ALMUSTAQBAL UNIVERSITY COLLEGE

Biomedical Engineering Department

Stage : Second year students

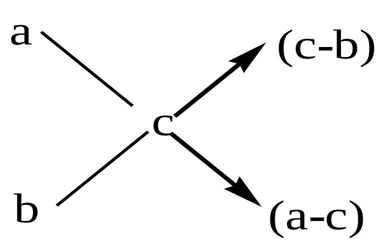
Subject : Chemistry 1 - Lecture 11

Lecturer: Assistant professor Dr. SADIQ . J. BAQIR

Mixing Rule:

To prepare a solution of certain substance percent concentration from the same substance solution of higher concentration or from two solutions of the same substance of different concentrations the mixing rule is to be used. Mixing a solution of (a%) concentration with a solution of (b%) concentration the resulting solution will be of (c%) concentration .

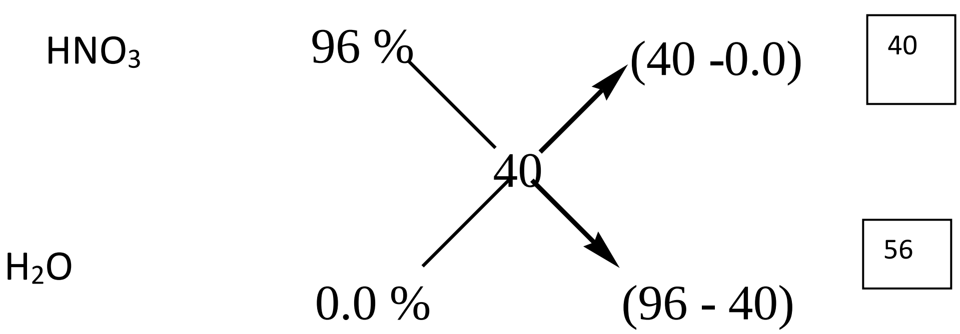
If a > b then a > c >b



Example 1:

Describe the preparation of 40% HNO_3 solution from 96% HNO_3 solution(sp.g 1.495).

Answer:



40 grams of 96% HNO_3 + 56 grams of H_2O → 40% HNO_3 solution

Density = sp.gr x d_{H2O}

Density of 96% HNO_3 = 1.495 x1 g / mL =1.495 g / mL

Density of H_2O = 1 g / mL

Volume of 96% HNO_3 solution = $\frac{weight(\,g\,)}{\text{density}(\frac{\text{g}}{\text{mL}})} = \frac{40g}{1.495\ \text{g/mL}}$ = 26.76 mL

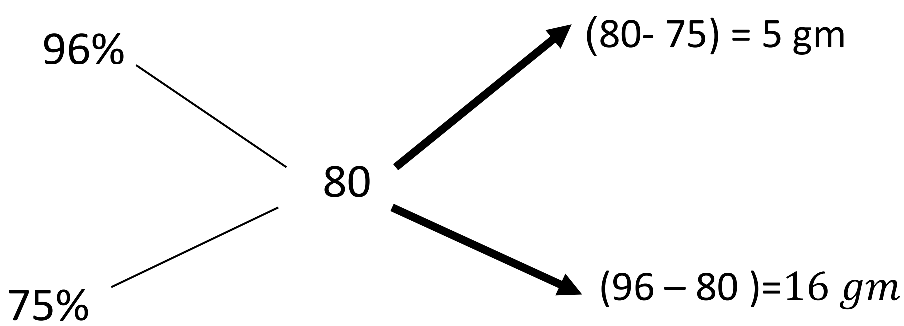
Volume of water = $\frac{weight(\,g\,)}{\text{density}(\frac{\text{g}}{\text{mL}})} = \frac{56\ g}{1\ \text{g /mL}}$ = 56 mL

Then 26.76 mL of 96% HNO_3 + 56 mL of H_2O → 40% HNO_3 solution

Example 2:

Describe the preparation of 80% HNO_3 solution from the two different concentration of HNO_3 solution 96%(sp.gr 1.495) and 75%(sp.gr 1.452).

