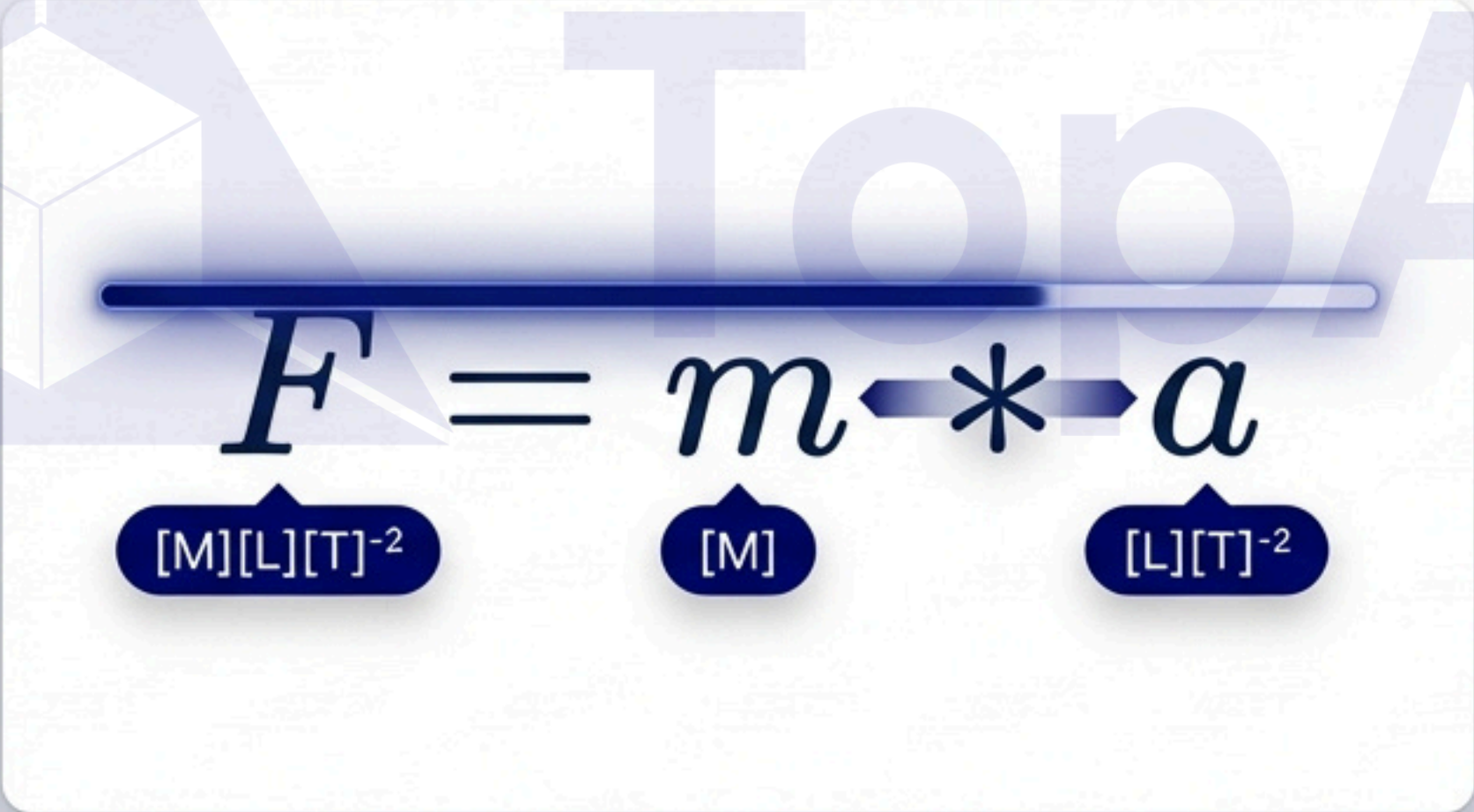


Dimensional Consistency of Equations

The Ultimate Equation Scanner

A visual guide to verifying mathematical relationships in physics using the Principle of Homogeneity.

