



GCE

Chemistry A

H032/02: Depth 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 **3(b)*** 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:

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 

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

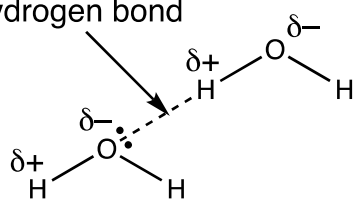
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- 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.

| Question | | Answer | Marks | Guidance |
|----------|---------|--|-------|--|
| 1 | (a) | <p>The ability/tendency of an atom to attract electrons ✓</p> <p>in a covalent bond ✓</p> | 2 | <p>ALLOW 'attraction of an atom for electrons'</p> <p>ALLOW 'pull' for 'attract'</p> <p>DO NOT ALLOW 'element' for 'atom'</p> <p>DO NOT ALLOW ability to attract an electron (i.e. reference to a single electron)</p> <p>ALLOW 'shared pair' or 'bond(ing) pair' for 'covalent bond'</p> <p>2nd mark is independent of first mark</p> |
| | (b) (i) | <p><i>Dipole</i></p> <p>At least one $H^{\delta+}$ AND one $O^{\delta-}$ shown correctly on each water molecule (see diagram) ✓</p> <p><i>Hydrogen bonding</i></p> <p>H bond between H in one H_2O molecule and lone pair of O in an adjacent H_2O molecule ✓</p> <p>hydrogen bond</p>  | 2 | <p>IGNORE lone pairs for first marking point</p> <p>All Hydrogen bonds must hit a lone pair.</p> <p>Hydrogen bond does NOT need to be labelled but it must be different from the covalent bond if it is not labelled.</p> <p>ALLOW H-bond as label</p> <p>ALLOW only one lone pair on O atom</p> <p>ALLOW additional, correctly drawn hydrogen bonded water molecules with correct dipoles</p> <p>DO NOT ALLOW more than 2 lone pairs on O atom</p> |
| | (ii) | <p>Dipoles do not cancel out OR</p> <p>Has an overall dipole ✓</p> | 1 | <p>ALLOW (Water is) unsymmetrical/ non-symmetrical/ asymmetrical</p> <p>IGNORE polar bonds do not cancel</p> <p>IGNORE charges uneven/ do not cancel</p> |

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| Question | | Answer | Marks | Guidance |
|----------|---------|--|-------|--|
| | (iii) | (In ice) molecules are held apart by H bonds OR (Ice) has an open lattice due to H bonds ✓ | 1 | Response must refer to H bonds/bonding ALLOW spread/spaced out/apart instead of 'held apart' IGNORE length of hydrogen bonds DO NOT ALLOW 'atoms' instead of 'molecules' ALLOW H bonding (in ice) creates gaps in the lattice/structure/between molecules... But DO NOT ALLOW if gaps contain 'air' |
| | (c) (i) | (Ammonia has) weaker hydrogen bonds (than ice/water) ✓ N has one lone pair AND O has two OR N less electronegative than O ✓ | 2 | ORA but assume 'it' refers to ammonia Answer must be comparative between hydrogen bonding in ammonia and ice ALLOW Ammonia has less hydrogen bonds ALLOW response in terms of energy required to break hydrogen bonds e.g. less energy needed to break hydrogen bonds (in ammonia) DO NOT ALLOW reference to breaking N-H and O-H bonds i.e. covalent bonds IGNORE reference to other intermolecular forces e.g. London forces, dipole-dipole interactions. ALLOW ammonia has one lone pair AND water/ice has two |
| | (ii) | $\left[\begin{array}{c} \text{H} \\ \cdot\cdot \\ \text{H} \times \text{N} \times \text{H} \\ \cdot\cdot \\ \text{H} \end{array} \right]^+$ <p>Bonded pairs Electron pairs in 3 x N-H covalent bonds shown correctly using dots and crosses ✓</p> <p>Dative bond shown with two crosses or two dots ✓</p> | 2 | ALLOW shell circles IGNORE inner shell in N Charge and brackets not required DO NOT ALLOW additional electrons on either N or H for dative bond mark |

