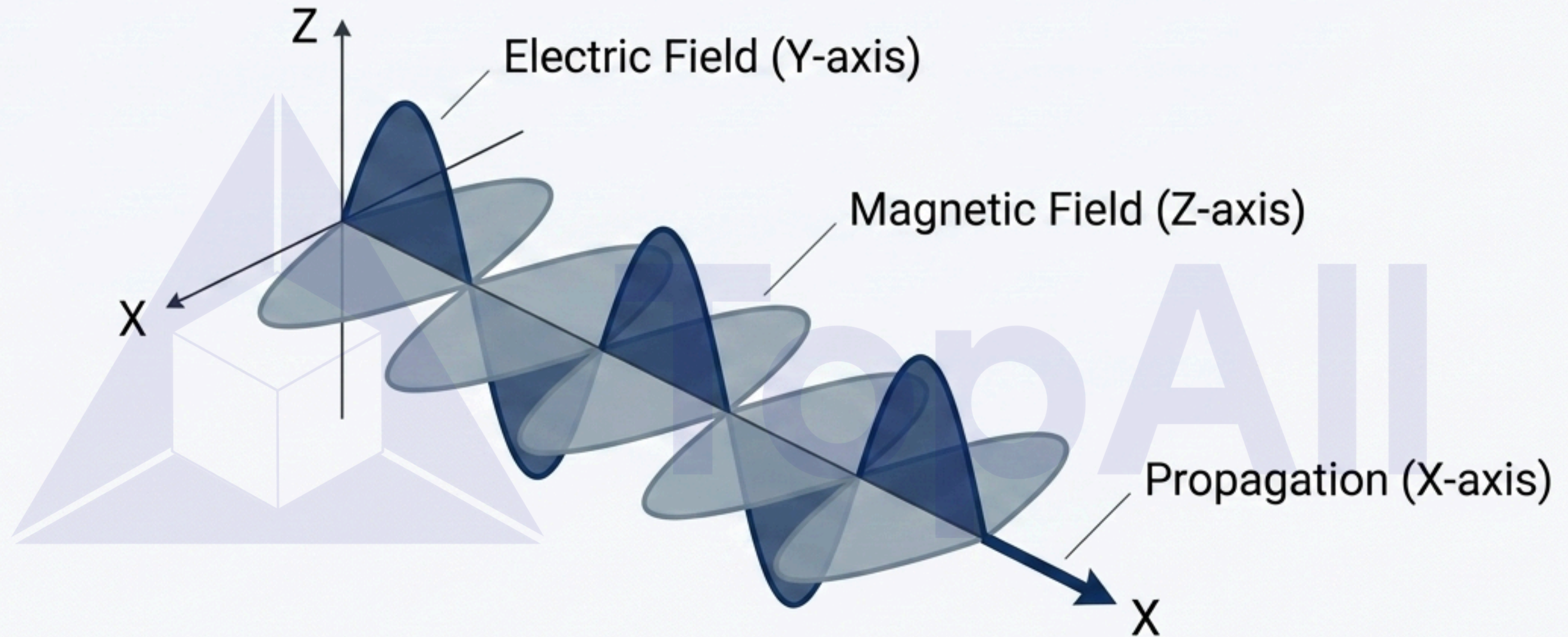


Wave Nature of EM Radiation

High-Yield Concepts & Formulas for JEE Class 11

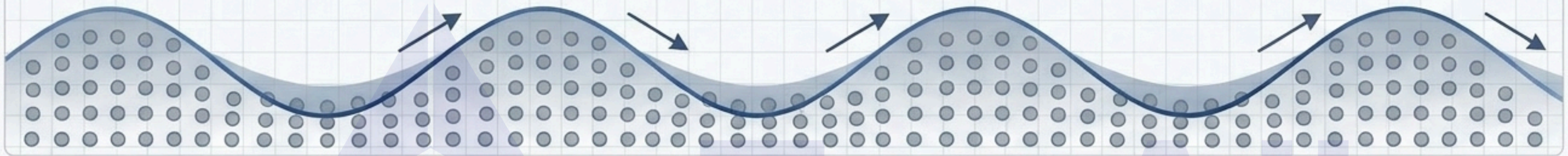
Anatomy of an EM Wave



Electric and magnetic fields are mutually perpendicular—and both are perpendicular to the direction of propagation.

