Analytical Chemistry
Lecture 1
Concentration

Concentration

The a mount of solute dissolved in a certain amount of solution is called the **concentration** of the solution .Although there are many ways to express a concentration ,they all specify a certain amount of solution .

$$\text{Concentration of a solution} = \frac{\text{amount of solute}}{\text{amount of solution}}$$

Mass Percent

The mass percent (%m / m)concentration of a solution is the percent by mass of solute in a certain mass of solution .This is also known as weigh percent (%wt / wt). In laboratory ,both solute and solution are weighed on a balance .

$$\text{mass \%} = \frac{\text{mass of solute (g)}}{\text{mass of solution (g)}} \times 100\%$$

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Suppose we prepared a solution by mixing 8.0 g of KCl (solute) with 42.0 g of water (solvent). Together the mass of the solute and mass of solvent give the mass of the solution (8.0 g + 42.0 g = 50.0 g) the mass % is calculated by substituting in the values into the mass percent expression .

$$\frac{\text{8.0 g of KCl}}{\text{50.0 g of solution}} \times 100\ \% = 16\ \%\ (\ m\ /\ m\ )$$

8.0 g of KCl + 42.0 g water
(solute) (solvent)

Problem

What is the mass percent of a solution prepared by dissolving 30 g NaOH in 120 g of water ?

Solution

30 g NaOH + 120 g water = 150 g of solution

$$\text{Mass\%} = \frac{30\text{ g NaOH}}{150\text{ g}} \times 100\ \% = 20\ \%\ (\text{ m / m })$$

Volume Percent

Because the volume of liquids or gases can by easily measured , the concentrations of their solutions are often expressed as volume percent (% v / v). The units of volume used in the ratio must be the same, for example, both in milliters or both in liters .

$$\text{Volume \%} = \frac{\text{Volume (mL) solute}}{\text{Volume (mL) solution}} \times 100\ \%$$

We interpret a volume /volume percent as the volume of solute in 100 ml of solution. In the vinegar industry, a label that reads 12% (v/v) means 12 ml of alcohol in 100 ml in vinegar .

Mass / volume percent

A **mass / volume percent** (%m / v), or weigh / volume percent, is calculated by dividing the grams of the solute by the volume of the (ml) of solution and multiplying by 100. Widely used in hospitals and pharmacies, the preparations of intravenous solutions and medicines involves the mass / volume percent .

$$\text{mass / volume \%} = \frac{\text{grams of solute}}{\text{milliters of solution}} \times 100\ \%$$

Problem

What is the mass / volume percent, % (m / v) of bromine in a solution prepared by dissolving 12 g of bromine in enough carbon tetra chloride to make 250 ml of solution ?

Solution

$$\text{mass / volume \%} = \frac{12 \text{ g } Br_2}{250 \text{ ml solution}} \times 100\ \% = 2\ \%\ (\text{m / v})\ Br_2$$

Molarity

When the solutes of solutions take part in reactions, chemists are interested in the number of reacting particles. For this purpose use **Molarity (M),** a concentration that states the number of moles of solute in exactly 1 liter of solution. The molarity of a solution can be calculated knowing the moles of solute and the volume of solution.

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}} = \frac{\frac{\text{Wt of solute}}{\text{M.Wt of solute}}}{\text{Liters of solution}}$$

For example, if 1.0 mole of NaCl were dissolved in enough water to prepare 1.0 L of solution, the resulting NaCl solution has a molarity of 1.0 M. the abbreviation M indicates the units of moles per liter (moles / L).

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}} = \frac{\text{1.0 mole NaCl}}{\text{1.0 L of solution}} = \frac{\text{1.0 mole NaCl}}{\text{1.0 L of solution}}$$

$$= \text{1.0 M NaCl}$$

Problem

What is the molarity of 60 g of NaOH in 0.25 L solution ?

Solution

Because molarity requires moles of solute, we convert grams of NaOH to moles of NaOH using the molar mass NaOH (40) .

$$\underset{\text{Grams of NaOH}}{60\text{ g }\cancel{\text{NaOH}}} \times \frac{1\text{ mole NaOH}}{\underset{\text{Molar mass}}{40\text{ g }\cancel{\text{NaOH}}}} = 1.5\text{ moles NaOH}$$

$$M = \frac{\overset{\text{Moles of solute}}{1.5\text{ moles NaOH}}}{\underset{\text{liters of solution}}{0.25\text{ L}}} = 6\text{ M}$$

Normality

The number of gram equivalent wt which dissolve in 1 L of solvent

$$Normalty = \frac{Wt}{Eq\ .\ wt} \times \frac{1000}{V}$$

Wt = *weigh*
Eq . Wt = *equivalent weigh*
V = *volume*

$$\text{Eq .wt for acids} = \frac{\text{M.Wt}}{\text{No of H+}}$$

HCL , H2SO4 , H3PO4

$$\text{Eq .wt for Basie} = \frac{\text{M.Wt}}{\text{No of HO-}}$$

NaOH , $Ca(OH)_2$, $Al(OH)_3$

$$\text{Eq .wt for salts} = \frac{\text{M.Wt}}{\text{No of atoms} \times \text{metal equivalent}}$$

(NaCl , Na_2SO_4 , $Al_2(SO_4)_3$)

$$\text{Eq .wt for oxi-red} = \frac{\text{M.Wt}}{\text{No of electron donor or excepted}}$$

$$\underset{-1\ \ +\ \ 8\ =\ 7}{MnO_4^- + 8\,H^+} \rightleftharpoons \underset{+2}{Mn^{2+}} + 4\,H_2O \qquad = 5\ e^-$$

For liquid

$$N = \frac{\text{Specific gravity} \times \text{percentage or density} \times 1000}{\text{equivalent weigh}}$$

$$M = \frac{\text{Specific gravity} \times \text{percentage or density} \times 1000}{\text{molecular weigh}}$$

Problem

Prepare 0.1 N of HCl in 250 ml if you know the Specific gravity is equal 1,1 and the acid percentage 30-34 %

Solution

$$N = \frac{1.1 \times \frac{32}{100} \times 1000}{36.5} = 10\ N$$

$$N1 \times V1 = N2 \times V2$$

$$10 \times V1 = 0.1 \times 250\ ml$$

$$V1 = 0.25\ ml$$