

Chemistry A

Advanced GCE

Unit **F325**: Equilibria, Energetics and Elements

Mark Scheme for January 2011

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2011

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

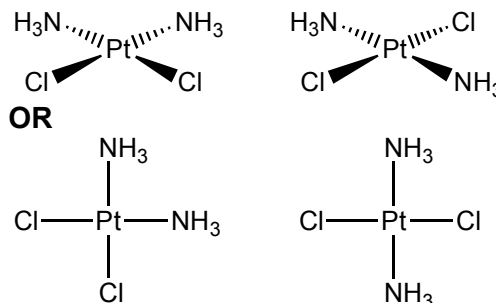
Question	Answer	Mark	Guidance
1 (a)	<p>FIRST, CHECK THE ANSWER ON ANSWER LINE IF answer = 8.3×10^4 OR 83333 award 2 marks THEN IF units are $\text{dm}^6 \text{mol}^{-2} \text{s}^{-1}$, award 1 further mark</p> $k = \frac{\text{rate}}{[\text{H}_2(\text{g})][\text{NO}(\text{g})]^2} \quad \text{OR} \quad \frac{3.6 \times 10^{-2}}{(1.2 \times 10^{-2}) \times (6.0 \times 10^{-3})^2}$ <p>✓</p> <p>= 8.3×10^4 OR 83000 OR 83333 ✓</p> <p>units: $\text{dm}^6 \text{mol}^{-2} \text{s}^{-1}$ ✓</p>	2 1	<p>ALLOW 1 mark for 8.3×10^x with no working (power of 10 is error)</p> <p>ALLOW 2 SF up to calculator value of 8.33333333×10^4 correctly rounded</p> <p>ALLOW ECF for calculated answer from incorrectly rearranged <i>k</i> expression but not for units (Marked independently see below)</p> <p>ALLOW dm^6, mol^{-2} and s^{-1} in any order, eg $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$ DO NOT ALLOW other units (Rate equation supplied on paper – not derived from data)</p>
(b) (i)	effect on rate × 2 ✓	1	ALLOW ‘doubles’ OR rate = $7.2 \times 10^{-2} (\text{mol dm}^{-3} \text{s}^{-1})$
(ii)	effect on rate × $\frac{1}{4}$ OR × 0.25 ✓	1	<p>ALLOW ‘a quarter’ OR decrease by $\frac{1}{4}$ OR decrease by 0.25 OR rate decreases by 4 OR decrease by 75% OR rate = $0.9 \times 10^{-2} (\text{mol dm}^{-3} \text{s}^{-1})$</p> <p>DO NOT ALLOW just 0.5^2 of rate OR rate decreases by 2^2</p>
(iii)	effect on rate × 64 ✓	1	<p>ALLOW rate = 2.3(04) ($\text{mol dm}^{-3} \text{s}^{-1}$) DO NOT ALLOW just ‘increases by 4 and then by 16 / 4^2 OR increases by 4^3</p>