The Propagation Rule

Mechanical Waves (Sound/Water)



Electromagnetic Waves



Unlike sound or water, EM waves do not require a material medium. They travel seamlessly through a pure vacuum.

$$c = 3.0 \times 10^8 \text{ m/s (Speed of light in vacuum)}$$



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

$$E=mc^2$$



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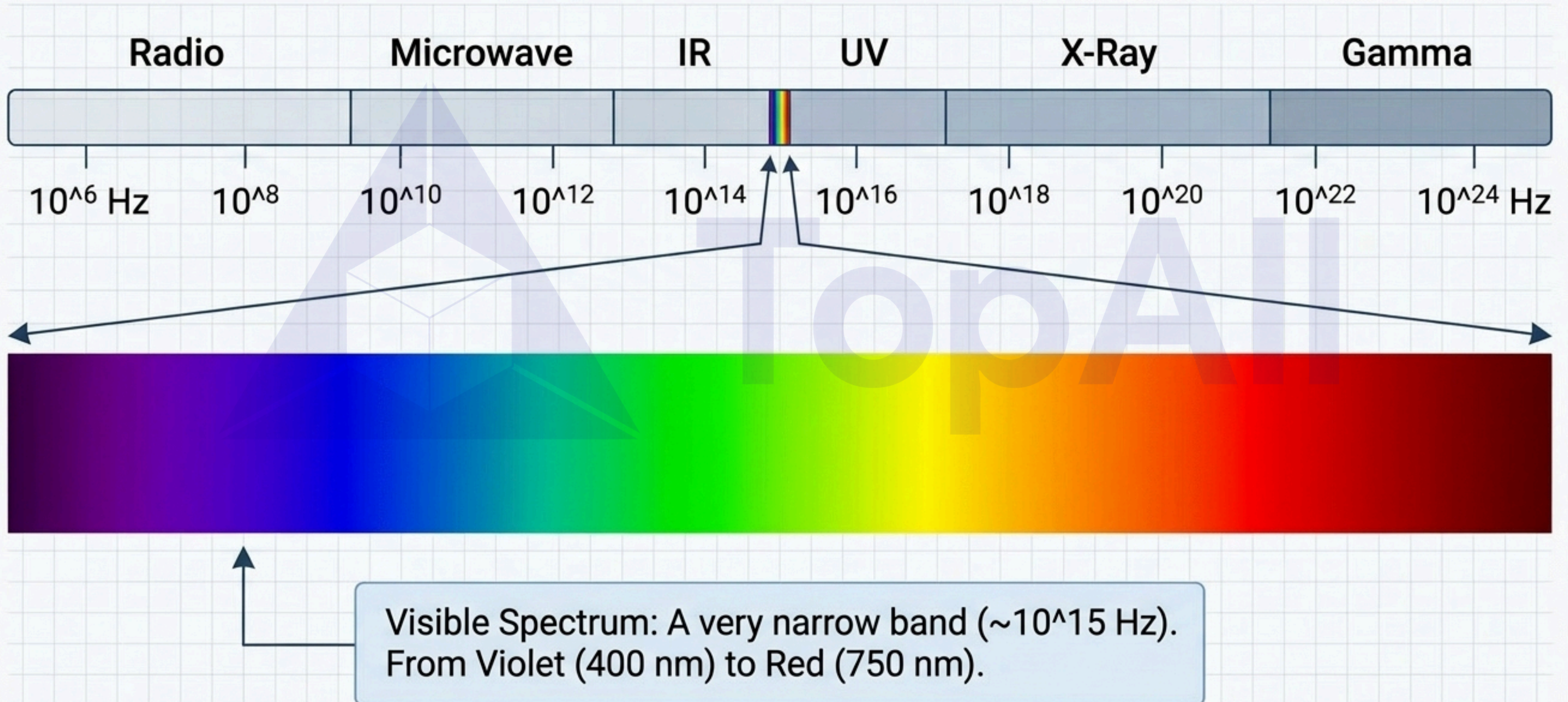
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The Electromagnetic Spectrum



