UNITS

BASICS OF CHEMISTRY

PART 2/3

SI UNITS

cm^3

volume

CHEMISTRY

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In Laboratory, Volume Of Liquids Can Be Measured By Graduated Cylinder, Burette, Pipette, Standard Measuring Flask (SMF) & Micro Syringe.

To Calculate Volume Of An Irregular Shaped Object, Displacement Method (Volume Of Water Displaced), Is Used. eg. If Object Displaced 3mL. Of Water, Its Volume is 3mL or $3cm^3$ or 3cc since 1mL Water = $1cm^3$

VOLUME EQUIVALENCE

- 10 cm x 10 cm x 10 cm = 1000 cm^3 = 1000 cc = 1 L = 1000 ml (because (cm^3) centimeter cube is seldom denoted by cc)
- 1 dm x 1 dm x 1 dm = 1000 cm^3 = 1000 cc = 1 L = 1000 ml (because 10cm = 1 dm)
- 1 m x 1 m x 1 m = 1 m^3 = 1000 L
- 10^6 µL = 1 L

SI UNITS

kg/m^3

density

CHEMISTRY

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SI Unit

Kg/m^3

The Mass of Atoms, Their Size And How They Are Arranged Determine The Density Of A Substance.

Other Units

g/L, g/cm^3, g/ml, kg/L

Formula

$$Density = \frac{mass}{volume} = \frac{kg}{cm^3}$$

DENSITY?

The Density Of A Substance Is The Relationship Between The Mass Of The Substance And How Much Space It Takes Up (Volume).

Density Of A Substance Is The Amount Of Mass Per Unit Volume.

SI UNITS

kg/m^3

density

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DIGITAL DENSITY METER

Equipment Used To Measure Density During Quality & Process Control

PICNOMETER

HYDROMETERS

What Is Density?

Density for some common materials in kg/L.

Sr. No.	Material	Density (kg/L)	Remark
1	Petrol	0.71 - 0.77	…
2	Diesel	0.82 – 0.86	…
3	Water	1	1 kg water = 1 litre water
4	Ice	0.917	…
5	Sulphuric Acid (H_2SO_4)	1.84	When We Make 20% Diluted H_2SO_4 Solution Then We Will Use This Density
6	Hydrochloric Acid (HCl)	1.13	When We Prepare 1 N HCl Solution Then We Will Use This Density
7	Mercury (Hg)	13.6	Hence, 13.6 Kg Mercury = 1 litre Mercury

SI UNITS

kg/m^3

density

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SI Unit

Kg/m^3

Density Is The Most Important Measurement Used In Industries And Laboratories

$Density \propto P$

Where,
P = Pressure

$Density \propto \frac{1}{T}$

Where,
T = Temperature

Density Measurement Of Raw Materials Can Be Used To Validate The Purity Of The Material. If A Substance Has Been Adulterated With A Cheaper Alternative, The Measured Density Of The Composite Material Will Be Different From The Pure Substance.

Density Of A Substance Is The Amount Of Mass Per Unit Volume.

SI UNITS

K

temperature

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TEMPERATURE ?

