A-LEVEL CHEMISTRY • EXERCISE SHEET

23.1 Lattice energy and Born-Haber cycles

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS enthalpy change 焓变 • lattice energy 晶格能 • electron affinity 电子亲和能 • atomisation 原子化 • enthalpy change of atomisation 原子化焓变

Objective

Build the skills to answer exam questions on **lattice energy and Born–Haber cycles** — **atomisation** 原子化, **lattice energy** 晶格能, **electron affinity** 电子亲和能, and Born–Haber calculations.

You must be able to:

- define enthalpy of atomisation, lattice energy and first electron affinity
- explain the trends in electron affinity down Groups 16 and 17
- construct and use Born–Haber cycles to calculate an unknown step

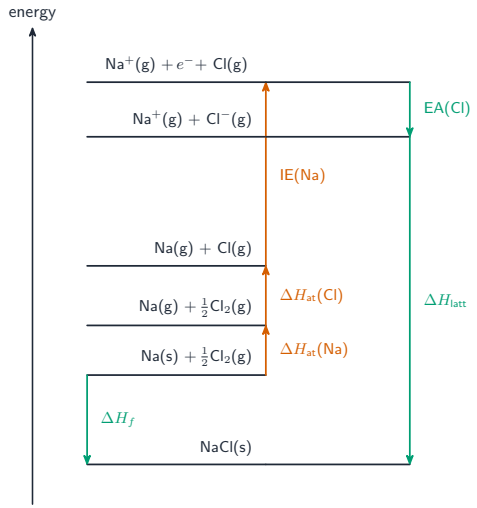
1 Worked examples

The key terms

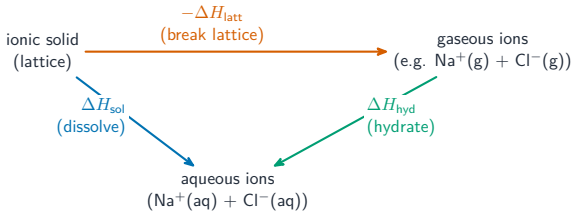
- $\Delta H_{\mathbf{at}}$ — energy to make 1 mol of gaseous atoms from an element (always +).
- $\Delta H_{\mathbf{latt}}$ — change when 1 mol of ionic solid forms from gaseous ions (always −).
- **first electron affinity (EA)** — change when 1 mol of gaseous atoms each gain an electron → 1 mol of 1− ions (usually −).

EA becomes **less exothermic** down Groups 16/17 (larger atom attracts the electron less).

Born–Haber cycle



By Hess's law, the direct route (ΔHf) equals the sum of the steps round the cycle — solve for any unknown



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

Born-Haber alongside the dissolving cycle

For NaCl: $\Delta H_f = \Delta H_{\text{at}}(\text{Na}) + \text{IE}_1(\text{Na}) + \Delta H_{\text{at}}(\text{Cl}) + \text{EA}_1(\text{Cl}) + \Delta H_{\text{latt}}$.

2 Practice

2.1 Define **lattice energy**. [2]

2.2 State why the first electron affinity of chlorine is exothermic. [1]

3 Exam-style questions

3.1 The enthalpy change of atomisation is always: [1]

A | B
C | D

A negative
B positive
C zero
D equal to the lattice energy

3.2 Down Group 17, the first electron affinity becomes: [1]

A | B
C | D

A more exothermic
B less exothermic
C zero
D positive

3.3 Use these data (kJ mol^{-1}) for NaCl: $\Delta H_f = -411$; $\Delta H_{at}(Na) = +107$; $IE_1(Na) = +496$; $\Delta H_{at}(Cl) = +122$; $EA_1(Cl) = -349$.

(a) Calculate the lattice energy of NaCl. [3]

(b) State why the lattice energy is negative. [1]

3.4 Explain why the lattice energy of MgO is more exothermic than that of NaCl. [2]