InkChemistry

QUESTION WORKBOOK

Colour in transition metal complexes and colorimetry

Transition metals · Unit C14

AQA 3.2.5.4 · OCR A 5.3.1 (colour as a property only)

17 questions · 54 marks

PRINT EDITION

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SECTION A · Short, 1 to 2 marks

A1 CTM-Q10
Suggest the colour of filter to use when measuring the concentration of pink $[Co(H_2O)_6]^{2+}$ ions in a colorimeter, and explain your choice. [2]

A2 CTM-Q14
Suggest why copper(I) chloride is a white solid but copper(II) chloride is coloured. [2]

A3 CTM-Q19
Suggest why the purple colour of the manganate(VII) ion cannot be explained by a d electron moving between split d orbitals. [2]

SECTION B · Standard, 3 to 5 marks

B1 CTM-Q1
State what happens to a d electron in a complex ion when the ion absorbs visible light, and state the equation that links the energy absorbed with the frequency of the light, giving the meaning of each symbol. [4]

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B2 CTM-Q2 Explain why a solution containing $[Cu(H_2O)_6]^{2+}$ ions is blue. [4]

B3 CTM-Q4 Calculate the frequency of the light absorbed by a complex whose split d orbitals are 2.6×10^{-19} J apart, and the energy absorbed per mole of complex in kJ mol^{-1}. h = 6.63×10^{-34} J s and L = 6.022×10^{23} mol^{-1}. [4]

B4 CTM-Q3 Calculate the energy gap ΔE between the split d orbitals of a complex that absorbs light most strongly at a wavelength of 500 nm. h = 6.63×10^{-34} J s and c = 3.00×10^{8} m s^{-1}. [3]

B5 CTM-Q5 Explain why solutions of zinc sulfate are colourless. [3]

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B6 CTM-Q6 Give three changes to a complex ion that alter ΔE and so alter its colour, with an example of each. [3]

B7 CTM-Q7 Explain why adding excess ammonia to a pale blue solution of $[Cu(H_2O)_6]^{2+}$ produces a deep blue solution. [3]

B8 CTM-Q11 Suggest why a student's result is unreliable when her unknown solution gives an absorbance of 0.92 but her highest standard gives only 0.60, and suggest what she should do. [3]

B9 CTM-Q13 Compare $[Co(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$ in terms of shape, d-orbital splitting and colour. [3]

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B10 CTM-Q15 Explain why the solution of a complex looks colourless when the complex has a partly filled d subshell but absorbs only at 300 nm. [3]

B11 CTM-Q17 Evaluate a student's conclusion that the hexaaqua ions of Fe^{3+} and Mn^{2+} must be the same colour because both ions have the configuration [Ar] $3d^5$. [3]

B12 CTM-Q18 Explain why, in an octahedral complex, the $3dz^2$ and $3dx^2-y^2$ orbitals are raised in energy more than the 3dxy, 3dxz and 3dyz orbitals. [3]

B13 CTM-Q20 Calculate the wavelength, in nm, of the light absorbed by a complex for which ΔE is 186 kJ mol^{-1}. h = 6.63×10^{-34} J s, c = 3.00×10^8 m s^{-1} and L = 6.022×10^{23} mol^{-1}. [3]

SECTION C · Long, 6 marks or more

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C1 CTM-Q8 Describe how a colorimeter can be used to find the concentration of Cu^{2+} ions in a solution, and explain why excess ammonia is added to every solution before it is measured. [6]

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