



GCE

Chemistry B

H033/02: Chemistry in depth

AS Level

Mark Scheme for June 2025

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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. These are available in RM Assessor
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 40% 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 or the RM Assessor messaging system, or by email.
5. **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.
1. 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 is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

7. 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 e-mail.

8. 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.

9. 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 **1(b)** and **3(c)**.

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 **A**

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**

10. Annotations

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

11. Subject Specific Marking Instructions

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

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
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
<u>—</u>	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

INTRODUCTION

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

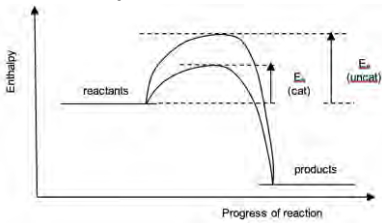
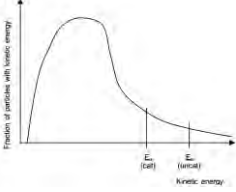
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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	Mark	Guidance
1	(a)	(i)	(catalyst) and the reactants are in different (physical) states/phases ✓	1	ALLOW exhaust emissions for reactants
1	(a)	(ii)	toxic/poisonous ✓	1	IGNORE 'harmful', respiratory problems and haemoglobin/red blood cells
1	(a)	(iii)	$2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ ✓	1	IGNORE state symbols ALLOW multiples
1	(a)	(iv)	Step 2 Bonds break (in reactants) AND Step 3 Bonds form (in products) ✓	1	ALLOW Intramolecular for bonds ALLOW New bonds are made

1	(b)*	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) Both enthalpy profile and Boltzmann distribution drawn and labelled with most points made including both points in bold. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3-4 marks) Some points from both enthalpy profile and Boltzmann distribution OR Most points from one including either bold statement. OR Both bold statements and some points from either enthalpy profile or Boltzmann distribution <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1-2 marks) Some points from either enthalpy profile or Boltzmann distribution.	6 Indicative scientific points include: • Enthalpy profile  • Correctly labelled axes. • Correct profiles for uncatalysed/catalysed reactions. • Correct labels $E_a \text{ uncat}/E_a \text{ cat}$, with directional arrow. $E_a \text{ (cat)} < E_a \text{ (uncat)}$. (ALLOW exothermic or endothermic enthalpy profile) • Activation energy/E_a is the minimum kinetic energy required for colliding particles to react. • A catalyst provides an alternative pathway of lower activation energy. Boltzmann distribution  • A catalyst provides a greater fraction/proportion of particles with sufficient energy to react/collide successfully (AW). • Correctly labelled axes. • Correctly drawn distribution curve. • Correct labels $E_a \text{ uncat}/E_a \text{ cat}$ on K.E. axis. (or on line extended to the curve)
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			<i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i> Total	10	•E _a (cat) < E _a (uncat).
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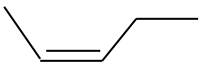
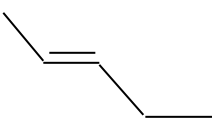
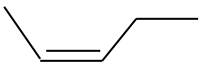
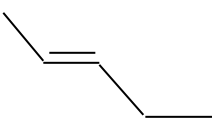
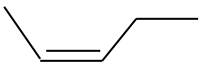
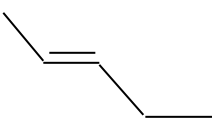
Question			Answer	Mark	Guidance
2	(a)		Heat (or high temperature) and pressure ✓ phosphoric acid/H ₃ PO ₄ AND catalyst ✓	2	DO NOT ALLOW reflux (contradiction) Phosphoric acid AND catalyst are required to clarify that H ₃ PO ₄ is the catalyst
2	(b)		CH ₂ =CH ₂ + H ₂ O → CH ₃ CH ₂ OH/C ₂ H ₅ OH ✓	1	IGNORE state symbols and H ₂ SO ₄ above arrow ALLOW CH ₂ CH ₂ and C ₂ H ₄
2	(c)	(i)	Carry out the reaction in a flask fitted with a (reflux) condenser ✓	1	ALLOW stand the flask in cold water (while adding the acid to the alkene) DO NOT ALLOW references to heating
2	(c)	(ii)	The conversion has not gone to completion (AW) ✓	1	ALLOW some alkene is unreacted/alkene present

