CAIE Chemistry A-level

7: Equilibria

Definitions

Definitions and Concepts for CAIE Chemistry A-level

Equilibria

Brønsted-Lowry acid: Proton donors. These species release hydrogen ions in solution.

Brønsted-Lowry base: Proton acceptors.

Catalysts: Increases the rate of reaction by providing an alternative reaction route with a lower activation energy. A catalyst does not affect the equilibrium constant since it increases the rate of the forward and backward reaction equally.

CH_3COOH: The molecular formula for ethanoic acid.

Closed system: A system where there is only heat exchange occurring between the system and its surroundings. No matter can enter or exit the system.

Dynamic equilibrium: Reached when the rate of the forward reaction of a reversible reaction equals the rate of the backward reaction. The concentrations of the reactants and products remain constant.

Effect of changing concentration on equilibrium: If the concentration of a reactant is increased, more products will be formed until equilibrium is reached again. If the concentration of a product is decreased, more reactants will react until equilibrium is reached again.

Effect of changing pressure on equilibrium: If pressure is increased, the position of equilibrium shifts towards the side with the fewest number of molecules. If the pressure is decreased, the position of equilibrium shifts towards the side with the greatest number of molecules to oppose this change.

Effect of changing temperature on equilibrium: If the temperature of a system in equilibrium is increased, there will be an increase in the relative amount of products for an endothermic reaction and a decrease for an exothermic reaction.

Equilibrium: A chemical state in which the forward and reverse reactions of a process occur at the same rate. This means there is no overall change in the concentrations of the reactants and products.

Equilibrium constant (K): A value that relates the amount of products and reactants at equilibrium in a reversible reaction at a specific temperature. K is unaffected by pressure and presence of a catalyst but is affected by temperature.

HCl: The molecular formula for Hydrochloric acid.

HNO_3: The molecular formula for nitric acid.

H_2SO_4: The molecular formula for sulfuric acid.

Indicator: Chemical solutions whose colour depends on the pH of the solution they are in. Methyl orange and phenolphthalein are indicators commonly used in titrations. Methyl orange is red in acid and yellow in alkali. Phenolphthalein is colourless in acid and pink in alkali.

K_c: A value that relates the concentrations of products and reactants present at equilibrium in a reversible reaction at a specific temperature. The equilibrium constant that is equal to the concentration of products raised to their stoichiometric coefficients divided by the concentration of reactants raised to the power of their stoichiometric coefficients. Liquids and solids are not included in heterogeneous K_C expressions as their concentrations effectively remain constant.

KOH: The molecular formula for potassium hydroxide.

K_p: A value that relates the amounts of gaseous products and gaseous reactants present at equilibrium in a reversible reaction at a specific temperature. For example:

$$A + 3B \rightleftharpoons 2C$$

$$K_P = \frac{p(C)^2}{p(A) \times p(B)^3}$$

where p(X) is the partial pressure of each gas at equilibrium.

Le Chatelier's principle: If a reaction at equilibrium is subjected to a change in concentration, temperature or pressure, the position of equilibrium will move to counteract the change.

Mole fraction: A value used to calculate partial pressure.

$$\text{Mole Fraction} = \frac{\textit{Number of moles of a particular gas}}{\textit{Total number of moles of all gases in the mixture}}$$

NaOH: The molecular formula for sodium hydroxide.

Neutralisation: A reaction between an acid and a base to form water and a salt. The ionic equation for neutralisation is:

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

NH_3: The molecular formula for Ammonia.

Partial pressure: The pressure that would be exerted by one gas in a mixture if it occupied the container alone.

$$P_A = PX_A,$$

where P_A is the partial pressure of A, P is the total pressure and X_A is the mole fraction of A.

pH: A value that represents the acidity or alkalinity of a solution. Acidic solutions have a pH of less than 7 while alkali solutions have a pH of greater than 7. Neutral solutions have a pH of 7.

$$pH = -\log[H^+]$$

$$[H^+] = 10^{-pH}$$

Reversible reaction: A reaction in which the products from the reaction can react together to form the original reactants. The direction of a reversible reaction can be changed by changing the conditions.

Strong acid: An acid which dissociates/ionises almost completely in water. This means nearly all the H^+ ions will be released. E.g. HCl.

Strong base: A base which dissociates/ionises almost completely in water. E.g. NaOH.

Titration: An experimental technique used to determine the concentration of an unknown solution by using a second solution with a known concentration.

Weak acid: Acids which only dissociate/ionise very slightly in water so that only a small number of H^+ ions are released. E.g. Ethanoic acid.

Weak base: A base which only slightly dissociates/ionises in water. E.g. NH_3.