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2002

XVIII

1583

Time allowed
77 Minutes

Score

/64

Percentage

%

CHEMISTRY

**Edexcel
AS & A LEVEL**

Mark Scheme

**Paper 1: Advanced Inorganic
and Physical Chemistry**

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Question Number	Acceptable Answers	Reject	Mark
1(a)	<p>First mark Electronic configurations: Cu^{2+} is $[\text{Ar}] 3d^9$ and Zn^{2+} is $[\text{Ar}] 3d^{10}$</p> <p>IGNORE $4s^0$ / full electronic configuration of Ar (1)</p> <p>Second mark If both EC are correct:</p> <p>EITHER Copper (is a transition element because it) forms a (stable) ion with an incompletely / partially filled d-subshell / orbital(s) ALLOW forms an ion with unpaired d electron(s)</p> <p>OR Zinc only forms an ion with a full d-subshell / all d orbitals full (1)</p> <p>If one or both EC are incorrect:</p> <p>Copper (is a transition element because it) forms a (stable) ion with an incompletely filled d-subshell / orbital(s) and zinc only forms an ion with a full d-subshell / all d orbitals full (1)</p>	d shell sub-shell / orbital other than 3d	(2)

Question Number	Acceptable Answers	Reject	Mark
1(b)	$\text{CuCl} + \text{AgCl} \rightleftharpoons \text{CuCl}_2 + \text{Ag}$ OR $\text{Cu}^+ + \text{Ag}^+ \rightleftharpoons \text{Cu}^{2+} + \text{Ag}$ OR $\text{CuCl} + \text{Ag}^+ \rightleftharpoons \text{Cu}^{2+} + \text{Ag} + \text{Cl}^-$ ALLOW → (1) IGNORE state symbols / half-equations Stand alone mark (Equilibrium moves to the right in sunlight) producing silver (1) IGNORE copper(II) compounds	 Copper (metal)/ copper(I) compounds	(2)



Question Number	Acceptable Answers	Reject	Mark
2(i)	Ni: $(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^8 4s^2$ (1) Cu: $(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^{10} 4s^1$ (1) ALLOW capital letters, subscripts for superscripts ALLOW 4s before 3d Penalise omission of $3s^2 3p^6$ once only if rest is correct		2

Question Number	Acceptable Answers	Reject	Mark
2*(ii)	First electron removed is from 4s (in both atoms) (1) Second electron in Cu (is harder to remove so it is) EITHER closer to nucleus/in inner shell OR less shielded (1) IGNORE Comments about second electron being in full shell/ in a 3d shell/in a 3d orbital Reference to $3d^{10}$ stability		2

Question Number	Acceptable Answers	Reject	Mark
2a(iii)	(attraction on (3d) electrons increases due to) number of protons increasing / nuclear charge increasing IGNORE The charge density of the 2^+ ions increases Effective nuclear charge		1



Question Number	Acceptable Answers	Reject	Mark
2b(i)	$2\text{Cu}^+(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Cu}^{2+}(\text{aq})$ IGNORE Eqm sign for \rightarrow	Reverse equation Any equation involving electrons	1

Question Number	Acceptable Answers	Reject	Mark
2b(ii)	Both white ALLOW (both) Colourless (1) COMMENT Ignore states eg solution/precipitate As have $3d^{10}$ / have a full 3d sub-shell /ALL 3d orbitals are full (1) IGNORE Does not have partially filled d orbitals They do not absorb light No d-d transitions occur		2

Question Number	Acceptable Answers	Reject	Mark
2c	(Zinc) does not form a (stable) ion with incompletely/partially filled d orbitals ALLOW d sub-shell for d orbitals The only (stable) ion formed by zinc has full d sub-shell It does not form a (stable) oxidation state with incompletely/partially filled d orbitals	Element has full d shells.	1

Question Number	Acceptable Answers	Reject	Mark
3 (a)	(A transition metal) forms ions / oxidation states with partially filled / incomplete d orbital(s) / d sub-shell		1

Question Number	Acceptable Answers	Reject	Mark
3 (b) (i)	<p>W = chromate(VI) (ion) / CrO_4^{2-} (1)</p> <p>X = chromium(III) hydroxide / $\text{Cr}(\text{OH})_3$ / $\text{Cr}(\text{OH})_3(\text{H}_2\text{O})_3$ (1)</p> <p>Y = hexahydroxochromate(III) (ions) / $[\text{Cr}(\text{OH})_6]^{3-}$ / tetrahydroxochromate(III) (ions) / $[\text{Cr}(\text{OH})_4]^-$ / $[\text{Cr}(\text{H}_2\text{O})_2(\text{OH})_4]^-$ (1)</p> <p>Z = chromium(II) (ions) / chromium(II) sulfate / Cr^{2+} / $\text{Cr}^{2+}(\text{aq})$ / $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ (1)</p> <p>ALLOW Name or formula of the compounds</p> <p>IGNORE Omission of square brackets around complexes</p>	Names without oxidation numbers.	4

Question Number	Acceptable Answers	Reject	Mark
3 (b) (ii)	<p>A = ethanol / $\text{C}_2\text{H}_5\text{OH}$ / ethanal / CH_3CHO OR any primary or secondary alcohol or any aldehyde (1)</p> <p>B = zinc / Zn ALLOW magnesium / Mg (1)</p> <p>C = any acid (name or formula) (1)</p> <p>IGNORE Omission of (aq) with acid formula Concentration of acid</p>	<p>CH_3COH</p> <p>Alkali metals Tin / Sn</p> <p>H^+ or H_3O^+ or acid</p>	3

Question Number	Acceptable Answers	Reject	Mark
3 (b) (iii)	<p>$\text{Cr}_2\text{O}_7^{2-} + 2\text{OH}^- \rightarrow 2\text{CrO}_4^{2-} + \text{H}_2\text{O}$ OR Multiples</p> <p>Ignore state symbols even if incorrect</p>		1