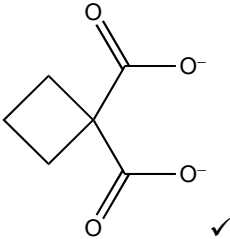
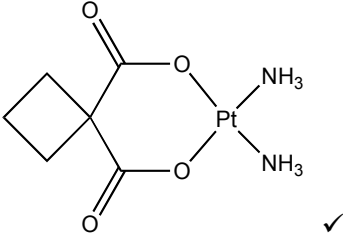
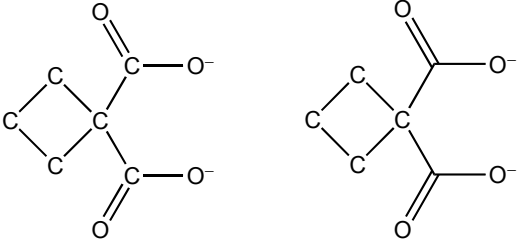
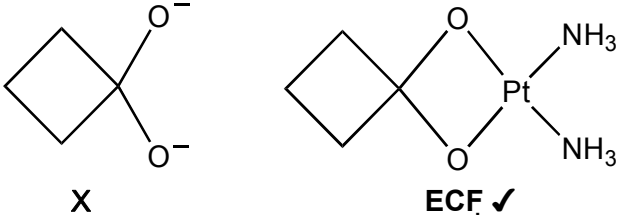
Question			Answer	Mark	Guidance
1	(c)	(i)	(initial) rate increases AND more frequent collisions OR more collisions per second/time ✓	1	BOTH points required for mark ALLOW rate increases AND concentration increases For concentration increases, ALLOW particles closer together OR less space between particles DO NOT ALLOW just more collisions OR collisions more likely
		(ii)	rate constant does not change ✓	1	
	(d)		step 1: $\text{H}_2(\text{g}) + 2 \text{NO}(\text{g}) \longrightarrow \text{N}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{g})$ LHS of step one ✓ step 2: $\text{H}_2(\text{g}) + \text{N}_2\text{O}(\text{g}) \longrightarrow \text{N}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$ rest of equations for step 1 AND step 2 ✓	2	State symbols NOT required For 'rest of equations', This mark can only be awarded if 1st mark can be awarded ALLOW other combinations of two steps that together give the overall equation (shown above part in scoris window), eg step 1: $\longrightarrow \text{N}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$ step 2: $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{g})$ step 1: $\longrightarrow \text{H}_2\text{O}_2(\text{g}) + \text{N}_2(\text{g})$ step 2: $\text{H}_2(\text{g}) + \text{H}_2\text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{l})$ There may be others with species, such as $\text{H}_2\text{N}_2\text{O}_2$ and HNO . Provided the two steps add up to give the overall equation AND charges balance, the 2nd mark can be awarded
			Total	10	

Question	Answer	Mark	Guidance
2 (a)	Fe: $(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^6 4s^2$ ✓ Fe ²⁺ : $(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^6$ ✓	2	ALLOW 4s before 3d, i.e. $(1s^2 2s^2 2p^6) 3s^2 3p^6 4s^2 3d^6$ ALLOW 4s ⁰ ALLOW subscripts IGNORE 1s ² 2s ² 2p ⁶ is written out a second time
(b)	coloured (compound/complex/precipitate/ions) OR catalyst ✓	1	IGNORE 'variable oxidation states' but ALLOW the idea that Fe ²⁺ can react to form an ion with a different charge/oxidation state. 'ion' is essential: 'atom' or 'metal' is not sufficient IGNORE partially filled d sub-shell/d orbital (question refers to property of Fe ²⁺)
(c)	Fe oxidised from +2 to +3 ✓ Cr reduced from +6 to +3 ✓	2	CHECK and credit oxidation numbers on equation ALLOW Fe ²⁺ oxidised to Fe ³⁺ ALLOW Cr ⁶⁺ reduced to Cr ³⁺ ALLOW + sign after number in oxidation number, <i>ie</i> 2+, etc ALLOW 1 mark only if oxidation numbers given with no identification of which species has been oxidised or reduced, <i>ie</i> Fe goes from +2 to +3 AND Cr goes from +6 to +3 Fe reduced from +2 to +3 AND Cr oxidised from +6 to +3 (<i>oxidation and reduction the wrong way around</i>) DO NOT ALLOW just 'Fe is oxidised and Cr reduced' IGNORE other oxidations numbers (even if wrong) IGNORE any references to electrons

