GCE

Chemistry A

H032/02: Depth in chemistry

AS Level

Mark Scheme for June 2024

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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 **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:



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



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

No marks (0) should have a cross: 

Place the annotations alongside the mark for the question.

On additional pages, annotate using 

11. Annotations available in RM Assessor

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

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

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

13. **Subject-specific Marking Instructions**

INTRODUCTION

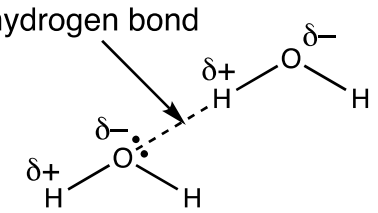
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

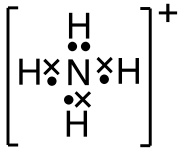
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

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

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 'a**toms' 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)	 **Bonded pairs** Electron pairs in 3 x N-H covalent bonds shown correctly using dots and crosses ✓ **Dative bond** shown with two crosses or two dots ✓	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

Question			Answer	Marks	Guidance
		(iii)	**Reagent and conditions** (Heat with) hydroxide ✓ **Observation *(Independent mark)*** 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 $ZnSO_4 \cdot 7H_2O$ = 287.5 ✓ *n*($ZnSO_4 \cdot 7H_2O$) = 11.5/287.5 **OR** 0.04 (mol) ✓ *m*($ZnSO_4$) = 0.04 × 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(H_2O) = 0.04 x 7 = 0.28 (mol) m(H_2O) = 0.28 x 18 = 5.04 (g) m($ZnSO_4$) = 11.50 – 5.04 = 6.46 (g) ✓

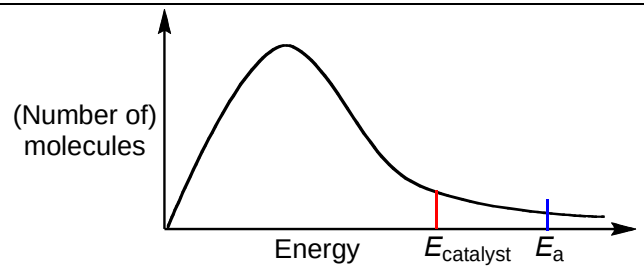
Question			Answer	Marks	Guidance
2	(a)	(i)	Be: $1s^2 2s^2$ F: $1s^2 2s^2 2p^5$ ✓ Mg: $1s^2 2s^2 2p^6 3s^2$ C*l:* $1s^2 2s^2 2p^6 3s^2 3p^5$ ✓ Block: s p ✓	3	**1 mark** per correct row **ALLOW** upper case letter S and P, and subscripts, e.g. $2S_2 2P_5$ **IGNORE** superscripts/numbers given on block (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^2p^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

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*(HC*l*) = 0.012 (mol)✓ *n*(Ca) required to react with HC*l* = 0.006 (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)	$B^+(g) \rightarrow B^{2+}(g) + e^-$ *Equation correct* ✓ *Correct state symbols* ✓	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

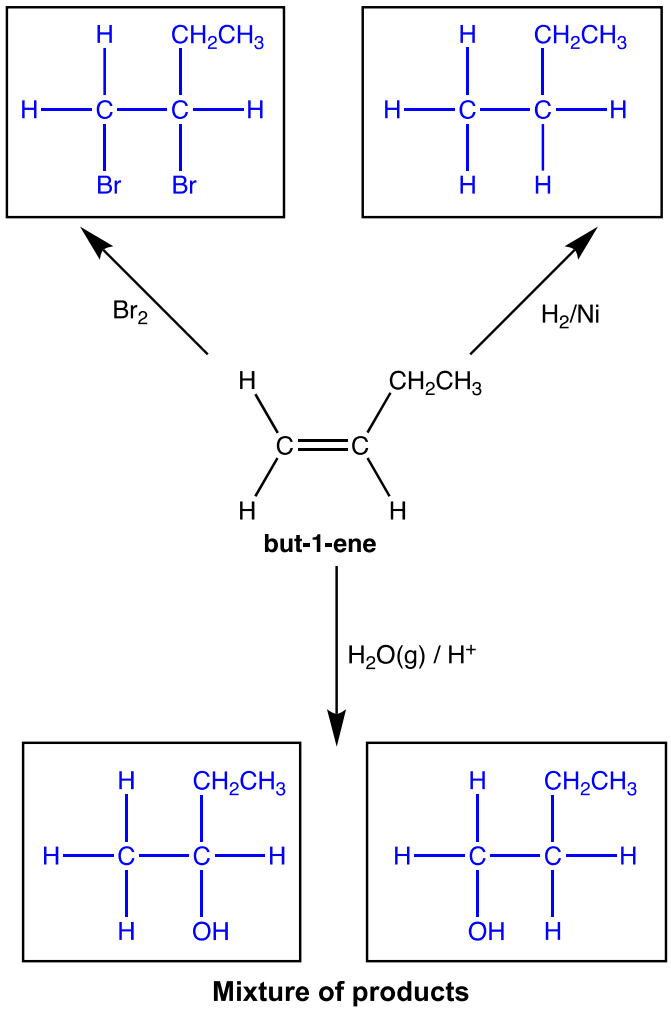
Question			Answer	Marks	Guidance
3	(a)		(The enthalpy change) for the stated equation ✓	1	**ALLOW** reaction in molar quantities/stoichiometric ratio as shown/stated/given/in equation **IGNORE** standard states or conditions **DO NOT ALLOW** Energy released (can't assume reaction is exothermic)
	(b)		*Please refer to the marking instructions on page 5 of the mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Calculates **CORRECT** enthalpy change **AND** states **multiple** assumptions **AND** 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)** Calculates **CORRECT** enthalpy change **OR** Correctly calculates the moles **AND** attempts the calculation of q **AND** states **multiple** assumptions **OR** improvements. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*		**Indicative Scientific Points** **Energy change from *mc*Δ*T*** Energy in J **OR** kJ q = 100.0 × 4.18 × 18.6 = 7774.8(J) **OR** 7.7748 (kJ) **Δ*H* in kJ mol^{-1}** $n(Cu(NO_3)_2)$ = 0.05 (mol) $\Delta H = -qln =$ 7.7748/0.05 = –155 kJ mol^{-1} (3 SF) **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 **Assumptions and Improvements (NOT INCLUSIVE)** ***Assumptions*** • 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

