

Chemistry A

Advanced GCE F325

Equilibria, Energetics and Elements

Mark Scheme for June 2010

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 2010

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		Expected Answers	Marks	Additional Guidance
1	a	<p>F B G E D</p> <p>FIVE correct ✓✓✓ FOUR correct ✓✓ THREE correct ✓</p>	3	<p>ALLOW</p> <p>1450 736 G 76 -642</p>
	b	<p>Correct calculation $-642 - (+76 + (2 \times 150) + 736 + 1450 + (2 \times -349)) \checkmark$ $-642 - 1864$ $= -2506 \checkmark$ (kJ mol⁻¹)</p>	2	<p>ALLOW for 1 mark: -2705 (2 × 150 and 2 × 349 not used for Cl) -2356 (2 × 150 not used for Cl) -2855 (2 × 349 not used for Cl) +2506 (wrong sign) DO NOT ALLOW any other answers</p>
	c	<p>Magnesium ion OR Mg²⁺ has greater charge (than sodium ion OR Na⁺) OR Mg²⁺ has greater charge density ✓</p> <p>Magnesium ion OR Mg²⁺ is smaller ✓</p> <p>Mg²⁺ has a stronger attraction (than Na⁺) to Cl⁻ ion OR Greater attraction between oppositely charged ions ✓</p>	3	<p>ANNOTATIONS MUST BE USED</p> <p>ALLOW magnesium/Mg is 2+ but sodium/Na is 1+ DO NOT ALLOW Mg atom is 2+ but Na atom is 1+ ALLOW 'charge density' here only</p> <p>ALLOW Mg OR magnesium is smaller DO NOT ALLOW Mg²⁺ has a smaller atomic radius</p> <p>ALLOW anion OR negative ion for Cl⁻ DO NOT ALLOW chlorine ions DO NOT ALLOW Mg has greater attraction</p> <p>ALLOW 'attracts with more force' for greater attraction but DO NOT ALLOW 'greater force' (could be repulsion)</p> <p>ALLOW reverse argument throughout in terms of Na⁺</p>
Total			8	

Question	Expected Answers	Marks	Additional Guidance
	<p>Calculation of rate constant (3 marks)</p> $k = \frac{\text{rate}}{[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2}$ <p>OR</p> $\frac{1.19 \times 10^{-5}}{(5.0 \times 10^{-2})(1.5 \times 10^{-1})(3.1 \times 10^{-1})^2} \checkmark$ <p>= 1.7×10^{-2} OR $1.65 \times 10^{-2} \checkmark$ $\text{dm}^9 \text{mol}^{-3} \text{s}^{-1} \checkmark$</p>	3	<p>ANNOTATIONS MUST BE USED</p> <p>Calculation can be from any of the experimental runs – they all give the same value of k</p> <p>ALLOW $\text{mol}^{-3} \text{dm}^9 \text{s}^{-1}$</p> <p>ALLOW 1.6510579×10^{-2} and correct rounding to 1.7×10^{-2}</p> <p>Correct numerical answer subsumes previous marking point</p> <p>DO NOT ALLOW fraction: $\frac{238}{14415}$</p> <p>-----</p> <p>ALLOW ECF from incorrect rate equation.</p> <p>Examples are given below for 1st line of initial rates data. IF other rows have been used, then calculate the rate constant from data chosen.</p> <p>Example 1: 1st order with respect to H^+</p> $\text{rate} = k [\text{BrO}_3^-] [\text{Br}^-] [\text{H}^+]$ $k = \frac{\text{rate}}{[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]}$ <p>OR</p> $\frac{1.19 \times 10^{-5}}{(5.0 \times 10^{-2})(1.5 \times 10^{-1})(3.1 \times 10^{-1})} \checkmark$ <p>= 5.1×10^{-3} OR $5.12 \times 10^{-3} \checkmark$ $\text{dm}^6 \text{mol}^{-2} \text{s}^{-1} \checkmark$</p> <p>ALLOW $5.11827957 \times 10^{-3}$ and correct rounding to 5.1×10^{-3}</p> <p>-----</p> <p>Example 2: Zero order with respect to BrO_3^-</p> $\text{rate} = k [\text{Br}^-] [\text{H}^+]^2$ $k = \frac{\text{rate}}{[\text{Br}^-][\text{H}^+]^2}$ <p>OR</p> $\frac{1.19 \times 10^{-5}}{(1.5 \times 10^{-1})(3.1 \times 10^{-1})^2} \checkmark$ <p>= 8.3×10^{-4} OR $8.26 \times 10^{-4} \checkmark$ $\text{dm}^6 \text{mol}^{-2} \text{s}^{-1} \checkmark$</p> <p>ALLOW $8.255289629 \times 10^{-4}$ and correct rounding to 8.3×10^{-4}</p>
	Total	10	

