Toppersnotes
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CSIR-NET

Council of Scientific & Industrial Research

CHEMICAL SCIENCE

VOLUME - I

PHYSICAL **CHEMISTRY**

SIERRA INNOVATIONS

Index

Electro chemistry

PHY. GENERAL

General Physical

$$mol = \frac{\text{Mass in gm } (W)}{\text{molar mass } (M)} \longrightarrow (1)$$

$$mol = \frac{N_o}{N_A} \longrightarrow (2)$$

$$Mol = \frac{V_L}{22.4} \longrightarrow (3)$$

$$\frac{W}{M} = \frac{N_o}{N_A} = \frac{V_L}{22.4}$$

Molar Mass → mass of 1 mol of subs.
(or)
Mass of N_A particles.

- Atom ⇓ Gram Atomic mass (GAM)
- molecule ⇓ Gram molecular mass (GMM)
- Formula (Ionic Cmpd) ⇓ Gram formula Mass (GFM)

GAM:
- H → 1 gm
- O → 16 gm
- C → 12 gm
- K → 39 gm
- Na → 23 gm
- N → 14 gm

GMM:
- H_2 → 2 gm
- H_2SO_4 → 98 gm
- SO_2 → 64 gm
- H_2O → 18 gm
- O_2 → 32 gm

GFM:
- NaCl → 58.5 gm
- KCl → 74.5 gm

SOLUTION

→ Homogenous mix. of 2 or more components c/o so.

→ Depending upon the no. of Component ⊕nt in the solⁿ it is classified into following categories:-

Binary solⁿ → 2 component.
Ternary solⁿ → 3 —"—
Quartenary sol → 4 —"—

* In the solⁿ, one component is always solvent & remaining all are solute.

Binary solⁿ
↙ ↘
Solute — Solvent.

→ Component whose phy. state is same as that of the final solⁿ k/o solvent & another cmpnt c/o solute

→ If both the component s in same phase. then the cmpnt c is ⊕nt in excess c/o solvent & the other i,e ⊕nt in smaller amount c/o solute.

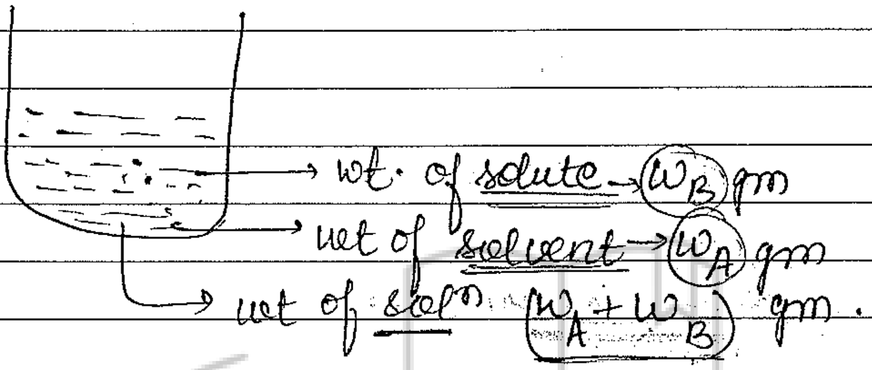
Concentration :

→ For a given solⁿ, the amnt of solute dissolved in unit volume / unit weight of solvent / solⁿ c/o so.

→ It is applicable for solid – liq & liq – liq solⁿ. (Gases ni Pressure chlta h)

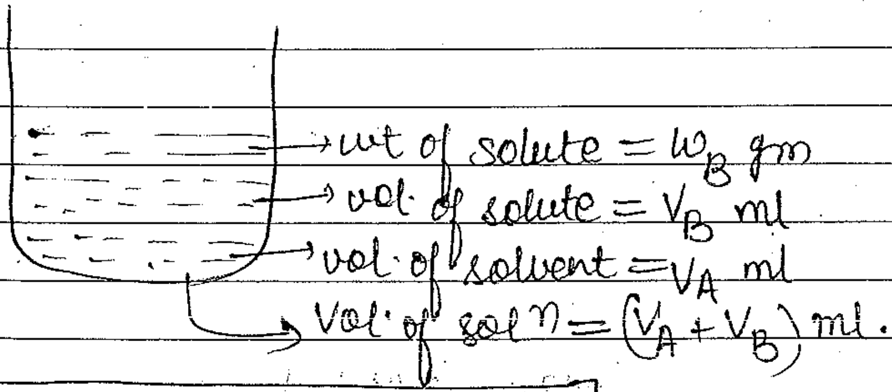
Conc. terms

⟹ % weight/wt (% w/w) ⟶ Amount of solute in gm dissolved in 100 gm of sol^n.



$$\% \frac{w}{w} = \frac{W_B}{W_A + W_B} \times 100$$

⟹ % wt/vol. (% w/V) ⟶ Amount of solute in gm dissolved in 100 ml sol^n.



$$\% \frac{w}{V} = \frac{W_B \text{ gm}}{(V_A + V_B) \text{ ml}} \times 100$$

⟹ % $\frac{vol}{vol}$ $\left(\%\frac{V}{V}\right)$ → Always applicable for liq in liq soln.

