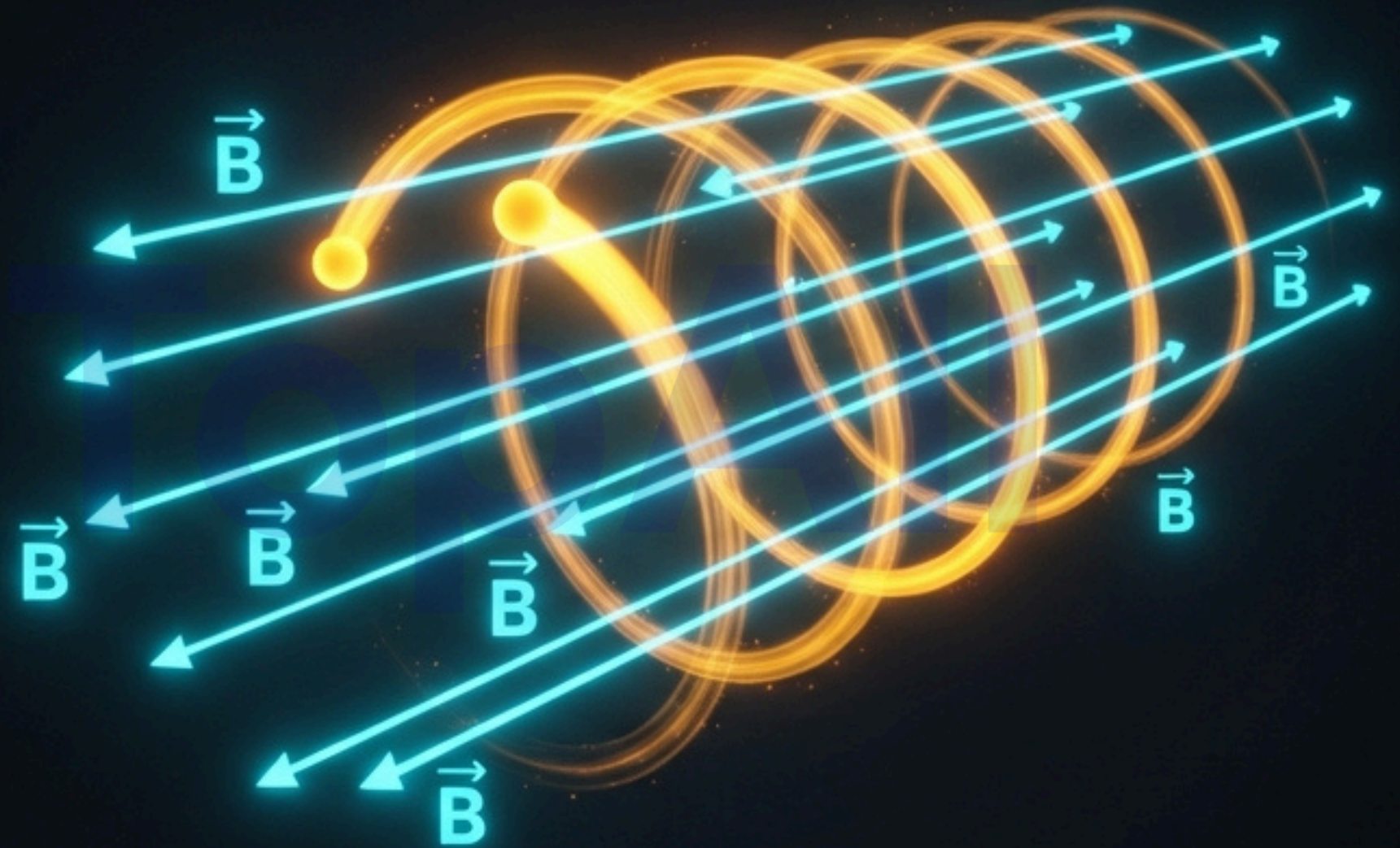
