OCR
Oxford Cambridge and RSA

GCE

Chemistry A

Unit **H432A/03:** Unified chemistry

Advanced GCE

Mark Scheme for June 2017

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.

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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.

Annotations available in RM Assessor

Annotation	Meaning
✓	Correct response
✗	Incorrect response
^	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

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

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
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

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.

Question			Answer	Marks		Guidance
1	(a)		Throughout • **ALLOW** bonding regions for bonded pairs • **ALLOW** diagrams for communicating **two** bonds, **two** lone pairs and hydrogen bonding in ice • **IGNORE** responses about open lattice/tetrahedral structure in ice			
			Ice Ice has hydrogen bonds/bonding ✓ **H_2O(g)** 2 bonded pairs **AND** 2 lone pairs ✓ **Repulsion** Lone pairs repel more (than bonded pairs) ✓	3		**ALLOW** more hydrogen bonding/H bonds For H_2O(g), • **ALLOW** water • **IGNORE** hydrogen bonding
	(b)		It increases/causes/contributes to global warming **OR** C–H bonds vibrate **OR** absorb IR ✓	1		**ALLOW** it is a greenhouse gas/increases temp **IGNORE** ozone, radicals **OR** acid rain
	(c)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = CH_4•5.74 H_2O **OR** 5.74 award 2 marks --- **Mole ratio** $n(CH_4) : n(H_2O) = \frac{13.4}{16.0} : \frac{86.6}{18.0}$ **OR** 0.8375 : 4.811 ✓ **Formula** CH_4•5.74 H_2O **OR** 5.74 ✓	2		Working to at least 3 SF but **IGNORE** 'trailing zeroes', e.g. **ALLOW** 16 for 16.0 --- **ALLOW** algebraic approach, e.g. $n(CH_4) = n(CH_4•xH_2O)$ $\frac{13.4}{16.0} = \frac{100}{16.0 + 18x}$ x = 5.74 **ALLOW ECF** from incorrect mole ratio -- For 1 mark, **ALLOW** x with < 2 DP: • x = 5.7 • x = 6 • x = 5.73 from 0.8375 and 4.8 from 0.84 and 4.811 • x = 5.71 from 0.84 and 4.8
	(d)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE**	4		

Question			Answer	Marks		Guidance
			IF answer = 188 (dm^3) **AND** use of ideal gas equation Award **4 marks** for calculation --- ***n*(CH₄) in 1 kg** $n(CH_4) = \frac{1 \times 10^3}{16.0} \times \frac{13.4}{100}$ = 8.375 **OR** 8.38 (mol) ✓ ***Rearranging ideal gas equation*** $V = \frac{nRT}{p}$ ✓ ***Substitution of values into*** $V = \frac{nRT}{p}$ **:** • *Calculated value of $n(CH_4)$ (Use **ECF**)* • *R = 8.314 **OR** 8.31* • *T in K: 273 K* • *p in Pa **OR** kPa 101 **OR** 101×10^3 **OR** 1.01×10^5* *e.g.* $\frac{8.375 \times 8.314 \times 273}{(101 \times 10^3)}$ **OR** $\frac{8.375 \times 8.314 \times 273}{101}$ ✓ *Final volume in dm^3 to **3 SF*** V = 188 (dm^3) ✓			**ALLOW** use of *M*(answer to **(c) OR** 119.32 *Examples* From $n(CH_4•5.74\,H_2O)$ $\frac{1 \times 10^3}{119.32}$ = 8.38(1) → 188 (dm^3) From $n(CH_4•5.7\,H_2O)$ $\frac{1 \times 10^3}{118.6}$ = 8.43(2) → 189 (dm^3) From $n(CH_4•6\,H_2O)$ $\frac{1 \times 10^3}{124.0}$ = 8.06 (mol) → 181 (dm^3) --- **IF** $V = \frac{nRT}{p}$ is omitted, **ALLOW** when values are substituted into rearranged ideal gas equation.
			COMMON ERRORS **Use of 298 K** **ALLOW ECF** **3 marks max** *Example* $n(CH_4•5.74\,H_2O)$ = 8.375 ✓ $V = \frac{8.375 \times 8.314 \times 298}{101 \times 10^3}$ → 205 (dm^3) ✓✓ **Use of 24.0 dm^3 OR 22.4 dm^3** **ALLOW ECF** from $n(CH_4)$ **2 marks max for $n(CH_4)$ and V in dm^3** *24.0 dm^3* $n(CH_4•5.74\,H_2O)$ = 8.375 ✓ $V = 8.375 \times 24.0$ = 201 (dm^3) ✓ *22.4 dm^3* $n(CH_4•5.74\,H_2O)$ = 8.375 ✓ $V = 8.375 \times 22.4$ = 188 (dm^3) ✓ **13.4% (13.4/100) omitted** **3 marks** $n = \frac{1 \times 10^3}{16}$ = 62.5 (mol) ✗ $V = \frac{62.5 \times 8.314 \times 273}{101 \times 10^3}$ → 1400 (dm^3) ✓✓✓			
	(e)		For fuel **OR** energy ✓	**1**		**ALLOW** responses linked with energy. e.g. • to generate electricity

