OCR
Oxford Cambridge and RSA

GCE

Chemistry A

H032/02: Depth in chemistry

AS Level

Mark Scheme for June 2022

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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM 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.
3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

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 RM Assessor 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 RM Assessor messaging system.
5. Work crossed out:

   Crossed Out Responses
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions
Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

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 RM Assessor **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 RM Assessor 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, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column 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 skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

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 skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response questions on this paper are **4a(i)** and **6**

The only annotation on a level of response question should be the indication of the level.

A level annotation should be used where all marks for a level have been achieved.
e.g. if a candidate has 6 marks, they would have this annotation on their script:

If a candidate has achieved 5 marks then they have reached Level 3 but will not have met the communication statement.
They should have the following annotations on their scripts:

The same principle should be applied to Level 2 and Level 1.

No marks (0) should have a cross: 

Place the annotations alongside the mark for the question.

On additional pages, annotate using 

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore
	Blank page

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

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

13. **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.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>(Acid) releases H^+ ions/ H^+ donor ✓</td><td>1</td><td>AO1.1</td><td>ALLOW H^+ OR proton</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>(weak acid) partially dissociates/ionises ✓</td><td>1</td><td>AO1.1</td><td>IGNORE vague responses that do not imply a number, e.g.
• poor proton donor

IGNORE ‘doesn’t easily dissociate’

IGNORE ‘strong acid completely dissociates’</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>
<table>
<tr><th></th><th>Titration 1</th><th>Titration 2</th><th>Titration 3</th></tr>
<tr><td>Final reading/ cm^3</td><td>27.35</td><td>27.65</td><td>27.85</td></tr>
<tr><td>Initial reading/cm^3</td><td>0.05</td><td>0.10</td><td>0.45</td></tr>
<tr><td>Titre/cm^3</td><td>27.30</td><td>27.55</td><td>27.40</td></tr>
</table>
Initial and final readings
All titration readings (×6) correct ✓

Titres
Correct subtractions to obtain final titre values ✓

Mean titre calculated from concordant results
Correct mean titre = 27.35 (cm^3) ✓

Reading recorded to accuracy of burette
All values including mean titre recorded to two decimal places with the last figure either 0 or 5 ✓
</td><td>4</td><td>AO1.2
×4</td><td>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC

ALLOW missing zeroes throughout except for last marking point

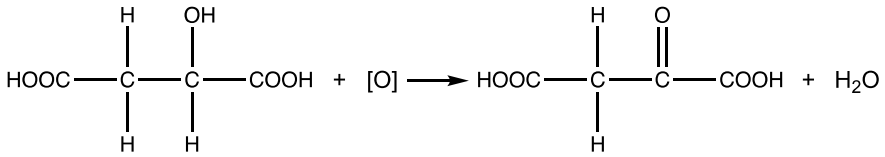
e.g. 0.1 for 0.10

ALLOW ECF from incorrect burette readings

IF MEAN IS CALCULATED FROM ECF, IT MUST BE FROM CLOSEST TITRES
ALLOW any number of decimal places for mean titre for this mark