Question		Expected Answers	Marks	Additional Guidance
3	a	<p>measured pH > 1 OR $[H^+] < 0.1$ (mol dm⁻³) ✓</p> <p>$[H^+] = 10^{-pH}$ ✓</p> <p>$K_a = \frac{[H^+][CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$ OR $\frac{[H^+]^2}{[CH_3CH_2COOH]}$ ✓</p> <p>Calculate K_a from $\frac{[H^+]^2}{0.100}$ ✓</p>	4	<p>ALLOW C₂H₅ throughout question</p> <p>ALLOW $[H^+] < [CH_3CH_2COOH]$ OR $[H^+] < [HA]$ ALLOW measured pH is higher than expected ALLOW measured pH is not as acidic as expected ALLOW a quoted pH value or range > 1 and < 7 OR between 1 and 7</p> <p>ALLOW $[H^+] = \text{antilog } -pH$ OR $[H^+] = \text{inverse log } -pH$</p> <p>ALLOW $\frac{[H^+][A^-]}{[HA]}$ OR $\frac{[H^+]^2}{[HA]}$</p> <p>IF K_a is NOT given and $K_a = \frac{[H^+]^2}{0.100}$ is shown, award mark for K_a also (i.e. $K_a = \frac{[H^+]^2}{0.100}$ is automatically awarded the last 2 marks)</p>
	b	<p>Marks are for correctly calculated values. Working shows how values have been derived.</p> <p>$[H^+] = 10^{-13.46} = 3.47 \times 10^{-14}$ (mol dm⁻³) ✓</p> <p>$[OH^-] = \frac{1.0 \times 10^{-14}}{3.47 \times 10^{-14}} = 0.29$ (mol dm⁻³) ✓</p>	2	<p>ALLOW $3.467368505 \times 10^{-14}$ and correct rounding to 3.5×10^{-14}</p> <p>ALLOW 0.28840315 and correct rounding to 0.29, i.e. ALLOW 0.288</p> <p>ALLOW alternative approach using pOH:</p> <p>pOH = 14 – 13.46 = 0.54 ✓ $[OH^-] = 10^{-0.54} = 0.29$ (mol dm⁻³) ✓</p> <p>Correct answer gets BOTH marks</p>

Question		Expected Answers	Marks	Additional Guidance	
	d	$\text{HNO}_3 + \text{CH}_3\text{CH}_2\text{COOH} \rightleftharpoons \text{CH}_3\text{CH}_2\text{COOH}_2^+ + \text{NO}_3^- \checkmark$ <p>acid 1 base 2 acid 2 base 1 \checkmark</p>	2	<p>State symbols NOT required ALLOW 1 AND 2 labels the other way around. ALLOW 'just acid' and 'base' labels throughout if linked by lines so that it is clear what the acid–base pairs are.</p> <p>IF proton transfer is wrong way around then ALLOW 2nd mark for idea of acid–base pairs, i.e.</p> $\text{HNO}_3 + \text{CH}_3\text{CH}_2\text{COOH} \rightleftharpoons \text{CH}_3\text{CH}_2\text{COO}^- + \text{H}_2\text{NO}_3^+ \times$ <p>base 2 acid 1 base 1 acid 2 \checkmark</p>	
	e	i	$2\text{CH}_3\text{CH}_2\text{COOH} + \text{Mg} \rightarrow (\text{CH}_3\text{CH}_2\text{COO})_2\text{Mg} + \text{H}_2 \checkmark$	1	<p>IGNORE state symbols ALLOW ionic equation: $2\text{H}^+ + \text{Mg} \rightarrow \text{Mg}^{2+} + \text{H}_2$</p> <p>IGNORE any random charges in formula of $(\text{CH}_3\text{CH}_2\text{COO})_2\text{Mg}$ as long as the charges are correct (charges are treated as working) i.e. $(\text{CH}_3\text{COO}^-)_2\text{Mg}$ OR $(\text{CH}_3\text{COO})_2^- \text{Mg}$ should not be penalised However, Mg^{2+} instead of Mg on the left side of equation is obviously wrong</p>
		ii	$2\text{H}^+ + \text{CO}_3^{2-} \longrightarrow \text{H}_2\text{O} + \text{CO}_2$ <p>OR $2\text{H}^+ + \text{CO}_3^{2-} \longrightarrow \text{H}_2\text{CO}_3$ OR $\text{H}^+ + \text{CO}_3^{2-} \longrightarrow \text{HCO}_3^- \checkmark$</p>	1	State symbols NOT required
Total			17		

