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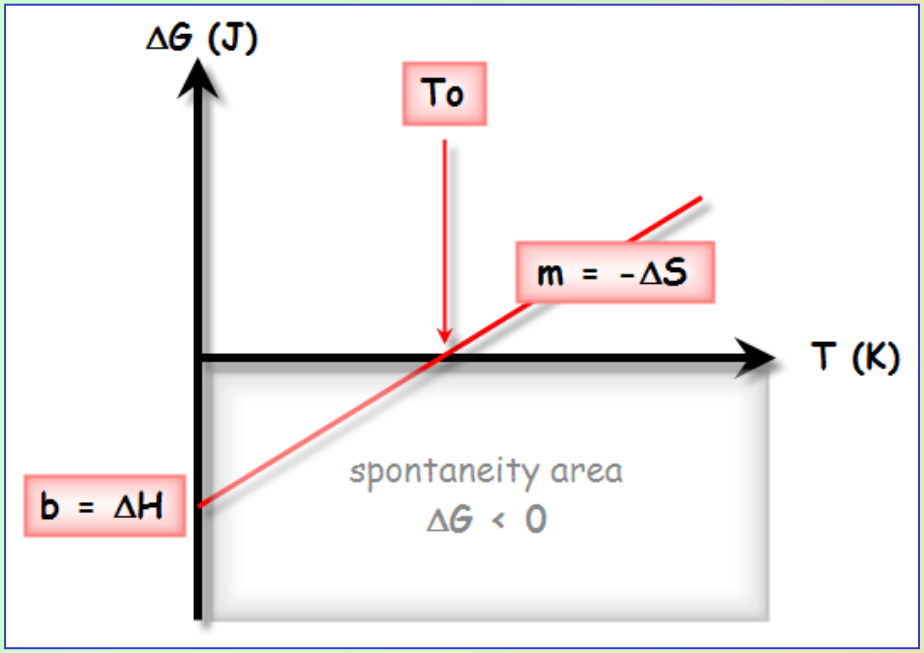
Study of spontaneity



Study of change in spontaneity with temperature

From this expression of Gibbs energy (free energy):

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

if we consider that more o less

$$\Delta H = \Delta H^0$$
$$\Delta S = \Delta S^0$$

we have a expression similar to that of the straight line:

$$\Delta G = \Delta H^0 - T * \Delta S^0$$
$$y = b + m\,x$$

where the change in enthalpy is the vertical value at the origin of T and the change in entropy (with the change in its sign) is related with the slope of the line

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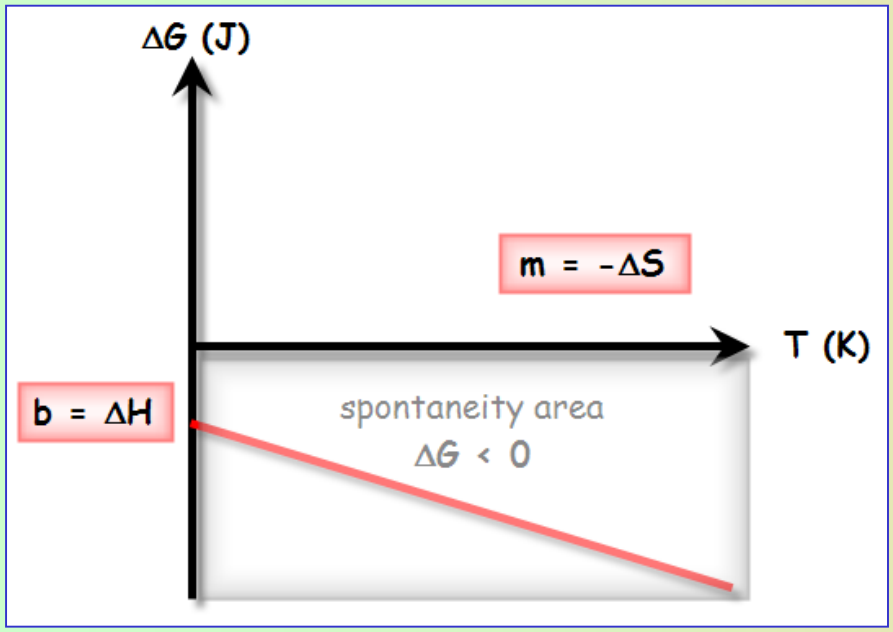
Case #1

When the change in enthalpy is negative (exothermic process) and the change in entropy is positive (a greater disorder is reached), the process will be spontaneous at any temperature.