Question			Answer	Marks		Guidance
						• for burning/heat **ALLOW** (chemical) feedstock **IGNORE** cooking
			Total	**11**		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th></th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.
Level 3 (5–6 marks)
A comprehensive conclusion, using all quantitative data, to calculate the energy change and ΔH values for reactions 3.1 and 3.2
AND linking ΔH data using Hess' Law

There is a well-developed line of reasoning which is clear and logically structured. The working throughout is clearly shown. All values calculated with reasonable numbers of SF and correct signs mostly shown, allowing for ECF.

Level 2 (3–4 marks)
Attempts to describe all three scientific points but explanations may be incomplete.
OR Explains two scientific points thoroughly with few omissions.

There is a line of reasoning with some logical structure. There may be minor errors in energy change and errors in the calculations of ΔH for reaction 3.1 or reaction 3.2.

Level 1 (1–2 marks)
Processes raw mass and temperature data and obtains a calculated value for the energy change using $mc\Delta T$
OR attempts to obtain values for two scientific points but explanations may be incomplete

There is an attempt at a logical structure with a line of reasoning to obtain a value for energy change. There may be minor errors in calculation of energy change.

0 marks – No response or no response worthy of credit.</td><td>6</td><td></td><td>Indicative scientific points may include:
1. Masses and ΔT from raw results
• $m(Na_2O)$ = 1.24 (g)
• m(solution) = 25.75 (g)
• ΔT = 35.0 (ºC)

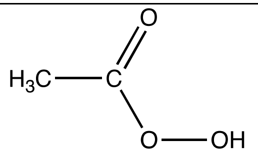
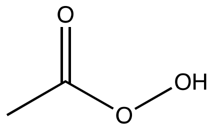
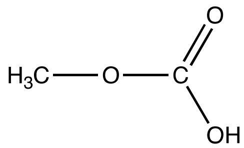
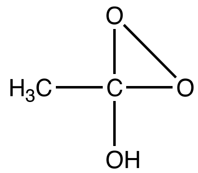
Energy change from $mc\Delta T$
• energy released in J OR kJ
= 25.75 × 4.18 × 35.0
= 3767 (J) OR 3.767 (kJ)
(3.767225 unrounded)
----
2. $\Delta_r H$ for reaction 3.2
• $n(Na_2O) = \frac{1.24}{62.0}$ = 0.0200 (mol)
• $\Delta_r H$ value $-\frac{3767}{0.0200}$ = –188 (kJ mol^{-1})
(–188.36125 unrounded)
----
3. $\Delta_r H$ for reaction 3.1
• ΔH value for reaction 3.1 clearly linked to ΔH for reaction 3.2 and reaction 3.3 in energy cycle or an expression:
ΔH(3.1) = ΔH(3.2) + 2ΔH(3.3)
• ΔH(3.1) = –188 + (2 × –57.6)
= –188 – 115.2 = –303(.2) (kJ mol^{-1})
(–303.56125 unrounded)