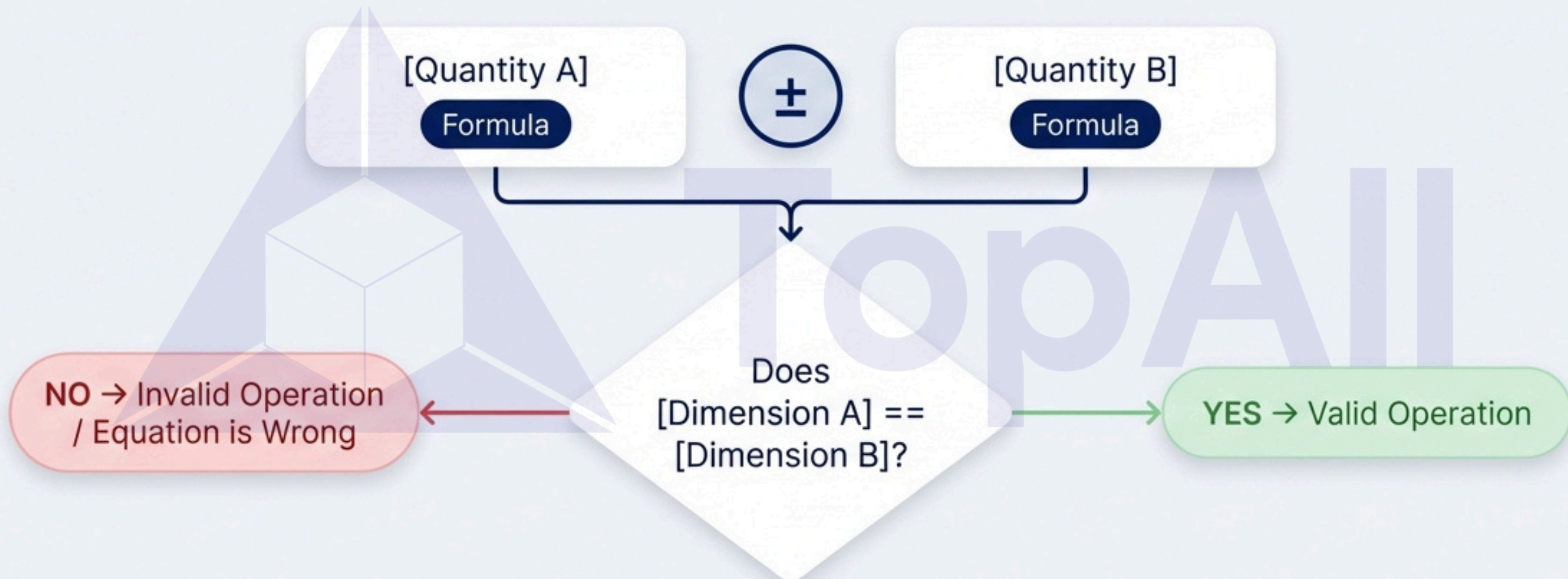


The diagram shows the equation $F = m * a$ on a white rectangular background. Below each variable is its dimensional formula in a dark blue rounded rectangle. A horizontal blue line is positioned above the equation. A large, faint 'TopAll' watermark is visible in the background.

$$\begin{array}{ccccc} F & = & m & * & a \\ \text{[M][L][T]}^{-2} & & \text{[M]} & & \text{[L][T]}^{-2} \end{array}$$

The Principle of Homogeneity

You cannot add velocity to force. Magnitudes of physical quantities can only be added or subtracted if they share the exact same dimensions.



Example: An electric current cannot be subtracted from thermodynamic temperature. $[A] - [K] = \text{Error}$



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$$E=mc^2$$



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Application 1: Term-by-Term Breakdown

Scanning the kinematic equation for a particle with uniform acceleration.

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$[x] \rightarrow [L]$

$[x_0] \rightarrow [L]$

$[L T^{-1}] \times [T] \rightarrow [L]$

$$\frac{1}{2} \text{ dimensionless}$$
$$[L T^{-2}] \times [T^2] \rightarrow [L]$$

All terms = [L]. Status: Dimensionally Correct.

Application 2: LHS vs. RHS Match

Verifying the mechanical energy equation: $\frac{1}{2}mv^2 = mgh$

LHS - Kinetic Energy

$$\frac{1}{2}mv^2$$

$$[M] \times [L T^{-1}]^2$$



$$[M L^2 T^{-2}]$$

RHS - Potential Energy

$$mgh$$

$$[M] \times [L T^{-2}] \times [L]$$



$$[M L^2 T^{-2}]$$

==

The dimensions of LHS and RHS are identical. The equation passes the consistency check.

The Exam Trap: Blind Spots in the Scanner

Key Takeaway: If an equation fails this consistency test, it is proved wrong. But if it passes, it is NOT proved right.

Example Equation:

$$K = \frac{3}{16}mv^2$$

Scanner Output: Dimensionally Correct
[M L² T⁻²]

Reality Check: Physically Wrong! The actual formula is $K = \frac{1}{2}mv^2$.

The Blind Spots

Dimensional analysis cannot verify:

- ✗ Value of dimensionless constants (like 1/2 or 2π)
- ✗ Pure ratios (like refractive index or angles)
- ✗ Arguments of special functions (trigonometric, logarithmic, exponential)



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