separated solute   &   separated solvent particles

sep. solvent part

$\Delta H_2 > 0$ (or $\Delta H_{\text{sep solvent}}$)

sep. solute & solvent

form solute-solvent AF

$\Delta H_3 < 0$ (ΔH_{mix} or $\Delta H_{\text{solvation}}$)

sep. solute part

H

$\Delta H_1 > 0$ (or $\Delta H_{\text{sep solute}}$)

solution
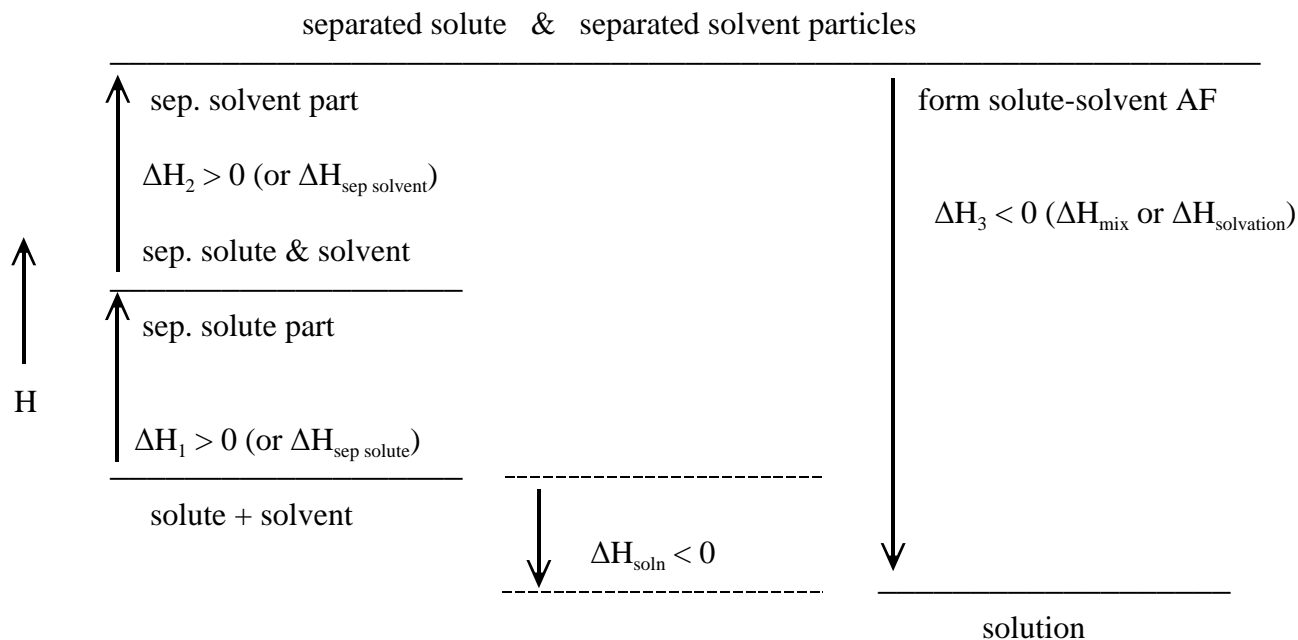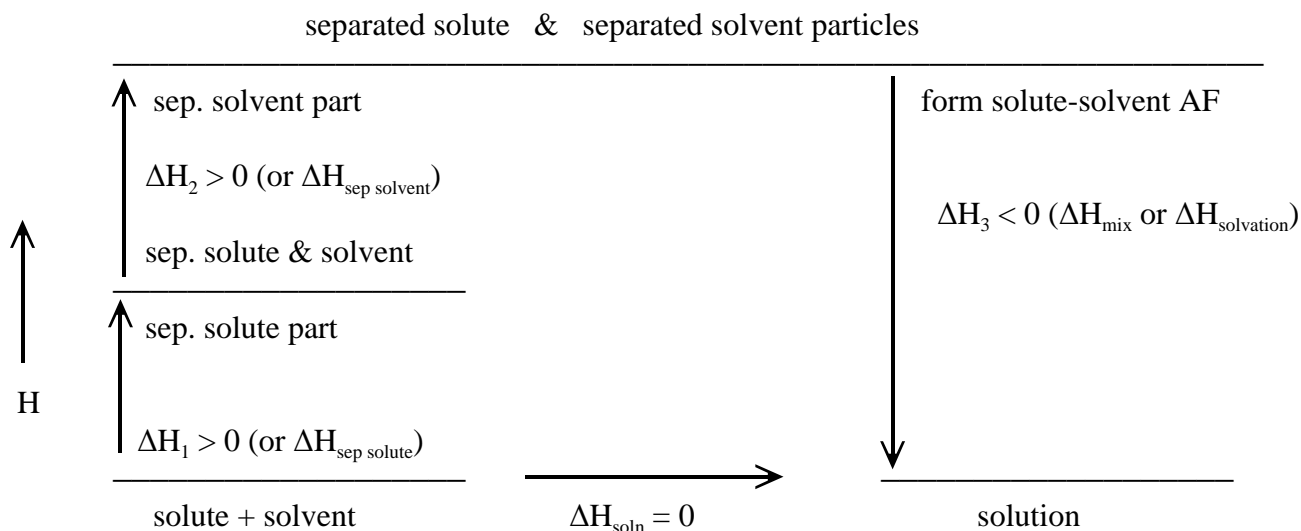
$\Delta H_{\text{soln}} > 0$

solute + solvent

$\Delta H_{\text{soln}} > 0$ (**endothermic**); product (solution) has a higher energy than reactants (solute & solvent).