2	(d)	'curly arrow' from double bond to H $\delta+$ ✓ 'curly arrow' from H-O bond to O $\delta-$ ✓ carbocation to include positive charge ✓ anion to include negative charge ✓	4 Curly arrows should start (when projected back if necessary) on the relevant bond, and end (when projected forward if necessary) on the atom concerned. ALLOW omission of 'H' on cyclic cation DO NOT ALLOW a hydrogen attached to the cation if NO OTHER hydrogens are shown in the diagram Anion to include negative charge on oxygen. No need for O-S bond.
2	(e)	Platinum/Pt ✓	1

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2	(f)	(i)	<table><tr><td>Skeletal formula</td><td></td><td></td></tr><tr><td>Name</td><td>Z-pent-2-ene</td><td>E-pent-2-ene</td></tr></table> Both correct skeletal formula ✓ Both correctly named ✓ Explanation Each C atom of the C=C has two different groups bonded AND There is no free rotation about the C=C ✓	Skeletal formula			Name	Z-pent-2-ene	E-pent-2-ene	3	ALLOW one mark for correct skeletal formula correctly named Dashes between Z/E and p of pent not required Mark MP 1 and 2 independently DO NOT ALLOW different functional groups bonded ALLOW restricted/limited rotation
Skeletal formula											
Name	Z-pent-2-ene	E-pent-2-ene									
2	(f)	(ii)	Name: 2-methylbut-1-ene OR 3-methylbut-1-ene OR 2-methylbut-2-ene ✓ Type: structural ✓	2	Mark independently ALLOW chain or positional isomerism						
			Total	15							

Question			Answer	Mark	Guidance
3	(a)	(i)	$\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$ ✓ for equation (correct formulae AND balancing)	1	IGNORE state symbols
3	(a)	(ii)	$\text{Ca}(\text{g}) \rightarrow \text{Ca}^+(\text{g}) + \text{e}^-$ ✓ for equation ✓ for state symbols	2	ALLOW e for electron IGNORE 1 on charge
3	(a)	(iii)	Ba is more reactive than Ca ✓ The outer electrons/electrons in the last shell (AW) are further from the nucleus (in Ba than in Ca) ✓ The attraction between the nucleus and the outer electrons is less (in Ba than in Ca) ✓ The outer electrons are lost more easily (in Ba than in Ca) (and so reactivity increases) ✓	4	ORA ALLOW Ba (atoms/atomic radius) are larger than Ca (atoms) for MP2 One of MP2, 3, or 4 must contain comparison between Ba and Ca, otherwise award maximum of 2/3 marks Reference to outer electrons must be seen once to award MP2, 3, or 4 otherwise award maximum of 2/3 marks IGNORE references to shielding
3	(b)		React MgCO_3 with sulfuric acid AND until reactant is in excess/no more fizzing. ✓ Filter (to remove excess reactant). ✓ Evaporate (filtrate) (to crystallisation point/about half volume) AND cool/allow crystals to form/evaporate to dryness (to crystallise nearly saturated solution). ✓ Filter (crystals of hydrated magnesium sulfate) AND dry (on absorbent paper/air dry/warm oven). ✓	4	MgCO_3 should be in excess, not H_2SO_4 If H_2SO_4 is described as being in excess, MP 2 cannot be awarded DO NOT ALLOW MP3 if heating to dryness is mentioned/implied.