Answer:



Density = sp.gr x d_{H2O}

Density of 96% HNO_3 = 1.495 x1 g / mL =1.495 g / mL

Density of 75% HNO_3 = 1.452 x1 g / mL =1.452 g / mL

Volume of 96% HNO_3 solution = $\frac{weight(g)}{\text{density}(\frac{g}{mL})} = \frac{5\ g}{1.495\ g/mL}$ = 3.34 mL

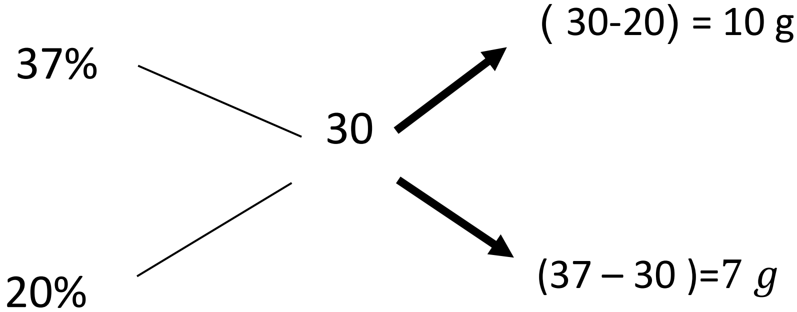
Volume of 75% HNO_3 solution = $\frac{weight(g)}{\text{density}(\frac{g}{mL})} = \frac{16\ g}{1.452\ g/mL}$ = 5.9 mL

Then 3.34 mL of 96% HNO_3 + 5.9 mL of 75% HNO_3 $\rightarrow$ 80% HNO_3 solution

Example 3:

Describe the preparation of 30% HCl solution from the two different concentration of HCl solution 20%(sp.gr 1.098)and 37%(sp.gr 1.181).

Answer:



Density = sp.gr x d_{H2O}

Density of 20% HCl = 1.098 x1 g / mL =1.098 g / mL

Density of 37% HCl = 1.181 x1 g / mL =1.181 g / mL

10 grams of 20% HCl + 7 grams of 37% HCl $\longrightarrow$ 30% HCl solution

Volume of 20% HCl solution = $\frac{weight(g)}{\text{density}(\frac{\text{g}}{\text{mL}})} = \frac{10g}{1.098\ \text{g/mL}}$ = 9.1 mL

Volume of 37% HCl solution = $\frac{weight(g)}{\text{density}(\frac{\text{g}}{\text{mL}})} = \frac{7g}{1.181\ \text{g/mL}}$ = 5.9 mL

Then 9.1 mL of 20% HCl + 5.9 mL of 37% HCl $\longrightarrow$ 30 % HCl solution

Conversions:

Molarity(M) = mole/Liter

Mole = 1000 mmole

**** Molarity(M) x 1000 = m mol/L** **(Molarity $\rightarrow$ mmol/L)**

Example:

Calculate the concentration of the solution, prepared by dissolving 1.5 g of KNO_3 (101 g /mol) in 750 mL of water, in mmol/L .

Solution:

Molarity(M) = $\frac{\boldsymbol{wt\ x\ 1000}}{\boldsymbol{M.wt\ x\ V(mL)}}$

Molarity(M) = $\frac{\mathbf{1.5}\ \boldsymbol{g\ x}\ \mathbf{1000}}{\mathbf{101}\ \boldsymbol{x}\ \mathbf{750}(\boldsymbol{mL})}$ **= 0.02 M**

mmol/L = Molarity(M) x 1000

$C_{mmol/L}$ = 0.02 x 1000 = 20 mmol/L

dL = 100 mL

dL = $\frac{Liter}{10}$

mmol/ L x M.wt(mg/mmol) = mg / L

**** m mol/L x** $\left(\frac{\text{Mwt}}{10}\right)$ **= mg/dL** **(mmol/L → mg/dL)**

[$Molarity(M)x\ 1000$**]x** $\left(\frac{\text{Mwt}}{10}\right)$ **= mg/dL**

**** Molarity(M) x M.wt x 100 = mg/dL (Molarity(M) → mg/dL)**

Example:

Calculate the concentration in mg/dL for HCl (36.5 g/mol) solution that is 37(w/w)% and specific gravity of 1.18 .

