

TD 1 : Les solutions aqueuses

Exercice 1 :

$$m_{\text{solute}} = 0,71 \text{ g} , m_{\text{solution}} = 100 \text{ g}$$

$$d_{\text{solution}} = 1 , \text{ dissociation complete : } \alpha = 1$$

Les différentes concentrations :

① Les fractions molaires :

$$f_m(\text{solute}) = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvant}}}$$

$$n_{\text{solute}} = \frac{m_{\text{solute}}}{M_{\text{solute}}} = \frac{0,71 \text{ g}}{142 \text{ g/mol}} = 5 \times 10^{-3} \text{ mol}$$

$$n_{\text{solvant}} = \frac{m_{\text{solvant}}}{M_{\text{solvant}}} = \frac{(100 - 0,71) \text{ g}}{18 \text{ g/mol}} = 5,51 \text{ mol}$$

$$f_m(\text{solute}) = \frac{5 \times 10^{-3} \text{ mol}}{5 \times 10^{-3} \text{ mol} + 5,51 \text{ mol}} = \underline{\underline{9 \times 10^{-4}}}$$

$$f_m(\text{solvant}) = \frac{n_{\text{solvant}}}{n_{\text{solvant}} + n_{\text{solute}}} = \underline{\underline{0,9991}}$$

$$f_m(\text{solvant}) + f_m(\text{solute}) = 1$$

② La molarité (m_r)

$$m_r = \frac{n_{\text{solute}} \text{ (mol)}}{V_{\text{solution}} \text{ (l)}}$$

$$m_r = \frac{5 \times 10^{-3} \text{ mol}}{100 \times 10^{-3} \text{ l}} = 5 \times 10^{-2} \text{ mol/l}$$

$$d_{\text{solution}} = \frac{\rho_{\text{solution}}}{\rho_{\text{H}_2\text{O}}}$$

$$\rho_{\text{solution}} = d_{\text{solution}} \times \rho_{\text{H}_2\text{O}}$$

$$= 1 \times 1 \text{ g/cm}^3 = 1 \text{ g/cm}^3$$

$$\rho_{\text{solution}} = \frac{m_{\text{solution}}}{V_{\text{solution}}} / \frac{m_{\text{solvant}}}{V_{\text{solvant}}}$$

③ La molarité (m)

$$m = \frac{n_{\text{solute}} \text{ (mol)}}{m_{\text{solvant}} \text{ (Kg)}} = \frac{5 \cdot 10^{-3} \text{ mol}}{99,29 \cdot 10^{-3} \text{ Kg}} = \underline{5,03 \cdot 10^{-2} \text{ mol/Kg}}$$

④ La concentration pourcentage (C%)

$$C\% = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 100 = \frac{0,71}{100} \times 100 = \underline{0,71\%}$$

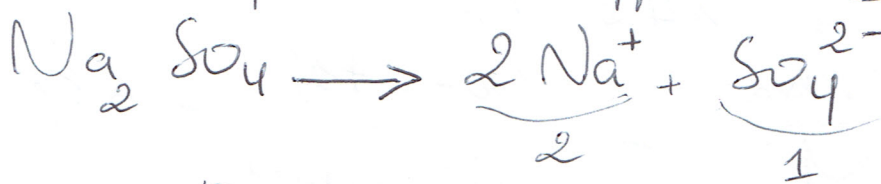
⑤ L'osmolarité (w_r):

$$w_r = [1 + d(\beta - 1)] m_r$$

d : coefficient de dissociation

$d = 1 \rightarrow$ dissociation complète
 $0 < d < 1 \rightarrow$ Partielle.
 $d = 0 \rightarrow$ Pas de dissociation

β : nbre de particules après dissociation.



$$\beta = 2 + 1 = 3$$

$$w_r = [1 + 1(3 - 1)] 5 \cdot 10^{-2} = \underline{15 \cdot 10^{-2} \text{ osmol/l}}$$

⑥ l'osmolarité (w_e):

$$w_e = [1 + d(\beta - 1)] m_e = [1 + 1(3 - 1)] 5,03 \cdot 10^{-2} = \underline{15,09 \cdot 10^{-2} \text{ osmol/Kg}}$$

⑦ La concentration pondérale (C_p):

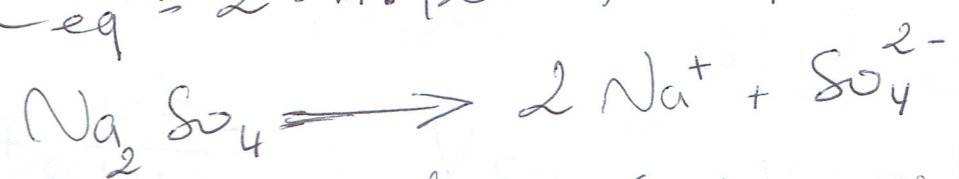
$$C_p = \frac{m_{\text{solute}} \text{ (g)}}{V_{\text{solution}} \text{ (l)}} = \frac{0,71 \text{ g}}{100 \cdot 10^{-3} \text{ l}} = \underline{7,1 \text{ g/l}}$$

