HL: Entropy and spontaneity

Entropy, a measure of "disorder"

Entropy S of a substance, measured in $J.K^{-1}.mol^{-1}$, can be considered as a measure of the disorder in it. The more different configurations are possible for a substance,the higher its entropy.

Note: $S_{solid} < S_{liquid} \ll S_{gas}$

Gibbs tells us if it's possible or not

Enthalpy has been defined as the total energy of a substance. However not all this energy can be used to do useful work (e.g. chemical reaction).
Therefore, another type of energy needs to be introduced, Gibbs Free Energy, G:

$$\boldsymbol{G = H - T \times S}$$

With:

G: Energy available to do useful work
H: Total energy of the substance
TxS: unavailable energy *Comment: As mum and dad always say, disorder never leads to something useful.*

Note: Gibbs energy is not an absolute value. It depends on a chosen reference, for which the value is set to 0. Therefore, its value can be positive, but also negative, even if some energy is still available.

As seen previously, a chemical reaction is a process involving an energy input in step 1. If this energy is taken from the system itself, the reaction is considered as spontaneous.

Note: Sometimes, like in combustion reactions, an initial energy input from outside the system is needed, through friction or a spark for example. The temperature increase due to the first individual reactions is then enough to provide the energy needed internally. Therefore, this spark can be neglected, and a combustion reaction is considered as spontaneous.

The energy used by a spontaneous reaction is taken in the stock of available energy, the Gibbs energy, leading to a decrease of its amount.

Criteria of spontaneousity of a chemical reaction: $\boldsymbol{\Delta G < 0}$

Note: A reaction for which $\Delta G \geq 0$ needs an external input of useful energy to be possible.