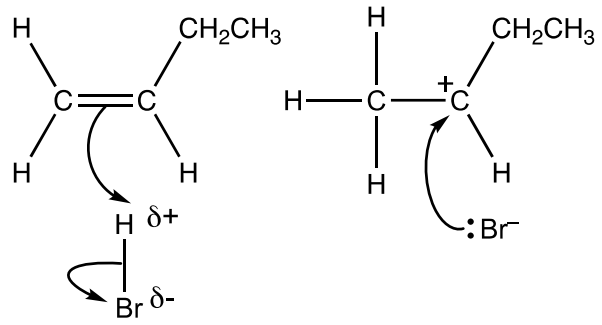
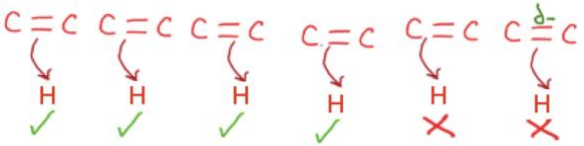
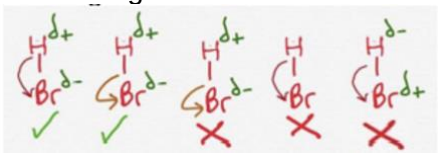
Question			Answer	Marks	Guidance
			Level 1 (1–2 marks) Attempts any part of the calculation **AND** states **an** assumption **OR an** improvement. **OR** Correctly calculates the moles **AND** attempts calculation of q **OR** States **multiple** assumptions **OR** improvements *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant* **0 marks** *No response or no response worthy of credit.*		***Improvements*** • 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 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.
	(c)		Half the energy/q **OR** volume/mass of solution **AND** half the moles ✓ Temperature change would be same ✓	**2**	**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 **ALLOW both marks** if seen by a calculation i.e. q = 50.0 × 4.18 × 18.6 = 3887.4(J) **OR** 3.8874(kJ) $n(Cu(NO_3)_2)$= 0.025 (mol) ΔH = (–) q/n = 3.8874/0.025 = (–)155 kJ mol^{-1} ✓ Use of same temperature ✓ **May need to check answer in 3b to compare** **IGNORE** Sign

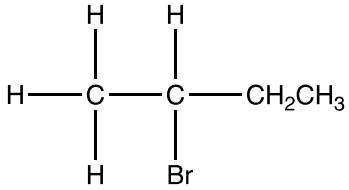
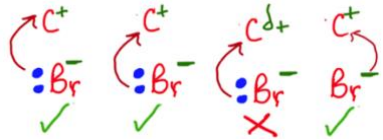
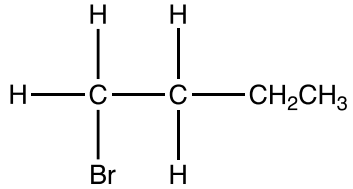
Question			Answer	Marks	Guidance
4	(a)		 ***Correct drawing of Boltzmann distribution*** Curve starts within **one** small square of origin **AND** **not** touching the x axis at high energy ✓ ***Axes labels*** y: (number of) molecules/particles **AND** x: (kinetic) energy ✓ ***Catalyst and activation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

