GCE

Chemistry A

H032/02: Depth in chemistry

AS Level

Mark Scheme for June 2023

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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.

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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 **3a** and **4b(ii)**.

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. a candidate has 6 marks, so they would have this annotation on their script:

L3

If a candidate has achieved 5 marks then they have reached Level 3 but with one mark omitted. 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
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

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>FIRST CHECK ANSWER ON ANSWER LINE
If answer = 47.92 (to 2 DP) seen award 2 marks

(46 x 8.3) + (47 x 7.4) + (48 x 73.7) + (49 x 5.4) + (50 x 5.2)
OR
381.8 + 347.8 + 3537.6 + 246.6 + 260
OR
4791.8 ✓

4791.8/100
= 47.92 ✓ 2DP required</td><td>2</td><td>AO2.2

AO1.1</td><td>ALLOW one mark for ECF from seen incorrect sum provided final answer between 46 and 50 and to 2 DP</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>$(1s^2)2s^22p^63s^23p^63d^24s^2$ ✓

Look carefully at $(1s^2)\,2s^22p^63s^23p^6$
– there may be a mistake</td><td>1</td><td>AO1.1</td><td>ALLOW subscripts

ALLOW 4s before 3d i.e.
$(1s^2)2s^22p^63s^23p^64s^23d^2$

ALLOW upper case D, etc and subscripts, e.g. ……$3S_23P^6$

DO NOT ALLOW [Ar] as shorthand for $1s^22s^22p^63s^23p^6$</td></tr>
<tr><td></td><td></td><td>(iii)</td><td><table><tr><th></th><th>Protons</th><th>Neutrons</th><th>Electrons</th></tr><tr><td>$^{48}Ti^{2+}$</td><td>22</td><td>26</td><td>20</td></tr></table> ✓

ALL 3 numbers required for the mark</td><td>1</td><td>AO2.1</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Titanium (IV) oxide ✓</td><td>1</td><td>AO2.5</td><td>DO NOT ALLOW titanium dioxide</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
1	(b)	(ii)	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 2.67 kg award 4 marks** --- $n(\text{Ti}) = \frac{1000}{47.9}$ **OR** 20.8768… (mol) ✓ n(Na) for 72% yield = 20.88 × 4 **OR** 83.5073… (mol) ✓ $n(\text{Na})$ for 100% yield = $83.51 \times \frac{100}{72}$ **OR** 115.98237… (mol) ✓ mass Na = 115.98 x 23.0 = 2667.659… (g) = 2.67 (kg) ✓ **3 SF AND kg required**	**4**	AO2.2 × 4	**ALLOW ECF** throughout **TAKE CARE: values shown may be truncated calculator values.** Steps can be calculated in any order which will change the intermediate answers**.** Marks are for the processing of the data. **ALLOW 3SF** up to calculated value throughout **IGNORE** rounding errors past **3SF** **Common Errors for 3 marks:** 1.92 (missing yield) 1.38 (yield wrong way round) 0.673 (use of Mr 189.9 for $TiCl_4$ instead 47.9 for Ti)
		(iii)	Add water **AND** filter ✓ Ti does not dissolve **OR** NaC*l* does dissolve ✓	**2**	AO3.3 × 2	**ALLOW** dissolve **in water** **ALLOW** Ti is insoluble **OR** NaCl is soluble/aqueous **ALLOW** Ti is the residue **OR** NaCl is the filtrate

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	**Equation** $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ All formulae and balancing correct ✓ **Observation** Effervescence/fizzing/bubbles **OR** Ca/solid disappears/dissolves **OR** Forms a white ppt/solid ✓	**2**	AO2.6 AO1.2	**ALLOW** correct multiples including fractions **IGNORE** state symbols, even if wrong **IGNORE** temperature change, pH change or gas formed i.e. must be an observable change. **IGNORE** turns cloudy **DO NOT ALLOW** Colour change
		(ii)	More vigorous effervescence/fizzing/bubbling **OR** Ba/solid disappears/dissolves faster **OR** White ppt formed less rapidly ✓	**1**	AO1.2	**ORA** if clearly references Ca **ALLOW AW** such as stronger/ rapid/ quicker/ more quickly/ more violent **ALLOW** less or no ppt (as barium hydroxide is more soluble) **Note:** Must reference observation not just reaction e.g. more vigorous reaction. **IGNORE** finishes first **IGNORE** more bubbles (need idea of rate) **IGNORE** exothermic
	(b)	(i)	$Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaNO_3(aq)$ Balanced equation ✓ State symbols ✓	**2**	AO2.5 x2	**ALLOW** ionic equation $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **M2 dependent on M1** **IGNORE** NaCl balanced on both sides

