

Chemistry Notes

A level Chemistry

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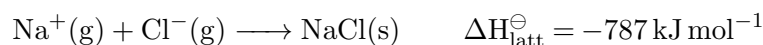
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1 Lattice Energy

1.1 What is Lattice Energy

The energy given out when ions of opposite charges come together to form a crystalline lattice. This is called the lattice energy, $\Delta H_{latt}^{\ominus}$.



Lattice energy is the enthalpy change when 1 mol of an ionic compound is formed from its gaseous ions under standard conditions.

Lattice Energy is always negative. The value of lattice energy depends on the size of the ion and the ionic charge. As the ion size increases, or as ionic charge increases, lattice energy becomes more exothermic.

1.2 Other Enthalpies

1.2.1 Enthalpy Change of Atomisation

The standard enthalpy change of atomisation, ΔH_{at}^{\ominus} , is the enthalpy change when 1 mol of gaseous atoms is formed from its elements under standard conditions.



The Values of ΔH_{at}^{\ominus} are always positive.

1.2.2 Electron Affinity

The energy change occurring when a gaseous non metal atom accepts one electron is called the electron affinity. The symbol is ΔH_{ea}^{\ominus}

The first electron affinity, ΔH_{ea1}^{\ominus} , is the enthalpy when 1 mol of electrons is added to 1 mol of gaseous atoms to form 1 mol of gaseous atoms 1- ions under standard conditions.



ΔH_{ea1}^{\ominus} is usually negative.

1 Lattice Energy

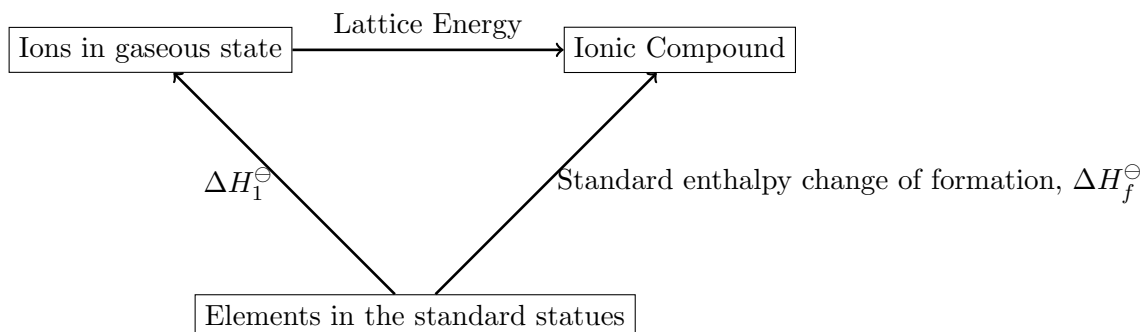
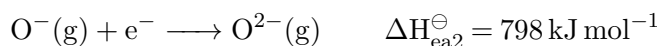


Figure 1.2: Born-Haber Cycle

The second electron affinity, ΔH_{ea2}^\ominus , is the enthalpy when 1 mol of electrons is added to 1 mol of gaseous 1- ions to form 1 mol of gaseous atoms 2- ions under standard conditions.



ΔH_{ea2}^\ominus and ΔH_{ea3}^\ominus are always positive

1.3 Born-Haber Cycle

A Born-Haber cycle is a particular type of enthalpy cycle used to calculate lattice energy. Fig.1.2 shows a summary of the cycle. The ΔH_1^\ominus is the enthalpy involved in changing the elements from their standard states to their gaseous ionic states. Fig 1.1 shows it in greater detail. ΔH_1^\ominus is the sum of each step converting from Lithium and Fluorine in standard states to the ionic states.

1.4 Ion Polarisation

Sometimes the positive charge on the cation in an ionic lattice may attract the electrons on the anion causing a distortion in the electron cloud. The anion is more likely to be polarised if:

- The cation is small or the anion is large.
- The cation has a large positive charge or the anion has a large negative charge.

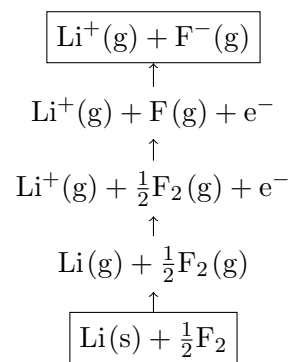
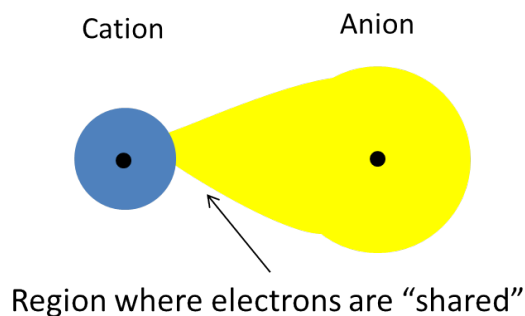


Figure 1.1: ΔH_1^\ominus in detail

Figure 1.3: Ion Polarisation and distortion [1]



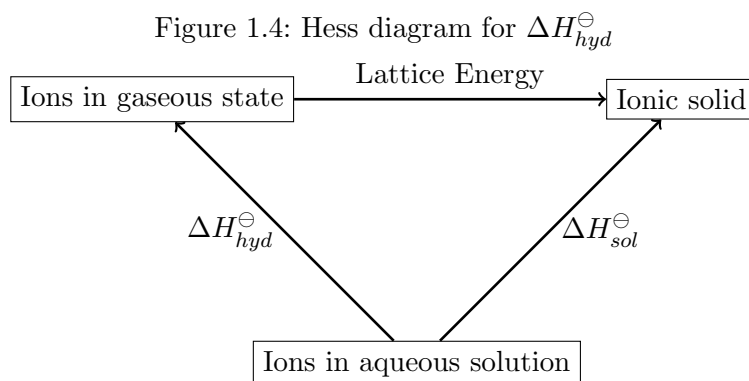
1.5 Enthalpy changes in solution

The enthalpy change of solution, ΔH_{sol}^{\ominus} , is the energy absorbed or released when 1 mol of ionic solid dissolves in sufficient water to form a very dilute solution



The value of ΔH_{sol}^{\ominus} is much less than $\Delta H_{latt}^{\ominus}$ because a lot of energy to overcome to lattice energy comes from the strong attraction between the ions and the molecules of water. This is called the enthalpy change of hydration.

The enthalpy change of hydration, ΔH_{hyd}^{\ominus} , is the enthalpy change when 1 mol of a specified gaseous ion dissolves in sufficient water to form a very dilute solution



The decrease in solubility of Group 2 sulphates can be explained in terms of the relative values of the enthalpy change of hydration and the corresponding lattice energies.

2 Electrochemistry

2.1 Electrolysis

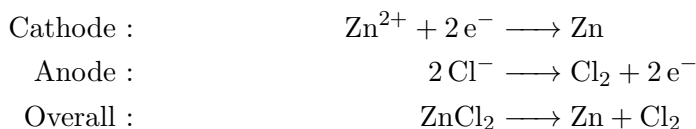
2.1.1 Electrolytic cells

Electrolysis is the decomposition of a compound by an electric current

Electrolysis is carried out in an electrolysis cell. The electrolyte is the compound that is decomposed. The electrodes are rods which conduct electricity. Anodes are positive electrodes and Cathodes are negative. The power supply is always a Direct Current.

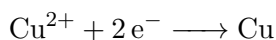
2.1.2 Redox reactions

Electrolysis is a redox reaction. During electrolysis positive ions move to the cathode and gain electrons, where as the negative ions move to the anode and lose electrons. The electrolysis of Zinc Chloride can be summarised by the following reactions:



2.2 Quantitative electrolysis

The mass of the substance deposited is directly proportional to the charge that flows through the electrolyte. The charge of 1 mol of electrons is said to be 1 Faraday. It's value is equal to $96\,500\text{ C mol}^{-1}$. This can be used to calculate the mass of the deposited substance. For example, in the following equations, Cu^{2+} required 2 mol of electrons to produce 1 mol of Cu atoms.



This means it needs 2 Faraday of electricity to produce 1 mol of Cu. If a current of x amperes went through it for t seconds, a charge of xt went through the cell. The number of Faraday that passed through the electrolyte is:

$$F = \frac{xt}{96500}$$

The number of moles of Cu is half that value. The mass can be calculated by multiplying the molar mass of Cu to the number of moles of Cu

2.3 Electrode Potentials

2.3.1 Metal/Metal ion system

When a metal is placed into a solution of its ions, an electric potential is established between the metal and the metal ion solution. This potential is not measurable but the difference between the metal/metal ion system and another system can be measured.

