

H2 Chemistry

Inorganic Chemistry

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Abstract

This book is written with the intention to provide readers with a brief summary of each topic in the Singapore GCE A-Level Chemistry at the H2 Level. The full syllabus can be found [here](#).

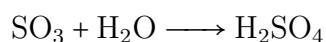
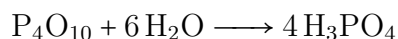
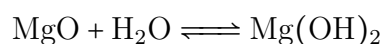
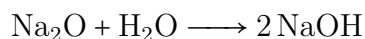
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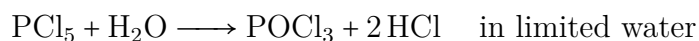
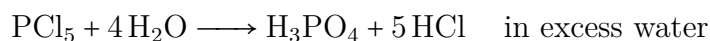
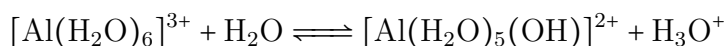
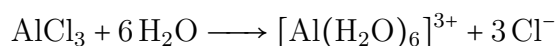
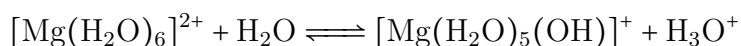
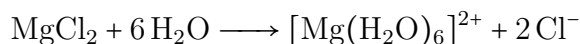
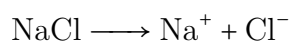
§1 Periodic Table

§1.1 Period 3 Elements

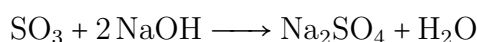
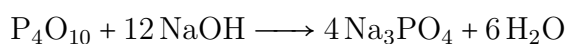
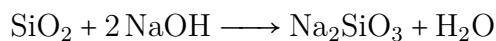
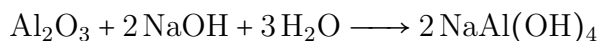
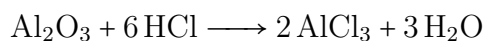
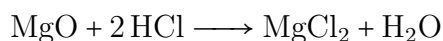
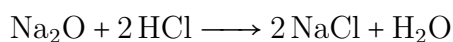
§1.1.1 Reaction of oxides with water



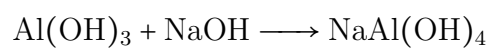
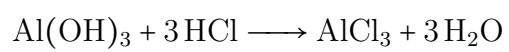
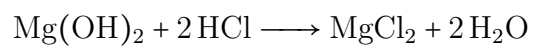
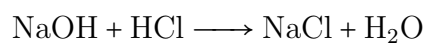
§1.1.2 Reaction of chlorides with water



§1.1.3 Acid/base behaviour of oxides



§1.1.4 Acid/base behaviour of hydroxides



§1.2 Group 2 Elements

§1.2.1 Reducing agents

Reactivity as reducing agents increases down the group

- **Ionisation energies, ease of losing electrons**

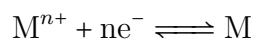
Down the group, number of electronic shells increases so screening effect increases, and each successive element has valence electrons located in shell with higher principal quantum number.

Valence electrons are increasingly further away from nucleus, less strongly attracted to nucleus, outweigh increase in nuclear charge.

Less energy required to move valence electron. Sum of first and second ionisation energy of Group 2 metals decrease down the group. Increase ease of atom losing electrons to form cations during oxidation. Reducing power (and hence reactivity) of Group 2 metals increases.

- **E° values, ease of losing electrons**

Standard electrode potential E° value is a measure of tendency for species M^{n+} to undergo reduction.



E° value more positive, greater tendency for M^{n+} to be reduced; E° value more negative, greater tendency for M to be oxidised to M^{n+} .

- **Reaction of metal with oxygen**

Reaction of metal with water

§1.2.2 Thermal stability of compounds

Down the group,

- ionic radius of cation increases, charge density of cation decreases (since charge remains the same), polarising power of cation decreases
- extent of polarisation of electron cloud of CO_3^{2-} decreases, extent of weakening of C–O bond within CO_3^{2-} decreases
- thermal stability of carbonates increases, hence decomposition temperature increases

Exercise 1.1

Why does $Mg(OH)_2$ decompose at a lower temperature than $Ca(OH)_2$?

Answer. Mg^{2+} ion being smaller in size than Ca^{2+} ion has a greater charge density and hence greater polarising power. The OH^- ion is thus more polarised by the smaller Mg^{2+} ion, O–H bond in $\text{Mg}(\text{OH})_2$ is weakened to larger extent. Hence $\text{Mg}(\text{OH})_2$ is less stable than $\text{Ca}(\text{OH})_2$ and thus decomposes at lower temperature. \square

§1.3 Group 17 Elements

Trends and variations in atomic and physical properties For elements in the third period (sodium to chlorine), and in Group 2 (magnesium to barium) and Group 17 (chlorine to iodine) candidates should be able to: (a) recognise variation in the electronic configurations across a Period and down a Group (b) describe and explain qualitatively the general trends and variations in atomic radius, ionic radius, first ionisation energy and electronegativity: (i) across a Period in terms of shielding and nuclear charge (ii) down a Group in terms of increasing number of electronic shells, shielding and nuclear charge (c) interpret the variation in melting point and in electrical conductivity across a Period in terms of structure and bonding in the elements (metallic, giant molecular, or simple molecular) (d) describe and explain the trend in volatility of the Group 17 elements in terms of instantaneous dipole-induced dipole attraction

§2 Transition Elements

§2.1 Physical properties

§2.2 Chemical properties

§2.3 Colour of complexes

(a) explain what is meant by a transition element, in terms of d block elements forming one or more stable ions with partially filled d subshells (b) state the electronic configuration of a first row transition element and its ions (c) explain why atomic radii and first ionisation energies of the transition elements are relatively invariant (d) contrast, qualitatively, the melting point and density of the transition elements with those of calcium as a typical s block element (e) describe the tendency of transition elements to have variable oxidation states (f) predict from a given electronic configuration, the likely oxidation states of a transition element (g) describe and explain the use of $\text{Fe}^{3+}/\text{Fe}^{2+}$, $\text{MnO}_4^-/\text{Mn}^{2+}$ and $\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}$ as examples of redox systems (see also Section 12) (h) predict, using E° values, the likelihood of redox reactions (i) define the terms ligand and complex as exemplified by the complexes of copper(II) ions with water, ammonia and chloride ions as ligands (including the transition metal complexes found in the Qualitative Analysis Notes) (j) explain qualitatively that ligand exchange may occur, as exemplified by the formation of the complexes in (i), including the colour changes involved, and CO/O_2 exchange in haemoglobin (k) describe, using the shape and orientation of the d orbitals, the splitting of degenerate d orbitals into two energy levels in octahedral complexes (l) explain, in terms of d orbital splitting and d-d transition, why transition element complexes are usually coloured [knowledge of the relative order of ligand field strength is not required] (m) explain how some transition elements and/or their compounds can act as catalysts (see also 8(j))