Question			Expected Answers	Marks	Additional Guidance
4	a	i	Complete circuit (with voltmeter) and salt bridge linking two half-cells ✓ Pt electrode in solution of Fe ²⁺ /Fe ³⁺ ✓ Ag in solution of Ag ⁺ ✓	3	DO NOT ALLOW 'solution of a silver halide', e.g. AgCl (as these are insoluble) but DO ALLOW any solution of any other silver salt (whether insoluble or not) IF candidate has used incorrect redox systems, then mark ECF as follows: (i) each incorrect system will cost the candidate one mark (ii) ECF if species have been quoted (see Additional Guidance below) (iii) ECF for equation (iv) ECF for cell potential YOU MAY NEED TO WORK OUT THESE ECF RESPONSES YOURSELF DEPENDING ON THE INCORRECT REDOX SYSTEMS CHOSEN
		ii	electrons AND ions ✓	1	For electrons, ALLOW e ⁻ For 'ions', ALLOW formula of an ion in one of the half-cells or salt bridge, e.g. Ag ⁺ , Fe ²⁺ , Fe ³⁺ ALLOW ECF as in (i)
		iii	Ag + Fe ³⁺ → Ag ⁺ + Fe ²⁺ ✓	1	ALLOW ECF as in (i) ALLOW equilibrium sign
		iv	0.43 V ✓	1	ALLOW ECF as in (i)
	b	i	Cl ₂ OR O ₂ AND H ⁺ ✓	1	ALLOW chlorine ALLOW O ₂ AND 4H ⁺ ALLOW O ₂ AND acid DO NOT ALLOW O ₂ alone DO NOT ALLOW equation or equilibrium
		ii	I ⁻ ✓	1	ALLOW 2I ⁻ OR iodide DO NOT ALLOW equation or equilibrium

Question	Expected Answers	Marks	Additional Guidance
c	<p>A fuel cell converts energy from reaction of a fuel with oxygen into a voltage/electrical energy ✓</p> <p>$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ ✓</p> <p>Two from:</p> <ul style="list-style-type: none"> • under pressure OR at low temperature OR as a liquid • adsorbed on solid • absorbed within solid <p style="text-align: right;">✓✓</p> <p>Energy is needed to make the hydrogen OR energy is needed to make fuel cell ✓</p>	5	<p>ANNOTATIONS MUST BE USED</p> <p>ALLOW combustion for reaction of fuel with oxygen/reactants</p> <p>ALLOW a fuel cell requires constant supply of fuel</p> <p>OR operates continuously as long as a fuel (and oxygen) are added</p> <p>ALLOW multiples, e.g. $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$</p> <p>IGNORE state symbols</p> <p>ALLOW 'material' OR metal for solid</p> <p>ALLOW as a metal hydride</p>
	Total	13	