Note
Throughout, ALLOW ECF from previous value
ALLOW omission of trailing zeroes
--</td></tr>
</table>

Question			Answer	Marks		Guidance
	(b)		% uncertainties to at least *1 SF, rounded or truncated* --- **ONE** correct % uncertainty ✓ **BOTH** correct % uncertainties ✓ --- ***mass***: $\frac{0.005 \times 2}{1.24} \times 100 = 0.8/0.81$ **OR** 0.80 (truncated) $\Delta \boldsymbol{T}$: $\frac{0.1 \times 2}{35.0} \times 100 = 0.6 / 0.57$ (%) ✓ *Calculator values:* mass: 0.8064516129 ΔT: 0.5714285714	2		**ALLOW** error for uncertainty -- **ALLOW ECF** from mass and ΔT in **2(a)** **IGNORE** % uncertainty of mass of solution -- **ALLOW one** mark for: • 2 calculations with both ×2 factors missing i.e. mass 0.3% **AND** ΔT 0.4% • Not converting to %s using ×2 factors i.e. 0.008 **AND** 0.006
	(c)		**ALLOW** uncertainty **OR** error throughout Greater mass of Na_2O **OR** more Na_2O ✓ For mass, **ALLOW** amount/moles/quantity larger ΔT **OR** reduces % uncertainty in ΔT ✓	2		**ALLOW** up to 2 marks based on a single mass measurement: one mass measurement **OR** measure mass directly ✓ *e.g. tare balance* % uncertainty reduced by **half** ✓ -- **IGNORE** • repeat and take average • read to more figures *(same apparatus)* • increase volume (*reduces mass error but increases* ΔT *error*) • use a cooling curve • use a lid

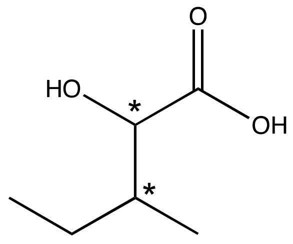
Question			Answer	Marks		Guidance
	(d)	**(i)**	sodium nitrate(III)	**1**		**ALLOW** sodium nitrite **OR** sodium nitrite(III)
	(d)	**(ii)**	Sodium/Na oxidised from 0 to +1 ✓ Nitrogen/N reduced from +3 to 0 ✓	**2**		**ALLOW** 1+ for +1 and 3+ for +3 **ALLOW** N_2 for nitrogen **ALLOW** 1 mark for elements **AND** all oxidation numbers correct, but N on oxidised line and Na on reduced line '+' is required in +3 and +1 oxidation numbers
	(d)	**(iii)**	$2NaNO_2 + 6Na \rightarrow 4Na_2O + N_2$ ✓ **IGNORE** state symbols	**1**		**ALLOW** multiples, e.g. $NaNO_2 + 3Na \rightarrow 2Na_2O + ½N_2$
			Total	**14**		