Question	Answer	Mark	Guidance
2 (d)	$(K_{\text{stab}} =) \frac{[\text{Fe}(\text{NH}_3)_6]^{2+}}{[\text{Fe}(\text{H}_2\text{O})_6]^{2+} [\text{NH}_3]^6}$ <p>On top, ONLY $[\text{Fe}(\text{NH}_3)_6]^{2+}$ shown AND on bottom, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ AND $[\text{NH}_3]^6$ shown ✓</p> <p>correct use of square brackets and double square brackets in expression ✓</p>	2	<p>IGNORE state symbols ALLOW 1 mark if complete expression with correct use of double brackets is shown but upside down</p> <p>DO NOT ALLOW round brackets for concentrations and complex ions</p> <p>ALLOW for 1 mark $(K_{\text{stab}} =) \frac{[\text{Fe}(\text{NH}_3)_6]^{2+} [\text{H}_2\text{O}]^6}{[\text{Fe}(\text{H}_2\text{O})_6]^{2+} [\text{NH}_3]^6}$</p>
(e)	(i) O_2 /oxygen bonds to Fe^{2+} / $\text{Fe}(\text{II})$ / Fe ✓ When required, O_2 substituted OR O_2 released ✓	2	<p>ANNOTATE WITH TICKS AND CROSSES, etc</p> <p>ALLOW O_2 binds to Fe^{2+} OR O_2 donates electron pair to Fe^{2+} ALLOW O_2 bonds to metal ion/metal DO NOT ALLOW just O_2 bonds to haemoglobin OR O_2 bonds to complex</p> <p>ALLOW bond breaks between O_2 and Fe^{2+} when O_2 required OR O_2 replaces H_2O OR vice versa ALLOW O_2 replaces CO_2 OR vice versa ALLOW O_2 replaces a ligand OR vice versa IGNORE just 'by ligand substitution' (in the question)</p>

Question		Answer	Mark	Guidance
2	(e) (ii)	<p>(For complex) with CO, stability constant is greater (than with complex in O₂) OR with CO, stability constant is high ✓</p> <p>(Coordinate) bond with CO is stronger (than O₂) OR bond with CO is strong ✓</p>	2	<p>ANNOTATE WITH TICKS AND CROSSES, etc</p> <p>Comparison of CO and O₂ is NOT required ALLOW stability constant with/of CO is greater IGNORE (complex with) CO is more stable</p> <p>ALLOW bond with CO is less likely to break OR bond with CO more likely to form OR 'CO cannot be removed' OR idea that attachment of CO is irreversible OR CO is a stronger ligand (than O₂) OR CO has greater affinity for ion/metal/haemoglobin (than O₂)</p> <p>IGNORE CO bonds more easily</p>
	(f) (i)	Pt ²⁺ /Pt is +2/2+, 2 x Cl ⁻ -2 ✓	1	<p>DO NOT ALLOW response in terms of Cl₂ rather than Cl⁻ DO NOT ALLOW 'charges cancel' without the charges involved being stated</p>

Question	Answer	Mark	Guidance
2 (f) (ii)	 <p>✓✓ For each structure</p> <p>Ligand donates an electron pair to metal (ion)/Pt²⁺/Pt OR forms a coordinate bond to the metal (ion)/Pt²⁺/Pt ✓</p>	3	<p>IGNORE any charge, ie Pt²⁺ OR Cl⁻, even if wrong IGNORE any angle, even if wrong ACCEPT bonds to H₃N (does not need to go to 'N')</p> <p>Assume that a solid line is in plane of paper Each structure must contain 2 'out wedges' AND 2 'in wedges' or dotted lines OR 4 solid lines at right angles (all in plane of paper)</p> <p>DO NOT ALLOW any structure that cannot be in one plane DO NOT ALLOW any structure with Cl₂ as a ligand DO NOT apply ECF from one structure to the other</p> <p>ALLOW coordinate bonds shown on diagrams provide that they start from a lone pair</p> <p>ALLOW 'dative covalent bond' or 'dative bond' as alternative for 'coordinate bond'</p> <p>IGNORE <i>cis</i> and <i>trans</i> labels (even if incorrect) IGNORE incorrect connectivity to NH₃, ie ALLOW NH₃—</p>
	(iii) platin binds to DNA (of cancer cells) OR platin stops (cancer) cells dividing/replicating ✓	1	

