2815/01 Trends and Patterns

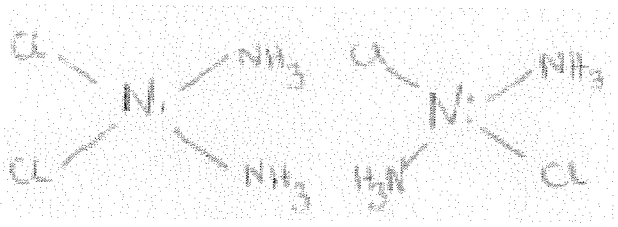
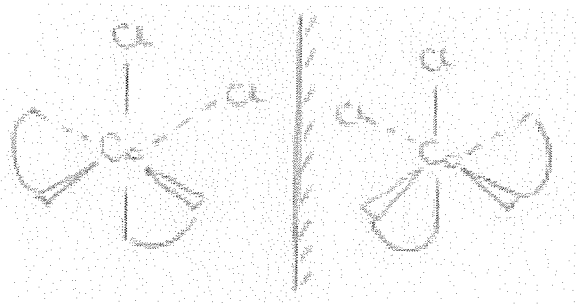
Qu.	Expected Answers	Marks	Additional Guidance
1 (a)	(Enthalpy change of/energy change of) atomisation (1) $Ba(g) \rightarrow Ba^{+}(g) + e^{-}$ (1) Second electron affinity (1) $Ba(s) + \frac{1}{2}O_2(g) \rightarrow BaO(s)$ (1)	4	Ss must be correct throughout No multiples
(b)	Impossible/difficult to get gaseous ions (without them reacting)/difficult to vapourise ions and measure the enthalpy change at the same time/AW (1)	1	
(c)	Oxide ion is smaller than carbonate ion/oxide ion has a higher charge/electron density/ora (1) (So) stronger attraction between ions in barium oxide/ora (1)	2	**Must** use correct particle but only penalise once
(d)	**Rb^{+}, Na^{+}, Mg^{2+}, Al^{3+} (1)** and Any two from Idea that polarising power depends on ionic radius and ionic charge/idea that polarising power depends on charge density of ion (1) Rb^{+} is larger than Na^{+}/Na^{+} is larger than Mg^{2+}/Mg^{2+} is larger than Al^{3+}/Al^{3+} smallest radius/Rb^{+} largest radius ora (1) Rb^{+} is less charged than Mg^{2+}/Na^{+} is less charged than Mg^{2+}/Mg^{2+} is less charged than Al^{3+}/Al^{3+} highest charge ora (1)	3	
		10	

Qu.	Expected Answers	Marks	Additional Guidance
3 (a)	moles of MnO_4^- = 0.000571 (1) moles of H_2O_2 = 0.00143 (1) concentration (of diluted H_2O_2 is 0.143 and of) undiluted is 1.43 mol dm^{-3} (1) Concentration = 48.5 g dm^{-3} (1) (accept range 48.45–48.63 g dm^{-3})	4	**Allow** ecf within the question **Allow** 2 or more sig figs for first three marking points **Allow** 3 or 4 for the last marking point
(b)	$Fe^{2+} \rightarrow Fe^{3+} + e^-$ / Unbalanced full equation with all correct species (1) but $H_2O_2 + 2H^+ + 2Fe^{2+} \rightarrow 2H_2O + 2Fe^{3+}$ (2)	2	**Allow** full marks for the correct ionic equation between H_2O_2 and Fe^{2+} **Allow** correct multiples of equation **Ignore** state symbols
(c)	There is no longer a green precipitate/green solid (1) $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ (1) **or** There is now a red-brown precipitate/orangey brown/brown/rusty solid (1) $Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$ (1)	2	**Allow** precipitate mark if state symbol given in equation **Ignore** state symbols
(d) (i)	-1/1-/- (1)	1	**Allow** O_2^-
(ii)	Oxygen from -1 to -2/0 to -2 which is reduction (1) Oxygen from -1 to 0/-2 to 0 which is oxidation (1)	2	**Allow** 1 mark for either 2 correct ON changes (1 ox and 1 red) OR correct reference to oxidation and reduction from their ON changes
(iii)	Moles of KO_2 = 14.1 (1) Moles of CO_2 = 7.05 (1) Volume of CO_2 = 168.8 dm^3 (1) Allow range 168 to 169.2	3	**Allow** ecf within question **Allow** 2 or more sig figs for first two marking points **Allow** 3 or 4 sig figs for answer
		14	