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| Question | | | Answer | Marks | Guidance |
|----------|--|-------|---|-------|--|
| | | | | | |
| | | (iii) | Reagent and conditions (Heat with) hydroxide ✓ Observation (<i>Independent mark</i>) pH/litmus/indicator paper turns blue/purple ✓ | 2 | ALLOW NaOH/KOH/Ca(OH) ₂ /OH ⁻ DO NOT ALLOW Ammonium hydroxide OR ammonia |
| | | (d) | FIRST CHECK ANSWER ON THE ANSWER LINE If answer = 6.46 (g) or 6.5 (g) award 3 marks ----- Molar mass ZnSO ₄ ·7H ₂ O = 287.5 ✓ $n(\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}) = 11.5/287.5$ OR 0.04 (mol) ✓ $m(\text{ZnSO}_4) = 0.04 \times 161.5 = 6.46$ (g) ✓ | 3 | ALLOW final answer to at least 2SF ALLOW ECF from incorrect molar mass but not if 161.5 is used (as this is the molar mass of anhydrous) ALLOW ECF from incorrect number of moles; either multiplied by 161.5 or using alternative approach below Alternative approach, finding mass of water, for final mark: $n(\text{H}_2\text{O}) = 0.04 \times 7 = 0.28$ (mol) $m(\text{H}_2\text{O}) = 0.28 \times 18 = 5.04$ (g) $m(\text{ZnSO}_4) = 11.50 - 5.04 = 6.46$ (g) ✓ |

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| Question | | | Answer | Marks | Guidance |
|----------|-----|-------|---|-------|--|
| 2 | (a) | (i) | Be: $1s^2 2s^2$ Mg: $1s^2 2s^2 2p^6 3s^2$ Block: s | 3 | 1 mark per correct row ALLOW upper case letter S and P, and subscripts, e.g. $2S_2 2P_5$ IGNORE superscripts/numbers given on block (e.g. s^2 and p^5) if the letter is clear |
| | | (ii) | Across period 2, the (2)s subshell fills first, followed by the (2)p ✓ same pattern or trend of filling (the subshells) repeated in other periods ✓ | 2 | ALLOW Elements in the same group have same number of electrons in their outer shells or subshell e.g. s^2 in group 2/ $s^2 p^5$ in group 17(7) ALLOW Elements in the same period have the same number of energy levels/shells ALLOW for both marks for indication that the pattern repeats across each period e.g Across each period, elements repeat the pattern of electrons filling the s-subshell then p-subshell ✓✓ |
| | | (iii) | Mg loses (2) electrons AND Cl gains an electron ✓ To gain a full/complete shell OR Noble gas configuration OR Stable/full octet ✓ | 2 | ALLOW Mg is oxidised AND Cl is reduced |
| | | (iv) | $2Mg + O_2 \rightarrow 2MgO$ ✓ | 1 | ALLOW multiples e.g. $Mg + \frac{1}{2}O_2 \rightarrow MgO$ IGNORE state symbols even if wrong |

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| Question | | | Answer | Marks | Guidance |
|----------|-----|------|---|----------|--|
| | (b) | (i) | Ca loses 2 electrons AND Oxidised✓ H gains 1 electron (per atom) AND Reduced✓ | 2 | ALLOW H gains an electron OR gains electrons OR gains 2 electrons ALLOW 1 mark for Ca is oxidised AND H is reduced ALLOW 1 mark for Ca loses electron(s) AND H gains electron(s) IGNORE oxidation numbers even if incorrect |
| | | (ii) | $n(\text{HCl}) = 0.012 \text{ (mol)}$ ✓ $n(\text{Ca})$ required to react with $\text{HCl} = 0.006 \text{ (mol)}$ OR 0.0100 mol Ca would need 0.02 mol HCl to completely react ✓ Ca reacts with water ✓ | 3 | Second mark must show recognition of the 2:1 ratio e.g. ALLOW ratio is 1:2 but here only 1:1.2 so Ca is in excess |
| | (c) | (i) | B is below Be but above Li (about 800 kJ mol^{-1}) ✓ Mg is above Na but below Be (about 700 kJ mol^{-1}) ✓ | 2 | DO NOT ALLOW if on the line of 900 kJ mol^{-1} . It must be clear that IE for Mg is less than Be as below it in group 2 |

| Question | | | Answer | Marks | Guidance |
|----------|--|------|---|-------|---|
| | | (ii) | $B^{+}(g) \rightarrow B^{2+}(g) + e^{-}$ <i>Equation correct ✓</i> <i>Correct state symbols ✓</i> | 2 | ALLOW $B^{+}(g) - e^{-} \rightarrow B^{2+}(g)$ for 2 marks The second mark is dependent upon the first mark except for the following close attempts: ALLOW one mark for the following for state symbols $B(g) \rightarrow B^{2+}(g) + 2e^{-}$ $B^{+}(g) + e^{-} \rightarrow B^{2+}(g) + 2e^{-}$ $B(g) \rightarrow B^{+}(g) + e^{-}$ ALLOW e for electron (i.e. charge omitted) IGNORE states on the electron |

