

AQA A-Level Chemistry

Transition metals

Questions only

The newest questions, about an hour. All 36 are in the exam generator.

Questions

10

Total marks

46

Time allowed

1 h

Name

Class or teacher

Date

Instructions

- Answer all questions in the spaces provided.
- Use black ink. Show your working for every calculation.
- You may use a scientific calculator and the AQA Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2022 A-level P3 Q19	1	
2	2023 A-level P3 Q23	1	
3	2024 A-level P3 Q21	1	
4	2025 A-level P1 Q3	23	
5	2025 A-level P1 Q7	15	
6	2025 A-level P3 Q17	1	
7	2025 A-level P3 Q23	1	
8	2025 A-level P3 Q32	1	
9	2023 A-level P3 Q27	1	
10	2023 A-level P3 Q24	1	

Total _____ / 46 Percentage _____ %

Questions from AQA past papers, 2022–2025, reproduced for revision. Practise these topics online, with instant marking:
whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions?topics=transition-metals&len=0

Questions

Transition metals · 10 questions · 46 marks · time allowed 1 h

Q1 · June 2022 · Paper 3 · Q19 · [1 mark]

Which pair of reagents reacts to form a tetrahedral complex?

Tick (✓) one box.

- ☐ **A** $\text{CoCl}_2(\text{aq})$ and concentrated $\text{NH}_3(\text{aq})$
- ☐ **B** $\text{CuSO}_4(\text{aq})$ and concentrated $\text{NH}_3(\text{aq})$
- ☐ **C** $\text{CuSO}_4(\text{aq})$ and sodium ethanedioate(aq)
- ☐ **D** $\text{FeCl}_3(\text{aq})$ and concentrated $\text{HCl}(\text{aq})$
-

Q2 · June 2023 · Paper 3 · Q23 · [1 mark]

Which statement about the shapes of ions is not correct?

Tick (✓) one box.

- ☐ **A** $[\text{CoCl}_4]^{2-}$ is square planar.
- ☐ **B** NH_4^+ is tetrahedral.
- ☐ **C** $[\text{Co}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_3]^{2+}$ is octahedral.
- ☐ **D** $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ is octahedral.
-

Q3 · June 2024 · Paper 3 · Q21 · [1 mark]

Which statement about chloride ions is correct?

Tick (✓) one box.

- ☐ **A** They are oxidised by concentrated sulfuric acid.
- ☐ **B** They form a cream precipitate with silver nitrate solution.
- ☐ **C** They form a cobalt(II) complex with a tetrahedral shape.
- ☐ **D** They have the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^4$

Q4 · June 2025 · Paper 1 · Q3 · [23 marks]

This question also needs Amount of substance.

This question is about the chemistry of copper.

03.1 Deduce the number of unpaired electrons in a Cu^{2+} ion.

[1 mark]

03.2 Describe how water acts as a ligand in the formation of $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$

[1 mark]

03.3 A solution of sodium carbonate is added to a blue solution containing

$[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ ions.

State what is observed.

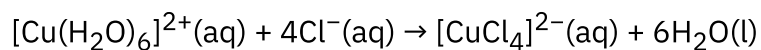
Give an equation for the reaction.

[2 marks]

Observation

Equation

03.4 When a solution containing $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ ions reacts with an excess of concentrated hydrochloric acid, a ligand exchange reaction occurs.



Blue Yellow

The shape and the colour of the $[\text{CuCl}_4]^{2-}$ ion are different from the shape and the colour of the $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ ion.

Explain

- the shape of each complex ion and why these shapes are different
- how colour arises in complex ions
- why the $[\text{CuCl}_4]^{2-}$ ion has a yellow colour, different from the blue colour of the

$[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ ion.

[6 marks]

03.5 An excess of water, followed by an excess of concentrated aqueous ammonia, is added to a solution containing $[\text{CuCl}_4]^{2-}$ ions.

State what is observed.

Give an equation for the overall change that occurs.

[2 marks]

Observation

Equation

A solution contains $\text{M}_2[\text{Cu}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]$ where M is a metal.

A student does a titration to determine the identity of M.

- 2.52 g of solid $\text{M}_2[\text{Cu}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]$ are dissolved in dilute sulfuric acid.
- This solution is transferred to a volumetric flask and made up to 250 cm^3 with dilute sulfuric acid.
- A 25.0 cm^3 portion is pipetted into a conical flask.
- The mixture in the conical flask is heated to 60°C and then titrated with

$0.0200 \text{ mol dm}^{-3}$ KMnO_4 solution.

- Several titrations are done and the student's results are shown in Table 3.

In this titration, only the $\text{C}_2\text{O}_4^{2-}$ ions react with the MnO_4^- ions.

2 mol of MnO_4^- ions react with 5 mol of $\text{C}_2\text{O}_4^{2-}$ ions.

Table 3

	Rough	1	2	3
Final reading / cm ³	29.5	28.60	30.35	34.05
Initial reading / cm ³	0.0	0.00	1.55	5.55
Titre / cm ³	29.5	28.60	28.80	28.50

03.6 Give an equation for the reaction between C₂O₄²⁻ ions and

MnO₄⁻ ions in acidic solution.

