

OCR

Oxford Cambridge and RSA

day June 20XX – Morning/Afternoon**A Level Chemistry B (Salters)****H433/01 Fundamentals of chemistry****SAMPLE MARK SCHEME****Duration:** 2 hours 15 minutes**MAXIMUM MARK 110****This document consists of 20 pages**

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Mark Scheme

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MARKING INSTRUCTIONS**PREPARATION FOR MARKING****SCORIS**

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal <http://www.rm.com/support/ca>
3. Log-in to scoris and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
- where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
 - if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.
6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.
7. There is a NR (No Response) option. Award NR (No Response)
- if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
 - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.
- Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).
8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
- If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.

Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme.

Once the level is located, award the higher or lower mark.

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

- **The science content determines the level.**
- **The communication statement determines the mark within a level.**

Level of response questions on this paper are **32(b)** and **34(b)**.

11. Annotations

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

12. Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

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SECTION A

Question	Answer	Marks	Guidance
1	D	1	
2	D	1	
3	D	1	
4	B	1	
5	A	1	
6	A	1	
7	D	1	
8	B	1	
9	B	1	
10	C	1	
11	C	1	
12	B	1	
13	D	1	
14	A	1	
15	B	1	
16	C	1	
17	A	1	
18	B	1	
19	B	1	
20	A	1	

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Question	Answer	Marks	Guidance
21	B	1	
22	B	1	
23	D	1	
24	C	1	
25	A	1	
26	A	1	
27	B	1	
28	B	1	
29	A	1	
30	D	1	
	Total	30	

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SECTION B

Question			Answer	Marks	Guidance
31	(a)	(i)	Cerium(IV) oxide ✓	1	ALLOW without parentheses
		(ii)	$4\text{CeO}_2 \rightarrow 2\text{Ce}_2\text{O}_3 + \text{O}_2$ OR $2\text{CeO}_2 \rightarrow \text{Ce}_2\text{O}_3 + 0.5\text{O}_2$ ✓ $\text{Ce}_2\text{O}_3 + \text{H}_2\text{O} \rightarrow 2\text{CeO}_2 + \text{H}_2$ ✓	2	
		(iii)	Enthalpy changes of formation ✓	1	ALLOW bond enthalpies/energies
	(b)	(i)	E^\ominus of $\text{Ce}^{4+}/\text{Ce}^{3+}$ in $\text{H}_2\text{SO}_4(\text{aq})$ is more positive than E^\ominus of Cl_2/Cl^- ✓ So will oxidise Cl^- to Cl_2 ✓ In $\text{HCl}(\text{aq})$ E^\ominus of $\text{Ce}^{4+}/\text{Ce}^{3+}$ is less positive so will not oxidise Cl^- to Cl_2 AND so $\text{H}_2\text{SO}_4(\text{aq})$ is used ✓	3	ALLOW less negative ALLOW more negative
		(ii)	FIRST CHECK ANSWER ON ANSWER LINE answer = 83% to 2 sig figs award 5 marks $n(\text{AsO}_3^{3-})$ used in titration = $3.00/1000 \times 0.500$ OR 0.00150 (mol) (conc. of AsO_3^{3-} is double that of As_2O_3) ✓ $n(\text{Ce}^{4+})$ used in titration = $2 \times (3.00/1000 \times 0.500)$ OR 2×0.00150 OR 0.00300 (mol) ✓ M_r of $\text{CeO}_2 = 172.1$ ✓ mass CeO_2 present in 100 cm^3 of solution = $4 \times 172.1 \times 0.00300 = 2.0652 \text{ g}$ ✓ % purity of CeO_2 sample = $2.0652 \times 100/2.5 = 83\%$ to 2 sig figs ✓	5	ALLOW ECF from first marking point ALLOW ECF from second marking point