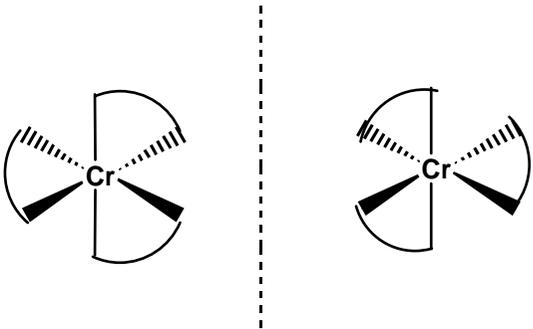
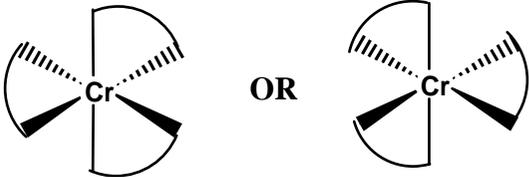
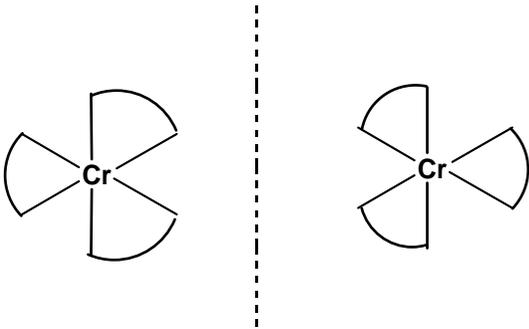
Question			Expected Answers	Marks	Additional Guidance
5	a	i	$(K_c =) \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \checkmark$	1	Must be square brackets
		ii	$\text{dm}^6 \text{ mol}^{-2} \checkmark$	1	ALLOW $\text{mol}^{-2} \text{ dm}^6$ ALLOW ECF from incorrect K_c expression
	b		<p>Unless otherwise stated, marks are for correctly calculated values. Working shows how values have been derived.</p> <p>$[\text{N}_2] = \frac{7.2}{6.0}$ OR $1.2 \text{ (mol dm}^{-3}\text{)}$</p> <p>AND $[\text{H}_2] = \frac{12}{6.0}$ OR $2.0 \text{ (mol dm}^{-3}\text{)}$ \checkmark</p> <p>$[\text{NH}_3] = \sqrt{(K_c \times [\text{N}_2] \times [\text{H}_2]^3)}$</p> <p>OR $\sqrt{(8.00 \times 10^{-2} \times 1.2 \times 2.0^3)}$ \checkmark</p> <p>$= 0.876$ OR $0.88 \text{ (mol dm}^{-3}\text{)}$ \checkmark</p> <p>amount $\text{NH}_3 = 0.876 \times 6 = 5.26$ OR 5.3 (mol) \checkmark</p>	4	<p>ANNOTATIONS MUST BE USED</p> <p>For all parts, ALLOW numerical answers from 2 significant figures up to the calculator value</p> <p>1st mark is for realising that concentrations need to be calculated.</p> <p>Correct numerical answer with no working would score all previous calculation marks</p> <p>ALLOW calculator value: 0.876356092 down to 0.88, correctly rounded</p> <p>ALLOW calculator value down to 5.3, correctly rounded</p>

Question	Expected Answers	Marks	Additional Guidance
b	<p>EXAMPLES OF INCORRECT RESPONSES IN (b) THAT MAY BE WORTHY OF CREDIT</p>		<p>-----</p> <p>ALLOW ECF from incorrect concentrations (3 marks) For example, If concentrations not calculated at start, then</p> $[\text{NH}_3] = \sqrt{(8.00 \times 10^{-2} \times 7.2 \times 12.0^3)} \checkmark$ $= 31.5 \text{ mol dm}^{-3} \checkmark$ <p>Equilibrium amount of $\text{NH}_3 = 31.5 \times 6 = 189.6 \text{ (mol)} \checkmark$</p> <p>-----</p> <p>IF candidate has K_c expression upside down, then all 4 marks are available in (b) by ECF</p> <p>Correct $[\text{N}_2]$ AND $[\text{H}_2] \checkmark$</p> $[\text{NH}_3] = \sqrt{\frac{[\text{N}_2][\text{H}_2]^3}{K_c}} = \sqrt{\frac{1.2 \times 2^3}{8.00 \times 10^{-2}}} \checkmark$ $= 11.0 \text{ mol dm}^{-3} \checkmark$ <p>Equilibrium amount of $\text{NH}_3 = 11.0 \times 6 = 66.0 \text{ (mol)} \checkmark$</p> <p>-----</p> <p>IF candidate has used K_c value of 8.00×10^{-2} AND values for N_2 AND H_2 with powers wrong, mark by ECF from calculated as below (3 max in (b))</p> <p>Correct $[\text{N}_2]$ AND $[\text{H}_2] \checkmark$</p> <p>$[\text{NH}_3]$ expression ✗</p> <p>ECF: Calculated $[\text{NH}_3] \checkmark$</p> <p>ECF: Equilibrium amount of $\text{NH}_3 \checkmark$</p>