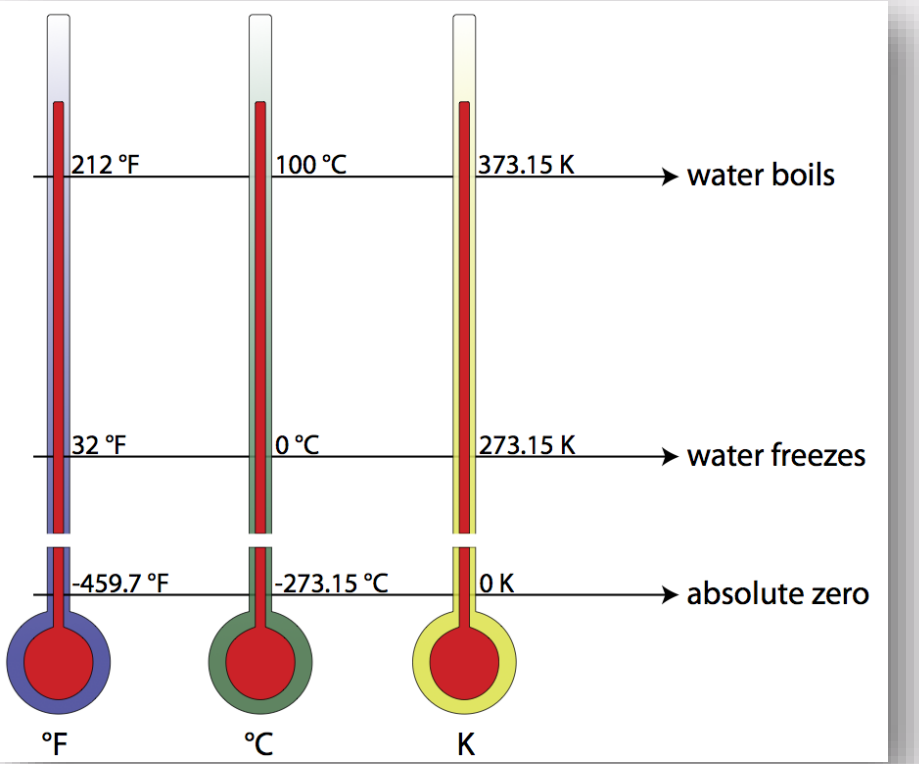
Temperature Is A Physical Property Of Matter That Quantitatively Expresses Hotness & Coldness.

SI Unit

Kelvin
(K)

Other Units

Degree Celsius
(°C),
Degree Fahrenheit
(°F)



SI UNITS

K

temperature

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°C To °F

$$°F = \left(°C \times \frac{9}{5}\right) + 32$$

°F To °C

$$°C = \frac{5}{9}(°F - 32)$$

Temperatures Below 0°C Are Possible In Celsius Scale But In Kelvin Scale Negative Temperature Is Not Possible.

K = C + 273.15
But Rounded Upto
K = C + 273

0°C = 32°F = 273 K

SI UNITS

amu

atomic mass

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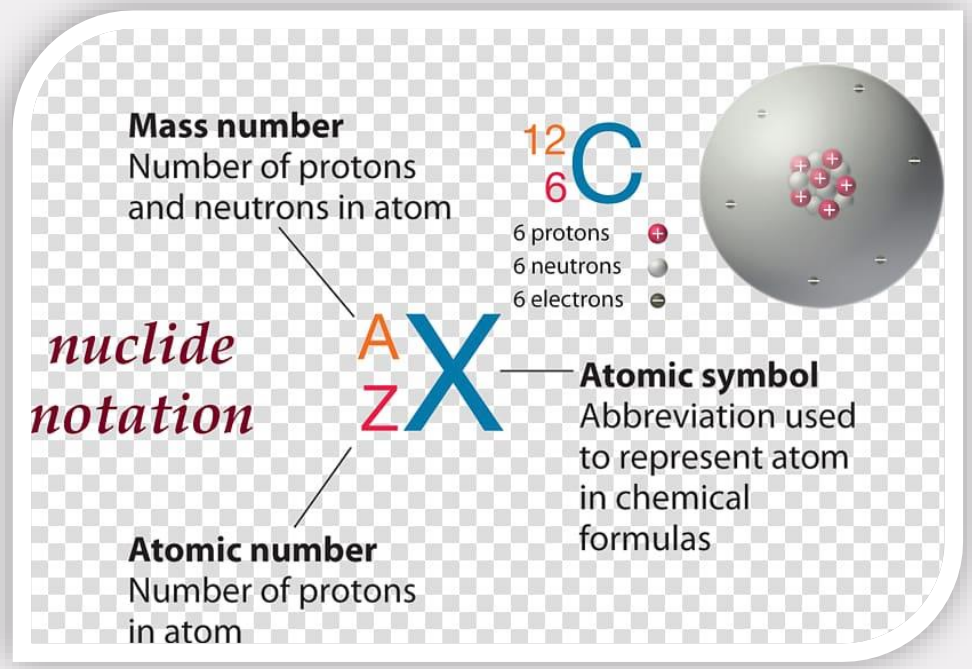
ATOM?