Question			Answer	Marks	AO element	Guidance

Question			Answer	Marks	AO element	Guidance
2	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 26.6 % award 4 marks** --- $n(BaSO_4)$ = $\frac{3.28}{233.4}$ **OR** 0.014053… (mol) ✓ mass $Ba(NO_3)_2$ = 0.014053… × 261.3 **OR** 3.672.....(g) ✓ mass NaCl = 5.00 – 3.672.. **OR** 1.3279… (g) ✓ % NaCl = $\frac{1.3279 \times 100}{5.00}$ = 26.6(%) **3 SF** ✓	**4**	AO3.1 ×3 AO3.2	**ALLOW ECF** from incorrect equation in 2(b)(i) and throughout **ALLOW 3SF** up to calculated value throughout **IGNORE** rounding errors past **3SF** *Calculator*: 0.01405312768 *Calculator*: 3.672082262 *Calculator:* 1.327917738 **ALLOW ECF** for use of calculated mass NaCl e.g. 0.014053…x 58.5 = 0.8221…. to give final % 16.4 to 3SF --- **Alternative approach for last 2 marks** % $Ba(NO_3)_2$ = $\frac{3.672 \times 100}{5.00}$ = 73.44 … ✓ % NaCl = 100 – 73.44 = 26.6 % ✓
		(iii)	Silver chloride/AgC*l* would be produced (as a precipitate) ✓ (Mass of NaCl) can be calculated from the mass/moles of AgCl ✓	**2**	AO3.4 × 2	**ALLOW** Chlor**ide** reacts to give (white) ppt **IGNORE** incorrect formula of silver chloride **ALLOW** equation showing formation of AgCl(s)

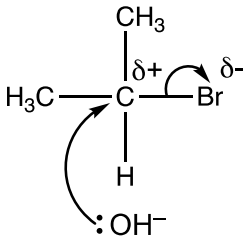
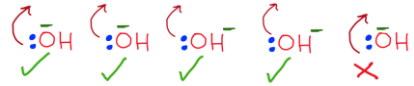
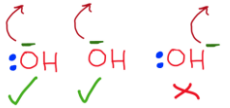
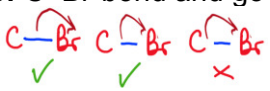
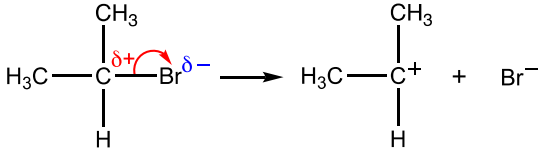
						ALLOW Weigh AgC*l* and use to calculate %/mass/moles

Question			Answer	Marks	AO element	Guidance
2	(c)	(i)	<table><tr><td>Substance</td><td>Magnesium sulfide</td><td>Aluminium</td><td>Silicon</td><td>Phosphorus trichloride</td></tr><tr><td>Melting point/°C</td><td>2000</td><td>660</td><td>1414</td><td>–94</td></tr><tr><td>Electrical conductivity</td><td></td><td>Good</td><td>Poor</td><td></td></tr><tr><td>Type of lattice structure</td><td>Giant **Ionic**</td><td>**Giant Metallic**</td><td>**Giant Covalent**</td><td>**Simple Molecular**</td></tr></table> ✓ ✓ ✓ ✓	4	AO1.1 × 2 AO2.1 × 2	**ALLOW** Simple covalent instead of simple molecular
		(ii)	**Melting points** MgS: ionic bonds (between oppositely charged ions) ✓ PCl_3: intermolecular forces ✓ More energy needed (to separate ions in MgS) **OR** Strong ionic bonds **AND** weak intermolecular forces✓ **Conductivity** Al: mobile/delocalised electrons **AND** Si: no mobile/delocalised electrons **OR** no charge carriers **OR** no mobile ions	4	AO1.1 AO2.1 AO3.1 × 2	**ALLOW** London forces or permanent dipole dipole interactions **ORA** answer must be comparative **ALLOW ECF** from incorrect type of bonding i.e. stronger attraction/more energy **IGNORE** 'free electrons' for mobile/delocalised electrons

