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Chapter-1

Some basic concepts of chemistry

* **Matter** – Anything that occupies space and has mass is called matter.

Physical classification of matter

- Solid - Ex:- Chair, table, etc
- Liquid - Ex:- water
- Gas - Ex:- Air, Oxygen, etc.

→ Chemical classification of matter

1. Pure Substance →

a) Element - It is the pure form of matter which causes only one type of particles.

Ex:- C, H, O, Au, Ag, etc.

b) Compound - It is the pure form of matter which consist of two or more elements in a fixed ratio of mass

- The properties of compounds are completely different from its constituent element

H_2O : $\frac{2\times H}{1\times 16} = \frac{2}{16} = \frac{1}{8}$

H_2O_2 : $\frac{2\times H}{1\times 32} = \frac{2}{32} = \frac{1}{16}$

2. Mixture :-

a.) Homogeneous mixture :- It is a mixture in which differ compound produce only single phase

Ex :- Sugar + H_2O
$C_2H_5OH + H_2O$

b.) Heterogeneous mixture :- It is a mixture in which different compound produce more than one phase

Ex :- Oil + Water
Sand + water

→ Difference between Homogeneous and Heterogeneous

1. It show only one phase	1. It show more than one phase.
2. Uniform composition throughout	2. Non - uniform composition throughout.
3. Ex :- Sugar solution, Salt solution	3. Ex :- Sand in water

* Precise and Accurate

→ Accurate :-
If the average value of measurement is equal to the actual value the measurement is said to be accurate

Actual value → 10
Average value → 10 , 10·02, 9·98

→ Precise :-
If average value of different measurements is not equal to the actual value then the measurement is said to be Precise

Actual value → 10
Precise → 9.0, 9.9 9·0

* Rules for Significant figure

1. All non-zero digits are significant in nature

Ex:- 81437 – 5 sf
211 – 3 sf

2. Zero between non-zero are significant

Ex:- 80037 → 5 sf
201 → 3 sf

3. Initial zeroes or zero in the starting will not be significant
Ex:- 00087 → 2 sf 00811 → 3 sf

4. Zeroes in the end or right hand side are significa

Ex:- 3700 → 4 Sf
1.81000 → 6 Sf
1.0800 → 5 Sf

5. If any exact no. or a constant value is given there will be infinite significant figures

Ex:- • $R = 8.314 \rightarrow \infty$
• $G = 6.67 \times 10^{11} \rightarrow \infty$
• $\pi = \frac{22}{7} \rightarrow \infty$
• 6 marker (Exact no.) $\rightarrow \infty$

6. For non decimal digits first we have to convert in two scientific notation $\rightarrow N \times 10^n$ where the value of capital I to 10

Ex:- 7200
7.2×10^2
2 Sf

4. 2.01×10^6
3 Sf

2. 0.020
0.2 Sf

5. 0.004200
4 Sf

3. 2.314
4 Sf

6. 26001
5 Sf

7. 180.0

4sf

8. 130×10^7

$\frac{3}{2}$ sf

9. $180 - \frac{3}{2}$ sf

☆ $180 \rightarrow N \times 10^n$

$\rightarrow 1.8 \times 10^2 \rightarrow 2$ sf

$\rightarrow 1.80 \times 10^2 \rightarrow 3$ sf

☆ 130×10^7

$\rightarrow 1.3 \times 10^9 \rightarrow 2$ sf

$\rightarrow 1.30 \times 10^9 \rightarrow 3$ sf

Q- 0.0010100

5sf

Rounding off

1. $2.43 \rightarrow 2.4$
2. $2.26 \rightarrow 2.3$
3. $2.25 \rightarrow 2.2$
4. $2.35 \rightarrow 2.4$

→ If the digit is 4 and less than 4 there will be no addition of 1 during rounding off, In case of more than 5 we have to add while rounding off

→ In case of 5 if even no. is present there will be no addition but incase of odd no. we have to add 1 to make it even.