Attractive forces between solute and solvent (unlike particles) are not as strong as solute-solute and solvent-solvent AF (like particles).

separated solute   &   separated solvent particles

sep. solvent part

$\Delta H_2 > 0$ (or $\Delta H_{\text{sep solvent}}$)

sep. solute & solvent

form solute-solvent AF

$\Delta H_3 < 0$ (ΔH_{mix} or $\Delta H_{\text{solvation}}$)

sep. solute part

H

$\Delta H_1 > 0$ (or $\Delta H_{\text{sep solute}}$)

solute + solvent

$\Delta H_{\text{soln}} < 0$

solution

$\Delta H_{\text{soln}} < 0$ (**exothermic**); product (solution) has a lower energy than reactants (solute & solvent).

Attractive forces between solute and solvent (unlike particles) are stronger than solute-solute and solvent-solvent AF (like particles).

separated solute   &   separated solvent particles
_____

sep. solvent part

$\Delta H_2 > 0$ (or $\Delta H_{\text{sep solvent}}$)

sep. solute & solvent
_____

sep. solute part

H

$\Delta H_1 > 0$ (or $\Delta H_{\text{sep solute}}$)
_____

solute + solvent $\Delta H_{\text{soln}} = 0$

form solute-solvent AF

$\Delta H_3 < 0$ (ΔH_{mix} or $\Delta H_{\text{solvation}}$)

_____

solution

$\Delta H_{\text{soln}} = 0$ (**ideal**); product (solution) has same energy as reactants (solute & solvent).

Attractive forces between solute and solvent (unlike particles) are similar to solute-solute and solvent-solvent AF (like particles). Generally, particles with only LF are the most likely to form ideal solutions.

For **ideal** solutions ($\Delta H_{\text{soln}} = 0$) and **endothermic** ($\Delta H_{\text{soln}} > 0$) solutions to form the **change** in **entropy** (disorder) __**must**__ be **positive** ($\Delta S_{\text{soln}} > 0$, **disorder __must__ inc**.). Generally, $\Delta S_{\text{soln}} > 0$ for mixing.

For **exothermic** ($\Delta H_{\text{soln}} < 0$) solutions an increase in entropy (disorder) is not necessary for a solution to form since an exothermic process already tends to be spontaneous (going to a lower energy state tends to be spontaneous already so an inc. in disorder, $\Delta S_{\text{soln}} > 0$, is not required for the solution to form).

Remember, as given in class:

$\Delta G = \Delta H - T \cdot \Delta S$ and $\Delta G < 0$ (negative) for a spontaneous process
$\Delta G > 0$ (positive) for a nonspontaneous process

If,
$\Delta H > 0$ (+)   or $\Delta H = 0$

then,

__**MUST**__ have $\Delta S > 0$ (+), **increase** in **disorder**, to have $\Delta G < 0$ (-), at some temperature (i.e. a spontaneous process).

For an endothermic solution process, the more positive the ΔH_{soln} the less soluble the solute because not enough entropy can be created to overcome a really large ΔH_{soln} .

Remember: "**Like Dissolves Like**"   (which is about attractive. forces, AF)

       Polar solvents **dissolve polar** & **ionic** solutes

       Nonpolar solvents dissolve **non**polar solutes

The more similar the solute and solvent AF the more soluble the solute will be.

For temp. effects on solubility you need to consider whether heat is a reactant (endothermic) or product (exothermic) and use Le Chatelier's Principle

     exothermic, $\Delta H_{soln} < 0$ (**heat released**, a **product**)

     Solute + Solvent ⇌ Solution + **heat**

     Inc. **T** (add heat), shifts **left** (**away** from **added** heat), **less** solution ==> **Solubility Dec**

     - rxn shifts to use up added heat and proceeds in the **reverse** direction
         - shifts to left to use up added product, the heat - away from what was added (heat).
         As this happens you get less solution and more solute and solvent (solubility dec).

     endothermic, $\Delta H_{soln} > 0$ (**heat required,** a **reactant**)

     Solute + Solvent + **heat** ⇌ Solution

     Inc. **T** (add heat), shifts **right** (**away** from **added** heat), **more** solution ==> **Solubility Inc**

     - rxn shifts to use up added heat and proceeds in the **forward** direction
         - shifts to right to use up added reactant, the heat - away from what was added (heat).
         As this happens you get more solution (solubility inc).