Question	Answer	Mark	Guidance
2 (g)	<p>1,1-cyclobutanedicarboxylate ion</p>  <p>Correct charge required (could also be 2- outside square brackets)</p> <p>carboplatin (cis isomer shown below)</p> 	2	<p>Must show cyclobutane ring with both COO^- groups bonded to same carbon</p> <p>ALLOW COO^- OR CO_2^- for each carboxylate ion ALLOW structures showing CH_2 or C atoms provided it is clear that C skeleton is shown, Note: H atoms are not required if C atoms shown, <i>ie</i></p>  <p>DO NOT ALLOW circle inside cyclobutane ring</p> <p>Two bonds from Pt to O atoms</p> <p>Any bonds from ligand MUST come from O OR from atom with lone pair</p> <p>IGNORE any charge shown Note: H atoms are not required if C atoms shown, (see ion in 1st structure)</p> <p>ALLOW ECF from 1st structure provided that the attached atoms are capable of forming coordinate bonds (<i>ie</i> they contain a lone pair of electrons) Example if 1st structure is as below, then ALLOW 1 mark ECF</p>  <p>X ECF ✓</p>
	Total	18	

Question			Answer	Mark	Guidance
3	(a)	(i)	$\text{HOCH}_2\text{COOH} + \text{NaOH} \rightarrow \text{HOCH}_2\text{COONa} + \text{H}_2\text{O}$ ✓	1	ALLOW: $\text{HOCH}_2\text{COOH} + \text{OH}^- \rightarrow \text{HOCH}_2\text{COO}^- + \text{H}_2\text{O}$ ALLOW: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ DO NOT ALLOW molecular formulae (cannot see which OH has reacted)
		(ii)	FIRST, CHECK THE ANSWER ON ANSWER LINE IF answer = 0.142 (mol dm⁻³), award 2 marks ----- $\text{amount of HOCH}_2\text{COOH} = 0.125 \times \frac{25.0}{1000}$ $= 0.003125 \text{ (mol) } \checkmark$ $\text{concentration NaOH} = 0.003125 \times \frac{1000}{22.00}$ $= 0.142 \text{ (mol dm}^{-3}\text{) } \checkmark$ -----	2	IF there is an alternative answer, check to see if there is any ECF credit possible using working below ----- ANNOTATE WITH TICKS AND CROSSES, etc ALLOW $3.125 \times 10^{-3} \text{ mol}$ ALLOW ECF: answer above $\times \frac{1000}{22.00}$ ALLOW 2 SF: 0.14 to calculator value: 0.142045454 ----- If candidate has written in (a)(i) : $\text{HOCH}_2\text{COOH} + 2\text{NaOH}$, mark by ECF : $\text{concentration NaOH} = 2 \times 0.003125 \times \frac{1000}{22.00}$ $= 0.284 \text{ (mol dm}^{-3}\text{)}$
		(iii)	Vertical section matches the (pH) range (of the indicator) OR colour change (of the indicator) OR end point (of the indicator) ✓	1	ALLOW stated pH range for vertical section at about 7–10, 6–10, etc ie ALLOW 'pH range must be about 7–10' ALLOW 'pH changes rapidly' for vertical section ALLOW 'equivalence point' for vertical section, ie ALLOW equivalence point matches the (pH) range, etc DO NOT ALLOW just 'end point matches (pH) range' DO NOT ALLOW just 'indicator matches vertical section' Response must link either the pH range or colour change or end point with the vertical section / pH range ~ 7–10

