WJEC (Eduqas) Chemistry A-level

PI5 - Equilibria

Definitions and Concepts

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PI5 - Equilibria

PI5.1 - Equilibrium Constants

Endothermic reaction: A reaction that takes in energy from the surroundings. The energy of the products is higher than the reactants.

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 the presence of a catalyst but is affected by temperature.

Exothermic: A reaction that releases energy to the surroundings. The energy of the reactants is higher than the products.

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.

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.

Mole fraction: A value used to calculate partial pressure.

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

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.

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

PI5.2 - Acid-Base Equilibria

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

Brønsted-Lowry base: Proton acceptors.

Buffer: A solution which is able to resist changes in pH when small volumes of acid or base are added.

End point: The point during the titration when the indicator changes colour. A suitable indicator should change colour near the equivalence point (so should have a pH range within the pH change during the equivalence point).

Equivalence point: The point when full neutralisation occurs. In acid-base titrations it is the point where all the acid/base has been neutralised and $[H^+]=[OH^-]$. This is the vertical section of an acid/base titration curve.

Hydrolysis: A reaction in which a molecule is broken down by its reaction with water.

Indicator: Indicators are 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_a: Acid dissociation constant, a quantitative measure of the strength of an acid in solution. The larger the K_a value the stronger the acid, since it means the acid is largely dissociated into its ions.

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

K_w: Ionic product of water. At 298K, Kw = 1.0×10^{-14} $mol^2\ dm^{-6}$.

$$Kw = [H^+][OH^-]$$

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.

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

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

pH curve: A graph of pH against the volume of acid/base that is added to a solution. The curve usually has a vertical part which can be identified as the equivalence point.

pH meter: An instrument which measures the pH of a solution. A digital pH meter is preferred to a universal indicator as it can give a more precise value.

pH scale: The pH scale, from 0 to 14, is a measure of the hydrogen ion concentration and tells you about the acidity or alkalinity of a solution. It can be measured using a universal indicator or a pH probe.

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: Bases which only slightly dissociate/ionise in water. E.g. NH_3.