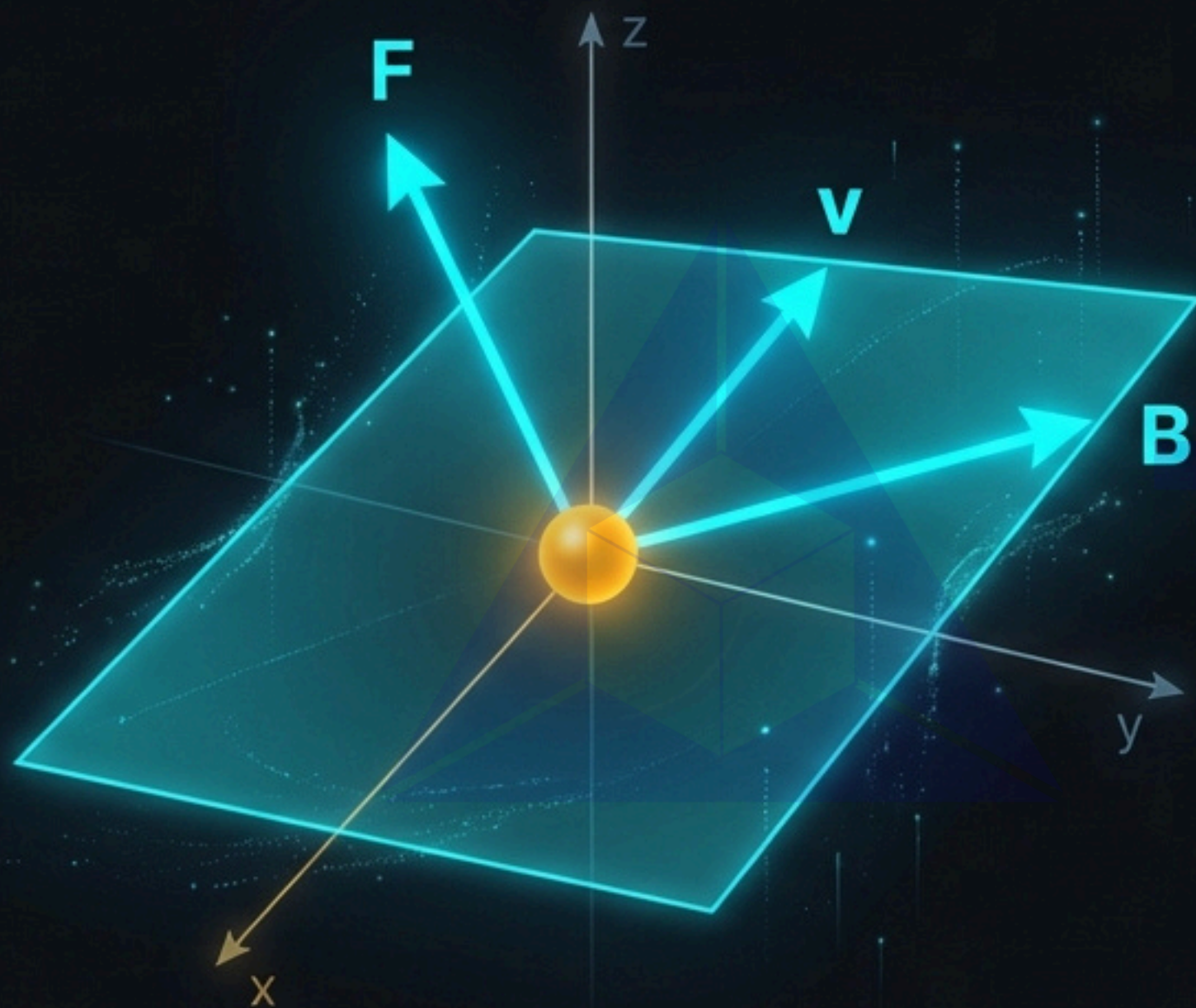


