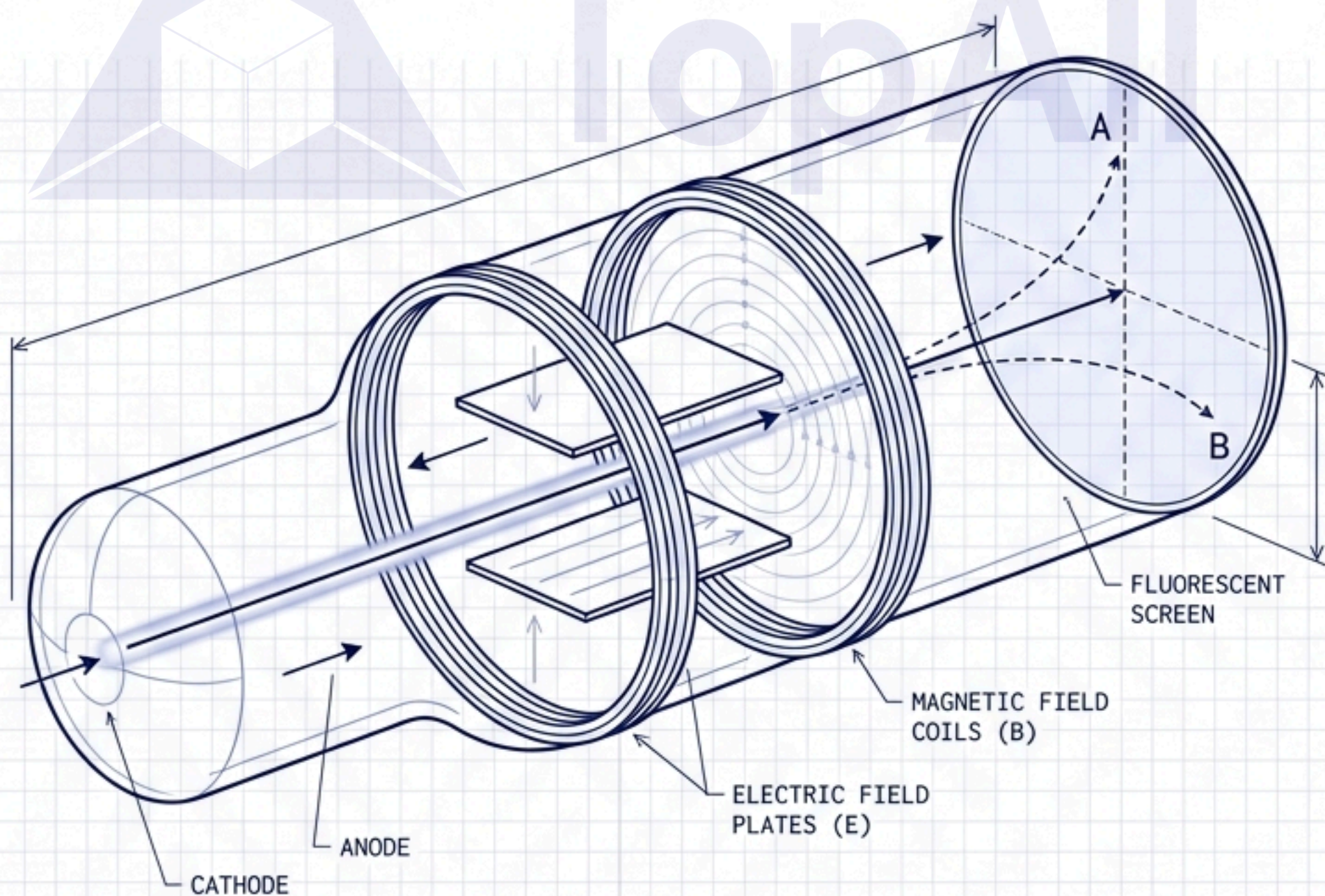
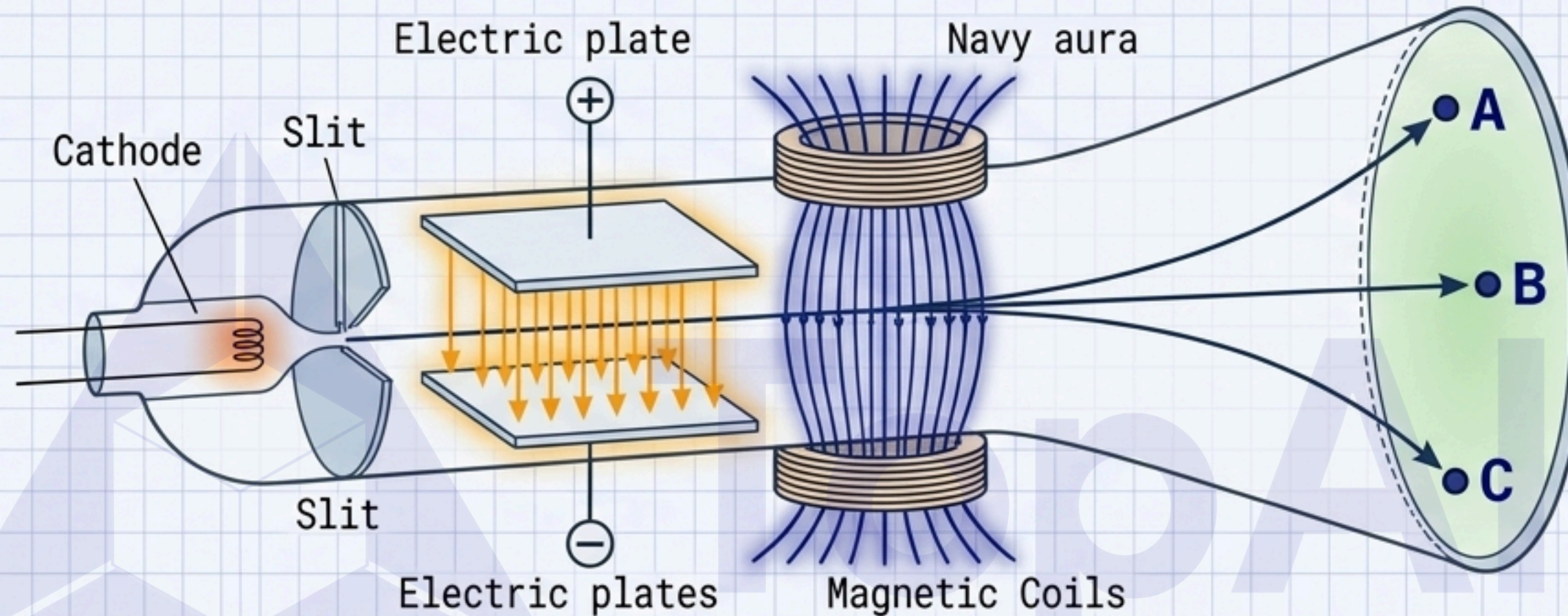


