GCE

Chemistry A

H032/01: Breadth in chemistry

AS Level

Mark Scheme for June 2024

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.

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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:



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
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
BP	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)**	Fe_2O_3 + **3** CO → **2** Fe + **3** CO_2 ✓	**1**	**ALLOW** multiples e.g. **2** Fe_2O_3 + **6** CO → **4** Fe + **6** CO_2 **ALLOW** 1 Fe_2O_3 ….. but **NOT** 0 Fe_2O_3 …..

Question	Answer	Marks	Guidance
(c)	**FIRST CHECK ANSWER ON THE ANSWER LINE** **IF answer = 1.8(0) (dm^3) award 3 marks** $n(Fe(NO_3)_3) = \frac{4.836}{241.8}$ = 0.02(00) (mol) ✓ $n(NO_2 + O_2)$ = 0.06 + 0.015 **OR** 15/4 × 0.0200 **OR** 0.0750 (mol) ✓ Total volume = 0.0750 × 24 = 1.8(0) (dm^3) ✓ **DO NOT ALLOW 0.02 × 24 = 0.48 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) *Only award **ECF** using moles for NO_2, O_2, $NO_2 + O_2$* e.g. NO_2: 0.06 × 24 = 1.44 (dm^3) O_2: 0.015 × 24 = 0.36 (dm^3) **ALLOW** Omission of ÷4 for 1 NO_2 **AND/OR** O_2 *e.g.* 1.8 × 24 = 7.2 (dm^3) --- **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 dm^3 **ALLOW** 1 DP: 1.8 dm^3 from 100 kPa and 298 K $\rightarrow V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 298}{1000}$ = 1.86 dm^3 **ALLOW** 1 DP: 1.9 dm^3 from 100 kPa and 273 K $\rightarrow V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 273}{1000}$ = 1.7(0) dm^3 Examples of 'sensible' *p* and *T*: *p* = 100 kPa, 101 kPa, 101,325 Pa *T* = 273 – 298 K

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>22</td><td>(a)</td><td></td><td>strong acid: fully dissociates/ionises
AND
weak acid: partially dissociates/ionises ✓</td><td>1</td><td>ALLOW strong acid fully dissociates
weak acid dissociates/ionises less

ALLOW strong acid releases all H^+ ions
weak acid partially releases H^+ ions

IGNORE strrong acid dissociates more
strrong acid dissociates quicker

DO NOT ALLOW
strong acid fully dissociates
weak acid does not fully dissociate
Response does not state that weak acid dissociates

IGNORE breaks down for dissociate/ionise

DO NOT ALLOW comparison of concentrations</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td><table><tr><td>Titre/cm^3</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</td><td>1</td><td>DO NOT ALLOW 24.4</td></tr>
<tr><td></td><td>(b)</td><td>(ii)</td><td>mean titre = $\frac{24.15 + 24.25}{2}$ = 24.20 (cm^3) ✓
i.e. using concordant (consistent) titres</td><td>1</td><td>ALLOW 24.2 DP already assessed in b(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)</td></tr>
</table>

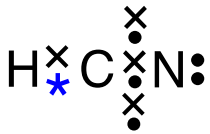
Question			Answer	Marks	Guidance
	(b)	(iii)	**FIRST CHECK ANSWER ON ANSWER LINE** **IF answer = 89.4 (%) award 5 marks** **CHECK** mean titre from **22b(ii)** first. **THEN** apply **ECF** throughout using THIS mean titre **First 3 mark must come from the titration** ***n*(Na$_2$CO$_3$)** = $0.200 \times \frac{24.20}{1000}$ = 4.84×10^{-3} (mol) ✓ ***n*(CH$_3$COOH) in 25.0 cm^3** = $2 \times 4.84 \times 10^{-3}$ = 9.68×10^{-3} (mol) ✓ ***n*(CH$_3$COOH) in 250 cm^3** = $10 \times 9.68 \times 10^{-3}$ = 9.68×10^{-2} (mol) ✓ **mass of CH$_3$COOH) in 250 cm^3** = $60 \times 9.68 \times 10^{-2}$ = 5.808 (g) ✓ **% composition to 3 SF** = $\frac{5.808}{6.50} \times 100$ = 89.4 (%) ✓ **3 SF** *Calculator: 89.35384615*	**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 × incorrect *n*(Na$_2$CO$_3$) **ALLOW ECF** from incorrect *n*(CH$_3$COOH), **OR** from *n*(Na$_2$CO$_3$) if *n*(CH$_3$COOH) stage omitted **ALLOW** 5.81 (3 SF) **IF** mass is rounded to 5.81, Answer is still 89.4% *Calculator = 89.38461538* *8.94% is 4 marks (omission of × 10 stage)* **IF** incorrect mean titre of 24.26/24.27 cm^3 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*(CH$_3$COOH) based on the 6.50 g sample being pure **DO NOT ALLOW 0.108(3……** *n*(CH$_3$COOH) = $\frac{6.50}{60}$ = 0.108(3……