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Question	Answer	Marks	Guidance
	<p>(iii) Use a more dilute AsO_3^{3-} solution to increase volume of titre / reduce % error in titre</p> <p>OR</p> <p>Use more ceria sample to increase volume of titre / reduce % error in titre ✓</p>	1	
	<p>(iv) FIRST CHECK ANSWER ON ANSWER LINE answer = 1.7×10^{22} atoms of oxygen award 2 marks</p> <p>$n(\text{CeO}_2) = 2.5/172.1 = 0.01453$ (mol) ✓</p> <p>$n(\text{O}) = 0.01453 \times 2 = 0.02905$ (mol)</p> <p>$0.02905 \times 6.02 \times 10^{23} = 1.7 \times 10^{22}$ atoms of oxygen ✓</p>	2	<p>ALLOW ECF from first marking point ALLOW 2 or more sig figs</p>
	<p>(v) Reactants adsorbed onto surface of catalyst and form bonds to surface (AW) ✓</p> <p>Bonds within reactants weaken and break ✓</p> <p>New bonds form (AW) ✓</p> <p>Products formed desorb/leave from catalyst (AW) ✓</p>	4	
	Total	19	

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Question		Answer	Marks	Guidance
32	(a)	<p><i>Two marking points from the following:</i></p> <ul style="list-style-type: none">• Large amounts of arable land are required to produce the crops required to obtain large amounts ethanol• (Environmental problem caused by) disposal of fermentation waste• Current car engines need to be modified to use high concentrations of ethanol <p>✓ ✓</p>	2	<p>ALLOW ethanol has a lower enthalpy change of combustion than petrol</p> <p>IGNORE better for the environment</p>

Question	Answer	Marks	Guidance
(b)*	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Analyses information AND spectral data to provide evidence to support the correct and full identification of all compounds A, B, C and D. Evidence from reactions of A AND no reaction of B with Tollens' reagent or NaOH AND MS spectrum AND ^{13}C NMR spectrum.</p> <p><i>The information and evidence used is relevant and fully supports the identification. The answer is clear and logically structured.</i></p> <p>Level 2 (3–4 marks) Analyses information AND data to provide evidence to support the partial identification of compound A as a secondary alcohol, B as a ketone and C and D as alkenes. Evidence from reactions of A AND no reaction of B with Tollens' reagent or NaOH AND EITHER MS spectrum OR ^{13}C NMR spectrum</p> <p><i>The information and evidence used is in the most-part relevant and supports the identification. The answer is presented with some structure.</i></p> <p>Level 1 (1–2 marks) Analyses information OR data to provide evidence allowing partial identification of the compounds A AND B OR C AND D using reactions of A OR no reaction of B with Tollens' reagent or NaOH OR using information from MS Spectrum OR ^{13}C NMR spectrum</p>	6	<p>Indicative scientific points may include:</p> <p>Full identification Compound A is $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ Compound B is $\text{CH}_3\text{CH}_2\text{COCH}_3$ Compounds C & D are $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ and $\text{CH}_3\text{CH}=\text{CHCH}_3$</p> <p>Evidence from spectral data</p> <p>MS Spectrum:</p> <ul style="list-style-type: none"> $M_r (\text{C}_x\text{H}_y\text{O}) = 74$ $M_r (\text{C}_x\text{H}_y)$ $74 - 16 = 58$ so $x = 4$ and $y = 10$. <p>^{13}C NMR:</p> <p>2 from</p> <ul style="list-style-type: none"> 4 carbon environments no $\text{C}=\text{O}$ or $\text{C}=\text{C}$ $\text{C}-\text{O}$ (and $\text{C}-\text{C}$) present. <p>Evidence from the Reactions:</p> <ul style="list-style-type: none"> A is alcohol from formula plus $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ reaction Heating A with Al_2O_3 results in elimination of water from A forms 2 different alkenes, C and D Thus A secondary and B a ketone. A reacts with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ when heated \rightarrow B is aldehyde, ketone or carboxylic acid No reaction with Tollens' \rightarrow B is NOT an aldehyde No reaction with NaOH \rightarrow B is NOT a carboxylic acid Conclusion: B is a ketone AND A a secondary alcohol.

