Heat of Solution and Dilution

Enthalpy changes occur as well when

Solute dissolves in a solvent	**A solution is diluted**
↓	↓
Enthalpy of solution (ΔH_{sol})	Enthalpy of dilution (ΔH_{dil})

Enthalpy of solution → Is the heat generated or absorbed when a certain amount of solute dissolved in a certain amount of solvent " At constant pressure".

Note that

The quantity ΔH_{soln} represents the difference between enthalpy of the final solution and the enthalpy of its original components before they are mixed

$$\Delta H_{soln} = H_{soln} - H \text{ components}$$

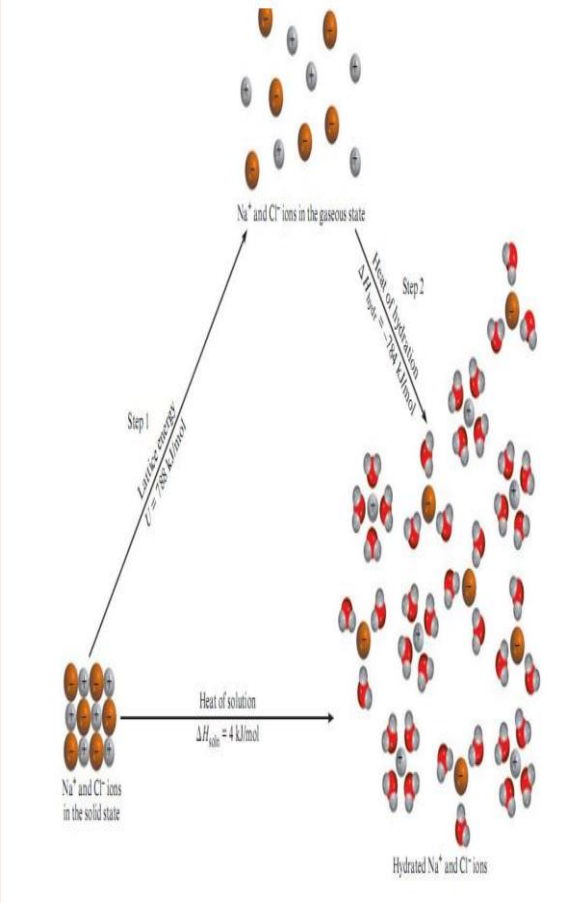
- ✓ Neither H_{soln} nor $H_{components}$ can be measured , but their difference ,ΔH_{soln} can be determined in constant pressure calorimeter.

Ex : If solid NaCl dissolved in H_2O, What will happen?

There are Two steps:-

1) ($Na^+$and Cl^-) ions in the solid crystal are separated and this required energy , this energy is called (Latic energy)(U)

Latic energy of NaCl is 788KJ/mol



Latic energy :

The energy required to completely separate one mole of a solid ionic compound into gaseous ions.

$Energy + NaCl_{(s)} \rightarrow Na^+_{(g)} + Cl^-_{(g)}$

2) The gaseous Na^+ and Cl^- ions surrounded by water and become hydrated , the enthalpy change associated with the hydration process is called (heat of hydration) ΔH_{hydr} (heat of hydration is negative for cations and anions).

$Na^+_{(g)} + Cl^-_{(g)} \_\_ H_2O \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$

$\Delta H_{hydr} = -784KJ/mol$

$NaCl_{(s)} \rightarrow Na^+_{(g)} + Cl^-_{(g)}$ U= 788KJ/mol

$Na^+_{(g)} + Cl^-_{(g)} \_\_ H_2O \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ $\Delta H_{hydr} = -784KJ/mol$

$NaCl_{(s)} \_\_ H_2O \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ $\Delta H_{soln} = 4KJ/mol$

$\Delta H_{soln} = U + \Delta H_{hydr}$.

2) Heat of Dilution

Is the heat change associated with the dilution process.