Electron e/m Ratio

J.J. Thomson's Cathode Ray Deflection Experiment



The Physical Setup: Perpendicular Fields



Core Constraint

Electric and magnetic fields are applied strictly perpendicular to the electron path and to each other.

The Balancing Act

Point A: Deflection due to Electric field alone.

Point C: Deflection due to Magnetic field alone.

Point B: Balanced state ($\text{Net Force} = 0$).
Electron strikes undeflected.

The Deflection Logic



The amount of deviation from the straight path depends on three physical factors.



Magnitude of Charge

$e \uparrow$

Greater negative charge leads to stronger interaction with the applied fields.

Result: More Deflection



Mass of Particle

$m_e \downarrow$

Lighter particle means less physical inertia to overcome during transit.

Result: More Deflection



Strength of Field

$E, B \uparrow$

Higher voltage or magnetic strength applies greater physical force to the particle.

Result: More Deflection

High Charge + Low Mass + Strong Field = Maximum Deflection



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The Mathematical Core



$$\frac{e}{m_e} = 1.758820 \times 10^{11} \text{ C kg}^{-1}$$

m_e
= mass of the electron in kg

e
= magnitude of the charge on the electron in C

Historical Note: By carefully measuring the exact amount of deflection under varying electric and magnetic field strengths, J.J. Thomson derived this universal constant, proving electrons are basic constituents of all atoms.

The JEE Calculation Trap

THE TRAP



COMMON ERROR

Plugging in the actual negative charge of the electron:

$$-1.602 \times 10^{-19} \text{ C}$$



Result: Calculating a negative ratio. This will lead to an incorrect multiple-choice answer.

THE TRUTH



THE RULE

While the physical charge of an electron is conceptually negative ($-e$), the Thomson ratio formula strictly utilizes the magnitude of the charge.

$$|-1.602 \times 10^{-19} \text{ C}| = e$$

The e/m_e ratio is **ALWAYS** a positive scalar value.

Key Takeaways: Electron e/m_e Ratio



The Setup

Electric and magnetic fields must be mutually perpendicular to each other, and perpendicular to the path of the electron beam.

The Logic

The extent of deflection reveals the ratio. A high electrical charge and a low physical mass result in maximum deflection.

The Rote Value

$$\frac{e}{m_e} = 1.758820 \times 10^{11} \text{ C kg}^{-1}$$

The Historical Significance

Thomson successfully discovered the ratio. Later, Millikan's Oil Drop Experiment determined the exact charge (e), which finally allowed for the calculation of the exact electron mass.



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