2.251 → 2.2
2.258 → ~~2.3~~ 2.2

1. 0.01100 → 4sf
2. 0.8010 → 4sf
3. 1.090 → 4sf
4. 130 → $\frac{2}{3}$ sf

Q 1. 8.352 → 8.4
2. 8.350 → 8.4
3. 8.450 → 8.4

Mathematical operation with significant figure

1. Addition and Subtraction

The Result of Addition & subtraction must have the same no. of decimal place as present in value width least decimal place

Ex:- 4.11
$\pm$ 0.1
4.21 → 4.2

Q- A vessel of 2·5 kg contains 1·22 g substance what will be sum of both?

$1\,kg = 1000\,g$

$1.22 \rightarrow 0.00122\,g$

$$\begin{array}{r} 2.5 \\ \underline{0.00122} \\ 2.50122 \end{array} \rightarrow 2.5$$

2. Multiply and division

The result is rounded off to same number of significant figures as present in the value width least significant figures

Ex- $1.1 \times 1.1 = 1.21 \rightarrow 1.2$

Q-* The solid has volume $1.23\,m^3$ its mass plus(+)mass of the weighing paper is 10·024 the paper has mass mass 0·03g. Calculate the density of the solid and find the significant no. also.

1.23

$10.024 - 0.03$

$= 9.994 \rightarrow 9.99$

$$\frac{9.994}{1.23}$$

$$\begin{array}{r} 9/99 \\ +123 \end{array} \quad \begin{array}{l} 333\,111 \\ 41 \end{array}$$

$8.12\,g/cm^3$

H.W:
Q 16 ; 18, 19, 20

18. (i) $0.0048 \rightarrow 4.8 \times 10^{-3}$
(ii) $234,000 \rightarrow 2.34 \times 10^{5}$
(iii) $8008 \rightarrow 8.008 \times 10^{3}$
(iv) $500.0 = 5.000 \times 10^{2}$
(v) $6.0012 = 6.0012$

19. (i) $0.0025 \rightarrow$ 2sf
(ii) $208 \rightarrow$ 3sf
(iii) $5005 \rightarrow$ 4sf
(iv) $126,000 \rightarrow$ 3sf
(v) $500.0 \rightarrow$ 4sf
(vi) $2.0034 \rightarrow$ 5sf

20. (i) $34.216 \rightarrow 34.2$
(ii) $10.4107 \rightarrow 10.4$
(iii) $0.04597 \rightarrow 0.0460$
(iv) $2808 \rightarrow 2810$

16. Significant figures are those meaningful digits that are known with certainity.
They indicate uncertainity in an experiment or calculated value.
for ex:- If 5.6 m.l. is the result of an experiment, then 15 is certain while 6 in uncertain, and the total no. Significant figures are 3

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1. Law of conservation of mass:-

According to this law the sum of the reactants is always equal to the sum of the product

Ex:- $A + B \longrightarrow C + D$

$70g \quad 30g \qquad 60g \quad 40g$

$100g \qquad 100g$

Ques Calcium carbonate is decompose to form calcium oxide and CO_2

Data given

Mass of $CaCO_3 = 100g$

Mass of $CO_2 = 44g$

Calculate the mass of CaO = ?

$CaCO_3 = 100$

$CO_2 = 44$

$CaO = 100 - 44$

$= 56g$

2. Law of definite ratio / proportion:-

According to this law a chemical compound is always made up of some constituent elements present in a fix ratio by mass

1. Sea
2. Pond
3. River

.

H_2O — 2gH — $\frac{2}{16} = \frac{1}{8}$
— 16gO

Mg_2O_2 — 2xH — $\frac{2}{32} \frac{1}{16}$
— 2xO

} fixed ratio by mass

1. $C + O_2 \longrightarrow CO_2$

2. $Na_2CO_3 \xrightarrow{\Delta} CaO + CO_2$

3. $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$

CO_2 — 1x6 — $= \frac{3}{8}$
— 2xO

3. Law of multiple proportion or ratio:-

According to this law when two elements combine in different mass ratio several compounds will be formed. If the mass of element is given (fix) then the mass of another element will be a simple multiple ratio.

