InkChemistry

QUESTION WORKBOOK

Metal-aqua ions and the acidity of their solutions

Ions in aqueous solution · Unit C15

AQA 3.2.6

18 questions · 63 marks

PRINT EDITION

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SECTION A · Short, 1 to 2 marks

A1
MAI-Q14

Suggest why a solution of sodium chloride is neutral while a solution of aluminium chloride of the same concentration is acidic. [2]

SECTION B · Standard, 3 to 5 marks

B1
MAI-Q15

Compare what is seen, and the products formed, when sodium carbonate solution is added to separate solutions of iron(II) sulfate and iron(III) chloride. Give the equation, with state symbols, for the iron(III) reaction. [5]

B2
MAI-Q1

Give the formula of the metal-aqua ion and the colour of the solution for iron(III) nitrate, copper(II) sulfate and aluminium sulfate, and state why the aluminium sulfate solution is colourless. [4]

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B3 MAI-Q4 Complete the equation, with state symbols, for the reaction that makes a solution of $[Al(H_2O)_6]^{3+}$ acidic, $[Al(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons$, and identify the Brønsted–Lowry acid and the Brønsted–Lowry base on its left-hand side. [4]

B4 MAI-Q3 Describe the bonding and the shape of the $[Fe(H_2O)_6]^{2+}$ ion. [3]

B5 MAI-Q6 Explain why a solution of iron(III) chloride is acidic, although iron(III) chloride is a salt. [3]

B6 MAI-Q8 Calculate the pH of a solution in which the concentration of $[Al(H_2O)_6]^{3+}$ is 0.0500 mol dm^{-3}. Ka for $[Al(H_2O)_6]^{3+}$ is 1.0×10^{-5} mol dm^{-3}. [3]

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B7 MAI-Q9 Calculate Ka for $[Fe(H_2O)_6]^{2+}$, given that a 0.100 mol dm^{-3} solution of iron(II) sulfate has a pH of 5.25. [3]

B8 MAI-Q10 Calculate the pH of a 0.250 mol dm^{-3} solution of copper(II) sulfate. Ka for $[Cu(H_2O)_6]^{2+}$ is 3.2×10^{-8} mol dm^{-3}. [3]

B9 MAI-Q11 Explain why sodium carbonate solution releases carbon dioxide from a solution of $[Al(H_2O)_6]^{3+}$ but not from a solution of $[Cu(H_2O)_6]^{2+}$. [3]

B10 MAI-Q13 Suggest why a yellow-brown solution of iron(III) nitrate turns almost colourless, with a faint violet tint, when concentrated nitric acid is added. [3]

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B11 MAI-Q16 Evaluate the use of the weak-acid approximation to find the pH of a 0.0500 mol dm^{-3} solution of $[Fe(H_2O)_6]^{3+}$, for which Ka is 6.3×10^{-3} mol dm^{-3}. [3]

B12 MAI-Q19 Calculate the pH of the solution made when 10.0 cm^3 of 0.200 mol dm^{-3} copper(II) sulfate solution is diluted to 100.0 cm^3 with water. Ka for $[Cu(H_2O)_6]^{2+}$ is 3.2×10^{-8} mol dm^{-3}. [3]

B13 MAI-Q20 Explain why diluting a solution of $[Al(H_2O)_6]^{3+}$ tenfold raises its pH by about 0.5, whereas diluting hydrochloric acid tenfold raises its pH by 1. [3]

B14 MAI-Q21 Suggest why a solution of magnesium chloride has a pH of about 6.5, between the pH of sodium chloride solution and that of aluminium chloride solution of the same concentration. [3]

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B15 MAI-Q22 Show that a 0.100 mol dm^{-3} solution of copper(II) sulfate has a pH of 4.25 at 298 K. Ka for $[Cu(H_2O)_6]^{2+}$ is 3.2×10^{-8} mol dm^{-3}. [3]

SECTION C · Long, 6 marks or more

C1 MAI-Q7 Explain, with equations, why a 0.100 mol dm^{-3} solution of $[Fe(H_2O)_6]^{3+}$ has a lower pH than a 0.100 mol dm^{-3} solution of $[Fe(H_2O)_6]^{2+}$. Refer to charge density in your answer. [6]

C2 MAI-Q17 Explain, with equations, how sodium carbonate solution can be used to decide whether an unknown solution contains $[M(H_2O)_6]^{2+}$ or $[M(H_2O)_6]^{3+}$ ions, and why the two charges behave differently. [6]

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