



**GCE**

**Chemistry A**

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

Advanced GCE

**Mark Scheme for June 2015**

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, 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 2015

F325

## Mark Scheme

June 2015

1. These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning of annotation
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response

F325

## Mark Scheme

June 2015

2. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	Or reverse argument

3. The following questions should be annotated with **ALL annotations** to show where marks have been awarded in the body of the text:

1(d)

3(b)(i)

3(b)(iv)

4(e)(iii)

5(b)(ii)

7(b)

F325

Mark Scheme

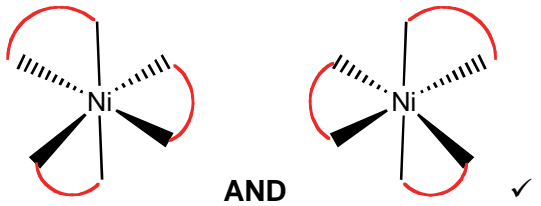
June 2015

Question		Answer	Marks	Guidance
1	(a)	(+)5 ✓	1	<b>ALLOW</b> 5+ <b>OR</b> V <b>OR</b> Cr <sup>5+</sup>
1	(b)	For equations, <b>IGNORE</b> any state symbols; <b>ALLOW</b> multiples ----- Any correct equation for a reaction catalysed by a transition element, compound or ion <b>AND</b> transition element, compound or ion (by formula or name) ✓	1	<b>EXAMPLES</b> N <sub>2</sub> + 3H <sub>2</sub> ⇌ 2NH <sub>3</sub> (allow →) <b>AND</b> Fe/iron oxide 2SO <sub>2</sub> + O <sub>2</sub> ⇌ 2SO <sub>3</sub> (allow →) <b>AND</b> V <sub>2</sub> O <sub>5</sub> /Pt 2CO + 2NO → 2CO <sub>2</sub> + N <sub>2</sub> <b>AND</b> Pt/Pd/Rh/Au Equation for any alkene + H <sub>2</sub> → alkane <b>AND</b> Ni/Pt/Pd C <sub>6</sub> H <sub>6</sub> + Cl <sub>2</sub> → C <sub>6</sub> H <sub>5</sub> Cl + HCl <b>AND</b> Fe/FeCl <sub>3</sub> /Fe <sup>3+</sup> C <sub>6</sub> H <sub>6</sub> + Br <sub>2</sub> → C <sub>6</sub> H <sub>5</sub> Br + HBr <b>AND</b> Fe/FeBr <sub>3</sub> /Fe <sup>3+</sup> 2H <sub>2</sub> O <sub>2</sub> → 2H <sub>2</sub> O + O <sub>2</sub> <b>AND</b> MnO <sub>2</sub>  For other examples, <b>CHECK</b> with TL
1	(c)	(i) <b>Donates two</b> electron <b>pairs</b> (to a metal ion) <b>AND</b> forms <b>two</b> coordinate <b>bonds</b> (to a metal ion) ✓  <i><b>NOTE:</b> Metal ion not required as Ni<sup>3+</sup> is in the question</i>	1	<b>ALLOW</b> lone pairs for electron pairs  <b>ALLOW</b> dative (covalent) bonds for coordinate bonds  <b>TWO</b> is only needed once, e.g. <b>Donates two</b> electron <b>pairs</b> to form coordinate <b>bonds</b> <b>Donates</b> electron <b>pairs</b> to form <b>two</b> coordinate <b>bonds</b>
1	(c)	(ii) C <sub>3</sub> H <sub>10</sub> N <sub>2</sub> ✓	1	<b>ALLOW</b> in any order <b>IGNORE</b> structure
1	(c)	(iii) <b>MARK INDEPENDENTLY</b> ----- H <sub>2</sub> NCH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> ✓  Each N <b>OR</b> each NH <sub>2</sub> <b>OR</b> amine group has a lone pair/electron pair <b>OR</b> lone pairs shown on N atoms in structure ✓	2	<b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> mixture of the above (as long as unambiguous)  <b>ALLOW</b> H <sub>2</sub> NCH <sub>2</sub> CH(CH <sub>3</sub> )NH <sub>2</sub> <b>OR</b> H <sub>2</sub> NCH(CH <sub>2</sub> CH <sub>3</sub> )NH <sub>2</sub> <b>ALLOW</b> secondary or tertiary diamines or mixture  <b>IGNORE</b> complex ion  For other examples, <b>CHECK</b> with TL

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
1	(c)	(iv)	6 ✓	1	
1	(c)	(v)	3-D diagrams of <b>BOTH</b> optical isomers required for the mark  	1	In this part, Charge <b>AND</b> Square brackets <b>NOT</b> required  <b>IGNORE</b> N or attempts to draw structure of bidentate ligand  Other orientations possible but all follow same principle with 2nd structure being a mirror image of the first

F325

Mark Scheme

June 2015

Question		Answer	Marks	Guidance
1	(d)	<p><i>Quality of written communication</i> Observation must be linked to the correct reaction</p> <p><b>REACTIONS OF AQUEOUS Cu<sup>2+</sup></b></p> <p>-----</p> <p><b>REACTION OF Cu<sup>2+</sup> with NaOH(aq)</b></p> <p><b>Correct balanced equation</b> Cu<sup>2+</sup>(aq) + 2OH<sup>-</sup>(aq) → Cu(OH)<sub>2</sub>(s) ✓ state symbols <b>not</b> required</p> <p><b>Observation</b> blue precipitate/solid ✓</p>	2	<p><b>FULL ANNOTATIONS MUST BE USED THROUGHOUT</b> <b>ALLOW</b> some reactions for Cu<sup>2+</sup> and some for Co<sup>2+</sup> <b>ALLOW</b> equilibrium signs in all equations <b>IGNORE</b> any incorrect initial colours <b>IGNORE</b> state symbols <b>IGNORE</b> an incorrect formula for an observation</p> <p>-----</p> <p><b>ALLOW</b> [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 2OH<sup>-</sup> → Cu(OH)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub> + 2H<sub>2</sub>O</p> <p><b>ALLOW</b> full or 'hybrid' equations, e.g. Cu<sup>2+</sup> + 2NaOH → Cu(OH)<sub>2</sub> + 2Na<sup>+</sup> [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 2OH<sup>-</sup> → Cu(OH)<sub>2</sub> + 6H<sub>2</sub>O</p> <p>4 + 2NaOH → Cu(OH)<sub>2</sub> + Na<sub>2</sub>SO<sub>4</sub></p> <p><b>ALLOW</b> any shade of blue <b>ALLOW</b></p>
1	(d)	<p><b>REACTION OF Cu<sup>2+</sup> WITH excess NH<sub>3</sub>(aq)</b></p> <p><b>Correct balanced equation</b> [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 4NH<sub>3</sub> → [Cu(NH<sub>3</sub>)<sub>4</sub>(H<sub>2</sub>O)<sub>2</sub>]<sup>2+</sup> + 4H<sub>2</sub>O ✓</p> <p><b>Observation</b> deep/dark blue (solution) ✓</p>	2	<p><b>IGNORE</b> initial precipitation of Cu(OH)<sub>2</sub></p> <p><b>IGNORE</b> [Cu(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup></p> <p><b>ALLOW</b> royal blue, ultramarine blue or any blue colour that is clearly darker than for [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup></p> <p><b>DO NOT ALLOW</b> deep blue precipitate for observation</p>
1	(d)	<p><b>REACTION OF Cu<sup>2+</sup> WITH HCl(aq)</b></p> <p><b>Correct balanced equation</b> [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 4Cl<sup>-</sup> → [CuCl<sub>4</sub>]<sup>2-</sup> + 6H<sub>2</sub>O ✓</p> <p><b>Observation</b> yellow (solution) ✓</p>	2	<p><b>IGNORE</b> mention of different concentrations of HCl</p> <p><b>ALLOW</b> CuCl<sub>4</sub><sup>2-</sup> i.e. no brackets <b>OR</b> Cu(Cl)<sub>4</sub><sup>2-</sup> <b>ALLOW</b> [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 4HCl → [CuCl<sub>4</sub>]<sup>2-</sup> + 6H<sub>2</sub>O + 4H<sup>+</sup> <b>IGNORE</b> Cu<sup>2+</sup> + 4Cl<sup>-</sup> → CuCl<sub>4</sub><sup>2-</sup></p> <p><b>ALLOW</b> green–yellow <b>OR</b> yellow–green</p> <p><b>DO NOT ALLOW</b> yellow precipitate for observation</p>

