

WJEC Chemistry A-level

3.6: Enthalpy Changes for Solids and Solutions

Detailed Notes

Welsh Specification

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Types of Enthalpy Change

Some reactions have total enthalpy changes that are very **difficult to measure** directly. Therefore, by measuring lots of different smaller enthalpy changes for reactions, the total enthalpy change can be found indirectly by the **summation** of these other enthalpy values.

There are many different enthalpy changes that can be measured.

Atomisation Enthalpy ($\Delta_{\text{at}}H$)

This is defined as:

The energy required for the formation of a mole of gaseous atoms under standard conditions.

Lattice Enthalpies ($\Delta_{\text{le}}H$)

Lattice enthalpies are used for ionic substances. Lattice **breaking** enthalpy is defined as:

The energy required to break apart an ionic lattice into its constituent ions in a gaseous state under standard conditions.

Lattice **formation** enthalpy is defined as:

The energy required to form an ionic lattice from its constituent ions in a gaseous state under standard conditions.

Enthalpies of Solution ($\Delta_{\text{sol}}H$) and Hydration ($\Delta_{\text{hyd}}H$)

These can be used as a way of measuring lattice enthalpies indirectly. They are combined using a similar idea to **Hess's Law**.

Enthalpy of solution is defined as:

The enthalpy change when one mole of an ionic solid is dissolved in water to infinite dilution so that the ions no longer interact under standard conditions.

Enthalpy of hydration is defined as:

The enthalpy change when one mole of gaseous ions is dissolved in water to form one mole of aqueous ions under standard conditions.



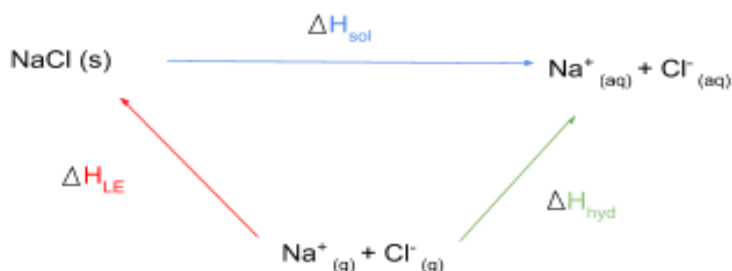


Ionic Solubility

The **solubility** of ionic compounds **changes** depending on the balance of **lattice breaking** enthalpy and the enthalpy of **hydration** for that substance. This is because the lattice of the compound first has to be broken down into **individual ions**, then it can be **hydrated** to produce **aqueous ions** in a solution.

Enthalpy of solution, hydration and lattice enthalpy can all be combined together into a single **energy cycle**.

Example:



$$\Delta_{\text{le}} H = (\sum \Delta_{\text{hyd}} H) - \Delta_{\text{sol}} H$$

This demonstrates how reactions can be broken down into **several separate processes**, each with a **different enthalpy change** that can then be used to find the **total change**.

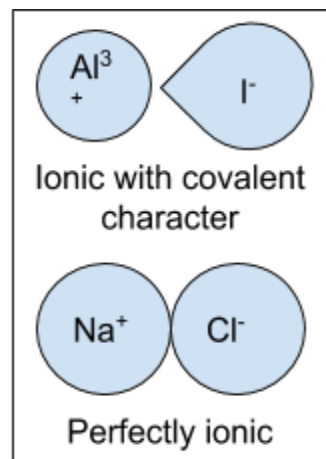
Perfect Ionic Model

Hydration enthalpy is heavily influenced by the **size and charge** of the molecules being dissolved. Therefore it is often assumed that the ions are '**perfectly ionic**'.

The perfect ionic model assumes that:

- All the ions are **perfectly spherical**
- The ions display **no covalent character**

Covalent character occurs in ions when two joined ions have varying sizes or charges meaning the **distribution of charge is not even**.



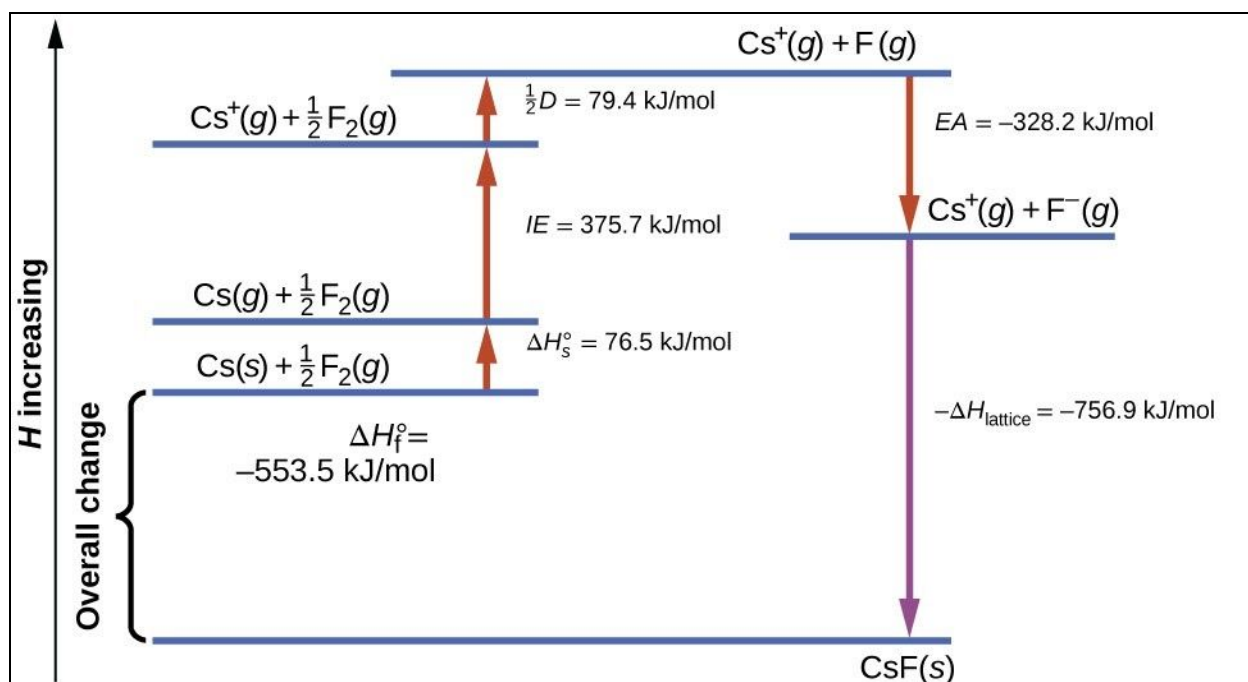


Born-Haber Cycles

Born-Haber cycles are similar to the cycles used with Hess's Law. They allow **enthalpy changes** to be determined which **cannot be measured directly**.

Enthalpy changes can be combined to produce a **Born-Haber cycle**. As with Hess's Law, the arrows represent a **reaction** and are therefore treated like **vectors**. If the cycle counters the direction of the arrow, the sign of the enthalpy change represented by that arrow is reversed.

Example:



<https://courses.lumenlearning.com/sanjacinto-atdcoursereview-chemistry1-1/chapter/strengths-of-ionic-and-covalent-bonds/>
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