Motion in a Magnetic Field

Understanding the 3D spatial geometry of moving charges, magnetic forces, and the resulting circular and helical paths.





Why Speed Stays Constant

Lorentz force is perpendicular to velocity:

$$\mathbf{F} \perp \mathbf{v}$$



Work done by magnetic force is zero:

$$W = \mathbf{F} \cdot d\vec{r} = F \cdot d\vec{r} \cos(90^\circ) = 0$$



Work-Energy Theorem:

$$\Delta KE = 0 \rightarrow \text{Kinetic Energy is constant.}$$



Therefore, speed $|\mathbf{v}|$ remains constant.

! EXAM TRICK: Momentum direction changes constantly, but momentum magnitude remains exactly the same.



ENTRY ANGLE: $\theta = 90^\circ$

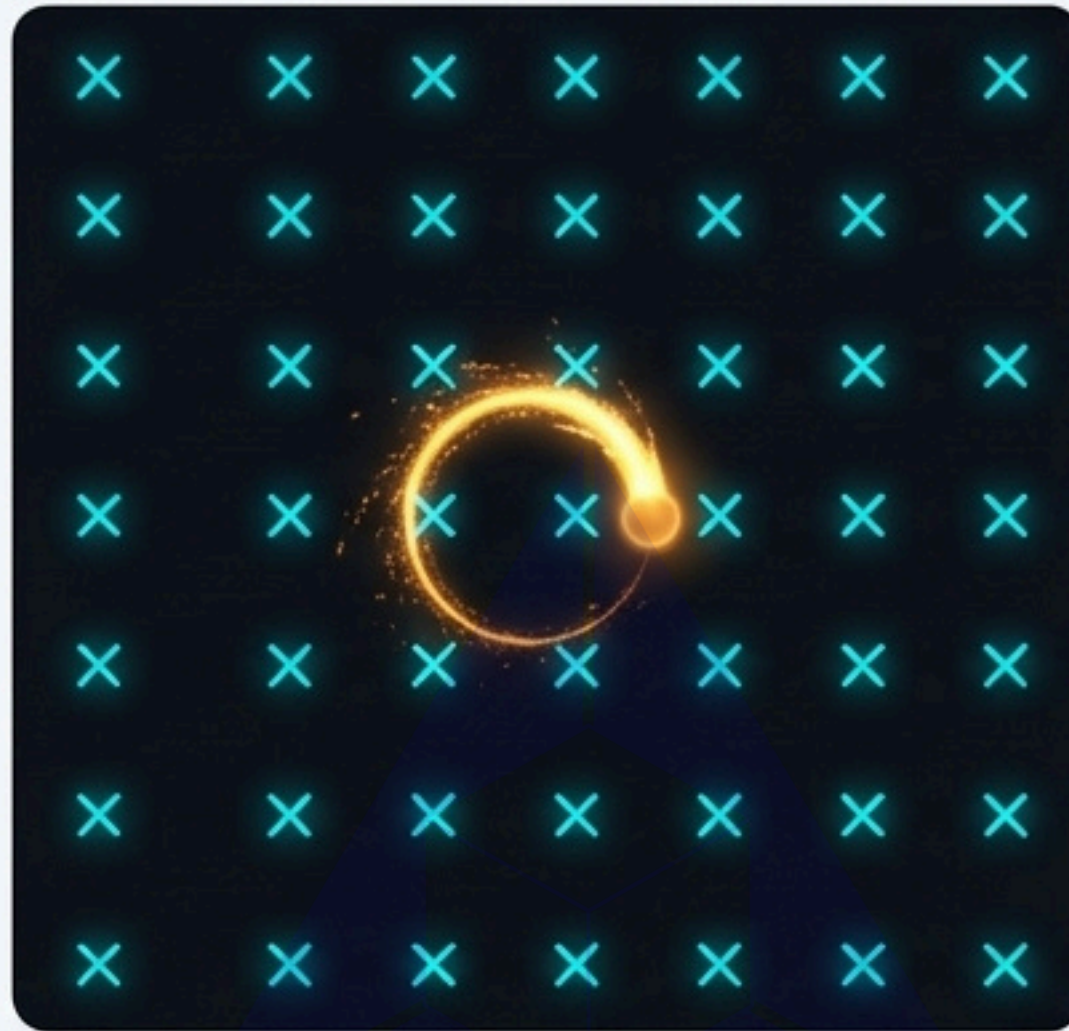
Magnetic Force
(qvB)

Centripetal Force
(mv^2/r)

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

The perpendicular magnetic force provides the exact centripetal force required to lock the particle into a circular orbit.

Viewport A



Viewport B



$$r = \frac{mv}{qB}$$

$r \propto 1/q$ (Higher charge = tighter circle)

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$mv = p$ (Momentum) $\rightarrow r \propto p$
The larger the momentum of the particle, the larger the radius of its circular path.