F325

Mark Scheme

June 2015

Question		Answer	Marks	Guidance
1	(d)	<p><i>Quality of written communication</i> Observation must be linked to the correct <b>reaction</b></p> <p><b>REACTIONS OF AQUEOUS Co<sup>2+</sup></b></p> <p>-----</p> <p><b>REACTION OF Co<sup>2+</sup> with NaOH(aq)</b></p> <p><b>Correct balanced equation</b> Co<sup>2+</sup>(aq) + 2OH<sup>-</sup>(aq) → Co(OH)<sub>2</sub>(s) ✓ state symbols <b>not</b> required</p> <p><b>Observation</b> blue precipitate/solid ✓</p>	2	<p><b>FULL ANNOTATIONS MUST BE USED THROUGHOUT</b> <b>ALLOW</b> some reactions for Cu<sup>2+</sup> and some for Co<sup>2+</sup> <b>ALLOW</b> equilibrium signs in all equations <b>IGNORE</b> any incorrect initial colours <b>IGNORE</b> state symbols <b>IGNORE</b> an incorrect formula for an observation</p> <p>-----</p> <p><b>ALLOW</b> [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 2OH<sup>-</sup> → Co(OH)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub> + 2H<sub>2</sub>O</p> <p><b>ALLOW</b> full or 'hybrid' equations, e.g. Co<sup>2+</sup> + 2NaOH → Co(OH)<sub>2</sub> + 2Na<sup>+</sup> [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 2OH<sup>-</sup> → Co(OH)<sub>2</sub> + 6H<sub>2</sub>O</p> <p style="text-align: center;">+ 2NaOH → Co(OH)<sub>2</sub> + Na<sub>2</sub>SO<sub>4</sub></p> <p><b>ALLOW</b> any shade of blue <b>IGNORE</b> changes in colour over time</p>
1	(d)	<p><b>REACTION OF Co<sup>2+</sup> WITH excess NH<sub>3</sub>(aq)</b></p> <p><b>Correct balanced equation</b> [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 6NH<sub>3</sub> → [Co(NH<sub>3</sub>)<sub>6</sub>]<sup>2+</sup> + 6H<sub>2</sub>O ✓</p> <p><b>Observation</b> brown/yellow (solution) ✓</p>	2	<p><b>IGNORE</b> initial precipitation of Co(OH)<sub>2</sub></p> <p><b>ALLOW</b> any shade of brown or yellow</p> <p><b>DO NOT ALLOW</b> brown/yellow precipitate for observation</p>
1	(d)	<p><b>REACTION OF Co<sup>2+</sup> WITH HCl(aq)</b></p> <p><b>Correct balanced equation</b> [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 4Cl<sup>-</sup> → [CoCl<sub>4</sub>]<sup>2-</sup> + 6H<sub>2</sub>O ✓</p> <p><b>Observation</b> blue (solution) ✓</p>	2	<p><b>IGNORE</b> mention of different concentrations of HCl</p> <p><b>ALLOW</b> CoCl<sub>4</sub><sup>2-</sup> i.e. no brackets <b>OR</b> Co(Cl)<sub>4</sub><sup>2-</sup> <b>ALLOW</b> [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + 4HCl → [CoCl<sub>4</sub>]<sup>2-</sup> + 6H<sub>2</sub>O + 4H<sup>+</sup> <b>IGNORE</b> Co<sup>2+</sup> + 4Cl<sup>-</sup> → CoCl<sub>4</sub><sup>2-</sup></p> <p><b>ALLOW</b> any shades of blue <b>DO NOT ALLOW</b> blue precipitate for observation</p>
		<b>Total</b>	<b>14</b>	



F325

Mark Scheme

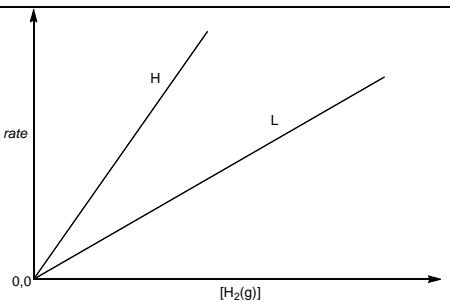
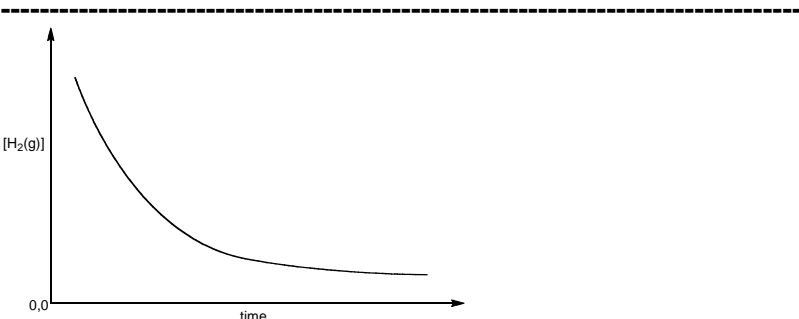
June 2015

