

OCR (B) Chemistry A-level

Storyline 9: Developing Metals

Definitions and Concepts

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Definitions and Concepts for OCR (B) Chemistry A-level Developing Metals

Formulae, Equations and Amount of Substance

Standard solution: A solution that has a known concentration of a compound/element.

Titration: The addition of a solution that has a known concentration to a solution with a known volume and an unknown concentration until the reaction reaches neutralization or completion. The end-point is often indicated by the color change of an indicator.

Bonding and Structure

Bond angle: The angle between two bonds formed from the same atom.

Coordination number: The number of dative covalent bonds formed with the central metal ion.

Octahedral: The shape of a transition metal complex with a coordination number of 6 and a bond angle of 90° . E.g. $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$.

Square planar: One of the possible shapes of a transition metal complex with a coordination number of 4 and a bond angle of 90° . Platinum and nickel complexes form square planar complexes. E.g. $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$.

Tetrahedral: One of the possible shapes of a transition metal complex with a coordination number of 4 and a bond angle of 109.5° . E.g. CuCl_4^{2-} .

Redox

Cell potential: A measure of the potential difference between two half cells, calculated by combining two standard electrode potentials. The calculated cell potential can be used to predict the feasibility of a reaction, although this doesn't consider concentration or kinetics.

E.M.F: Electromotive force, measured in volts. The difference between the potential differences of the cathode and anode in an electrochemical cell.





Electrochemical cell: A combination of two half cells. Consists of two electron conductors (electrodes) separated by an ionic conductor (electrolyte). Cells are used to measure electrode potentials by reference to the standard hydrogen electrode (SHE).

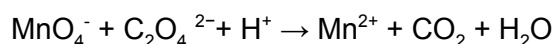
Electrochemical series: A series of elements arranged in order of their standard electrode potentials.

Electrode: A conductor through which electricity enters or leaves the electrolyte in an electrochemical cell.

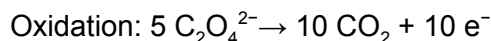
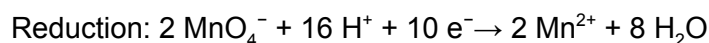
Electrode potential: The potential difference of a cell consisting of a specific electrode as the cathode and the standard hydrogen electrode as the anode. Reduction always takes place at the cathode, and oxidation at the anode.

Feasible reaction: For a reaction to be feasible at a given temperature it must occur spontaneously. This means no extra energy is required for the reaction to occur.

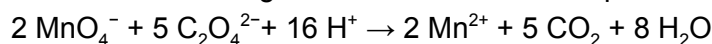
Half equation: A full redox equation can be split into two half-equations, one involving oxidation and the other involving reduction. This concept is useful for balancing complex redox reactions, such as:



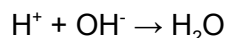
Can be split into:



And combined to give the balanced redox equation:



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



Oxidation state: The charge of an ion or a theoretical charge of an atom in a covalently bonded compound assuming the bond becomes ionic.

Redox reaction: A reaction in which reduction and oxidation occur simultaneously.





Rusting: An example of an oxidation reaction, in which iron reacts with oxygen and water to make hydrated iron oxide. This reaction is what causes iron to rust.

Salt bridge: A porous substance soaked with a solution of an inert, strong electrolyte, e.g. a filter paper soaked in $\text{KNO}_3(\text{aq})$. The salt ions flow through the bridge to complete the circuit and balance charges in solutions.

Standard conditions: These conditions are: solutions of 1.0 mol dm^{-3} concentration, a temperature of 298K and 100 kPa pressure.

Standard electrode (redox) potential (E^\ominus): The EMF of a half cell compared with a standard hydrogen half cell. This is measured under standard conditions (1 mol dm^{-3} concentrations, 298K temperature and 1 atm pressure).

Standard hydrogen electrode (SHE): The standard hydrogen electrode is the measuring standard for half-cell potentials. It has a cell potential of 0.00V, measured under standard conditions.

Inorganic Chemistry and the Periodic Table

Bidentate ligand: Ligands that can form two dative covalent (coordinate) bonds with a metal ion/metal.

Catalytic activity of transition metals: Due to transition metals having variable oxidation states they can catalyse other reactions by acting as oxidising/reducing agents.

Colours in transition metal complexes: Colour arises when some of the wavelengths of visible light are absorbed and the remaining wavelengths of light are transmitted or reflected. The d-orbital electrons move from the ground state to an excited state when light is absorbed.

Complex ion: An ion that has a central metal atom (typically a transition element) surrounded by ligands. The ligands are bound to the transition metal centre by dative coordinate bonds.

Coordination number: The number of dative covalent bonds formed with the central metal ion.

d-block: The block of elements in the middle of the periodic table. Most d-block elements are transition metals. Elements in the d block have their outer electron in the d orbital.

Dative covalent (coordinate) bond: A type of covalent bond in which one bonding atom provides both electrons in the bonding pair.





Electron configuration: The arrangement of electrons into orbitals and energy levels around the nucleus of an atom/ion.

Electron subshell: Electron shells are divided into subshells that have slightly different energy levels. The subshells have different numbers of orbitals which can each hold up to two electrons. The first four types of sub-shell are s, p, d and f.

Ligand: An atom, ion, or molecule that forms a coordinate bond with a central transition metal ion by donating a pair of electrons.

Ligand substitution: A reaction in which one ligand in a transition metal complex is replaced by another. Typically, these reactions are associated with a colour change.

Monodentate ligand: Ligands that can form one dative covalent (coordinate) bond with a metal ion/metal. E.g. H_2O , Cl^- and NH_3 .

Oxidation state: The charge of an ion or a theoretical charge of an atom in a covalently bonded compound assuming the bond becomes ionic.

Polydentate/Multidentate ligand: Ligands that can form two or more dative covalent (coordinate) bonds with a metal ion/metal.

Splitting of d-orbitals: When a ligand bonds to a central metal ion it can have different effects on the d-orbitals, depending on how they are arranged in space. Consequently the d-orbitals split into two sets of degenerate (same energy) orbitals: two that are higher in energy and three that are lower.

Transition metal elements: d-block elements that can form one or more stable ions with an incomplete d-subshell. Transition elements have more than one oxidation state, form coloured ions and can often act as catalysts.

Variable oxidation states: Due to transition metals having incomplete d subshells they have the ability to have variable stable oxidation states. This is due to the 4s and 3d subshells being similar in energies.

Energy and Matter

Colorimeter: A piece of apparatus used to measure the concentrations of solutions.



Colorimetry: Method used to calculate the concentration of a specific coloured compound in a solution by measuring the extent to which it absorbs certain wavelengths of light. This is measured with a colorimeter.

Visible spectrophotometer: A piece of apparatus used to measure the concentrations of solutions.

