

GCE

Chemistry A

H032/01: Breadth in chemistry

AS Level

Mark Scheme for June 2024

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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.

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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 **NONE**

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:

L3

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:

L3



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

SEEN

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.

SECTION A

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

SECTION B

Question			Answer	Marks	Guidance
21	(a)		FIRST CHECK ANSWER ON THE ANSWER LINE IF answer = 54.63 (to 2 DP) award 2 marks $\frac{(54 \times 78.54) + (56 \times 8.88) + (57 \times 5.10) + (58 \times 7.48)}{100}$ OR 54.6298 OR 54.630 ✓ = 54.63 (to 2 DP) ✓	2	For 1 mark: ALLOW ECF → to 2 DP if: • %s used with wrong isotopes ONCE OR • transposed decimal places for ONE %
	(b)	(i)	iron(III) oxide ✓	1	IGNORE iron(3) oxide, iron(III) dioxide, etc i.e. MUST be systematic ALLOW no brackets
	(b)	(ii)	$\text{Fe}_2\text{O}_3 + 3 \text{CO} \rightarrow 2 \text{Fe} + 3 \text{CO}_2$ ✓	1	ALLOW multiples e.g. $2 \text{Fe}_2\text{O}_3 + 6 \text{CO} \rightarrow 4 \text{Fe} + 6 \text{CO}_2$ ALLOW 1 Fe₂O₃ but NOT 0 Fe₂O₃

Question	Answer	Marks	Guidance
(c)	FIRST CHECK ANSWER ON THE ANSWER LINE IF answer = 1.8(0) (dm³) award 3 marks $n(\text{Fe}(\text{NO}_3)_3) = \frac{4.836}{241.8} = 0.02(00) \text{ (mol)} \checkmark$ $n(\text{NO}_2 + \text{O}_2) = 0.06 + 0.015$ OR $15/4 \times 0.0200$ OR $0.0750 \text{ (mol)} \checkmark$ Total volume = $0.0750 \times 24 = 1.8(0) \text{ (dm}^3\text{)} \checkmark$ DO NOT ALLOW $0.02 \times 24 = 0.48 \text{ dm}^3$ 0.48 dm^3 is 1 mark only for whole question	3	ALLOW ECF throughout ALLOW no trailing zeroes (e.g. 0.02 for 0.0200) <i>Only award ECF using moles for NO₂, O₂, NO₂ + O₂</i> e.g. NO₂: $0.06 \times 24 = 1.44 \text{ (dm}^3\text{)}$ O₂: $0.015 \times 24 = 0.36 \text{ (dm}^3\text{)}$ ALLOW Omission of $\div 4$ for 1 NO₂ AND/OR O₂ e.g. $1.8 \times 24 = 7.2 \text{ (dm}^3\text{)}$ ALLOW use of ideal gas equation using sensible p and T for final mark. e.g. from 100 kPa and 293 K $\rightarrow V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 293}{1000} = 1.83 \text{ dm}^3$ ALLOW 1 DP: 1.8 dm³ from 100 kPa and 298 K $\rightarrow V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 298}{1000} = 1.86 \text{ dm}^3$ ALLOW 1 DP: 1.9 dm³ from 100 kPa and 273 K $\rightarrow V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 273}{1000} = 1.7(0) \text{ dm}^3$ Examples of 'sensible' p and T: $p = 100 \text{ kPa, } 101 \text{ kPa, } 101,325 \text{ Pa}$ $T = 273 - 298 \text{ K}$