An Atom Is The Structural & Functional Unit Of Matter And The Defining Structure Of Elements.

All 118 Element Of Periodic Table Are Atoms

Eg.

Hydrogen (H),
Oxygen (O),
Carbon (C),
Neon (Ne),
Argon (Ar), Iron (Fe),
Calcium (Ca)



CHEMISTRY

SI UNITS

amu

atomic mass

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ATOMIC NUMBER ?

The Atomic Number (Z) Is Equal To The Number Of Protons In An Atom's Nucleus.

The Number Of Electrons In A Neutral Atom Is Equal To The Number Of Protons.

For Example, Any Atom That Contains Exactly 47 Protons In Its Nucleus Is An Atom Of Silver.

The Atomic Number Determines Which Element An Atom Is.

The Mass Number Of The Atom Is Equal To The Sum Of The Number Of Protons And Neutrons In The Nucleus.

SI UNITS

amu

atomic mass

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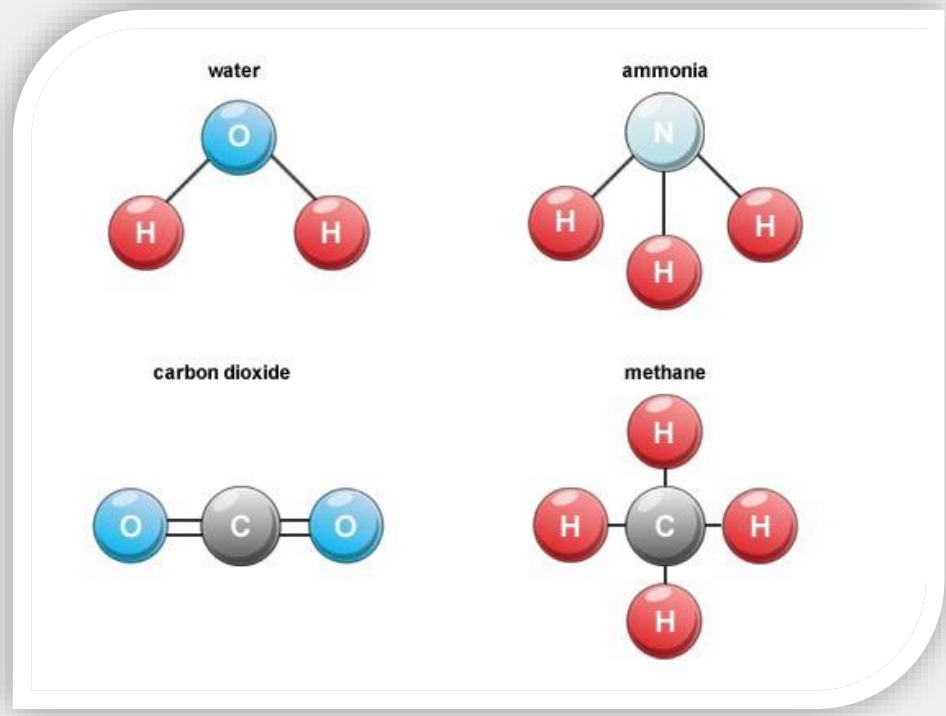
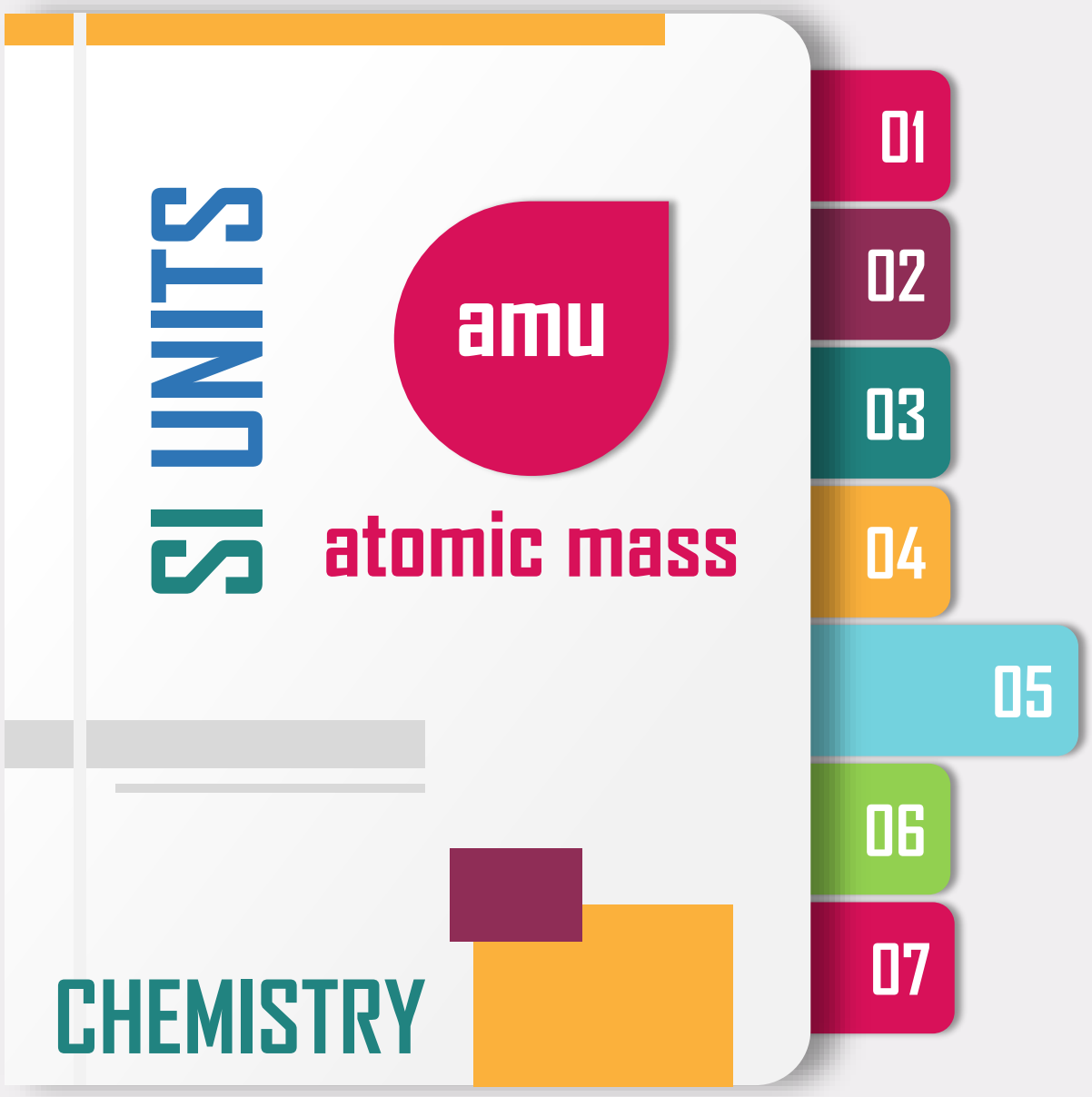
What Is A Molecule?

A Molecule Is The Smallest Particle Of A Substance That Retains All The Properties Of The Substance And Is Composed Of One Or More Atoms.

Example: H_2, N_2, O_2, CO_2, Cl_2, H_2O, NH_3, CH_4, HCl, H_2SO_4, etc.