Note: Question asks for mean titre to nearest 0.05 cm^3</td></tr>
</table>

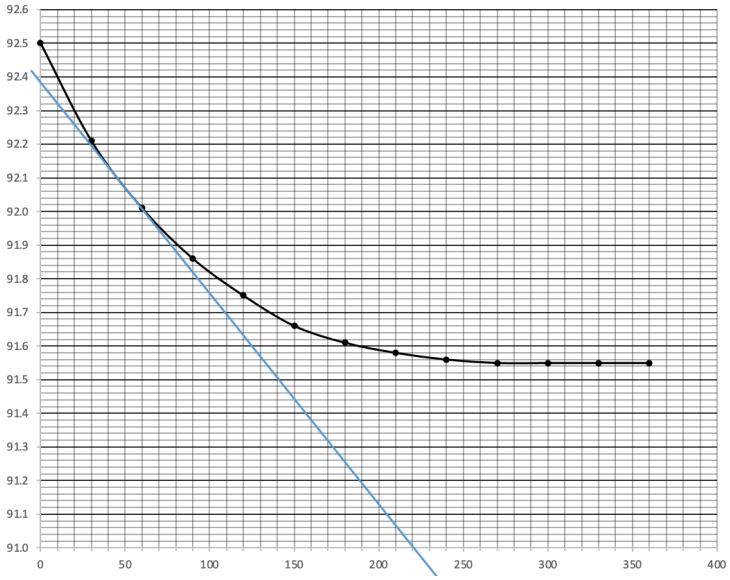
Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer =** 7.(00) **award 5 marks** --- *n*(NaOH) $= \frac{27.35 \times 0.800}{1000} = 0.02188$ ✓ *n*(A) in 25.0 cm^3 $= \frac{0.02188}{3} = 0.00729(33)$ ✓ *n*(A) in 250 cm^3 $= 10 \times 0.00729(33) = 0.0729(33)$ ✓ mass citric acid in 250 cm^3 = 0.0729 × 192 = 14(.0032) (g**)** ✓ mass citric acid in one lime $= \frac{14.0}{2} = 7.(00)$ (g) ✓	**5**	AO2.8 ×4 AO2.4	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** --- ALLOW ECF from incorrect titre calculated in 1(b)(i) Throughout: **ALLOW** 3 SF or more, correctly rounded e.g. *n*(NaOH) = 0.0219 for 0.02188 **ALLOW ECF** from incorrect *n*(NaOH) **ALLOW ECF** for all subsequent steps From *n*(NaOH) = 0.0219, *n*(A) = 0.073(0) *mass* citric acid = 14(.016) *mass* in 1 lime = 7(.008)
	(c)		**Action taken to modify method** Use half a lime **OR** Make up lime juice (solution) in 1 dm^3 volumetric flask ✓ **Dilution ratio to justify** 4 times less citric acid/lime juice **OR** NaOH is 4 times more dilute (giving same titre) **OR** 1:4 ratio for NaOH concentration ✓	**2**	AO3.4 ×2	**ALLOW** any feasible method that would give a dilution factor of 4 **ALLOW** quartered

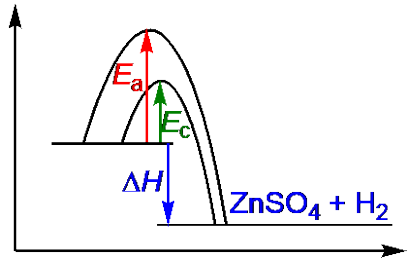
Question			Answer	Marks	AO element	Guidance
	(d)		 Correct structure of product ✓ Correctly balanced equation ✓	2	AO2.5 AO2.6	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous
			Total	**15**		

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	$Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$ All formulae and balancing correct ✓	1	AO2.6	**IGNORE STATE SYMBOLS** **ALLOW** multiples **IGNORE** state symbols (even if wrong)
		(ii)	**Oxidation** Sr from **0** to **+2** ✓ **Reduction** H from **+1** to **0** ✓	2	AO2.1 ×2	**ALLOW** 2+ for +2 and 1+ for +1 '+' is required in +2 and +1 oxidation numbers **ALLOW** H_2 for hydrogen **ALLOW** 1 mark for elements **AND** all oxidation numbers correct but oxidation and reduction wrong way round **OR** not given. **IGNORE** numbers around equation in **(i)** *(treat as rough working)*

Question			Answer	Marks	AO element	Guidance
		(iii)	*Atomic radius* Ca has smaller atomic radius **OR** fewer shells ✓	3	AO1.2	**FULL ANNOTATIONS MUST BE USED** --- **ORA in terms of Sr** **Comparison** needed for each mark. **ALLOW** 'fewer energy levels' **ALLOW** 'electrons closer to nucleus' **IGNORE** fewer orbitals **OR** fewer sub-shells **OR** different shell
			Effect of nuclear charge/shielding Ca has **less**/**decreased** shielding ✓		AO1.2	**ALLOW more** electron repulsion from inner shells
			Nuclear attraction Ca has greater nuclear attraction (for electrons) **OR** Ca has a higher ionisation energy **OR** more energy is required to lose the outer electrons✓		AO1.2	**IGNORE** nuclear charge/effective nuclear charge **ALLOW** 'less nuclear pull' **OR** 'electrons held less tightly'
	(b)	(i)	Any value in range: 8–14 ✓	1	AO1.1	
		(ii)	White precipitate/white solid ✓ $BaSO_4$ ✓	2	AO3.1 AO3.2	
			Total	9		

