Abdelhafid Boussouf University Center - Mila **Academic year 2024-2025**

Institute of Natural and Life Sciences

Biological and Agricultural Sciences/ Biotechnology/ Ecology and Environmental Sciences

Practical Work N° 2:

Conductimetry of Electrolytic Solutions

1. The purpose of practical work

- Measured the electrical conductivity of an electrolytic solution.
- Check the influence of the composition (type of ions) and the concentration of the solution on the conductivity.
- Check other factors influencing the conductivity of an aqueous solution.

2. Theoretical Background

2.1 Mechanism of electrical conduction of electrolytic solutions

Electrolytic solutions (also called ionic solutions) have the property of conducting electricity. The passage of electric current in an electrolytic solution results from the movement of anions and cations. Cations move toward the cathode and anions move toward the anode (see Figure 1).

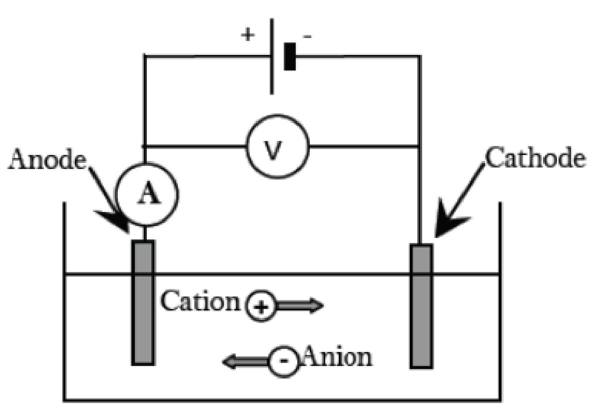

Figure 1: Representative diagram of the principle of electrical conduction in electrolytic solutions.

2.2 Ohm's law

For two electrodes immersed in an electrolytic solution, Ohm's law is written:

$$\mathbf{U} = \mathbf{RI} \text{ So } \frac{\mathbf{1}}{\mathbf{R}} = \frac{\mathbf{I}}{\mathbf{U}}$$

With

U is the voltage in volts (V), I is the current intensity in amperes (A) and R is the resistance of the solution in ohms (Ω).

On the other hand, for a conductimetric cell whose distance between its two electrodes is L and its immersed surface is S, the resistance of the solution is given by:

$$\mathbf{R} = \boldsymbol{\rho}\frac{\mathbf{L}}{\mathbf{S}}$$

With

ρ it is the electrical resistivity of the solution in Ωm. In other words:

$$\mathbf{R} = \mathbf{K}.\boldsymbol{\rho} \text{ with } \mathbf{K} = \frac{\mathbf{L}}{\mathbf{S}}$$

K is called the cell constant in m^{-1}

The conductance G and the conductivity σ of an electrolytic solution are equal to the inverse of its resistance and its resistivity

$$\mathbf{G} = \frac{\mathbf{1}}{\mathbf{R}}$$

And

$$\boldsymbol{\sigma} = \frac{\mathbf{1}}{\boldsymbol{\rho}}$$

σ is a characteristic of the solution, and it presents its ability to conduct electricity.

From these relations we obtain

$$\sigma = K.G$$

The conductance G is expressed in Ω^{-1} or in Siemens S

The conductivity σ is expressed in Ω^{-1} m^{-1} or in S m^{-1}

2.3 Molar ionic conductivity of an ion

The ionic conductivity σ_i is the ability of each ion to conduct current in an electrolytic solution. The conductivity σ is the sum of the ionic conductivities of the ions present in the solution

$$\sigma = \sum_{i=1}^{N} \sigma_i$$

On the other hand, each ion is characterized by its molar ionic conductivity λi.

The ionic conductivity of a monocharged ion is equal to the product of its molar ionic conductivity λi by its concentration [Ci], So

$$\sigma_i = \lambda_i [C_i]$$

With Ci is expressed in mol m^{-3}

Therefore the conductivity of the ionic solution is

$$\sigma = \sum_{i=1}^{N} \lambda_i [C_i]$$

The table below (Table 1) gives some values of molar ionic conductivities λi, at 25 °C.

Ions	**H^+**	**OH^-**	**SO_4^{-2}**	**Ca^{+2}**	**Cl^-**	**K^+**	**NO_3^-**	**Na^+**
λi ($S.m^2$ mol^{-1}	35.00	20.00	16.00	11.90	7.63	7.35	7.14	5.00

3. Experimental part

3.1 Influence of the solute

We have three monocharged solutions (Na^+, Cl^-), (Na^+, HO^-) and (K^+, Cl^-) of the same concentration C = 5×10^{-3} $mol.l^{-1}$

1. Measure the conductivity of each solution and then complete Table 2.

Table 2: Conductivity for different types of ions

The ions present in the solution	**(Na^+, Cl^-)**	**(Na^+, OH^-)**	**(K^+, Cl^-)**
Conductivity (µS cm^{-1})			

2. Compare the ionic molar conductivities of Cl^- and HO^- and those of Na^+ and K^+
3. What can we conclude?

3.2 Influence of concentration

As indicated in Table 3, aqueous solutions of sodium chloride (Na^+, Cl^-) of different concentrations are available.

1. Report the conductivity measurements of each solution in Table 3

Table 3: Conductivity for different concentrations.

Solution concentration (mol/l)	**1×10^{-5}**	**2×10^{-5}**	**3×10^{-5}**	**4×10^{-5}**	**5×10^{-5}**
Conductivity (µS cm^{-1})					

2. Draw the curve $\sigma = f(C)$.
3. Deduce the mathematical relationship between σ and C.
4. Conclusion.