Question Number	Acceptable Answers	Reject	Mark
3 (b) (iv)	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \rightarrow \text{Cr}_2\text{O}_3 + \text{N}_2 + 4\text{H}_2\text{O}$ Allow multiples (1) Chromium is reduced from (+)6 to (+)3 (1) Nitrogen is oxidized from -3 to 0 (1) Penalise use of 'changes' / 'increases' / 'decreases' for 'oxidises' or 'reduces' once only		3

Question Number	Acceptable Answers	Reject	Mark
3 (b) (v)	(chromium(II) ions) oxidized by (oxygen in the) air ALLOW Just 'oxygen'		1

Question Number	Acceptable Answers	Reject	Mark
3 (c) (i)	(A ligand is a) molecule or (negative) ion with a (lone) pair (of electrons) ALLOW Species / Compound / group (1) Which forms a dative covalent bond with a (central) metal ion or atom (to form a complex) (1) ALLOW (if no other marked scored) Electron pair donor	Positive ion	2

Question Number	Acceptable Answers	Reject	Mark
3 (c) (ii)	$\text{Cr}(\text{H}_2\text{O})_6^{3+} + 6\text{NH}_3 \rightarrow \text{Cr}(\text{NH}_3)_6^{3+} + 6\text{H}_2\text{O}$ ALLOW $\text{Cr}(\text{H}_2\text{O})_6^{3+} + 4\text{NH}_3 \rightarrow \text{Cr}(\text{NH}_3)_4(\text{H}_2\text{O})_2^{3+} + 4\text{H}_2\text{O}$ Correct formula for ammine (1) Rest of the equation correct (1)	Cr^{3+} and $\text{Cr}^{3+}(\text{aq})$	2



Question Number	Acceptable Answers	Reject	Mark
4 (a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 (4s^0)$ (1) Accept $[\text{Ar}]3d^5(4s^0)$ (Ion) has an incompletely filled (3)d-orbital / sub-shell / unpaired d electron (1)		2

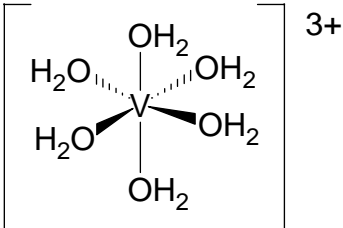
Question Number	Acceptable Answers	Reject	Mark
*4 (b)	Gases adsorb onto / bind to catalyst (surface) (1) Allow gases are absorbed onto surface Then react and desorb / leave (1) Reaction could be faster because Any two <ul style="list-style-type: none">• These processes lower the activation energy (by providing an alternative route so a greater proportion of molecules react)• Bonds in reactant(s) are weakened• Reactants may be positioned in more favourable orientations• Reactants can migrate towards each other on surface• Increases likelihood of molecules coming into contact / colliding• Adsorption onto surface means more reactant molecules in a given space	Just 'bonds in reactants are broken'	4



Question Number	Acceptable Answers	Reject	Mark
4 (c)	<p>E_{cell} for reaction is (+) 0.84 (V) (so will work) / E_{cell} for item 44 is more positive than for item 19 / illustrate using anti-clockwise rule (1)</p> <p>$2\text{Fe} + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Fe}^{2+} + 4\text{OH}^-$ or $2\text{Fe} + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Fe}(\text{OH})_2$ (1)</p> <p>E_{cell} for reaction is (+)0.96 (V) (so will work) / E_{cell} for item 44 is more positive than for item 17 / illustrate using anti-clockwise rule (1)</p> <p>$4\text{Fe}(\text{OH})_2 + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{Fe}(\text{OH})_3$ (1)</p>	Just 'because of the anti-clockwise rule'	4

Question Number	Acceptable Answers	Reject	Mark
4 (d)	<p>Lone pair(s) (from nitrogen(s)) (1)</p> <p>Forms dative / dative covalent / coordinate bond (with Fe^{2+}) (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
5(a)(i)	<p>Any TWO of:</p> <p>complex ions / complexes (1)</p> <p>coloured ions / compounds / solutions (1)</p> <p>catalytic properties (1)</p> <p>paramagnetic (1)</p> <p>Allow</p> <p>coloured complexes (2)</p> <p>coloured complex compound (1)</p> <p>If a list appears with 1 or 2 correct properties followed by properties related to the element, then (1) mark only</p> <p>Ignore 'partially filled <i>d</i>-orbitals'</p>	complex compounds	2

Question Number	Acceptable Answers	Reject	Mark
5(a)(ii)	 <p>ignore absence of charge</p> <p>clearly octahedral (ignore bonds to the H in H₂O) (1) but allow some latitude in the symbols used to show the 3D structure.</p> <p>Wedges do not have to be exact - if used they are enough to show 3D if the axial bonds are lines</p> <p>The word 'octahedral' does not salvage a poor drawing</p> <p>dative (covalent) / coordinate (bond) (1) not just shown by an arrow</p> <p>lone pair (of electrons on the oxygen) (1) can be shown on the diagram</p>		3

Question Number	Acceptable Answers	Reject	Mark
5(b)(i)	(+) 0.34 (V) OR (+) 0,34 V sign not needed		1

Question Number	Acceptable Answers	Reject	Mark
5(b)(ii) QWC	(simultaneous) oxidation and reduction (1) Allow redox of a species / substance / reactant / compound / chemical / element (1)		2

Question Number	Acceptable Answers	Reject	Mark
5(b)(iii)	– 0.66(V) (1) Allow TE from (b)(i) reaction not feasible since the potential is negative (2 nd mark is for an answer consistent with sign of E^\ominus) (1)		2