Question		Answer	Mark	Guidance
3	(e)	$2\text{HSCH}_2\text{COO}^- + \text{R-S-S-R}$ $\longrightarrow \text{}^-\text{OOCCH}_2\text{S-SCH}_2\text{COO}^- + 2\text{R-SH} \checkmark$ $2\text{R-SH} + \text{H}_2\text{O}_2 \longrightarrow \text{R-S-S-R} + 2\text{H}_2\text{O} \checkmark$	2	ALLOW $(\text{SCH}_2\text{COO}^-)_2$ ALLOW equation with ammonium salt, ie: $2\text{HSCH}_2\text{COONH}_4 + \dots\dots\dots$ $\longrightarrow \text{H}_4\text{NOOCCH}_2\text{S-SCH}_2\text{COONH}_4 + \dots\dots\dots$
		Total	20	

Question		Answer	Mark	Guidance
4	(a)	(i)		
		Complete circuit with electrodes to voltmeter AND salt bridge between solutions ✓ Sn ⁴⁺ /Sn ²⁺ half cell with Pt electrode AND both solutions labelled as 1 mol dm ⁻³ / 1M H ⁺ /H ₂ half cell with Pt electrode AND H ⁺ solution labelled as 1 mol dm ⁻³ / 1M ✓	3	ANNOTATE WITH TICKS AND CROSSES, etc circuit shown must be complete, <i>ie</i> must be capable of working salt bridge must be labelled and must dip into both solutions ALLOW concentration label of 'equimolar' or similar wording for Sn ⁴⁺ /Sn ²⁺ half cell ALLOW any strong acid IF both half cells are correct with no concentrations, ALLOW 1 out of the 2 marks available for the 2 half cells IGNORE any stated temperature or pressure, even if wrong
		(ii)		
		2Cr + 3Sn ⁴⁺ → 2Cr ³⁺ + 3Sn ²⁺ ✓ Cr + 3Cu ⁺ → Cr ³⁺ + 3Cu ✓ Sn ²⁺ + 2Cu ⁺ → Sn ⁴⁺ + 2Cu ✓ Conditions not standard OR concentrations not 1 mol dm ⁻³ ✓ High activation energy OR slow rate ✓	5	ANNOTATE WITH TICKS AND CROSSES, etc Correct species AND balancing needed for each mark ALLOW equations as shown with equilibrium sign ALLOW multiples but electrons must not be shown IF three equations have correct species but no balancing, AWARD 1 mark ALLOW not favoured kinetically
	(b)	(i)		
		CH ₃ OH + 1½O ₂ → CO ₂ + 2H ₂ O ✓	1	Correct species AND balancing needed ALLOW multiple, <i>ie</i> 2CH ₃ OH + 3O ₂ → 2CO ₂ + 4H ₂ O ALLOW CH ₄ O for formula of methanol
		(ii)		
		CH ₃ OH + H ₂ O → 6H ⁺ + 6e ⁻ + CO ₂ ✓	1	
		(iii)		
		less CO ₂ OR less greenhouse gases ✓ greater efficiency ✓	2	ALLOW no CO ₂ OR no greenhouse gases ALLOW (very) efficient IGNORE less pollution OR 'renewable fuels'
		(iv)		
		methanol is a liquid AND methanol is easier to store/transport ✓	1	Both points required for mark Response MUST state that methanol is a liquid IGNORE methanol has a higher boiling point Assume that 'it' refers to methanol IGNORE safety issues, eg H ₂ leakage, flammability, explosive
Total			13	