Question	Answer	Marks	Guidance
	COMMON ERRORS **Omitting ÷ 1000 for *n*(Na_2CO_3)** *Up to 3 marks are possible* ***n*(Na_2CO_3)** = 0.200 × 24.20 = 4.84 (mol) × ***n*(CH_3COOH) in 25.0 cm^3** = 2 × 4.84 = 9.68 (mol) ✓ ***n*(CH_3COOH) in 250 cm^3** = 10 × 9.68 = 96.8 (mol) ✓ **mass of CH_3COOH) in 250 cm^3** = 60 × 96.8 = 5808 (g) ✓ **% composition to 3 SF** = $\frac{5808}{6.50} \times 100$ = 89400 (%) × *Impossible value*		**COMMON ERRORS** **Using 25.0 cm^3 (pipette volume) instead of 24.20 cm^3** *Up to 4 marks are possible* ***n*(Na_2CO_3)** = $0.200 \times \frac{25.00}{1000}$ = 5.00×10^{-3} (mol) × ***n*(CH_3COOH) in 25.0 cm^3** = $2 \times 5.00 \times 10^{-3}$ = 1×10^{-2} (mol) ✓ ***n*(CH_3COOH) in 250 cm^3** = $10 \times 1 \times 10^{-2}$ = 1×10^{-1} (mol) ✓ **mass of CH_3COOH) in 250 cm^3** = $60 \times 1 \times 10^{-2}$ = 6.00 (g) ✓ **% composition to 3 SF** = $\frac{6.00}{6.50} \times 100 = 92.3$ (%) ✓ *Calculator: 92.30769231*

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	***FULL ANNOTATIONS MUST BE USED*** **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'/NH_3/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 Δ*H* 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** *Wrong sign for N–H bond enthalpy* **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** *Wrong sign for –581* 945 + 4 × 464 = 2801 ✓ 2801 – –581 – 158 – 498 = 2726 ✗ Then 2726/4 = **681.5** ✓ **536.25** → **2 marks** (Δ*H*, *–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** *Wrong sign for 2801* 945 + 4 × 464 = 945 + 928 = 2801 ✓ –2801 – 581 – 158 – 498 = –4035 ✗ Then –4035/4 = **–1009.5** ✓

Question	Answer	Marks	Guidance
	233.75 → **1 mark** *158 instead of 945 and 158 omitted from N_2H_4* 158 + 4 × 464 = 2014 × 2014 – 581 – 0 – 498 = 935 × Then 935/4 = **233.75** ✓ **155.83** → **0 marks** *As above but ÷6 instead of ÷4* Then 935/6 = **155.83** × **194.25** → **2 marks** *158 instead of 945* 158 + 4 × 464 = 2014 × 2014 – 581 – 158 – 498 = 777 ✓ Then 777/4 = **194.25** ✓ **129.5** → **1 mark** *As above but ÷6 instead of ÷4* Then 777/6 = **129.5** × **484.75** → **2 marks** *158 instead of 945. Then wrong sign for –581* 158 + (4 × 464) = 2014 × 2014 – – 581 – 158 – 498 = 1939 ✓ Then 1939/4 = **484.75** ✓ **721** → **2 marks** *–158 omitted and wrong signs for 581 and 498* 945 + (4 × 464) = 2801 ✓ 2801 – –581 – 0 – –498 = 2884 × Then 2884/4 = **721** ✓		**430.5** → **2 marks** (*–158* omitted) 945 + (4 × 464) = 2801 ✓ 2801 – 581 – 0 – 498 = 1722 × 1722/4 = **430.5** ✓ **536.25** → **2 marks** (*ΔH, –581* omitted) 945 + 4 × 464 = 945 + 928 = 2801 ✓ 2801 – 0 – 158 – 498 = 2145 × Then 2145/4 = **536.25** ✓ **719** → **2 marks** *Wrong signs for 158 and 498* 945 + 4 × 464 = 945 + 928 = 2801 ✓ 2801 – 581 + 158 + 498 = 2876 × Then 2876/4 = **719** ✓ **449.5** → **1 mark** *Wrong sign for –581 and 2 × O–H* 945 + 2 × 464 = 945 + 928 = 1873 × 1873 – –581 – 158 – 498 = 1798 × Then 1798/4 = **449.5** ✓ **489** → **1 mark** *2 × O–H instead of 4 × O–H* *Wrong sign for –581 and –158 omitted* 945 + 2 × 464 = 945 + 928 = 1873 × 1873 – –581 – 0 – 498 = 1956 × Then 1946/4 = **489** ✓ **43** → **2 marks** *No 4 × O–H* 945 + 1 × 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** *Could be seen anywhere within response* Branching linked to the amount of (surface) contact / interaction/overlap (between molecules) ✓ **Type and strength of intermolecular force** *Could be seen anywhere within response* Branching/ boiling points/contact linked to strength of London forces **OR** induced dipole(–dipole) interactions **OR** extent of surface contact ✓ **Energy and intermolecular forces** *Linked to **energy** seen anywhere* More energy to break intermolecular forces with less branching ✓ **IGNORE** just 'bonds' *intermolecular or type of forces required*		**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 *must have idea of contact.* **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**	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
			Initiation ultraviolet / UV **AND** $Br_2 \rightarrow 2Br\bullet$ **OR** $Br_2 \rightarrow Br\bullet + Br\bullet$ **OR** Br–Br $\rightarrow 2Br\bullet$, etc ✓		**DO NOT ALLOW** if reagents also present, e.g..steam
			Propagation **1** $C_2H_6 + Br\bullet \rightarrow C_2H_5\bullet + HBr$ ✓		**ALLOW** $\bullet CCH_5$ for $C_2H_5\bullet$
			2 $C_2H_5\bullet + Br_2 \rightarrow C_2H_5Br + Br\bullet$ ✓		
			Termination In either order: $C_2H_5\bullet + C_2H_5\bullet \rightarrow C_4H_{10}$ **OR** $2C_2H_5\bullet \rightarrow C_4H_{10}$ ✓		**ALLOW** $C_2H_5C_2H_5$ for C_4H_{10} ✓
			$C_2H_5\bullet + Br\bullet \rightarrow C_2H_5Br$ ✓		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td></td><td>
<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 C1/109.5º, 4 bonded pairs/bonding regions/bonds ✓