Question	Answer	Marks	Guidance																																
2 (a)	<p><b>NOTE: First 3 marks are ONLY available from an expression using [NO]<sup>2</sup></b>  <b>Units are marked independently</b></p> <hr/> <p><b>Using values ON THE CURVE in CORRECT expression 1 mark</b>                      Use of any two correct values for rate and [NO] from graph                      e.g. for <math>5.0 \times 10^{-4}</math> and <math>4.2 \times 10^{-4}</math>,</p> $k = \frac{4.2 \times 10^{-4}}{(2.0 \times 10^{-2}) \times (5.0 \times 10^{-4})^2}$ <p><b>OR</b> <math>4.2 \times 10^{-4} = k(2.0 \times 10^{-2}) \times (5.0 \times 10^{-4})^2 \checkmark</math></p> <hr/> <p><b>Calculation of k 2 marks</b></p> <p><b>FOR 1 MARK</b>                      k calculated <b>correctly</b> from values obtained from graph  <b>BUT NOT</b> in standard form <b>AND/OR</b> more than 2 SF                      e.g. <math>k = \frac{6.0 \times 10^{-4}}{(2.0 \times 10^{-2}) \times (6.0 \times 10^{-4})^2} = 83333.33 \checkmark</math></p> <p><b>OR FOR 2 MARKS</b>                      k calculated <b>correctly</b> from values obtained from graph  <b>AND</b> in standard form <b>AND TO 2 SF</b>                      e.g. <math>k = 83333.33</math> gives <b><math>8.3 \times 10^4 \checkmark</math></b></p> <hr/> <p><b>UNITS FOR 1 MARK:</b>  <math>\text{dm}^6 \text{mol}^{-2} \text{s}^{-1} \checkmark</math></p>	<p>1</p> <p>4</p>	<p><b>Note:</b> rate and [NO] are any correct pair of readings from the graph,                      The [NO] below are the most commonly seen.                      For these [NO] values, these are the <b>ONLY</b> rates allowed</p> <table border="1" data-bbox="1346 408 2101 756"> <thead> <tr> <th>[NO]</th> <th>rate</th> <th>k</th> <th>k</th> </tr> </thead> <tbody> <tr> <td><math>1.0 \times 10^{-4}</math></td> <td><math>0.1 \times 10^{-4}</math> to <math>0.2 \times 10^{-4}</math></td> <td>50000 100000</td> <td><math>5.0 \times 10^4</math> <math>1.0 \times 10^5</math></td> </tr> <tr> <td><math>2.0 \times 10^{-4}</math></td> <td><math>0.6 \times 10^{-4}</math> to <math>0.7 \times 10^{-4}</math></td> <td>75000 87500</td> <td><math>7.5 \times 10^4</math> <math>8.8 \times 10^4</math></td> </tr> <tr> <td><math>3.0 \times 10^{-4}</math></td> <td><math>1.5 \times 10^{-4}</math></td> <td>83333</td> <td><math>8.3 \times 10^4</math></td> </tr> <tr> <td><math>4.0 \times 10^{-4}</math></td> <td><math>2.7 \times 10^{-4}</math></td> <td>84375</td> <td><math>8.4 \times 10^4</math></td> </tr> <tr> <td><math>5.0 \times 10^{-4}</math></td> <td><math>4.2 \times 10^{-4}</math></td> <td>84000</td> <td><math>8.4 \times 10^4</math></td> </tr> <tr> <td><math>6.0 \times 10^{-4}</math></td> <td><math>6.0 \times 10^{-4}</math></td> <td>83333</td> <td><math>8.3 \times 10^4</math></td> </tr> <tr> <td><math>7.0 \times 10^{-4}</math></td> <td><math>8.2 \times 10^{-4}</math></td> <td>83673</td> <td><math>8.4 \times 10^4</math></td> </tr> </tbody> </table> <p><b>IF OTHER values are given, mark using the same principle. If any doubt, contact TL.</b></p> <p><b>NOTE: IGNORE any numbers used from tangents</b></p> <hr/> <p><b>SPECIAL CASES that ALLOW ECF for calculation of k from ONLY ONE of the following (2 marks)</b></p> <ol style="list-style-type: none"> <li>1. Powers of 10 incorrect or absent in initial k expression</li> <li>2. <math>[\text{H}_2]^2[\text{NO}]</math> used instead of <math>[\text{H}_2][\text{NO}]^2</math></li> <li>3. Any value within <math>\pm 0.2</math> of actual values from graph</li> </ol> <hr/> <p><b>ALLOW</b> units in any order, e.g. <math>\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}</math></p>	[NO]	rate	k	k	$1.0 \times 10^{-4}$	$0.1 \times 10^{-4}$ to $0.2 \times 10^{-4}$	50000 100000	$5.0 \times 10^4$ $1.0 \times 10^5$	$2.0 \times 10^{-4}$	$0.6 \times 10^{-4}$ to $0.7 \times 10^{-4}$	75000 87500	$7.5 \times 10^4$ $8.8 \times 10^4$	$3.0 \times 10^{-4}$	$1.5 \times 10^{-4}$	83333	$8.3 \times 10^4$	$4.0 \times 10^{-4}$	$2.7 \times 10^{-4}$	84375	$8.4 \times 10^4$	$5.0 \times 10^{-4}$	$4.2 \times 10^{-4}$	84000	$8.4 \times 10^4$	$6.0 \times 10^{-4}$	$6.0 \times 10^{-4}$	83333	$8.3 \times 10^4$	$7.0 \times 10^{-4}$	$8.2 \times 10^{-4}$	83673	$8.4 \times 10^4$
[NO]	rate	k	k																																
$1.0 \times 10^{-4}$	$0.1 \times 10^{-4}$ to $0.2 \times 10^{-4}$	50000 100000	$5.0 \times 10^4$ $1.0 \times 10^5$																																
$2.0 \times 10^{-4}$	$0.6 \times 10^{-4}$ to $0.7 \times 10^{-4}$	75000 87500	$7.5 \times 10^4$ $8.8 \times 10^4$																																
$3.0 \times 10^{-4}$	$1.5 \times 10^{-4}$	83333	$8.3 \times 10^4$																																
$4.0 \times 10^{-4}$	$2.7 \times 10^{-4}$	84375	$8.4 \times 10^4$																																
$5.0 \times 10^{-4}$	$4.2 \times 10^{-4}$	84000	$8.4 \times 10^4$																																
$6.0 \times 10^{-4}$	$6.0 \times 10^{-4}$	83333	$8.3 \times 10^4$																																
$7.0 \times 10^{-4}$	$8.2 \times 10^{-4}$	83673	$8.4 \times 10^4$																																

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
2	(b)	(i)	 <p>One straight upward line <b>AND</b> starting at 0,0 ✓</p> <p>2nd straight upward line starting at 0,0 and steeper <b>AND</b> Steeper line labelled H <b>OR</b> less steep line labelled L ✓</p>	2	<p><b>ALLOW</b> 1 mark for two upward sloping curves starting at origin <b>AND</b> upper curve labelled H and lower curve labelled L</p> <p><b>NOTE: ALLOW</b> some leeway for lines starting from origin</p> <p><b>ALLOW</b> straight line not drawn with ruler, i.e. is a straight line rather than a curve</p> <p><b>ALLOW</b> similar labelling as long as it is clear which line is which</p>
2	(b)	(ii)	increases ✓	1	
2	(c)		<p><b>MARK INDEPENDENTLY</b></p>  <p>Downward curve ✓</p> <p>Half life is constant ✓</p>	2	<p><b>ALLOW</b> curve touching y axis</p> <p><b>ALLOW</b> curve touching x axis</p> <p><b>ALLOW</b> Two half lives are the same</p> <p><b>IGNORE</b> 'regular' half life (not necessarily the same)</p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
2	(d)	(i)	$\text{H}_2 + \text{N}_2\text{O} \rightarrow \text{N}_2 + \text{H}_2\text{O} \checkmark$	1	<b>ONLY</b> correct answer <b>DO NOT ALLOW</b> multiples
2	(d)	(ii)	Steps 1 <b>AND</b> Step 2 together give $2\text{NO} + \text{H}_2 \checkmark$	1	<b>ALLOW</b> Step 1 <b>AND</b> Step 2 together give species in same ratio as in rate equation  <b>ALLOW</b> rate-determining step/slow step for Step 2  <b>ALLOW</b> $\text{H}_2$ reacts with $\text{N}_2\text{O}_2$ which is formed from $2\text{NO}$  <b>NOTE:</b> The response must link Step 1 with Step 2 Steps can be referenced from the species in each step
			<b>Total</b>	<b>11</b>	