The Master Formula

Speed of light $\rightarrow 3.0 \times 10^8 \text{ m/s}$

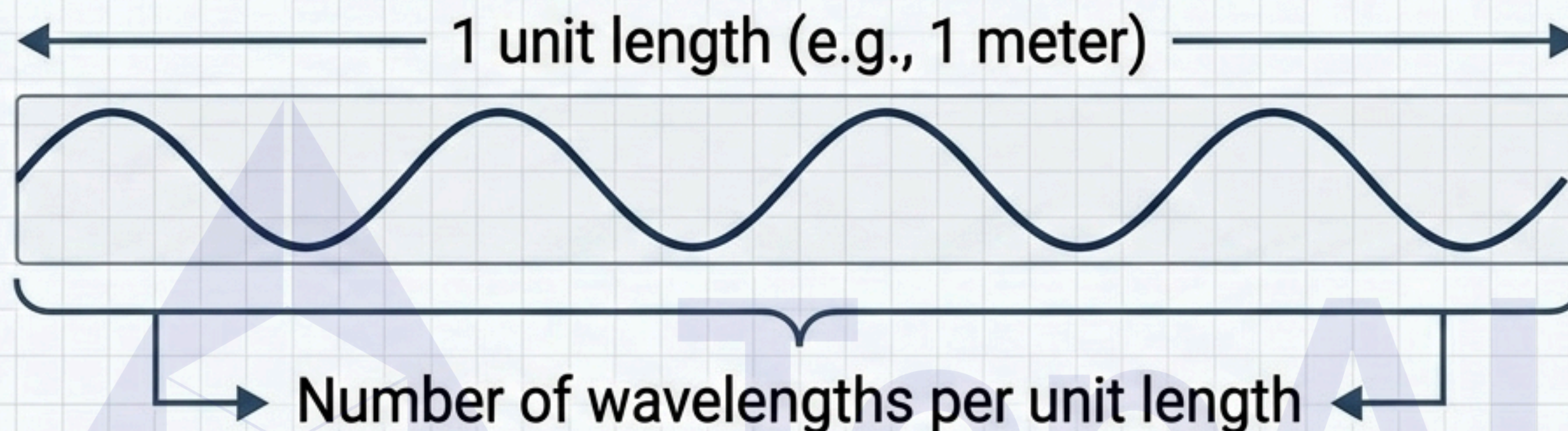
$$c = v\lambda$$

Frequency $\rightarrow$ Hertz (Hz) or s^{-1}

Wavelength $\rightarrow$ Meters (m)

Unit Check: Exam questions often give λ in nm or pm. Always convert to **meters** (10^{-9} m or 10^{-12} m) for SI calculations.

