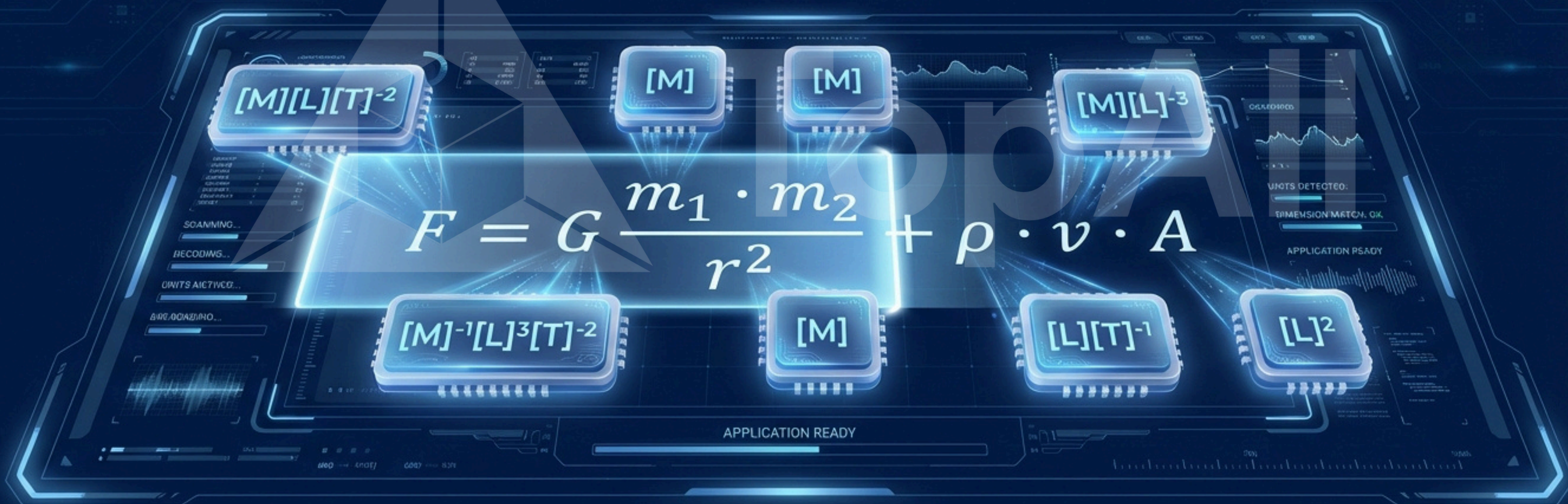


Dimensional Analysis and its Applications

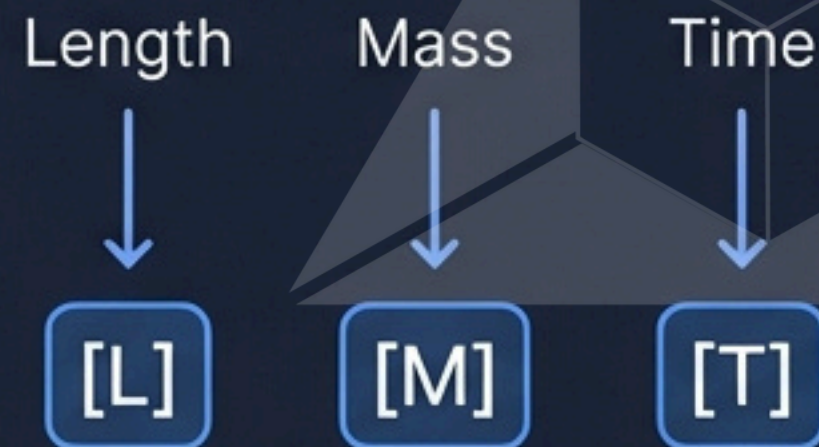
A shortcut tool to test and build physics relations



What is Dimensional Analysis?

The Concept

The nature of a physical quantity is described by its dimensions.



The Golden Rule

Dimensions multiply and divide exactly like algebraic symbols.

$$[L] \times [L] = [L^2]$$

The Application

Building derived quantities.

Force = Mass × Acceleration

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

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

Why It Is Useful



Checking Consistency

Quickly verifying if a derived physics equation is mathematically possible and balanced.



Deducing Relations

Building new physics formulas from scratch by finding unknown exponent powers.



Understanding Structure

Revealing the fundamental nature and internal dependencies of physical quantities.