Qu.	Expected Answers	Mark
2. (a) (i)	Orange to yellow.	1
(ii)	(Named) acid/H^+	1
(iii)	**All** oxidation numbers worked out for both sides of equation.	1
	ie Cr=+6, O=-2, H=+1	
(b)	Moles $Cr_2O_7^{2-}$ used = 0.000348 mol	1
	Moles Fe^{2+} = 6 x 0.000348 = 0.002088 mol	1
	250 cm^3 Fe^{2+} = 10 x 0.00209 = 0.02088 mol	1
	Mass Fe = 0.02088 x 55.8 = 1.165104 g	1
	% Fe in sample = 1.165104/1.20 x 100 = 97.1% (3 sf)	1
	Allow consequential marking throughout	
	If candidates use 3 sf from the start then answer is 97.5 %	
	Allow range from 97.0 – 97.5%	
		Total: [8]

Qu.	Expected Answers	Mark
3. (a) (i)	Emf/voltage/potential difference (of a half cell) (not potential)	1
	Combined with a standard hydrogen half cell	1
(ii)	298K/25°C, 10^5 Pa/1 Atm, 1 mol dm^{-3} (all 3 needed)	1
(b)	Voltmeter, salt bridge and complete circuit (salt bridge must be in contact with a solution)	1
	Platinum electrode in the $\frac{1}{2}Cl_2/Cl^-$ half cell (labelled)	1
	Chlorine gas feed and chloride ions in solution	1
(c) (i)	$BrO_3^- + 6H^+ + 5Br^- \rightleftharpoons 3Br_2 + 3H_2O$	
	correct species	1
	balanced	1
(ii)	Yellow/orange/brown (solution) (not ppt or solid or gas)	1
(d)	$Cr_2O_7^{2-}$ has a more positive electrode potential than Br_2 but less positive than Cl_2 /Cl_2 is a better oxidising agent than $Cr_2O_7^{2-}$ but Br_2 is poorer	1
	Credit the working out of cell emf – positive (+0.26) for bromide, negative	
	(-0.03) for chloride	
	(accept lower/higher argument)	
		Total: [10]

Qu.	Expected Answers	Mark
4. (a) (i)	$1s^2 2s^2 2p^6 3s^2 3p^6$	1
(ii)	White	1
	No d-electrons (to absorb visible light) (not does not have a partially filled d-sub shell)	1
(b) (i)	Dative covalent/co-ordinate	1
(ii)	partially filled d-orbitals (accept a suitable diagram)	1
	(Ligands cause) splitting of d-orbital energy levels/lower & higher energy d-orbitals/implication of a gap/d-electrons promoted	1
	Particular frequency of visible light is absorbed to promote electrons	1
	(need to have idea that only part of visible light is absorbed)	
(c)	Little or no absorbance in violet and blue region (between 400 and 500 nm) rising to maximum absorbance in yellow/orange/red (allow maximum between 600 and 700 nm)	1
		Total: [8]

Qu.	Expected Answers	Mark
5.	Same structural formula/same atoms & order of bonds but a different arrangement in space (not same molecular formula)	1
	Cis and *trans/geometric* and optical both mentioned	1
	Correct 3-D diagrams of *cis* and *trans* isomers	2
	e.g 	
	Cis has same ligands adjacent/at 90^0. *Trans* opposite/at 180^0 (allow this mark from clearly labelled diagrams)	1
	Correct 3-D diagrams of optical isomers.	2
	e.g 	
	Non-superimposable mirror images	1
	Cis-platin used to treat cancer	1
	Binds to DNA	1
	Prevents replication of cancerous cells/cells dividing	1
	Quality of Written Communication.	
	1 mark to be awarded for a minimum of two grammatically correct sentences with good spelling and punctuation.	1
		Total: [12]

Qu.	Expected Answers	Mark
2(a)(i)	OH^-: When $[OH^-]$ increases by 2.5, rate increases by 2.5 ✓, so order = 1 (with respect to OH^-) ✓ ClO_2: When $[ClO_2]$ increases by 3, rate increases by $9/3^2$ ✓, so order = 2 (with respect to ClO_2) ✓ *For both OH^- and ClO_2, explanation and order to be marked independently*	4
2(a)(ii)	rate = $k[OH^-]\,[ClO_2]^2$ ✓ **ALLOW** $r = k[OH^-]\,[ClO_2]^2$ **ALLOW ECF** from **(a)(i)** *rate* = **is essential**	1
2(a)(iii)	$k = \dfrac{rate}{[OH^-]\,[ClO_2]^2}$ **OR** $\dfrac{6.00 \times 10^{-4}}{0.0300 \times 0.0100^2}$ ✓ = 200 ✓ *200 without working scores the first 2 marks* ***ALLOW ECF** from an incorrectly rearranged equation* units: $dm^6\ mol^{-2}\ s^{-1}$ ✓ **ALLOW ECF** from rate equation **(a)(ii) but** the units **must** be derived from the rate equation	3
2(b)(i)	rate equation shows (2 ClO_2 and) 1 OH^- and overall equation shows (2 ClO_2 and) 2 OH^- **OR** Rate equation has a different number of moles of OH^- from overall equation ✓	1
2(b)(ii)	$2ClO_2(aq) + 2OH^-(aq) \longrightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O$ 1 mark for ClO_3^- ✓ 1 mark for total equation (conditional on 1st mark) ✓	2
	Total:	**11**