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
3	(a)	(i)	5 mol/molecules (of gas) forms 3 mol/molecules (of gas) ✓	1	<b>ALLOW</b> reaction forms fewer moles/molecules <b>IF</b> stated, numbers of molecules <b>MUST</b> be correct <b>IGNORE</b> comments related to $\Delta G$ <b>OR</b> disorder (even if wrong)
3	(a)	(ii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b> <b>IF answer =(+)<math>131 \text{ (J K}^{-1} \text{ mol}^{-1})</math>, award 2 marks</b></p> <p>-----</p> <p><math>-164 = (186 + 2 \times 206) - (4 \times S + 238)</math> <b>OR</b> <math>4 S = 164 + (186 + 2 \times 206) - 238</math> ✓</p> <p><math>S = (+)131 \text{ (J K}^{-1} \text{ mol}^{-1})</math> ✓</p>	2	<p><b>NOTE:</b> IF any values are omitted, <b>DO NOT AWARD</b> any marks. e.g. <math>-164</math> may be missing</p> <p><b>ALLOW FOR 1 mark</b></p> <p><math>-131</math> wrong final sign  <math>49</math> wrong sign for 164  <math>79.5</math> no use of 2  <math>524</math> no division by 4  <math>38</math> wrong sign for 186  <math>-75</math> wrong sign for 206  <math>250</math> wrong sign for 238</p> <p>Any other number:  <b>CHECK</b> for <b>ECF</b> from 1st marking point for expressions using <b>ALL</b> values with <b>ONE</b> error only  e.g. one transcription error:, e.g.146 for 164</p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
3	(a)	(iii)	<p><b>NOTE: DO NOT ALLOW answer to 3(a)(ii) for <math>\Delta G</math> calculation</b></p> <p>-----</p> <p><b><math>\Delta G</math> calculation: 2 marks</b></p> <p><math>\Delta G = -234 - 298 \times -0.164 \checkmark</math></p> <p><math>= -185 \text{ (kJ mol}^{-1}\text{)} \checkmark</math></p> <p><b>IGNORE</b> units (even if wrong) <math>-185</math> subsumes 1st mark)</p> <p><b>Feasibility comment for negative <math>\Delta G</math> answer: 1 mark</b> (Forward) reaction is feasible / spontaneous <b>AND <math>\Delta G &lt; 0 / \Delta H - T\Delta S &lt; 0 \checkmark</math></b></p>	<p><b>2</b></p> <p><b>1</b></p>	<p><b>ALLOW</b> <math>\Delta G</math> correctly calculated from 3 SF up to calculator value of <math>-185.128</math></p> <p><b>ALLOW</b> working in J, <i>ie</i>: <math>\Delta G = -234000 - 298 \times -164 \checkmark</math> <math>= -185000 \text{ (J mol}^{-1}\text{)} \checkmark</math></p> <p><b>ALLOW</b> 1 mark for use of 25 <b>OR</b> mixture of kJ and J, e.g. <math>\Delta G = -234 - 25 \times -0.164 = -229.9</math> <math>\Delta G = -234 - 298 \times -164 = +48638</math></p> <p><b>ALLOW ECF</b> if calculated value for <math>\Delta G</math> is +ve Then 'correct' response for 3rd mark would be <b>not feasible/not spontaneous AND <math>\Delta G &gt; 0 / \Delta H - T\Delta S &gt; 0</math></b></p>
3	(a)	(iv)	<p><math>(\Delta G =) -234 - 1427 \times \frac{-164}{1000} = 0 \text{ (calculator } 0.028\text{(kJ) OR } 28 \text{ (J)) } \checkmark</math></p> <p><b>2<sup>nd</sup> mark only available if 1<sup>st</sup> mark has been awarded</b></p> <p>(Above <math>1427\text{K}/1154^{\circ}\text{C}</math>), reaction is <b>not feasible/not spontaneous</b>✓ <b>OR</b> <math>1427 \text{ K}</math> is maximum temperature that reaction happens</p>	<p><b>2</b></p>	<p><b>ALLOW</b> (When <math>\Delta G = 0</math>) <math>T = \frac{-234}{-0.164} = 1427 \text{ K OR } \frac{-234000}{-164} = 1427 \text{ K}</math></p> <p>For 2nd mark, <b>IF</b> <math>\Delta G</math> is +ve from (a)(iii) <b>ALLOW ECF</b> for: Above <math>1427 \text{ K}</math>, reaction is feasible / spontaneous <b>OR</b> <math>1427 \text{ K}</math> is minimum temperature that reaction happens</p> <p><b>IGNORE LESS feasible</b></p> <p><b>IGNORE</b> comparisons of the signs of <math>T\Delta S</math> and <math>\Delta H</math>, <i>e.g</i> <b>IGNORE</b> <math>T\Delta S</math> is more negative than <math>\Delta H</math></p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
3	(b)	(i)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF answer = 57.6 dm<sup>3</sup> mol<sup>-1</sup>, award 6 marks</b>  <b>IF answer = 57.6 with incorrect units, award 5 mark</b></p> <p>-----</p> <p><b>Equilibrium amounts in mol                      2 MARKS</b>  <math>n(\text{SO}_2) = 0.180</math> (mol)    <b>ALL 3</b> correct: ✓✓  <math>n(\text{O}_2) = 0.090</math> (mol)    <b>ANY 2</b> correct: ✓  <math>n(\text{SO}_3) = 0.820</math> (mol)</p> <p><b>Equilibrium concentrations (moles × 4)      1 MARK</b></p> <p><math>\text{SO}_2 = 0.720</math> (mol dm<sup>-3</sup>)  <b>AND</b> <math>\text{O}_2 = 0.360</math> (mol dm<sup>-3</sup>)  <b>AND</b> <math>\text{SO}_3 = 3.28</math> (mol dm<sup>-3</sup>) ✓</p> <p><b>Calculation of <math>K_c</math> and units                      3 MARKS</b></p> $K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]} \quad \text{OR} \quad \frac{3.28^2}{(0.720)^2 \times (0.360)} \quad \checkmark$ <p><math>= 57.6</math> ✓ dm<sup>3</sup> mol<sup>-1</sup> ✓</p> <p><i>At least 3SF is required</i></p>		<p><b>FULL ANNOTATIONS NEEDED</b></p> <p><b>IF</b> there is an alternative answer, check to see if there is any <b>ECF</b> credit possible using working below</p> <p>-----</p> <p><b>ALLOW ECF</b> from incorrect moles of <math>\text{SO}_2</math>, <math>\text{O}_2</math> <b>AND</b> <math>\text{SO}_2</math></p> <p><b>ALL three</b> concentrations required for this mark</p> <p><b>ALLOW ECF</b> from incorrect concentrations</p> <p><b>NO ECF</b> for numerical value with a square missing</p> <p><b>6</b> For <math>K_c</math>, <b>ALLOW</b> 3 significant figures up to calculator value of 57.64746228 correctly rounded</p> <p>For units, <b>ALLOW</b> mol<sup>-1</sup> dm<sup>3</sup>  <b>DO NOT ALLOW</b> dm<sup>3</sup>/mol</p> <p><b>ALLOW ECF</b> from incorrect <math>K_c</math> expression for both calculation and units</p> <p><b>COMMON ERRORS</b>  0.0294    <b>3 marks + units mark</b>  from <math>\text{SO}_2 = 0.820</math>, <math>\text{O}_2 = 0.410</math>, <math>\text{SO}_3 = 0.180</math> (mol)</p>
3	(b)	(ii)	(Pressure) decreases <b>AND</b> fewer molecules/moles ✓	1	For fewer moles, <b>ALLOW</b> 3 mol → 2 mol <b>ALLOW</b> more moles of reactants

