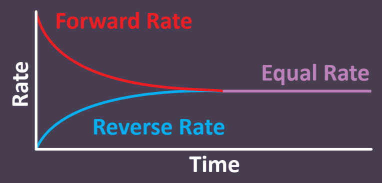
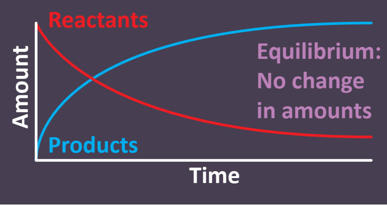
Equilibrium



Rate of forward reaction = Rate of reverse reaction



No change in the Amount/concentrations of the reactants and the products

Equilibrium Constant

$$aA(aq) + bB(aq) \rightleftharpoons cC(aq) + dD(aq)$$

$$Kc = \frac{K_f}{K_b} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$[C]^c [D]^d$ → Equilibrium concentration of products

$[A]^a [B]^b$ → Equilibrium concentration of reactants

Gibbs free energy and equilibrium constant

$\triangle G = 0$ and $K_{eq} = \frac{[C]\ [D]}{[A]\ [B]}$

hence

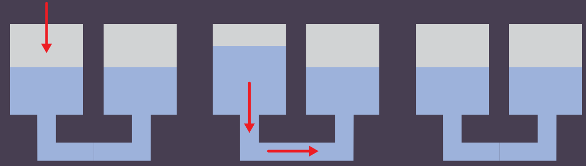
$0 = \triangle G^\circ + RT \ln K_{eq}$

$\triangle G^\circ = -RT \ln K_{eq}$

Le chatelier's Principle

It states that changes in the temperature, pressure, volume, or concentration of a system will result in predictable and opposing changes in the system in order to achieve a new equilibrium state.

An analogy for changing equilibrium conditions



Factors influencing Equilibrium

Concentration

REDUCE REACTANT CONCENTRATION

$A + 2B \rightleftharpoons C + D$

REDUCE PRODUCT CONCENTRATION

Increasing concentration of one side favours the other

Reactant concentration is increased	Product concentration is increased
↓ Equilibrium shifts to reduce the reactant concentration	↓ Equilibrium shifts to reduce the Product concentration
↓ Forward reaction is Favoured	↓ Reverse reaction is Favoured

Temperature

EXOTHERMIC (increases temperature)

$A + 2B \rightleftharpoons C + D$

(decreases temperature) ENDOTHERMIC

If the forward reaction is exothermic,the backward reaction will be endothermic, and vice versa.

Temperature is Increased	Temperature is Decreased
↓ Equilibrium will shift to reduce the temperature	↓ Equilibrium will shift to Increase the temperature
↓ Endothermic reaction will be favoured	↓ Exothermic reaction will be favoured

Pressure

DECREASES PRESSURE (fewer gas molecules on right)

$A + 2B \rightleftharpoons C + D$

(more gas molecules on left) INCREASES PRESSURE

If the number of gas molecules is the same on either side, then changing pressure will have no effect.

Pressure is Increased	Pressure is decreased
↓ Equilibrium will shift to reduce the pressure	↓ Equilibrium will shift to increase the pressure
↓ Side of reaction with fewer gaseous moles will be favoured	↓ Side of reaction with more gaseous moles will be favoured

Addition of Catalyst or inert gas do not have any effect on Equilibrium

Theories of Acids and Bases

The Arrhenius Theory	The Bronsted Lowry Theory	The Lewis Theory
Acids are substances that contain hydrogen Bases are substances that contain hydroxyl, OH, group	An acid is a proton donor (H^+) A base is a proton acceptor	Acid are electron pair acceptors. Bases are electron pair donors.
HCl and NaOH	NH_3 and H_2O	BF_3 and NH_3
Limited to water solutions only	Limited to proton transfer reactions only	Generalised theory

Ionic Equilibrium

Ionization of weak acid

$HA\ (aq) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + A^-$

$K_a = [\ H_3O^+\ ]\ [A^-]\ /\ [HA]$

Ionization of weak Base

$A + H_2O \rightarrow OH^- + HA^+$

$K_b = [\ OH^-\ ]\ [\ HA^+\ ]\ /\ [\ A\ ]$

Solubility and Solubility product

$$M_yX_z\ (s) \rightleftharpoons yM^{Z+}\ (aq) + zX^{Y-}\ (aq)$$

$$K_{sp} = [M^{Z+}]^y[X^{y-}]^Z$$

Solubility product constant (K_{sp})

Molar solubility of the ions ($[M^{Z+}]$, $[X^{y-}]$)

Buffer action

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$$

H_3O^+ added, quilibrium position shifts to the left

$CH_3COOH(aq) \leftarrow CH_3COO^-(aq) + H_3O^-$

OH^- added, quilibrium position shifts to the right

$OH^- + CH_3COOH(aq) \rightarrow H_2O(l) + CH_3COO^-(aq)$