Question			Answer	Marks	Guidance					
22	(a)		strong acid: fully dissociates/ionises AND weak acid: partially dissociates/ionises ✓	1	ALLOW strong acid fully dissociates weak acid dissociates/ionises less ALLOW strong acid releases all H ⁺ ions weak acid partially releases H ⁺ ions IGNORE strong acid dissociates more strong acid dissociates quicker DO NOT ALLOW strong acid fully dissociates weak acid does not fully dissociate <i>Response does not state that weak acid dissociates</i> IGNORE breaks down for dissociate/ionise DO NOT ALLOW comparison of concentrations					
	(b)	(i)	<table border="1"><tr><td>Titre/cm³</td><td>24.40</td><td>24.15</td><td>24.25</td><td>✓</td></tr></table> Correct subtractions to obtain titres to 2 DP	Titre/cm ³	24.40	24.15	24.25	✓	1	DO NOT ALLOW 24.4
Titre/cm ³	24.40	24.15	24.25	✓						
	(b)	(ii)	mean titre = $\frac{24.15 + 24.25}{2}$ = 24.20 (cm ³) ✓ <i>i.e. using concordant (consistent) titres</i>	1	ALLOW 24.2 <i>DP already assessed in b(i)</i> DO NOT ALLOW mean of all three titres, i.e. $\frac{24.40 + 24.15 + 24.25}{3}$ = 24.26/24.27 ALLOW ECF from incorrect concordant titres from 22b(i)					

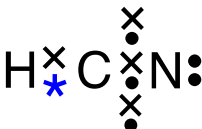
Question	Answer	Marks	Guidance
(b) (iii)	FIRST CHECK ANSWER ON ANSWER LINE IF answer = 89.4 (%) award 5 marks CHECK mean titre from 22b(ii) first. THEN apply ECF throughout using THIS mean titre First 3 mark must come from the titration $n(\text{Na}_2\text{CO}_3)$ $= 0.200 \times \frac{24.20}{1000} = 4.84 \times 10^{-3} \text{ (mol) } \checkmark$ $n(\text{CH}_3\text{COOH})$ in 25.0 cm³ $= 2 \times 4.84 \times 10^{-3} = 9.68 \times 10^{-3} \text{ (mol) } \checkmark$ $n(\text{CH}_3\text{COOH})$ in 250 cm³ $= 10 \times 9.68 \times 10^{-3} = 9.68 \times 10^{-2} \text{ (mol) } \checkmark$ mass of CH₃COOH) in 250 cm³ $= 60 \times 9.68 \times 10^{-2} = 5.808 \text{ (g) } \checkmark$ % composition to 3 SF $= \frac{5.808}{6.50} \times 100 = 89.4 \text{ (%) } \checkmark \quad \mathbf{3 \text{ SF}}$ <i>Calculator: 89.35384615</i>	5	ALLOW 3SF or more throughout IGNORE trailing zeroes, e.g. ALLOW 24.2 for 24.20 ALLOW ECF from incorrect mean titre in b(ii) ALLOW ECF from $2 \times$ incorrect $n(\text{Na}_2\text{CO}_3)$ ALLOW ECF from incorrect $n(\text{CH}_3\text{COOH})$, OR from $n(\text{Na}_2\text{CO}_3)$ if $n(\text{CH}_3\text{COOH})$ stage omitted ALLOW 5.81 (3 SF) IF mass is rounded to 5.81, Answer is still 89.4% <i>Calculator = 89.38461538</i> 8.94% is 4 marks (omission of $\times 10$ stage) IF incorrect mean titre of 24.26/24.27 cm³ used: (mean of all 3 titres in b(ii)), % composition = 89.6% to 3 SF for ALL 5 marks by ECF NOTE: Some candidates are calculating $n(\text{CH}_3\text{COOH})$ based on the 6.50 g sample being pure DO NOT ALLOW 0.108(3.....) $n(\text{CH}_3\text{COOH}) = \frac{6.50}{60} = 0.108(3.....$

