WJEC (Eduqas) Chemistry A-level

PI2 - More Complex Patterns of the Periodic Table

Definitions and Concepts

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PI2 - More Complex Patterns of the Periodic Table

PI2.1 - Chemistry of the p-block

Amphoteric: A substance that is able to react as both an acid and a base.

Disproportionation reaction: A reaction in which a species is both oxidised *and* reduced, seen as both an increase and a decrease in oxidation number for that species.

Oxidation: Process involving the loss of electrons. Results in an increase in oxidation number.

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

Oxidising ability: Oxidising ability is the ability of a substance to act as an oxidising agent and accept electrons.

Oxidising agent: Electron acceptors. A substance that can oxidise another species by being reduced.

p-block element: Elements in Groups 3-8/0 of the periodic table. p-block non-metals generally undergo reduction reactions.

Reducing agent: Electron donors. A substance that can reduce another species by being oxidised.

Reduction: Process involving the gain of electrons. Results in a decrease in oxidation number.

Thermal stability trend: As you go down the period more heat is required for the thermal decomposition of Group 2 nitrates and carbonates because the ions increase in size and therefore have greater thermal stability.

Valence shell: The outermost shell that is occupied by electrons is the valence shell.

Water treatment: The addition of chlorine to water to kill bacteria. The risks associated with the use of chlorine to treat water are the hazards of toxic chlorine gas and the possible risks from the formation of chlorinated hydrocarbons.

PI2.2 - Chemistry of the d-block Transition Metals

Adsorption: The process by which reactants form bonds to the surface of a solid catalyst. This weakens the covalent bonds in the reactants and brings them closer together, allowing the reaction to occur more easily.

Catalyst: A substance that speeds up the rate of a reaction without being used up. It speeds up the rate of reaction by providing an alternative reaction pathway with a lower activation energy.

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

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 which 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.

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

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.

Heterogeneous catalysts: Catalysts that are in a different phase or state to the species in the reaction.

Homogeneous catalysts: Catalysts that are in the same phase or state as the species in the reaction.

Hydrogenation: A reaction between H_2 and another substance, this often reduces or saturates a compound. These reactions usually require a catalyst like nickel.

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

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

Octahedral: The shape of a transition metal complex with a coordination number of 6 and a bond angle of 90^o. E.g. $[Cu(H_2O)_6]^{2+}$.

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

Splitting of d-orbitals: When a ligand forms a bond with a central metal ion it affects the d orbitals differently depending on how they are arranged in space. Consequently the d-orbitals split into two sets of degenerate (same energy) orbitals; in octahedral complexes there are two orbitals that are higher in energy and three that are lower, in tetrahedral complexes there are three orbitals higher and two lower.

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. $CuCl_4^{2-}$.

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.