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
3	(b)	(iii)	$\Delta H$ is negative / '- ' / -ve <b>AND</b> yield of $\text{SO}_3$ decreases ✓	1	<b>IGNORE</b> exothermic and endothermic
3	(b)	(iv)	<p><b>IGNORE</b> le Chatelier responses</p> <p>-----</p> <p><b>Each marking point is independent</b></p> <p><math>K_c</math>  <math>K_c</math> does not change (with pressure/ concentration) ✓</p> <p><b>Comparison of conc terms with more <math>\text{O}_2</math></b>  <math>[\text{O}_2]</math>/concentration of oxygen is greater  <b>OR</b> denominator/bottom of <math>K_c</math> expression is greater ✓</p> <p><b>QWC: yield of <math>\text{SO}_3</math> linked to <math>K_c</math></b>  (Yield of) <math>\text{SO}_3</math> is greater/increases  <b>AND</b>  numerator/top of <math>K_c</math> expression is greater/increases ✓</p>	3	<p><b>FULL ANNOTATIONS NEEDED</b></p> <p><b>ALLOW <math>K_c</math> only</b> changes with temperature</p> <p><b>IF 1<sup>st</sup> marking point has been awarded, IGNORE</b> comments about '<math>K_c</math> decreasing' or '<math>K_c</math> increasing' and assume that this refers to how the ratio subsequently changes. i.e <b>DO NOT CON</b> 1<sup>st</sup> marking point.</p> <p><b>IGNORE</b> <math>\text{O}_2</math> is greater/increases</p> <p><b>ALLOW</b>  <b>(Yield of) <math>\text{SO}_3</math> is greater/increases</b>  <b>AND</b>  to reach/restore <math>K_c</math> value ✓</p>
			<b>Total</b>	<b>19</b>	

F325

Mark Scheme

June 2015

Question		Answer	Marks	Guidance
4	(a)	Proton/H <sup>+</sup> donor <b>AND</b> Partially dissociates/ionises ✓	1	
4	(b)	<b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b> <b>IF</b> answer = 13.7(0), award <b>2</b> marks ----- $[H^+] = \frac{1.00 \times 10^{-14}}{0.5(00)}$ <b>OR</b> $2(.00) \times 10^{-14}$ (mol dm <sup>-3</sup> ) ✓  $pH = -\log 2(.00) \times 10^{-14} = \mathbf{13.7(0)}$ ✓	2	For pOH method; <b>ALLOW</b> $pOH = -\log[OH^-] = 0.3(0)$ ✓ (calculator 0.301029995)  <b>ALLOW</b> $pH = 14 - 0.3 = 13.7$ ✓  <b>ALLOW</b> 13.7 up to calculator value of 13.69897 correctly rounded.  <b>ALLOW ECF</b> from incorrect $[H^+(aq)]$ provided that $pH > 7$
4	(c)	(i) $(K_a =) \frac{[H^+][C_2H_5COO^-]}{[C_2H_5COOH]}$ ✓	1	<b>IGNORE</b> $\frac{[H^+]^2}{[C_2H_5COOH]}$ <b>OR</b> $\frac{[H^+][A^-]}{[HA]}$  <b>ALLOW</b> $[H_3O^+]$ for $[H^+]$  <b>IGNORE</b> state symbols



F325

Mark Scheme

June 2015

Question		Answer	Marks	Guidance
4	(c) (ii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF answer = 2.9(0), award 3 marks</b></p> <p>-----</p> <p><math>[C_2H_5COOH] = 0.12(0) \text{ mol dm}^{-3} \checkmark</math></p> <p><math>[H^+] = \sqrt{K_a \times [C_2H_5COOH]} = \sqrt{1.35 \times 10^{-5} \times 0.12(0)}</math></p> <p><b>OR</b> <math>1.27 \times 10^{-3} \text{ (mol dm}^{-3}) \checkmark</math></p> <p><math>\text{pH} = -\log 1.27 \times 10^{-3} = \mathbf{2.9(0)} \checkmark</math></p> <p><b>NOTE:</b> The final two marks are <b>ONLY</b> available from attempted use of <math>K_a</math> <b>AND</b> <math>[C_2H_5COOH]</math></p>	3	<p><b>ALLOW</b> HA for <math>C_2H_5COOH</math> and <math>A^-</math> for <math>C_2H_5COO^-</math></p> <p><b>ALLOW ECF</b> from incorrectly calculated <math>[C_2H_5COOH]</math></p> <p><b>ALLOW</b> <math>1.27 \times 10^{-3}</math> to calculator value of <math>1.272792206 \times 10^{-3}</math> correctly rounded</p> <p><b>ALLOW</b> <math>2.9(0) \times 10^{-3}</math> to calculator value of 2.895242493 correctly rounded</p> <p><b>ALLOW</b> use of quadratic equation which gives same answer of 2.90 from <math>0.120 \text{ mol dm}^{-3}</math></p> <p>-----</p> <p><b>COMMON ERRORS (MUST be to AT LEAST 2 DP unless 2<sup>nd</sup> decimal place is 0)</b></p> <p><b>pH = 2.59 2 marks</b>  <math>-\log \sqrt{(1.35 \times 10^{-5} \times 0.480)}</math> <i>Original conc</i></p> <p><b>pH = 5.79 2 marks</b>  <math>-\log(1.35 \times 10^{-5} \times 0.120)</math> <i>No <math>\sqrt</math></i></p> <p><b>pH = 5.19 1 mark</b>  <math>-\log(1.35 \times 10^{-5} \times 0.480)</math> <i>Original conc, no <math>\sqrt</math></i></p> <p><b>pH = 4.87 0 marks</b>  <math>-\log(1.35 \times 10^{-5}) = 4.87</math> <i><math>-\log K_a</math></i></p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
4	(d)	(i)	$2\text{C}_2\text{H}_5\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{C}_2\text{H}_5\text{COONa} + \text{CO}_2 + \text{H}_2\text{O} \checkmark$	1	<b>IGNORE</b> state symbols and use of equilibrium sign <b>FOR</b> $\text{CO}_2 + \text{H}_2\text{O}$ <b>ALLOW</b> $\text{H}_2\text{CO}_3$ <b>ALLOW</b> $\text{C}_2\text{H}_5\text{COO}^-\text{Na}^+$ <b>OR</b> $\text{C}_2\text{H}_5\text{COO}^- + \text{Na}^+$ <b>BUT BOTH</b> + and – charges <b>must</b> be shown <b>ALLOW</b> $\text{NaC}_2\text{H}_5\text{COO}$
4	(d)	(ii)	$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} \checkmark$	1	<b>ALLOW</b> $\text{C}_2\text{H}_5\text{COOH} + \text{OH}^- \rightarrow \text{C}_2\text{H}_5\text{COO}^- + \text{H}_2\text{O}$ <b>IGNORE</b> state symbols
4	(e)	(i)	$\text{pH} = -\log 1.35 \times 10^{-5} = 4.87 \checkmark$	1	<b>ONLY</b> correct answer <b>DO NOT ALLOW</b> 4.9 (Question asks for 2 DP)
4	(e)	(ii)	<b>Added ammonia</b> $\text{C}_2\text{H}_5\text{COOH}$ removes added $\text{NH}_3$ /alkali/base <b>OR</b> $\text{C}_2\text{H}_5\text{COOH} + \text{NH}_3 / \text{OH}^- \rightarrow$ <b>OR</b> $\text{NH}_3$ /alkali reacts with/accepts $\text{H}^+$ <b>OR</b> $\text{H}^+ + \text{NH}_3 \rightarrow$ <b>OR</b> $\text{H}^+ + \text{OH}^- \rightarrow \checkmark$  Equilibrium $\rightarrow \text{C}_2\text{H}_5\text{COO}^-$ <b>OR</b> Equilibrium $\rightarrow$ right $\checkmark$	2	<b>ALLOW</b> use of HA/weak acid/acid for $\text{C}_2\text{H}_5\text{COOH}$ ;  <b>ALLOW</b> use of $\text{NH}_4\text{OH}$ for $\text{NH}_3$  <b>ALLOW</b> $\text{A}^-$ for $\text{C}_2\text{H}_5\text{COO}^-$  <b>ASSUME</b> that equilibrium applies to that supplied in the question, i.e. <b>IGNORE</b> any other equilibria