Question			Answer	Marks	Guidance
			COMMON ERRORS Omitting $\div 1000$ for $n(\text{Na}_2\text{CO}_3)$ <i>Up to 3 marks are possible</i> $n(\text{Na}_2\text{CO}_3) = 0.200 \times 24.20 = 4.84 \text{ (mol)} \quad \times$ $n(\text{CH}_3\text{COOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 4.84 = 9.68 \text{ (mol)} \quad \checkmark$ $n(\text{CH}_3\text{COOH}) \text{ in } 250 \text{ cm}^3 = 10 \times 9.68 = 96.8 \text{ (mol)} \quad \checkmark$ $\text{mass of CH}_3\text{COOH} \text{ in } 250 \text{ cm}^3 = 60 \times 96.8 = 5808 \text{ (g)} \quad \checkmark$ $\% \text{ composition to 3 SF} = \frac{5808}{6.50} \times 100 = 89400 \text{ (\%)} \quad \times$ <i>Impossible value</i>		COMMON ERRORS Using 25.0 cm^3 (pipette volume) instead of 24.20 cm^3 <i>Up to 4 marks are possible</i> $n(\text{Na}_2\text{CO}_3) = 0.200 \times \frac{25.00}{1000} = 5.00 \times 10^{-3} \text{ (mol)} \quad \times$ $n(\text{CH}_3\text{COOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 5.00 \times 10^{-3} = 1 \times 10^{-2} \text{ (mol)} \quad \checkmark$ $n(\text{CH}_3\text{COOH}) \text{ in } 250 \text{ cm}^3 = 10 \times 1 \times 10^{-2} = 1 \times 10^{-1} \text{ (mol)} \quad \checkmark$ $\text{mass of CH}_3\text{COOH} \text{ in } 250 \text{ cm}^3 = 60 \times 1 \times 10^{-2} = 6.00 \text{ (g)} \quad \checkmark$ $\% \text{ composition to 3 SF} = \frac{6.00}{6.50} \times 100 = 92.3 \text{ (\%)} \quad \checkmark$ <i>Calculator: 92.30769231</i>

Question			Answer	Marks	Guidance
23	(a)	(i)	Two (✓ ✓) from: rate of forward reaction = rate of reverse reaction - Concentrations (of reactants and products) do not change/are constant - In a closed system/environment	2	IGNORE reactions take place together/reversible reaction ALLOW backward for reverse DO NOT ALLOW concentration of reactants = concentration of products ALLOW 'nothing can leave/enter'
	(a)	(ii)	Temperature: (Forward) reaction is exothermic/ΔH is negative/ (Forward) reaction gives out heat AND Low temperature ✓ Pressure: Right-hand side has fewer (gaseous) moles/ 4 (gaseous) moles form 2 (gaseous) moles AND High pressure ✓ Equilibrium shift: Equilibrium/system/equation shift expressed correctly seen at least once ✓	3	<u>FULL ANNOTATIONS MUST BE USED</u> ALLOW reverse reaction is endothermic / ΔH is positive OR reverse reaction takes in heat ALLOW decrease temperature for low temperature For moles, ALLOW molecules/particles ORA for reverse reaction DO NOT ALLOW gaseous atoms ALLOW increase pressure for high pressure For shifts, ALLOW 'shifts/moves/pushes' towards right'/NH₃/products OR in favours the forward direction OR favours the right