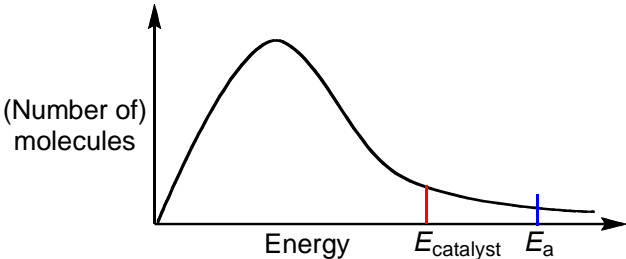
| Question | | Answer | Marks | Guidance |
|----------|-----|---|-------|--|
| 3 | (a) | (The enthalpy change) for the stated equation ✓ | 1 | <p>ALLOW reaction in molar quantities/stoichiometric ratio as shown/stated/given/in equation</p> <p>IGNORE standard states or conditions</p> <p>DO NOT ALLOW Energy released (can't assume reaction is exothermic)</p> |
| | (b) | <p><i>Please refer to the marking instructions on page 5 of the mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Calculates CORRECT enthalpy change AND states multiple assumptions AND improvements</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Calculates CORRECT enthalpy change</p> <p>OR Correctly calculates the moles AND attempts the calculation of q AND states multiple assumptions OR improvements.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> | | <p>Indicative Scientific Points <u>Energy change from $mc\Delta T$</u> Energy in J OR kJ $q = 100.0 \times 4.18 \times 18.6 = 7774.8(\text{J})$ OR 7.7748 (kJ)</p> <p><u>ΔH in kJ mol^{-1}</u> $n(\text{Cu}(\text{NO}_3)_2) = 0.05 \text{ (mol)}$ $\Delta H = -q/n = 7.7748/0.05 = -155 \text{ kJ mol}^{-1}$ (3 SF)</p> <p>ALLOW -156 kJ mol^{-1} (use of 7.775 kJ) ALLOW answer in J mol^{-1} if units are given ALLOW a single slip/rounding errors</p> <p><u>Assumptions and Improvements (NOT INCLUSIVE)</u> <u>Assumptions</u></p> <ul style="list-style-type: none"> • density of solution is 1 g cm^{-3}/same as water • c of solution is same as water • ignore the mass and c of zinc • no heat escapes the system/lost to surroundings • mass of solution remains constant • no water lost/evaporated • reaction goes to completion • reaction completed under standard conditions • measurements recorded are accurate |

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|----------|-----|--|---|-------|---|
| | | | <p>Level 1 (1–2 marks) Attempts any part of the calculation AND states an assumption OR an improvement.</p> <p>OR Correctly calculates the moles AND attempts calculation of q</p> <p>OR States multiple assumptions OR improvements</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p> | | <p>Improvements</p> <ul style="list-style-type: none"> • polystyrene cup /thermos flask • use a lid • more precise thermometer • more precise balance • measure mass of solution • use burette to measure volume • use a cooling curve • use standard conditions <p>Aspects of the communication statement might typically have been met when calculations have been completed in a logical order, and for L3 or L2 (where level awarded for calculation only) the use of the correct sign with the final answer given to 3 or 4 significant figures.</p> |
| | (c) | | <p>Half the energy/q OR volume/mass of solution AND half the moles ✓</p> <p>Temperature change would be same ✓</p> | 2 | <p>ALLOW response that links the same proportionality/ratio of energy/volume/mass of solution to number of moles ALLOW same amount of energy (released) per mole</p> <p>ALLOW both marks if seen by a calculation i.e. $q = 50.0 \times 4.18 \times 18.6 = 3887.4(\text{J})$ OR $3.8874(\text{kJ})$ $n(\text{Cu}(\text{NO}_3)_2) = 0.025 (\text{mol})$ $\Delta H = (-) q/n = 3.8874/0.025 = (-)155 \text{ kJ mol}^{-1}$ ✓ Use of same temperature ✓ May need to check answer in 3b to compare</p> <p>IGNORE Sign</p> |