Ques- If N_2 and O_2 combine to form different compounds

Mass of $N_2(g)$	Mass of $O_2(g)$
~~Mass of O_2~~	
$14 \times 2 = 28$	$16 \times 2 = 32$
$14 \times 2 = 28$	$32 \times 2 = 84$
28	$32 = 32$
28	$80 = 80$

$32 : 84 : 32 : 80$

~~$2 : 3 : 2 : 5$~~

Ques- If two elements A and B combine to form different compounds

A	B
12 ~~$\times 2$~~	28
12	28
$12 \leftarrow 24 / 2$	$28 / 2 \rightarrow 14$
12	56

which rule of chemical combination is followed by this data → 28 : 28 : 14 : 56

2 : 2 : 1 : 4

This data follows multiple proportion of data

Ques- If N_2 and O_2 combines to form different oxides

N_2O NO N_2O_3 N_2O_4 N_2O_5

verify with the help of atomic masses does this formation follows law of multiple proportion

	N	O
N_2	28	16
N	14x2	16x2
N_2	28	48
N_2	28	64
	28	80

16 : 32 : 48 : 64 : 80

1 : 2 : 3 : 4 : 5

Ques- Formation of SO_2 and SO_3 from Sulphur (S) and Oxygen. Does this formation follow law of multiple propotion

	S	O
SO_2	32	32
SO_3	32	48

32 : 48

2 : 3

* Limitation of Law of Conservation of Mass

Nuclear reactions are the limitation of conservation of mass because here mass is converted into high amount of energy

$$E = mc^2$$

* Limitation of Law of definite Proportion

Isotope — Same A.N.
Diff. A M

H_2O — 2XH = $\frac{2}{16} = \frac{1}{8}$
1XO

D_2O — 2XH = $\frac{4}{16} = \frac{1}{4}$
1X16

} Ratio

4.→ Avagadro's Law

100ml		100mL	→ STP
1000mol		1000mol	

According to this law equal volume of all gases contain equal no. of molecules at STP(standard temp. pressure)

Ex:- $H_2 + Cl_2 \longrightarrow 2HCl$
(g) (g) (g)

At STP
100 ml $C_2H_4(g)$ = Y mol.
200 ml $CO_2(g)$ = 2Y mol.
300 ml of $CO(g)$ = 3Y mol.
400 ml of $O_2(g)$ = 4Y mol
75 ml of (g) = 0.75Y

5 → Gay Lossac's Law :-

According to this law gaseous reactants combine to form gaseous products. They do so in terms of volume which will be a simple ratio.

Ex :- $H_2(g) + Cl_2 \longrightarrow 2HCl$

1 vol. 1 vol. 2 vol.

100 ml 100 ml 200 ml

Ques - If H_2 and Cl_2 reacts to form HCl gas and we have taken 500 ml H_2. How much Cl_2 is required?
2. How much HCl will be formed ?

$H_2 + Cl_2 \longrightarrow 2HCl$

500ml 500ml 1000ml

Ques - If N_2 and H_2 reacts together to form NH_3 (Ammonia) if 100 ml N_2 is taken in the rxn how much H_2 will be required and How much NH_3 will be formed?

$N_2 + 3H_2 \longrightarrow 2NH_3$

100ml 300ml 200ml

Ques - If 90 ml H_2 is taken. How much N_2 is required

$N_2 + 3H_2 \longrightarrow 2NH_3$

30ml 90 ml 60 ml

Ques If 90ml H_2 and 90ml N_2 are taken in a reaction vessel then what will be the resultant solution?

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

90ml 90ml ~~60ml~~ 2vol

30ml 1 ↓

60 ml 3vol 60ml

Ques - If the cumbstion of CH_4 is given in a simple reaction

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

If we have taken 500ml CH_4 what will be the volume of other reactant and the products?