Question	Answer	Marks	Guidance
(b)	FIRST, CHECK THE ANSWER ON ANSWER LINE IF bond enthalpy = (+)391 (kJ mol⁻¹) award 3 marks ALLOW ECF Throughout FULL ANNOTATIONS MUST BE USED Energy for bonds made (N≡N + 4 × O–H) = 945 + 4 × 464 OR 945 + 1856 OR 2801 ✓ IGNORE sign 4 N–H bond enthalpy correctly calculated 4 × N–H = 2801 – 581 – 158 – 498 = 1564 ✓ N–H bond enthalpy ONLY ALLOW from use of at least 4 ΔH values N–H bond enthalpy = $\frac{1564}{4}$ = (+)391 kJ mol⁻¹ ✓ ALLOW ECF throughout, where calculation shown See common errors For other answer, work on: x = Energy for bonds made (N≡N + 4 × O–H) 4 N–H = x – 1237 OR x – 581 – 158 – 498 656 N–H = $\frac{x - 1237}{4}$	3	COMMON ERRORS (allow rounding down to whole number) –391 → 2 marks <i>Wrong sign for N–H bond enthalpy</i> 159 → 2 marks 2 × O–H instead of 4 × O–H 945 + 2 × 464 = 1873 ✗ 1873 – 581 – 158 – 498 = 636 ✓ Then 636/4 = 159 ✓ 681.5 → 2 marks <i>Wrong sign for –581</i> 945 + 4 × 464 = 2801 ✓ 2801 – –581 – 158 – 498 = 2726 ✗ Then 2726/4 = 681.5 ✓ 536.25 → 2 marks (ΔH, –581 omitted) 945 + 4 × 464 = 2801 ✓ 2801 – 0 – 158 – 498 = 2145 ✗ Then 2145/4 = 536.25 ✓ 445.25 → 2 marks 945 omitted 0 + (4 × 464) = 1856 ✗ 1856 – 581 – 158 – 498 = 619 ✓ Then 619/4 = 154.75 ✓ 194.25 → 2 marks 158 instead of 945 158 + (4 × 464) = 2014 ✗ 2014 – 581 – 158 – 498 = 777 ✓ 777/4 = 194.25 ✓ –37.75 → 2 marks 158 used instead of 945 and 2 × O–H 158 + (2 × 464) = 1086 ✗ 1086 – 581 – 158 – 498 = –151 ✓ –151/4 = –37.75 ✓ –1009.5 → 2 marks <i>Wrong sign for 2801</i> 945 + 4 × 464 = 945 + 928 = 2801 ✓ –2801 – 581 – 158 – 498 = –4035 ✗ Then –4035/4 = –1009.5 ✓

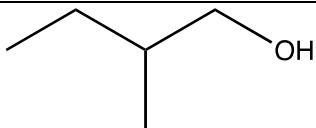
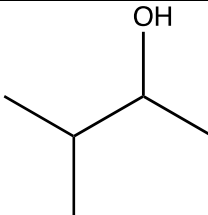
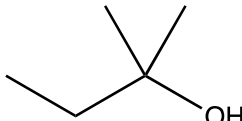
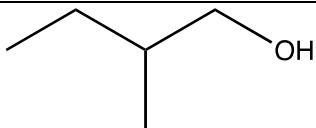
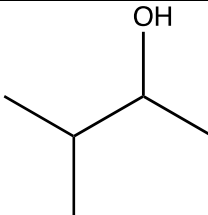
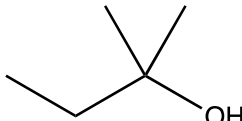
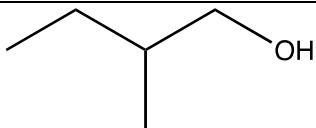
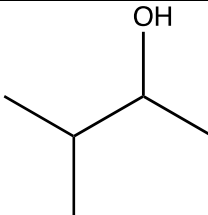
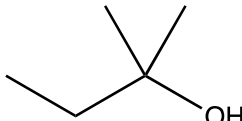
Question	Answer	Marks	Guidance
	233.75 → 1 mark <i>158 instead of 945 and 158 omitted from N₂H₄</i> $158 + 4 \times 464 = 2014$ ✗ $2014 - 581 - 0 - 498 = 935$ ✗ Then $935/4 = 233.75$ ✓ 155.83 → 0 marks <i>As above but ÷6 instead of ÷4</i> Then $935/6 = 155.83$ ✗ 194.25 → 2 marks <i>158 instead of 945</i> $158 + 4 \times 464 = 2014$ ✗ $2014 - 581 - 158 - 498 = 777$ ✓ Then $777/4 = 194.25$ ✓ 129.5 → 1 mark <i>As above but ÷6 instead of ÷4</i> Then $777/6 = 129.5$ ✗ 484.75 → 2 marks <i>158 instead of 945. Then wrong sign for -581</i> $158 + (4 \times 464) = 2014$ ✗ $2014 - -581 - 158 - 498 = 1939$ ✓ Then $1939/4 = 484.75$ ✓ 721 → 2 marks <i>-158 omitted and wrong signs for 581 and 498</i> $945 + (4 \times 464) = 2801$ ✓ $2801 - -581 - 0 - -498 = 2884$ ✗ Then $2884/4 = 721$ ✓		430.5 → 2 marks (-158 omitted) $945 + (4 \times 464) = 2801$ ✓ $2801 - 581 - 0 - 498 = 1722$ ✗ $1722/4 = 430.5$ ✓ 536.25 → 2 marks (ΔH, -581 omitted) $945 + 4 \times 464 = 945 + 928 = 2801$ ✓ $2801 - 0 - 158 - 498 = 2145$ ✗ Then $2145/4 = 536.25$ ✓ 719 → 2 marks <i>Wrong signs for 158 and 498</i> $945 + 4 \times 464 = 945 + 928 = 2801$ ✓ $2801 - 581 + 158 + 498 = 2876$ ✗ Then $2876/4 = 719$ ✓ 449.5 → 1 mark <i>Wrong sign for -581 and 2 × O-H</i> $945 + 2 \times 464 = 945 + 928 = 1873$ ✗ $1873 - -581 - 158 - 498 = 1798$ ✗ Then $1798/4 = 449.5$ ✓ 489 → 1 mark <i>2 × O-H instead of 4 × O-H</i> <i>Wrong sign for -581 and -158 omitted</i> $945 + 2 \times 464 = 945 + 928 = 1873$ ✗ $1873 - -581 - 0 - 498 = 1956$ ✗ Then $1956/4 = 489$ ✓ 43 → 2 marks <i>No 4 × O-H</i> $945 + 1 \times 464 = 1409$ ✗ $1409 - 581 - 158 - 498 = 172$ ✓ Then $172/4 = 43$ ✓