Qu.	Expected Answers	Mark
3(a)	C_6H_5COOH ⇌ $H^+ + C_6H_5COO^-$ ✓ Accept $C_6H_5COOH + H_2O$ ⇌ $H_3O^+ + C_6H_5COO^-$ ✓ Accept molecular formulae, *ie* C_6H_5COOH ⇌ $H^+ + C_6H_5COO^-$ Equilibrium sign **essential**	1
3(b)	$K_a = \frac{[H^+][C_6H_5COO^-]}{[C_6H_5COOH]}$ ✓	1
3(c)	concentration = $\frac{3.40}{122}$ ✓ = 0.0279 (mol dm^{-3}) ✓ Accept 0.028 up to calculator value of 0.027868852(46) *(first mark for M_r of benzoic acid – incorrect answer here will give ecf for remainder of question)* $[H^+] = \sqrt{(K_a \times [C_6H_5COOH])}$ **OR** $\sqrt{(6.30 \times 10^{-5} \times 0.0279)}$ ✓ = 1.33 x 10^{-3} (mol dm^{-3}) ✓ pH = –log $[H^+]$ = –log 1.33 x 10^{-3} = 2.89 ✓ answer = 2.88 if no rounding. **DO NOT ALLOW** 2.9 unless more d.p. shown elsewhere pH **must** be greater than 1 and less than 7 If no square root, pH = 5.76 4 marks If g dm^{-3} used instead on mol dm^{-3}, pH = 1.83–1.84 3 marks *Watch out for evidence of correct M_r as there may be another mark*	5
3(d)	buffer minimises pH changes ✓ **DO NOT ALLOW** pH is constant HA discussion is OK here C_6H_5COOH reacts with added alkali / $C_6H_5COOH + OH^- \rightarrow H_2O + C_6H_5COO^-$ / added alkali reacts with H^+/$H^+ + OH^- \rightarrow H_2O$ ✓ $\rightarrow C_6H_5COO^-$/C_6H_5COOH ⇌ $H^+ + C_6H_5COO^- \rightarrow$ right (counteracts change)✓ $C_6H_5COO^-$ reacts with added acid or H^+ ✓ $\rightarrow C_6H_5COOH$/ C_6H_5COOH ⇌ $H^+ + C_6H_5COO^- \rightarrow$ left (counteracts change) ✓ $[H^+] = K_a \times \frac{[C_6H_5COOH]}{[C_6H_5COO^-]}$ ✓ = $6.30 \times 10^{-5} \times \frac{0.105}{0.125}$ **OR** 5.292 x 10^{-5} ✓ pH = –log (5.292 x 10^{-5}) = 4.28 ✓ (calculator: 4.276380164) **ALLOW** 4.3 **OR** ALTERNATIVE APPROACH USING H.H. EQUATION: pK_a = –log 6.30 x 10^{-5} = 4.20 ✓	1 **EXPL 4** **CALC 3**

	$pH = pK_a + \log \frac{[C_6H_5COO^-]}{[C_6H_5COOH]}$ **OR** $pH = -\log K_a + \log \frac{[C_6H_5COO^-]}{[C_6H_5COOH]}$ ✓ pH = 4.20 + 0.08 = 4.28 ✓ QWC: correct equilibrium shift discussed at least once ✓	1
	Total:	**16**

Qu.	Expected Answers	Mark
4(a)(i)	0.1 mol dm^{-3} ✓	1
4(a)(ii)	final pH (approximately) 11/equivalence point <7 ✓ **ALLOW** correct reference to shape of curve: ie No vertical part after 7/starts to curve at 7	1
4(a)(iii)	NH_4NO_3 ✓ **ALLOW** $N_2H_4O_3$	1
4(a)(iv)	resazurin ✓	1
4(a)(v)	sharp rise after addition of 12.5 cm^3/half the volume of NH_3 ✓ final pH higher ✓ For 'sharp rise', **ALLOW** neutralisation/equivalence/end point	2
4(b)(i)	$Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$ ✓ $Mg + 2H^+ \longrightarrow Mg^{2+} + H_2$ ✓ **IGNORE** state symbols **DO NOT ALLOW** $2NO_3^-$ added to both sides of ionic equation	2
4(b)(ii)	With dilute HNO_3: **H** (reduced) from +1 to 0 ✓ With conc. HNO_3: **N** (reduced) from +5 to +4 ✓	2
	Total:	**10**