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

~~500~~ ~~1000~~ ~~250~~

500ml 1000ml 500ml ~~1000ml~~

→ Atomic mass:-

Atomic mass of any element is the average relative mass of its atom in comparison it with mass of ~~C-12 Or~~ C-12.

Ex:- Atomic mass of Oxygen is 16 u.

→ Molecular mass:-

- Molecular mass of any substance is the average mass of its molecules in comparison to C-12 isotope.
- Molecular is the sum of atomic masses of elements present a molecule It is obtained by multiplying the atomic mass of each element by the no. of its atoms and adding together

$CH_4 \rightarrow 1 \times C - Mass + 4 \times H - mass$

$= 1 \times 12 + 4 \times 1$

$= 16\ u$

B $C_6H_{12}O_6$

$= 12 \times 6 + 1 \times 12 + 16 \times 6$

$= 72 + 12 + 96$

$= 180\ u$

$C_{12}H_{12}O_{11}$

$= 12 \times 12 + 1 \times 22 + 16 \times 11$

$= 144 + 22 + 176$

$= 342\ u$ $342\ u$

Formula mass :- Formula mass of any ionic compound is the mass of all ions present in one formula unit. (Only Ionic compound)

Formula mass of NaCl

$Na^+Cl^- \rightarrow 23 + 35.5$

$\Rightarrow 58.5\ u$

$CaCl_2 \rightarrow 40 + 35.5 \times 2$

$111\ u$

→ Average Atomic Mass:-

$$\frac{\%\text{ Natural Abun. } \times \text{A.M. of that isotope} + \%\text{ Nat. Ab(2)} \times \text{A.M. of (2}}{\%\text{ N (1+2)}}$$

Cl — 35 — 75%

37 — 25%.

$$\frac{75 \times 35 + 25 \times 37}{75 + 25}$$

$$= \frac{75 \times 35 + 25 \times 37}{75 + 25} = \boxed{35.5u}$$

→ Gram Atomic Mass:-

It is the mass of any atom (element) expressed in grams.

Ex:- Atomic mass of C-Atom = 12u

Gram - - - - - - - - - = 12g

Atomic mass of N-Atom = 14u

Gram - - - - - - - - - = 14g

→ Gram molecular Mass:-

It is the mass of any molecule expressed in gram.

Ex:- Molecular mass of Ethyl Alcohol (C_2H_5OH) = 24 + 1 × 6 + 16

= 24 + 6 + 16

= 46u

→ Gram formula mass:-
It is the formula mass of ionic compounds expressed in grams.

Ex:- Formula mass of NaCl = 58.5u
Gram formula mass of NaCl = 58.5g

- Formula mass of $CaCl_2$ = 111u
Gram formula mass of $CaCl_2$ = 111g

* Mole Concept
1 mole is the amount of substance which contains as many as particles or entities as there are atoms in exactly 12g of C-12 isotope.
1 Mole = 6.022×10^{23} entity

Mole Concept
- In terms of Mass
- In terms of Number
- In terms of volume

→ In terms of Mass:- A mole is defined as that amount of substance which has mass equal to gram atomic mass if the substance is molecular.

Ex:- 1 mole of C-Atom = 12g
0.5 mole - - - $\frac{12}{2}$ = 6g

1 mole of Na Atom = 23g
1 mole of N-Atom = 14g

1 mole of H_2O molecules → 18 g molecules
1 mol of $C_{12}H_{22}O_{11}$ → 342 g molecules
1 mol of C_2H_5OH → 46 g molecules

Q- 0.5 mole of water molecules contains

a.) 27 g molecules
b.) 18 g molecules
c.) 36 g molecules
d.) None of the above

H_2O = 18 g molecules

$= \frac{18}{2}$ g

→ In terms of Number :- A mole is defined as amount of substance which contains Avagadro no. $N_A = 6.022 \times 10^{23}$ molecules of the substance is atomics molecular

