

## Entropy

Entropy is the disorder of a system and is denoted by S. Enthalpy, however, is the total energy of a thermodynamic system and is denoted by H.

A spontaneous reaction is one which just 'happens on its own' without any external influence. Spontaneous reactions can be fast (the reaction of sodium with water) or slow (the rusting of a piece of iron).

An instantaneous reaction is one which 'happens in an instant' (quickly).

Most spontaneous reactions involve a decrease in enthalpy (are exothermic). Is this decrease in enthalpy, therefore, the driving force of a spontaneous chemical reaction or is something else involved? If we can find an endothermic reaction (one involving an increase in enthalpy) that is spontaneous then something else must be involved. The dissolution of ammonium chloride in water is both a spontaneous reaction and an endothermic one (the surroundings get colder). Thus some other factor (other than a decrease in enthalpy) must be involved in this driving force of a spontaneous reaction. The other factor is entropy or disorder.

The two factors which favour a spontaneous reaction are:

- 1) A decrease in enthalpy
- 2) An **increase** in entropy

If, on going from A to B, there is a decrease in enthalpy and an **increase** in entropy the reaction will be spontaneous (will happen).

If, on going from A to B, there is an increase in enthalpy and a **decrease** in entropy the reaction will not be spontaneous (will not happen).

If, however, there is a decrease in **both** enthalpy **and** entropy or an increase in **both** enthalpy **and** entropy then we have to use an equation (Gibbs Free Energy Equation) to find out whether or not the reaction is spontaneous (will go).

Gibbs Free Energy Equation

$$\Delta G = \Delta H - T\Delta S$$

Where

$\Delta G$  = Gibbs Free Energy in kJ

$\Delta H$  = enthalpy change in kJ

T = temperature in Kelvin/K

$\Delta S$  = entropy change in kJ K<sup>-1</sup>

**IF**

**$\Delta G < 0$**  The reaction is spontaneous

**$\Delta G > 0$**  The reaction is non-spontaneous

**$\Delta G = 0$**  The reaction is at equilibrium

Free energy change is the net driving force of a chemical reaction – it tells us whether the reaction will be spontaneous or not