Analytical Chemistry

1st Class

Second Lecture

Steps of Analysis:

1. The aim of analysis (determination, identification, separation).
2. Select the analysis method (which depends on: Accuracy in analysis, time, amount of sample to be determined.
3. Prepare the sample.
4. Using separation technique if it's necessary.
5. Analysis.
6. Results and discussion.

Solutions

A homogeneous mixture of two or more of substances.

That is mean: overlapping molecules or ions of solute between molecules or ions of solvent, the product called ***Solution***.

Solution = Solute + Solvent

Chemical Methods for Expressing concentration

1. ***Molarity (M):*** Is the total number of moles of a solute in 1L of solution. Or the total number of millimoles in 1 mL.

$$M = \frac{no.moles\ (solute)}{V.\ Soln.L}$$

No. = number.

Soln. = Solution.

$$Moles = \frac{W}{M.wt.}$$

$$M = \frac{\frac{W}{M.Wt.}}{V} \leftrightarrow \frac{W}{M.wt.\ \times V.L}$$

$$M = \frac{W \times 1000}{M.Wt. \times VmL}$$

This law used for ***solid state*** material

mole/L, mmol/mL → Molar

No. of moles = $M \times V_{(L)}$

No. of millimoles = $M \times V_{(mL)}$

$$M = \frac{Sp.gr.\times\%\times10}{M.Wt.}$$ Molarity of ***liquid state*** solution

$$Specific\ gravity : Sp.gr. = \frac{Density\ of\ Substance}{density\ of\ Water}$$

∵Density of water (H_2O) d (H_2O) = 1 ∴ Sp.gr. = d

Dilution Law: Number of moles of **concentration solution** = number of moles of **dilution solution.**

Conc. Soln.		***dil. Soln,***
no. of moles	=	no. of moles
no. of millimoles	=	no. ofmillimoles

$$M_1 . V_1 = M_2 . V_2$$

2. ***Formality (F):*** It is number of formula weight of solute in liter of solution

$$F = \frac{W\times1000}{F.Wt.\times VL}$$ $$F= F.w/L,\ m.Fw./mL \rightarrow Formal$$

3. ***Normality (N):*** It is the number of equivalents of solute in liter of solution.

$$N = \frac{no.of\ equivalent}{Vol.of\ solution\ (L)}$$

$$no.eq. = \frac{Wt.}{eq.Wt.} \quad ....$$

The equivalent weight (eq.wt.) of a substance is not a constant quantity, but it's value depend upon the reaction, in which it is taken part.

Since; $Eq.wt = \frac{Mwt.}{n}$ n : the reacting units

$$N = \frac{W \times 1000}{eq.wt. \times VmL}$$ For **solid state** material

$$N = eq/L,\ m.eq./mL \rightarrow Normal$$

$$N = \frac{Sp.gr. \times \% \times 10}{eq.wt.}$$ For **liquid state** solution

To calculate the equivalent weight (eq.wt.):

$$eq.wt. = \frac{M.wt.}{n}$$

n =active unite.

n = H^+ (acids).

n = OH^- (bases).

n = charge × number of ions (salt).

n = no.of electrons lost or gained (oxidation –reduction).

Calculate the equivalent weight:

A. Of Element

$$eq.wt. = \frac{A.wt.}{no.of\ oxidant}$$

Ex. 1. What is the eq.wt. of Mg? A.wt. = 24

$$Eq.wt. = \frac{A.wt.}{no.of\ oxidant} = \frac{24}{2} = 12$$

B. Of Acid

$$eq.wt. = \frac{A.wt.}{no.of\ hydrogen\ atoms\ interacting}$$

Ex.1. Calculate the equivalent weight of HCl? M.wt. = 36.5

$$HCl \rightarrow H^+ + Cl^-$$

$$eq.wt.\ of\ HCl = \frac{M.wt.}{no.of\ proton\ replacable\ of\ base}$$

$$eq.wt.\ of\ HCl = \frac{36.5}{1} = 36.5$$

Ex.2. Calculate the equivalent weight of H_2SO_4? M.wt. = 98.