**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

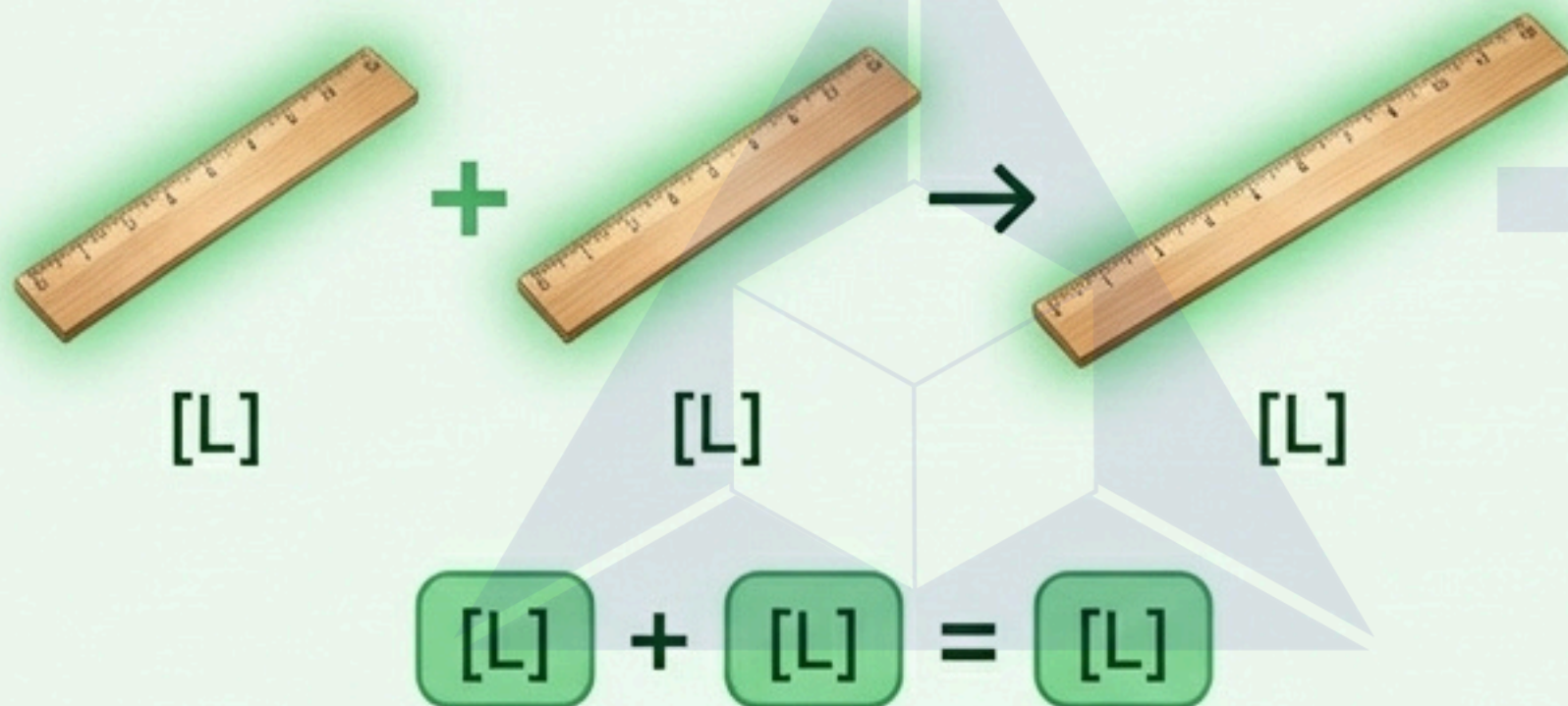
Key Highlights

- » 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

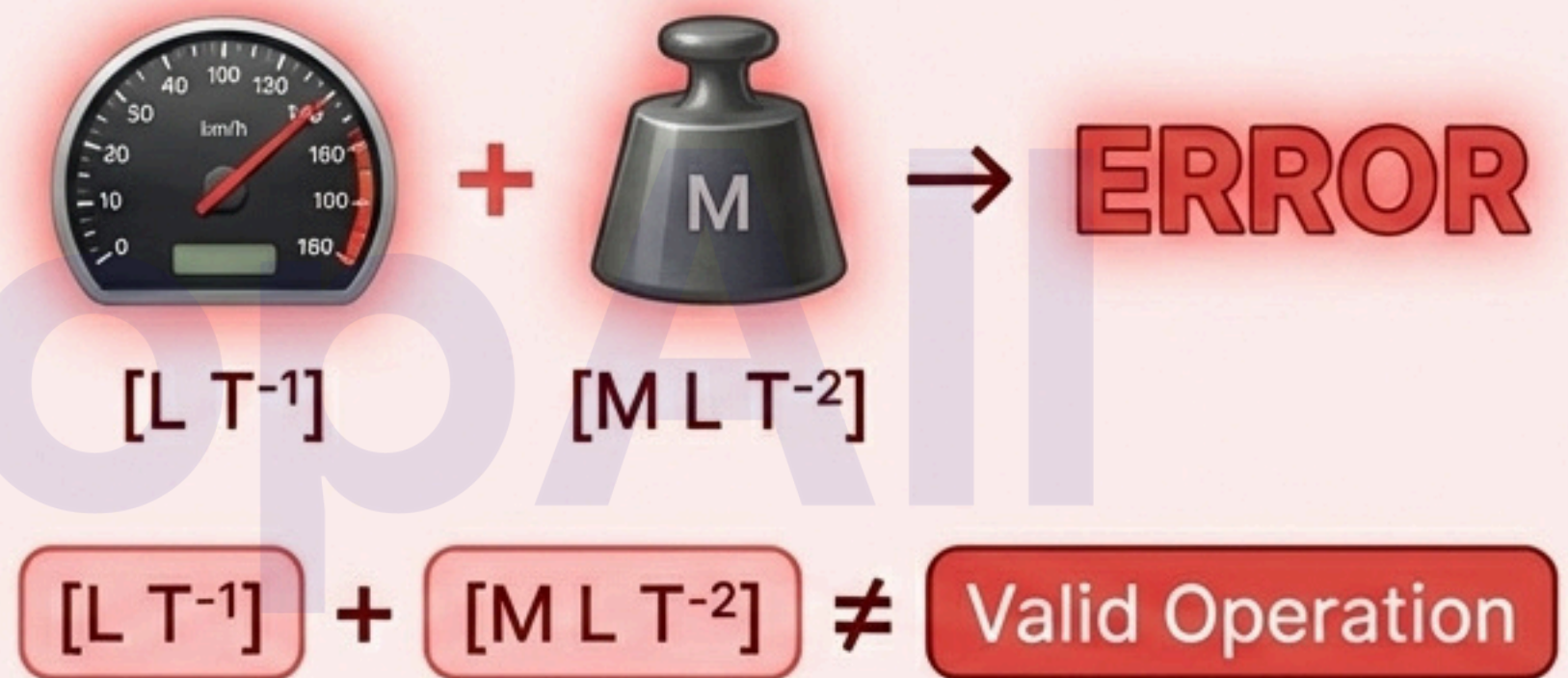


The Principle of Homogeneity

Correct: Same Dimensions



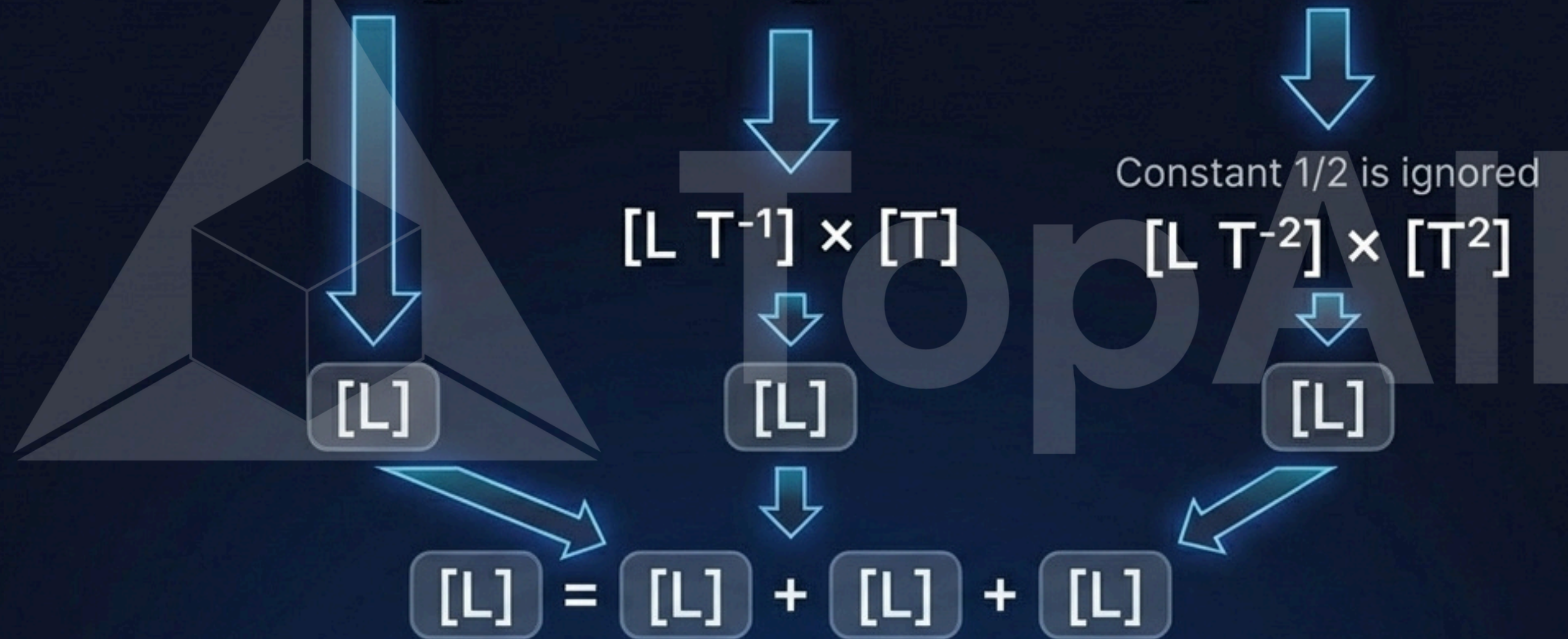
Incorrect: Different Dimensions



We can only add or subtract physical quantities that have the **exact same dimensions**.

Checking Dimensional Consistency

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



✓ Dimensionally Consistent

Deducing Relations Among Quantities

The Unknown Power Method

Step 1: The Guess

Assume a product dependence with unknown exponents.

$$\text{Quantity} = k \cdot (A)^x \cdot (B)^y \cdot (C)^z$$

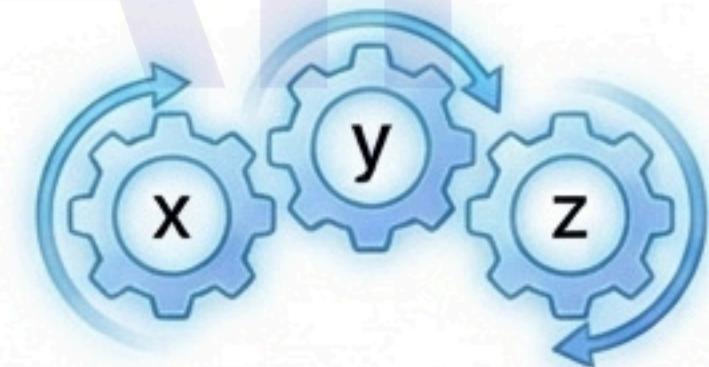
Step 2: The Translation

Replace variables with dimensional formula chips.

$$[\text{Target}] = [\text{Dim A}]^x \cdot [\text{Dim B}]^y \cdot [\text{Dim C}]^z$$