Question	Answer	Marks	AO element	Guidance
3 (a) *	*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** A comprehensive explanation of relative reactivities of chlorine and iodine **AND** Uses an appropriate method to calculate volume of seawater allowing for an **acceptable error** *There is a well-developed line of reasoning which is clear an* *d logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A comprehensive explanation of relative reactivities of chlorine and iodine **AND** Some attempt at calculation **OR** Explanation of relative reactivities of chlorine and iodine containing **most** details **AND** A reasonable attempt at calculation **OR** Explanation of relative reactivities of chlorine and iodine containing **some** details **AND** Uses an appropriate method to calculate volume of seawater allowing for an **acceptable error**	**6**	AO1.1 × 2 AO1.2 ×1 AO2.6 × 3	*Indicative scientific points may include:* **Explanation of relative reactivities** Comparison required throughout • Chlorine gains electron more easily **OR** forms negative ion more easily **OR** attracts an electron (to its outer shell) more easily • Because chlorine (atom) is smaller **OR** outer shell of chlorine less shielded/closer • Greater nuclear attraction (on chlorine electrons) • **ORA** **IGNORE** 'nuclear charge' for 'nuclear attraction' **Determination of volume of seawater** • $Cl_2(g) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$ **OR** molar ratio I^-: I_2 = 2:1 • $n(I_2) = \frac{1 \times 10^6}{253.8} = 3940(.11\ldots)$ (mol) • n(KI) = 3940(.11…) × 2 = 7880.(22…) (mol) • n(KI) in 1 dm^3 seawater = $\frac{0.150}{166}$ = 9.036(144..) × 10^{-4} (mol) • Volume of seawater = $\frac{7880.(22..)}{9.036(\ldots) \times 10^{-4}}$ = 8.72…… × 10^6 dm^3

Question	Answer	Marks	AO element	Guidance
	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)** Explanation of relative reactivities of chlorine and iodine containing **some** details **AND** Some attempt at the calculation **OR** Explanation of relative reactivities containing **most** details **OR** A reasonable attempt at calculation *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** *No response or no response worthy of credit.*			**Alternative method:** • m(KI) = 7880.(22…) x 166 (mol) = 1.308(116627) x 10^6 • $\text{Volume of seawater} = \frac{1.308(116627)\ x\ 10^6}{0.15}$ = 8.72…… × 10^6 dm^3 **Acceptable errors:** Volume of seawater obtained from: • Use of 126.9 to find n(I_2) giving 1.74….x 10^7 • Missing x 2 ratio giving 4.36….x 10^6 **DO NOT ALLOW** for L3 if both errors are present, please note it gives a volume of 8.72…… × 10^6 dm^3 **ALLOW** minor slips in rounding, transcription errors, etc throughout