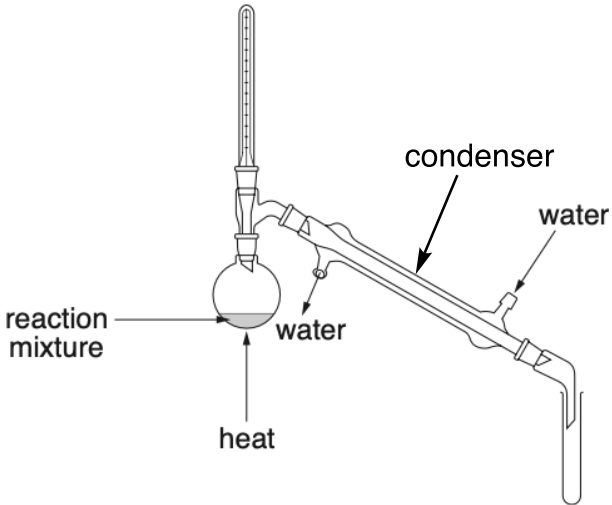
Question	Answer	Marks	Guidance
(c)	 'Dot and cross' of triple bond correct ✓ Complete 'dot and cross' correct ✓	2	ALLOW vertical arrangement: x•••xx as long as there are 3 electrons of each type ALLOW 2 different symbols, provided that it is clear to which atom the electrons belong, i.e. • 5 N electrons • 4 C electrons • 1 H electron The H electron could look the same as the N electrons. Dots could be open or filled.

