

Atomic Mass and Carbon-12 Standard

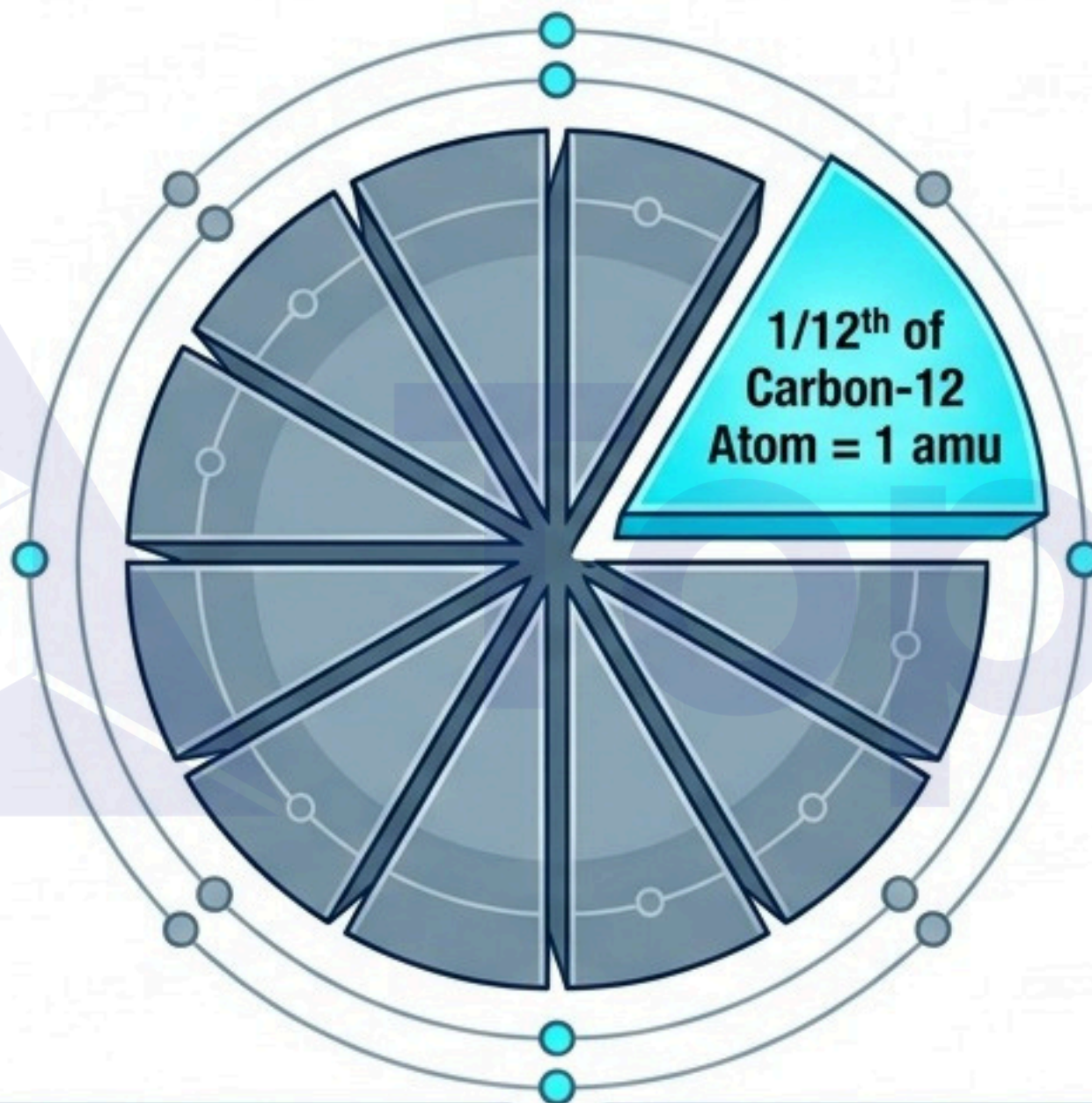
JEE Chemistry Concept Module 1.7.1

TECHNICAL DATA:

Carbon-12 Isotope (^{12}C).
Protons: 6
Neutrons: 6
Electrons: 6
Total Mass Number: 12
Unified Atomic Mass Unit (u) or Dalton (Da) definition base.

