Chemistry 3.6
Aqueous Systems

Recap on Equilibrium

Closed system

- In a closed system…
  - **Particles** in a closed system **cannot escape**
    - An example of closed system is **aqueous solution**
- There are only **two possible situations** in a closed system
  - Reactions **towards equilibrium**
  - System **at equilibrium**

Equilibrium

- Equilibrium is a “state” where the **concentration** of species in the close system is not changing over time.
- More correctly, the **rate** of the forward reaction is the same as the **rate** of the reverse reaction.

Equilibrium expression

- The “mathematical product” (multiplications) of the **concentration of products over** the mathematical product of the **concentration of reactants equal** to the **equilibrium constant (K)**
- Example

For reaction $A + 2B \rightleftharpoons 3C + 4D$

$A+B+B \rightleftharpoons C+C+C+D+D+D+D$

$$\frac{[C]^3[D]^4}{[A][B]^2} = K$$

Pure substances

- When pure substances (solid or liquid) are involved in equilibria, they do not appear in the equilibrium expression.
- Example: the dissociation of ethanoic acid

$$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$$

$$K = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} = Ka$$

Reaction Quotient (Q)

- Reaction quotient is the concentration expression at **a specific point of time**
- When **Q** is **equal** to **K**
  - The system is **at** dynamic **equilibrium**
- When **Q** is **bigger** than **K**
  - **Reverse reaction** will occur until Q = K
- When **Q** is smaller than **K**
  - **Forward reaction** will occur until Q = K

Le Chatelier's Principle

Changes will occur to reach the state of unchanged

Le Chatelier's Principle

Factors	Condition	Effect
Concentration	Increase reactant or decreasing product	Forward reaction
	Decrease reactant or increasing product	Reverse reaction
Temperature	Increase for endothermic or decrease in exothermic	Forward reaction
	Decrease for endothermic or increase in exothermic	Reverse reaction
Pressure (gas only)	Increase in pressure	Reaction towards the side with less gas
	Decrease in pressure	Reaction towards the side with more gas
Catalysis	Catalysis added	No change