Solution:

$$\text{Molarity } M_{HCl} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{Mwt}$$

$$M_{HCl} = \frac{1.18\ x\ \frac{37.1}{100}\ x\ 1000}{36.5}$$

M_{HCl} **= 12 M**

mmol/L = Molarity(M) x 1000

$C_{mmol/L}$ = 12 x 1000 = 12000 mmol/L

m mol/L x $\left(\frac{Mwt}{10}\right)$ = mg/dL

12000 x $\left(\frac{36.5}{10}\right)$ = 43800 mg/dL

Example :

A 25 μL serum sample was analyzed for glucose content and found to contain 26.7 μg. Calculate the concentration of glucose in ppm and in mg/dL.

Solution:

1 mL = 1000 μL

V (mL) = $\frac{V(\mu L)}{1000}$ = $\frac{25(\mu L)}{1000}$ = $25x10^{-3}$ mL

Cppm = $\frac{wt(\mu g)}{VmL}$ = $\frac{26.7}{25x10^{-3}}$ = 1068 ppm

1 dL = 100 mL

V(dL) = $\frac{V_{mL}}{100}$

V(dL) = $\frac{V(mL)}{100}$ = $\frac{25x10^{-3}\ mL}{100}$ = $25x10^{-5}$ dL

mg = 1000 μg

wt (mg) = $\frac{weight\ (\mu g)}{1000}$ = $weight\ (\mu g)$ x 10^{-3}

wt (mg) = 26.7 x 10^{-3}

Concentration (mg/dL) = $\frac{wt(mg)}{V(dL)}$ = $\frac{26.7\ x\ 10^{-3}}{25x10^{-5}}$ = 106.8 mg/dL

يمكن ان نطبق القانون التالي بشكل مباشر :

** $C_{(mg/dL)} = \frac{C_{ppm}}{10}$

Then $C_{(mg/dL)} = \frac{1068}{10} = 106.8$ mg/dL

Conversions:

As $C_{(mg/dL)} = \frac{C_{ppm}}{10}$

Cppm = Molarity(M) x M.wt x 1000

Then $C_{(mg/dL)} = \frac{Molarity(M) x M.wt\ x 1000}{10}$

**** $C_{(mg/dL)}$ = Molarity(M) x M.wt x100**

Example:

For the solution of 100 ppm of Fructose (180 g/mol) Calculate the concentration in:

a. **Molarity** b. **mmol / L** c. **mg/dL**

Solution:

a. Molarity(M) $= \frac{PPm}{Mwt\ x 1000} = \frac{100}{180\ x 1000} = 5.55 \times 10^{-4}$ M

b. mmol/L = Molarity(M) x 1000 = 5.55×10^{-4} x1000 = 0.555

c. **mg/dL = Molarity(M) x M.wt x 100**

mg/dL = 5.55x10^{-4} x 180 x100 = 10

Or **C (mg/dL) =** $\frac{C_{ppm}}{10} = \frac{100}{10}$ = **10** mg/dL

Example:

A solution was prepared by dissolving 1210 mg of $K_3Fe(CN)_6$ (329.2 g/mol) in sufficient water to give 775 mL. Calculate:

a) the molar concentration of $K_3Fe(CN)_6$. (b) pK^+ for the solution.

c) the (w/v)% of $K_3Fe(CN)_6$ (d) the ppm concentration of $K_3Fe(CN)_6$.

Solution :

a.

Molarity(M) = $\frac{wt\ x\ 1000}{M.wt\ x\ V(mL)}$

Wt (g) = $\frac{1210\ mg}{1000}$ **= 1.21 g**

Molarity(M) = $\frac{1.21\ x\ 1000}{329.2\ x\ 755(mL)}$ **= 0.005 M**

b.

$K_3Fe(CN)_6$ → $3K^+$ + $[Fe(CN)_3]^{3-}$

Molarity (M) of K^+ = 3 x 0.005 = 0.015 M

pK = - log $[K^+]$

pK = -log(0.015) = 1.824

c.(w/v)%

$$(w/v)\% = \frac{wt(\ g)}{v(mL)} \times 100$$

$$(w/v)\% = \frac{1.21(\ g)}{775(mL)} \times 100 = 1.56\%$$

d. C_{ppm}

$$Cppm = \frac{wt(g)}{V(mL)} \times 10^6 =$$

$$Cppm = \frac{1.21(g)}{755(mL)} \times 10^6 = 1.56 \times 10^4$$

Cppm = 15600 ppm