AQA Chemistry A-level

Inorganic Chemistry II

Definitions

Selected Definitions modified or taken from: AQA Specification for GCSE Chemistry, 8462, Version 1.1 04 October 2019 & AQA Specification for AS & A-Level Chemistry, 7404 & 7405, Version 1.1, December 2015

Definitions and Concepts for AQA Chemistry A-level

Inorganic Chemistry II

2.4 Properties of Period 3 Elements and their Oxides

Acidic solution: A solution with a pH in the range 0-6. Simple covalent oxides of phosphorus and sulfur form acidic solutions when they dissolve in water. The acids formed are strong so the pH is in the range 0-2. E.g. $P_4O_{10} + H_2O \rightarrow H_3PO_4$.

Alkaline solution: A solution with a pH in the range 8-14. Ionic oxides of sodium and magnesium form alkaline solutions when they dissolve in water. This is because when they dissolve the O^{2-} ions accept protons from the water molecules to form hydroxide ions. E.g. $Na_2O + H_2O \rightarrow 2NaOH$.

Amphoteric: A substance is called amphoteric if it is able to react as a base and as an acid. Aluminium oxide will react with acids and bases to form salts so it is classed as amphoteric. Aluminium oxide is amphoteric due to the fact that it is partially ionic and partially covalent bonded.

Oxides: A compound containing oxygen bonded with one other element.

Dissociate: Split up into ions.

2.5 Transition Metals

Adsorption: The process of forming weak bonds by reactants to a surface of a solid catalyst.

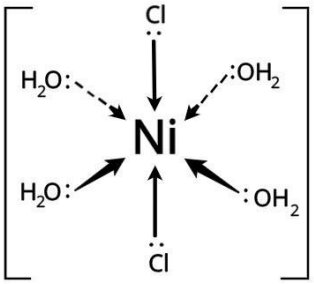
Autocatalysis: A reaction where the product of a reaction acts as a catalyst for the reaction.

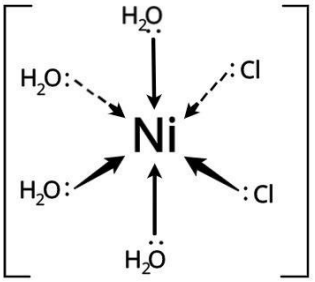
Bidentate ligand: Ligands that can only form two coordinate bonds. E.g. ethane-1,2-diamine, ethanedioate.

Calibration curve: A calibration curve is used in colorimetry to plot the amount of absorbance vs concentrations of standard solutions. This is then used to measure the concentration of an unknown solution of your transition metal ion.

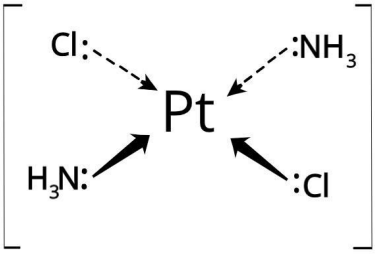
Catalyst poisoning: Impurities in a reaction mixture may bind to a heterogeneous catalyst's surface and block reactants from being adsorbed.

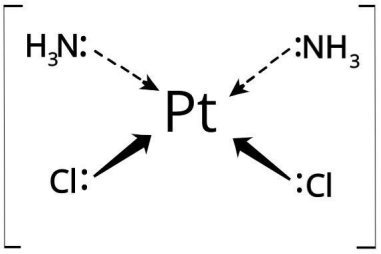
Cis-trans isomerism: A type of stereoisomerism. Octahedral complexes with four monodentate ligands of one type and two monodentate ligands of another type can show cis-trans isomerism. If the two odd ligands are opposite, it is the trans isomer. If the two odd ligands are next to each other, it is the cis isomer. Below left: trans isomer, below right: cis isomer.





Square planar complex ionsthat have two pairs of ligands also show cis-trans isomerism. When two paired ligands are opposite it is the trans isomer, when they're next to each other it is the cis isomer.(Below left: trans isomer, below right: cis isomer).





Cisplatin: A transition metal compound which is used as an anti cancer drug. It has a square planar shape.

Colorimeter: Instrument used in spectroscopy which calculates how much light is absorbed by the sample.

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 electrons move from the ground state to an excited state when light is absorbed.

Complex: A central metal atom or ion surrounded by coordinately bonded ligands.

Contact Process: An industrial process used to produce sulfuric acid. Vanadium(V) oxide acts as a heterogeneous catalyst. Vanadium(V) oxide is able to oxidise SO_2 to SO_3 because it can be reduced to vanadium(IV) oxide. It is then oxidised so that it can be used again:

$$V_2O_5 + SO_2 \rightarrow SO_3 + V_2O_4$$

$$V_2O_4 + ½O_2 \rightarrow V_2O_5$$

Coordinate bond: A co-ordinate, or dative, bond is a covalent bond in which both electrons in the shared pair come from the same atom.

Coordination number: The number of coordinate bonds that are 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.

Heterogeneous catalysts: A catalyst that is in a different phase from the reactants. The reaction takes place on the active sites on the surface of the heterogeneous catalyst. Examples include iron in the Haber Process and vanadium(V) oxide in the Contact Process.

Homogeneous catalysts: Catalysts that are in the same phase as the reactants - i.e. in the same physical state. They work by combining with the reactants to form an intermediate species which then reacts to form the products and re-form the catalyst. An example is Fe^{2+} ions in the reaction between $S_2O_8^{2-}$ and I^-:

$$S_2O_8^{2-} + 2Fe^{2+} \rightarrow 2Fe^{3+} + 2SO_4^{2-}$$

$$2Fe^{3+} + 2I^- \rightarrow I_2 + 2Fe^{2+}$$

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

Ligand substitution: A reaction in which a ligand is substituted by another ligand.

$$\text{e.g. } Cu(H_2O)_6^{2+} + 4Cl^- \rightarrow CuCl_4^{2-} + 6H2O$$

Monodentate ligand: Ligands that can only form one co-ordinate bond. E.g. H_2O and NH_3.

Multidentate ligand: Ligands that can form more than one co-ordinate bond.

Optical isomerism: Optical isomerism is a type of stereoisomerism which occurs when a substance exists in two forms that are non-superimposable mirror images. Complex ions can show optical isomerism when a central metal ion is coordinately bonded to three bidentate ligands.

Redox titrations: A titration experiment to determine the concentration of an unknown solution by carrying out a redox reaction between the two reactants.

Spectroscopy: A technique used to determine the concentration of a solution by measuring how much light it absorbs.

Transition metal: A metal that can form one of more stable ions with a partially filled d sub-level.

Variable oxidation states: Transition elements have variable oxidation states which means they can form ions with different oxidation states. For example, vanadium can form ions with the oxidation states +2, +3,+4 or +5, and this is because the energy levels of the 4s and 3d sub-levels are very similar so different numbers of electrons can be gained or lost using similar amounts of energy.

2.6 Reactions of Ions in Aqueous Solution

Amphoteric: A substance is called amphoteric if it is able to react as a base and as an acid. Some metal hydroxides show amphoteric character by dissolving in both acids and bases.

Metal aqua ions: Metal ions in aqueous solution. In aqueous solution, the following metal-aqua ions are formed:

$[M(H_2O)_6]^{2+}$, limited to M = Fe and Cu
$[M(H_2O)_6]^{3+}$, limited to M = Al and Fe