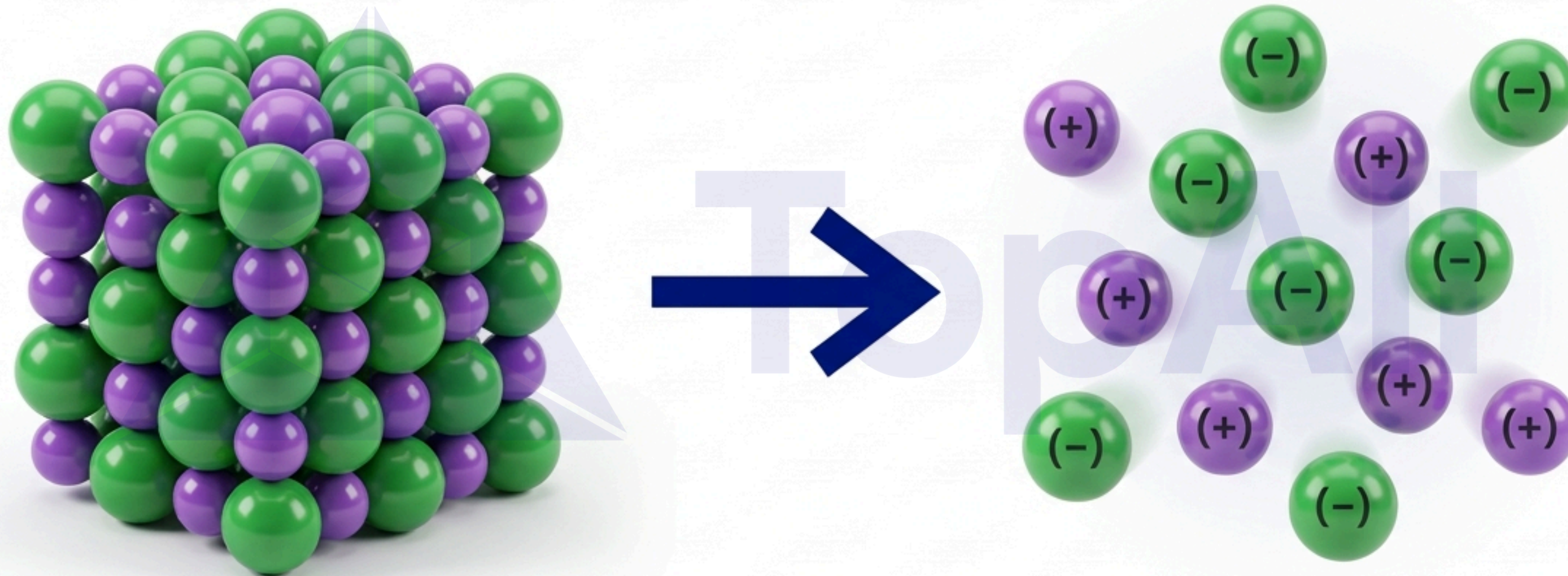


Lattice Enthalpy & Born-Haber Cycle | JEE

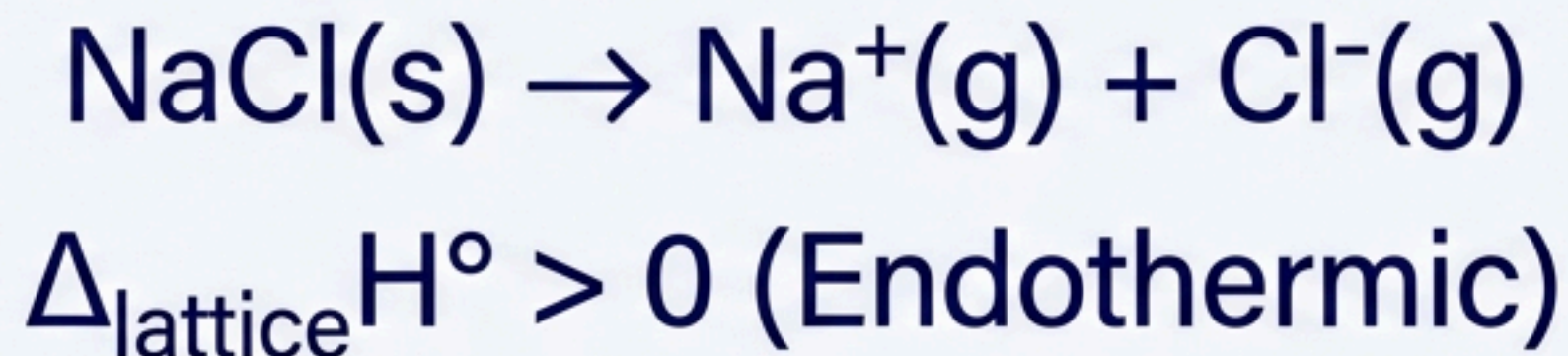
Thermodynamics: Decoding the energy of ionic crystals.