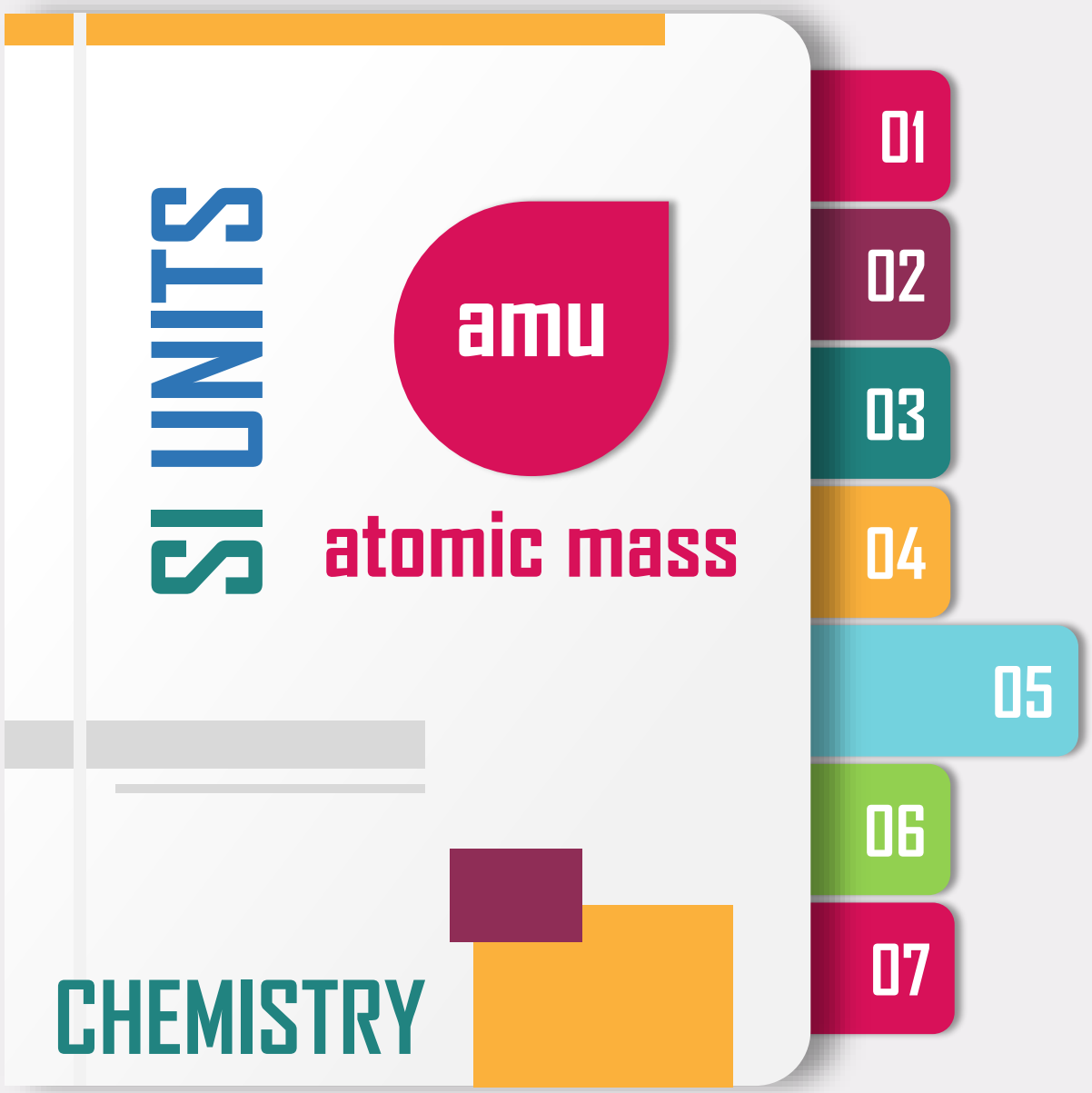


What Is "Atomic Mass"?

Atomic Mass Is Mass Of 1 Atom. Atomic Mass (A) Is Typically Calculated By Adding The Number Of Protons And Neutrons Together, Ignoring The Electrons Because Of Their Small Size.

Particle	Charge	Mass(g)	Mass (amu)
Proton	+1	1.6727×10^{-24} g	1.007316
Neutron	0	1.6750×10^{-24} g	1.008701
Electron	-1	9.110×10^{-28} g	0.000549

We Can Measure The Mass Of Atom With The Help Of A Modern Instrument Mass Spectrometer.



What Is "Atomic Mass"?

