InkChemistry

QUESTION WORKBOOK

Variable oxidation states: vanadium, chromium and manganate(VII) titrations

Transition metals · Unit C14

AQA 3.2.5.5 · OCR A 5.3.1

18 questions · 57 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks

A1 VO-Q3

Calculate E°_{cell} for the reduction of V^{3+} to V^{2+} by zinc. $E^\circ(V^{3+}/V^{2+}) = -0.26$ V and $E^\circ(Zn^{2+}/Zn) = -0.76$ V. [2]

A2 VO-Q12

Explain why no indicator is added in a manganate(VII) titration. [2]

A3 VO-Q18

Calculate E°_{cell} for the oxidation of iron(II) hydroxide by oxygen in alkaline solution. E° for $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ is +0.40 V and E° for $Fe(OH)_3 + e^- \rightarrow Fe(OH)_2 + OH^-$ is −0.56 V. [2]

A4 VO-Q20

Explain why chromium(III) hydroxide dissolves in excess sodium hydroxide but iron(III) hydroxide does not. [2]

SECTION B · Standard, 3 to 5 marks

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B1 VO-Q9 Calculate the percentage purity of a sample of sodium ethanedioate, $Na_2C_2O_4$ (Mr = 134.0). 2.00 g of the impure solid is dissolved and made up to 250.0 cm^3; 25.0 cm^3 portions are acidified, warmed and titrated with 0.0200 mol dm^{-3} potassium manganate(VII), and the mean titre is 23.50 cm^3. [5]

B2 VO-Q10 Suggest what goes wrong when a manganate(VII) titration of Fe^{2+} is acidified with hydrochloric acid, and when it is acidified with ethanoic acid, instead of with dilute sulfuric acid. [5]

B3 VO-Q1 Give the formula and the colour in solution of the vanadium species in the +5, +4, +3 and +2 oxidation states. [4]

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B4 VO-Q2 Complete and balance the equation for the reduction of VO^{2+} by zinc in acid, Zn + VO^{2+} + H^+ →, and explain why a solution of VO_2^+ turns green before it turns blue when zinc and acid are added. [4]

B5 VO-Q22 Show that two moles of manganate(VII) ions react with five moles of ethanedioate ions, $C_2O_4^{2-}$, in acidic solution, and give the overall ionic equation. [4]

B6 VO-Q4 Explain why tin reduces VO^{2+} to V^{3+} but does not reduce V^{3+} to V^{2+}. $E^\circ(Sn^{2+}/Sn)$ = −0.14 V, $E^\circ(VO^{2+}/V^{3+})$ = +0.34 V and $E^\circ(V^{3+}/V^{2+})$ = −0.26 V. [3]

B7 VO-Q6 Describe how chromium(III) ions in solution can be oxidised to chromate(VI) ions, giving the colours. [3]

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B8 VO-Q7 Explain why chromium(III) is oxidised to chromium(VI) more easily in alkaline solution than in acidic solution. [3]

B9 VO-Q8 Calculate the concentration of Fe^{2+} in an acidified solution of iron(II) sulfate, given that 25.0 cm^3 of it needs 23.20 cm^3 of 0.0180 mol dm^{-3} potassium manganate(VII) to reach the end point. [3]

B10 VO-Q14 Compare the reduction of dichromate(VI) by zinc in acid with the reduction of VO_2^+ by zinc in acid. [3]

B11 VO-Q15 Explain why the green precipitate formed when sodium hydroxide is added to Fe^{2+} turns orange-brown on standing in air, whereas acidified Fe^{2+} solution changes only slowly. [3]

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B12 VO-Q16 Outline how Tollens' reagent distinguishes an aldehyde from a ketone, in terms of the oxidation state of silver. [3]

B13 VO-Q17 Describe what is seen when sodium hydroxide solution is added drop by drop until in excess to a solution of $[Cr(H_2O)_6]^{3+}$, and give an equation for the first change. [3]

B14 VO-Q19 Suggest how sodium hydroxide solution could be used to tell apart solutions containing Mn^{2+} ions and Cr^{3+} ions. [3]

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