STANDARD REFERENCE:

1 mole of ^{12}C = exactly 12 grams.
Avogadro constant (N_A) $\approx$
 $6.022 \times 10^{23} \text{ mol}^{-1}$.



CRITICAL ALERT:

The atomic mass unit is defined relative to Carbon-12, NOT Hydrogen-1.
This is the foundational reference point for all atomic and molecular masses.

SUMMARY:

The atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes, expressed in amu, relative to the 1/12th mass of a single Carbon-12 atom.

FORMULA BLOCK 1: Relative Atomic Mass (A_r)

$$A_r = \frac{(\text{Average Mass of Atom})}{(1/12 \times \text{Mass of one } ^{12}\text{C atom})}$$

FORMULA BLOCK 2: Mass of 1 mole of substance

$$\text{Molar Mass (g/mol)} = \text{Atomic Mass (amu)} \times N_A \text{ (Avogadro Constant)}$$

The Need for a Relative Unit

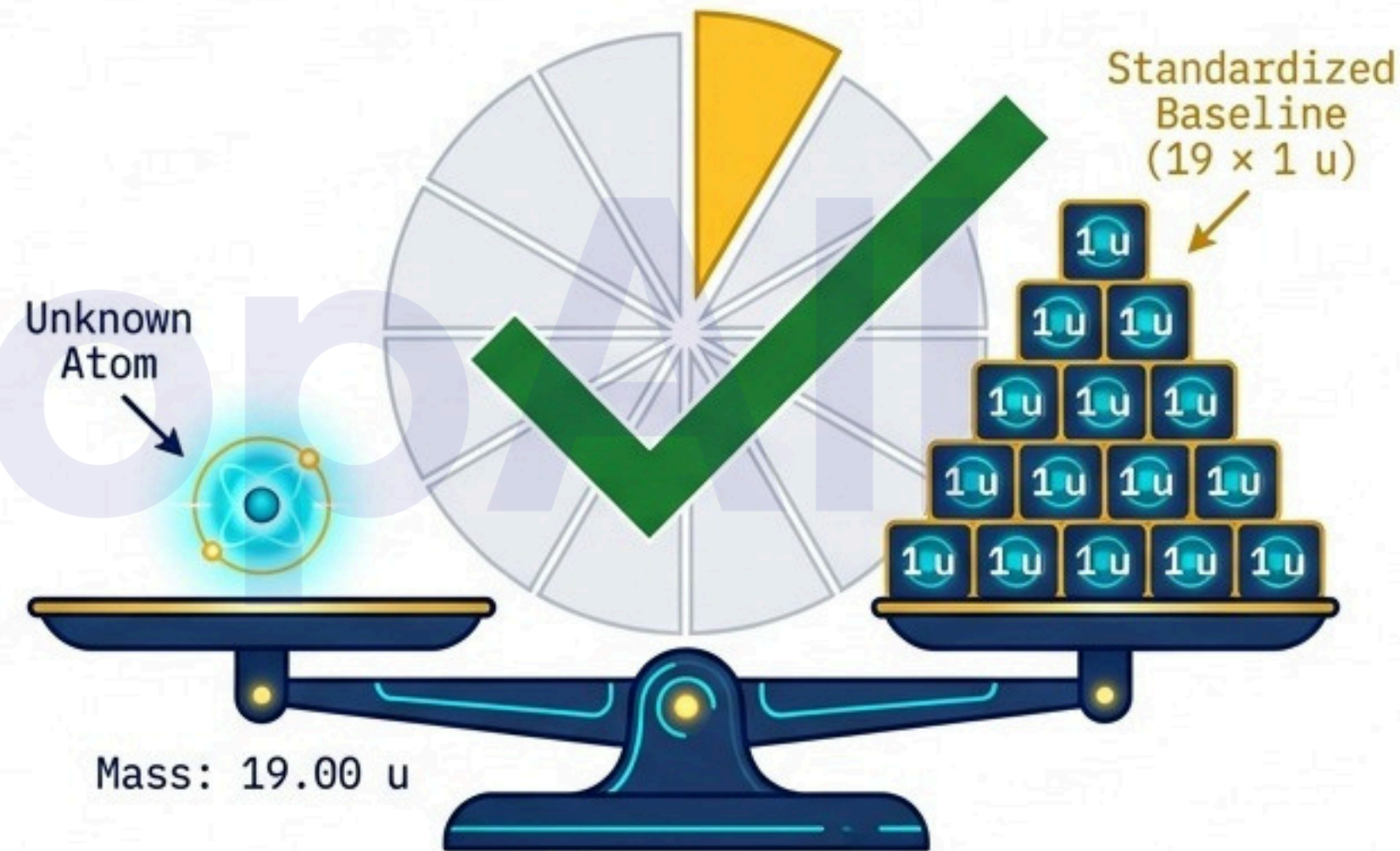
Atoms are infinitesimally small. Weighing them in grams results in unwieldy exponents. Scientists measure atomic mass relatively—balancing an unknown atom against a standardized baseline.