The Present System Of Atomic Masses Is Based On Carbon-12 As The Standard And Agreed Upon In 1961 By IUPAC & IUPAP.

In This System ^{12}C Is Assigned A Mass Of Exactly 12 amu (Atomic Mass Unit) & Masses Of All Other Atoms Are Given Relatively To This Standard.

Mass Of An Atom Of Hydrogen Is Defined As A Mass $= \frac{1}{12}$ Of The Mass Of ^{12}C Atom.

12 amu = The Mass Of One C Atom.

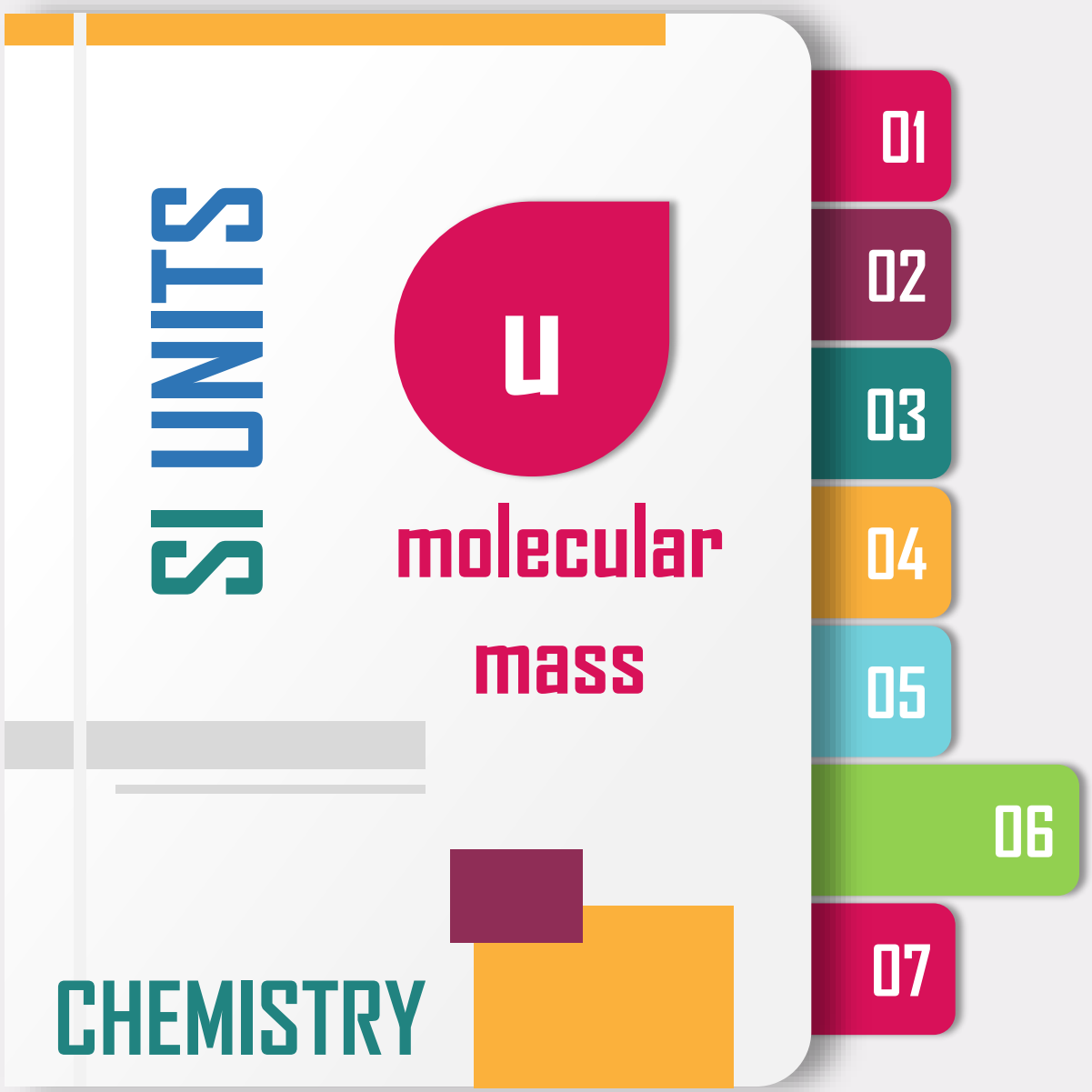
1 amu $= \frac{1}{12}$ Of The Mass Of One C Atom.

