# Dissolving ionic compounds

## Dissolution of an ionic compound in water

### 1. Dissociation of an ionic compound by water

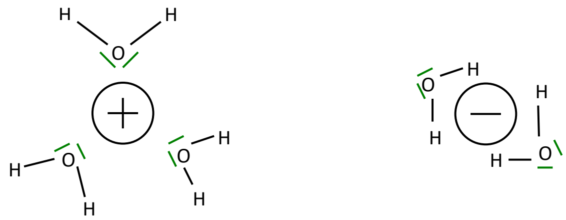
When an ionic solid is introduced into water, the solvent molecules weaken the electrostatic bonds between the ions through Coulombic interaction.

*Note: Water molecules are polar. See lesson on polarity of molecules for this*

As a large number of water molecules are present around the ionic solid, this interaction is important. It enables the separation of ions from the solid when the solid and solvent molecules collide.

### 2. Ion solvation

The ions formed are then surrounded by several water molecules. This prevents the solid from reforming.




Ions have become solvated (or hydrated)

### 3. Dispersion of the solvated ions

Thermal agitation causes solvated ions to disperse among the water molecules.

## Equation of dissolution

Dissolved in water, ionic solid $C_nA_{m(s)}$ separates in aqueous cations, $C^{m+}{}_{aq}$, and aqueous anions, $A^{n-}{}_{aq}$.
The equation of dissolution of the solid is:

$$\mathbf{C_nA_{m(s)} \xrightarrow{H_2O} nC^{m+}{}_{(aq)} + mA^{n-}{}_{(aq)}}$$

*Note: The dissolution of an ionic solid is NOT a chemical reaction. There is no change in structure of chemicals, as the cations and anions are both ALREADY present in the solid.*

## Molar concentrations

### 1. « Solute concentration »

The solute concentration is the ratio of ionic solid per unit volume of the solution.

$$\underbrace{\mathbf{C(C_nA_m)}}_{\mathbf{(mol.L^{-1})}} = \frac{\overbrace{\mathbf{n(C_nA_m)}}^{\textbf{quantity of solid (mol)}}}{\underbrace{\mathbf{V}}_{\textbf{volume of the solution(L)}}}$$

*Note: **The solute concentration is fictious!!!***
*The ionic solid $C_nA_m$ doesn't exist in the solution, it has been dissolved and therefore dissociated in individual ions.*

## 2. Concentration of the ions, after dissolution

Ion $X_{aq}$ in the solution:

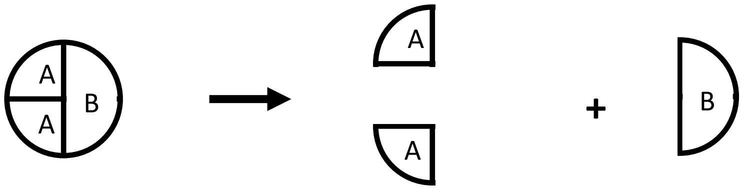
$$\underbrace{[\mathbf{X}]}_{\text{molar concentration of X in the solution (mol.L}^{-1}\text{)}} = \frac{\overbrace{\mathbf{n(X_{aq})}}^{\text{quantity of ion } X_{aq} \text{ in the solution (mol)}}}{\underbrace{\mathbf{V}}_{\text{volume of the solution (L)}}}$$

*Notes:*

- *notations $C(C_nA_m)$ and [X] : different conventions for the solute and the ions.*
- *Fictious molar concentration of solute and effective molar concentrations of the ions are related through the equation of dissolution*

***Ex :*** *Dissolution of $n_0$ moles of $Na_2SO_4$, sodium sulfate, in a volume V of water.*

| | $Na_2SO_{4(s)}$ | $\xrightarrow{water}$ | $2Na^+_{aq}$ | + | $SO_4^{2-}{}_{aq}$ |
|---|---|---|---|---|---|
| ***Initial state:*** | $n_0$ | | 0 | | 0 |
| ***Final state:*** | 0 | | $2n_0$ | | $n_0$ |




$$C(Na_2SO_4) = \frac{n_0}{V} \qquad [Na^+] = \frac{2n_0}{V} = 2C(Na_2SO_4) \qquad [SO_4{}^{2-}] = \frac{n_0}{V} = C(Na_2SO_4)$$

# Properties of an ionic solution

## 1. The solution is electrically neutral

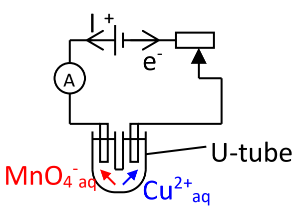
An ionic solution is made of ions coming from an electrically neutral ionic solid. Therefore, it is neutral.

## 2. The solution is conducting electricity

If an ionic solution is overall neutral, it is made of mobile ions, moving freely in the solution.
An electric current is created by moving electrical charges, which is the case of ions. Therefore, an ionic solution can conduct electricity.

*Ex :* *Electrolysis of a mixture of potassium permanganate and copper sulfate.*

$$KMnO_{4(s)} \xrightarrow{water} \underbrace{K^+{}_{aq}}_{colorless} + \underbrace{MnO_4{}^-{}_{aq}}_{purple} \text{ and } CuSO_{4(s)} \xrightarrow{water} \underbrace{Cu^{2+}{}_{aq}}_{blue} + \underbrace{SO_4{}^{2-}{}_{aq}}_{colorless}$$




*<u>Observations:</u>*
*Four different ions are in the solution.*
*The ammeter shows that a current is travelling through the circuit.*
*The separation of colors shows that the copper ions are travelling in the same direction than the current, and permanganate ions are travelling in the opposite direction.*

*Notes:*

- *An ionic solution is also called electrolytic solution.*
- *In an ionic solid, ions, and therefore electrical charges, are stationary. Therefore, an ionic solid is an insulator.*