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Question	Answer	Marks	Guidance
	<p><i>The information and evidence is used to make a partial identification of A AND B OR C and D. The evidence chosen does not fully support the identification and is not presented in a logical order.</i></p> <p>0 marks No response or no response worthy of credit.</p>		For Level 1: partial identification of A required. May be supplemented by partial identification of B OR partial identification of C and D .
(c)	Substrate/reactant has specific <u>shape</u> ✓ Fits <u>active site</u> in enzyme ✓	2	
(d)	$n(\text{O}_2) = 25 \times 0.21/24.0 = 0.219 \text{ mol}$ ✓ M_r of $\text{C}_2\text{H}_5\text{OH} = 46.0$ $n(\text{C}_2\text{H}_5\text{OH}) = 4.0/46.0 = 0.087 \text{ mol}$ Recognition of ratio $\text{O}_2 / \text{C}_2\text{H}_5\text{OH}$: $0.219 / 0.087 = 2.5$ ✓ This is smaller than the required ratio of 3 (from $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$), so the ethanol is not completely burned. ✓	3	ALLOW ECF from first marking point.
	Total	13	

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Question		Answer	Marks	Guidance	
33	(a)	$\begin{array}{c} \text{CH}_2\text{OOC}(\text{CH}_2)_{10}\text{CH}_3 \\ \\ \text{CHOOC}(\text{CH}_2)_{10}\text{CH}_3 \\ \\ \text{CH}_2\text{OOC}(\text{CH}_2)_{10}\text{CH}_3 \end{array}$ <p>Any of the ester groups circled correctly ✓</p>	1	IGNORE circled adjacent carbons	
	(b)	(i)	$K_{\text{sp}} = [\text{Na}^+(\text{aq})] \times [\text{L}^-(\text{aq})]$ ✓	1 State symbols required ALLOW $K_{\text{sp}} = [\text{Na}^+(\text{aq})] [\text{L}^-(\text{aq})]$	
		(ii)	$[\text{Na}^+]$ increases but K_{sp} remains constant ✓ so NaL precipitates to make $[\text{L}^-]$ smaller / to move equilibrium left ✓	2	
		(iii)	<p>FIRST CHECK ANSWER ON ANSWER LINE minimum mass of NaCl = 34.2 g award 4 marks</p> <p>Solubility of F = $24.0/222 = 0.108 \text{ mol dm}^{-3}$</p> <p>$K_{\text{sp}} = (\text{solubility})^2 = 0.0117$ ✓</p> <p>$0.0117 = [\text{Na}^+(\text{aq})] \times 1.0 \times 10^{-2}$ ✓</p> <p>$[\text{NaCl}]$ to exceed $K_{\text{sp}} = 0.0117 / 1.0 \times 10^{-2} = 1.17 \text{ (mol dm}^{-3}\text{)}$ ✓</p> <p>Min mass of NaCl to add to 500 cm^3 to form ppt of F = $(1.17/2) \times 58.5 = 34.2 \text{ g}$ ✓</p> <p>Assumption: volume of solution does not change when NaCl added ✓</p>	5	IGNORE units

