

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.

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

No. = number.

Soln. = Solution.

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

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

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

This law used for **solid state** material

mole/L, mmol/mL → Molar

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

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

$$M = \frac{Sp.gr. \times \% \times 10}{M.Wt.}$$

Molarity of liquid state solution

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

$$\therefore \text{Density of water (H}_2\text{O)} \quad d(\text{H}_2\text{O)} = 1 \quad \therefore Sp.gr. = d$$

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

Conc. Soln.

no. of moles

no. of millimoles

=

=

dil. Soln,

no. of moles

no. of millimoles

$$M_1 \cdot V_1 = M_2 \cdot V_2$$

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

$$F = \frac{W \times 1000}{F.Wt. \times VL}$$

$$F = F.w/L, m.Fw./mL \rightarrow \text{Formal}$$

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

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

$$\text{no.eq.} = \frac{\text{Wt.}}{\text{eq.Wt.}} \dots$$

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.

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

$$N = \frac{W \times 1000}{\text{eq.wt.} \times V \text{mL}} \quad \text{For solid state material}$$

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

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

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

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

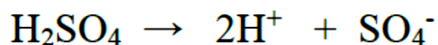
Ex.1. Calculate the equivalent weight of HCl? M.wt. = 36.5



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

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

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



$$\text{eq.wt. of H}_2\text{SO}_4 = \frac{\text{M.wt.}}{\text{no.of proton replacable of base}}$$

$$\text{eq.wt. of H}_2\text{SO}_4 = \frac{98}{2} = 49$$

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.

$$\text{N of H}_2\text{SO}_4 = \text{M} \times 2$$

C. Of Base

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

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

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

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

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

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

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

D. Of Salt

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

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

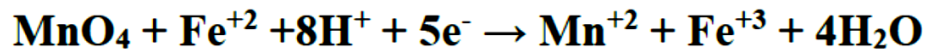
$$\begin{aligned} \text{eq.wt. of } \text{Na}_2\text{CO}_3 &= \frac{\text{M.wt.}}{2 \times (+1)} \\ &= \frac{106}{2 \times (+1)} = 53 \end{aligned}$$

E. Of material that suffer oxidation reduction

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

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

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



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

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

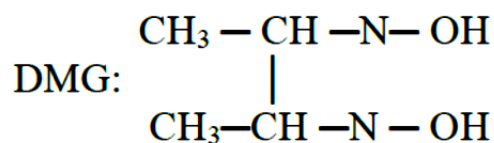
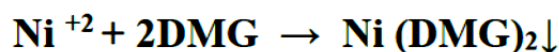
$$\text{eq.wt. of Fe}^{+2} = \frac{\text{M.wt.}}{\text{number of gain electrons}}$$

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

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?



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

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

- 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

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

$$M = \frac{ppm \times 1000}{M.Wt. \times 10^6}$$

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

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

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