Question			Answer	Marks	AO element	Guidance
3	(b)		**Disproportionation** Oxidation **AND** reduction of same element/chlorine **OR** Chlorine/Cl/Cl_2 has been **oxidised AND** chlorine/Cl/Cl_2 has been **reduced** ✓ **Oxidation** from **0** in **Cl_2** to **+1** in **$Ca(OCl)_2$ OR ClO^-** ✓ **Reduction** from **0** in **Cl_2** to **–1** in **$CaCl_2$ OR Cl^-**✓	**3** AO1.1 AO2.2 AO2.2	**IGNORE** numbers around equation for oxidation numbers **IGNORE** 'species' or 'reactant' for element **ALLOW** 1+ for +1 **AND** 1– for –1 **NOTE** for chlorine/Cl_2 **from 0** only needs to be seen once, does not need to be stated twice **ALLOW** 1 mark for 3 oxidation numbers correct but no mention of words **oxidation/reduction**: e.g. 0 in Cl_2 **AND** –1 in $CaCl_2$ **AND** +1 in $Ca(OCl)_2$ **ALLOW** 1 mark for species missing oxidised from 0 to +1 **AND** reduced (from 0) to –1

Question	Answer	Marks	AO element	Guidance
3 (c)	**Mechanism** Curly arrow from OH^- to C atom of C−Br bond in 2-bromopropane✓ Dipole shown on C–Br bond, $C^{\delta+}$ and $Br^{\delta-}$, **AND** curly arrow from C−Br bond to Br atom ✓  **Name** nucleophilic substitution ✓ **NOTE:** Curly arrows can be straight, snake-like, etc. but **NOT** double headed or half headed arrows	3	AO1.2 AO2.1 AO1.1	**1st curly arrow** must • go to the C of C–Br **AND** • start from, **OR** be traced back to **any point across width** of lone pair on O of OH^-  • **OR** start from – charge **on O** of ^-OH ion  *(Lone pair **NOT** needed if curly arrow shown from O^-)* **2nd curly arrow** must start from, **OR** be traced back to, **any part of** C–Br bond and go to Br  --- **ALLOW** S_N1 mechanism for 2 curly arrow marks **First mark** Dipole shown on C–Br bond, $C^{\delta+}$ and $Br^{\delta-}$, **AND** curly arrow from C−Br bond to Br atom ✓  **Second mark** Curly arrow from OH^- **AND** to correct carbocation ✓ Curly arrow must come from lone pair on O of HO^- **OR** OH^- **OR** from minus on O of HO^- ion (no need to show lone pair if curly came from negative charge) ✓

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>3</td><td>(d)</td><td>(i)</td><td>
<table>
<tr><th>Haloalkane</th><th>Formula</th><th>Colour</th></tr>
<tr><td>2-bromopropane</td><td>AgBr</td><td>cream</td></tr>
<tr><td>2-iodopropane</td><td>AgI</td><td>yellow</td></tr>
</table>
✓ ✓

Formula AND colour required for each mark</td><td>2</td><td>AO1.1 x 2</td><td>ALLOW 1 mark if correct formula for both OR correct colour for both</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>AgI OR yellow (precipitate forms first)

AND
C–I bond is weaker (than C–Br bond) ✓</td><td>1</td><td>AO2.3</td><td>ALLOW (precipitate from) 2-iodopropane

ALLOW ECF from incorrect formula or colour ppt from 3(d)(ii)

ALLOW C–I bond has a lower bond enthalpy OR C–I bond is longer

ORA

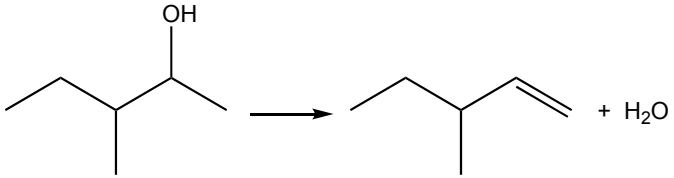
IGNORE references to bond length, polarity and electronegativity</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
4	(a)		(The enthalpy change) for complete combustion ✓ of 1 mol (of substance)✓	2	AO1.1 × 2	**DO NOT ALLOW** energy required **IGNORE** energy released **ALLOW** combustion in excess oxygen/air **OR** reacts in excess oxygen **OR** reacts completely in oxygen **ALLOW** element **OR** compound **OR** reactant **DO NOT ALLOW** atoms **IGNORE** standard states/conditions
	(b)	(i)	$\frac{2 \times 0.25}{31} \times 100 = 1.6$ % ✓	1	AO2.8	**ALLOW** 1 d.p. up to calculator value of 1.612903226 correctly rounded