1 amu (Atomic Mass Unit) = 1 u (Unified Atomic Mass)

1 amu = 1.66×10^{-24} gm = 1 Da (Dalton)

E.G. Mass Of N (Nitrogen) Is 14 u

Note : When We Write 14 u, It Is Atomic Mass While 14 g Is Gram Atomic Mass (GAM)



What Is "Molecular Mass"?

Molecular Mass Is The Mass Of One Molecule That Is Equal To The Sum Of The Masses Of All The Atoms Present In The Compound/Molecule.

If We Know The Molecular Formula Of Any Compound, The Molecular Mass Can Be Found By Considering Total Number Of Atoms Present And Adding Together Their Total Atomic Masses.

E.g., Calculate Molecular Mass Of Glucose $C_6H_{12}O_6$

Molecular Mass Of $C_6H_{12}O_6$

= 6 (Atomic Mass Of C) + 12 (Atomic Mass Of H) + 6 (Atomic Mass Of O)

= 6 (12 u) + 12 (1 u) + 6 (16 u)

= 72 u + 12 u + 96 u

= 180 u

Note : Remember Atomic Mass Of Atoms To Calculate Molecular Mass. If Mass Of A Molecule Is 18, Then 18 u Is Molecular Mass And 18 g Is Gram Molecular Mass (GMM)

SI UNITS

mol

mole concepts

CHEMISTRY

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MOLE?

Number Of Atoms 6.022×10^{23} Present In 12 Gram Of C-12 As A Standard, Is Accepted As Mole

