

# UNITS

BASICS OF CHEMISTRY

**PART 3/3**



# SI UNITS

g/mol

molar mass

08

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CHEMISTRY

## MOLAR MASS?

Molar mass is the mass of one mole particles/atom/molecule/ion.

Molar mass is measured in grams per mole (g/mol).

## If ATOMS?

molar mass = mass of  $6.022 \times 10^{23}$  atoms which is **GRAM ATOMIC MASS = GAM**

## If MOLECULE?

molar mass = mass of  $6.022 \times 10^{23}$  molecules which is **GRAM MOLECULAR MASS = GMM**

## If GASES?

Gaseous molar volume = Volume of  $6.022 \times 10^{23}$  molecules = **22.4L @ STP (1 atm, 273K)**

**Note: The molar mass in grams is numerically equal to atomic/molecular mass in (u).**

SI UNITS

g/mol

molar mass

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CHEMISTRY

## Molar Mass Calculation:

Calculate the molar mass of the  
Glucose ( $C_6H_{12}O_6$ )

$$\text{Molar Mass of H} = 1 \text{ g.mol}^{-1}$$

$$\text{Molar Mass of C} = 12 \text{ g.mol}^{-1}$$

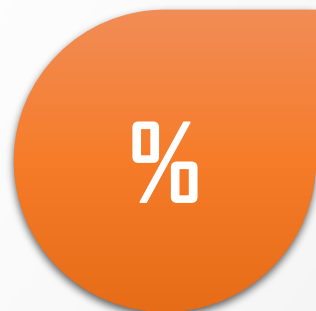
$$\text{Molar Mass of O} = 16 \text{ g.mol}^{-1}$$

Molar Mass of  $C_6H_{12}O_6$

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

$$= 72 + 12 + 96$$

$$= 180 \text{ g.mol}^{-1}$$



Mass % of element

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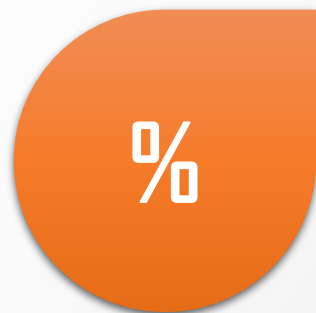
If Molecular Formula Of Compound Is Known, One Can Calculate The Mass Percentage Of Element Present In That Compound. In Contrast To This, If One Knows The Mass Percentage Of All Elements Present In A Compound, Its Molecular Formula Can Be Determined.

When Compound Is Formed From Two Or More Elements, The Amount Of Element Present In A Compound Is Always Proportional To Its Definite Mass.

**Percentage Composition Of An Element**

**Mass % Of An Element**

$$= \frac{\text{mass of the element in the compound} \times 100}{\text{molar mass of compound}}$$



Mass % of element

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# Calculate The Percentage Of Each Element Present In Ethanol (C<sub>2</sub>H<sub>5</sub>OH).

## Solution :

Atomic mass of C = 12.0 gram mole<sup>-1</sup>

Atomic mass of H = 1.0 gram mole<sup>-1</sup>

Atomic mass of O = 16.0 gram mole<sup>-1</sup>

Molecular mass of ethanol (C<sub>2</sub>H<sub>5</sub>OH)

$$= 2(12) + 6(1) + 1(16)$$

$$= 24 + 6 + 16$$

$$= 46 \text{ gram mole}^{-1}$$

$$\text{Mass \% of H} = \frac{6 \times 100}{46} = 13.03\%$$

$$\text{Mass \% of C} = \frac{2(12) \times 100}{46} = 52.17\%$$

$$\text{Mass \% of O} = \frac{1(16) \times 100}{46} = 34.78\%$$

# PERCENTAGE BY WEIGHT

SI UNITS

$\%w/w$   
 $\%w/v$

percent by weight

CHEMISTRY

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$\%w/w$ ,  
 $\%w/v$   
It Is The  
Expression Of  
Concentration  
Of Solute In  
Solution



%w/w  
%w/v

percent by  
weight

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%w/w?

The Weight Of Substance In Gram Dissolved In 100 Gram Solution Is Called Percentage By Weight (%w/w). It Stands For Weight Per Weight

Formula

%w/w =

$$\frac{\text{weight of solute} \times 100}{\text{weight of solution in gm}}$$

EXAMPLE

In How Many Grams Of Water 36.5 gram HCl Should Be Dissolved So That 10% w/w Solution Will Be Obtained?

