Statistics – confidence interval

http://www.learner.org/resources/series65.html#

World of Chemistry – Cement (15:09)

http://www.learner.org/resources/series61.html#

Chapter 6 : Chemical Equilibrium

- Should be review from General Chemistry
- Foundation of the Rest of the Course!

The Difference Between Equilibrium and Kinetics ?

Differences between Equilibrium and Kinetics?

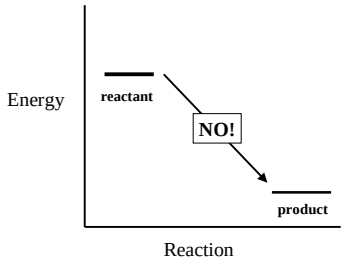
- Kinetics
- How fast does a reaction take?
- Equilibrium
- Will it happen?

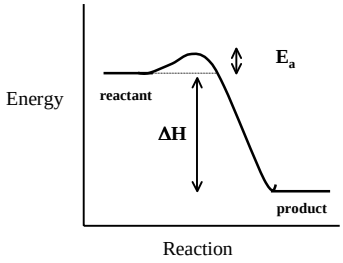
Fast and Slow Kinetic Processes

- Play sodium video
- Play world of chemistry video

In a Quantitative Analysis:

- Do we want the reactions to be driven by Equilibrium or Kinetics?
- We want FAST reactions (Kinetics out of the Picture)
- Reactions only driven by ΔG





Things to remember about equilibrium

Standard States

Solute: 1 M
Gas : 1 bar (1.0000 bar = 0.98692 atm)

Pure liquid or solid : pure liquid or solid

CO_2 (g) + H_2O (l) H_2CO_3 (aq)

$$K = \frac{[H_2CO_3]}{P_{CO2} \cdot 1} \quad \begin{matrix} \text{Molarity} \\ \text{Bar} \end{matrix}$$

In general

$aA + bB \rightleftharpoons cC + dD$

$$K = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$ **= constant if at equilibrium**

WHAT?

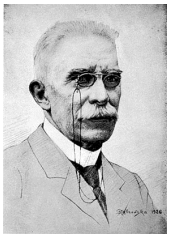
- If a reaction is not at equilibrium, due to an outside stress, the reaction will "shift" to relieve the stress.

Le Châtelier's Principle

« Toute modification d'un facteur d'un équilibre chimique réversible provoque, si elle se produit seule, un déplacement de l'équilibre dans un sens qui tend à s'opposer à la variation du facteur considéré »

"Every change in one of the factors of an equilibrium occasions a rearrangement of the system in such direction that the factor in question experiences a change in the sense opposite to the original change"

HENRI LOUIS LE CHÂTELIER



Became interested in the conditions needed for equilibrium in chemical reactions after examining some unexpected results at a mine's furnace.

In 1888, he stated what became known as the Le Chatelier principle: every change in one of the factors of an equilibrium occasions a rearrangement of the system in such direction that the factor in question experiences a change in the sense opposite to the original change.

The reaction was thought to be:

$Fe_2O_3 + C \rightarrow Fe + CO_2$

Henri noticed CO was also made:

$Fe_2O_3 + C \rightarrow Fe + CO_2 + CO$

EUREKA !
The CO_2 was in equilibrium $CO_2 \overset{Fe_2O_3}{\rightleftharpoons} C + CO$

The Equilibrium Constant and Free Energy (K and ΔG^o)

ΔG^o Gibbs free energy change for all reactants and products in standard state.

ΔG Free energy under some other conditions.

$\Delta G = \Delta G^o + RT \ln Q \Rightarrow \Delta G^o = - RT \ln K$

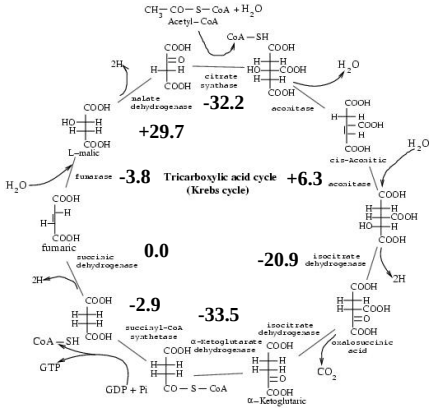
At Equilibrium, $\Delta G = 0$ (no driving force)

$$\Delta G^o = - RT \ln K$$

or

$$K = e^{\frac{-\Delta G^o}{RT}}$$

$\Delta G^o =$ (-)	**K > 1**	**Products Favored Spontaneous Reaction**
$\Delta G^o =$ (+)	**K < 1**	**Reactants Favored Non-Spontaneous**
$\Delta G^o =$ **0**	**K = 1**	**Neither Products or Reactants Favored**



Biochemical Energetics

Gibbs Free Energy Changes Rxn#	Enzyme	$\Delta G^{o\prime}$ (kJ/mol)	
1	Citrate synthase	-32.2	
2	Aconitase	+6.3	
3	Isocitrate dehydrogenase	-20.9	
4	a-Ketoglutarate dehydrogenase complex	-33.5	
5	Succinyl-CoA synthetase	-2.9	
6	Succinate dehydrogenase	0.0	
7	Fumerase	-3.8	
8	Malate dehydrogenase	+29.7	

Overall free energy -57.6 kJ/mol