1 Mole = 6.022×10^{23} Numbers Of Particles

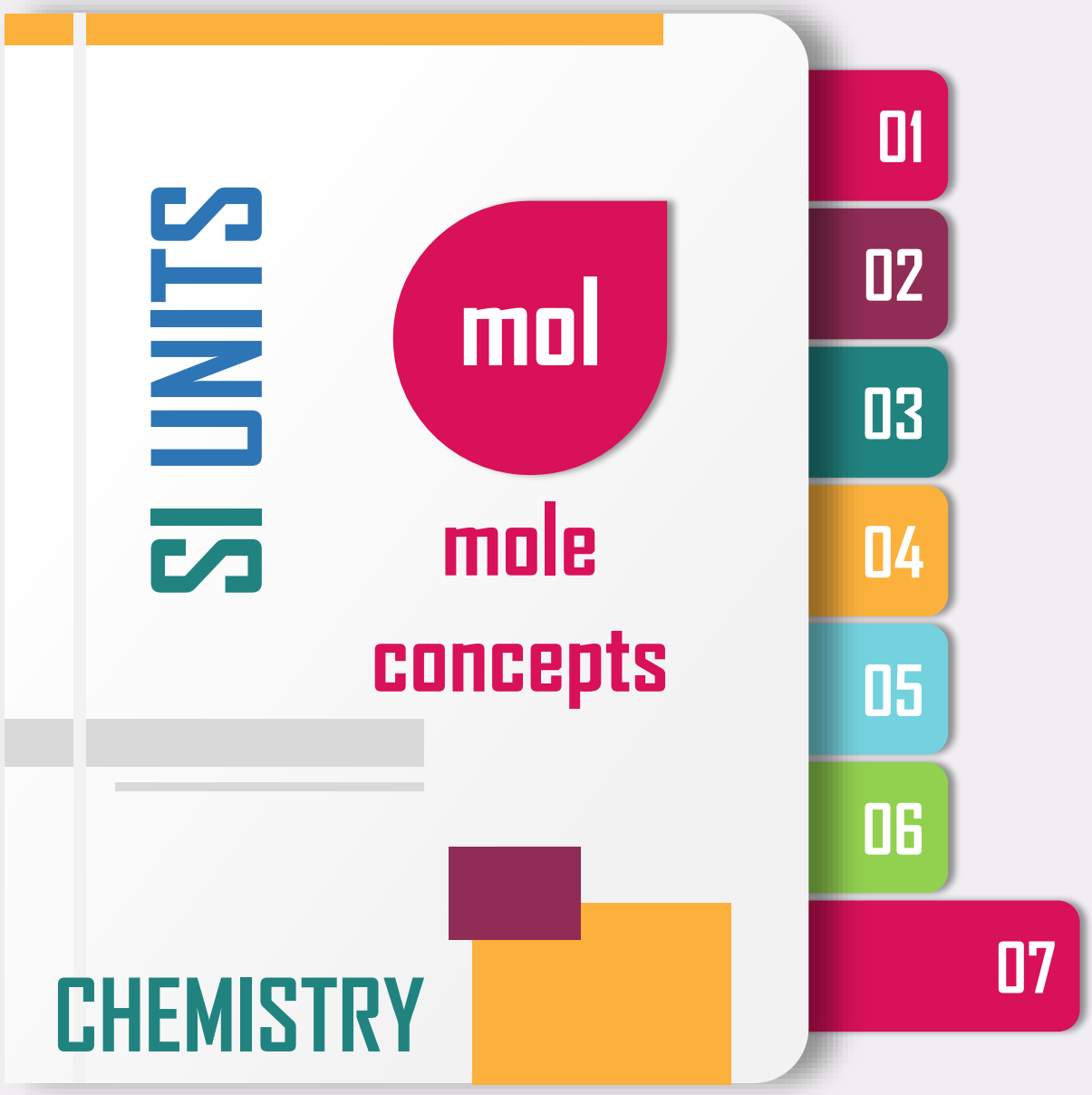
1 Dozen = 12 Numbers Of Any Item

1 Gross = 12 Dozen = 144 Numbers Of Any Item

AVOGADROS NUMBER?

A Quantity 6.022×10^{23} Is Called Avogadro's Number. The Symbol Of Avogadro's Number Is N_A.

1 Mole = 6.022×10^{23} Particles/Atoms/ Molecules/Ions In One Mole



Formula For Number of Moles?

In case of atomic substance:

NUMBER OF MOLES

$$(n) = \frac{Given\ mass}{Gram\ Atomic\ Mass\ or\ Gram\ Molecular\ Mass}$$

In case of molecular substance :

$$\text{NUMBER OF MOLES (n)} = \frac{Given\ mass}{Gram\ Molecular\ Mass}$$

If no. of particles is given:

$$\text{NUMBER OF MOLES (n)} = \frac{Number\ of\ particles}{Avogadro\ No.}$$

In case of gaseous substance:

$$\text{NUMBER OF MOLES (n)} = \frac{Volume\ at\ STP\ in\ litres}{22.4\ L}$$

$$\text{MOLE (n)} = \frac{V}{22.4\ L}$$

SI UNITS

mol

mole concepts

CHEMISTRY

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Example: Calculate the number of the constituent atoms in 53g of Na_2CO_3

m = 53g,

GMM of Na_2CO_3 = 2(23) + 12 + 3(16) = 46 + 12 + 48 = 106 g/mol

$$n = \frac{m}{GMM} = \frac{53}{106} = 0.5\ mol$$

- 1 mole = 6.022×10^{23} molecules
- 0.5 mole = 3.011×10^{23} molecules
- 1 molecule of Na_2CO_3 :
  Na atoms = 2, C atoms = 1, O atoms = 3

So, In 3.011×10^{23} molecules of Na_2CO_3 :

Molecules of Na atoms = $2 \times 3.011 \times 10^{23}$,

Molecules of C atoms = 3.011×10^{23},

Molecules of O atoms = $3 \times 3.011 \times 10^{23}$

UNITS

BASICS OF CHEMISTRY

END OF PART 2/3

SUMMARY

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03 DENSITY

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06 MOLECULAR MASS

07 MOLE CONCEPTS