AQA A-Level Chemistry

Transition metals mark scheme · goes with “Transition metals” · whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions

Mark schemes

Transition metals · 10 questions

Q1 · June 2023 · Paper 3 · Q23 · [1 mark]

Answer: **A**

$[CoCl_4]^{2-}$ is square planar.

Q2 · June 2024 · Paper 3 · Q21 · [1 mark]

Answer: **C**

They form a cobalt(II) complex with a tetrahedral shape.

Q3 · June 2025 · Paper 1 · Q3 · [23 marks]

03.1

1 or one

[1 mark]

03.2

(Water) has a lone pair (of electrons on the O) that it can donate (to copper)

Or

(Water) has a lone pair (of electrons on the O) that forms a co-ordinate/dative covalent bond (to copper)

Allow lone pair donor/electron pair donor/both

electrons

[1 mark]

03.3

M1 Blue-green/green-blue/green precipitate/solid

M2 $[Cu(H_2O)_6]^{2+} + CO_3^{2-} \rightarrow CuCO_3 + 6H_2O$

M1 Do not accept blue

M2 $[Cu(H_2O)_6]^{2+} + Na_2CO_3 \rightarrow CuCO_3 + 6H_2O + 2Na^+$

Ignore state symbols

Allow multiples

[2 marks]

03.4

This question is marked using levels of response.

Level 3

5–6 marks

All stages are covered and the description of each stage is generally correct and virtually complete.

Answer is communicated coherently and shows a logical progression from stage 1 to stage 2 and stage 3.

Level 2

3–4 marks

All stages are covered but the description of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows progression from stage 1 to stage 2 and/or stage 3.

Level 1

1–2 marks

Two stages are covered but the description of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes isolated statements and these are presented in a logical order.

Level 0

0 marks

Insufficient correct chemistry to gain a mark.

Stage 1

1a Octahedral $[Cu(H_2O)_6]^{2+}$ (with 6 ligands) and tetrahedral $[CuCl_4]^{2-}$ (with 4 ligands) or diagram of both complexes

1b Cl^- ligands are bigger (so only 4 fit around the

Cu^{2+}) or reverse argument

Stage 2

2a d-orbitals split (into ground state and excited state)

2b (some wavelengths/frequencies) of white/visible light are absorbed (by the complex)

2c electrons are excited/promoted (from ground state to excited state) OR d–d transitions occur

Stage 3

3a Different ligand/co-ordination number changes the energy gap/splitting OR octahedral and tetrahedral complexes have different energy gap/splitting (in the d orbitals)

3b The energy gap is related to the wavelength/frequency OR $\Delta E = h\nu$ OR $\Delta E = hf$ OR

$$\Delta E = \frac{hc}{\lambda}$$

3c Wavelengths/frequencies/colour not absorbed are transmitted/reflected (not emitted) OR light reflected is complementary to light absorbed.

[6 marks]

03.5

M1 (yellow solution turns to a) deep/dark blue solution

M2 $[CuCl_4]^{2-} + 4NH_3 + 2H_2O \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 4Cl^-$

[2 marks]

03.6

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

Allow multiples

Ignore state symbols

[1 mark]

03.7

28.55 cm^3

[1 mark]

03.8

M1 n MnO_4^- = $28.55 \times 10^{-3} \times 0.0200 = 5.71 \times 10^{-4}$ mol

M2 n $C_2O_4^{2-}$ = M1 × $\frac{(5)}{(2)}$

M3 n $C_2O_4^{2-}$ in 250 cm^3 = M2 × 10

M4 n complex = $\frac{(M3)}{(2)}$

M5 M_r complex = $\frac{(2.52)}{(M4)}$ and answer on line

M6 M_r of 2M = M5 – 275.5

M7 M_r of M = $\frac{M6}{2}$ and metal with +1 oxidation state

and answer on line

M1 n MnO_4^- = $28.55 \times 10^{-3} \times 0.0200 = 5.710 \times 10^{-4}$ mol

M2 n $C_2O_4^{2-}$ = $5.71 \times 10^{-4} \times \frac{(5)}{(2)} = 1.4275 \times 10^{-3}$ mol

M3 n $C_2O_4^{2-}$ in 250 cm^3 = $1.4275 \times 10^{-3} \times 10 = 1.4275 \times 10^{-2}$ mol

M4 n complex = $\frac{(1.4275 \times 10^{-2})}{(2)} = 7.1375 \times 10^{-3}$ mol

M5 M_r complex = $\frac{(2.52)}{(7.1375 \times 10^{-3})}$ = 353 and answer on line

