

Solutions

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

2.1 Iron(II) chloride and iron(III) chloride. $\text{Cu}(\text{NO}_3)_2$; one Cu^{2+} needs two NO_3^- , total charge zero.

2.2 $4\text{Li} + \text{O}_2 \rightarrow 2\text{Li}_2\text{O}$, $\text{O} = -2$. $2\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}_2$, $\text{O} = -1$. $\text{K} + \text{O}_2 \rightarrow \text{KO}_2$, average $\text{O} = -\frac{1}{2}$. The products and conditions are specified; do not replace every oxygen product with a simple oxide.

2.3 $\text{Mg} + \text{H}_2\text{O}(\text{g}) \rightarrow \text{MgO} + \text{H}_2$; $\text{Ba} + 2\text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 + \text{H}_2$. Cold-water reactivity increases $\text{Mg} < \text{Ca} < \text{Ba}$. Radius/shielding increase, weakening attraction to outer electrons so electron loss is easier.

3.1 $\text{K}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{KOH}$; $\text{K}_2\text{O} + 2\text{HCl} \rightarrow 2\text{KCl} + \text{H}_2\text{O}$. $\text{Ba}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$; $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$. The oxide–acid and hydroxide–acid changes are neutralisation; oxidation numbers do not change, so none of the stated changes is redox.

3.2 The saturated $\text{Ba}(\text{OH})_2$ solution needs more acid because hydroxide solubility increases down Group 2 and it contains more dissolved OH^- per equal volume. The Ba^{2+} solution gives more precipitate because sulfate solubility decreases down the group. Solubility controls how much dissolves; alkali strength concerns dissociation of the dissolved substance, so low solubility does not by itself mean weak alkali.

3.3 Mg^{2+} is smaller and has greater charge density, polarising the anion more strongly and lowering stability. $\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$; $2\text{Mg}(\text{NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2$. CO_2 turns limewater milky. O_2 relights a glowing splint; NO_2 is brown and acidic. Bubble timing also depends on heating rate/amount/apparatus, so temperature under controlled conditions must be measured. These are supervised methods; NO_2 requires approved ventilation.