Enthalpy of Solution part 2

Click here for enthalpy of solution part 1

Definitions

Enthalpy of hydration: *the enthalpy change that occurs when 1 mole of gaseous ions forms aqueous/hydrated ions.*

$$Na^+(g) + aq \rightarrow Na^+(aq)$$

Hydration and lattice enthalpies

Both of these enthalpy changes are exothermic and both are affected in the same way by the same factors. It's back to **size** and **charge** again as discussed in the Born-Haber cycles tutorials.

a **high charge** on the ions: **both** hydration and lattice enthalpies become more **exothermic**.

small size of the ions: **both** hydration and lattice enthalpies become more **exothermic**.

✓ as lattice and hydration enthalpies are on different sides of the subtraction they will have opposite effects on the ΔH_{sol} value.

$$\Delta H_{sol} = \Delta H_{hyd} - \Delta H_{latt}$$

- as ΔH_{latt} becomes more exothermic, ΔH_{sol} becomes more positive i.e. harder to dissolve.
- as ΔH_{hyd} becomes more exothermic, ΔH_{sol} becomes more negative i.e. easier to dissolve.

✓ as was mentioned in part 1, you can think of ΔH_{sol} as a "fight" between hydration and lattice. Whichever is **more** negative "wins".

Calculations

You just have to remember that: $\Delta H_{sol} = \Delta H_{hyd} - \Delta H_{latt}$

Example

Calculate the enthalpy of solution of $Mg(OH)_2$ given that ΔH_{latt} = -2694 kJ mol^{-1}, $\Delta H_{hyd\ (OH-)}$ = -460 kJ mol^{-1} and $\Delta H_{hyd\ (Mg2+)}$ = -1926 kJ mol^{-1}.

$$Mg(OH)_2 \rightarrow Mg^{2+}(aq) + 2OH^-(aq)$$

ΔH_{hyd}: you need the ΔH_{hyd} values for OH^- and Mg^{2+}, which are given in the question. Just make sure that you multiply the OH^- value by 2:

$$\Delta H_{hyd} = (2 \times -460) + (-1926) = \mathbf{-2846\ kJ\ mol^{-1}}$$

ΔH_{sol}: we have the lattice enthalpy and the hydration enthalpies so we now just use **$\Delta H_{sol} = \Delta H_{hyd} - \Delta H_{latt}$**

$$\Delta H_{sol} = -2846 - (-2694) = \mathbf{-152\ kJ\ mol^{-1}}$$

They could also ask you to calculate a lattice enthalpy or a hydration enthalpy, it just depends on the question.

- ✓ if they ask you to calculate ΔH_{hyd}, you may have to **divide by 2** at the end. For example, $MgCl_2 \rightarrow Mg^{2+} + 2Cl^-$.The ΔH_{hyd} value calculated would be for 2 x Cl^-.

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