Chapter Summary: Thermodynamics

Spontaneous change: A change that occurs without external action.
If the forward reaction is spontaneous then reverse is nonspontaneous.
(note: spontaneous does not mean fast)

Entropy: Degree of orderliness of a system. (Represented by S). E.g. entropy increases when ice melts to liquid and liquid vaporizes to steam.
Second Law of Thermodynamics: All spontaneous processes increase the entropy of the universe.
Third Law of Thermodynamics: Entropy of a pure, perfect crystal can be taken to be 0 at 0K.

Standard Molar Entropy (S^o): entropy of a mole of substance in its standard state.
Standard entropy change of a reaction (ΔS^o) can be calculated by:
$\Delta S = \sum n_p S_f^o$ (products) $- \sum n_f S_f^o$ (reactants)

Free Energy and Free Energy Change (ΔG): Gibbs free energy determines the spontaneity of a process.

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

hence
if $\Delta G < 0$ then process is spontaneous
if $\Delta G > 0$ then nonspontaneous and
if $\Delta G = 0$ then process is in equilibrium.

Standard free energy of a system (ΔG^o) is when all reactants and products are in their standard states (P = 1 atm, solids and liquids are pure, etc.). It predicts the direction of the equilibrium.
$\Delta G^o = \Delta H^o - T\Delta S^o$
– ΔG^o indicates large K value (products favored)
+ ΔG^o indicates small K value (reactants favored)

Standard free energy of formation (ΔG_f^o) is free energy change that occurs in the formation of one mole of substance in its standard state.

Standard free energy of a reaction can be calculated by:
$\Delta G^o = \sum n_p G_p^o$ (products) $- \sum n_r G_r^o$ (reactants)

Key Words

Spontaneous and nonspontaneous	Entropy	Enthalpy
Gibbs free energy	Standard entropy	Standard free energy
Three laws of thermodynamics		