

Colour, complexes and catalysis in the d-block

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Compare your answers with the model answers and the marking points. Credit is given for correct working even if a later number is wrong; use the gaps to decide which topic to revise.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.2.5

Question 1 Electron configurations (2 marks)

- a. **[Ar] 3d⁵ 4s¹.**
- b. Cu⁺ loses the 4s electron: **[Ar] 3d¹⁰.**

Marking: 1 mark each.

Question 2 Definition (3 marks)

- a. A d-block element that forms at least one ion with a **partially filled d subshell**.
- b. Zinc forms only Zn²⁺, which is 3d¹⁰ and so has a full d subshell; it has no ion with a partially filled d subshell.

Marking: 1 for definition, 1 for Zn²⁺ 3d¹⁰, 1 for full subshell link.

Question 3 Read the complex (2 marks)

- a. Coordination number **6, octahedral**.
- b. NH₃ is neutral, so cobalt is **+3**.

Marking: 1 for number and shape together, 1 for +3.

Question 4 Colour of a complex (3 marks)

- a. Ligands split the 3d orbitals into two energy sets. An electron absorbs a photon of energy ΔE (red-orange light) to jump to the higher set. The remaining blue light is transmitted.

Marking: 1 for orbital splitting, 1 for absorbing light of energy ΔE, 1 for transmitted colour.

Question 5 Ligand substitution (2 marks)

- a. **[Cu(H₂O)₆]²⁺ + 4NH₃ → [Cu(NH₃)₄(H₂O)₂]²⁺ + 4H₂O; deep blue.**

Marking: 1 for the balanced equation, 1 for the colour.

Question 6 Titration with manganate(VII) (4 marks)

- a. $n = 0.02000 \times 0.0200 = \mathbf{4.00 \times 10^{-4} \text{ mol.}}$
- b. $n(\text{Fe}^{2+}) = 5 \times 4.00 \times 10^{-4} = \mathbf{2.00 \times 10^{-3} \text{ mol.}}$
- c. $c = 2.00 \times 10^{-3} \div 0.0250 = \mathbf{0.0800 \text{ mol dm}^{-3}.}$

Marking: 1 each for (a) and (b); 1 for correct ratio use and 1 for concentration in (c).

Question 7 Catalysts (2 marks)

- a. They can change oxidation state and so form intermediates, giving an alternative route with lower activation energy; solid catalysts also adsorb reactants on the surface.

Marking: 1 for variable oxidation states or surface, 1 for lower activation energy.

Question 8 Cisplatin (2 marks)

- a. **Square planar.**
- b. **cis-trans (geometric) isomerism.**

Marking: 1 mark each.