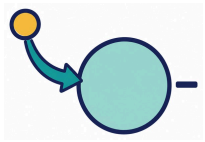
Born–Haber Cycles Map

AQA A-level Chemistry · 3.1.8.1 Born–Haber cycles

1 Atomisation and EA

3.1.8.1 ii

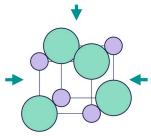
- $\Delta_{at}H$: **1 mol of gaseous atoms**
- $\frac{1}{2}Cl_2(g) \rightarrow Cl(g)$: ½ × bond enthalpy
- **EA_1**: $X(g) + e^- \rightarrow X^-(g)$, exothermic
- **EA_2** endothermic: repelled by X^-



2 Lattice enthalpy, both ways

3.1.8.1 i

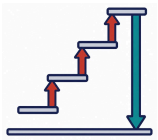
- **Formation**: gaseous ions → 1 mol of solid
- Formation is **exothermic**: ions attract
- **Dissociation**: the reverse, **endothermic**
- Same size: **say which you use**

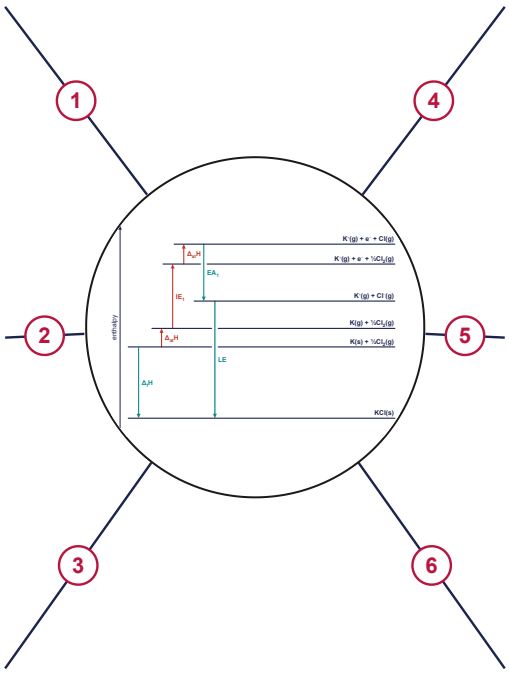


3 Born–Haber cycles

3.1.8.1 iii

- Up: atomise, ionise; down: EA, LE
- **LE(formation) = ΔfH − (other steps)**
- Hess: both routes have the **same total**
- **Keep every sign**

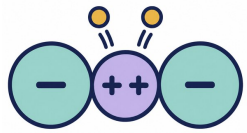




4 2+ ions, missing values

3.1.8.1 iii, iv

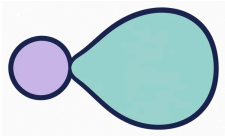
- 2+ ions: **IE_1 + IE_2**; double for two ions
- Oxides: **EA_1 (−) and EA_2 (+)**
- Missing value: the **same cycle, rearranged**
- e.g. EA_2 or ΔatH from a known LE



5 Covalent character

3.1.8.1 v

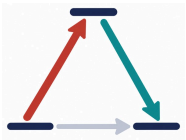
- Theory: **perfect ionic model**
- Experimental more exothermic: **covalent**
- **Small, charged cation** polarises
- a **large, charged anion**



6 Solution and hydration

3.1.8.1 vi, vii

- $\Delta_{hyd}H$: 1 mol of gaseous ions → aq
- **$\Delta_{sol}H = -LE + \Sigma\Delta_{hyd}H$**
- Count **every** ion
- Level diagram: gaseous ions at the top



The steps of a Born–Haber cycle

sodium fluoride; values in kJ mol⁻¹

Step	Equation	Value	Direction
ΔatH(Na)	$Na(s) \rightarrow Na(g)$	+107	up
IE_1(Na)	$Na(g) \rightarrow Na^+(g) + e^-$	+496	up
ΔatH(F)	$\frac{1}{2}F_2(g) \rightarrow F(g)$	+79	up
EA_1(F)	$F(g) + e^- \rightarrow F^-(g)$	−328	down
Lattice formation	$Na^+(g) + F^-(g) \rightarrow NaF(s)$	−928	down
ΔfH	$Na(s) + \frac{1}{2}F_2(g) \rightarrow NaF(s)$	−574	down

Worked examples

Lattice enthalpy of NaF

- sum = 107 + 496 + 79 − 328
- = +354 kJ mol⁻¹
- formation **−928**; dissociation **+928**

A missing value

- LiCl: LE −861, ΔfH −409
- ΔatH(Cl) = −409 + 861 − 159 − 520 + 349
- = **+122 kJ mol⁻¹**

$\Delta_{sol}H$ of KBr

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

Entropy and ΔG decide whether a salt dissolves (3.1.8.2).

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