| Question | | | Answer | Marks | Guidance |
|----------|-----|--|--|-------|--|
| 4 | (a) | | <div><p>Correct drawing of Boltzmann distribution Curve starts within one small square of origin AND not touching the x axis at high energy ✓</p><p>Axes labels y: (number of) molecules/particles AND x: (kinetic) energy ✓</p><p>Catalyst and activation energy Catalyst provides a lower activation energy OR E_c shown below E_a on Boltzmann distribution ✓</p><p>Particles with $E > E_a$ More molecules/particles/collisions have energy above activation energy (with catalyst) OR more molecules have enough energy to react OR greater area under curve above activation energy ✓</p></div> | 4 | <p>ANNOTATE ANSWER WITH TICKS AND CROSSES</p> <p>DO NOT ALLOW two curves <i>Confusion with effect of temperature</i></p> <p>IGNORE a slight inflexion on the curve if less than one small square</p> <p>DO NOT ALLOW 'atoms' as y-axis label DO NOT ALLOW 'enthalpy' for x-axis label</p> <p>IF y axis labelled as 'atoms' ALLOW ECF for atoms (instead of molecules/particles)</p> <p>IGNORE (more) successful collisions IGNORE response implying 'more collisions' <i>(confusion with effect of greater temperature)</i></p> |

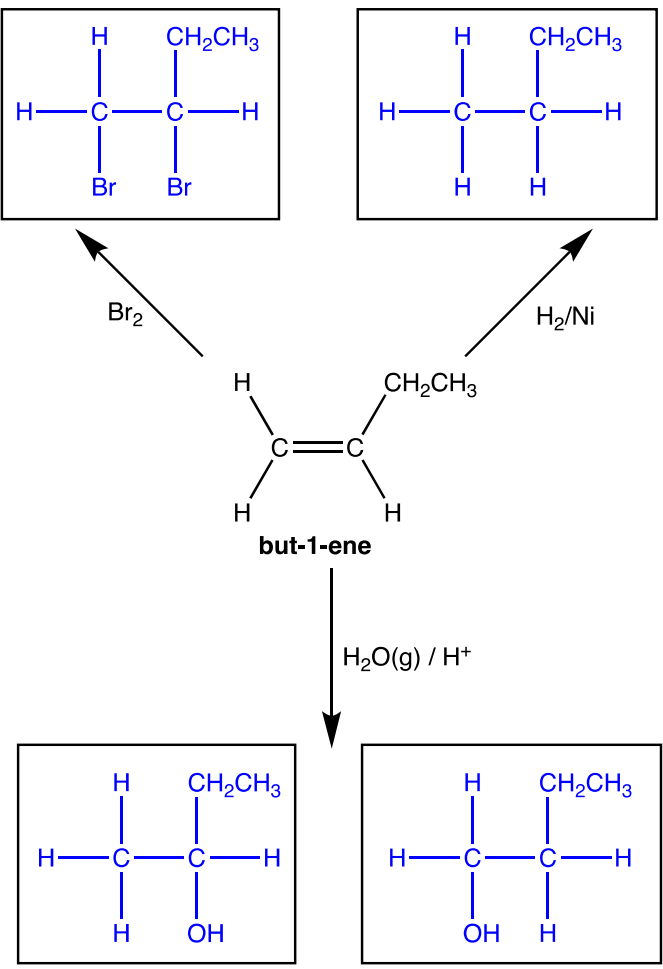
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| Question | | | Answer | Marks | Guidance |
|----------|-----|-------|--|-------|--|
| | (b) | (i) | Line Smooth curve using all points EXCEPT point at 100 s. ✓ Anomaly Point at 100 s circled ✓ | 2 | ALLOW flexibility around point at 120 s Graph should be seen to level off on or very near to 90 cm ³ |
| | | (ii) | Tangent on graph drawn at = 50 s (± 10 s) ✓ Calculation of rate = gradient (y/x) of tangent drawn = 0.67 ± 0.2 cm ³ s ⁻¹ ✓ | 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 or a straight line of best fit |
| | | (iii) | FIRST CHECK ANSWER ON THE ANSWER LINE If answer = 0.15 (mol dm⁻³) award 3 marks $n(\text{O}_2) = 90/24000$ OR $0.09/24$ OR 0.00375 (mol) ✓ $n(\text{H}_2\text{O}_2) = 2 \times 0.00375$ OR 0.0075 (mol) ✓ $c(\text{H}_2\text{O}_2) = 0.0075 \times 1000/50.0 = 0.15 \text{ mol dm}^{-3}$ ✓ | 3 | ALLOW ECF COMMON ERRORS For 2 marks: 0.075 missing x 2 150 missing a cm ³ to dm ³ conversion ----- ALLOW use of ideal gas equation using sensible p and T for first mark. e.g. from 100 kPa and 293 K $n = \frac{pV}{RT}$ $\rightarrow n = \frac{pV}{RT} = \frac{(100 \times 10^3) \times (90 \times 10^{-6})}{8.314 \times 293} = 0.00369... \text{ (mol)}$ 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 |
|----------|-----|--|---|----------|--|
| | (c) | | ANY two ✓✓ <ul style="list-style-type: none">• Amount of catalyst/metal oxide (allow same mass OR same moles)• Temperature• Volume of H₂O₂• Concentration of H₂O₂• Moles/amount of H₂O₂• Pressure• Surface area of catalyst | 2 | DO NOT ALLOW concentration/volume of catalyst/metal oxide |

