GCE

Chemistry B

H433/02: Scientific literacy in chemistry

A Level

Mark Scheme for June 2022

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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.

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 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. **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 'SEEN' to confirm that the work has been seen.

7. Award No Response (NR) if:
   - there is nothing written in the answer space.

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

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 **3c** and **5g**

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

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

Annotation	Meaning
I	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
__	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.

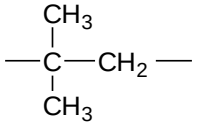
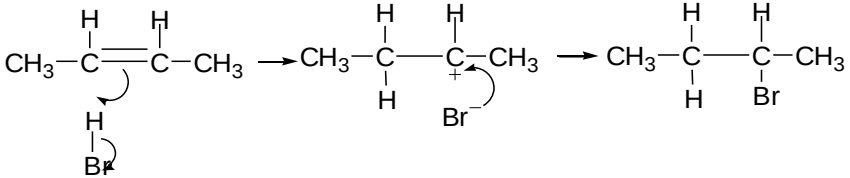
You should ensure that you have copies of these materials.

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	Mark	AO element	Guidance
1	a		iron(III) oxide ✓	1	**2.5**	**IGNORE** gaps in name
1	b	i	$CaO + H_2O \rightarrow Ca^{2+} + 2OH^-$ selection of CaO ✓ correct equation ✓	2	**3.1 x 2**	**IGNORE** state symbols
1	b	ii	$CaO + CO_2 \rightarrow CaCO_3$✓	1	**2.7**	**IGNORE** state symbols
1	c	i	(brick) red✓	1	**1.1**	**ALLOW** orange or orange/red **IGNORE** 'bright/light/dark' qualifiers
1	c	ii	electrons are raised/excited to higher energy levels (by heat from flame) ✓ they drop emitting photons ✓ **OR** they drop emitting light of specific(AW) frequency / wavelength✓	2	**1.2 x 2**	Energy absorbed from other sources eg light is CON **ALLOW** use of E=hv
1	c	iii	**CHECK ANSWER LINE** **If frequency = 4.87 x 10^{14} award 2 marks** Rearrange to $\upsilon = c/\lambda$ ✓ $\upsilon = 3.00 \times 10^8/6.16 \times 10^{-7}$ (scores 1st mark if calc wrong) $= 4.87 \times 10^{14}$ (Hz) ✓	2	**2.6 x 2**	**ALLOW** 2 or more sf.
1	d	i	Ca: s Fe: d ✓	1	**1.2**	**BOTH** required for 1 mark Lower case letters only
1	d	ii	$(1s^22s^22p^63s^23p^6)3d^5$ / [Ar] $3d^5$ / ✓	1	**2.1**	**IF** other sub-shells included they must be correct to score this mark
1	d	iii	more than one d configuration is stable	1	**2.5**	**ALLOW** (Iron is a transition metal and) can form ions with different oxidation states
1	e		Name: iron(III) hydroxide **AND** Colour: orange/orange-brown ✓	1	**2.3**	**ALLOW** 'red/brown' or 'brown' with qualifiers that are not colours, eg 'dark', 'gelatinous'

	f	**i**	pipettes 25 cm^3 of Fe^{3+} ✓ adds excess iodide(to fully react with Fe^{3+}); ✓ titrate with thiosulfate solution in burette ✓ starch indicator added near end point ✓ repeat ✓	5	**3.3** **3.3** **3.3** **2.7** **3.3**	
	f	**ii**	**CHECK ANSWER LINE** **If answer = 0.065 (mol dm^{-3}) award 3 marks** (Amount thio =) 3.2 x 0.51/ 1000 **or** 1.63..... x 10^{-3} mol ✓ (Conc Fe^{3+} =) 1.63..... x 10^{-3} x 1000/25 = 0.065... mol dm^{-3}✓ 2sf (0.065) ✓	3	 **2.8** **2.8** **3.1**	 **ALLOW** ECF **ALLOW** Any calculated value to 2sf for 1 mark
	f	**iii**	Titre(AW) larger ✓ Less measurement uncertainty/can quote answer to 3sf/smaller % error in titre. (AW) ✓	2	**3.4 x 2**	**IGNORE** references to accuracy/precision
1	**g**		$^{48}_{24}\text{Cr} + {}^{4}_{2}\text{He} \rightarrow {}^{52}_{26}\text{Fe}$ top row ✓ bottom row and chromium symbol ✓	2	**2.6 x 2**	
1	**h**	**i**	Number of protons plus neutrons ✓	1	**1.1**	**IGNORE** 'in the atom/element/isotope'
1	**h**	**ii**	abundance/% of isotope below 56 is bigger than abundances/% of isotopes above 56 ✓	1	**3.2**	**IGNORE** references to % abundance at 56 MUST be a comparative statement
				27		