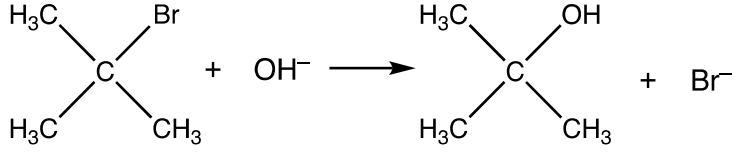
Question	Answer	Marks	Guidance
24 (a)	CHECK FOR RESPONSES ON TABLE Trend Boiling point decreases with more branching OR fewer methyl/alkyl groups/side chains ✓ Branching and surface contact <i>Could be seen anywhere within response</i> Branching linked to the amount of (surface) contact / interaction/overlap (between molecules) ✓ Type and strength of intermolecular force <i>Could be seen anywhere within response</i> Branching/ boiling points/contact linked to strength of London forces OR induced dipole(–dipole) interactions OR extent of surface contact ✓ Energy and intermolecular forces <i>Linked to energy seen anywhere</i> More energy to break intermolecular forces with less branching ✓ IGNORE just ‘bonds’ <i>intermolecular or type of forces required</i>		ANNOTATE WITH TICKS AND CROSSES Comparisons needed throughout ORA throughout ALLOW comparison between 2 alkanes, e.g. C has greatest branching AND lowest boiling point A has no branching AND highest boiling point IGNORE Chain length Surface area alone is not sufficient <i>must have idea of contact.</i> DO NOT ALLOW responses comparing different numbers of electrons (as all have the same number). ALLOW more branching results in fewer London forces ORA IGNORE van der Waals'/vdW forces OR IDID OR IDD ALLOW more energy to break/overcome London forces OR induced dipole(–dipole) interactions OR vdW forces IGNORE harder to overcome/break intermolecular forces (no reference to energy)

Question	Answer	Marks	Guidance
(b)	CORRECT DOTS REQUIRED FOR ALL MARKS Initiation ultraviolet / UV AND $\text{Br}_2 \rightarrow 2\text{Br}\cdot$ OR $\text{Br}_2 \rightarrow \text{Br}\cdot + \text{Br}\cdot$ OR $\text{Br}-\text{Br} \rightarrow 2\text{Br}\cdot$, etc ✓ Propagation 1 $\text{C}_2\text{H}_6 + \text{Br}\cdot \rightarrow \text{C}_2\text{H}_5\cdot + \text{HBr}$ ✓ 2 $\text{C}_2\text{H}_5\cdot + \text{Br}_2 \rightarrow \text{C}_2\text{H}_5\text{Br} + \text{Br}\cdot$ ✓ Termination In either order: $\text{C}_2\text{H}_5\cdot + \text{C}_2\text{H}_5\cdot \rightarrow \text{C}_4\text{H}_{10}$ OR $2\text{C}_2\text{H}_5\cdot \rightarrow \text{C}_4\text{H}_{10}$ ✓ $\text{C}_2\text{H}_5\cdot + \text{Br}\cdot \rightarrow \text{C}_2\text{H}_5\text{Br}$ ✓	5	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous DO NOT ALLOW charged formulae IGNORE position of dots within a formula DO NOT ALLOW if reagents also present, e.g..steam ALLOW $\cdot\text{CCH}_5$ for $\text{C}_2\text{H}_5\cdot$ ALLOW $\text{C}_2\text{H}_5\text{C}_2\text{H}_5$ for C_4H_{10} ✓

Question			Answer		Marks	Guidance									
	(c)		<table><tr><th>Carbon atom</th><th>Bond angle</th><th>Name of shape</th></tr><tr><td>1</td><td>109.5</td><td>tetrahedral</td></tr><tr><td>2</td><td>120</td><td>trigonal planar</td></tr></table> 2 OR 3 correct ✓ 4 correct ✓ Number of electron pairs In C1/109.5°, 4 bonded pairs/bonding regions/bonds ✓ In C2/120°, 3 bonded regions/bonds ✓ Electron pair repulsion Electron pairs/bonded pairs repel (as far apart as possible) ✓ <i>Electron pairs/bonded pairs essential</i> <i>DO NOT ALLOW 'bonded atoms' for this mark</i>	Carbon atom	Bond angle	Name of shape	1	109.5	tetrahedral	2	120	trigonal planar		5	ALLOW 109–110 for C1 ALLOW 118–122 for C2 ALLOW planar triangle ALLOW table responses if in wrong columns IGNORE areas of electron density For bonded pairs ALLOW bp, bonded groups, bonded atoms <i>Bonded/bonding essential</i> For C2, ALLOW 3 bonded areas/environments 3 bonded pairs/groups/atoms 2 bonded pairs and 1 double bond 2 bonded pairs and 1 bonded region DO NOT ALLOW 'atoms repel' IGNORE - electrons repel - bonds repel - electron region OR electron density - lone pairs repel more <i>irrelevant here</i> - shapes, even if wrong
Carbon atom	Bond angle	Name of shape													
1	109.5	tetrahedral													
2	120	trigonal planar													