2.3.2 Electrode potentials and redox reactions

Electrode potential values give us an indication of how easy it is to reduce a substance. The more positive the electrode potential is, the easier is it to reduce its ions.

2.3.3 Standard electrode potential

The voltage of an electrochemical cell is affected by concentration, temperature and pressure. Hence, when comparing electrode potentials, standard conditions are used. There are:

- Concentration of ions at 1.00 mol dm^{-3}
- Temperature at 25°C (298 K)
- Gases at 1 atm (101 kPa)
- The value of the electrode potential is measured against the standard hydrogen electrode.

The electrode potential, E^\ominus , for a half-cell is the voltage measured under standard conditions with a standard hydrogen electrode as the other half-cell.

2.4 Using E^\ominus values

2.4.1 Using E^\ominus values to predict cell voltages

E^\ominus values can be used to calculate the voltage of an electrochemical cell made up of two half-cells. It is the difference between the E^\ominus values of the two cells. Consider a cell with a Ag/Ag^+ half cell at the cathode and a Zn/Zn^{2+} cell at the anode.



The voltage of this cell is 1.56 V

2.4.2 E^\ominus values can help deduce the direction of electron flow

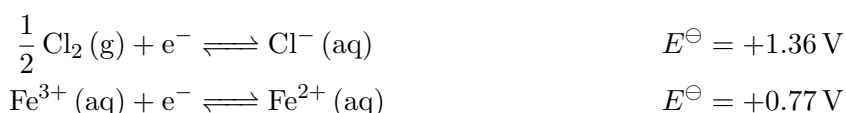
Looking at the previous equations again, we can see that Zn^{2+} ions are more difficult to reduce than Ag^+ ions. So, the Zn metal will lose electrons to the Ag^+/Ag half-cell, and the Ag^+ ions will accept electrons from the Zn^{2+}/Zn half-cell. Electrons will flow from the Zn^{2+}/Zn half-cell to the Ag^+/Ag half cell in the circuit.

2.4.3 Using E^\ominus values to predict a reaction will occur

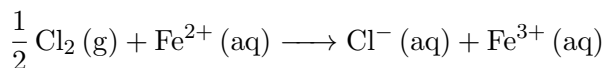
The E^\ominus values tell us how good of a reducing agent or oxidising agent a chemical is.

- The more positive the value of E^\ominus , the greater the tendency for the half-equation to proceed in the forward direction, the better oxidising agent it is.
- The less positive the value of E^\ominus , the greater the tendency for the half-equation to proceed in the backward direction, the better reducing agent it is.

A reaction occurs in a direction such that the stronger oxidising agent oxidises the stronger reducing agent. For example, we can answer the question whether Chlorine will oxidise Fe^{2+} ions to Fe^{3+} ions, by looking at their half-equations.



We can see that Cl_2 is a better oxidising agent than Fe^{3+} and Cl_2 oxidising Fe^{2+} to Fe^{3+} is feasible.



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2.5 Non standard Electrode Potentials

The effect of concentration and temperature on the value of E_{cell} can be deduced by using the Nerst equation. For a given electrode, the electrode potential, E , is given by,

$$E = E^\ominus + \frac{RT}{zF} \ln \frac{[\text{oxidised form}]}{[\text{reduced form}]}$$

Where E^\ominus is the standard electrode potential

R is the gas constant $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

T is the temperature in Kelvin

z is the number of electrons transferred in the reaction

F is the value of the Faraday constant, $96\,500 \text{ C mol}^{-1}$

2.6 Cells and Batteries

At this point im bored as heck. Summarise the following sub topics in the book and send me, I'll add it here:

- Rechargable Cells
- Solid state Cells
- Hydrogen-oxygen fuel Cells

The rest is useless.

Bibliography

- [1] juliantuition. *Why is aluminium chloride covalent?* <https://anhourofchemaday.wordpress.com/2013/03/07/why-is-aluminium-chloride-covalent/>. Accessed on 2018-1-24.