Remarque:

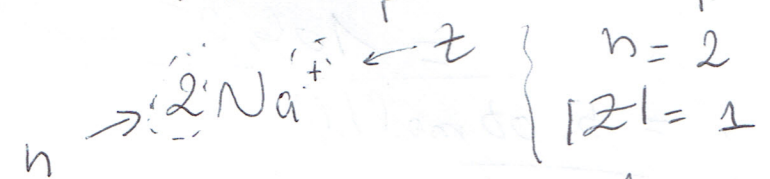
$$m_r = \frac{n_{\text{solute}}}{V_{\text{solution}}} = \frac{\frac{m_{\text{solute}}}{M_{\text{solute}}}}{V_{\text{solution}}} = \frac{m_{\text{solute}}}{V_{\text{solution}} \times M_{\text{solute}}} = \frac{C_p}{M_{\text{solute}}}$$

② La concentration équivalente: (C_{eq}):

$$C_{eq} = 2 \cdot n \cdot |Z| \cdot d \cdot m_r$$



On choisit une particule après dissociation, exemple:



On trouve le même résultat pour les 2 cas.

$$C_{eq} = 2 \cdot 2 \cdot |1| \cdot 1 \cdot 5 \times 10^{-2} = 0,2 \text{ eq/l.}$$

Exercice (02):

$$C\% = 25\%, \quad M_{al} = 46 \text{ g/mol}, \quad d_{al} = 0,8$$

① La fraction molaire:

$$f_m(\text{soluté}) = \frac{n_{\text{soluté}}}{n_{\text{soluté}} + n_{\text{solvant}}}$$

$$C\% = \frac{m_{\text{soluté}}}{m_{\text{solution}}} \times 100 = 25\%$$

Pour 100g de solution \rightarrow 25g de soluté

$$m_{\text{soluté}} = 25 \text{ g}, \quad m_{\text{solution}} = 100 \text{ g} \rightarrow m_{\text{solvant}} = 100 - 25 = 75 \text{ g.}$$

$$n_{\text{soluté}} = \frac{m_{\text{soluté}}}{M_{\text{soluté}}} = \frac{25 \text{ g}}{46 \text{ g/mol}} = 0,54 \text{ mol.}$$

$$n_{\text{solvant}} = \frac{75 \text{ g}}{18 \text{ g/mol}} = 4,16 \text{ mole} \rightarrow f_m = \frac{0,54}{0,54 + 4,16} = 0,111$$

② la molarité (m_r):

$$m_r = \frac{n_{\text{solute}} \text{ (mol)}}{V_{\text{solution}} \text{ (l)}} \quad / \quad V_{\text{solution}} = V_{\text{al}} + V_{\text{H}_2\text{O}}$$

$$f = \frac{m}{V} \Rightarrow V = \frac{m}{f} \Rightarrow V_{\text{solution}} = \frac{25\text{g}}{0,8\text{g/cm}^3} + \frac{75\text{g}}{1\text{g/cm}^3}$$

$$= 106,25 \text{ cm}^3$$

$$m_r = \frac{0,154 \text{ mol}}{106,25 \times 10^{-3} \text{ l}} = \underline{\underline{5,08 \text{ mol/l}}}$$

③ la molalité (m_e):

$$m_e = \frac{n_{\text{solute}} \text{ (mol)}}{m_{\text{solvant}} \text{ (kg)}} = \frac{0,154 \text{ mol}}{75 \cdot 10^{-3} \text{ kg}} = \underline{\underline{7,2 \text{ mol/kg}}}$$

exercice (03):

c'est le cas d'une solution contient plusieurs solutés:

dans ce cas:

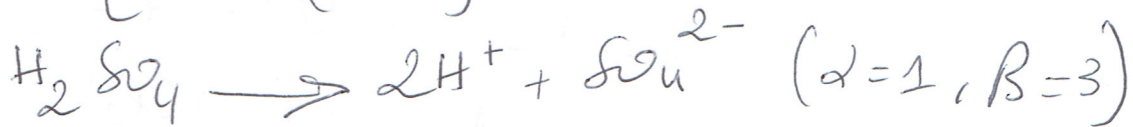
$$W_r(\text{solution}) = W_r(\text{HCl}) + W_r(\text{H}_2\text{SO}_4) + W_r(\text{CaCl}_2) + W_r(\text{glucose}).$$

$$* W_r(\text{HCl}) = [\alpha + \beta - 1] m_r \quad \text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$$

$$m_r = \frac{n_{\text{solute}}}{V_{\text{solution}}} = \frac{1 \text{ mol/l} \times 10 \times 10^{-3} \text{ l}}{1 \text{ l}} \quad \alpha = 1, \beta = 2 = 10^{-2} \text{ mol/l}$$