$N_A = 6.022 \times 10^{23}$ atoms

Ex:- 1 mol of C atom = 6.022×10^{23} atoms
1 mol of H_2O molecules = 6.022×10^{23} molecules
1 mol of Na (Sodium) = 6.022×10^{23}
1 mol of NaCl = 6.022×10^{23} formula units of NaCl

OR

6.022×10^{23} of Na^+ ions
6.022×10^{23} Cl^- ions

1 mol of $CaCl_2$ = 6.022×10^{23} formula units of $CaCl_2$
6.022×10^{23} of Ca^{+2} ions
12.044×10^{23} of Cl^- ions

Ca^{+2} $2Cl^-$

→ In terms of volume:- In case of gases a mole is defined as that amount of gas which has the volume 22.4L at STP

1 mole of oxygen gas = 22.4 Ltr. at STP
1 mole of CO_2 gas = 22.4 Ltr. at STP
0.5 mole of oxygen gas = 11.2 Ltr at STP

* Percentage Composition:- It is the ratio in which its constituent elements are present in given compound

$C_6H_{12}O_6$ → Total mass 180

% comp of C = $\frac{\text{Mass of carbon}}{\text{Total mass}} \times 100$

$= \frac{6 \times 12 - \text{Mass}}{180} \times 100$

$= \frac{\cancel{6} \times \cancel{12}}{\cancel{180}_{3}} \times 100\%$

$= 40\%$

% comp. of H = 6.6%

$\frac{\text{Mass of H}}{\text{T. mass}}$

$= \frac{\cancel{12}}{\cancel{180}_{3}} \times \cancel{100}_{5}$

$= \frac{20}{3} = 6.6\%$

% Comp. of oxygen

$= 53.4$

$100 - (40 + 6.6)$

$= 53.4\%$

Ques- Calculate the percentage composition of each element present in Na_2SO_4?

Na_2 S O_4

↓ ↓ ↓

23 32 16

% comp. of Na = $\frac{\text{Total mass of Na}}{\text{Total mass}} \times 100\%$

$= \frac{2 \times \text{Na-Mass}}{142} \times 100$

$\frac{46}{142}^{23} \times 100 = \frac{2300}{71} = 32.1\%$

$= \frac{3}{6} \times 23 \times \frac{50}{100} \quad \frac{2300}{7}$

$\frac{140}{71}$

$= 32.4$

% comp. of S $\frac{\text{Mass of S}}{\text{Total mass}} \times 100$

$\frac{32}{142}^{16} \times 100 = \frac{1600}{71} = 22.5\%$

% comp. of Oxygen = $\frac{\text{Mass of O}}{\text{T. mass}} \times 100$

$= \frac{32}{142} \times 100 \quad \frac{425}{}$

$= \frac{3200}{71} = 45.4\%$

Ques- Calculate the percentage composition of each element present in ethanol and find element with least compound.

C_2H_5OH

% composition of Carbon = $\frac{\text{Mass of C}}{\text{Total mass}} \times 100\%$

$= \frac{24}{46_{23}} \times 100$ $= \frac{24}{46_{23}} \times 100$

$= \frac{1200}{23} = \boxed{52\%}$

% composition of H → $\frac{\text{Mass of H}}{\text{T. mass}} \times 100\%$

$= \frac{6}{46_{23}} \times 100 = \frac{300}{23}$ 13.0%

$\boxed{= 13.13\%}$

% composition of O → $\frac{\text{Mass of O}}{\text{T. mass}} \times 100\%$

$= \frac{16}{46_{23}} \times 100$

$= \frac{800}{23} = \boxed{34.8\%}$

Element with least composition = Hydrogen

→ Calculate. - ① No. of atoms of Carbon = 1 mole of carbon = 2 ✱ = 2 X 3 =
- ② No. of atoms of Hydrogen 1 mole of H = 6 atoms = 3 X 6 = 18 atom
- ③ No. of molecules in C_2H_6 molecules

Three moles of C_2H_6 contains -

1 mole of C_2H_6 = 6.022×10^{23} ~~molecules~~ molecules
3 mole of C_2H_6 - = $3 \times 6.022 \times 10^{23}$ molecules
= 18.066×10^{23} molecules

→ Empirical & Molecular formula

⇒ Molecular formula = It is the chemical formula which represent actual number of atoms of each element in a given compound.