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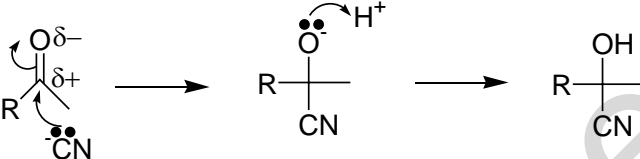
Question	Answer	Marks	Guidance
(c)	<p>FIRST CHECK ANSWER ON ANSWER LINE Answer = 0.043 award 4 marks</p> <p>concentration of H₂O = 5.00 – 1.20 = 3.80 (mol dm⁻³) ✓</p> <p>concentration of acid H = 0.60 (mol dm⁻³) AND concentration of CH₃OH = 1.20 (mol dm⁻³) ✓</p> $K_c = \frac{[(\text{CH}_2\text{COOH})_2][\text{CH}_3\text{OH}]^2}{[(\text{CH}_2\text{COOCH}_3)_2][\text{H}_2\text{O}]^2} = \frac{0.6 \times 1.2^2}{1.4 \times 3.8^2} \checkmark$ <p>= 0.043 ✓ (no units)</p>	4	<p>ALLOW 2 or more sig figs</p>
(d)	<p>FIRST CHECK ANSWER ON ANSWER LINE Answer = 22.5 g award 4 marks</p> <p>$[\text{H}^+] = 10^{-4.8} = 1.585 \times 10^{-5} \text{ mol dm}^{-3} \checkmark$</p> $K_a = \frac{[\text{H}^+][\text{salt}]}{[\text{acid}]} \text{ AND } \frac{[\text{salt}]}{[\text{acid}]} = \frac{K_a}{[\text{H}^+]} \checkmark$ $= \frac{1.74 \times 10^{-5}}{1.585 \times 10^{-5}} = 1.0979 \checkmark$ <p>Therefore amount of ethanoate required = 1.0979 × n(ethanoic acid) = 1.0979 × 0.250 = 0.274 (mol)</p> <p>0.274 × 82.0 = 22.5 (g) ✓</p>	4	<p>ALLOW ECF from first marking point</p> <p>ALLOW ECF from third marking point</p>
	Total	17	

Question		Answer	Marks	Guidance
34	(a)	Only small amount of raspberry ketone present in raspberries / difficult / high cost to extract ✓	1	
	(b)*	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Fully describes the differences between the two compounds in detail with both ring descriptions correct. Describes at least three reactions with examples and equations.</p> <p><i>The full description is detailed and correct. There is a clear and logical structure. The reactions are relevant and fully supported with examples and equations. Demonstrates a clear and confident knowledge of relevant technical language (names of compounds, 'substitution', 'elimination', 'delocalisation').</i></p> <p>Level 2 (3–4 marks) Describes the differences between the two compounds in detail including electron delocalisation in phenol. Describes at least two reactions with equations but not necessarily showing reactions for both structures.</p> <p><i>The description is detailed and is presented with some structure. The reactions are in the most-part relevant and supported by equations. Demonstrates ability to answer question with some indications of a sound grasp of technical language.</i></p>	6	<p>Indicative scientific points may include:</p> <p>Ring structures:</p> <ul style="list-style-type: none"> • saturated ring of 6 carbons in alcohol • unsaturated ring of 6 carbons in phenol with 6 delocalised electrons <p>Reactions of –OH group:</p> <ul style="list-style-type: none"> • acidic in phenol neutral in alcohol e.g. with alkalis* (NOT with carbonates) • nucleophilic substitution in alcohol e.g. with halide* • elimination in alcohol not in phenol e.g. form alkenes* with Al_2O_3 / H_2SO_4 • phenols give purple colour with $FeCl_3$ • phenols will not react with carboxylic acids but alcohols will*. <p>* an equation can be written here</p> <p>If other correct reactions are given which are NOT different between the two compounds mark lower at each level</p>

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Question	Answer	Marks	Guidance
	<p>Level 1 (1–2 marks) Identifies the differences between the two structures mentioning phenol and alcohol. Describes at least two reactions.</p> <p><i>The description is basic and communicated in an unstructured way. The reactions are relevant but lack detail. Demonstrates a basic grasp of relevant technical language.</i></p> <p>0 marks No response or no response worthy of credit.</p>		
(c)	Gas–liquid chromatography OR Thin layer chromatography OR paper chromatography ✓	1	ALLOW glc or tlc
(d)	 <p>Arrow from negative charge on cyanide ✓</p> <p>Partial charges on C=O correct AND arrow on carbonyl ✓</p> <p>Intermediate correct ✓</p> <p>Arrow from O to H AND correct cyanohydrin structure ✓</p>	4	Arrows MUST BE double headed AND pointing towards correct atom <p>ALLOW lone pair inserted on C and arrow starting from there</p>
(e)	(compound contains a) chiral C / chiral centre / asymmetric C ✓ (the enantiomers are) mirror images ✓	2	ALLOW 3-D sketch showing stereoisomers