It is vol of solute in ml dissolved in 100 ml of soln.

vol. of solute → V_B ml.
vol. of solvent → V_A ml.
— " soln → $(V_A + V_B)$ ml

$$\%\frac{V}{V} = \frac{V_B \, ml}{(V_A + V_B) ml} \times 100$$

Ppm conc (parts per million) 10^6

→ This conc unit is used in the soln in c amount of solute is very low/less.
→ Generally used to represent the Hardness of water
→ It is the wt of solute in gm dissolved in 1 million gm (10^6 gm) of soln.

$$ppm = \frac{w_B}{(w_A + w_B)} \times 10^6$$

$$ppm = \left[\frac{w_B}{(w_A + w_B)} \times 100\right] \times 10^4$$

$$ppm = \left(\%\frac{w}{w}\right) \times 10^4$$

ppb (parts per billion)

→ It is amount of solute in gm dissolved in 1 billion gm (10^9) gm of the solⁿ.

$$ppb = \frac{w_B}{(w_A + w_B)} \times 10^9$$

$$ppb = \left[\frac{w_B}{(w_A + w_B)} \times 100\right] \times 10^7$$

$$ppb = \left[\frac{w_B}{(w_A + w_B)} \times 10^6\right] \times 10^3$$

$$ppb = ppm \times 10^3$$

$$ppb = \frac{w_B}{w_A + w_B} \times 10^9 = \%\frac{w}{w} \times 10^7 = ppm \times 10^3$$

Q. If in a sample of Hard water ppm conc. of Ca is 400 ppm, then cal the % of Ca in this sample?

Ans → 0.04

$$ppm = \%\frac{w}{w} \times 10^4$$

$$400 = \%\frac{w}{w} \times 10^4$$

$$\%\frac{w}{w} = 0.04$$

$\frac{4\cancel{00}}{1\cancel{0000}} = 0.04$

gm to kg → ÷ 1000

kg to gm → × 1000

Q. An aq. solⁿ of H_2SO_4 % wt of H_2SO_4 is 20% then cal. mass of H_2SO_4 in 5 kg solⁿ.

~~$\% \frac{w}{V} = \frac{w_B}{V_A + V_B} \times 100$~~

$\% \frac{w}{w} = 20\%$ of H_2SO_4 (m+IB)

↳ 20 gm H_2SO_4 in 100 gm solⁿ

$$\frac{20}{100} \times 5000 \text{ gm}$$

$= 1000$ gm of H_2SO_4.

Strength :

→ Amount of solute in (gm) dissolved in (1 Lt) of solⁿ.

$$\text{Strength} = \frac{w_B}{(V_A + V_B)\,ml} \times 1000$$

$$\text{Strength} = \left[\frac{w_B}{(V_A + V_B)\,ml} \times 100\right] \times 10$$

$$\text{Strength} = \left(\% \frac{w}{V}\right) \times 10$$

MOLARITY : (M)

→ No. of moles of solute dissolved in (1 lt) of (solⁿ).

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute}}{\text{vol. of sol}^n \text{ in (lt)}} = \frac{n_B}{V_L}$$

$M \times V_L = n_B$ → no. of mols of solute.

$$\text{Molarity} = \frac{\dfrac{\text{no. of milimol of solute } (n_B)}{1000}}{\dfrac{\text{Vol. of sol}^n \text{ in ml}}{1000}}$$

$$M = \frac{\text{No. of millimol of solute } (n_B)}{\text{Vol. of sol}^n \text{ in ml}}$$

$$\boxed{M = \frac{n_B (\text{millimol})}{V_{ml}}}$$

$$\boxed{M \times V_{ml} = n_B (\text{millimol})}$$

No. of millimols of solute dissolved in 1 ml of solⁿ also g/o Molarity. (M)

$$M = \frac{n_B(\text{mol})}{V_L}$$

$$M = \frac{n_B(\text{mol})}{V(\text{ml})} \times 1000$$

$$M = \frac{w_B}{M_B \times V_{ml}} \times 1000$$

(M_B = molar mass of solute.)

$$M = \left(\frac{w_B}{V_{ml}} \times 100\right) \times \frac{10}{M_B}$$

$$M = \left(\frac{\% w}{V}\right) \times \frac{10}{M_B}$$

$$M = \left[\frac{w_B}{V_{ml}} \times 1000\right] \times \frac{1}{M_B}$$

$$M = \frac{\text{Strength}}{M_B}$$

(M → molarity)

Semimolar = $\frac{M}{2}$

Decimolar = $\frac{M}{10}$

Centimolar = $\frac{M}{100}$

Pentimolar = $\frac{M}{5}$

Pentamolar = 5M

Decamolar = 10M

NOTE

Since molarity is the $\frac{wt}{vol}$ conc. term, so it is temp. dependent conc. term.