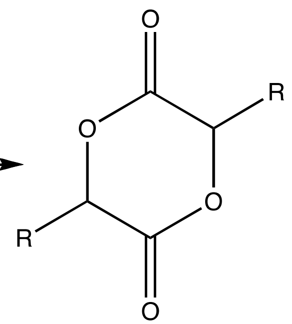
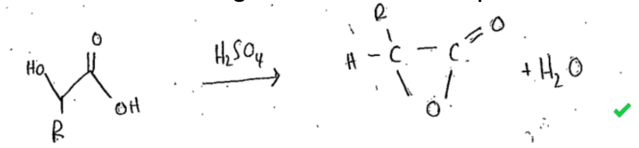
Question			Answer	Marks		Guidance
3	(a)	(i)	*(rate =)* $k\,[H_2O_2]\,[I^-]$ ✓ $k = \dfrac{rate}{[H_2O_2]\,[I^-]} = \dfrac{2.00 \times 10^{-6}}{0.0100 \times 0.0100} = 0.02(00)$ ✓ units: $dm^3\ mol^{-1}\ s^{-1}$ ✓	3		**Square brackets required** **IGNORE** any state symbols **IGNORE** $[H^+]^0$ **ALLOW ECF** from incorrect rate equation **BUT** units must fit with rate equation used **ALLOW** $mol^{-1}\ dm^3\ s^{-1}$ **OR** in any order **NOTE** K_c expression with calculation and units **0 marks**
	(a)	(ii)	Plot graph using ln k **AND** $1/T$ ✓ (Measure) gradient ✓ *Independent mark* $E_a = (–)R \times$ gradient **OR** (–)8.314 × gradient ✓ • *Independent mark, even if variables for graph are incorrect* • *Subsumes 'gradient' mark*	3		**Unless otherwise stated, assume, that ln *k* is on y axis and 1/*T* is on x axis** **IGNORE** intercept **ALLOW** gradient = $(–)\dfrac{E_a}{R}$ --- **NOTE: ALLOW 'Inverse graph' (special case)** Plot graph of $1/T$ against ln k ✓ (Measure) gradient ✓ *Independent mark* $E_a = (–)\dfrac{R}{\text{gradient}}$ **OR** $(–)\dfrac{8.314}{\text{gradient}}$ **OR** gradient = $(–)\dfrac{R}{E_a}$ ✓ *Subsumes 'gradient' mark*

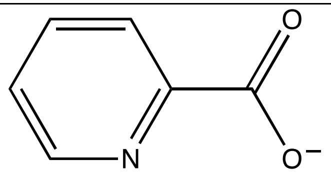
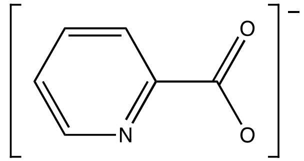
Question			Answer	Marks		Guidance
	(b)		**ALLOW** equilibrium sign in equations provided reactants on left **Reaction of H_2O_2 with MnO_2:** $H_2O_2 + MnO_2 + 2H^+ \rightarrow O_2 + Mn^{2+} + 2H_2O$ ✓ **Reaction of H_2O_2 with Mn^{2+}:** $H_2O_2 + Mn^{2+} \rightarrow MnO_2 + 2H^+$ ✓ **Use of *E* data** Use of *E* data to support equation(s) above or half direction of provided half equations (one including MnO_2) ✓ *Also look for evidence around half equations* MnO_2 regenerated/reformed ✓ *Must be linked to an equation showing MnO_2 as reactant and an equation showing MnO_2 as product*	4		**ALLOW** correct multiples **IGNORE** state symbols -- **ALLOW** uncancelled H_2O and H^+ $H_2O_2 + MnO_2 + \mathbf{4}H^+ \rightarrow O_2 + Mn^{2+} + 2H_2O \mathbf{+ 2H^+}$ $H_2O_2 + Mn^{2+} \mathbf{+ 2H_2O + 2H^+} \rightarrow MnO_2 + \mathbf{4}H^+ \mathbf{+ 2H_2O}$ ***Examples*** • More negative *E* moves to left **ORA** • Reduction half equation to the right **ORA** • Most positive *E* is reduced **ORA** • Calculated *E* cell = +0.81 V (*from top 2*) **OR** *+0.27 V (from bottom 2)* **ALLOW** combining of equations above to show that MnO_2 is used and reformed
	(c)	(i)	 ✓ **ALLOW** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous, e.g. 	1		**ALLOW**  **OR**  Structure must include OH as part of COOOH group **ALLOW** $–O^- H^+$ in structure