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
4	(e)	(iii)	<p><b>CHECK WORKING CAREFULLY AS CORRECT NUMERICAL ANSWER IS POSSIBLE FROM WRONG VALUES</b></p> <p>=====</p> <p><b>ALLOW</b> HA and A<sup>-</sup> throughout  <b>Amount of Mg (1 mark)</b>  <math>n(\text{Mg}) = \frac{6.075}{24.3} = 0.25(0) \text{ mol} \checkmark</math></p> <p>-----</p> <p><b>Moles/concentrations(2 marks)</b></p> <p><math>n(\text{C}_2\text{H}_5\text{COOH}) = 1.00 - (2 \times 0.25) = 0.50 \text{ (mol)} \checkmark</math>  <math>(\text{C}_2\text{H}_5\text{COO}^-) = 1.00 + (2 \times 0.25) = 1.50 \text{ (mol)} \checkmark</math></p> <p>-----</p> <p><b>[H<sup>+</sup>] and pH (1 mark)</b>  <math>[\text{H}^+] = 1.35 \times 10^{-5} \times \frac{0.50}{1.50} \text{ OR } 4.5 \times 10^{-6} \text{ (mol dm}^{-3}\text{)}</math>  <math>\text{pH} = -\log 4.5 \times 10^{-6} = 5.35 \text{ 2 dp required } \checkmark</math></p> <p><b>NOTE: IF there is no prior working,</b>  <b>ALLOW 4 MARKS</b> for <math>[\text{H}^+] = 1.35 \times 10^{-5} \times \frac{0.50}{1.50}</math> <b>AND</b> <math>\text{pH} = 5.35</math></p> <p><b>IF the ONLY response is pH = 5.35, award 1 mark ONLY</b></p>	4	<p><b>FULL ANNOTATIONS MUST BE USED</b></p> <p>-----</p> <p><b>For <math>n(\text{Mg})</math>, 1 mark</b>  <b>ALLOW ECF</b> for <b>ALL</b> marks below from incorrect <math>n(\text{Mg})</math></p> <p><b>ECF ONLY</b> available from concentrations that have</p> <ul style="list-style-type: none"> <li>subtracted 0.50 <b>OR</b> 0.25 from 1 for <math>[\text{C}_2\text{H}_5\text{COOH}]</math></li> <li>added 0.50 <b>OR</b> 0.25 to 1 for <math>[\text{C}_2\text{H}_5\text{COO}^-]</math></li> </ul> <p><i>i.e.</i>  <b>For moles/concentration 1 mark (1 mark lost)</b>  <b>1.</b> <math>n(\text{C}_2\text{H}_5\text{COOH}) = 0.75</math> <b>AND</b> <math>n(\text{C}_2\text{H}_5\text{COO}^-) = 1.25</math>  <b>2.</b> <math>n(\text{C}_2\text{H}_5\text{COOH}) = 0.50</math> <b>AND</b> <math>n(\text{C}_2\text{H}_5\text{COO}^-) = 1.25</math>  <b>3.</b> <math>n(\text{C}_2\text{H}_5\text{COOH}) = 0.75</math> <b>AND</b> <math>n(\text{C}_2\text{H}_5\text{COO}^-) = 1.50</math></p> <p>-----</p> <p><b>ALLOW ECF ONLY</b> for the following giving 1 additional mark and a total of <b>3 marks</b></p> <p><b>1.</b> <math>[\text{H}^+] = 1.35 \times 10^{-5} \times \frac{0.75}{1.25}</math> <math>\text{pH} = -\log 8.1 \times 10^{-6} = 5.09</math></p> <p><b>2.</b> <math>[\text{H}^+] = 1.35 \times 10^{-5} \times \frac{0.50}{1.25}</math> <math>\text{pH} = -\log 5.4 \times 10^{-6} = 5.27</math></p> <p><b>3.</b> <math>[\text{H}^+] = 1.35 \times 10^{-5} \times \frac{0.75}{1.50}</math> <math>\text{pH} = -\log 6.75 \times 10^{-6} = 5.17</math></p>
			<p><b>Award a maximum of 1 mark (for <math>n(\text{Mg}) = 0.25 \text{ mol}</math>) for:</b>  pH value from <math>K_a</math> square root approach (weak acid pH)  pH value from <math>K_w/10^{-14}</math> approach (strong base pH)</p> <p>-----</p> <p><b>ALLOW</b> alternative approach based on Henderson–Hasselbalch equation for final 1 mark</p> <p><math>\text{pH} = \text{p}K_a + \log \frac{1.5}{0.5} \text{ OR } \text{p}K_a - \log \frac{0.5}{1.5}</math> <math>\text{pH} = 4.87 + 0.48 = 5.35 \checkmark</math> <b>ALLOW</b> <math>-\log K_a</math> for <math>\text{p}K_a</math></p>		
			<b>Total</b>	<b>16</b>	

