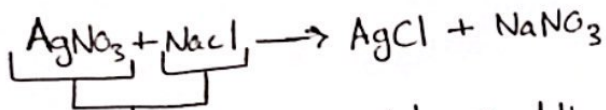


# General and Organic Chemistry L5

Ch4: Types of Chemical  
reactions and  
Solution Stoichiometry  
24/oct/2024

\* General and Organic Chemistry: Ch 4: Types of chemical reactions and Solution Stoichiometry

Ex: NaCl reacts with  $\text{AgNO}_3$  :



↳ these are solids, so adding them to each other in this state will not cause a reaction, therefore we need a solvent so that these compounds dissociate into ions, then a reaction will ~~be~~ start because now there are effective collisions between substances unlike when they are solids.

So here we will be talking about solutions  
حلول

therefore to do calculations for solutions we use the volume & concentration units because it is much easier

\* Some concentration units :

- Molarity → Most common
- Molality
- Normality
- Density

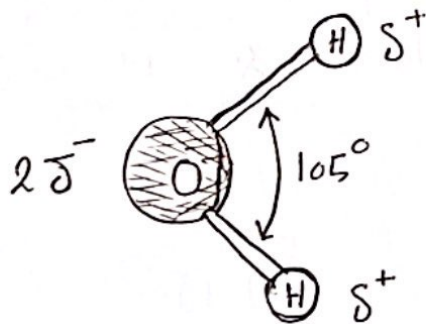
①

\* When choosing a solvent it should have 2 things :

- ① Must be chemically inert as Doesn't react with the substance in the solution and Just Dissolves them
- ② Can Dissolve all reactants

\* Most common solvent is water ( $H_2O$ )

- it's Polar, Most ~~organic~~ inorganic substances are salts so they contain ions, so they need a polar solvent like water
- Not expensive, so easier to use
- its boiling point is ~~at~~ at the middle so its not hard to get rid of it after the reaction by evaporating it under vacuum