The Problem



Impractical & Unwieldy

The Solution

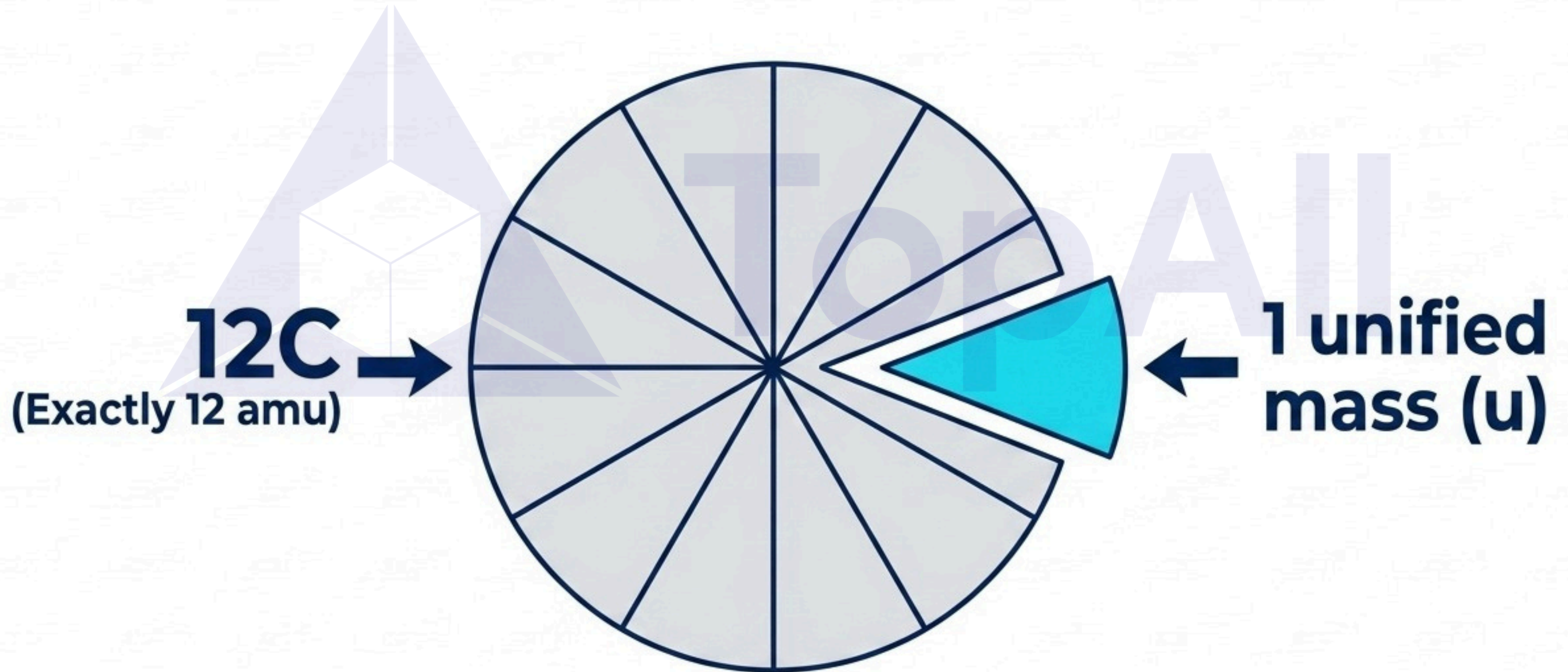


Precise & Relative

SUMMARY: Atomic mass is determined by comparing the mass of an atom to exactly 1/12th of the mass of a Carbon-12 atom, defining the unified atomic mass unit (u).

The 1961 Standard: Carbon-12

In 1961, the scientific community agreed to use the ^{12}C isotope as the universal baseline. By definition, one atom of ^{12}C is assigned a mass of exactly 12 atomic mass units (amu).





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Formula & Rule Bank

Note: The term amu has modernly been replaced by u (unified mass).

The Definition

$$1 \text{ u} = (1/12) * \text{mass of one } ^{12}\text{C} \text{ atom}$$

The Gram Conversion

$$1 \text{ amu} = 1.66056 \times 10^{-24} \text{ g}$$

JEE Trap Alert



