# A molecular view of the solution process

**Inter molecular attraction:** → hold molecules together in liquid and solid and also central role in the formation of solutions.

☒ The case at which a solute particles replaces a solvent molecules depend on the relative strength of tree types of interactions.

## Three types of interactions

1) Solvent-Solvent interaction

2) Solute-Solute interaction

3) Solvent-Solute interaction

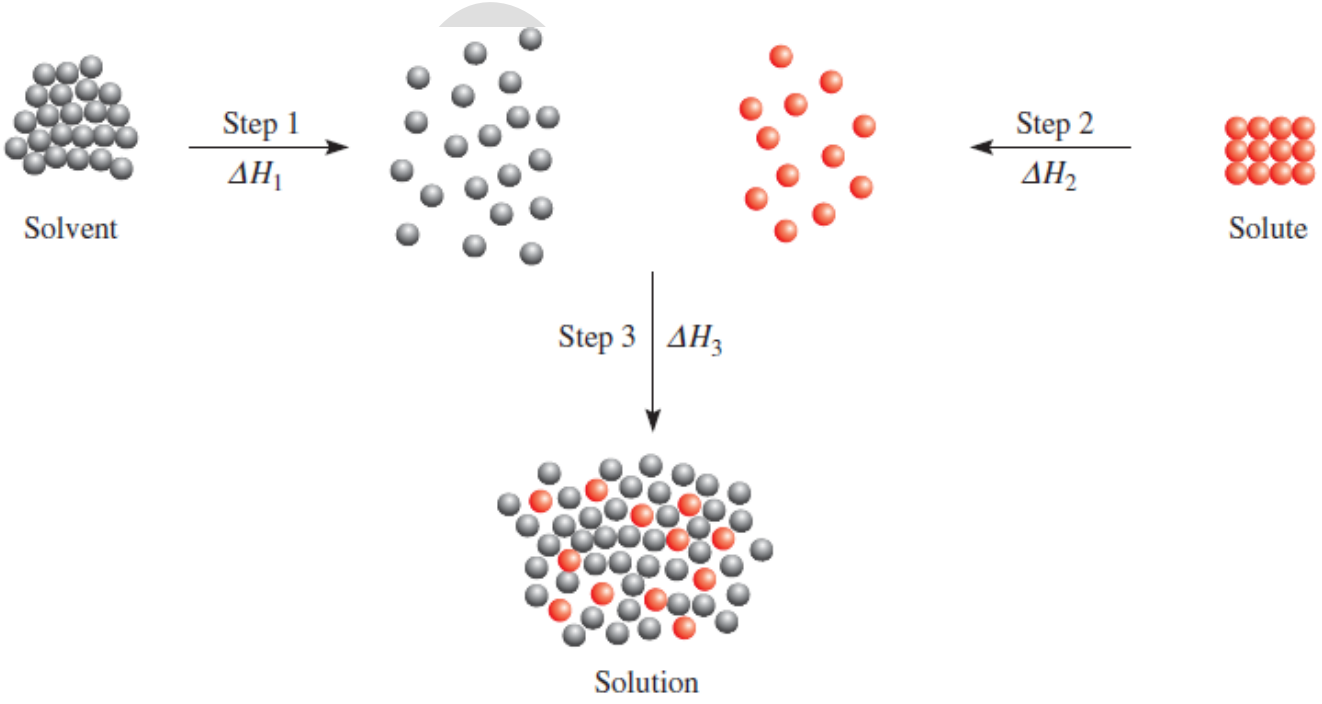
## Solution process taking place in three steps

**First step**: → separation of solvent molecules.

**Second step**: → separation of solute molecules.

**Third step:** → solvent and solute mix.

❖ The first and second step are endothermic because it required energy to break the attractive forces.



❖ **The solution process can be exothermic or endothermic**

$$\Delta Hsol = \Delta H_1 + \Delta H_2 + \Delta H_3$$

- If the solute-solvent attraction is stronger than the solute-solute and solvent-solvent→ exothermic process ($\Delta Hsol<0$).
- If the solute – solvent attraction is weaker than the solute – solute and solvent – solvent → endothermic process ($\Delta Hsol>0$).

**Solubility**: → Is a measure of how much solute will dissolve in a solvent at specific temp.

Like dissolves like what does these expression mean?!

This expression means that two substances with inter molecular forces of similar type and magnitude are likely to be soluble in each other.

- ✓ ($CCl_4$) and ($C_6H_6$) → are none polar liquid.
- ✓ The only inter molecular force that present in that substances are dispersion force.
- ✓ When these two liquid mixed they readily dissolve in each other.

**Miscible liquid**: → it's the liquid that completely soluble in each other in all proportions.

Note that: → Alcohol such as methanol, ethanol, and ethylene glycol are miscible with water.
→ Because they form hydrogen bond with water molecules.

Solvation: → the process in which an ion or molecules are surrounded by solvent molecules arranged in specific manner.
If the solvent is water → the process is called hydration.

How to predict the solubility?!

1- Ionic compounds should be much more soluble in polar solvent than non-polar solvent.

2- Non polar solute dissolves in non-polar solvent.

3- Solute that form hydrogen bond with the solvent will have high solubility in that solvent.

## Example

Predict the relative solubility in the following case:-

a) Bromine in benzene and in water.

b) KCl in carbon tetrachloride and in liquid ammonia.

c) formadhyde ($CH_2O$) in carbon disulfide and in water.

### Solution

a) Bromine is non-polar molecule and there force soluble in benzene than $H_2O$.

b) KCl is ionic compound so it soluble in liquid $NH_3$ "polar molecule".

c) because ($CH_2O$) is polar molecule and ($CS_2$) is non-polar , it can form hydrogen bonds with water , so it should be more soluble in that solvent.

Note that

Polar solvent: → (water/liquid $NH_3$/liquid hydrogen fluoride).

Non polar solvent :→( benzene/ carbon tetra-chloride).

## Choose

1) Which one of the following would be immiscible with water?

A) $CH_2$-$CH_2$-$CH_2$-$CH_2$
C) $CH_3$-S
B) $C_2H_5$-OH
D) $NH_3$

2) Which of the following liquid would make a good solvent for iodine $I_2$?

A) $H_2O$
C) $NH_3$
B) $CH_3OH$
D) $CS_3$

3) Which of the following compounds should be soluble in CCl4?

A) $H_2O$
C) NaOH
B) NaCl
D) $C_8H_{18}$

4) Which response lists all the following pairs that are miscible liquids?

Pair 1) octane ($C_8H_{18}$) and water.
Pair 2) acetic acid ($CH_3COOH$) and water.
Pair 3) octane ($C_8H_{18}$) and carbon tetrachloride

A) 1,3
C) 3
B) 1,2
D) 2,3

5) Solution process taking place in…….. steps.

A) two
C) five
B) three
D) seven

6) If the solute- solvent attraction is stronger than the solute –solute and the solvent- solvent. The process is …….. .

A) endothermic
C) equilibrium
B) exothermic
D) None of them

7) Is a measure of how much solute will dissolve in a solvent at specific temp?

A) solvation
C) crystallization
B) solubility
D) saturation

8) When the process is endothermic, …

A) $\Delta Hsol \cong 1$
C) $\Delta Hsol<o$
B) $\Delta Hsol>0$
D) $\Delta Hsol = 0$

9) Which of the following are polar solvent?

A) benzene
C) liquid $NH_3$
B) $C_6H_6$
D) carbon tetrachloride