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
5	(a)	(i)	<p> <math>\text{Fe}^+(\text{g}) + 2\text{I}(\text{g}) + \text{e}^-</math> ✓  <math>\text{Fe}(\text{g}) + 2\text{I}(\text{g})</math> ✓  <math>\text{Fe}(\text{s}) + \text{I}_2(\text{s})</math> ✓  <math>\text{Fe}^{2+}(\text{g}) + 2\text{I}^-(\text{g})</math> ✓                 </p> <p>Mark each marking point independently</p>	4	<p>Correct species <b>AND</b> state symbols required for each marks</p> <p><b>ALLOW</b> e for e<sup>-</sup></p> <p><b>TAKE CARE:</b> In top left box, e<sup>-</sup> may be in centre of response and more difficult to see than at end.</p> <p>There is only <b>ONE</b> correct response for each line  <i>From the gaps in the cycle, there is <b>NO</b> possibility of any ECF</i></p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
5	(a)	(ii)	<p>(The enthalpy change that accompanies) the <b>formation of one mole</b> of a(n ionic) compound from its <b>gaseous ions</b> (under standard conditions) ✓✓</p> <p>Award marks as follows.  <b>1st mark: formation of compound from gaseous ions</b>  <b>2nd mark: one mole for compound only</b></p> <p><b>DO NOT ALLOW</b> 2nd mark without 1st mark</p> <p><b>DO NOT ALLOW</b> any marks for a definition for enthalpy change of <b>formation BUT</b> note the two concessions in guidance</p>	2	<p><b>IGNORE</b> 'Energy needed' <b>OR</b> 'energy required'  <b>ALLOW one mole</b> of compound is <b>formed/made</b> from its <b>gaseous ions</b>  <b>ALLOW</b> as alternative for compound: lattice, crystal, substance, solid</p> <p><b>IGNORE:</b> <math>\text{Fe}^{2+}(\text{g}) + 2\text{I}^{-}(\text{g}) \longrightarrow \text{FeI}_2(\text{s})</math>  (Part of cycle)</p> <p><b>ALLOW</b> 1 mark for absence of 'gaseous' only, i.e. the <b>formation of one mole</b> of a(n ionic) compound from its <b>ions</b> (under standard conditions) ✓</p> <p><b>ALLOW</b> 1 mark for <math>\Delta H_f</math> definition with 'gaseous': the <b>formation of one mole</b> of a(n ionic) compound from its <b>gaseous</b> elements (under standard conditions) ✓</p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
5	(a)	(iii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF answer = <math>-2473 \text{ (kJ mol}^{-1}\text{)}</math> award 2 marks</b></p> <p>-----  <math>(-113) = 416 + (2 \times +107) + 759 + 1561 + (2 \times -295) + \Delta H_{LE}(\text{FeI}_2)</math>  <b>OR</b>  <math>\Delta H_{LE}(\text{FeI}_2) =</math>  <math>-113 - (416 + (2 \times +107) + 759 + 1561 + (2 \times -295))</math>  <b>OR</b> <math>-113 - 2360 \checkmark</math></p> <p><math>= -2473 \checkmark \text{ (kJ mol}^{-1}\text{)}</math></p>	2	<p><b>IF</b> there is an alternative answer, check to see if there is any <b>ECF</b> credit possible using working below.  <b>See list below for marking of answers from common errors</b></p> <p>-----  <b>ALLOW</b> for 1 mark:</p> <p>+2473 wrong sign  -2661 107 and -295 used instead of <math>2 \times 107</math> and <math>2 \times -295</math>  -2366 +107 used instead of <math>2 \times 107</math>  -2768 -295 used instead of <math>2 \times -295</math>  -3653 wrong sign for 295  -2247 wrong sign for 113  -1641 wrong sign for 416  -2045 wrong sign for <math>2 \times 107</math>  -955 wrong sign for 750  +649 wrong sign for 1561  -3653 wrong sign for <math>2 \times -295</math></p> <p>Any other number:  <b>CHECK</b> for <b>ECF</b> from 1st marking point for expressions with <b>ONE</b> error only  e.g. one transcription error: e.g. +461 instead of +416</p>
5	(b)	(i)	<p><math>\text{Fe}^{2+}: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 \checkmark</math></p> <p><math>\text{Br}^-: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 \checkmark</math></p>	2	<p><b>ALLOW</b> 4s before 3d, ie <math>1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6</math>  <b>ALLOW</b> <math>1s^2</math> written after answer prompt (ie <math>1s^2</math> twice)  <b>ALLOW</b> upper case D, etc and subscripts, e.g. ....4S<sub>2</sub>3D<sub>1</sub>  <b>ALLOW</b> for <math>\text{Fe}^{2+}</math> .....4s<sup>0</sup>  <b>DO NOT ALLOW</b> [Ar] as shorthand for <math>1s^2 2s^2 2p^6 3s^2 3p^6</math></p> <p>Look carefully at <math>1s^2 2s^2 2p^6 3s^2 3p^6</math> – there may be a mistake</p>

F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
5	(b)	(ii)	<p>With Cl<sub>2</sub> <b>AND</b> Br<sub>2</sub> <b>AND</b> I<sub>2</sub> products are Fe<sup>2+</sup> (AND halide ion) FeCl<sub>2</sub> <b>AND</b> FeBr<sub>2</sub> <b>AND</b> FeI<sub>2</sub> ✓</p> <p><b>OR</b> Evidence that <b>two</b> electrode potentials have been compared for at least <b>ONE</b> reaction, ✓ e.g. Fe -0.44 <b>AND</b> Cl<sub>2</sub> +1.36 e.g. Iron has more/most negative electrode potential</p> <p>With Cl<sub>2</sub> <b>AND</b> Br<sub>2</sub>, products are Fe<sup>3+</sup> (AND halide ion) FeCl<sub>3</sub> <b>AND</b> FeBr<sub>3</sub> ✓</p>	3	<p><b>FULL ANNOTATIONS NEEDED</b></p> <p><b>ALLOW</b> products within equations (even if equations are not balanced) <b>IF stated, IGNORE reactants</b></p> <p><b>ALLOW</b> response in terms of positive 'cell reactions', e.g. Fe + Cl<sub>2</sub> → Fe<sup>2+</sup> + 2Cl<sup>-</sup> E = (+)1.80 V</p> <p><b>IGNORE</b> comments about reducing and oxidising agents and electrons</p>
5	(c)		<p><b>BOTH EQUATIONS REQUIRE IONS PROVIDED IN QUESTION</b></p> <p><b>Reaction 1: 2 marks</b> <b>1st mark for ALL CORRECT species</b> e.g.: Fe<sup>2+</sup> + NO<sub>3</sub><sup>-</sup> + H<sup>+</sup> → Fe<sup>3+</sup> + NO + H<sub>2</sub>O</p> <p><b>2nd mark for CORRECT balanced equation</b> 3Fe<sup>2+</sup> + NO<sub>3</sub><sup>-</sup> + 4H<sup>+</sup> → 3Fe<sup>3+</sup> + NO + 2H<sub>2</sub>O ✓✓</p> <p>-----</p> <p><b>Reaction 2: 1 mark</b> [Fe(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> + NO → [Fe(H<sub>2</sub>O)<sub>5</sub>NO]<sup>2+</sup> + H<sub>2</sub>O ✓</p>	3	<p><b>ALLOW</b> correct multiples throughout <b>ALLOW equilibrium signs in all equations</b></p> <p>For 1st mark, <b>IGNORE</b> e<sup>-</sup> present</p> <p><b>Check carefully for correct charges</b></p>
			[Fe(H	<b>Total</b>	<b>16</b>

F325

Mark Scheme

June 2015

Question			Answer	Marks									
6	(a)		<table border="1"> <tr> <td><math>E^\circ</math></td> <td>redox system</td> </tr> <tr> <td>Most negative</td> <td>E</td> </tr> <tr> <td></td> <td>C</td> </tr> <tr> <td>Least negative</td> <td>D</td> </tr> </table> <p style="text-align: center;">✓</p>	$E^\circ$	redox system	Most negative	E		C	Least negative	D	1	ALL 3 correct for 1 mark
$E^\circ$	redox system												
Most negative	E												
	C												
Least negative	D												
6	(b)	(i)	pH = 0 ✓	1	Guidance								
6	(b)	(ii)	<p>H redox system is more negative (e.g. has a more -ve <math>E</math> OR less +ve <math>E</math> OR is -ve electrode) OR H redox system releases electrons (May be in equation, e.g. <math>H_2 \rightarrow 2H^+ + 2e^-</math>) ✓</p> <p>Equilibrium <b>shifts</b> to increase <math>[H^+]</math> OR <math>H^+</math> OR standard hydrogen equation <b>shifts</b> to increase <math>[H^+]</math> OR <math>H^+</math> ✓</p>	2	<p><b>ALLOW ORA</b>, ie Ag redox system (D) has more positive <math>E</math> / less negative <math>E</math></p> <p><b>ALLOW</b> equilibrium sign</p> <p><b>IGNORE</b> H is more reactive <b>ORA</b></p> <p><b>IGNORE</b> direction of equilibrium shift</p>								
6	(b)	(iii)	$H_2 + 2Ag^+ \rightarrow 2Ag + 2H^+$ ✓	1	<p><b>ALLOW</b> multiples e.g. <math>\frac{1}{2}H_2 + Ag^+ \rightarrow Ag + H^+</math></p> <p>State symbols <b>NOT</b> required <b>ALLOW</b> equilibrium sign</p>								
6	(c)	(i)	$\begin{matrix} - & & H_2O & \rightleftharpoons & HCN & & OH^- \\ \text{AND Base}_2 & & \text{Acid 1} & & \text{Acid 2}_+ & & \text{Base 1 } \checkmark \end{matrix}$ <p>CN</p>	1	<p>State symbols <b>NOT</b> required <b>ALLOW</b> CNH and <math>HO^-</math> (i.e. any order)</p> <p><b>ALLOW</b> 1 and 2 labels the other way around. <b>ALLOW</b> 'just acid' and 'base' labels throughout if linked by lines so that it is clear what the acid-base pairs are.</p>								