Question	Answer	Mark	Guidance
5 (a)	A: forms fewer moles/molecules of gas ✓ B: forms gas from a liquid ✓ C: forms liquid from gases ✓ D: forms more moles/molecules of gas ✓	4	Note: Responses must imply the key difference between the sides of the equation IGNORE comments about C(s)
(b)	$\Delta S = \Sigma S(\text{products}) - \Sigma S(\text{reactants})$ $= 40 + 214 - 89 = 165 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$ $= 0.165 \text{ (kJ K}^{-1} \text{ mol}^{-1}\text{)} \checkmark$ At 25 °C, $\Delta G = +178 - 298 \times 0.165 \checkmark$ $= (+)129 \checkmark$ units: $\text{kJ mol}^{-1} \checkmark$ OR $(+)129,000 \checkmark$ units: $\text{J mol}^{-1} \checkmark$ As $\Delta G > 0$, reaction is not feasible OR as $\Delta G > 0$, CaCO_3 is stable ✓ <hr/> Minimum temperature for feasibility when $0 = \Delta H - T\Delta S$ OR $\Delta H = T\Delta S$ OR $T = \frac{\Delta H}{\Delta S} \checkmark$ $= \frac{178}{0.165} = 1079 \text{ K OR } 806 \text{ °C} \checkmark$ The units must be with the stated temperature	1 4 2	ANNOTATE WITH TICKS AND CROSSES, etc <i>Mark is for the working line:</i> $40 + 214 - 89 = 165$ UNITS have a separate mark ALLOW 129 to calculator value of 128.83 DO NOT ALLOW 128 (incorrect rounding) IF 25 °C used rather than 298 K, credit by ECF , calculated $\Delta G = 174$ to calculator value of 173.875 ENTROPY APPROACH ----- ALLOW At 25 °C, $\Delta S_{\text{total}} = 0.165 - \frac{178}{298} \checkmark$ $= -0.432 \checkmark \text{ kJ K}^{-1} \text{ mol}^{-1} \checkmark$ OR $-432 \checkmark \text{ J K}^{-1} \text{ mol}^{-1} \checkmark$ As $\Delta S < 0$, reaction is not feasible ✓ ENTROPY APPROACH ----- Minimum temperature for feasibility when $0 = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}}$ OR $\Delta S_{\text{system}} = \frac{\Delta H}{T}$ ALLOW 1080 K up to calculator value of 1078.787879, correctly rounded, eg 1078.79 is correct value to 6SF DO NOT ALLOW 1078 (incorrect rounding) IF 1079 K is given and additional temperature in °C is incorrect, IGNORE °C temperature (and vice versa)
Total		11	

Question		Answer	Mark	Guidance
6	(a)	(i)	1	IGNORE state symbols ALLOW $[\text{H}_3\text{O}^+(\text{aq})]$ $[\text{OH}^-(\text{aq})]$
		(ii)	2	IF there is an alternative answer, check to see if there is any ECF credit possible using working below ANNOTATE WITH TICKS AND CROSSES, etc ----- ALLOW 4.3×10^{-5} up to calculator: $4.265795188 \times 10^{-5}$ ALLOW 0.0000427 Answer MUST be to 2 SF (in question) ALLOW = 2.3×10^{-x} (mol dm ⁻³) for 1 mark (must be a negative power) ALLOW alternative approach based on pOH: pOH = $14 - 4.27 = 9.63$ ✓ (DO NOT ALLOW 9.6) $[\text{OH}^-] = 10^{-\text{pOH}} = 10^{-9.63} = 2.3 \times 10^{-10}$ (mol dm ⁻³) ✓
	(b)	(i)	1	Endothermic AND reason required for the mark ALLOW Endothermic because increasing temperature shifts equilibrium/reaction to the right
		(ii)	3	ANNOTATE WITH TICKS AND CROSSES, etc Actual $K_w = 2.38 \times 10^{-14}$ mol ² dm ⁻⁶ For this mark, candidate must use a value between 2.0 and 3.0×10^{-14} (mol ² dm ⁻⁶), <i>ie</i> from the approximately correct region of the graph, ALLOW 6.8 up to calculator value Note: You will need to calculate the pH value from the candidate's estimate of K_w at 37 °C before awarding the 3rd marking point ONLY award an ECF pH mark if candidate has generated a value of $[\text{H}^+]$ by attempting to take a square root of a value between 2.0 and 3.0×10^{-14}