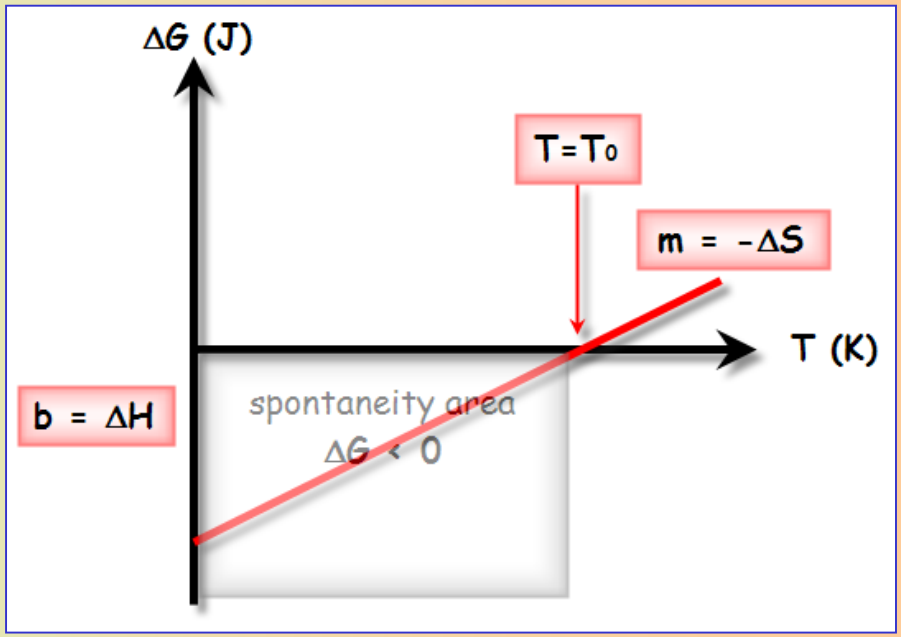
$$\left.\begin{array}{l}\Delta H^0 < 0 \\ \Delta S^0 > 0\end{array}\right\} \rightarrow \Delta G < 0 \text{ at any T}$$



Case #2

When the change in enthalpy is negative (exothermic process) and the change in entropy is negative (less disorder is reached), the process will be spontaneous from T = 0 to a temperature T_0.

$$\left.\begin{array}{l}\Delta H^0 < 0 \\ \Delta S^0 < 0\end{array}\right\} \rightarrow \Delta G < 0 \text{ from } T=0 \text{ to } T=T_0$$



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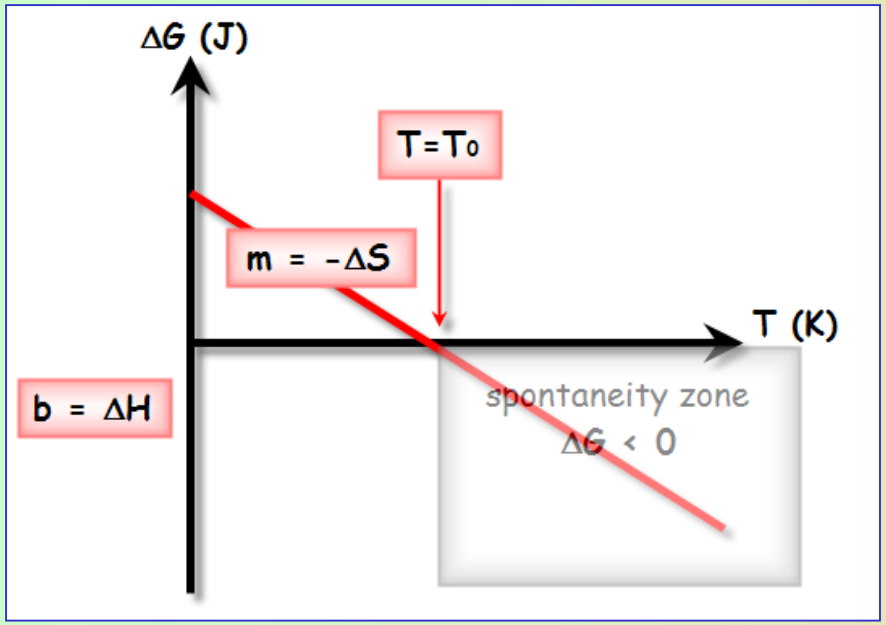
Case #3

When the change in enthalpy is positive (endothermic process) and the change in entropy is positive (more disorder is reached at the end), the process will be spontaneous from one temperature on.

$$\begin{matrix}\Delta H^0 > 0 \\ \Delta S^0 > 0\end{matrix} \rightarrow \Delta G < 0 \text{ from } T_0 \text{ on}$$



Case #4

When the change in enthalpy is positive (endothermic process) and the change in entropy is negative (less disorder is reached), the process will never be spontaneous.

$$\begin{matrix}\Delta H^0 > 0 \\ \Delta S^0 < 0\end{matrix} \rightarrow \Delta G < 0 \text{ never}$$