Total Weight Of Solution = M g,

Weight of Solute (HCl) = 36.5 gm,

w/w% = 10%

$$\%w/w = \frac{36.5 \times 100}{M} = 10\%$$

$$\text{Total Weight Of Solution } M = \frac{36.5 \times 100}{10} = 365 \text{ gm}$$

$$\text{Weight Of Water} = 365 - 36.5 = 328.5 \text{ gm H}_2\text{O} .$$

%w/w  
%w/v

percent by  
weight

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%w/v?

The Weight Of Substance In Gram Dissolved In 100 ml Solution Is Called Percentage By Weight By Volume (%w/v). It Stands For Weight Per Volume.

Formula

%w/v =

$$\frac{\text{weight of solute} \times 100}{\text{volume of solution in L}}$$

**Example:**

**How Many Grams of NaOH Will Be Will Be Required To Prepare 500 ml Solution Containing 5% w/v NaOH ?**

Ans.:  $\%w/v = \frac{\text{weight of solute} \times 100}{500} = 5 \%$

Weight of Solute =  $\frac{5 \times 500}{100} = 25 \text{ gm}$

**Weight of Solute = 25 gm**

$\%v/v$ percent by  
volume

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 $\%v/v$ 

The Volume Of Substance  
In ml Dissolved In 100 ml  
Solution Is Called Percentage  
By Volume ( $\%v/v$ ).  
It Stands For Volume  
Per Volume

Formula

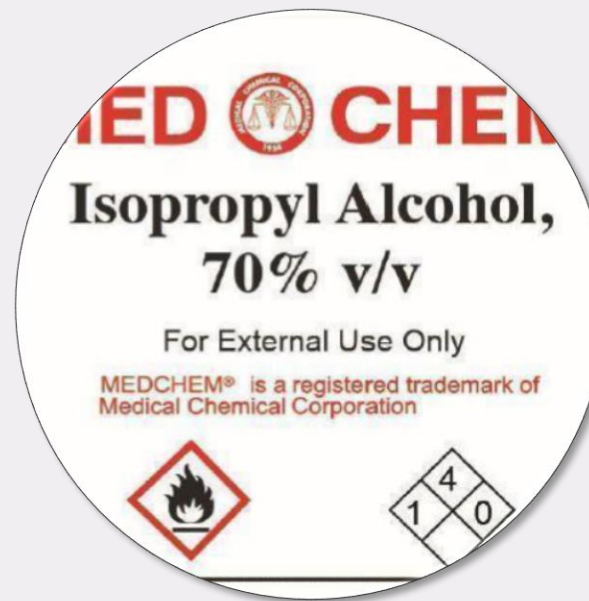
 $\%v/v =$ 

$$\frac{\text{Volume of solute} \times 100}{\text{Vol. of solution in lit.}}$$

EXAMPLE

2 L ethanol solution  
have 200 ml ethanol  
then find out  $\%v/v$ .

$$\%v/v = \frac{200 \times 100}{2000} = 10\%v/v$$



**Note: This is used when both chemicals in a solution are liquid.**

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# What Is “Mole Fraction”

The ratio of the moles of any component to the total moles in a solution is the mole fraction.

mole fraction of component

$$= \frac{\text{mole of component}}{\text{number of total moles of components in a solution}}$$

NOTE:

The sum of the mole fraction of all the components in a solution is always equal to 1.

Nos. of Moles of Solute A =  $n_A$

Nos. of Moles of Solvent B =  $n_B$

Total Nos. of Moles of Solution =  $n_A + n_B$

$$\text{Mole Fraction of Solute A} = \frac{n_A}{n_A + n_B}$$

$$\text{Mole Fraction of Solute B} = \frac{n_B}{n_A + n_B}$$

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# Mole Fraction Calculation Example

Find the Mole Fraction Of Water In A Solution When 13.8g NaCl Is Dissolved In 132 ml (g) Of Water.