In C2/120º, 3 bonded regions/bonds ✓

Electron pair repulsion
Electron pairs/bonded pairs repel (as far apart as possible) ✓

Electron pairs/bonded pairs essential
DO NOT ALLOW ‘bonded atoms’ for this mark
</td><td>5</td><td>
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
Bonded/bonding essential

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

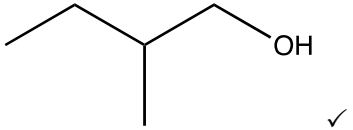
DO NOT ALLOW ‘atoms repel’

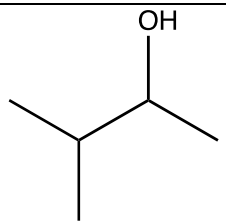
IGNORE
• electrons repel
• bonds repel
• electron region OR electron density
• lone pairs repel more irrelevant here
• shapes, even if wrong
</td></tr>
</table>

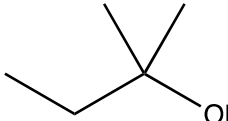
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>25</td><td>(a)</td><td></td><td>$C_5H_{12}O + 7½\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

CO_2 AND H_2O products ✓

Complete equation balanced ✓</td><td>2</td><td>ALLOW multiples
e.g. $2\ C_5H_{12}O + 15\ O_2 \rightarrow 10\ CO_2 + 12\ H_2O$

Watch for 15/2 OR 7.5 for 7½</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<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>

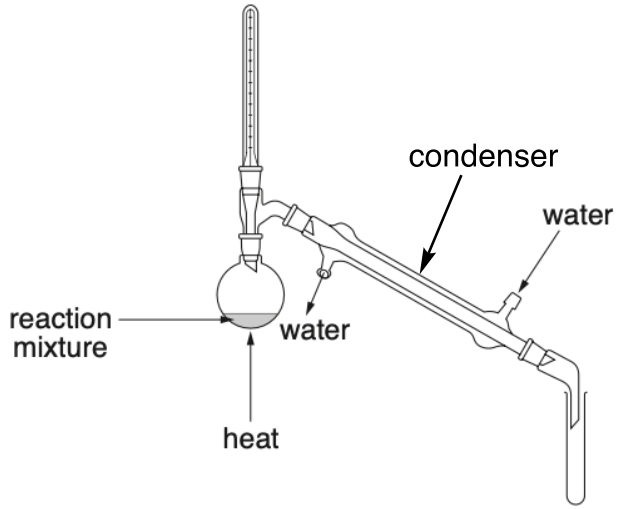
✓</td></tr>
</table>
</td><td>3</td><td>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous

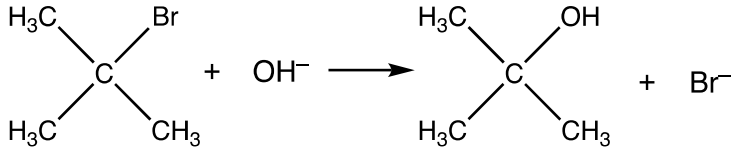
DO NOT ALLOW structure if H(s) are missing from ONE structural formula
……. BUT ALLOW any further omissions as ECF

Take care with numbers of carbons, the branches and the position of branching …. especially for C

IGNORE connectivity,
e.g.
ALLOW | |
OH CH_3

BUT DO NOT ALLOW –HO</td></tr>
</table>

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 *question about apparatus* • no thermometer *stopper is fine*

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** H_2O AND HBr *question specifies aqueous alkali.* **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 *no bonds* **DO NOT ALLOW** just 'strongest bond enthalpy iodine has weakest bond

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