

2.3.4 Group reactions: formulae, solubility and thermal evidence

Name: _____ Class: _____ Date: _____

Total: 33 marks

KEY WORDS oxidation number

Objective

Use charge balance and particle models to predict unfamiliar Group-1/2 reactions. All questions and marking guidance are original.

1 Key knowledge and worked examples

An oxidation number is written as a signed number; a Roman numeral in a name gives the positive oxidation state. Iron(III) oxide is Fe_2O_3 : two Fe at +3 balance three O at -2 . This is different from counting atoms with a subscript.

■ Worked comparison

Calcium oxide is a basic oxide. With water, $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2$. With acid, $\text{CaO} + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + \text{H}_2\text{O}$. Calcium hydroxide also neutralises acid: $\text{Ca}(\text{OH})_2 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + 2\text{H}_2\text{O}$. Check atoms and charge in each equation.

Down Group 2, hydroxide solubility increases but sulfate solubility decreases. Thermal stability of carbonates and nitrates increases: larger cations polarise their anions less strongly. Do not use the solubility trend to explain a decomposition temperature.

2 Practice

2.1 Write the names of FeCl_2 and FeCl_3 using Roman numerals. Write the formula of copper(II) nitrate and use charge balance to justify it. [4]

2.2 Write balanced equations for lithium burning to its oxide, sodium forming its peroxide, and potassium forming its superoxide in excess oxygen. Give the oxidation number of oxygen in each product. [6]

2.3 Write balanced equations for magnesium with steam and for barium with cold water. Compare the observed cold-water reactivity of Mg, Ca and Ba and explain the trend. [5]

3 Exam-style questions

3.1 For K_2O , write balanced equations with water and with dilute HCl. For $\text{Ba}(\text{OH})_2$, write the full equation with HCl and the net ionic equation. State which changes are neutralisation rather than redox. [6]

3.2 Equal volumes of saturated $\text{Mg}(\text{OH})_2$ and $\text{Ba}(\text{OH})_2$ solutions at the same temperature are separately titrated with the same acid. Predict which needs more acid. Separately, predict which gives more precipitate when equal volumes of equally concentrated Mg^{2+} and Ba^{2+} solutions receive excess sulfate. Explain both, and explain why solubility is different from alkali strength. [5]

3.3 Magnesium carbonate decomposes at a lower temperature than barium carbonate. Explain using cation size. Write balanced equations for magnesium carbonate and magnesium nitrate on heating. Give tests/observations distinguishing the released gases. Explain why timing bubbles alone does not establish a decomposition temperature. [7]