NaCl crystal $\rightarrow$ separated gaseous ions

The Textbook Convention

Lattice Enthalpy is the energy change when one mole of an ionic solid completely dissociates into its gaseous ions. Because strong electrostatic bonds are being broken, energy is inherently required.

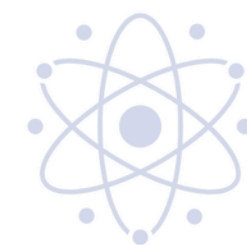


Note: $\Delta_{\text{lattice}}\text{H}^{\circ}$ for NaCl is experimentally derived as $+788 \text{ kJ mol}^{-1}$.



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$$E=mc^2$$



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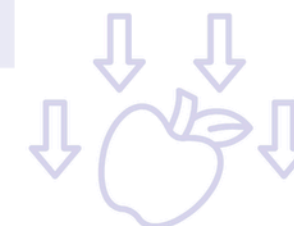
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The Measurement Problem

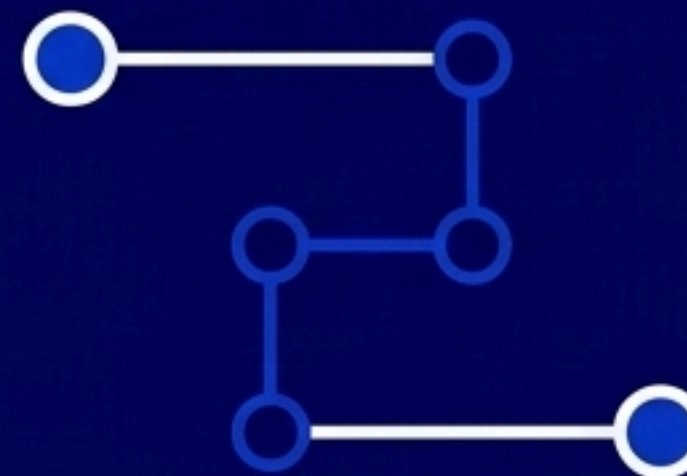
Direct Measurement is Impossible

Lattice enthalpy cannot be conveniently determined directly by experiment.