Question			Answer	Mark	AO element	Guidance
2	a		 and but-1-ene ✓	1	1.2	**MUST** be skeletal formula
2	b		π 1 σ 11 ✓	1	2.1	
2	c	i	 ✓	1	1.1	**ALLOW** any unambiguous structure
2	c	ii	No, because 2 of same groups on each/one C /ORA ✓	1	3.1	Eg 2 methyl groups on one carbon atom **DO NOT ALLOW** 'each side'
2	d		 ✓	1	2.1	**ALLOW** brackets and 'n' **ALLOW** any unambigous structure
2	e		instantaneous (dipole)-induced dipole /id-id ✓	1	1.1	**ALLOW** London/Van der Waals forces
2	f		 reactants with curly arrows ✓ intermediate attacked by bromide with curly arrow ✓ product ✓	3	2.5 x 3	**ALLOW** any unambiguous structure curly arrows must start (when extended, if necessary) on the bond concerned or a lone pair or the negative charge on the bromide ion and end pointing at an atom or the bond to be formed. **IGNORE** partial charges.
2	g		***Either*** Catalyst: Nickel **AND** Conditions: heat and pressure (between 1 and 5 atm) ✓ ***or*** Catalyst: Platinum **AND** Conditions: RTP (AW) ✓	1	1.1	**ALLOW** T between 100°C and 200°C
	h	~~i~~	$C_{12}H_{26}$ ✓	1	1.2	
	h	~~ii~~	adsorption (of the reactants onto the catalyst surface) ✓	1	1.2	
				12		

Question			Answer	Mark	AO element	Guidance
3	a	i	Working shown on graph ✓ Two values of '4.0±0.2' ✓ units: x 10^3 s ✓	3	**2.8 x 3**	Half-lives do not need to start at 2.1 and 1.05
	a	ii	3.5±0.5 x 10^{-4} (mol dm^{-3} s^{-1}) ✓	1	**2.8**	**ALLOW** ecf from omission of 10^3 in (i) [3.5±0.5 x 10^{-1}]
	a	iii	They are in excess ✓ their concentrations don't/hardly change ✓	2	**3.3 x 2**	**ALLOW** concentrations are not known/varied / only the concentration of H_2O_2 is known/varied
	b	i	thiosulfate reacts with the iodine until thiosulfate is used up✓ iodine (reacts to) form (blue/blue-black) colour with starch ✓	2	**3.4 x 2**	
	b	ii	1/time ✓	1	**3.3**	**ALLOW** Conc/time

	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)** Analyses data to determine orders and rate constant for the reaction, **AND** evaluates the data to suggest a possible mechanism including some fine detail *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)** Analyses data to determine orders, and rate constant for the reaction **AND** evaluates the data to outline a possible mechanism (little or no fine detail) **OR** Deals with two areas with some fine detail *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)** Analyses data to determine order of reaction wrt I^- and H^+ **OR** Constructs rate equation and determines the rate constant **OR** Suggests a possible mechanism for the reaction *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.*	**6**	**3.1 x 2** **3.2 x 4**	**Indicative scientific points include:** *fine detail in italic* ***AO3.1 Analysing data - Determining orders*** • first order I^- • zero order H^+ • *reason for I^- / as [I^-] doubles rate doubles / quotes relevant values from table* • *reason for H^+ / as [H+] doubles rate remains constant / quotes relevant values from table* ***AO3.2 Determining rate constant*** • rate equation: Rate = k [I^-] [H_2O_2] • k expression: k = Rate/[I^-] [H_2O_2] • k value: $k = 5.25 \times 10^{-6}/0.03 \times 0.01 = 1.75 \times 10^{-2}$ • *k units:* $dm^3\ mol^{-1}\ s^{-1}$ ***AO3.2 Interpreting and evaluating*** • I^- and H_2O_2 in rds/ no H^+ in rds • *suggestion of mechanism, eg* $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow) $H^+ + IO^- \rightarrow HIO$ (fast) $HIO + H^+ + I^- \rightarrow I_2 + H_2O$ (fast)

	d		Suitable line of best fit drawn on graph✓ **THEN CHECK ANSWER LINE** **IF answer = (+)50+/-5 (kJ mol^{-1}) award 3 further marks** Calculates Gradient ✓ Calculation of E_a = -gradient x R ✓ changing units from J mol^{-1} to kJmol^{-1} ