

# Edexcel IAL Chemistry

## A-Level

### Topic 12 - Entropy and Energetics

#### Flashcards

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Other than enthalpy changes, what else determines whether a reaction will occur?



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The standard entropies of the surroundings and of the system.



Enthalpy changes are not completely responsible for whether a reaction occurs. What is evidence for this?



Enthalpy changes are not completely responsible for whether a reaction occurs. What is evidence for this?

Endothermic reactions can occur spontaneously at room temperature so there must be something else determining feasibility of reaction.



# What is entropy?



# What is entropy?

The measure of disorder of a system in terms of the random dispersal of molecules and of energy quanta between molecules.



How does entropy change with the states of matter?





How does entropy change with the states of matter?

Entropy increases as the states of matter go from a solid to a liquid and to a gas.



When does the entropy of a substance equal zero?



When does the entropy of a substance equal zero?

Perfect crystals at zero kelvin have zero entropy.



How can you increase the entropy of a substance?



# How can you increase the entropy of a substance?

- Increase the temperature.
- Change phase e.g. liquid to gas.
- Increase the volume (for a gas).



# How does entropy naturally change?



# How does entropy naturally change?

Generally entropy change is naturally positive. E.g. a gas spontaneously spreading throughout a room increases its total entropy.



Why does entropy change during a change of state?





# Why does entropy change during a change of state?

As a state changes from solid  $\rightarrow$  liquid  $\rightarrow$  gas, the particles get more disordered as they move increasingly randomly and with more energy.

This means entropy increases as the state goes from a solid  $\rightarrow$  liquid  $\rightarrow$  gas.



Why and how does entropy change during the dissolving of a solid ionic lattice?



# Why and how does entropy change during the dissolving of a solid ionic lattice?

In a solid ionic lattice, ions are initially fixed in place. When the solid dissolves, the ions are free to move through the solution. There is more disorder in the solution, so entropy increases.



What is total entropy change equal to?



# What is total entropy change equal to?

$$\Delta_{\text{tot}} S = \Delta_{\text{sys}} S + \Delta_{\text{surr}} S$$

Total entropy change =

Entropy change of the system + Entropy change of the surroundings



How do you calculate the entropy change of the system (given the entropies of reactants and products)?



How do you calculate the entropy change of the system (given the entropies of reactants and products)?

$$\Delta S = \sum S^{\theta}_{\text{products}} - \sum S^{\theta}_{\text{reactants}}$$

If  $\Delta S$  is positive = more disordered

If  $\Delta S$  is negative = less disordered



What is the entropy change of the surroundings equal to?





What is the entropy change of the surroundings equal to?

$$\Delta_{\text{surr}} S = -\Delta H/T$$

$\Delta H$  - enthalpy change of the reaction

T - temperature (K)



What does the feasibility of a reaction depend on?



## What does the feasibility of a reaction depend on?

- A reaction is feasible when the total entropy change,  $\Delta_{\text{tot}} S$  is positive.
- It is dependent upon a balance between  $\Delta_{\text{sys}} S$  and  $\Delta_{\text{surr}} S$ .
- At higher temperatures,  $\Delta_{\text{surr}} S$  magnitude decreases and therefore contributes less to  $\Delta_{\text{tot}} S$ .
- Reactions are still able to occur even if one of  $\Delta_{\text{sys}} S$  and  $\Delta_{\text{surr}} S$  are negative, as long as  $\Delta_{\text{tot}} S$  is positive, the reaction can still occur.



# What is thermodynamic stability?



## What is thermodynamic stability?

- Positive entropy change: Reactants are thermodynamically unstable compared to products.
- Negative entropy change: Reactants are thermodynamically stable compared to products.

If a reaction is thermodynamically stable it is unlikely to occur.



# What is kinetic stability?



## What is kinetic stability?

The reaction may be feasible in terms of entropy, however the energy of the molecules may not be greater than the activation energy and hence the reaction cannot occur.