Ans.:

$$\text{Molar Mass of NaCl} = 23 + 35.5 = 58.5 \text{ g/mol}$$

$$\text{Mole Of NaCl} = \frac{13.8}{58.5} = 0.2358 \text{ mol}$$

$$\text{Molar Mass Of H}_2\text{O} = 2 + 16 = 18 \text{ g/mol}$$

$$\text{Mole Of Water} = \frac{132}{18} = 7.3333$$

$$\begin{aligned} \text{Total moles of Solution} &= 0.2358 + 7.3333 \\ &= 7.5691 \text{ mol} \end{aligned}$$

$$\text{Mole Fraction of Water} = \frac{7.3333}{7.5691} = 0.9688$$

# SI UNITS

## CHEMISTRY

M

molarity

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When One gram mole Of A Solute Is Dissolved In Solvent & Then Making One litre Of Solution It Is Called One molar (1M) solution.

OR

One litre Of Solution Containing One gram mole Of A Substance Is Called 1 molar (1 M) Solution

Molarity or molar concentration Is The Number Of moles Of Solute In 1 litre Of Solution

SI Unit  
mol/lit  
OR  
mol/m<sup>3</sup>

Other  
Units

M,  
mol/dm<sup>3</sup>



molarity

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## Molarity Formulas

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in litre}}$$

(here volume is in litre)

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute} \times 1000}{\text{Volume of solution in ml}}$$

(here volume is in ml)

$$\text{Molarity (M)} = \frac{\text{Mass of solute} \times 1000}{\text{GMM} \times \text{Volume of solution in ml}}$$

(here volume is in ml)

## Molarity Calculation Example

A Solution Prepared Using 15 g Of Sodium Sulphate. The Volume Of The Solution Is 125 ml. Calculate The Molarity Of The Given Solution Of Sodium Sulphate.

Solution:

$$\begin{aligned} \text{GMM of Na}_2\text{SO}_4 &= 2(23) + 32 + 4(16) \\ &= 46 + 32 + 64 \\ &= 142 \text{ g/mol} \end{aligned}$$

$$\begin{aligned} \text{Molarity (M)} &= \frac{\text{Mass of solute} \times 1000}{\text{GMM} \times \text{Volume in ml}} \\ &= \frac{15 \times 1000}{142 \times 125} \\ &= 0.85 \text{ M} \end{aligned}$$

# What Is "Molality"?

SI UNITS

m

molality

CHEMISTRY

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One Mole Of A Solute, When Dissolved In One kilogram Of The Solvent Is Called One molal (m) Solution Or molality Of Solution Is 1 m (1 molal).

OR

The Number Of Moles Of Solute Dissolved In 1 kilogram Of Solvent.

SI Unit  
mol/kg

A Solution Containing 3 moles Of Solute per kilogram Of Solvent For Example, Is Said To Be 3 molal or 3 m

Other Units  
molal  
m



molality

08

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## Molality Formulas

$$\text{Molality (m)} = \frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg.}}$$

(here weight is in kg.)

$$\text{Molality (m)} = \frac{\text{No. of moles of solute} \times 1000}{\text{Mass of solvent in gram}}$$

(here weight is in gram)

$$\text{Molality (m)} = \frac{\text{Mass of solute} \times 1000}{\text{GMM} \times \text{Mass of solvent in gram.}}$$

(here weight is in gram)



molality

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## Molality Calculation Example

What is the molality of a solution containing 5.0 g NaCl dissolved in 25.0 g water?

Solution:

$$\begin{aligned}\text{Molar mass of NaCl} &= 23 + 35.5 \\ &= 58.5 \text{ g/mol}\end{aligned}$$

$$\text{molality (m)} = \frac{\text{Mass of solute} \times 1000}{\text{GMM} \times \text{Mass of solvent in gram.}}$$

(in this example solute = NaCl, solvent = water)

$$\begin{aligned}&= \frac{5 \times 1000}{58.5 \times 25} \\ &= 3.42 \text{ m}\end{aligned}$$