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	**Rate** (Acid) **concentration** decreases ✓	3	AO1.1	**IGNORE** amount of acid decreases Response **MUST** imply a volume and **NOT** area, e.g. fewer particles/molecules/ions in **same space /volume**
			Collisions Fewer collisions per second **OR** less frequent collisions ✓		AO1.1	**IGNORE** responses not linked to rate, e.g. • 'fewer collisions' • fewer successful collisions • fewer collisions, less chance of collisions *No link to rate.*
			Reaction stops (Acid/reactant/limiting reagent) has reacted/been used up ✓		AO2.3	**AW**

Question			Answer	Marks	AO element	Guidance
		(ii)	**Tangent on graph** drawn at approximately t = 50 s (± 10 s) ✓ **Calculation of rate** = Gradient (y/x) of tangent drawn e.g. $\frac{92.4 - 91.0}{220} = \frac{1.4}{220} = 6.36 \times 10^{-3}$ (g s^{-1}) ✓  	**2**	AO3.1 AO3.2	**DO NOT ALLOW** interpolation (taking a direct reading from graph), answer must be derived from taking a gradient **ALLOW ECF from incorrectly drawn tangent** **ALLOW** range of 5.7 x 10^{-3} to 6.9 x 10^{-3} in calculation of tangent (rounded to 1 d.p.) **IGNORE** units **IGNORE** sign **Tolerance of readings:** y axis should be ± 0.02 g (i.e. within 1 square) x axis should be ± 5 min (i.e. within 1 of a square)
		(iii)	Slope is steeper **AND** levels off earlier ✓ **Same** loss in mass, i.e. levels off at ~91.55 g ✓	**2**	AO3.2 ×2	Tolerance ± 1 small square

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	More vigorous bubbling ✓ Zinc dissolves/disappears more quickly ✓	2	AO2.7 ×2	**AW**, e.g. bubbles/fizzes more quickly For 1 alternative marking point **ALLOW** responses related to displacement of Cu from $CuSO_4$ by Zn: **EITHER** red/brown/black precipitate/solid formed **OR** (blue solution) turns colourless
		(ii)	 **ΔH** ΔH labelled with product ($ZnSO_4 + H_2$) below reactant **AND** Arrow downwards ✓ E_a E_a correctly labelled ✓ E_c E_c correctly labelled with $E_c < E_a$ ✓	3	AO2.1 AO1.1 AO1.1	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IGNORE** state symbols **ΔH** **DO NOT ALLOW** $-\Delta H$ **DO NOT ALLOW** double headed arrow on ΔH **ALLOW** ΔH arrow even with small gap at the top and bottom, i.e. line does not quite reach reactant or product line. **E_a and E_c** **ALLOW** no arrowhead or arrowheads at both end of E_a or E_c lines E_a or E_c lines must reach maximum (or near to maximum) on curve For E_a, **ALLOW** AE **OR** A_E **ALLOW** marks for **E_a and E_c** for correctly labelled endothermic diagram (i.e. **ECF** from ΔH)
			Total	12		

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)*	*Please refer to the marking instructions on page 5 of the mark scheme for guidance on how to mark this question.* **Level 3 (5-6 marks)** A comprehensive explanation of effect of temperature **AND** pressure on equilibrium is given with some details about rate **AND** operating conditions *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** The candidate attempts three scientific points, but explanations are incomplete. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** A simple description based on at least two of the main scientific points. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.	**6**	AO1.2 × 3 AO2.5 × 3	**Indicative scientific points may include:** **ALLOW** reverse arguments throughout **<u>Effect of Temperature on equilibrium position</u>** • (Forward) reaction is endothermic/Δ*H* is +ve • High temperature shifts equilibrium to right **<u>Effect of Pressure on equilibrium position</u>** • Left-hand side has fewer (gaseous) moles • **OR** 2 (gaseous) moles form 4 (gaseous) moles • Low pressure shifts equilibrium to right **<u>Effect on rate of reaction</u>** • High temp increases rate • Low pressure reduces rate • Catalyst increases rate • Catalyst lowers activation energy • Discussion using collision theory to support arguments **<u>Operating conditions (not inclusive)</u>** • Compromise conditions needed • High temperatures increase energy demand/costs • Slightly higher pressure used than optimum • Higher pressures unsafe • Catalyst reduces need for higher temperatures • Catalyst doesn't effect the position of equilibrium • Excess steam shifts equilibrium to right

Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **IF answer =** 24.1, **award 2 marks** --- ***K_c expression*** $(K_c =) \frac{[CO]\,[H_2]^3}{[CH_4][H_2O]}$ **OR** $\frac{(0.510)\,(1.53)^3}{(0.111)\,(0.682)}$ **OR** 24.12…….. ✓ **Answer to 3 SF** K_c = 24.1 ✓	**2**	AO2.5 AO2.6	**IF** there is an alternative answer, check for any **ECF** credit possible using working below. --- **ALLOW** calculated value 24.12887731 correctly rounded to 3 or more SF for 1st marking point **ALLOW ECF to 3 SF** **ONLY** from inverted K_c expression → 0.0414 **DO NOT ALLOW** $\frac{[CO] + [H_2]^3}{[CH_4] + [H_2O]}$ (no marks) **IGNORE** attempts at units

Question			Answer	Marks	AO element	Guidance
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **IF answer = (+)198 award 3 marks** --- *Energy for bonds broken* *(1 × C–C + 5 × C–H + 1 × C–O + 7 × O–H)* 347 + 5(415) + 3 58 + 7(464) **OR** 6028 (kJ) ✓ *Energy for bonds made (6 × H–H + 4 × C=O)* 6 × 435 + 4 × 805 **OR** 2610 + 3220 **OR** 5830 (kJ) ✓ *ΔH correctly calculated from above* *ΔH* = 6028 – 5830 = (+)198 (kJ mol^{-1}) ✓	**3**	AO2.2 ×2 AO2.6	**FULL ANNOTATIONS MUST BE USED** --- **IGNORE** sign **IGNORE** sign --- **ALLOW ECF** **DO NOT ALLOW** – sign **Common errors for 2 marks** –198 (incorrect cycle) –149 (missed C-C from bonds broken) –2586 (missing 6 x O-H from H_2O)
	(c)		CO_2 bond angle = 180º **AND** H_2O bond angle = 104.5º ✓ CO_2 has 2 double bonds / 2 bonding regions ✓ H_2O has 2 bonded pairs **AND** 2 lone pairs ✓ Lone pairs repel more than bonding pairs ✓	**4**	AO1.1 AO2.1 ×3	**ALLOW** 104–105 **IGNORE** Names of shapes even if incorrect **ALLOW** alternative phrases/words for repel e.g. 'push apart' **DO NOT ALLOW** atoms repel
			Total	**15**		

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	UV **OR** ultraviolet ✓	1	AO1.1	**ALLOW** Sunlight **IGNORE** Temperature
		(ii)	$CH_3CH_2CH_2CH_3 + Br\bullet \rightarrow CH_3CH_2\dot{C}HCH_3 + HBr$ ✓ $CH_3CH_2\dot{C}HCH_3 + Br_2 \rightarrow CH_3CH_2CHBrCH_3 + Br\bullet$ ✓	2	AO2.5 ×2	**ALLOW** Displayed or Skeletal formulae **ALLOW 1 mark** if **BOTH** equations are 'correct' using molecular formulae, i.e. $CH_3CH_2CH_2CH_3 + Br\bullet \rightarrow C_4H_9\bullet + HBr$ $C_4H_9\bullet + Br_2 \rightarrow C_4H_9Br + Br\bullet$ ✓ **IGNORE** position of • within $CH_3CH_2CHCH_3\bullet$ **ALLOW 1 mark** if incorrect structure of intermediate radical is used, e.g. $CH_3CH_2\mathbf{CH_2CH_2}\bullet$ for $CH_3CH_2\mathbf{CHCH_3}\bullet$ ✓
		(iii)	Further substitution **OR** formation of di/ tri / etc. bromobutanes **OR** produces different termination products **OR** more than one termination step ✓ Formation of 1-bromobutane **OR** (Br) subsitution in a different position ✓	2	AO3.2 ×2	**ALLOW** multisubstitutation, including examples **ALLOW** an example of a different termination product **ALLOW** more than one hydrogen (atom) can be replaced **ALLOW** radicals react with each other to form other products