सारे $\frac{wt}{vol}$ conc. terms are temp. dependent.

→ All $\frac{wt}{vol}$ conc. terms are temp dependent & all $\frac{wt}{wt}$ conc. terms are temp. Independent.

$1 ml = 1 cm^3$

$1 lt = 1000 ml = 1000 cm^3$
$= 10 cm \times 10 cm \times 10 cm$
$= 1 dm \times 1 dm \times 1 dm$
$= 1 dm^3$

$1 dm = 10 cm$

$1 lt = 1000 ml = 1000 cm^3 = 1 dm^3$

Q. 2gm of NaOH dissolved in H_2O & sol^n is made to 500 cm^3 in volumetric flask. Find out Molarity of the sol^n.

NaOH → 40 gm
Mol. mass

$$M = \frac{w_B}{m_B \times V_{ml}} \times 1000$$

$$= \frac{2}{40 \times 500} \times 1000 = \frac{1}{10} m \Rightarrow .1M$$

Q. How many gm of Sod. sulphate is req. to prepare a 250 ml sol^n whose conc. is 0.688 M.

$$M = \frac{w_B}{m_B \times V_{ml}} \times 1000$$

* (Sod. sulphate = 142 gm
Mol. mass)

$$0.688 = \frac{w_B}{142 \times 250} \times 1000$$

Na_2SO_4
23+23+32+16×4 = 142

w_B = 4.42 gm.

Q. What amount of 95% of sod. Carbonate (Na_2CO_3) req. to prepare 250 ml pentimolar sol^n.

$$m = \frac{w_B}{M_B \times V_{ml}} \times 1000 \qquad \frac{m}{5} = m$$

$$\frac{m}{5} = \frac{w_B}{106 \times 250} \times 1000$$

$$w_B = \frac{106 \times 250}{1000 \times 5} = \frac{106}{20} = 5.3 gm$$

$95\ gm\ Na_2CO_3 \longrightarrow 100\ gm$

$1\ gm \text{ ---- '' ---- } \longrightarrow \frac{100}{95}\ gm$

$5.3\ gm \text{ ---- '' ---- } \longrightarrow \frac{100 \times 5.3}{95} = \boxed{5.57}\ gm$

Q. Cal. Molarity of Conc. of H_2SO_4 of specific gravity 1.84 & having 98% H_2SO_4 by wt.

(Specific gravity → density)

→ 98% H_2SO_4 by wt. (98 gm H_2SO_4 in 100 gm H_2O)

→ d = 1.84

→ m = ?

Soln

$$m = \frac{W_B}{m_B \times V_{ml}} \times 1000$$

$$= \frac{98}{98 \times \frac{100}{1.84}} \times 1000$$

$$= \frac{1.84 \times 1000}{100}$$

$$= \boxed{18.4\ M}$$

$d = \frac{m}{V}$

$V_{ml} = \frac{m}{d}$

$V_{ml} = \frac{100}{1.84}$

98% H_2SO_4 given है mtlb 100 gm soln है

(wt given है volume change)

(wt of soln given है ∴ Vol nikali जा सकती है)

Molality : (m)

→ No. of moles of solute dissolved in 1 kg of solvent

$$m = \frac{\text{No. of moles of solute } (n_B)}{\text{Amount of solvent in kg}} \qquad \frac{n_B}{w_A \text{ kg}}$$

$$m = \frac{n_B \text{ (moles)}}{\text{Amount of solvent in gm}} \times 1000$$

$$m = \frac{w_B}{M_B \times w_A \text{ (gm)}} \times 1000$$

$$m = \frac{n_B \text{ (millimol)}}{w_A \text{ (in gm)}}$$

Molality is the no. of millimoles of solute dissolved in 1 gm of Solvent.

Molality is Temp Independent conc term bcz it is ~~wt/vol~~ (wt/wt)

Q. What is molality of the solⁿ c contain 18 gm Glucose into 250 gm H_2O.

$$m = \frac{18}{180 \times 250} \times 1000 = \frac{10}{25} = 0.4\,m$$

$C_6H_{12}O_6$

$12\times6 + 12 + 16\times6$

$72 + 12 + 96$

(180)

16 × 3 = 48

+12 + 48 = 100

Q. Cal: molal conc. of sol^n containing 50% by wt of $CaCO_3$?

$\Rightarrow$ 50 gm $CaCO_3$ in 100 gm sol^n.

