

Tutorial N° 1

Exercise 1

A commercial phosphoric acid solution contains 75% by mass of H_3PO_4 , and its density is 1.57 g/mL. Determine the molar concentration, normality, molality, mole fraction, and molar percentage of H_3PO_4 in this commercial solution.

Exercise 2

The measurement of the conductivity of a potassium chloride ($\text{K}^+ + \text{Cl}^-$) solution with concentration C gives $1.224 \text{ mS}\cdot\text{cm}^{-1}$ at 21°C .

1. Express σ , the conductivity, in $\text{S}\cdot\text{m}^{-1}$.
2. The following values are provided :
 $\lambda_{\text{Cl}^-} = 7,63 \text{ mS}\cdot\text{m}^2\cdot\text{mol}^{-1}$; $\lambda_{\text{K}^+} = 7,35 \text{ mS}\cdot\text{m}^2\cdot\text{mol}^{-1}$
 - 2.1. What does the letter λ represent?
 - 2.2. Convert these values to $\text{S}\cdot\text{m}^2\cdot\text{mol}^{-1}$.
 - 2.3. Determine the concentration C in $\text{mol}\cdot\text{L}^{-1}$.

Exercise 3

An unknown amount m_{LiCl} of lithium chloride was dissolved in a 200 mL volumetric flask.

Given:

Molar conductivities at 25°C : $\lambda_{\text{Li}^+} = 3,86 \text{ mS}\cdot\text{m}^2/\text{mol}^{-1}$; $\lambda_{\text{Cl}^-} = 7,63 \text{ mS}\cdot\text{m}^2\cdot\text{mol}^{-1}$

Molar masses: $M_{\text{Li}} = 6,9 \text{ g}\cdot\text{mol}^{-1}$, $M_{\text{Cl}} = 35,5 \text{ g}\cdot\text{mol}^{-1}$

1. Determine the concentration C in $\text{mol}\cdot\text{L}^{-1}$ of this solution, knowing that its conductivity is $\sigma = 34,5 \text{ mS}\cdot\text{cm}^{-1}$ (we previously calibrated the conductometer).
2. What mass m_{LiCl} of lithium chloride was placed in the volumetric flask?

Exercise 4

A potassium chloride (KCl) solution has a concentration $C = 5\cdot 10^{-3} \text{ mol}\cdot\text{L}^{-1}$.

1. Write the equation for the dissolution reaction of potassium chloride in water.
2. The dissolution is complete. Calculate, in $\text{mol}\cdot\text{m}^{-3}$, the concentrations of the ions K^+ and Cl^- in the solution. Justify your answer clearly.
3. Calculate the conductivity of the solution.

Given :

Ionic molar conductivities: $\lambda_{\text{Cl}^-} = 7,63\cdot 10^{-3} \text{ S}\cdot\text{m}^2\cdot\text{mol}^{-1}$, $\lambda_{\text{K}^+} = 7,4\cdot 10^{-3} \text{ S}\cdot\text{m}^2\cdot\text{mol}^{-1}$

Exercise 5

Dissolve 0.5 g of calcium nitrate $\text{Ca}(\text{NO}_3)_2$ in a 200 mL volumetric flask.

Given :

Molar mass of calcium nitrate: $M_{\text{Ca}(\text{NO}_3)_2} = 164 \text{ g/mol}$.

Ionic molar conductivities at 25°C: $\lambda_{\text{Ca}^{2+}} = 11,90 \text{ mS.m}^2 \cdot \text{mol}^{-1}$; $\lambda_{\text{NO}_3^-} = 7,14 \text{ mS.m}^2 \cdot \text{mol}^{-1}$

Ionic molar conductivities at 20°C: $\lambda_{\text{Ca}^{2+}} = 7,44 \text{ mS.m}^2 \cdot \text{mol}^{-1}$; $\lambda_{\text{NO}_3^-} = 6,43 \text{ mS.m}^2 \cdot \text{mol}^{-1}$

a) Indicate the ions present in the solution and calculate their concentrations.

b) Calculate the conductivity σ at 25°C and 20°C. Explain the difference in results.

Exercise 6

We mix a volume $V_1 = 200 \text{ mL}$ of a potassium chloride ($\text{K}^+ + \text{Cl}^-$) solution with concentration $C_1 = 5,0 \cdot 10^{-3} \text{ mol/L}$ with a volume $V_2 = 800 \text{ mL}$ of a sodium chloride ($\text{Na}^+ + \text{Cl}^-$) solution with concentration $C_2 = 1,25 \cdot 10^{-3} \text{ mol/L}$.

1. What is the conductivity of the resulting solution?
2. In the previous mixture, a conductometer cell is placed. The surface area of the electrodes is $11,0 \text{ cm}^2$ and the distance between them is $1,1 \text{ cm}$.
 - 2.1. What is the value of the conductance?

Given:

$$\lambda_{\text{Na}^+} = 5,01 \cdot 10^{-3} \text{ S.m}^2 / \text{mol}$$

$$\lambda_{\text{Cl}^-} = 7,63 \cdot 10^{-3} \text{ S.m}^2 / \text{mol}$$

$$\lambda_{\text{K}^+} = 7,35 \cdot 10^{-3} \text{ S.m}^2 / \text{mol}$$

Exercise 7

Using a cell, the conductance G of a sodium chloride (NaCl) solution S_1 with concentration $c = 5 \cdot 10^{-3} \text{ mol/L}$ was measured, and it was found to be $G = 5,45 \cdot 10^{-3} \text{ S}$.

1. Write the equation for the dissociation reaction of sodium chloride in water.
2. The dissociation of NaCl is complete. Determine the concentrations (in mol/L and mol/m^3) of the ions Na^+ and Cl^- . Provide a clear justification for your answer.
3. Determine the conductivity σ of the solution.
4. The value $K = L / S$ (where L is the distance between the electrodes and S is the submerged surface area of an electrode) is called the "cell constant." Determine K .

Given:

Ionic molar conductivities: $\lambda_{\text{Na}^+} = 3,87 \cdot 10^{-3} \text{ S.m}^2 \cdot \text{mol}^{-1}$; $\lambda_{\text{Cl}^-} = 7,63 \cdot 10^{-3} \text{ S.m}^2 \cdot \text{mol}^{-1}$