Question		Expected Answers	Marks	Additional Guidance
	c i	Equilibrium shifts to right OR Equilibrium towards ammonia ✓ Right hand side has fewer number of (gaseous) moles ✓	2	ALLOW 'moves right' OR 'goes right' OR 'favours right' OR 'goes forwards' ALLOW 'ammonia side' has fewer moles ALLOW 'there are more (gaseous) moles on left'
	ii	K_c does not change ✓ Increased pressure increases concentration terms on bottom of K_c expression more than the top OR system is now no longer in equilibrium ✓ top of K_c expression increases and bottom decreases until K_c is reached ✓	3	ANNOTATIONS MUST BE USED Any response in terms of K_c changing scores ZERO for Part (ii) ALLOW K_c is temperature dependent only OR K_c does not change with pressure ALLOW $\frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$ no longer equal to K_c
	d i	$\text{CH}_4 + \text{H}_2\text{O} \longrightarrow 3\text{H}_2 + \text{CO}$ ✓	1	State symbols NOT required ALLOW : $\text{CH}_4 + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{OH} + \text{H}_2$ $\text{CH}_4 + 2\text{H}_2\text{O} \longrightarrow 4\text{H}_2 + \text{CO}_2$ $\text{CH}_4 + \text{H}_2\text{O} \longrightarrow 2\text{H}_2 + \text{HCHO}$ $\text{CH}_4 + 2\text{H}_2\text{O} \longrightarrow 3\text{H}_2 + \text{HCOOH}$
	ii	Electrolysis of water OR $\text{H}_2\text{O} \longrightarrow \text{H}_2 + \frac{1}{2}\text{O}_2$ ✓	1	ALLOW electrolysis of brine DO NOT ALLOW reforming DO NOT ALLOW cracking DO NOT ALLOW reaction of metal with acid

Question		Expected Answers	Marks	Additional Guidance
	iii	Activation energy is too high OR reaction too slow ✓	1	ALLOW increases the rate OR more molecules exceed activation energy OR more successful collisions ALLOW rate constant increases IGNORE comments on yield
Total			22	

Question			Expected Answers	Marks	Additional Guidance
6	a	i	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ ✓	1	ALLOW $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ (i.e. 4s before 3d) ALLOW $[\text{Ar}]4s^1 3d^5$ OR $[\text{Ar}]3d^5 4s^1$
		ii	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$ ✓	1	ALLOW $[\text{Ar}]3d^3$ ALLOW $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^0$ OR $[\text{Ar}]3d^3 4s^0$
	b		$\text{Zn} \longrightarrow \text{Zn}^{2+} + 2e^-$ ✓ $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 8e^- \longrightarrow 2\text{Cr}^{2+} + 7\text{H}_2\text{O}$ ✓ $4\text{Zn} + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \longrightarrow 4\text{Zn}^{2+} + 2\text{Cr}^{2+} + 7\text{H}_2\text{O}$ ✓	3	ALLOW multiples WATCH for balancing of the equations printed on paper IF printed equations and answer lines have different balancing numbers OR electrons, IGNORE numbers on printed equations (i.e. treat these as working) and mark responses on answer lines only NO ECF for overall equation i.e. the expected answer is the ONLY acceptable answer
	c	i	Ligand substitution ✓	1	ALLOW ligand exchange
		ii	$[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + 6\text{NH}_3 \longrightarrow [\text{Cr}(\text{NH}_3)_6]^{3+} + 6\text{H}_2\text{O}$ ✓ ✓	2	1 mark is awarded for each side of equation ALLOW equilibrium sign ALLOW 1 mark for 2+ shown instead of 3+ on both sides of equation ALLOW 1 mark for substitution of 4 NH_3 : $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + 4\text{NH}_3 \longrightarrow [\text{Cr}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{3+} + 4\text{H}_2\text{O}$
	d	i	Donates an electron pair to a metal ion OR forms a coordinate bond to a metal ion ✓	1	ALLOW donates an electron pair to a metal ALLOW dative (covalent) bond for coordinate bond
		ii	Donates two electron pairs OR forms two coordinate bonds ✓ Lone pairs on two O atoms ✓	2	First mark is for the idea of two coordinate bonds ALLOW lone pair on O and N DO NOT ALLOW lone pairs on COO^- (could involve C) Second mark is for the atoms that donate the electron pairs Look for the atoms with lone pairs also on response to (d)(iii) and credit here if not described in (d)(ii)