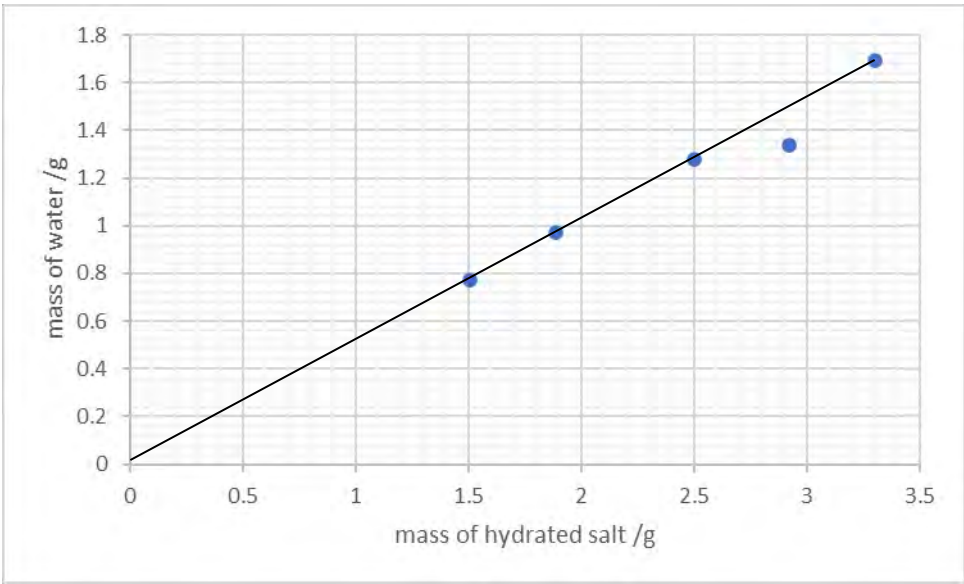
3	(c)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5-6 marks) • Calculation of % by mass Na_2SO_3 in sample correct and clearly structured. • Effect of Student 2's procedural error explained. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3-4 marks) Calculation of % by mass Na_2SO_3 in sample correct and clearly structured. OR Calculation incorrect but effect of errors explained OR Some points made for calculation and effect of errors <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i>	6 Indicative scientific points include: • Calculation of % Na_2SO_3 • (Amount BaSO_4) = $(0.33 / 233.4) = 1.41 \times 10^{-3}$ (mol) • (Amount Na_2SO_4) = 1.41×10^{-3} (mol) • (Mass Na_2SO_4) = $(1.41 \times 10^{-3} \times 142.1) = 0.20$ (g) • (Mass Na_2SO_3) = $(1.000 - 0.2) = 0.8$ (g) • (% by mass Na_2SO_3) = $(0.8 / 1.000 \times 100) = 80\%$ ALLOW 2 sig fig or more • Effects of procedural errors Student 2 • If less BaCl_2 is used, less barium sulfate is precipitated. • This would suggest that less sodium Na_2SO_4 is present/less Na_2SO_3 has been oxidised. • This would give a higher percentage (of Na_2SO_3) in the mixture.
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		Level 1 (1-2 marks) Some points for either bullet. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		
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3	(d)	(i)	 Axes labelled with mass of hydrated salt as x-axis AND scales chosen to fill at least 2/3 of grid available ✓ All points plotted accurately (± 1 small square) ✓ Line of best-fit straight AND going through origin AND except anomaly (2.92, 1.50) ✓	3	Mark Independently Allow MP 3 if plotted incorrectly
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(3)	(d)	(ii)	Anomalous point: Group D/(2.92, 1.30) AND Reason for anomaly: (hydrated salt) was not heated to constant mass/not heated enough ✓	1	Can identify by marking on graph
(3)	(d)	(iii)	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 7 award 3 marks Ratio of $\text{MgSO}_4 : \text{H}_2\text{O} / \text{g} = 1.22 : 1.28$ ✓ Ratio of $\text{MgSO}_4 : \text{H}_2\text{O} \text{ mol} = (1.22 / 120(.3)) : (1.28 / 18)$ $= 1.01 \times 10^{-2} : 7.11 \times 10^{-2}$ ✓ Simplest ratio of $\text{MgSO}_4 : \text{H}_2\text{O} / \text{mol}$ $= (1.01 \times 10^{-2} / 1.01 \times 10^{-2}) : (7.11 \times 10^{-2} / 1.01 \times 10^{-2})$ $= 1 : 7.04$ $x = 7$ ✓	3	ALLOW ECF
(3)	(e)		FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 24.33, award 2 marks [[$(24 \times 78.6) + (25 \times 10.11) + (26 \times 11.29)$]/ 100 OR $(1886.4 + 252.75 + 293.54)/100$ OR 2433/100 ✓ $A_r = 24.33$ (2 dp) ✓	2	ALLOW ECF MUST be to 2 dp for MP2
			Total	26	