F325

Mark Scheme

June 2015

Question			Answer	Marks	Guidance
6	(d)	(v)	oxidation: C from $-2$ to $+4$ '+' sign <b>not</b> required ✓  reduction: O from $0$ to $-2$ ✓	2	<b>ALLOW</b> $2-$ and $4+$ <b>ALLOW</b> $C^{2-} \rightarrow C^{4+}$  <b>ALLOW</b> $0$ and $2-$ <b>ALLOW</b> $O^0 \rightarrow O^{2-}$  <b>ALLOW</b> 1 mark if correct oxidation numbers shown for <b>BOTH</b> C and O but wrong way around <i>(ie C on reduction line and O on oxidation line)</i>  <b>IGNORE</b> $O_2$ reduced <b>IGNORE</b> any reference to electron transfer <i>(not in question)</i>
			<b>Total</b>	<b>13</b>	

F325

Mark Scheme

June 2015

Question		Answer	Marks	Guidance
7	(a)	<p>Equations can be in either order</p> $\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH} \checkmark$ $\text{NaFeO}_2 + 2\text{H}_2\text{O} \rightarrow \text{Fe}(\text{OH})_3 + \text{NaOH} \checkmark$	2	<p><b>ALLOW</b> multiples throughout  <b>IGNORE</b> state symbols</p> <p><b>ALLOW</b> <math>\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{Na}^+ + 2\text{OH}^-</math></p> <p><b>DO NOT ALLOW</b> equations with uncancelled species.  e.g. <math>\text{Na}_2\text{O} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\text{O}</math></p> <p><b>ALLOW</b> <math>2\text{NaFeO}_2 + \text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + 2\text{NaOH}</math>  <b>OR</b> <math>2 + \text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + 2\text{Na}^+ + 2\text{OH}^- \checkmark</math></p>

2NaFeO

F325

Mark Scheme

June 2015

Question	Answer	Marks	Guidance
7 (b)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF</b> answer = 33.7%, award <b>6 marks</b>.  <b>IF</b> there is an alternative answer, check to see if there is any <b>ECF</b> credit possible using working below</p> <p>-----</p> <p>amount <math>\text{S}_2\text{O}_3^{2-}</math> used = <math>0.1000 \times \frac{25.50}{1000}</math>  = <b><math>2.550 \times 10^{-3}</math></b> (mol) ✓</p> <p>amount <math>\text{I}_2</math> = <math>2.550 \times 10^{-3} \div 2</math>  = <b><math>1.275 \times 10^{-3}</math></b> (mol) ✓</p> <p>amount <math>\text{CrO}_4^{2-}</math>  <math>\frac{2}{3} \times 1.275 \times 10^{-3}</math> <b>OR</b> <math>1.275 \times 10^{-3} \div 1.5</math>  = <b><math>8.5(00) \times 10^{-4}</math></b> (mol) ✓</p> <p>amount <math>\text{CrO}_4^{2-}</math> in original <math>1000 \text{ cm}^3</math> = <math>40 \times 8.5(00) \times 10^{-4}</math>  = <b><math>3.4(00) \times 10^{-2}</math></b> mol ✓</p> <p>Mass of Cr/<math>\text{Cr}^{3+}</math> in ore = <math>52.0 \times 3.4(00) \times 10^{-2}</math> g  = <b>1.768 g</b> ✓</p> <p>percentage Cr in ore = <math>\frac{1.768}{5.25} \times 100</math>  = <b>33.7%</b> ✓</p> <p><b>MUST</b> be to <b>one</b> decimal place (in the question)</p>	6	<p><b>FULL ANNOTATIONS MUST BE USED</b></p> <p><b>IF</b> a step is omitted but subsequent step subsumes previous, then award mark for any missed step  <b>Working: at least 3 SF throughout until final % mark</b>  <b>BUT</b> ignore trailing zeroes, ie for 0.490 allow 0.49</p> <p>-----</p> <p><b>ECF</b> answer above <math>\div 2</math></p> <p><b>ECF</b> answer above <math>\div 1.5</math></p> <p><b>ECF</b> answer above <math>\times 40</math></p> <p><b>ECF</b> answer above <math>\times 52.0</math>  <b>IMPORTANT:</b> The last two marks are <b>ONLY</b> available by using 52.0 for Cr</p> <p>-----</p> <p><b>Common ECFs:</b>  <b>0.8%</b> <math>\times 40</math> missing            5 marks (scaling error)  <b>0.84%</b>    <math>\times 40</math> missing    4 marks (scaling error and 2 DP)  <b>33.68%</b>    5 marks (2 DP)  <b>16.8%</b>    5 marks (divide Cr somewhere by 2)  <b>144.9%; 72.5%</b> 4 marks (<b>Final 2 marks unavailable</b>)  Use of <math>M(\text{Fe}(\text{CrO}_2)_2) = 223.8</math> instead of <math>M(\text{Cr})</math>.</p>

F325

Mark Scheme

June 2015

Question	Answer	Marks	Guidance
(c)	<p>Overall:</p> $\text{CrO}_4^{2-} + 3\text{I}^- + 4\text{H}_2\text{O} \rightarrow \text{Cr}^{3+} + 1\frac{1}{2}\text{I}_2 + 8\text{OH}^- \checkmark$ <p>CrO</p> <p>Half equations:</p> $\text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3\text{e}^- \rightarrow \text{Cr}^{3+} + 8\text{OH}^- \checkmark$ <p>CrO</p> $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^- \checkmark$	<p>3</p>	<p><b>ALLOW multiples and equilibrium signs throughout</b>  <b>IGNORE</b> state symbols throughout</p> <p>e.g. <math>2\text{CrO}_4^{2-} + 6\text{I}^- + 8\text{H}_2\text{O} \rightarrow 2\text{Cr}^{3+} + 3\text{I}_2 + 16\text{OH}^-</math></p> <p><b>ALLOW</b> equation using <math>\text{H}^+</math>. i.e.</p> <p><b>OR</b> <math>\text{CrO}_4^{2-} + 3\text{I}^- + 8\text{H}^+ \rightarrow \text{Cr}^{3+} + 1\frac{1}{2}\text{I}_2 + 4\text{H}_2\text{O}</math>  <math>2\text{CrO}_4^{2-} + 6\text{I}^- + 16\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{I}_2 + 8\text{H}_2\text{O}</math>                  +</p> <p><b>ALLOW</b> <math>\text{CrO}_4^{2-}</math> half equation using <math>\text{H}^+</math>. i.e.</p> $\text{CrO}_4^{2-} + 8\text{H}^+ + 3\text{e}^- \rightarrow \text{Cr}^{3+} + 4\text{H}_2\text{O}$ <p>CrO</p>
	<p><b>Total</b></p>	<p><b>11</b></p>	

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

**OCR Customer Contact Centre**

**Education and Learning**

Telephone: 01223 553998

Facsimile: 01223 552627

Email: [general.qualifications@ocr.org.uk](mailto:general.qualifications@ocr.org.uk)

[www.ocr.org.uk](http://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 2015