Question	Expected Answers	Marks	Additional Guidance
iii	<p>Forms two optical isomers OR two enantiomers OR two non-superimposable mirror images ✓</p>  <p>✓✓ For each structure</p>	3	<p>IGNORE any charges shown</p> <p>ALLOW any attempt to show bidentate ligand. Bottom line is the diagram on the left.</p> <p>1 mark for 3D diagram with ligands attached for ONE stereoisomer. Must contain 2 out wedges, 2 in wedges and 2 lines in plane of paper:</p>  <p>2nd mark for reflected diagram of SECOND stereoisomer. The diagram below would score the 2nd mark but not the first</p> 

Question	Expected Answers	Marks	Additional Guidance
e	<p style="text-align: center;">N : H : Cr : O 11.1/14 : 3.17/1 : 41.27/52 : 44.45/16</p> <p>OR 0.793 : 3.17 : 0.794 : 2.78 ✓</p> <p>A: N₂H₈Cr₂O₇ ✓</p> <p>Ions: NH₄⁺ ✓ Cr₂O₇²⁻ ✓</p> <p>B: Cr₂O₃ ✓</p> <p>Correctly calculates molar mass of C = 1.17 × 24.0 = 28.08 (g mol⁻¹) ✓</p> <p>C: N₂ ✓</p> <p>Equation: (NH₄)₂Cr₂O₇ → Cr₂O₃ + 4H₂O + N₂ ✓</p>	8	<p>ANNOTATIONS MUST BE USED</p> <p>ALLOW A: (NH₄)₂Cr₂O₇</p> <p>IF candidate has obtained NH₄CrO₄ for A, ALLOW NH₄⁺ DO NOT ALLOW CrO₄⁻</p> <p>ALLOW: (relative) molecular mass ALLOW: 28 ALLOW: 'C is 28'</p> <p>ALLOW N₂H₈Cr₂O₇ in equation.</p>
Total		22	

Question	Expected Answer	Mark	Additional Guidance
5 e i	<p>MAX/MIN TEMPERATURE APPROACH: 5 MARKS MAX AVAILABLE</p> <p>Unless otherwise stated, marks are for correctly calculated values. Working shows how values have been derived.</p> $\Delta S = \Sigma S(\text{products}) - \Sigma S(\text{reactants}) /$ $= (2 \times 192) - (191 + 3 \times 131) \checkmark$ $= -200 \text{ (J K}^{-1} \text{ mol}^{-1}) \text{ OR } -0.200 \text{ (kJ K}^{-1} \text{ mol}^{-1}) \checkmark$ <p>Use of 298 K (could be within ΔG expression below) \checkmark</p> $\Delta G = \Delta H - T\Delta S$ <p>OR When $\Delta G = 0$, $0 = \Delta H - T\Delta S$;</p> <p>OR $T = \frac{\Delta H}{\Delta S} = \frac{-92}{-0.200}$</p> <p>OR $T = \frac{\Delta H}{\Delta S} = \frac{-92000}{-200} \checkmark$</p> <p>= 460 K \checkmark</p> <p>= 187 °C (use of 298) \checkmark</p> <p>The condition $\Delta G = 0$ because temperature at which $\Delta G = 0$ is the maximum temperature for feasibility AND justification for the being the maximum \checkmark</p>		<p>ANNOTATIONS MUST BE USED</p> <p>This candidate has not answered the question but many marks are still available.</p> <p>NO UNITS required at this stage IGNORE units</p> <p>By this approach, the calculated temperature is the switchover between feasibility and non-feasibility but it cannot be assumed that this is the maximum temperature</p>

Question			Expected Answer	Mark	Additional Guidance
5	e	ii	<p>As the temperature increases, $\Delta H/T$ becomes less negative OR $\Delta H/T$ becomes more negative than $\Delta S(\text{system})$ OR $\Delta H/T$ becomes less significant OR $\Delta S(\text{surroundings})$ becomes less significant OR $\Delta S(\text{system}) > \Delta H/T$ OR $\Delta S(\text{system}) > \Delta S(\text{surroundings})$ ✓</p> <p>Eventually $\Delta S(\text{total})$ becomes negative ✓</p>	2	<p>ALLOW $\Delta H/T > \Delta S_{\text{system}}$ (i.e. assume no sign at this stage)</p> <p>ALLOW $-\Delta H/T$ becomes more positive ALLOW $-\Delta H/T$ increases</p>

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 2010

