

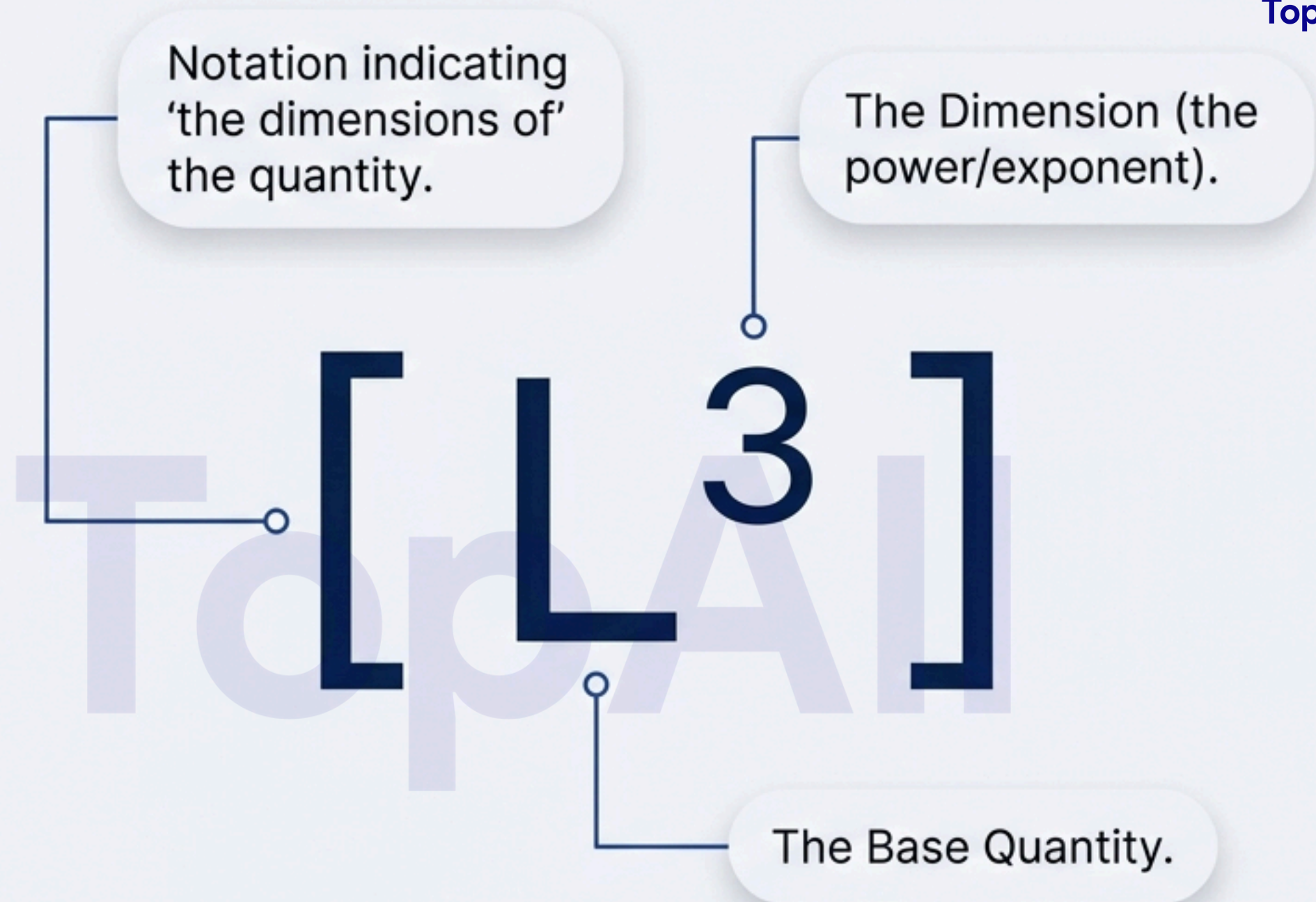
Dimensions of Physical Quantities



[M L T]