Understanding Wavenumber

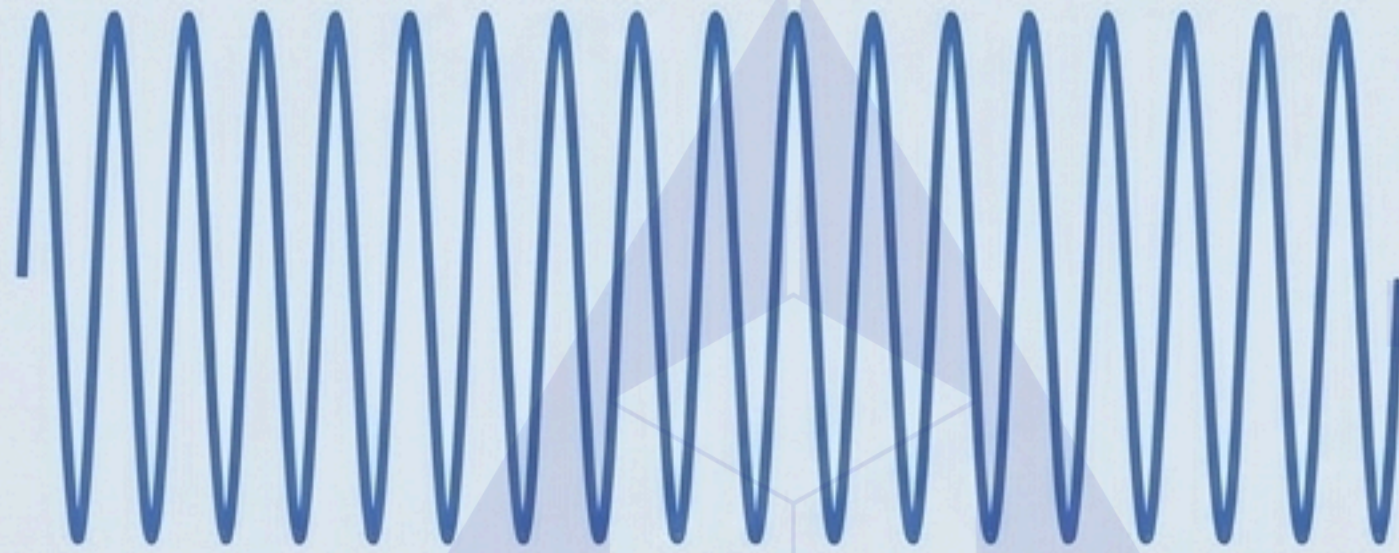


$$\bar{\nu} = 1 / \lambda$$

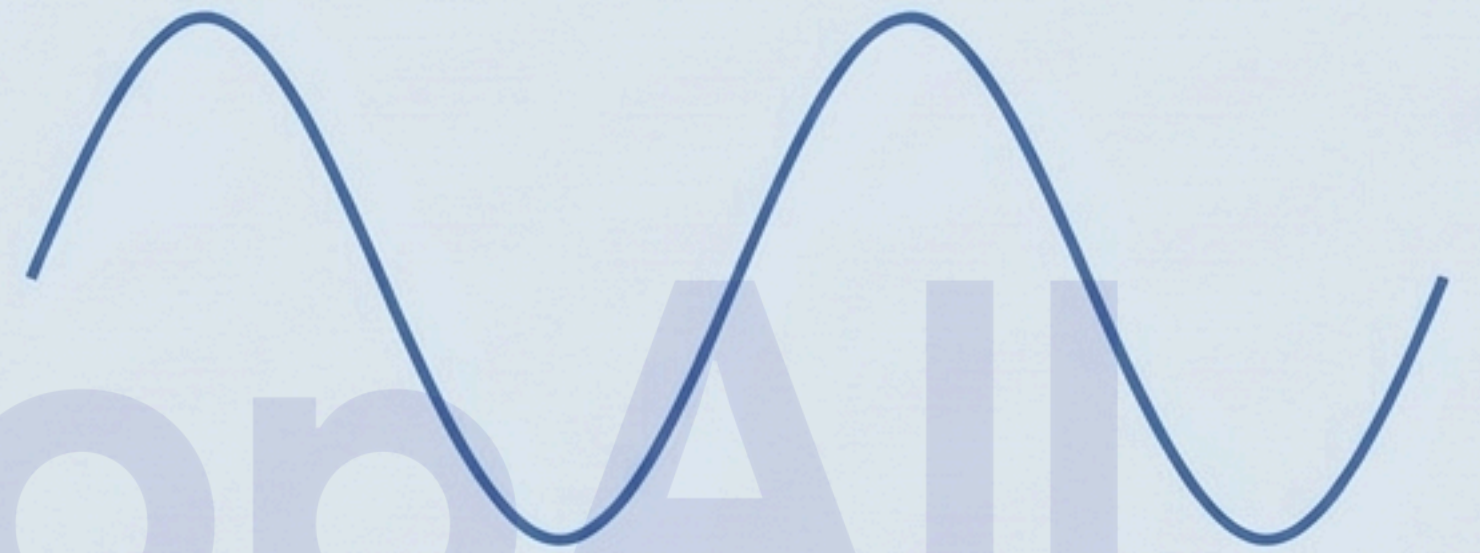
Wavenumber ($\bar{\nu}$) represents the number of waves packed into a specific length. It is the reciprocal of wavelength.

Spectroscopy standard: While the SI unit is m^{-1} , wavenumber is most commonly expressed in cm^{-1} .

The Inverse Relationship Trap



High Frequency ($\nu \uparrow$) $\rightarrow$
Short Wavelength ($\lambda \downarrow$)



Low Frequency ($\nu \downarrow$) $\rightarrow$
Long Wavelength ($\lambda \uparrow$)

Because **c** is a **constant**, **frequency** and **wavelength** must always move in **opposite directions**. **Never** assume they scale together.

Key Takeaways

ν (Frequency) =
Oscillations per second.
Unit: Hz or s^{-1} .

λ (Wavelength) =
Distance of one wave cycle.
Unit: m.

c (Speed of Light) =
Constant propagation in
vacuum. $3.0 \times 10^8 \text{ m/s}$.

$\bar{\nu}$ (Wavenumber) =
Waves per unit length.
 $\bar{\nu} = 1/\lambda$. Unit: m^{-1} or cm^{-1} .

Master the units. Master the exam.



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