

Solutions cont.:

homogeneous mixture

may be gaseous, liquid, or solid depending on solvent

liquid most common

alloy--solid soln.

brass, pewter, steel

miscible fluids-- fluids (gases or liquids) dissolve in each other

alcohol and water

immiscible fluids-- fluids that don't mix

oil and water

qualitative composition:

dilute--little solute as compared to the amount of solvent

concentrated--a lot of solute compared to the amount of solvent

For a solution to form:

"like dissolves like"

nonpolar solvent dissolves nonpolar substance

polar solvent dissolves a polar or ionic substance

3 steps involving energy for soln. formation:

1. separation of solute molecules ( $\Delta H_1$ ) *endothermic*

2. separation of solvent molecules ( $\Delta H_2$ ) *endothermic*

3. formation of solute-solvent interactions ( $\Delta H_3$ ) *exothermic*

energy change that occurs is called enthalpy of solution

$$\Delta H_{\text{soln}} = \Delta H_1 + \Delta H_2 + \Delta H_3$$

$\Delta H_{\text{soln}}$  can be positive or negative depending on intermolecular forces

*neg. value*

*exothermic*

MgSO<sub>4</sub> added to water has  $\Delta H_{\text{soln}} = -91.2$  kJ  
used in instant hot packs

NH<sub>4</sub>NO<sub>3</sub> added to water has  $\Delta H_{\text{soln}} = 26.4$  kJ  
used in instant cold packs

In general, solutions form if  $\Delta H_{\text{soln}}$  is negative. The solution process increases with an increase in disorder (entropy).

If  $\Delta H_{\text{soln}}$  is too endothermic a solution will not form.

**Breaking** intermolecular forces is always **endothermic**.  
 $\Delta H_1$  and  $\Delta H_2$  are both positive

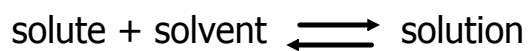
**Forming** intermolecular forces is always **exothermic**.

*Na<sup>+</sup>*  
*K<sup>+</sup>*  
*NH<sub>4</sub><sup>+</sup>*  
*Soluble*

Factors favoring solution formation:

1. decrease in enthalpy (negative value; exothermic;  
 $\Delta H_3 < \Delta H_1 + \Delta H_2$ )
2. increase in entropy (positive value; increase in disorder)

Solutions will form unless solute-solute or solvent-solvent interaction are too strong compared to the solute-solvent interactions.




If crystallization and dissolution are in equilibrium with no undissolved solute present, the solution is **saturated**. The solution has the **maximum amount of solute**.

Remember: solubility -- amount of solute required to form a saturated solution.

Unsaturated solution--has less solute than what is needed to form a saturated solution.

Supersaturated solution--has more solute than is necessary to have a saturated solution.

Factors affecting solubility:  Structure

1. nature of solute--molecular structure  
are bonds (intermolecular forces) similar?

water is polar and forms hydrogen bonds

other polar molecules that can form hydrogen bonds are miscible in water (hydrophilic--"water loving")

acetone, alcohol, water soluble vitamins (C & B)


nonpolar molecules are immiscible in water

hydrophobic--"water fearing"

oil, gasoline, fat soluble vitamins (A, E, K, D)

long C chain molecules are not soluble in water

the more --OH groups a molecule has the more soluble it is in water

  
hydroxy/  
group

2. pressure:

affects solubility of gases

increase pressure causes an increase in solubility

solids and liquids are not affected by pressure

soft drinks

scuba divers--ascend slowly to keep from releasing too much  $O_2$  so don't get "the bends"

3. temperature:

increase temperature most solids dissolve better

$Ce_2(SO_4)_3$  exception--solubility decreases with an increase in temp.

$Na_2SO_4$  not much change in solubility

gases are less soluble at high temp.

gases-low

Solids-high

thermal pollution:

lakes get too warm  $CO_2$  and  $O_2$  escape killing plant and animal life

factors that affect Rate of

Solution: make solid dissolve faster

{ 1- temp.

{ 2- stir, agitate

{ 3- ↑ surface area

4- pressure ↑ - only gases