Step 3: The Solve

Equate the powers on both sides (LHS = RHS) to find x, y, z.



Find x, y, z

Deriving the Simple Pendulum Formula



Target

Time period (T) depends on length (l), gravity (g), and mass (m).

Step 1: Setup

$$T = k \cdot l^x \cdot g^y \cdot m^z$$

Step 2: Substitute

$$[T^1] = [L]^x \cdot [LT^{-2}]^y \cdot [M]^z$$

- Mass: $z = 0$
- Length: $x + y = 0$
- Time: $-2y = 1$

Step 3: Equate

Step 4: Result

$$x = 1/2, y = -1/2, z = 0$$

$$T = k\sqrt{l/g}$$

Note: The exact value of dimensionless constant k (which is 2π) cannot be obtained by dimensional analysis alone.

Limits of Dimensional Analysis



TopAll



Limit 1: Dimensionless Constants

The method cannot determine the values of **pure numbers** or **dimensionless constants** (like $1/2$, π , or e).



Limit 2: Special Functions

Arguments of trigonometric ($\sin \theta$), logarithmic ($\log x$), and exponential (e^x) functions must be entirely dimensionless.



Limit 3: The False Positive Rule

A dimensionally wrong equation is definitely wrong. But a **dimensionally correct equation** might still be missing physical parts. (Consistency $\neq$ Absolute Truth).



Recap + Check Your Understanding

- **Dimensions** act exactly like algebraic symbols during multiplication and division.
- **Homogeneity Rule:** You can only add or subtract physical quantities with identical dimensions.
- Use it to check formula consistency or deduce unknown relations, but beware of its inability to find dimensionless constants.

Q: Can you subtract electric current from thermodynamic temperature?

A: No. They have different base dimensions ($[A]$ vs $[K]$).

Q: If an equation passes the dimensional consistency test, is it guaranteed to be 100% correct?

A: No. It may be missing dimensionless constants or numeric multipliers.



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