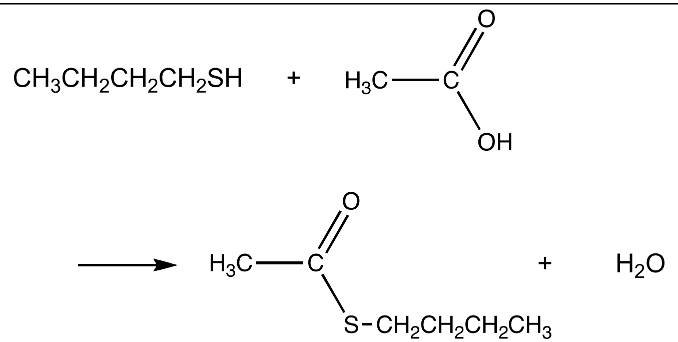
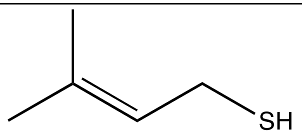
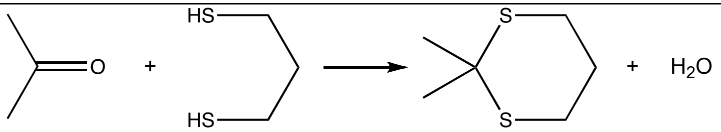
Question			Answer	Marks		Guidance
	(c)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = 0.023(125) (mol) award 3 marks for calculation -- ***K_c* expression** (K_c =) $\frac{[CH_3COOOH]}{[H_2O_2]\,[CH_3COOH]}$ ✓ **[CH_3COOOH]** = 0.37 × 0.500 × 0.500 = 0.0925 (mol dm^{-3}) ✓ *Subsumes K_c expression* ***n*(CH_3COOOH)** = 0.0925 × $\frac{250}{1000}$ = 0.023(125) (mol) ✓	3		**If there is an alternative answer, check for any ECF credit** -- **ALLOW** 0.37 = $\frac{[CH_3COOOH]}{0.500 \times 0.500}$ **ALLOW ECF** but **ONLY** if 0.37 **AND** 0.5 × 0.5 have been used **Common errors** **0.076** **2 marks** *Use of [CH_3COOOH]^2* **0.675** **2 marks** *Use of 0.5 for [H_2O] on K_c* **0.169** **2 marks** *Inverted K_c* **0.338** **1 mark** *Inverted K_c AND 0.5 for [H_2O]* **5.78 × 10^{-3}** **2 marks** × $\frac{250}{1000}$ *before [CH_3COOOH]*
			Total	**14**		

Question			Answer	Marks		Guidance
4	(a)	(i)	***Burette readings*** Final (reading)/cm^3: 23.15, 45.95, 32.45 ✓ Initial (reading)/cm^3: 0.60, 23.15, 10.00 • Correct titration results recorded with initial and final readings, clearly labeled **AND** all readings recorded to two decimal places with last figure either 0 or 5	4		Table **not** required **ALLOW** initial reading before final reading
			Titres Titre/cm^3: 22.55, 22.80, 22.45 ✓ • Correct subtractions to obtain final titres to 2 DP			**ALLOW ECF**
			Units • Units of cm^3 for initial, final and titres ✓			**ALLOW** units with each value **ALLOW** brackets for units, i.e. (cm^3)
			Mean titre • mean titre = $\frac{22.55 + 22.45}{2}$ = 22.50 **OR** 22.5 cm^3 ✓ *i.e. using concordant (consistent) titres*			**ALLOW ECF** from incorrect concordant titres