Question			Answer	Marks	AO element	Guidance
	(b)		% atom economy for butane and bromine (5.1) $= \frac{136.9}{217.8} \times 100 = 62.9\%$ ✓ atom economy for but-2-ene and HBr (5.2) is 100% ✓	2	AO2.2 AO1.2	Calculator: 62.85583104 **ALLOW** calculation for 5.2 **ALLOW** Calculations not expressed as a % i.e. 0.629 and 1.
	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8.07 g award 3 marks** **CARE: Intermediate rounding may give 8.06 g which is acceptable for 3 marks** --- *n*(2-bromobutane) $= \frac{10.0}{136.9} = 0.073(0)\ldots.$ (mol) ✓ *n*($CH_3CH_2CHOHCH_3$) $= 0.0730\ldots. \times \frac{100}{67.0} = 0.109$ (mol) ✓ mass $CH_3CH_2CHOHCH_3$ $= 0.109 \times 74.0 =$ **8.07** g ✓ **3 SF** required	3	AO2.4 ×3	**ALLOW ECF throughout** **IGNORE** trailing zeroes in intermediate working, e.g. 0.073 for 0.0730 **ALLOW** 3 SF or more, correctly rounded Calculator: 0.7304601899 Calculator: 0.1089552239 **ALLOW alternative method mass** • Theoretical mass of 2-bromobutane $= 100 \times \frac{10.0}{67.0} = 14.9\ldots..$ (g) Calculator: 14.925373 • Theoretical *n*($CH_3CH_2CHBrCH_3$) $= \frac{14.923373}{136.9} = 0.1902$ (mol) • Mass of $CH_3CH_2CHOHCH_3$ $= 0.109 \times 74.0 =$ **8.07** g ✓ **Common Errors for 2 marks** 5.41 g (no % yield) 3.62 g (inverted yield)

Question			Answer	Marks	AO element	Guidance
		(ii)	Separating funnel (to separate aqueous and organic layers) ✓ Dry organic layer with anhydrous salt ✓ Distil and collect fraction at 91°C ✓	3	AO3.3 ×3	**ALLOW** Use a drying agent **ALLOW** appropriate example of an anhydrous salt e.g. $MgSO_4$, $CaCl_2$
			Total	13		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>6*</td><td></td><td></td><td>

Please refer to the marking instructions on page 5 of the mark scheme for guidance on how to mark this question.

Level 3 (5-6 marks)
A comprehensive description including most of the evidence to justify the correct structure of **A** (accept *cis* or *trans*).

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)
Explains two scientific points thoroughly with few omissions.
AND
an attempt at a feasible structure with either a C=C **OR** COOH

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

Level 1 (1–2 marks)
The correct empirical formula
AND a simple description based on at least one of the main scientific points.
OR
Some aspects from two scientific points are given

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks No response or no response worthy of credit.

</td><td>6</td><td>AO3.1 ×3

AO3.2 ×3</td><td>

LOOK AT THE SPECTRA for labelled peaks
Indicative scientific points may include:

Empirical formula

- empirical formula = C_2H_3O

element	%mass	A_r	moles	ratio
C	55.8	12	4.65	2
H	7.0	1	7.0	3
O	37.2	16	2.325	1

Spectra and molecular formula
Mass spectrum

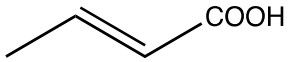
- (molecular ion peak m/z = 86)
- molar mass = 86 g mol^{-1}
- molecular formula = $C_4H_6O_2$

Infrared absorption;

- broad peak at 2500–3300 cm^{-1}, due to O–H in carboxylic acid,
- peak at 1630–1820 cm $^{-1}$ due to C=O
- (peak at 1620–1680 cm $^{-1}$ due to C=C)

Functional groups, structure and stereochemistry

- alkene / C=C
- carboxylic acid / –COOH
- mass spectrum; peak at 41 due to loss of COOH
- Correct structural formula: $CH_3CH=CHCOOH$ i.e. *cis* **OR** trans
- *trans* isomer indicates C=C bond with 2 different groups attached to both double bonded carbons
- *trans:* common groups on opposite sides of double bond
- Correct structure:



</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
						NOTE: *Correct trans assignment with justification would be an example of a well-developed line of reasoning that is substantiated*.
			Total	**6**		

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