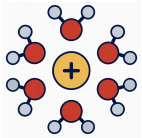
Solution and Solubility Map

Edexcel International A Level Chemistry · Unit 4 · Topic 12C Solution, Hydration and Solubility

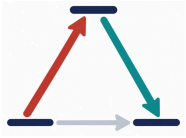
1 Solution and hydration 12.16

- $\Delta_{sol}H$: **1 mol of solid** → infinitely dilute
- $\Delta_{hyd}H$: **1 mol of gaseous ions** → aq
- Hydration always **exothermic**
- δ− O to cations, δ+ H to anions



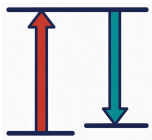
2 The solution cycle 12.17

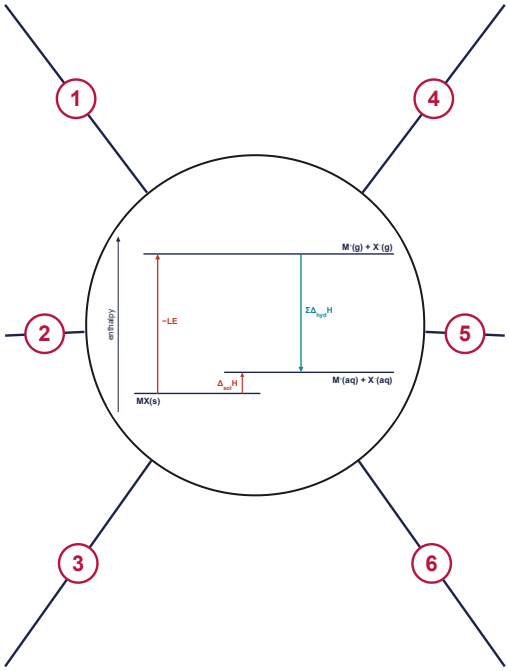
- **$\Delta_{sol}H = -LE + \Sigma\Delta_{hyd}H$**
- Break the lattice (−LE, up)
- Hydrate **every** ion (down)
- Small difference of large numbers



3 Energy level diagrams 12.17

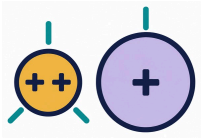
- Gaseous ions at the **top**
- Aqueous ions **above** solid: endothermic
- Aqueous ions **below** solid: exothermic
- Arrows to scale where possible





4 Charge and radius 12.18

- **Smaller** ions: more exothermic
- **Higher charge**: much more exothermic
- Charge density = charge ÷ size
- Charge beats radius



5 ΔG and solubility 12.19

- **$\Delta G = \Delta_{sol}H - T\Delta S$**
- Negative ΔG: **dissolves**
- Small, charged ions order water: ΔS negative
- Positive ΔS: more soluble when hot



6 Group 2 trends 12.19

- Hydroxides: **more soluble** down
- Sulfates: **less soluble** down
- Small OH^-: LE falls faster
- Large SO_4^{2-}: hydration falls faster



Hydration enthalpies: charge and radius

data-book values; radii in pm

Ion	Charge	Radius / pm	$\Delta_{hyd}H$ / kJ mol^{-1}
Li^+	1+	76	−519
K^+	1+	138	−322
Ca^{2+}	2+	100	−1650
Ba^{2+}	2+	135	−1360
Al^{3+}	3+	54	−4690
I^-	1−	220	−293

Worked examples

$\Delta_{sol}H$ of KBr

- −LE = +679
- $\Sigma\Delta_{hyd}H$ = −322 − 335 = −657
- $\Delta_{sol}H$ = **+22 kJ mol^{-1}**

An endothermic salt dissolves

- KI: $\Delta_{sol}H$ +17, ΔS +107.5
- ΔG = 17 − 298 × 0.1075
- = **−15.0 kJ mol^{-1}**: soluble

Why $BaSO_4$ is insoluble

- $\Delta_{sol}H$ +29, ΔS −102.5
- ΔG = 29 + 30.5
- = **+59.5 kJ mol^{-1}**

ΔG returns with the equilibrium constant in Topic 13.

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