# UNITS

BASICS OF CHEMISTRY



END OF

**PART 3/3**

# SUMMARY

01

MOLAR MASS

02

MASS % OF ELEMENT

03

PERCENT WEIGHT

04

PERCENT VOLUME

05

MOLE FRACTION

06

MOLARITY

07

MOLALITY

# SUMMARY

01 UNITS

02 METRIC SYSTEM

03 SI UNITS

04 IUPAC

05 IUPAP

06 UNIT PREFIXES

07 MASS

08 WEIGHT

09 VOLUME

10 DENSITY

11 TEMPERATURE

12 ATOMIC MASS

13 MOLECULAR MASS

14 MOLE CONCEPT

# SUMMARY

15 MOLAR MASS

16 MASS % OF ELEMENT

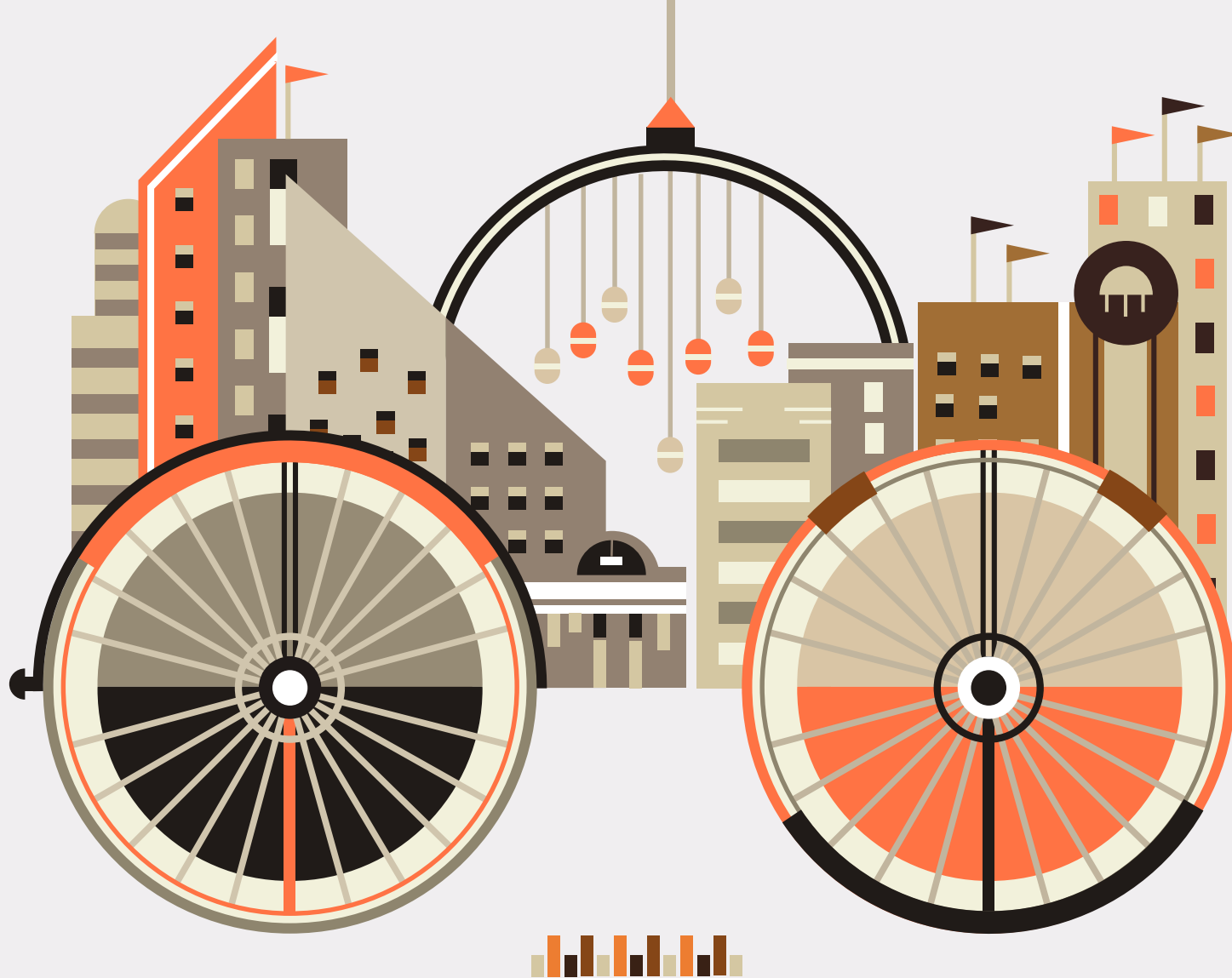
17 PERCENTAGE BY WEIGHT

18 PERCENTAGE BY VOLUME

19 MOLE FRACTION

20 MOLARITY

21 MOLALITY



**THANK YOU VERY MUCH**