Question			Answer	Mark	Guidance
4	(a)	(i)	Classification: secondary ✓ Reasoning: the hydroxyl/OH group is bonded/attached to a carbon atom: to which two other C-atoms are bonded OR has 1 H atom bonded/attached ✓	2	ALLOW 2 carbon chains attached
4	(a)	(ii)	(Heat under) reflux AND (conc.) sulfuric/hydrochloric acid ✓	1	DO NOT ALLOW heat without reflux DO NOT ALLOW dilute acid
4	(a)	(iii)	CH ₃ CH ₂ COOCH(CH ₃) ₂ ✓	1	ALLOW any unambiguous formula
4	(b)		The student is not correct to say that the forward and backward reactions have stopped AND (Instead) they are happening at equal rates ✓ (The student is correct to say that) the composition of the mixture remains constant/unchanged AW ✓	2	
4	(c)	(i)	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.343 award 2 marks 0.790 = m / 20.0 OR 15.8 g ✓ M of CH ₃ CH ₂ OH = 46 Amount CH ₃ CH ₂ OH = 15.8 / 46 = 0.343 (mol) ✓	2	ALLOW 2 or more sf. ALLOW ECF
4	(c)	(ii)	Amount NaOH in mean titre = 29.50 / 1000 x 0.100 OR 2.95 x 10 ⁻³ (mol) ✓ (Amount CH ₃ COOH = amount NaOH) Amount CH ₃ COOH in 40.0 cm ³ = 2.95 x 10 ⁻³ x 40.0 = 0.118 (mol) ✓	2	ALLOW ECF If 0.118 stated without any working out, 0 marks
4	(d)	(i)	[0.118 / (40.0 / 1000)] = 2.95 (mol dm ⁻³) ✓	1	ALLOW 2.96 ((2.78/0.111) x 0.118)

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4	(d)(ii)		$[\text{CH}_3\text{COOCH}_2\text{CH}_3] [\text{H}_2\text{O}] / [\text{CH}_3\text{COOH}] [\text{CH}_3\text{CH}_2\text{OH}] \checkmark$	1	IGNORE x between [] []
4	(d)(iii)		FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 4.10 award 2 marks $5.80 \times 5.80 / 2.95 \times 2.78$ $= 4.10 \checkmark$ 3 sig figs $\checkmark$	2	ALLOW ECF from expression in (d ii) and $[\text{CH}_3\text{COOH}]$ in (d i)
4	(e)		(In order) to reduce the uncertainty/error in the calculation of the (numerical value of the) equilibrium constant $\checkmark$	1	ALLOW reference to graduated pipette being more accurate/smaller uncertainty
4	(f)		This prevents the position of the <u>equilibrium</u> shifting (as the sodium hydroxide reacts with the ethanoic acid) $\checkmark$	1	
4	(g)		Increasing temperature shifts the (position of) equilibrium to the left-hand side/side of reactants $\checkmark$ The (position of) equilibrium shifts to oppose the change $\checkmark$ The enthalpy change for the forward reaction is exothermic $\checkmark$	3	ALLOW favours backward reaction /endothermic direction /less product formed (as K_c is smaller) ALLOW correct reference to the Principle of Le Chatelier for MP2 ALLOW the reverse/backward reaction is endothermic for MP3
			Total	19	

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