

2.3.1 Redox equations and Group 1/2 trends

Name: _____ Class: _____ Date: _____ Total: 24 marks

KEY WORDS oxidation number

Objective

Balance electron transfer and explain reactions and thermal stability using cation size. All questions and marking guidance are original.

1 Key knowledge and worked examples

Oxidation increases oxidation number and loses electrons. An oxidising agent gains electrons and is reduced. The oxidation-number sum equals the species charge. Oxygen is -1 in peroxides; hydrogen is -1 in metal hydrides.

■ Worked method

In $\text{Cr}_2\text{O}_7^{2-}$, $2x + 7(-2) = -2$, so $x = +6$. Combine $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$ with $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$. Electrons cancel to give $\text{Mg} + \text{Cl}_2 \rightarrow \text{Mg}^{2+} + 2\text{Cl}^-$. Both charge and atoms balance.

Down Groups 1/2, radius and shielding increase; outer electrons are easier to remove. Small cations polarise carbonate/nitrate anions more, so their salts generally decompose more easily. Group 2 hydroxide solubility increases down the group; sulfate solubility decreases.

2 Practice

2.1 Find the oxidation numbers of O in Na_2O_2 , H in NaH and Mn in MnO_4^- . [3]

2.2 Write a balanced equation for calcium with cold water and state one observation. [3]

2.3 Explain why potassium reacts more readily with water than lithium. [3]

3 Exam-style questions

3.1 Write half-equations and the overall ionic equation for aluminium reducing Cu^{2+} to copper. Identify the oxidising agent. [5]

3.2 Compare decomposition of LiNO_3 and NaNO_3 . Give balanced equations and explain why lithium differs. State a test for one gas. [5]

3.3 A calcium compound gives a brick-red flame. Explain how the light arises. State the characteristic flame colours for lithium, sodium, potassium and barium, and distinguish a magnesium-ion flame test from burning magnesium metal. [5]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $O = -1$; $H = -1$; $x + 4(-2) = -1$, so $Mn = +7$.

2.2 $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$. Effervescence/hydrogen gas or a cloudy hydroxide suspension.

2.3 Potassium has greater radius and more shielding, reducing attraction to its outer electron so it is lost more easily.

3.1 $Al \rightarrow Al^{3+} + 3e^-$; $Cu^{2+} + 2e^- \rightarrow Cu$. Multiply by 2 and 3: $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$. Cu^{2+} is reduced and is the oxidising agent.

3.2 $4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$; $2NaNO_3 \rightarrow 2NaNO_2 + O_2$. Smaller Li^+ has greater charge density and polarises the nitrate more strongly. Oxygen relights a glowing splint. Brown NO_2 is toxic; an approved controlled demonstration is required.

3.3 Excited electrons fall to lower energy levels and emit photons of characteristic energy. Lithium crimson and sodium yellow; potassium lilac and barium apple-green. Magnesium ions have no characteristic flame colour; bright white burning metal is a different observation.