- When a previously prepared solution is diluted ,that is, when more solvent is added to lower the overall concentration of the solute , additional heat is usually given off or absorbed.
  - ✓ If a certain solution process is endothermic and the solution is subsequently diluted more heat will be absorbed by the same solution from the surroundings.
  - ✓ The converse holds true for an exothermic solution process more heat will be liberated if additional solvent is added to dilute the solution. Therefore always be cautious when working on a dilution procedure in the laboratory.

Choose

1) Heat of solution is ……

A) the heat generated or absorbed when a certain amount of solute dissolves in a certain amount of solvent

B) The energy required to completely separate one mole of a solid ionic compound into gaseous ions

C) The enthalpy change associated with the hydration process.

D) is the heat change associated with the dilution process

2) The energy required to completely separate one mole of a solid ionic compound into gaseous ions is called

A) heat of solution

B) kinetic energy

C) lattice energy

D) heat of dilution

3) heat of hydration is ……. quantity for cations and anions

A) positive

B) negative

C) greater than zero

D) infinity

4) The enthalpy change associated with the hydration process is called……

A) heat of dilution

B) heat of solution

C) heat of hydration

D) heat of combustion

5) The heat of the solution of KCl is 17.2 kJ/mol and the lattice energy of KCl(s) is 701.2 kJ/mol. Calculate the total heat of hydration of 1 mol of gas phase K^+ ions and Cl^- ions.

A) 718 kJ
C) -684 kJ
B) 684 kJ
D) -718 kJ

Solution

$\Delta H_{soln} = U + \Delta H_{hyd}$

$\Delta H_{hyd} = \Delta H_{soln} - U$

$= 17.2 - 701.2 = -684.1KJ$

6) The heat of solution of LiCl is -37.1 kJ/mol, and the lattice energy of LiCl(s) is 828 kJ/mol. Calculate the total heat of hydration of 1 mol of gas phase Li^+ ions and Cl^- ions.

A) 791 kJ
C) -865 kJ
B) 865 kJ
D) -791 kJ

Solution

$\Delta H_{soln} = U + \Delta H_{hyd}$

$\Delta H_{hyd} = \Delta H_{soln} - U$

$= -37.1-828 = -865.1KJ$

7) The total heat of hydration of 1 mol of gas phase Li^+ ions and Cl^- ions is -865 kJ. The lattice energy of LiCl(s) is 828 kJ/mol. Calculate the heat of solution of LiCl.

A) 37 kJ/mol
C) -1,693 kJ/mol
B) 1,693 kJ/mol
D) -37 kJ/mol

Solution

$\Delta H_{soln} = U + \Delta H_{hyd}$

$\Delta H_{hyd} = \Delta H_{soln} - U$

$= 828 - 865 = -37 KJ/mol$

8) The enthalpy change when a strong acid is neutralized by strong base is -56.1kJ/mol. If 135 mL of 0.450 M HI at 23.15°C is mixed with 145 mL of 0.500 M NaOH, also at 23.15°C, what will the maximum temperature reached by the resulting solution?

[Assume that there is no heat loss to the container, that the specific heat of the final solution is 4.18 J/g·°C, and that the density of the final solution is that of water.]

A) 26.06°C
C) 32.35°C
B) 29.19°C
D) 20.24°C

9) The enthalpy change when a strong acid is neutralized by strong base is -56.1kJ/mol. If 12.0 mL of 6.00 M H Br at 21.30°C is mixed with 300. mL of 0.250 M NaOH, also at 21.30°C, what will the maximum temperature reached by the resulting solution?

[Assume that there is no heat loss to the container, that the specific heat of the final solution is 4.18 J/g·°C, and that the density of the final solution is that of water.]

A) 18.20°C
B) 24.53°C
C) 101.8°C
D) 24.40°C

10) If additional solvent is added to dilute the solution

A) heat will liberated
B) heat will absorbed
C) no change
D) Both A and B