Students often see Mass of Oxygen = 16 and reflexively write 16 g. Remember the scale: 16 u is the mass of one single atom, whereas 16 g is the mass of one mole (6.022×10^{23} atoms).

~~1 atom of O = 16 g~~



1 atom of O = 16 u



Mini Application: Hydrogen Relative to u



Using mass spectrometer data to calculate the relative atomic mass of a Hydrogen atom.

Given: Absolute Mass of H atom = 1.6736×10^{-24} g

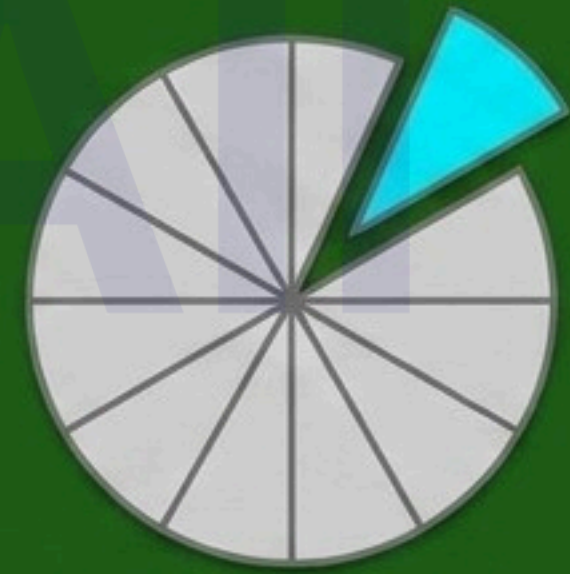
Baseline: Value of 1 u = 1.66056×10^{-24} g

$$\frac{1.6736 \times 10^{-24} \text{ g}}{1.66056 \times 10^{-24} \text{ g}}$$

$$= 1.0078 \text{ u (approx } 1.0080 \text{ u)}$$

Key Takeaways & Revision

1. Atomic masses are strictly relative values.
2. The universal baseline is the Carbon-12 isotope.
3. $1 \text{ u} = 1.66056 \times 10^{-24} \text{ g}.$





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