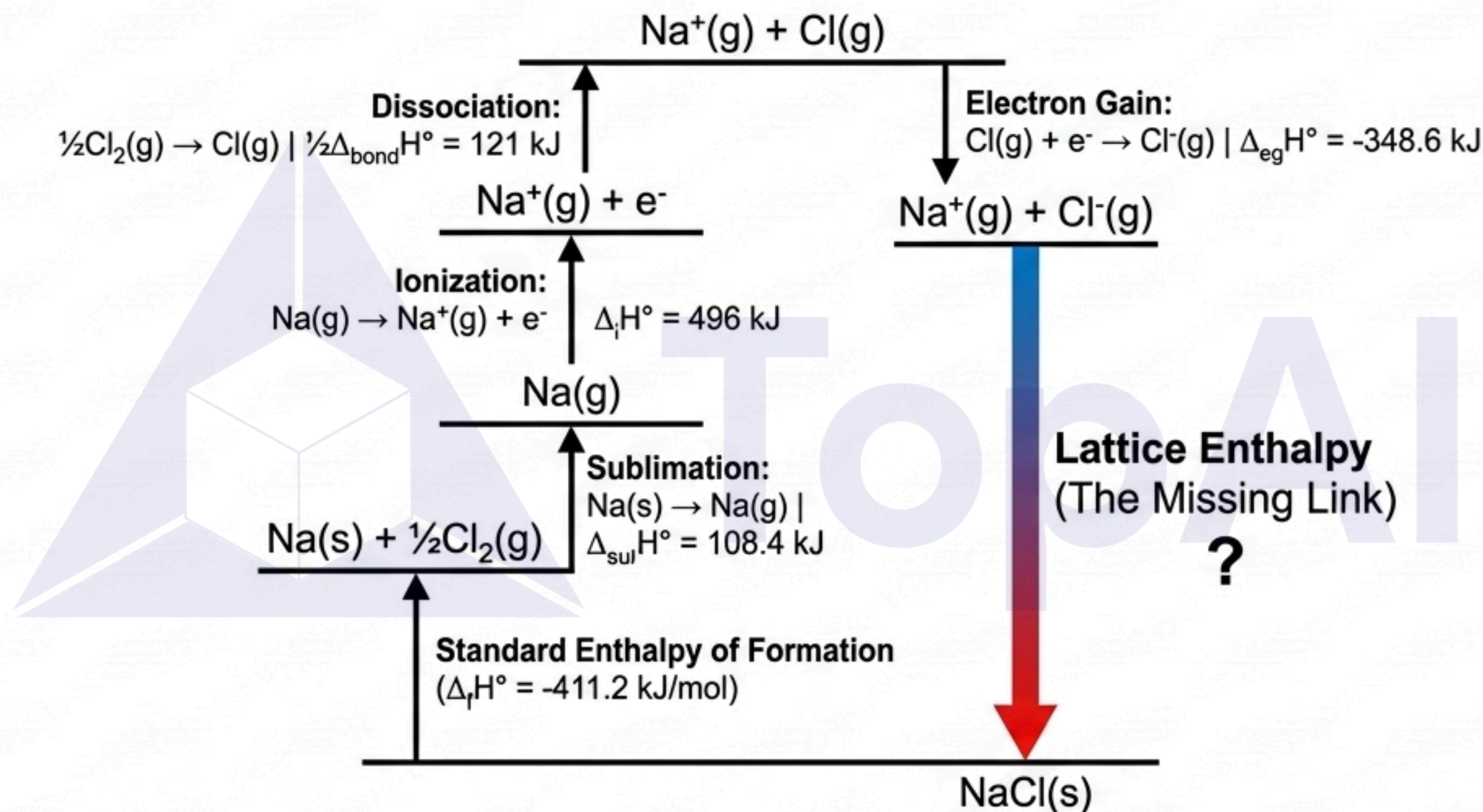


The Solution: The Born–Haber Cycle

We bypass the direct route using Hess's Law of Constant Heat Summation. By building an indirect thermodynamic pathway of measurable steps, we can mathematically isolate the missing lattice value.



Building the Energy Staircase (NaCl)



The net sum of these steps forms the alternative path to the Standard Enthalpy of Formation ($\Delta_fH^\circ = -411.2 \text{ kJ/mol}$).

JEE Trap: Watch the Sign Convention!



Always verify the lattice-enthalpy convention in the question parameters.

In older texts, lattice energy is often defined as the energy released during formation (resulting in a negative sign).

Modern JEE & NCERT standards rigidly define it as dissociation:

Solid ionic lattice $\rightarrow$ Gaseous ions

Therefore, $\Delta_{\text{lattice}}H^\circ$ is ALWAYS POSITIVE (>0). Never blindly assign a negative sign in Hess's Law equations without first checking the reaction direction.

Key Takeaways & Revision

- ✓ **Lattice Enthalpy ($\Delta_{\text{lattice}}H^\circ$):** The energy required to separate 1 mole of a solid ionic compound into its constituent gaseous ions. It is always endothermic (+).
- ✓ **Born-Haber Cycle:** A practical application of Hess's Law used to indirectly calculate Lattice Enthalpy because direct experimental measurement is impossible.
- ✓ **The Energy Sequence:** Sublimation + Ionization + Dissociation + Electron Gain + Lattice Enthalpy = Enthalpy of Formation.

$$\Delta_f H^\circ = \Delta_{\text{sub}} H^\circ + \Delta_i H^\circ + \frac{1}{2} \Delta_{\text{bond}} H^\circ + \Delta_{\text{eg}} H^\circ - \Delta_{\text{lattice}} H^\circ$$

(Note: The negative sign preceding lattice enthalpy accounts for the standard dissociation definition).



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