{ molality formula solvent use hota h ; given sol^n h! }

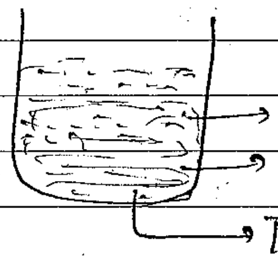
50 solute   50 gm solvent

$$m = \frac{w_B}{m_B \times w_A} \times 1000$$

$$= \frac{50}{100 \times 50} \times 1000 = 10m$$

Mole Fraction

$\longrightarrow$ Defined as no. of moles of component present in per unit mol of the sol^n.



solute (n_B)

solvent (n_A)

Total moles in $sol^n = n_B + n_A$

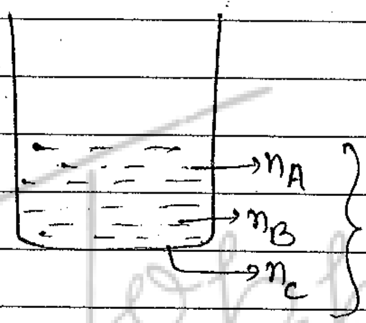
Mole fraction of Solute :-

$$X_B = \frac{n_B}{n_A + n_B} = \frac{\frac{w_B}{m_B}}{\frac{w_A}{m_A} + \frac{w_B}{m_B}}$$

Mole fraction of Solvent :

$$X_A = \frac{n_A}{n_A + n_B} = \frac{\frac{w_A}{m_A}}{\frac{w_A}{m_A} + \frac{w_B}{m_B}}$$

$$X_A + X_B = 1$$



Total moles of sol^n

⇓

$n_A + n_B + n_C$

$$X_A = \frac{n_A}{n_A + n_B + n_C}$$

$$X_B = \frac{n_B}{n_A + n_B + n_C}$$

$$X_C = \frac{n_C}{n_A + n_B + n_C}$$

$$X_A + X_B + X_C = 1$$

Mole fraction is Temp Independent Conc. term.

CH_3OH
$12+3+16+1 = 32$

H_2O
$2+16$
(18)

Q. Cal. mole fraction of MeOH in a soln that is prepared by adding 50 gm MeOH to 100 gm H_2O.

$$X_B = \frac{\frac{50}{32}}{\frac{100}{18} + \frac{50}{32}}$$

2	18, 32
3	9, 16
2	3, 4
2	3, 2
3	3, 1
	1, 1

(72)

$\frac{18}{72} \times 4$, $\frac{32}{64} \times 2$

$$\frac{\frac{50}{32}}{\frac{400+}{72}}$$

C_2H_5OH

Q. mixture of ~~MeOH &~~ EtOH & H_2O contain 54% H_2O by wt. then Cal. mole fraction of Alcohol in mixture.

54 % H_2O i.e (54 gm H_2O in 100 gm soln)

$$X_B = \frac{n_B}{n_A+n_B} \Rightarrow \frac{\frac{w_B}{m_B}}{\frac{w_A}{m_A} + \frac{w_B}{m_B}}$$

C_2H_5OH
$12\times2+5+16+1$
$24+5+17$
(46)

$$X_B = \frac{\frac{54}{18}}{\frac{46}{46} + \frac{54}{18}}$$

100 gm soltn
- solute → C_2H_5OH → $100 - 54 = 046$
- solvent → H_2O → 54

Normality :

→ No. of gm equivalent of solute dissolve in 1 lt sol^n
→ Represented by (N)

$$N = \frac{\text{gm equivalent of solute}}{\text{vol. of sol}^n \text{ in lts}}$$

$$N = \frac{(\text{gm equivalent})_B}{V_L}$$

$$N \times V_L = \text{gm equivalent.}$$

$$N = \frac{\text{milligm equivalent of solute}}{\text{vol. of sol}^n \text{ in ml}}$$

$$N = \frac{(\text{milligm equivalent})_B}{V_{ml}}$$

$$N \times V_{ml} = \text{milligm-equivalent}$$

No. of milligms equivalent of solute dissolved in 1 ml of soln.

$$\text{gm equivalent} = \frac{\text{mass in gm } (W_B)}{(GEM)_B} \quad (GEM)_B \rightarrow \text{gram eq. mass}$$

$$\text{gm eq} = \frac{W}{E}$$

$$E = \frac{M}{n} \quad n \rightarrow (\text{x factor})$$