$r \propto 1/B$ (Stronger field = tighter circle)



**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.**

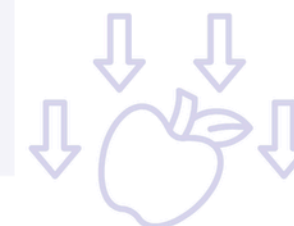
Practice Now

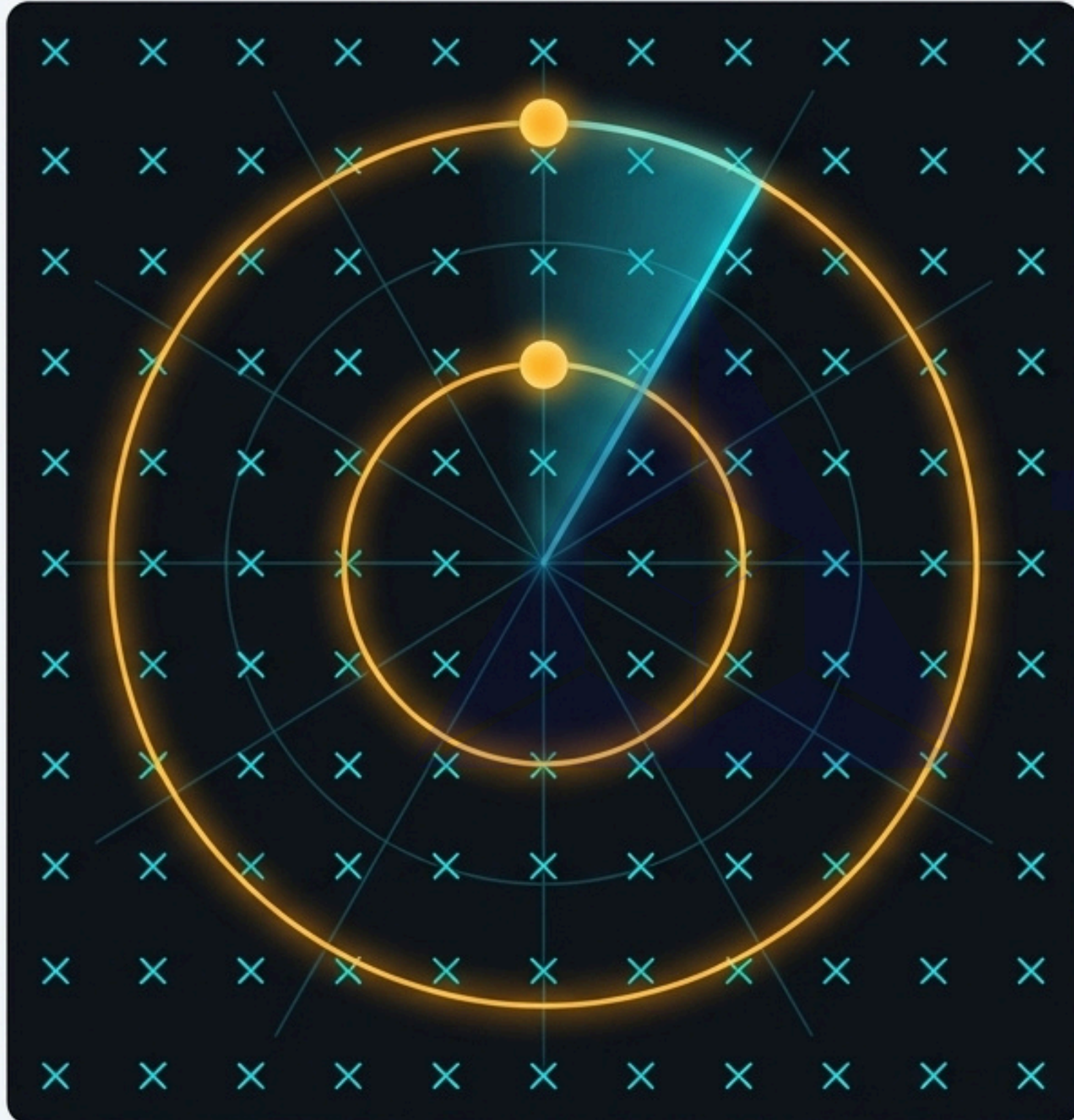


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- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter





Angular Frequency & Time Period

Plus Jakarta Sans

$$\omega = \frac{v}{r} = \frac{v}{mv/qB} = \frac{qB}{m}$$

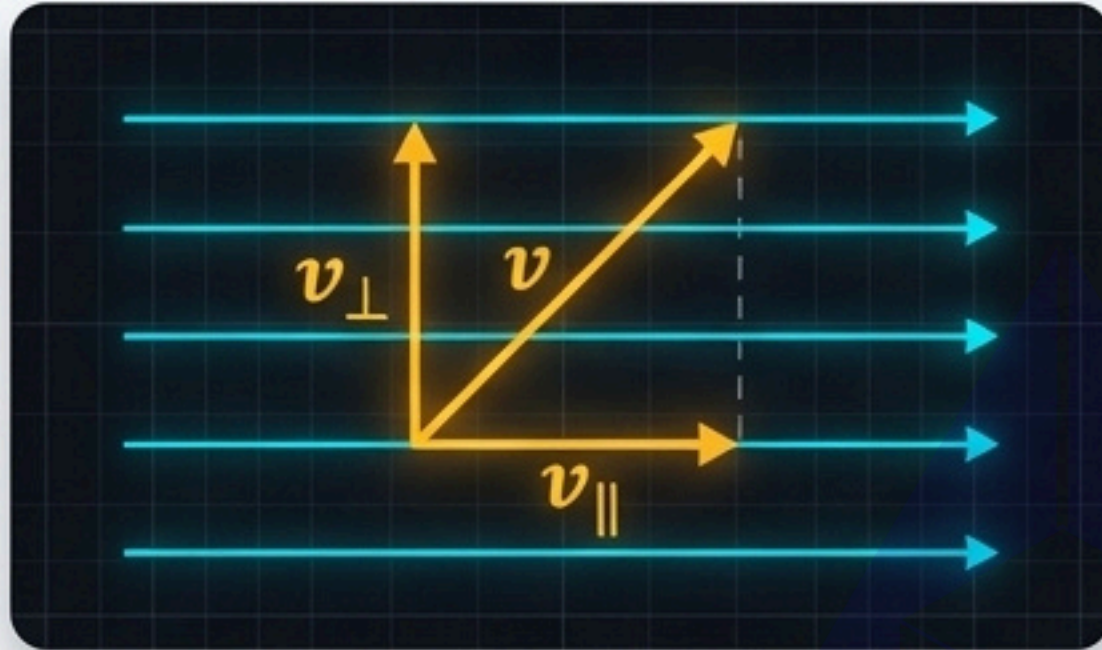
$$T = \frac{2\pi}{\omega} = \frac{2\pi m}{qB}$$

INDEPENDENT OF VELOCITY & RADIUS

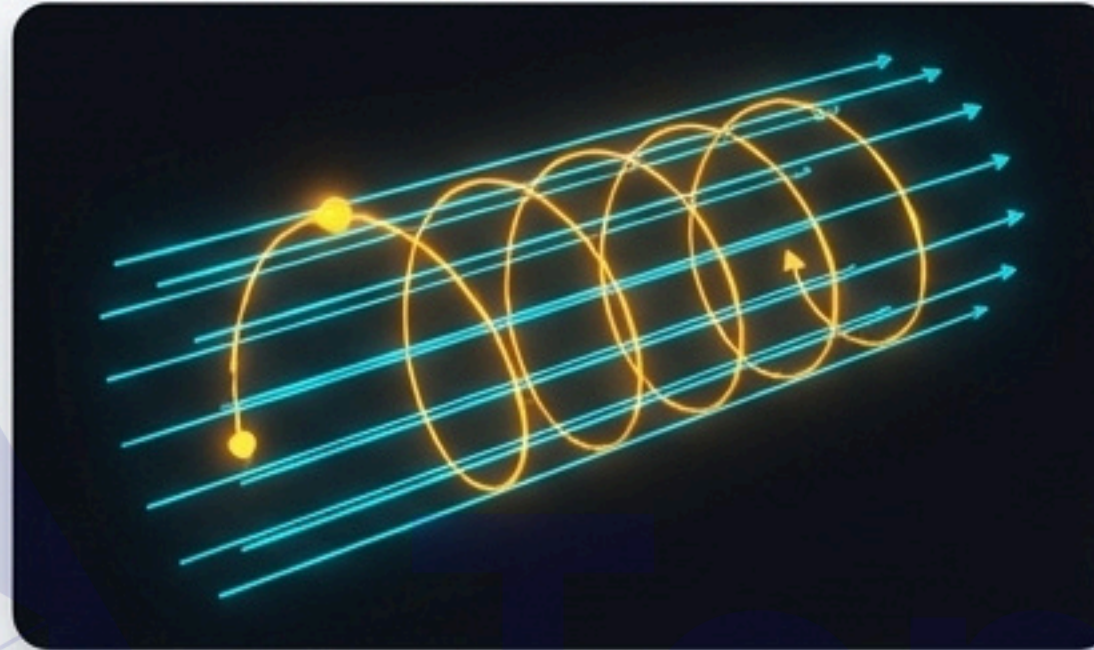
A fast particle travels a larger circle, while a slow particle travels a smaller circle—both complete one orbit in the exact same time.