Empirical formula - It is the chemical formula which represents simple ratio of no. of atoms of each element in a given compound.

Ex:- Mol. for = $C_6H_{12}O_6$
Emp. for = CH_2O

Relation -

$C_6H_{12}O_6 = 6 \times CH_2O$

Molecular formula = n X Empirical formula

No. of moles = $\frac{\text{Given mass}}{\text{Molar mass}}$

Ques- Empirical formula of an oxide of ions which has

69.9% iron (Fe)
30.1% O_2 by mass

Symbol	% mass	Atomic mass	no of moles	Ratio	Simple ratio
Fe	69.9	56	$\frac{69.9}{56} = 1.25$	$\frac{1.25}{1.25} = 1 \times 2$	2
O	30.1	16	$\frac{30.1}{16} = 1.88$	$\frac{1.88}{1.25} = 0.5 \times 2$	3

Fe_2O_3

Ques- A welding gas contains Carbon & Hydrogen only. The mass percent of C is 92.33. Calculate the Emplrical formula.

Symbol	% mass	Atomi mass	no. of moles	Ratio	Simple ratio
C	92.33	12	$\frac{92.33}{12} = 7.69$	$\frac{7.69}{7.67} = 1$	1
H	7.67	1	$\frac{7.67}{1} = 7.67$	$\frac{7.67}{7.67} = 1$	1

Ques- A compound contains 4.07% H and 24.2% Carbon and 71.65% Chlorine if its molar mass is 98.88 g what is E.f. and calculate Molfar. also?

Symbol	% mass	At. mass	No. of moles	ratio	E. form
H	4.07%	1	$\frac{4.07}{1}=4.07$	$\frac{4.07}{2.01}=2$	2
C	24.27%	12	$\frac{24.27}{12}=2.0225$	$\frac{2.0225}{2.07}=1$	1
Cl	71.65%	35.5	$\frac{71.65}{35.5}=2.01$	$\frac{2.01}{2.01}=1$	1

Empirical formula $= CH_2Cl$

Molecular formula $= n \times$ empirical formula

Molecular mass $= [CH_2Cl] = 1\times C + 2\times H + 1\times Cl$

$= 1\times 12 + 2\times 1 + 1\times 35.5$

$= 12 + 2 + 35.5$

$= 49.5\,g$

Molar mass $= 98.96 = 1.99 = 2$ [app.]

Emp. formula mass 49.5

Molecular formula $= n \times$ emp. formula

$= 2 \times CH_2Cl$

$= C_2H_4Cl_2$

~~Ques~~ Stochiometry

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$$

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

$$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

→ Before calculation of the reaction we have to balance the given chemical equation because of law of conservation of mass or atoms.

Ex: ~~$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$~~

→ In terms of mass

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

- 16g methane reacts with 64g Oxygen to give 44g of CO_2 and 36g of H_2O

16g methane reacts with 64g Oxygen to give 44g of CO_2 and 36g of H_2O

→ In terms of mol

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

1mol 2mol 1mol 2mol

1 mole of CH_4 react with 2 mole of oxygen to give 1 mole of CO_2 and 2 mole of H_2O

→ In terms of molecules

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

1 molecule 2 molecule 1 molecule 2 molecule

1 molecule of CH_4 is reacting with 2 molecules of O_2 to give 1 molecule of CO_2 and 2 molecules of H_2O