Question		Answer	Marks	Guidance												
25	(a)	$\text{C}_5\text{H}_{12}\text{O} + 7\frac{1}{2} \text{O}_2 \rightarrow 5 \text{CO}_2 + 6 \text{H}_2\text{O}$ CO_2 AND H_2O products ✓ Complete equation balanced ✓	2	ALLOW multiples e.g. $2 \text{C}_5\text{H}_{12}\text{O} + 15 \text{O}_2 \rightarrow 10 \text{CO}_2 + 12 \text{H}_2\text{O}$ Watch for 15/2 OR 7.5 for $7\frac{1}{2}$												
	(b)	<table><tr><th>Alcohol</th><th>Structure</th></tr><tr><td>A</td><td> ✓</td></tr><tr><td>B</td><td> ✓</td></tr><tr><td>C</td><td> ✓</td></tr></table>	Alcohol	Structure	A	 ✓	B	 ✓	C	 ✓	3	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous DO NOT ALLOW structure if H(s) are missing from ONE structural formula BUT ALLOW any further omissions as ECF Take care with numbers of carbons, the branches and the position of branching especially for C IGNORE connectivity, e.g. ALLOW <table><tr><td style="text-align: center;"> </td><td style="text-align: center;"> </td></tr><tr><td style="text-align: center;">OH</td><td style="text-align: center;">CH₃</td></tr></table> BUT DO NOT ALLOW -HO			OH	CH ₃
Alcohol	Structure															
A	 ✓															
B	 ✓															
C	 ✓															
OH	CH ₃															

Question	Answer	Marks	Guidance
(c)	 Workable set up • Flask with 'horizontal' OR 'angled down' condenser ✓ • NOT a sealed system for collection vessel • NOT open at the top above flask Key labels for distillation set up • Water in at bottom and out at top • AND condenser label ✓	2	DO NOT ALLOW ANY MARKS FOR A REFLUX SET UP IGNORE • no heat <i>question about apparatus</i> • no thermometer <i>stopper is fine</i>

Question	Answer	Marks	Guidance
(d) (i)	 Structure of BOTH organic compounds ✓ DO NOT ALLOW if H(s) are missing OH⁻ on left AND Br⁻ on right ✓ ALLOW NaOH/KOH with NaBr/KBr	2	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous IGNORE state symbols ALLOW OH⁻ AND Br⁻ in a balanced mechanism ALLOW OH⁻ over the arrow for LHS of equation DO NOT ALLOW unbalanced charges, e.g. OH⁻ with Br DO NOT ALLOW H₂O AND HBr <i>question specifies aqueous alkali.</i> DO NOT ALLOW 2nd mark if a CON reagent is present, e.g. an acid
(d) (ii)	Rates of hydrolysis of all 3 haloalkanes Fastest RI > RBr > RCl slowest ✓ Bond enthalpies/strength of bonds for any one RX Strongest: C–Cl > C–Br > C–I weakest ✓ MUST refer to C–X bond in some way	2	IGNORE reactivity of halogens ALLOW unambiguous comparison of two haloalkanes e.g. RI is fastest AND RCl is slowest ALLOW C–Cl is strongest bond ALLOW R–Cl, etc BUT NOT RCl > RBr > RI <i>no bonds</i> DO NOT ALLOW just 'strongest bond enthalpy iodine has weakest bond

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