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Question		Answer	Marks	Guidance
	(f)	Stronger intermolecular bonds present in raspberry ketone (than in 4-phenylbutan-2-one) ✓ due to hydrogen bonding ✓ so more energy needed to separate molecules ✓	3	ALLOW intermolecular forces
			Total	17

Specimen

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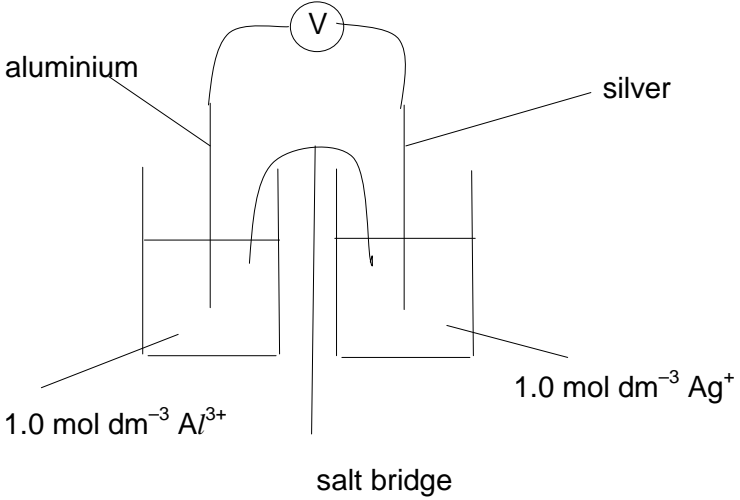
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Question		Answer	Marks	Guidance
35	(a)	Al^{3+} since group 3, O^{2-} since Group 6; charges balance (in Al_2O_3) ✓	1	
	(b)	(i) $Al^{3+} + 3e^- \rightarrow Al$ ✓	1	ALLOW 'e' without minus IGNORE state symbols
		(ii) FIRST CHECK ANSWER ON ANSWER LINE Answer = 35000 OR 35280 award 3 marks $n(Al_2O_3) = 100000/102$ OR 980 (mol) ✓ half a mol CO_2 for every mol O ✓ (stated or shown in calc) volume $CO_2 = 24 \times 980 \times 3/2$ = 35000 OR 35280 ✓	3	ALLOW ECF from first marking point
	(c)	(i) cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓ anode: $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$ ✓	2	ALLOW 'e' without minus IGNORE state symbols ALLOW multiples and halves ALLOW $2H^+ + 2e^- \rightarrow H_2$ and $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
		(ii) white ppt ✓ after adding Ba^{2+} / solution of (named) barium salt OR (formation of) barium sulfate/ $BaSO_4$ ✓	2	Any named barium salt must be soluble

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Question	Answer	Marks	Guidance
(d) (i)	 <p>labelled metal rods in labelled solutions of corresponding ions ✓ both ions 1.0 mol dm⁻³ ✓ wires, voltmeter and salt bridge ✓</p>	3	<p>ALLOW:</p> <ul style="list-style-type: none"> cell either way round any unambiguous representation of the voltmeter descriptions of solutions as, e.g., 'AgNO₃' and 'Al(NO₃)₃' (but molarity must be correct, in next mark, for ,e.g., Al₂(SO₄)₃). <p>IGNORE temperature any other label on salt bridge</p>
(ii)	<p>FIRST CHECK ANSWER ON ANSWER LINE Answer = 1.68 V award 2 marks</p> $\frac{RT}{nF} \ln 0.1 = 8.314 \times 298 \times (-2.3) / 3 \times 9.65 \times 10^4$ $= -0.02 \text{ (-0.0197) (V) } \checkmark$ $E_{\text{cell}} = -1.66 - 0.02 = 1.68 \text{ V } \checkmark$	2	
	Total	14	