| Question | | Answer | Marks | Guidance |
|----------|-----|---|-------|--|
| 5 | (a) |  <p style="text-align: center;">but-1-ene</p> <p style="text-align: center;">Mixture of products</p> <p>one mark for each correct structure ✓✓✓✓</p> | 4 | <p>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p> <p>DO NOT ALLOW structure if H(s) are missing from ONE structural formula BUT ALLOW any further omissions as ECF</p> <p>Take care with numbers of carbons</p> <p>IGNORE connectivity, e.g. ALLOW $\begin{array}{cc} & \\ \text{OH} & \text{CH}_2\text{CH}_3 \end{array}$ But DO NOT ALLOW -HO</p> |

| Question | (b) (i) | Answer | Marks | Guidance |
|----------|---------|--|-------|--|
| | | <div data-bbox="472 248 1061 564"> </div> <p data-bbox="394 643 1061 746">1st curly arrow (from ANY alkene) Curly arrow from double bond to H of H-Br ✓ DO NOT ALLOW partial charge on C=C</p> <p data-bbox="394 986 1061 1090">2nd curly arrow Correct dipole on H-Br AND curly arrow for breaking of H-Br bond ✓</p> | 4 | <p data-bbox="1290 217 2130 312">Throughout, ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p> <p data-bbox="1290 352 2107 448">For curly arrows, ALLOW straight or snake-like arrows and small gaps (see examples)</p> <p data-bbox="1290 488 2141 552">DO NOT ALLOW half headed or double headed arrows but allow ECF if seen more than once</p> <p data-bbox="1290 624 2119 807">1st curly arrow must</p> <ul data-bbox="1290 655 2119 807" style="list-style-type: none"> • go to a H atom of H-Br • AND • start from, OR be traced back to any point across width of C=C <div data-bbox="1290 815 1872 959"> </div> <p data-bbox="1290 999 2119 1102">2nd curly arrow must</p> <ul data-bbox="1290 1031 2119 1102" style="list-style-type: none"> • start from, OR be traced back to, any part of $\delta^+ \text{H}-\text{Br}^{\delta-}$ bond • AND go to $\text{Br}^{\delta-}$ <div data-bbox="1290 1110 1727 1254"> </div> <p data-bbox="1290 1286 2141 1350">ALLOW ECF for 2nd and 3rd curly arrow marking points if used Br₂ instead of HBr</p> |