$$H_2SO_4 \rightarrow 2H^+ + SO_4^-$$

$$\text{eq.wt. of } H_2SO_4 = \frac{\textbf{M.wt.}}{\textbf{no.of proton replacable of base}}$$

$$\text{eq.wt. of } H_2SO_4 = \frac{98}{2} = 49$$

So, H_2SO_4 has two reacting units of proton ; there are two equivalents of proton in each mole. While HCl has one reacting unit of proton, there is one equivalent of proton in each mole. So the normality of H_2SO_4 solution is twice its molarity.

$$N \text{ of } H_2SO_4 = M \times 2$$

C. Of Base

$$\boldsymbol{eq.wt.} = \frac{\boldsymbol{M.wt.}}{\boldsymbol{no.of\ reactivehydroxil\ groups}}$$

Ex.1. Calculate the equivalent weight of NaOH? M.wt. = 40

$$\text{eq.wt. of NaOH} = \frac{\textbf{M.wt.}}{\textbf{no.of reactivehydroxil groups}}$$

$$\text{eq.wt. of NaOH} = \frac{40}{1} = 40$$

Ex.1. Calculate the equivalent weight of $Mg(OH)_2$? M.wt.58

$$\text{eq.wt. of } Mg(OH)_2 = \frac{\text{M.wt.}}{\text{no.of reactivehydroxil groups}}$$

$$\text{eq.wt. of } Mg(OH)_2 = \frac{58}{2} = 29$$

D. Of Salt

$$eq.wt. = \frac{M.wt.}{\text{number of metal atoms} \times \text{no.of charge or no.of oxidant}}$$

Ex.: Calculate the eq.wt. of Na_2CO_3?M.wt. = 106

$$\text{eq.wt. of } Na_2CO_3 = \frac{\text{M.wt.}}{2\times(+1)}$$

$$= \frac{106}{2\times(+1)} = 53$$

E. Of material that suffer oxidation reduction

$$eq.wt.\ of\ oxidation = \frac{M.wt.}{number\ of\ loss\ electrons}$$

$$eq.wt.\ of\ reduction = \frac{M.wt.}{number\ of\ gain\ electrons}$$

Ex.: Calculate the eq.wt. of manganese Mn^{+2} and ferrous Fe^{+2} in the equation below?

$$\mathbf{MnO_4 + Fe^{+2} + 8H^{+} + 5e^{-} \rightarrow Mn^{+2} + Fe^{+3} + 4H_2O}$$

$$eq.wt.\ of\ Mn^{+2} = \frac{M.wt.}{number\ of\ loss\ electrons}$$

$$eq.wt.\ of\ Mn^{+2} = \frac{M.wt.}{5}$$

$$eq.wt.\ of\ Fe^{+2} = \frac{M.wt.}{number\ of\ gain\ electrons}$$

$$eq.wt.\ of\ Fe^{+2} = \frac{M.wt.}{1}$$

F. Of Complex Formation Reaction

$$eq.wt. = \frac{M.wt.}{no.of\ oxidant\ of\ ion\ which\ contact\ with\ ligand}$$

Ex.: Calculate the eq.wt. of Nickle Ni^{+2} in the equation below?

$$\mathbf{Ni^{+2} + 2DMG \rightarrow Ni\,(DMG)_2\downarrow}$$

DMG:

$$\begin{array}{l} CH_3 - CH - N - OH \\ \quad\quad\quad\ | \\ CH_3 - CH - N - OH \end{array}$$

$$eq.wt. = \frac{M.wt.}{no.of\ oxidant\ of\ ion\ which\ contact\ with\ ligand}$$

$$eq.wt. = \frac{M.wt.}{2}$$

- What is the relationship between Molarity or Normality with part per million ppm?

$$C\ ppm = \frac{Wt.g}{V.mL} \times 10^6$$

$$M = \frac{W \times 1000}{M.Wt. \times VmL}$$

Multiple denominator and numerator by 10^6

$$M = \frac{W \times 1000}{M.Wt. \times VmL}$$

$$M = \frac{ppm \times 1000}{M.Wt. \times 106}$$

$$M = \frac{ppm}{M.Wt. \times 1000}$$

$$\therefore\ ppm = M \times M.wt. \times 1000$$

$$ppm = N \times eq.wt. \times 1000$$