Qus- Calculate the amount of CO_2 that could be produced when

(i) 1 mol of C reacts with O_2 (C is burnt in air)

$$C + O_2 \longrightarrow 2CO_2$$

1 molecule 1 molecule 2 molecule

$CO_2 = 12 + 2 \times 16$

$= 12 + 32$

$= 44g$

(ii) 1 mol of C is burnt in $16g\ O_2$

$$C + O_2 \longrightarrow CO_2$$

1 mol 1 mol 1 mol

12g 32g 44g

6g 16g 22g

(iii) 2 moles of C are burnt in $16g\ O_2$

$$C + O_2 \longrightarrow CO_2$$

1 molecule 1 molecule 1 molecule

12g 32g 44g

6g $\longleftarrow$ 16g $\longrightarrow$ 22g

Limiting reagent = O_2

Ncert Ques 23 Identify the limiting ~~reagents~~ reagents if any in the following reactions

$$A + B_2 \longrightarrow AB_2$$

(i) 300 atoms of A + 200 molecules of B

Limiting Reagent → B

(ii) 2 mole of A + 3 mole of B

Limiting Reagent → A

(iii) 100 atoms of A + 100 molecules of B

No Limiting Reagent present.

* Concentration of a Solution

- Concentration terms
  - Mass %
  - Mole fraction
  - Molarity
  - Molality

→ Mass % is the one way of expressive the concentration of an element in a compound or a component in a mixture

Mass% = $\frac{\text{Mass of that compound}}{\text{Total Mass}} \times 100\%$

Ques- If 2 gram of substance A is dissolved in 18 g of water. Calculate mass % of A

$$\frac{2}{20} \times 100\%$$

$$= 10\%$$

5% (w/w) →
- Solute - 5g
- Solvent = 95g
- 100g - Solution

5% (w/v) →
- Solute - 5g
- Solvent - x
- Solution - 100ml

5% (v/v) →
- Solute - 5ml
- Solvent - 95ml
- Solution - 100ml

→ $\frac{90\,g\ H_2O}{18} + \frac{1026\,g\ Sugar}{342}$

→ 5 mol H_2O + 3 mol Sugar
Solvent Sugar

→ 5 mol H_2O + 5 mol Sugar
(l) Solvent (s) Solute

→ 5 mol H_2O + 5 mol ~~C_2H_5OH~~ C_2H_5OH
Solvent (l)

- H_2O is universal solvent

* Mole fraction:-
Ratio of no. of moles of a particular component to the total no. of moles of solution is called Mole fraction.

A → Solute
B → Solvent

Mole fraction of solute = $\frac{nA}{nA + nB}$

" " solvent = $\frac{nB}{nA + nB}$

Ques- Calculate the mole fraction of solute when two moles of solute are dissolved in 3 moles of solution?

$$\text{Mole fraction of solute} = \frac{nA}{nA + nB}$$

$$\chi_A = \frac{2}{2+3} \quad -(1)$$

$$= \frac{2}{5}$$

(ii) Calculate the mole fraction of solvent also?

$$\chi_B = \frac{nB}{nB + nB} \quad -(ii)$$

Eq (1) and (2)

$$\chi A + \chi B = \frac{nA}{nA+nB} + \frac{nB}{nA+nB}$$

$$= \frac{nA + nB}{nA+nB} \quad -(1)$$

$$\chi A + \chi B = 1$$

$$\chi B = 1 - \chi A$$

$$= 1 - 2$$

$$\chi B = -1 \text{ (Ans)}$$

$\chi A = nA$

$\chi B = nB$

Eq 1 and Eq 2

$$\frac{\chi A}{\chi B} = \frac{nA}{nB}$$

* Molarity:-

Molarity is defined as no. of moles of solute per ~~unit~~ litre solution. It denoted by 'M'.

$$M = \frac{\text{no. of moles of solute}}{\text{Vol. of solution (in lit.)}}$$

$$M = \frac{\text{no. of moles of solute}}{\text{Vol. of solution (in ml)}} \times 1000$$

$$\frac{\text{No. of moles of solute}}{\text{Mass of solution (g)}} \times 1000$$

$$\boxed{V = \frac{\text{Mass}}{\text{density}}}$$

* Molality:-(m)

It is defined as no. of moles present in 1 Kg of solvent.