(Core principle of the Cyclotron).

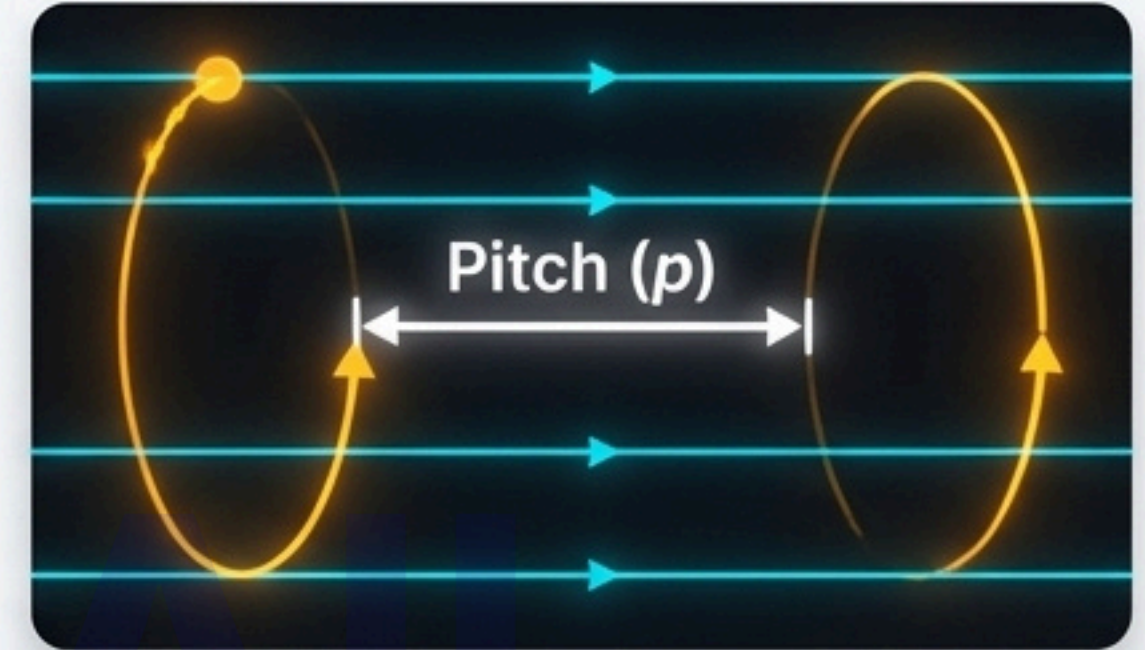
Decomposition



The Helix



Pitch Zoom



ENTRY ANGLE: $0^\circ < \theta < 90^\circ$

$$p = v_{\parallel} \times T = (v \cos \theta) \times \frac{2\pi m}{qB}$$

The parallel velocity component drags the circular motion forward, stretching the 2D circle into a unconstrained 3D helix.

Key Takeaways



[Dimension]	[Circular Motion]	[Helical Motion]
Condition	$\theta = 90^\circ (v \perp B)$	$0^\circ < \theta < 90^\circ$
Path Shape	2D Circle	3D Helix
Radius (r)	$\frac{mv}{qB}$	$\frac{m(v \sin \theta)}{qB}$
Time Period (T)	$\frac{2\pi m}{qB}$	$\frac{2\pi m}{qB}$ (Identical)
Pitch (p)	Zero (path closes on itself)	$(v \cos \theta) \left[\frac{2\pi m}{qB} \right]$

UNIVERSAL RULE: Regardless of the path, **Magnetic Force** never does work.
Speed ($|v|$) and **Kinetic Energy ALWAYS** remain constant.



You've Learned the Theory.

Now Let's Test It.

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