$$W_r(\text{HCl}) = \underline{\underline{2 \times 10^{-2} \text{ osmol/l}}}$$

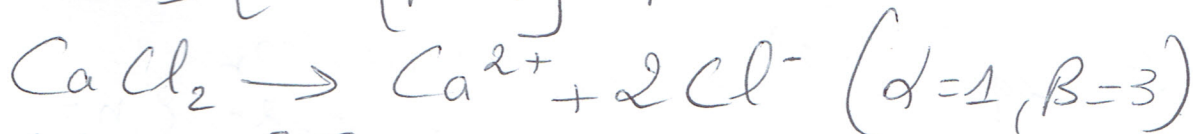
$$w_r(\text{H}_2\text{SO}_4) = [1 + \alpha(\beta - 1)] m_r$$



$$m_r = \frac{n_{\text{solute}}}{V_{\text{solution}}} = \frac{2 \text{ mol/l} \times 7,5 \times 10^{-3} \text{ l}}{1 \text{ l}} = 15 \times 10^{-3} \text{ mol/l}$$

$$w_r(\text{H}_2\text{SO}_4) = 45 \times 10^{-3} \text{ osmol/l}$$

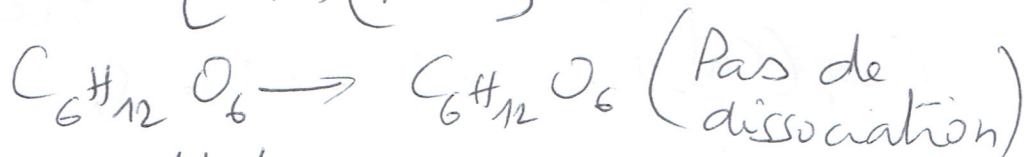
$$w_r(\text{CaCl}_2) = [1 + \alpha(\beta - 1)] m_r$$



$$m_r = \frac{n_{\text{solute}}}{V_{\text{solution}}} = \frac{5,17 \text{ g}}{111 \text{ g/mol}} = 5 \times 10^{-2} \text{ mol/l}$$

$$w_r(\text{CaCl}_2) = 15 \times 10^{-3} \text{ osmol/l}$$

$$w_r(\text{C}_6\text{H}_{12}\text{O}_6) = [1 + \alpha(\beta - 1)] m_r$$



$$m_r = \frac{n_{\text{solute}}}{V_{\text{solution}}} = \frac{14,4 \text{ g}}{180 \text{ g/mol}} = 0,08 \text{ mol/l} \quad (\alpha = 0, \beta = 1)$$

$$w_r(\text{C}_6\text{H}_{12}\text{O}_6) = 0,08 \text{ osmol/l}$$

$$w_r(\text{solution}) = 0,16 \text{ osmol/l}$$

La même chose pour la concentration équivalente:

$$C_{eq}(\text{solution}) = C_{eq}(\text{HCl}) + C_{eq}(\text{H}_2\text{SO}_4) \\ + C_{eq}(\text{CaCl}_2) + C_{eq}(\text{glucose})$$

$$\ast C_{eq}(\text{HCl}) = 2 \cdot n \cdot |z| \cdot \alpha \cdot m_r \\ \text{HCl} \rightarrow \text{H}^+ + \text{Cl}^- \quad \begin{cases} n=1 \\ |z|=1 \end{cases}$$

$$C_{eq}(\text{HCl}) = 2 \cdot 1 \cdot 1 \cdot 1 \cdot 10^{-2} = \underline{2 \cdot 10^{-2} \text{ eq/l}}$$

$$\ast C_{eq}(\text{H}_2\text{SO}_4) = 2 \cdot n \cdot |z| \cdot \alpha \cdot m_r \\ \text{H}_2\text{SO}_4 \rightarrow 2\text{H}^+ + \text{SO}_4^{2-} \quad \begin{cases} n=2 \\ |z|=1 \end{cases}$$

$$C_{eq}(\text{H}_2\text{SO}_4) = 2 \cdot 2 \cdot 1 \cdot 1 \cdot 15 \times 10^{-3} = \underline{60 \times 10^{-3} \text{ eq/l}}$$

$$\ast C_{eq}(\text{CaCl}_2): \quad \text{CaCl}_2 \rightarrow \text{Ca}^{2+} + 2\text{Cl}^- \\ \begin{matrix} n=1 \\ |z|=2 \end{matrix}$$

$$C_{eq}(\text{CaCl}_2) = 2 \cdot 1 \cdot 2 \cdot 1 \cdot 5 \times 10^{-2} = \underline{20 \times 10^{-2} \text{ eq/l}}$$

$$\ast C_{eq}(\text{C}_6\text{H}_{12}\text{O}_6) = \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6$$

$$C_{eq}(\text{C}_6\text{H}_{12}\text{O}_6) = 0 \text{ eq/l} \quad n=1, z=0$$

$$C_{eq}(\text{solution}) = \underline{\underline{0,28 \text{ eq/l}}}$$