Core Definition

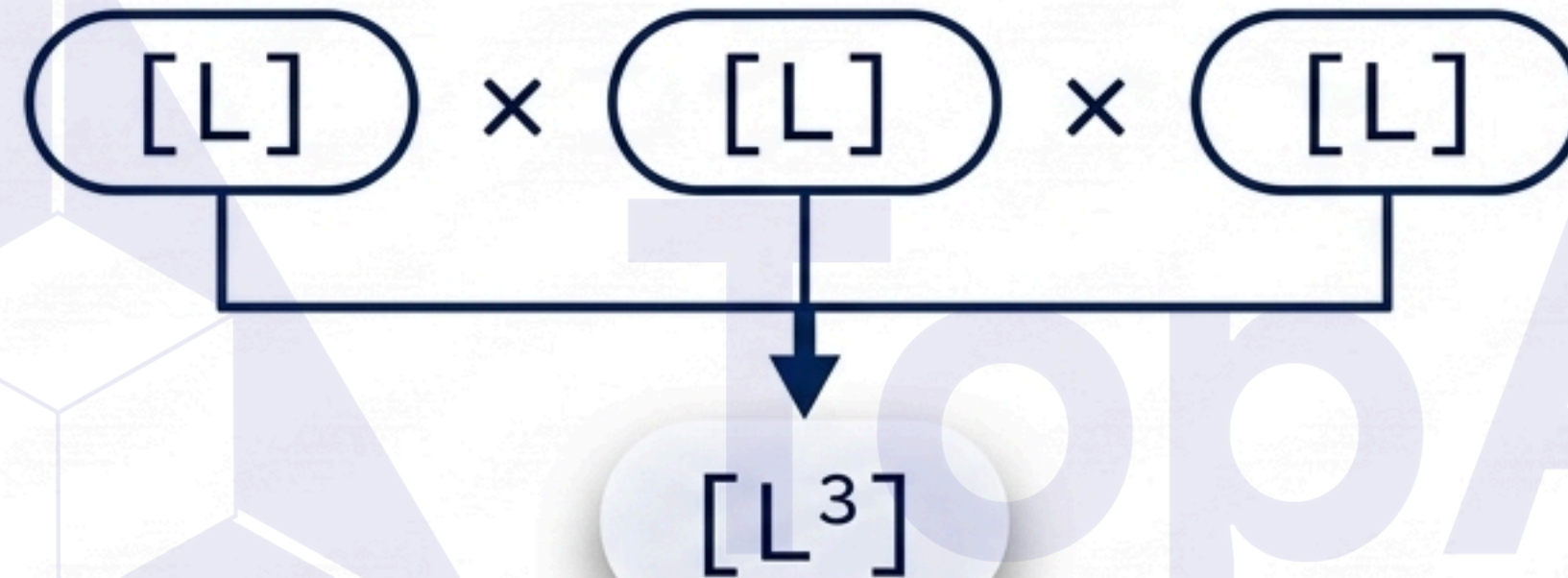
The dimensions of a physical quantity are the powers (or exponents) to which the base quantities are raised to represent that quantity.



In mechanics, all physical quantities can be written in terms of just **three base dimensions**: $[L]$ (Length), $[M]$ (Mass), and $[T]$ (Time).

Deriving Volume

Volume = length $\times$ breadth $\times$ height



Because volume is independent of mass and time, it possesses zero dimension in mass and zero dimension in time.