water molecule

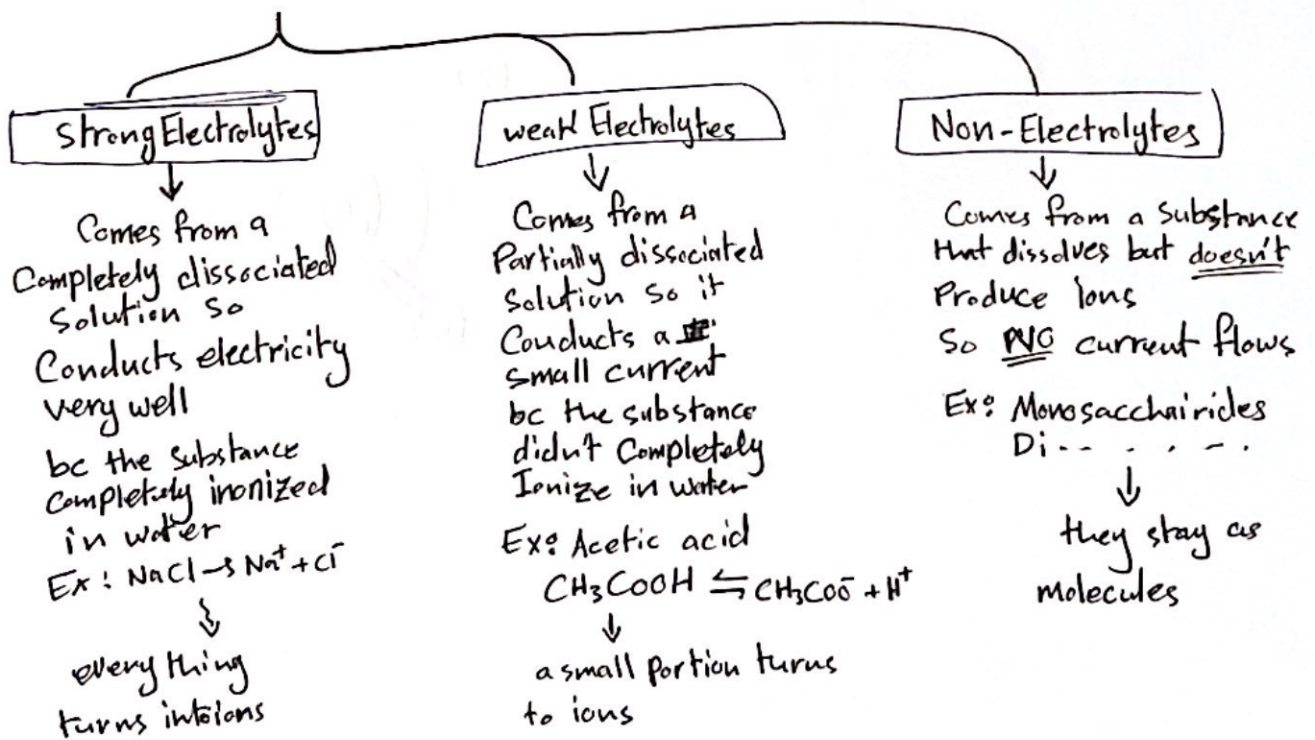
②

## \* Aqueous solutions consist of:

- Solute  $\text{المذاب}$ : the substance that is being dissolved
- Solvent  $\text{المذيب}$ : liquid water
- Electrolytes: A substance that when dissolved in water produces a solution that can conduct electricity  $\text{يُنقل الكهرباء}$

## \* The nature of aqueous solutions:

### Electrolytes:



★ For the chemical reactions of solutions :

★ We first must know :

- The nature of the reaction
- The amounts of chemicals present in the solutions

★ Some concepts to know :

- Molarity (M) : <sup>مولات المادة</sup> moles of solute <sup>حجم المحلول كالم</sup> per volume of solution in liters

$$M = \frac{\text{moles of Solute}}{\text{liters of Solution}}$$

the whole solution not just the solvent

$$M = \frac{n}{V}$$

Ex: 500.0 g of Potassium phosphate ( $K_3PO_4$ ) is dissolved in enough water to make 1.50 L of solution, calculate the Molarity of the solution

$$M = \frac{n}{V}$$

Conv to mols  $\rightarrow \left[ 500.0 \text{ g } K_3PO_4 \cdot \frac{1 \text{ Mol } K_3PO_4}{212.27 \text{ g } K_3PO_4} \right]$

$$= 2.35 \text{ Mol } K_3PO_4$$

Mr O = 16.00  
Mr K = 39.10  
Mr P = 30.97  
Mr  $K_3PO_4$   
= 212.27

$$M = \frac{2.35}{1.50} = \boxed{1.57 \text{ mol/L}}$$

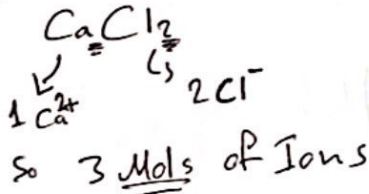
↳ or M

# \* Concentration of Ions :

- For a fully dissociated solute  
 ↳ its now all ions  
 So no partial ions

Ex: we have <sup>as concentration</sup> 1M  $\text{CaCl}_2$  solution

how many mols of Ions do we have :



For their concentration :

$$\text{Ca}^{2+} = (\# \text{ of mols}) \cdot (\text{Concentration of the whole solution})$$

$$1 \cdot 1 = 1 \text{ M}$$

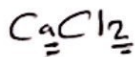
$$\text{Cl}^- = 2 \cdot 1 = 2 \text{ M}$$

↳ or mols of solutions

bc  $0.75 \text{ M} = \frac{0.75 \text{ mol}}{1 \text{ L}} = 0.75 \text{ mol}$   
 ↳ always (if a certain volume is given that isn't used) watch the concept check in next page

$\frac{0.25 \text{ mol}}{1 \text{ Liter}}$  so same a  $0.25 \text{ mol}$

- Suppose we have 0.25M  $\text{CaCl}_2$   
 Find the concentration of ions

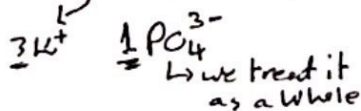


$$\text{Ca}^{2+} = 1 (0.25 \text{ M}) = 0.25 \text{ M}$$

$$\text{Cl}^- = 2 (0.25 \text{ M}) = 0.50 \text{ M}$$

So a total of 0.75M  
 of  $\text{CaCl}_2$  ions

ex:  $\text{K}_3\text{PO}_4$  how many Mols of ions?