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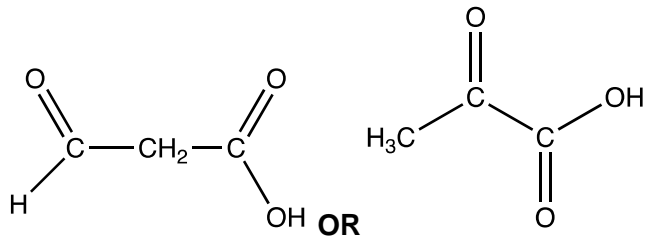
| Question | | | Answer | Marks | Guidance |
|----------|--|------|--|-------|---|
| | | (ii) | <p>(major product forms from) most/more stable intermediate/carbocation ✓</p> <p>(major product forms from a) secondary carbocation OR carbocation bonded to more C atoms / more alkyl groups OR carbocation bonded to fewer H atoms ✓</p> | 2 | <p>ALLOW carbonium ion for carbocation</p> <p>IGNORE descriptions of the major/minor product in terms of Markownikoff's rule e.g. H atom joins to C with most H</p> <p>IGNORE references to stability of the product</p> <p>ALLOW ORA</p> |

| Question | | Answer | Marks | Guidance | | | | | | | | | | | | | | | | | | | | |
|----------|-------|--|-------|--|---------|-------|----|-------|-------|---|-------|----|------|---|---|------|---|------|---|---|-------|----|------|---|
| 6 | | <p><i>Please refer to the marking instructions on page 5 of the mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) A comprehensive description including most of the evidence to justify the correct structure of X.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i></p> <p>Level 2 (3–4 marks) Explains two scientific points with few omissions OR some aspects from all three AND an attempt at a feasible structure with either a C=O OR COOH</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) Determines the correct empirical/molecular formula OR Some aspects from two scientific points are given</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant</i></p> <p>0 marks – No response worthy of credit.</p> | 6 | <p>LOOK ON THE SPECTRA for labelled peaks. Indicative scientific points may include:</p> <p><u>1. Empirical formula</u></p> <table><tr><th>Element</th><th>%mass</th><th>Ar</th><th>moles</th><th>ratio</th></tr><tr><td>C</td><td>40.91</td><td>12</td><td>3.41</td><td>3</td></tr><tr><td>H</td><td>4.54</td><td>1</td><td>4.54</td><td>4</td></tr><tr><td>O</td><td>54.55</td><td>16</td><td>3.41</td><td>3</td></tr></table> <p>Empirical formula = C₃H₄O₃ ALLOW Alternative method using M_r of 88 i.e. C = 88 x (40.91/100) x 12 = 3 etc.</p> <p><u>2. Spectra and Molecular formula</u></p> <p>Mass spectrum</p> <ul style="list-style-type: none">• molecular ion peak <i>m/z</i> or M_r = 88• molecular formula = C₃H₄O₃ <p>IR</p> <ul style="list-style-type: none">• peak at 2500 to 3500 cm⁻¹ is O–H• peak at 1630 to 1820 cm⁻¹ is C=O <p><u>3. Functional groups and structure of X</u></p> <ul style="list-style-type: none">• X contains a carboxylic acid• X doesn't decolourise Br₂ so no C=C bond• Mass spectrum fragment peak(s) identified e.g.<ul style="list-style-type: none">- <i>m/z</i> = 43 for CH₃CO⁺- <i>m/z</i> = 29 CHO⁺- <i>m/z</i> = 15 due to CH₃⁺ | Element | %mass | Ar | moles | ratio | C | 40.91 | 12 | 3.41 | 3 | H | 4.54 | 1 | 4.54 | 4 | O | 54.55 | 16 | 3.41 | 3 |
| Element | %mass | Ar | moles | ratio | | | | | | | | | | | | | | | | | | | | |
| C | 40.91 | 12 | 3.41 | 3 | | | | | | | | | | | | | | | | | | | | |
| H | 4.54 | 1 | 4.54 | 4 | | | | | | | | | | | | | | | | | | | | |
| O | 54.55 | 16 | 3.41 | 3 | | | | | | | | | | | | | | | | | | | | |

H032/02

Mark Scheme

June 2024

| Question | | | Answer | Marks | Guidance |
|----------|--|--|--------|-------|--|
| | | | | | <p>• Structure of X</p> <div style="text-align: center;">  </div> <p>Aspects of the communication statement might typically have been met when evidence is presented in a logical and clear order making good use of all the evidence given.</p> <p>Some points which may be seen where communication is good include:</p> <ul style="list-style-type: none"> • Easy to follow layout on empirical formula calculation • Empirical formula is same as molecular formula i.e. not given as CH_{1.33}O • IR peaks linked clearly to bond it refers to not just functional groups • Positive charge given on MS fragments • MS fragments plausible for the molecular formula determined. • No additional irrelevant/incorrect information given |

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