

kg

mol

SI Units: Chemistry's Measurement Language

The Universal Blueprint of Scientific Measurement

m

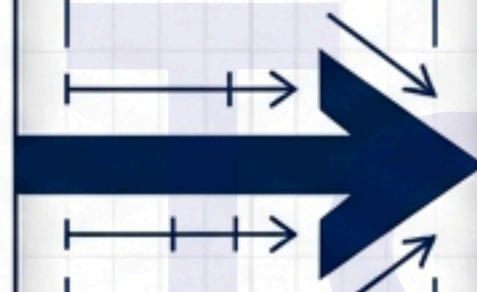
K

s

What is SI?

The 1875 Metre Convention

The International System of Units (abbreviated SI from the French *Le Système International d'Unités*) was established by the 11th General Conference on Weights and Measures (CGPM). It replaced fragmented historical systems with a unified decimal-based scientific standard.



Maintained by National Metrology Institutes

Each industrialized country maintains these rigorous standards. For example, in India, this responsibility falls to the National Physical Laboratory (NPL), New Delhi, which calibrates devices against international references.



The 7 Base Quantities

Length

m

Quantity: l
metre

Mass

kg

Quantity: m
kilogram

Time

s

Quantity: t
second

Electric current

A

Quantity: I
ampere

Thermodynamic temp

K

Quantity: T
kelvin

Amount of substance

mol

Quantity: n
mole

Luminous intensity

cd

Quantity: I_v
candela

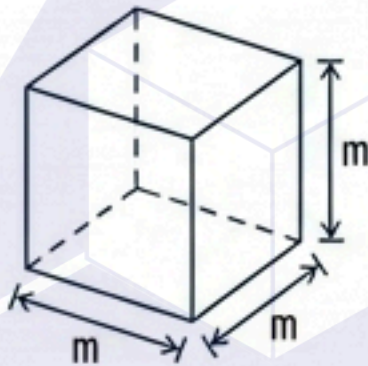
The Mechanical Realm: Defining Space, Matter, and Duration

m

metre

The foundation of space.

Volume (m^3) and density (kg/m^3) are derived directly from length and mass.



kg

kilogram

ALERT: Only base unit containing a native prefix.

Mass is an invariant constant (the amount of matter), whereas weight varies by gravity. Measured with ultimate precision using analytical balances.

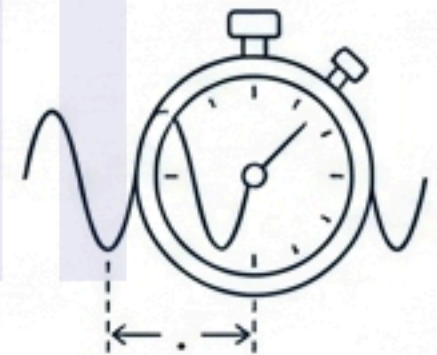


s

second

The baseline variable for capturing kinematics.

Essential for measuring chemical reaction rates and physical velocity.





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$$E=mc^2$$



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The Energetic & Chemical Realm



K

Temperature

ABSOLUTE SCALE: Kelvin cannot be negative.

Related to Celsius via the equation:

$$K = ^\circ C + 273.15$$

mol

Amount of Substance

THE CORE OF CHEMISTRY.

The crucial bridge linking the microscopic realm (atoms/molecules) to the macroscopic realm (weighable mass).

A

Electric Current (ampere)

cd

Luminous Intensity (candela)