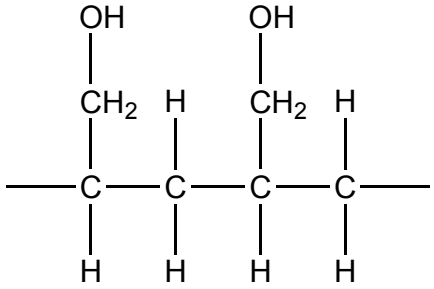
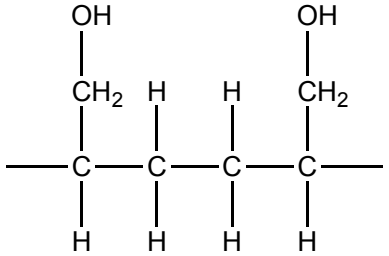
Question			Answer	Marks	AO element	Guidance
4	(b)*	(ii)	*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Calculates an acceptable value for $\Delta_c H$ **AND** Evaluates at least two differences from data book value **AND** suggests at least two suitable improvements. *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)** Use of results to calculate moles of butan-1-ol **AND** an attempt to calculate *q* **AND** Evaluate at least one difference from data book value **AND** suggests at least one suitable improvement. **OR** Calculates an acceptable value for $\Delta_c H$ *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)** Attempts to calculate moles of butan-1-ol **OR** attempts to calculate *q* **AND** Evaluate at least one difference from data book value **OR** suggests at least one suitable improvement.	**6**	AO2.4 × 2 AO3.1 × 2 AO3.3 AO3.4	*Indicative scientific points may include:* **Calculation of *q* and *n*** • mass butan-1-ol burnt = 1.31 g • ΔT = 31 ºC • $q = mc\Delta T$ = 200 × 4.18 × 31 = 259(16) J **OR** 25.9(16) (kJ) • n(butan-1-ol) = $\frac{1.31}{74}$ = 0.0177(017…) (mol) **Calculation of $\Delta_c H$** • $\Delta H = \frac{q}{0.0177017..}$ • ΔH = (–)1460 to (–)1464 (kJ mol^{-1}) **ALLOW** answer in J mol^{-1} if units are given **ALLOW** a single slip/rounding errors e.g. Mr = 73 **IF** no calculation seen check **4(b)(i) /page 10** for any working. **Difference from data book value** • Heat losses • Incomplete combustion • Data book uses standard values • Evaporation of alcohol from wick • Evaporation of water from beaker **Examples of improvements** • Burn in plentiful oxygen • Draft shield

			OR Correct use of results to calculate moles of butan-1-ol **AND** an attempt to calculate *q* **OR** Evaluate at least one difference from data book value **AND** suggests at least one suitable improvement. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** *No response or no response worthy of credit.*			• Copper can in place of beaker • Use a bomb calorimeter • Add lid to beaker • Place cap over wick when not burning • Reduce gap between burner and beaker • Use standard conditions • Use 3 DP balance **OR** digital thermometer • Heat for longer to reduce % uncertainty in mass/temperature measurements
4	**(b)**	**(iii)**	Mass burnt = 0.9825 (g) ✓	**1**	AO3.4	**ALLOW** any value from 0.98 to 0.99 g **ALLOW ECF from b(ii)** i.e. 0.75 × mass change calculated **OR** q = 150 x 4.18 x 31 = 19437 J = 19.4(37) kJ $\text{Mass burnt} = \frac{19.4(37)}{\text{calculated } \Delta H} \text{ x } 74$