$$[M^0 L^3 T^0]$$



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$$E=mc^2$$



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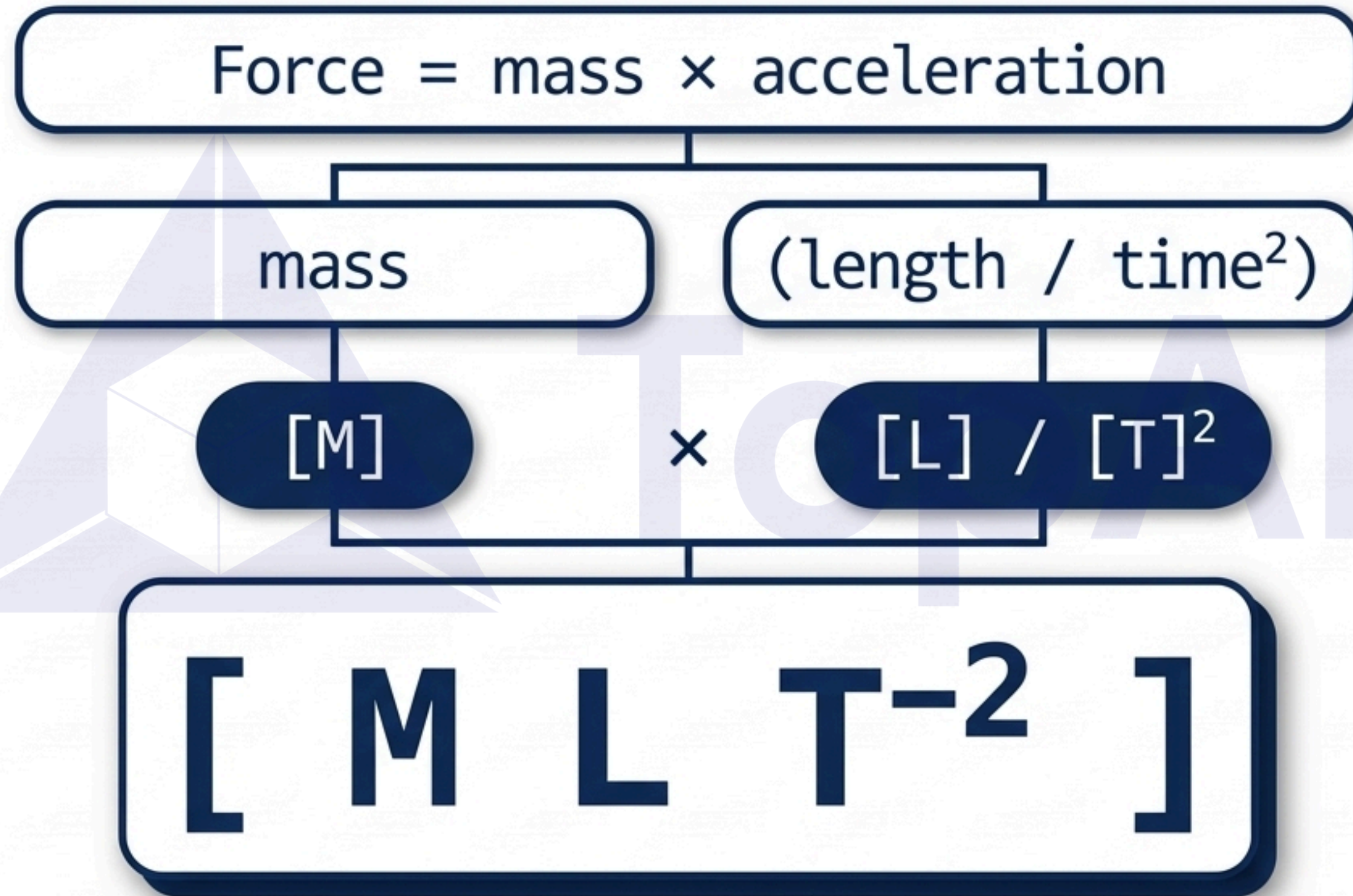
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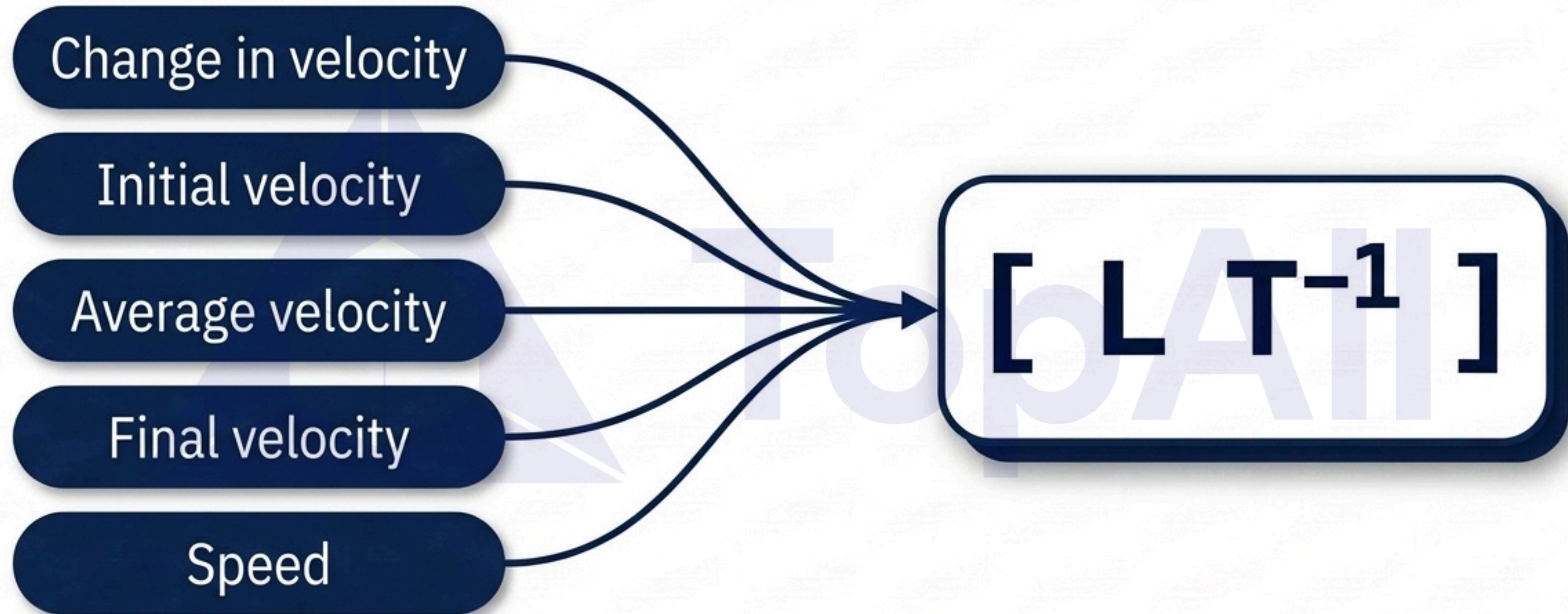


Deriving Force



Force has one dimension in mass, one dimension in length, and -2 dimensions in time.

Dimensional Equivalence



It is the quality of the physical quantity that enters dimensional analysis.
Magnitudes and specific contexts are not considered.



TRAP ALERT

Identical dimensions never mean identical quantities.

Dimensional notation intentionally discards magnitude and direction. For example, two variables with the dimension $[L T^{-1}]$ could be moving in opposite directions at vastly different speeds, or one might be a scalar (speed) while the other is a vector (velocity). Passing a dimensional consistency test does not mean the physical quantities are the same.

Key Takeaways

- **The mechanics alphabet:** All physical quantities in mechanics can be expressed using only $[L]$ (Length), $[M]$ (Mass), and $[T]$ (Time).
- **Dimensions are exponents:** A dimension is specifically the power to which a base quantity is raised (e.g., in $[L^3]$, 3 is the dimension of length).
- **Quality over magnitude:** Dimensional equations capture the physical nature of a quantity, discarding magnitude and direction. Consequently, the same dimension (like $[LT^{-1}]$) can represent entirely different physical realities (like initial velocity vs. average speed).



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