Question			Answer	Marks		Guidance
	(a)	(ii)	**ALLOW 3SF** or more throughout **IGNORE** trailing zeroes, e.g. **ALLOW** 0.084 for 0.0840 -- n(NaOH) = $0.0840 \times \frac{22.50}{1000}$ = 1.89×10^{-3} (mol) ✓ n(**A**) in 250 cm^3 = $10 \times 1.89 \times 10^{-3}$ = 1.89×10^{-2} (mol) ✓ M(**A**) = $\frac{2.495}{1.89 \times 10^{-2}}$ = 132 (g mol^{-1}) ✓ M(alkyl group) (= 132 – 75) = 57 ✓ R = C_4H_9 ✓ **ALLOW** alkyl group in drawn structure with straight chain or branch(es) in wrong position, e.g. for R = C_4H_9, $CH_3CH_2CH_2CH_2$ **OR** $(CH_3)_3C$ Structure with chiral carbon atoms identified (see * below)  ✓	6		**ALLOW ECF** from incorrect mean titre in **4a(i)** e.g. From 22.60 cm^3 (mean of all 3 titres in **(i)**, n(NaOH) = 1.8984×10^{-3} (mol) **ALLOW ECF** from incorrect n(NaOH) **ALLOW ECF** from incorrect n(**A**) **ALLOW ECF** from incorrect M(**A**) – 75 **ALLOW ECF** for alkyl group closest to calculated M(alkyl group), e.g. for M = 45, **ALLOW** C_3H_7 (43) **ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous **IGNORE** poor connectivity to OH groups *Given in question* --- **Common error for 4 marks max** *25.00 instead of 22.50 and scaling by* $\times 10$ 2.10×10^{-3} ✗ $\rightarrow$ 2.10×10^{-2} ✓ $\rightarrow$ 118.81 ✓ $\rightarrow$ 43.81 ✓ $\rightarrow$ C_3H_7 ✓ *25.00 instead of 22.50 and scaling by* $\times \frac{250}{22.50}$ 2.10×10^{-3} ✗ $\rightarrow$ 2.33×10^{-2} ✓ $\rightarrow$ 106.93 ✓ $\rightarrow$ 31.93 ✓ $\rightarrow$ C_2H_5 ✓ No structure with 2 chiral centres possible ✗

Question			Answer	Marks		Guidance
	(b)	(i)	***Equation*** 2HOCH(R)COOH + Mg $\rightarrow$ (HOCH(R)COO)$_2$Mg + H$_2$ Organic product ✓ Balance ✓ ***Type of reaction*** Redox ✓	3		**ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous **ALLOW** 2HOCH(R)COOH + Mg $\rightarrow$ 2HOCH(R)COO$^-$ + Mg^{2+} + H$_2$ **ALLOW** multiples **IGNORE** poor connectivity to OH groups *Given in question*
	(b)	(ii)	***Equation*** 2HOCH(R)COOH $\longrightarrow$  + 2H$_2$O Organic product ✓ Balance ✓ ***Type of reaction*** Condensation **OR** esterification ✓	3		**ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous **ALLOW** 1 mark of the 2 equation marks for formation of '3 ring' with balanced equation:  **ALLOW** condensation polymerisation **ALLOW** addition–elimination **IGNORE** elimination **IGNORE** dehydration

Question			Answer	Marks		Guidance
	(c)	(i)	 ✓	1		**ALLOW** brackets around structure with negative charge outside, i.e.  **ALLOW** ring (Kekulé structure)
	(c)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 1.61 × 10^{-3} award 2 marks** *M* = 418(.0) (g mol^{-1}) **OR** *n*(Cr) = 3.85 × 10^{-6} (mol) ✓ Mass = 3.85 × 10^{-6} × 418.0 = 1.61 × 10^{-3} g ✓	2		**Note**: $\frac{200 \times 10^{-6}}{52.0}$ = 3.85 × 10^{-6} (at least 3 SF) **ALLOW ECF** from incorrect *M* **OR** *n*(Cr) **ALLOW 3 SF** up to calculator value correctly rounded
			Total	19		

Question			Answer	Marks		Guidance
			For 5a(i)–(iv) IGNORE poor connectivity to SH groups	*Given in question*		
5	(a)	(i)	$K_a = \frac{[H^+]\,[C_4H_9S^-]}{[C_4H_9SH]}$ ✓ *Square brackets required*	1		**ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous
	(a)	(ii)	 Structure of thioester ✓ Complete equation ✓	2		**ALLOW** correct skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous **ALLOW** C_4H_9SH **ALLOW** CH_3COOH Thioester functional group **must** be fully displayed, **OR** as a skeletal formula but allow SC_4H_9 in thioester
	(a)	(iii)	 ✓	1		**IF** correct **skeletal** formula is shown, **IGNORE** displayed formula in a second structure
	(a)	(iv)	 Reactants ✓ Products **AND** balanced equation ✓	2		**ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th></th><th>Guidance</th></tr>
<tr><td></td><td>(b)*</td><td></td><td>

Refer to the marking instructions on page 5 of the mark scheme for guidance on marking this question.