Question			Answer	Marks	AO element	Guidance
4	(c)	(i)	**FIRST, CHECK ANSWER ON ANSWER LINE** **IF bond enthalpy = (+)805 (kJ mol^{-1}) award 4 marks** **IF bond enthalpy = (+)3220 (kJ mol^{-1}) award 3 marks** --- *Energy for bonds made: (6O–H)* 6 × 464 **OR** 2784 (kJ) ✓ *Energy for bonds broken:* *(1 C–C + 5C–H + 1C–O + 1O–H + 3O=O)* 347 + (5 × 413) + 358 + 464 + (3 × 498) **OR** 347 + 2065 + 358 + 464 + 1494 **OR** 4728 (kJ) ✓ *4C=O bond enthalpy correctly calculated* –1276 = 4728 – (4C=O + 2784) 4C=O bond enthalpy = 4728 – 2784 + 1276 **OR** (+)3220 (kJ mol^{-1}) ✓ *C=O bond enthalpy correctly calculated* C=O bond enthalpy = $\frac{3220}{4}$ = (+)805 kJ mol^{-1} ✓	**4**	AO2.2 ×4	**FULL ANNOTATIONS MUST BE USED** --- **ALLOW ECF throughout** **IGNORE** signs for first 3 marking points **Alternative method** **ALLOW** (*5O–H)* from bonds made if O-H is omitted from bonds broken. Made: 5 x 464 **OR** 2320 (kJ) ✓ Broken: 347 + (5 × 413) + 358 +(3 × 498) **OR** 4264 (kJ) ✓ 4C=O bond enthalpy = 4264 – 2320 + 1276 = (+)3220 (kJ mol^{-1}) ✓ **DO NOT ALLOW** – sign **COMMON ERRORS for 3 marks** -805 (Wrong Sign) (+)718(.25) (Missing C-C) (+)431.5 (Missing 3 x O=O) (+)167 (Incorrect rearrangement)
	(c)	(ii)	Less energy is required to break bonds in methoxymethane ✓ Energy released in bond forming is same ✓	**2**	AO3.2 × 2	**ORA** **ALLOW** bonds in methoxymethane are weaker (than in ethanol) **IGNORE** calculations **ALLOW** Same bonds being formed

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	3-methylpentan-2-ol ✓	1	AO2.1	**IGNORE** lack of hyphens or addition of commas **ALLOW** 3-methylpentane-2-ol **DO NOT ALLOW** 2-methylpentan-3-ol 3-methylpent-2-ol 3-methpentan-2-ol 3-methypentan-2-ol 3-methlypentan-2-ol
		(ii)	 Correct structure of organic product ✓ Balanced equation ✓	2	AO2.7 × 2	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **DO NOT ALLOW** additional reactants such as H^+ or [O] in the equation. **ALLOW** incorrect isomer 3-methylpent-2-ene for balancing mark.

Question			Answer	Marks	AO element	Guidance
5	(a)	(iii)	Priority groups on same side ✓ High(est) priority groups are CH_3CH_2 and CH_3 **OR** Low(est) priority groups are CH_3 and H ✓	2	AO3.1 × 2	**ALLOW** suitable alternatives to 'priority' e.g. Groups with highest atomic number or more important groups etc. **ALLOW** priority groups are both on the top **IGNORE** references to relative mass of groups, Ar, Mr, **ALLOW** identification by name e.g. ethyl and methyl, or by circling on the structure. **IF** 'priority' is not mentioned **ALLOW** 1 mark for CH_3CH_2 and CH_3 are on same side **OR** H and CH_3 are on same side

Question			Answer	Marks	AO element	Guidance
5	(b)	(i)	**Section of polymer**  ✓ - **Reason for solubility in water** <u>OH/alcohol</u> groups form hydrogen bonds <u>with water</u> ✓	**2**	AO2.5 AO3.1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula. **ALLOW** alternating side chains i.e.  **IGNORE** brackets and use of 'n' **IGNORE** incorrect connectivity for -CH_2OH **DO NOT ALLOW** -HO End bonds **MUST** be shown (solid or dotted) **DO NOT ALLOW** one repeat unit *Question asks for 2 repeat units.* - **DO NOT ALLOW** 'it forms hydrogen bonds'
		(ii)	Any two ✓✓ • Recycled (to make other plastic materials) • Combustion to generate energy / electricity	**2**	AO1.1 × 2	**IGNORE** Reused **ALLOW** Used as a fuel to generate energy / electricity

Question			Answer	Marks	AO element	Guidance
			• As (organic) feedstock			

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