Question	Answer	Mark	Guidance
6 (b) (iii)	(Work is) inaccurate OR invalid because K_w varies with temperature ✓	1	Response requires reason for inaccuracy/invalidity in terms of K_w ALLOW incorrect with reason IGNORE unreliable ALLOW inaccurate because wrong K_w was used For K_w varies with temperature, ALLOW equilibrium shifts with temperature
(c)	<p>Acid and alkali mixed ✓</p> <p>Amounts of acid AND alkali stated ✓</p> <p>Temperature taken at start AND finish ✓</p> <p>energy, $Q = mc\Delta T$ OR in words AND meaning of m, c AND ΔT given ✓</p> <p>Energy scaled up to form 1 mol of water ✓</p> <p>$\Delta H_{\text{neut}} = -\text{energy change}$ ✓</p>	6	<p>ANNOTATE WITH TICKS AND CROSSES, etc</p> <p>ALLOW 'base' for 'alkali throughout ALLOW if mentioned anywhere which could be within a definition for enthalpy change of neutralisation</p> <p>Amounts could be expressed as amounts, moles, volumes OR concentrations</p> <p>ALLOW temperature change</p> <p>m = mass/volume of solution/reactants/mixture, etc (but NOT surroundings) c = (specific) heat capacity (of solution/water) OR 4.18/4.2 ΔT = temperature change</p> <p>ALLOW divide energy by moles</p> <p>ALLOW '-' sign shown in earlier part, ie $\Delta H_{\text{neut}} = -\frac{Q}{n}$ ALLOW a statement linking ΔH with temperature change, ie: IF temperature increases, ΔH_{neut} is -ve OR IF temperature decreases, ΔH_{neut} is +ve</p>

Question	Answer	Mark	Guidance
6 (d)	<p>Ionic radius Potassium ion OR K^+ OR K ion is smaller OR K^+ has greater charge density ✓</p> <p>Lattice enthalpy Lattice enthalpy of KF is more negative than RbF ✓ OR K^+ has greater attraction for F^-</p> <p>Hydration enthalpy $\Delta H(\text{hydration})$ of K^+ is more negative than Rb^+ ✓ OR K^+ has greater attraction for H_2O</p> <p>Enthalpy change of solution Idea that $\Delta H(\text{solution})$ is affected more by lattice enthalpy than by hydration enthalpy ✓</p>	4	<p>ANNOTATE WITH TICKS AND CROSSES, etc</p> <p>Throughout question, ORA in terms of Rb^+ Throughout question, ALLOW energy for enthalpy</p> <p>DO NOT ALLOW potassium OR K OR reference to atoms (<i>ie</i> reference to ions is required throughout a response)</p> <p>ALLOW lattice enthalpy of KF > lattice enthalpy of RbF</p> <p>ALLOW more energy needed to separate K^+ AND F^- IGNORE KF has stronger bonds</p> <p>ALLOW $\Delta H(\text{hydration})$ of K^+ > $\Delta H(\text{hydration})$ of Rb^+</p> <p>ALLOW more energy needed to separate K^+ AND H_2O IGNORE K^+ has a stronger bond to H_2O</p> <p>ALLOW a correct attempt to link the contribution of lattice enthalpy and hydration enthalpy to $\Delta H(\text{solution})$, <i>ie</i> lattice enthalpy is a more important factor than hydration enthalpy</p>
(e)	<p>(During dissolving,) entropy/disorder increases OR disorder increases ✓</p> <p>$T\Delta S > \Delta H$ OR $T\Delta S$ is more positive than ΔH OR $\Delta H - T\Delta S$ is negative ✓</p>	2	<p>ALLOW entropy change is positive OR ΔS is positive OR $T\Delta S$ is positive</p> <p>ALLOW $\Delta S(\text{system}) > \Delta H/T$ ALLOW $\Delta S(\text{system})$ is more positive than $\Delta H/T$ ✓ ALLOW $\Delta S(\text{system}) + \Delta S(\text{surroundings})$ is positive</p> <p>ALLOW Energy contribution from increase in entropy is greater than decrease in energy from enthalpy change OR entropy change outweighs enthalpy change</p> <p>IGNORE ΔG is negative</p>
	Total	20	