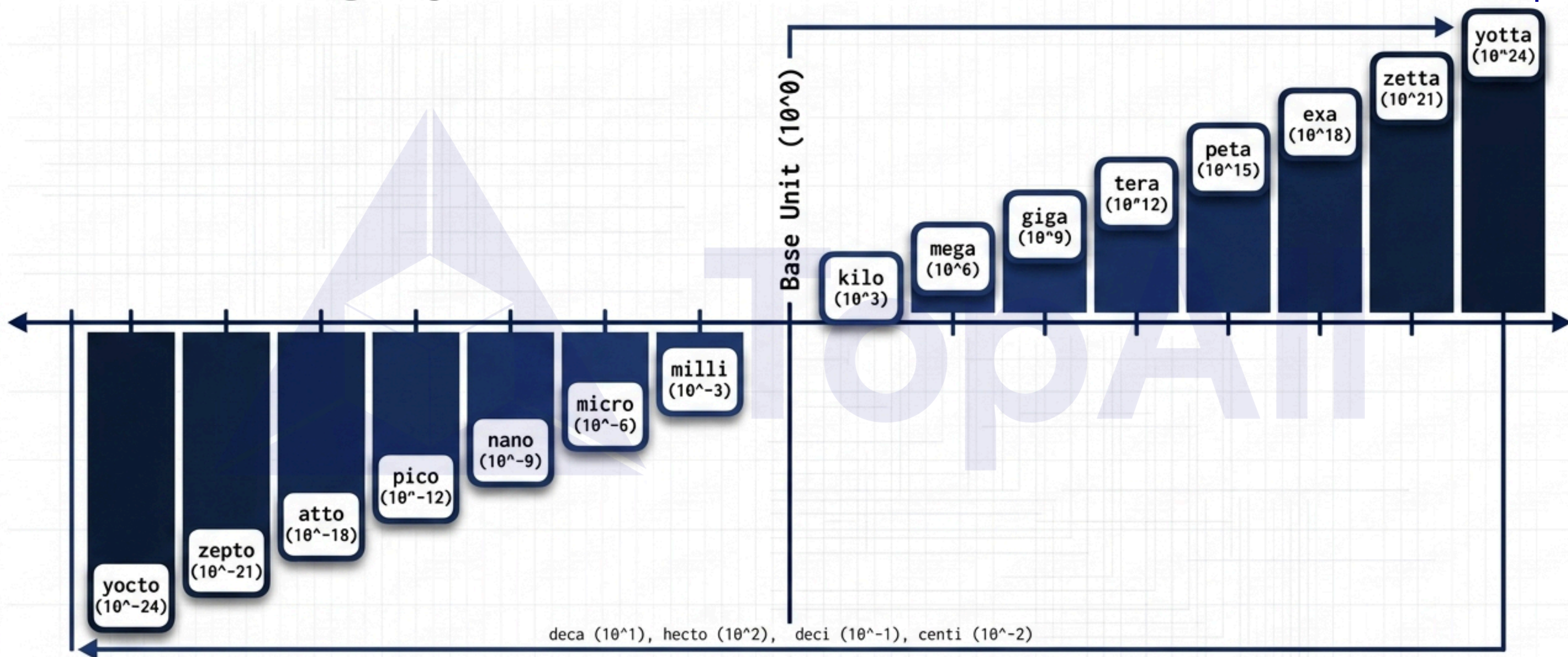
The Constants Framework



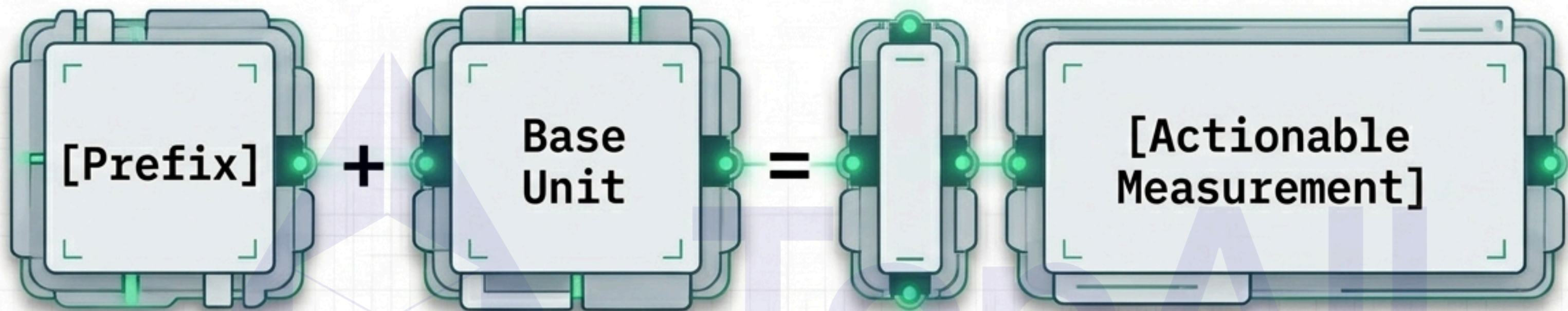
To achieve ultimate precision, SI units are no longer anchored to physical artifacts (like metal cylinders). They are **woven directly into the unchanging fabric of the universe**.

metre	Speed of light (c) = $299,792,458 \text{ m s}^{-1}$
kilogram	Planck constant (h) = $6.62607015 \times 10^{-34} \text{ J s}$
second	Caesium frequency ($\Delta \nu_{\text{Cs}}$) = $9,192,631,770 \text{ Hz}$
ampere	Elementary charge (e) = $1.602176634 \times 10^{-19} \text{ C}$
kelvin	Boltzmann constant k = $1.380649 \times 10^{-23} \text{ J K}^{-1}$
mole	Avogadro constant (N_A) = $6.02214076 \times 10^{23} \text{ mol}^{-1}$
candela	Luminous efficacy (K_{cd}) = 683 lm W^{-1}

The Scaling System: Prefixes



The Power of Dimensional Analysis



Example 1: $(\text{milli}, 10^{-3}) + (\text{metre}, \text{m}) = \text{mm (millimetre)}$

Example 2: $(\text{kilo}, 10^3) + (\text{gram}, \text{g}) = \text{kg (kilogram)}$

By standardizing these units and applying decimal-based prefixes, chemists use the “factor label method” to seamlessly convert scales. This allows us to move elegantly from the mass of a single hydrogen atom ($1.67 \times 10^{-24} \text{ g}$) up to massive industrial metric tons—all without ever changing the underlying mathematical logic.



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