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

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

$$m = \frac{\text{no. of moles of solute}}{\text{mass of soln. - mass of solute (g)}} \times 1000$$

$$m = \frac{\text{no. of moles of solute} \times 1000}{\text{density of soln (g/ml)} \times \text{vol. of soln (ml)} - \text{mass of solute (g)}}$$

→ Effect of Temperature on Concentration Terms

The quantities which directly involves volume always changes with change in temperature.

- Mass % → $\frac{\text{Mass}}{\text{Soln (mass)}}$ X, no change
- Mole fraction → $\frac{n_1}{n_1+n_2\,(\text{Soln})}$ X, no change
- Molarity → $\frac{n}{V(\text{soln})}$ → change
- Molality → $\frac{n}{\text{mass (solvent)}}$ → No change

(A) Molality is preferred or over molarity

(R) Molality changes with change in temperature because it contains mass

Ans (C)

Ques- Calculate the mass of Sodium acetate (CH_3COONa) required to make 500 ml of 0.8375 molar solution molar mass of sodium acetate is 82 g/mol

$$\text{Molarity} = \frac{\text{no. of moles}}{\text{Vol. of soln(ml)}} \times 1000$$

$$0.375 = \frac{\text{Vol.} \times 1000}{82 \times 500}$$

$$w = 15.38\,g$$

n = mass / molar mass

Ques- 49g H_2SO_4 is present in 250 ml of solution calculate molarity.

$w = 49g$
$M = 98\ g/mol$
$V = 250\,ml$
Molarity = ?

$$\text{Molarity} = \frac{\text{mass } (w) \times 1000}{\text{Molar mass} \times V(ml)}$$

$$= \frac{49 \times 1000}{98 \times 250} = 2\,M$$

Ques Calculate the mole fraction of solute when 4% (w/w) NaOH soln is prepared in water?

4·1·(w/w)

- → solute → 4g → NaOH → 40 ⇒ $\frac{4}{40}$
- → solvent (100-4) = 96g → water = 18 ⇒ $\frac{96}{18}$
- → Soln → 100g

$$\chi_{NaOH} = \frac{\frac{4}{40}}{\frac{96}{18}+\frac{4}{40}} = \frac{\frac{1}{10}}{\frac{96}{18}+\frac{1}{10}}$$

$$= \frac{9}{489} = \frac{3}{163}$$

Q- from the above data calculate molality?

$$= \frac{\frac{4}{40}}{96(g)} \times 1000$$

$= 0.1 \times 1000$ ~~500~~ ~~250~~ 125

~~96~~ ~~48~~ ~~24~~ 12

$$= \frac{12.5}{12}$$

M = 1.41 (Ans)

Ques- Calculate the Molarity of 4 % [w/v] NaOH aq. Soln

Mass of solute = 4g/40 = $\frac{1}{10}$

Soln Vol → 100ml

$$M = \frac{\text{no. of moles of solute}}{\text{Vol. of Soln (ml)}} \times 1000$$

$$= \frac{\frac{1}{10}}{100} \times 1000$$

$$= 1\ M$$

→ Dalton's Atomic Theory

Postulates

1. Atom is indivisible and it is the smallest unit of matter.
2. All the atoms of same element are identical in all aspects. (Size, shape, etc.)
3. All the atoms of different element are different in all aspects.
4. Matter can neither be created nor be destroyed
5. Atom can combine in different mass ratio it produces different compounds.

→ Limitations / Drawbacks

1. Atom can be further divided into sub atomic particles (electron, proton, neutron).

2. It cannot explain why atoms combine.
3. It cannot explain the nature of binding forces.
4. It ~~does~~ cannot explain why the atoms of different element are different in all aspect.

Ques- If 10 volumes of H_2 gas reacts with 5 volumes of O_2 gas How many volumes of water vapour could be produced?

$$\underset{(g)}{2H_2} + \underset{(g)}{O_2} \longrightarrow \underset{(g)}{2H_2O}$$

10 vol. 5 vol. 10 vol.