Basic chemistry

Methods for Expressing Concentrations

Concentration is referring to the amount of the component in a certain amount of hole sample or solution expressed by certain unit.

Molar mass of a substance

is the mass (in grams) of 1 mole of that substance. We calculate molar masses by summing the atomic masses of all the atoms appearing in a chemical formula.

In analytical chemistry, we often determine the amount of chemical species from mass measurements.

For such measurements, units of, grams (g), milligrams (mg), or micrograms (µg) are used.

Volumes of liquids are measured in units of liters (L), milliliters (mL), microliters (µL), and sometimes nanoliters (nL).

Weight and Mass:

Mass m is an invariant measure of the quantity of matter.

Weight w is the force of gravitational attraction between that matter and Earth.

Classification of Analysis according to weight of sample:

Analysis can be analyzed according to weight ranges:

Sample Size Type of Analysis

0.1g Macro

0.01to 0.1 g Semimicro

0.0001to 0.01 g Micro

Less than 10-4 g Ultramicro

\Mole: it refers to Avogadro’s number (6.022 x 1023) of particles represented by atoms, molecules, ions, electrons or ion pairs.

Ex: M.wt of glucose $C_6H_{12}O_6$ is =(6x12) + (12x1) + (6x16) = 180 g/mole.

Millimole (mmol) is 1/1000 of mole (1 mol. = 1000 mmol).

Note: Mole can be calculated by:

mole = w/mwt(w :weight /mwt: molecular weight).

Ex: How many moles and millimoles of benzoic acid (122.1 g/mol.) are contained in 2.00 g of the pure acid?

no.ofmole=Weight (Wt) in gramMWt g/mole = 2122.1=0.01638 mole

mmol. = 0.0163x 1000 = 163.8 mmol.

Ex: How many grams of Na^+ (23 g/mol) are contained in 25.0 g of Na_2SO_4 (142 g /mol) ?

The chemical formula tells us that 1 mole of Na_2SO_4 contains 2mole of Na^{+2}

Na	Na_2SO_4	Na	Na_2SO_4
2*AW	Mw	2*23	142
Wt (Na)g	Wt (gm)	W Na^+	25

$$WNa = \frac{2\times23\times25}{142} =$$ 8.1g of Na^+ contains in Na_2SO_4

Percentage concentration:

1- Weight percentage

$$\text{Wt Wt\%} = \frac{\text{Wt of solute}}{\text{Wt of solution}} \times 100$$

Ex: **What is the weight percent of glucose in a solution made by dissolving 4.6 g of glucose in 145.2 g of water** ?

To get weight percent we need the weight of the solute and the total weight of the solution which equal (Wt of glucose + Wt of water)

Wt of solution = 4.6 + 145.2 = 149.8 g

WtWt%= Wt of solute × 100 = 4.6149.8 X100 = 3.1% glucose
Wt of solution

Ex: How would you prepare 400. g of a 2.50% solution of sodium chloride?

WtWt%=Wt of soluteWt of solution × 100⁄

2.5 =Wt of NaCl400 X100=10 g NaCl

2- Volume percent is usually used when the solution is made by mixing two miscible liquids.

$$V/V\% = \frac{V\ of\ solute}{V\ of\ solution} \times 100$$

Ex: Rubbing alcohol is generally 70% by volume isopropyl alcohol. How many milliliter of isopropyl alcohol contain in liter of solution?

$$V/V\% = \frac{V\ of\ solute}{V\ of\ solution} \times 100$$

$$70 = \frac{V\ of\ isopropanol}{1000} \times 100 = 700ml$$

3-Weight – volume w/v %

$$Wt/V\% = \frac{Wt\ of\ solute}{V\ of\ solution} \times 100$$

Ex: A solution was prepared by dissolving 2.45g of AgNO3 in sufficient water to give 50 ml . for this solution, Calculate the weight – volume percentage of AgNO3?

$$W/V\% = \frac{Wt\ of\ solute}{V\ of\ solution} \times 100 =$$

$$\frac{2.45\ g}{50\ ml} \times 100 = 4.9\ g/ml$$

ppm , ppb , ppt = used for very dilute solution

part per thousand (ppt)= $\frac{Wt(g)}{Vml} \times 1000$ **µg/L= mg/ml g/L**

part per million (ppm) = $\frac{Wt(g)}{Vml} \times 10^6$ **µg/ml = mg/L**

part per billion (ppb) = $\frac{Wt(g)}{Vml} \times 10^9$ **µg/L**

Ex: Describe the preparation of 100ml of 100 ppm Na^+ solution by using Na_2SO_4 (M.wt = 142 g/mole)? AW of Na23 g/ mole.

$$\text{ppm } Na^+ = \frac{Wt(g) \text{ of } Na^+}{Vml} * 10^6$$

$$100 = \frac{Wt(g)\text{of } Na^+}{100} * 106 = 0.01g \text{ of } Na^+$$

$$\frac{Na^+}{2 * \text{ A. wt}} \qquad \frac{Na_2SO_4}{\text{M. Wt}} \qquad \frac{Na^+}{2*23} \qquad \frac{Na_2SO_4}{142}$$

$2*23$	142
0.01	Wt Na_2SO_4

$$\text{Wt of } Na_2SO_4 = \frac{0.01 \times 142}{46} = 0.03086 \text{ g}$$

Formality (F): can be define as the number of formula weights of substance contained in one liter of solution , or the number of milliformula weights per milliliter of solution.

$$F = \frac{\text{no. of formulas}}{\text{V Liter}} = \frac{\text{no. of milliformulas}}{\text{Vml}}$$

$$\text{no.of formulas (fw)} = \frac{\text{Weight (Wt) in gram}}{\text{gfw /formulas}}$$

$$(fw/L) \text{ or } (mfw/ml) \text{ or } (F) = \frac{Wt(g) \times 1000}{gfw \times Vml} \quad \text{formula / Liter}$$

B/ Formality (F) for concentrated solutions :

$$F = \frac{Wt(g) \times 1000}{gfw \times Vml}$$

$$\text{density for solutioion (d)} = \frac{\text{Wt g of solution}}{\text{Vml of solution}},$$

$$\therefore V_{ml} = \frac{\text{Wt g of sol.}}{d}$$

$$F = \frac{Wt(g) \times 1000 * d}{gfw \times \text{Wt g of sol.}}$$

$$F = \frac{\% \times d \times 10}{gfw} \qquad \text{or } F = \frac{\% \times Sp.g \times 10}{gfw}$$