Level 3 (5–6 marks)
Develops a plan that identifies **all** compounds by a process of elimination
AND
includes essential detail for all required tests and observations

There is a well-developed line of reasoning which is clear and logically structured

Level 2 (3–4 marks)
Develops a plan that identifies at least half of the compounds **OR** identifies the functional groups in most of the compounds
AND
includes detail of the required tests and observations

There is a line of reasoning with some structure. The information is mostly relevant and supported by some evidence.

Level 1 (1–2 marks)
Develops a plan that attempts to identify the compounds **OR** functional groups
AND
includes detail of the required tests and observations
There is a line of reasoning using information that is mostly relevant.

0 marks – *No response or no response worthy of credit with no compounds identified*

</td><td>6</td><td></td><td>

Indicative scientific points may include:

<u>Functional groups</u>
- **B** alkene and tertiary alcohol
- **C** alkene and aldehyde
- **D** alkene and primary alcohol
- **E** ketone
- **F** secondary alcohol
- **G** alkene and ketone

<u>Tests</u>
- **B, C, D** and **G** → **Bromine** decolourises
- **C**, **D** and **F** → **$(H^+/)Cr_2O_7^{2-}$** green
- **C**, **E** and **G** → **2,4-DNP** orange precipitate
- **C** → **Tollens** silver mirror

For Tollens' **ALLOW** alternative: Fehling's solution produces a 'brown/brick red/orange precipitate

For 2,4-DNP, **ALLOW** 2,4-DNPH and Brady's

<table>
<tr><th></th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th></tr>
<tr><td>Bromine</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td>✓</td></tr>
<tr><td>$(H^+/)Cr_2O_7^{2-}$</td><td></td><td>✓</td><td>✓</td><td></td><td>✓</td><td></td></tr>
<tr><td>2,4-DNP</td><td></td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td></tr>
<tr><td>Tollens'</td><td></td><td>✓</td><td></td><td></td><td></td><td></td></tr>
</table>

No credit for tests on products of tests, melting points, spectra, etc.
For other tests seen, contact TL for advice

</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>12</td><td></td><td></td></tr>
</table>

Appendix for Q5b Level of Response

Results of tests

	B	C	D	E	F	G
Bromine	✓	✓	✓			✓
$(H^+/)Cr_2O_7^{2-}$		✓	✓		✓	
2,4-DNP		✓		✓		✓
Tollens		✓				

Possible processes of elimination (not inclusive)

BCDEFG with 2,4 DNP	**CEG** orange ppt		
	CEG with Tollens	**C** silver mirror	
	EG with bromine	**G** decolourises	**E** no change
BDF with $(H^+)/Cr_2O_7^{2-}$	**DF** green	**B** no colour change	
	DF with bromine	**D** decolourises	**F** no change

BCDEFG with $(H^+)/Cr_2O_7^{2-}$	**CDF** green		
	CDF with Tollens/2,4DNP	**C** silver mirror/orange ppt	
	DF with bromine	**D** decolourises	**F** no change
BEG with 2,4 DNP	**EG** orange ppt	**B** no change	
	EG with bromine	**G** decolourises	**E** no change

BCDEFG with **bromine**	**BCDG** decolourise	**EF** no change	
	EF with 2,4-DNP/$(H^+/)Cr_2O_7^{2-}$	**E** orange ppt/**F** green	
	BCDG with Tollens'	**C** silver mirror	**BDG** no change
	BDG with $H^+/Cr_2O_7^{2-}$	**D** green	**BG** no change
	BG with 2,4-DNP	**G** orange ppt	**B** no change

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