# What is electron affinity?





# What is electron affinity?

The change in energy of an atom when an electron is added to the atom to form a negative ion.



# What is lattice energy?



What is lattice energy?

The exothermic process for the formation of one mole of an ionic solid from its gaseous ions.



What is the enthalpy change of atomisation?



What is the enthalpy change of atomisation?

The enthalpy change when one mole of gaseous atoms is formed from its element in its standard state, under standard conditions.



What can be used to experimentally calculate the lattice energy value?



What can be used to experimentally calculate the lattice energy value?

Born-Haber cycles.



What does the comparison of the experimental and theoretical lattice energy value show?





# What does the comparison of the experimental and theoretical lattice energy value show?

The comparison indicates the degree of covalent bonding present.

If an ionic compound has some covalent character, the experimental value will be greater than the theoretical value. This is because more energy is required to overcome the covalent character.



# Why do some ionic compounds have covalent character?



# Why do some ionic compounds have covalent character?

A small cation can polarise a larger electron dense anion.

If the cation is able to polarise the anion, it has a significant pull on the electrons in orbitals around the anion. The more polarisation, the greater the covalent character.



What is the enthalpy change of hydration?



What is the enthalpy change of hydration?

The enthalpy change that occurs when one mole of gaseous ions is completely hydrated by water to form one mole of aqueous ions, under standard conditions.



# What is the enthalpy change of solution?



# What is the enthalpy change of solution?

The enthalpy change when one mole of an ionic substance dissolves in water to give a solution of infinite dilution.

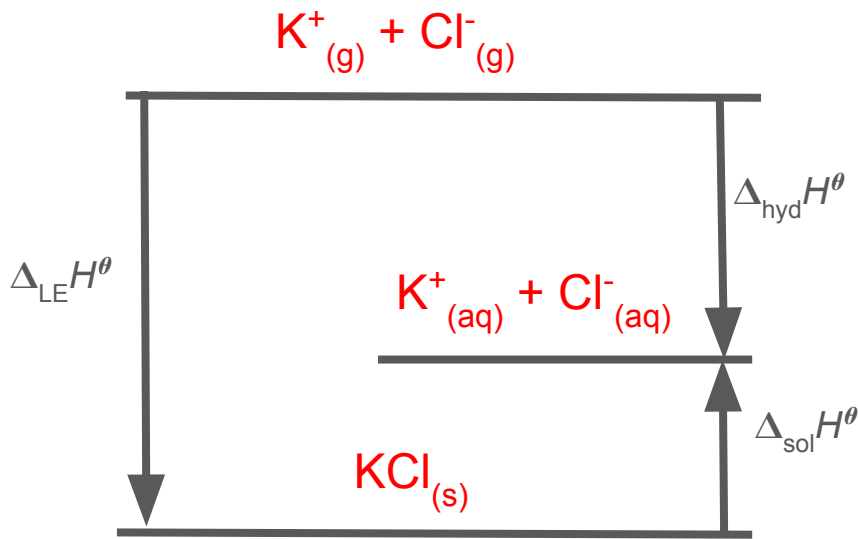


Use a diagram to explain how lattice energy, enthalpy change of solution and enthalpy change of hydration are related?





Use a diagram to explain how lattice energy, enthalpy change of solution and enthalpy change of hydration are related?



# What factors affect the enthalpy change of hydration?



# What factors affect the enthalpy change of hydration?

Ionic radius: The smaller the ionic radius, the closer the ion can get to the water molecules and hence attract them more strongly, causing enthalpy change to be more exothermic.

Charge: The greater the charge, the greater the attraction between the water molecules and the ions, causing enthalpy change to be more exothermic.



# What factors affect lattice energy?



# What factors affect lattice energy?

- Ionic radius: The smaller the ionic radius, the closer the positive ion can get to the negative ion and hence attract it more strongly, causing enthalpy change to be more exothermic.
- Charge: The greater the charge, the greater the attraction there is between the positive ion and negative ion, causing enthalpy change to be more exothermic.