[1 mark]

03.7 Calculate the mean titre from the student's results.

cm³

[1 mark]

03.8 Calculate the M_r of $M_2[Cu(C_2O_4)_2(H_2O)_2]$

Identify M.

[7 marks]

M_r of $M_2[Cu(C_2O_4)_2(H_2O)_2]$

Identity of M

03.9 Draw the structure of two stereoisomers of the complex ion in $M_2[Cu(C_2O_4)_2(H_2O)_2]$

and include the charge on each structure.

Structure 1 Structure 2

[2 marks]

Q5 • June 2025 • Paper 1 • Q7 • [15 marks]

This question also needs Reactions of aqueous ions, Atomic structure and Electrode potentials.

This question is about vanadium and some of its compounds.

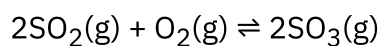
07.1 State the block in the Periodic Table that contains vanadium.

[1 mark]

07.2 Suggest why vanadium can be pulled into thin wires.

[1 mark]

07.3 Vanadium(V) oxide is a catalyst in the Contact process.



Give two equations to show how vanadium(V) oxide acts as a catalyst in this process.

[2 marks]

Equation 1

Equation 2

07.4 Table 6 shows some electrode half-equations and their standard electrode potentials.

Table 6

Electrode half-equation	$E^\ominus / \text{V}$
$\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00
$\text{VO}^{2+}(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$	-0.14
$\text{V}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{V}^{2+}(\text{aq})$	-0.26

Sn reduces VO_2^+ in acidic solution.

Use the data in Table 6 to deduce an overall equation for the reaction that occurs.

Vanadium(III) sulfate is a pale yellow solid at room temperature.

[2 marks]

07.5 Explain why vanadium(III) sulfate has a high melting point.

[2 marks]

07.6 When vanadium(III) sulfate dissolves in water, the vanadium-containing species formed is acidic.

Give an equation to show how vanadium(III) sulfate dissolves in water to form the acidic vanadium-containing species.

Explain why the vanadium-containing species is acidic.

[3 marks]

Equation

Explanation

07.7 Compound Q is found in crude oil and has the molecular formula $\text{C}_{33}\text{H}_{34}\text{N}_4\text{VO}_4$

A sample of Q is ionised by electrospray ionisation in a time of flight (TOF) mass spectrometer. The spectrum produced shows that the vanadium in Q is ^{51}V

Give an equation to show how Q is ionised using electrospray ionisation.

Determine the m/z value of the molecular ion formed in this ionisation process.

[2 marks]

Equation

m/z

07.8 A sample of vanadium contains only ^{49}V and ^{51}V

The relative atomic mass of vanadium in this sample is 50.97

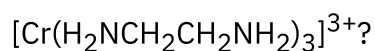
Calculate the percentage abundance of ^{51}V in this sample.

Percentage abundance of ^{51}V

[2 marks]

Q6 • June 2025 • Paper 3 • Q17 • [1 mark]

Which type(s) of stereoisomerism is/are shown by the complex ion



Tick (✓) one box.

- ☐ **A** none
- ☐ **B** cis-trans only
- ☐ **C** optical only
- ☐ **D** cis-trans and optical

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

Which reaction produces an octahedral complex ion?

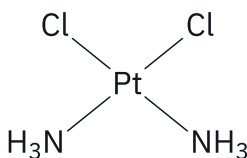
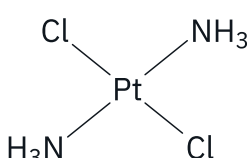
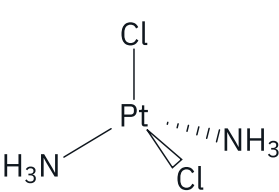
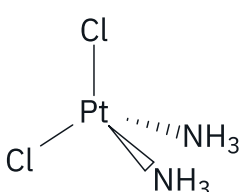
Tick (✓) one box.

- ☐ **A** The addition of excess aqueous ammonia to a solution containing $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ ions.
- ☐ **B** The addition of excess aqueous sodium carbonate to a solution containing $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ ions.
- ☐ **C** The addition of excess concentrated hydrochloric acid to a solution containing $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ ions.
- ☐ **D** The addition of excess aqueous sodium carbonate to a solution containing $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ ions.

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

Which structure is correct for transplatin?

Tick (✓) one box.

- ☐ **A**
- 
- ☐ **B**
- 
- ☐ **C**
- 
- ☐ **D**
- 

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

This question also needs Halogenoalkanes.

Which process does not involve a heterogeneous catalyst?

Tick (✓) one box.

- ☐ **A** catalytic cracking of alkanes
- ☐ **B** Contact process
- ☐ **C** decomposition of ozone
- ☐ **D** Haber process

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

Which compound can decolourise acidified potassium manganate(VII) solution?

Tick (✓) one box.

- ☐ **A** AgNO_3
- ☐ **B** CuSO_4
- ☐ **C** FeSO_4
- ☐ **D** $\text{Fe}_2(\text{SO}_4)_3$

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Mark scheme:

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