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** $n(O_2)$ = 90/24000 **OR** 0.09/24 **OR** 0.00375 (mol) ✓ $n(H_2O_2)$ = 2 × 0.00375 **OR** 0.0075 (mol) ✓ $c(H_2O_2)$ = 0.0075 × 1000/50.0 = 0.15 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… (mol) Examples of 'sensible' p and T: p = 100 kPa, 101 kPa, 101,325 Pa T = 273 – 298 K

Question			Answer	Marks	Guidance
	(c)		**ANY two** ✓✓ • Amount of catalyst/metal oxide (allow same mass **OR** same moles) • Temperature • Volume of H_2O_2 • Concentration of H_2O_2 • Moles/amount of H_2O_2 • Pressure • Surface area of catalyst	**2**	**DO NOT ALLOW** concentration/volume of catalyst/metal oxide

Question			Answer	Marks	Guidance
5	(a)		 **Mixture of products** one mark for each correct structure ✓✓✓✓	4	**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 **IGNORE** connectivity, e.g. **ALLOW** I I OH CH_2CH_3 But **DO NOT ALLOW** –HO

Question			Answer	Marks	Guidance
	(b)	(i)	 **1st curly arrow (from ANY alkene)** Curly arrow from double bond to H of H–Br ✓ **DO NOT ALLOW** partial charge on C=C **2nd curly arrow** Correct dipole on H–Br **AND** curly arrow for breaking of H–Br bond ✓	4	**Throughout,** **ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **For curly arrows,** **ALLOW straight or snake-like arrows and small gaps (see examples)** **DO NOT ALLOW** half headed or double headed arrows but allow **ECF** if seen more than once **1st curly arrow** must • go to a H atom of H–Br • **AND** • start from, **OR** be traced back to **any point across width** of C=C  **2nd curly arrow** must • start from, **OR** be traced back to, **any part of** $^{\delta+}$H–Br$^{\delta-}$ bond • **AND** go to Br $^{\delta-}$  **ALLOW ECF** for 2nd and 3rd curly arrow marking points if used Br_2 instead of HBr

Question	Answer	Marks	Guidance
	3rd curly arrow Correct carbocation with + charge on C **AND** curly arrow from Br^- to C+ of carbocation ✓ **DO NOT ALLOW** δ+ on C of carbocation **Correct product *(independent mark)*** ✓ 		**3rd curly arrow** must • go to the C^+ of carbocation **AND** • start from, **OR** be traced back to **any point across width** of lone pair on :Br^- • **OR** start from – charge on Br^- ion  *(Lone pair **NOT** needed if curly arrow shown from – charge on Br^-)* **IGNORE** connectivity of alkyl groups in carbocation and product **IF** drawn both intermediates and products with no labelling **ALLOW** 3rd curly arrow mark **BUT NOT** product mark, unless clearly labelled as'2-bromobutane' or 'major' product **ALLOW ECF** for product from incorrect carbocation. e.g. 1-bromobutane: 

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

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

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

Level 3 (5–6 marks)
A comprehensive description including most of the evidence to justify the correct structure of **X.**

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

Level 2 (3–4 marks)
Explains **two** scientific points with few omissions **OR** some aspects from all **three**
AND
an attempt at a feasible structure with either a C=O **OR** COOH

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

Level 1 (1–2 marks)
Determines the correct empirical/molecular formula
OR
Some aspects from two scientific points are given

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

0 marks – No response worthy of credit.

</td><td>6</td><td>

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

1. Empirical formula

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

Empirical formula = $C_3H_4O_3$
ALLOW Alternative method using M_r of 88 i.e.
C = 88 x (40.91/100) x 12 = 3 etc.

2. Spectra and Molecular formula

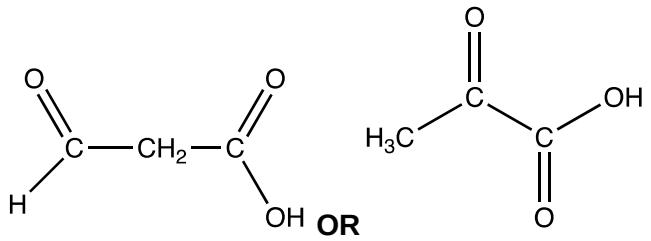
Mass spectrum
- molecular ion peak *m*/*z* or M_r = 88
- molecular formula = $C_3H_4O_3$

IR
- peak at 2500 to 3500 cm^{-1} is O–H
- peak at 1630 to1820 cm^{-1} is C=O

3. Functional groups and structure of X

- **X** contains a carboxylic acid
- **X** doesn't decolourise Br_2 so no C=C bond
- Mass spectrum fragment peak(s) identified e.g.
  - *m*/*z* = 43 for CH_3CO^+
  - *m*/*z* = *29 CHO*$^+$
  - *m*/*z* =15 due to CH_3^+

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

Question	Answer	Marks	Guidance
			• ***Structure of X***  **OR** 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. Some points which may be seen where communication is good include: • 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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