Question	Answer	Mark	Guidance
7 (a) (i)	<p>amount $\text{S}_2\text{O}_3^{2-}$ used $= 0.00100 \times \frac{24.6}{1000} = 2.46 \times 10^{-5} \text{ mol } \checkmark$</p> <p>amount O_2 in 25 cm³ sample $= \frac{2.46 \times 10^{-5}}{4} = 6.15 \times 10^{-6} \text{ mol } \checkmark$</p> <p>Concentration of O_2 in sample $= 6.15 \times 10^{-6} \times \frac{1000}{25} = 2.46 \times 10^{-4} \text{ (mol dm}^{-3}\text{) } \checkmark$</p> <p>mass concentration of O_2 in mg dm⁻³ $= 2.46 \times 10^{-4} \times 32 \text{ g} = 7.872 \times 10^{-3} \text{ (g dm}^{-3}\text{)}$ $= 7.872 \text{ (mg dm}^{-3}\text{) } \checkmark$</p>	4	<p>ANNOTATE WITH TICKS AND CROSSES, etc</p> <p>ALLOW 0.0000246 (mol)</p> <p>ECF = $\frac{\text{answer above}}{4}$</p> <p>ALLOW 0.00000615 g</p> <p>ECF answer above $\times \frac{1000}{25}$</p> <p>ALLOW 0.000246 g</p> <p>ECF = answer above $\times 32 \times 1000$</p> <p>ALLOW 7.9 OR 7.87</p> <p>ALLOW 2 SF up to calculator value</p> <p>Must be in mg for mark</p> <p>Note: Candidate may work out steps 3 and 4 in the opposite order, <i>ie</i></p> <p>mass of O_2 in sample $= 6.15 \times 10^{-6} \times 32 \times 1000 = 1.968 \times 10^{-1} \text{ mg}$</p> <p>mass concentration of O_2 in mg dm⁻³ $= 1.968 \times 10^{-1} \times \frac{1000}{25} = 7.872 \text{ (mg dm}^{-3}\text{)}$</p>
(ii)	<p>Comment $7.872 > 5$ so fish can survive \checkmark</p>	1	<p>ECF If final answer > 5 fish can survive If final answer < 5 fish cannot survive</p>
(b) (i)	NO \checkmark	1	ALLOW N_2H_2

Question			Answer	Mark	Guidance
7	(b)	(ii)	$2\text{H}_2\text{O} + 2\text{I}^- + 2\text{NO}_2^- \longrightarrow 2\text{NO} + \text{I}_2 + 4\text{OH}^-$ OR $2\text{H}^+ + 2\text{I}^- + 2\text{NO}_2^- \longrightarrow 2\text{NO} + \text{I}_2 + 2\text{OH}^-$ species ✓ balance ✓	2	IGNORE state symbols ALLOW multiples For species ONLY, IGNORE any extra H_2O or e^- on either side of the equation ALLOW on LHS: $2\text{HI} + 2\text{NO}_2^-$ OR $2\text{I}^- + 2\text{HNO}_2$ ALLOW species and equation involving N_2H_2 : $6\text{H}_2\text{O} + 8\text{I}^- + 2\text{NO}_2^- \longrightarrow \text{N}_2\text{H}_2 + 4\text{I}_2 + 10\text{OH}^-$ OR $6\text{H}^+ + 8\text{I}^- + 2\text{NO}_2^- \longrightarrow \text{N}_2\text{H}_2 + 4\text{I}_2 + 4\text{OH}^-$ species ✓ balance ✓
			Total	8	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2011