So we have 4 mols of Ions

link to a video that explains and do examples

<https://www.youtube.com/watch?v=H5S4TRazXhQ&t=382s>

# \* The Concept check :

- which solution contains the greatest number of ions

①  $V = 400 \text{ mL}$  of  $0.10 \text{ M NaCl}$   
 $\hookrightarrow 0.4 \text{ L}$

$$n = M \cdot V = 0.4 \times 0.10 = \boxed{0.04 \text{ mol}}$$

$$\begin{aligned} \text{Na}^+ &= 0.04 (1) = 0.04 \text{ mol of Na}^+ \\ \text{Cl}^- &= 0.04 (1) = 0.04 \text{ mol Cl}^- \end{aligned}$$

so  $0.080 \text{ mol}$  of ions

Same with the others

②  $300 \text{ mL}$  of  $0.10 \text{ M CaCl}_2$   
 $\hookrightarrow 0.300 \text{ L}$

$$n = 0.3 \times 0.1 = 0.03 \text{ mol}$$

$$\text{Ca}^{2+} = (1)(0.03) = 0.03 \text{ mol}$$

$$\text{Cl}^- = (2)(0.03) = 0.06 \text{ mol}$$

so  $0.09 \text{ mol}$

③  $\sim 200 \text{ mL}$  of  $0.10 \text{ M FeCl}_3$   
 $= 0.08 \text{ mol}$

④  $\sim 800 \text{ mL}$  of  $0.10 \text{ M}$  sucrose

does not contain ions bc sucrose doesn't break into ions

So answer is ② or b)

Notice: The solution with greatest number of ions is NOT necessarily the one:

- That has largest volume bc it depends on concentration too  
 ex: the sucrose had the largest volume but no ions

- The formula unit has the greatest number of ions

Such as  $\text{K}_3\text{PO}_4$  (3 ions)

$\text{CaCl}_2$  (3 ions)

doesn't mean  $\text{K}_3\text{PO}_4$  has more ions

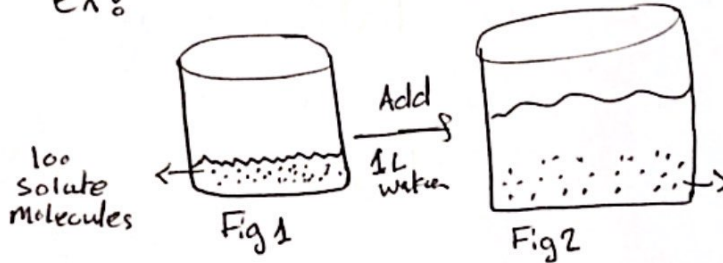
bc it the concentration of ions depends on solution concentration and volume too

⑥

# \* Dilution :

- The process of adding water to a concentrated or stock solution to achieve desired molarity
- Dilution with water does NOT alter the numbers of moles of solute present

ex:



still 100 solute molecules  
we just decreased (concentration)  
↳ how many molecules for every said volume

ex:  
in Fig 1 lets say we had 10 molecules per every  $cm^3$  of solution, when we added more water in Fig 2 it changed to 5 molecules for every  $cm^3$  but there is still 100 molecules present

Moles of solute before dilution = Moles of solute after dilution

$$n_{\text{before}} = n_{\text{after}}$$

$$n = MV$$

$$M_1 \cdot V_1 = M_2 \cdot V_2$$



## \* The concept check :

- we have 0.50 M solution of NaCl, which process would decrease the concentration of that solution

① Adding water  because it will decrease the # of molecules in said volume or space

② Pouring some of the solution out  because ~~as~~ you still have same concentration [or number of molecules per space or volume]

③ Add more NaCl  this would increase the concentration

④ Let the solution sit in the sun  this wouldn't change anything and even if something changes it would be evaporating of water which will increase the concentration

