بسم الله الرحمن الرحيم

يَرْفَعْ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِير

سورة المجادلة – الآية (١١)

Important aspects in analytical chemistry

Abdel Ghany Farag Shoair

Professor of Inorganic Chemistry

Department of Science and technologyy, University college of Ranyah, Taef University, KSA

Analytical Chemistry

The branch of chemistry that is concerned identification and determination of the composition of matter

qualitative analysis

- Identification of each component in sample

Quantitative analysis

- Determination of the percentage of each component in the sample

Concentration

Concentration is a very common concept used in chemistry and related fields. It is the measure of how much of a given substance that can be mixed with another substance

Solution

A solution is a single-phase homogenous mixture of two components called the solvent and the solute

The solvent

A solvent is the component of a solution that is present in the greatest amount.

The solute

- A solute is a substance that can be dissolved by a solvent to create a solution.

How can you determine the concentration of the solution

Methods of expressing concentration

- All materials are present as solid, liquids and gases. We usually treat materials in solids and liquids

Solis materials

Liquid materials

How can you express the concentration

- For solid in solvents
- Molarity, Normality, percentage by weight (the weight percent of a solution %w/w), ppm(mg per liter = part per million) and ppb (microgram per liter = part per billion) and dl(deciliter = a metric unit of volume equal to one tenth of a liter)

Molarity

- The number of moles of solute per liter of solution

Normality

- The number of grams equivalent of the solute that is present in a one-liter solution

The weight percent of a solution %W/W

- The mass of the solute by the mass of the solution (solute and solvent together) and multiply by 100 to obtain percent.

Ppm(part per million)

- It is used for very small concentration
- ppm(mg per liter = part per million)

Ppb (part per billion)

- ppb (microgram per liter = part per billion)

Deciliter(dl)

- This unit is used for clinical Lab tests
- dl(deciliter = a metric unit of volume equal to one tenth of a liter)

Molarity Calculation

Molarity (M) = moles of solute / volume of solution (in liters)

Example

- What is the molarity of a 0.40 moles of NaCl dissolved in 0.250 liters?
  - M = 0.4 / 0.250 = 1.6 M

Example

- Calculate the molarity of 10 g sodium carbonate when it is mixed in a 250 ml solution.

Wt (g) = M x Mol. Wt. x VL

- M = molarity?
- Wt(g) = weight in gram = 10 g
- Mol. Wt. = molecular weight = 106
- VL = volume in liter = 250/1000
- Ans: 10 = M x 106 x 0.25

M = 0.377 M

Normality Calculation (N)

- Normality (N) = number of gram equivalents / one liter of the solution

Example

- Calculate the normality of 10 g sodium carbonate
  - when it is mixed in a 250 ml solution.

- Wt (g) = N x Eqv. Wt. x V_L
  - N = normality?
  - Wt(g) = weight in gram = 10 g
  - Eqv. Wt. = equivalent weight = 53
  - VL = volume in liter = 250/1000
  - Ans: 10 = N x 53 x 0.25
  - N = 0.75 N

Dilution

- A solution can be made less concentrated by dilution with solvent. If a solution is diluted from V_1 to V_2, the molarity of that solution changes according to the equation:
  - $M_1 V_1 = M_2 V_2$
  - Moles of solute in original solution 1
  - =
  - Moles of solute in diluted solution 2

Do not forget

- Remember that the number of moles of solute does not change when more solvent is added to the solution. Concentration, however, does change with the added amount of solvent.

Example

- How do you prepare 100 ml of 0.40 M $MgSO_4$ from a stock solution of 2.0 M $MgSO_4$?
  - M_1 = 2.0M $MgSO_4$; V_1 = unknown
    M_2 = 0.40M $MgSO_4$; V_2 = 100ml
    - 1 X V_1= 100 X 0.4
    - V1 = 10 ml
- Transfer quantitatively 10 ml of the stock solution to a 100-ml measuring flask then complete to a 100 ml with water

Percent %

1- Percent by weigh-weight

2- Percent of volume - volume

3- Percent by weight - volume

Percent by weight

- Percent by weight

- Mass of solute / mass of solution X100

Example

- A solution was prepared by dissolving 25.0 g of sugar into 100 g of water. The percent by mass would be calculated as follows:
- Percent by mass = 25 g of the suger / 125 g of the solution$\times$100% = 20%

Percent of volume

- When the solute and solvent are liquids
  - Percent of volume
- Volume of solute/volume of solution X 100

Example

- If a solution is made by taking 40 ml of ethanol and adding enough water to make 240 ml of solution, the percent by volume is
  - 40/240 x100 = 16.7%

Percent by weight-volume

- If a solution is prepared from 10 g NaCl in enough water to make a 150 ml solution, the mass-volume concentration is
- Mass-volume = 10/150 X 100 = 6.7%

Parts per Million and Parts per Billion

There are several ways of expressing two units of ppm and ppb, we will treat them as mg or µg of solutes per liter of the solution, respectively.

- 15 ppm = 15 mg of solute per one liter of the solution
- 15 ppb = 15 microgram of solute per one liter of the solution

Example

- If a solution is prepared from 10 g NaCl in enough water to make a 150 ml solution, the mass-volume concentration is
- Mass-volume = 10/150 X 100 = 6.7%

Specific gravity and density

- Density
- is the mass of a unit volume of a material substance
- Specific gravity
- (relative density)
- is the ratio of the density (mass of a unit volume) of a substance to the density of water

Uses of density and specific gravity

- If you have a bottle of HCl that has 35% purity and specific gravity = 1.18 Calculate the normality of HCl.

Answer

- spg of HCl =1.18, EQ Wt = 36.45 and Purity = 35%
- Normality = spg $\times$ purity % $\times$1000 / EQ WT
- = 1.18 $\times$ 35 $\times$ 1000 / 36.45 $\times$ 100 = 11.13 N

Thanks for every body