If answer on line is not correct but final answer is correct lose M5

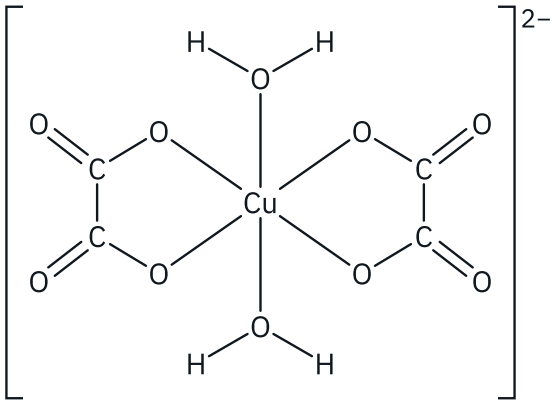
M6 M_r of 2M =353 – 275.5 = 77.5

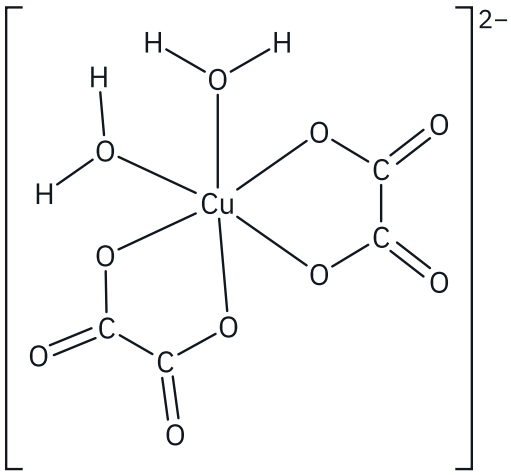
M7 M_r of M = 38.8 so potassium / K on answer line

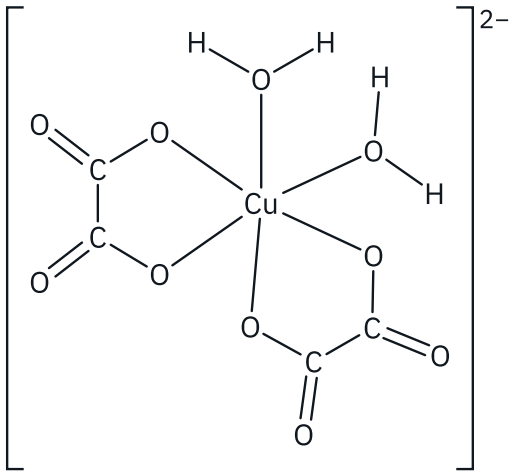
M7 Allow K^+

[7 marks]

03.9







any 2 from these 3 structures

allow one mark for 2 structures with no charge shown

Ligands must be bonded via correct atoms

1 mark for structure

1 mark for 2- charge outside both brackets

[2 marks]

Q4 · June 2025 · Paper 1 · Q7 · [15 marks]

07.1

d (block)

Do not accept 3d

[1 mark]

07.2

layers of atoms can slide over one another

allow layers of (positive) ions can slide over one

another

[1 mark]

07.3

M1 $V_2O_5 + SO_2 \rightarrow V_2O_4 + SO_3$

M2 $V_2O_4 + ½\ O_2 \rightarrow V_2O_5$

allow multiples

allow 1 mark for equations in wrong order

[2 marks]

07.4

M1 identification of V^{3+} as only vanadium product

M2 $VO_2^+ + 4H^+ + Sn \rightarrow V^{3+} + Sn^{2+} + 2H_2O(l)$

Ignore state symbols

[2 marks]

07.5

M1 ions are V^{3+} and SO_4^{2-}

OR

contains oppositely charged ions

M2 strong attraction between them

[2 marks]

07.6

M1 $V_2(SO_4)_3 + 12H_2O \rightarrow 2\ [V(H_2O)_6]^{3+} + 3SO_4^{2-}$

M2 V^{3+} has a high charge and small size

OR V^{3+} has a high charge density

M3 V^{3+} weakens the O–H bond (in water ligands and donates H^+ to water or forms H_3O^+ ions)

Allow as product $[V(H_2O)_6]_2(SO_4)_3$

M3 V^{3+} attracts electrons from the O-H bond (in ligand and releases H^+ or H_3O^+)

OR

V^{3+} polarises the O–H bond/water molecule

[3 marks]

07.7

M1 $Q + H^+ \rightarrow QH^+$

M2 602

Allow $C_{33}H_{34}N_4VO_4 + H^+ \rightarrow C_{33}H_{35}N_4VO_4^+$

Allow $C_{33}H_{34}N_4VO_4 + H^+ \rightarrow C_{33}H_{34}N_4VO_4H^+$

Ignore state symbols

[2 marks]

07.8

M1 $\frac{(51x + 49(100 - x))}{(100)} = 50.97$

M2 $^{51}V = x = 98.5\%$

Alternatives for M1

51x + 49(1-x) = 50.97, giving x = 0.985

Or

$\frac{(49x + 51(100 - x))}{(100)} = 50.97$, giving x = 1.5% for ^{49}V

98.5% scores M1 and M2

[2 marks]

Q5 · June 2025 · Paper 3 · Q17 · [1 mark]

Answer: **C**

Optical only

Q6 · June 2025 · Paper 3 · Q22 · [1 mark]

Answer: **A**

Tollens' reagent contains linear $[Ag(NH_3)_2]^+$ ions.

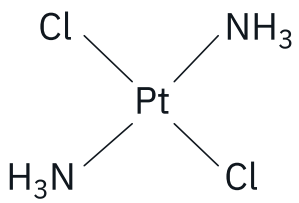
Q7 · June 2025 · Paper 3 · Q23 · [1 mark]

Answer: **A**

The addition of excess aqueous ammonia to a solution containing $[Co(H_2O)_6]^{2+}$ ions.

Q8 · June 2025 · Paper 3 · Q32 · [1 mark]

Answer: **B**



Q9 · June 2023 · Paper 3 · Q27 · [1 mark]

Answer: **C**

decomposition of ozone

Q10 · June 2023 · Paper 3 · Q24 · [1 mark]

Answer: **C**

$FeSO_4$

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