⑤ at least two options will decrease the concentration

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Ex: what is the minimum volume of 2.00 M NaOH solution needed to make 150.0 mL of 0.800 M NaOH solution

$$M_1 = 2.00 \text{ M}$$

$$V_1 = ??$$

$$M_2 = 150.0 \text{ mL}$$

$$M_2 = 0.800$$

$$n_1 = n_2$$

$$M_1 V_1 = M_2 V_2$$

$$2 V_1 = 0.800 \times 0.150 \text{ L}$$

$$V_1 = 0.06 \text{ L} = 60 \text{ mL}$$

so we get 60 mL of <sup>2.00 M</sup> NaOH and  $150 - 60 = 90$  add 90 mL of water to it to make 150 mL of 0.800 M solution

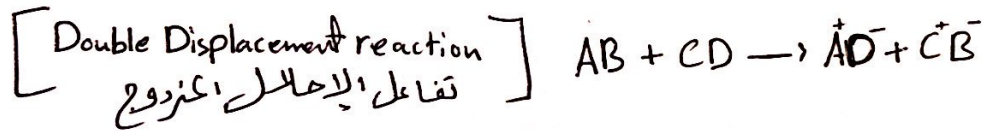
⑧

## \* Types of chemical reactions

	Observation & (Evidence of reaction)
- Precipitation reactions : تفاعلات الترسيب	<u>Precipitate</u> appears راس
- Acid - Base reactions : تفاعلات الحمض والقاعدة	Exothermic - Heat
- oxidation - Reduction Reaction : تفاعلات التأكسد والاختزال	Change in colour

## \* Precipitation Reaction

- one of the most common precipitation reactions is the :

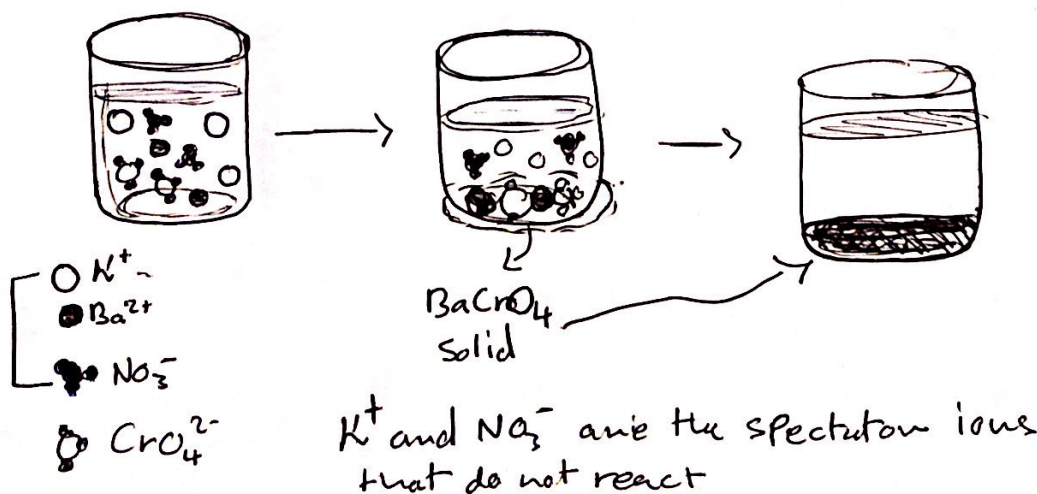
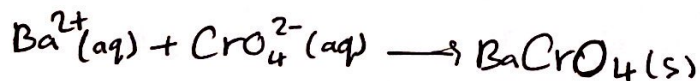


L> A solid forms and separates from the solution

- when ionic compounds like salts dissolve in water the resulting solution contains the separated ions

the solid that forms is called a Precipitate

Ex: reaction of  $K_2CrO_4(aq)$  and  $Ba(NO_3)_2(aq)$



## -Precipitates :

\* Soluble - Solid dissolves in Solution (aq), is used in the reaction equation

\* insoluble - Solid doesn't dissolve in solution (s), is used in the reaction equation

- insoluble and slightly soluble are often used interchangeably - and we are gonna count both as insoluble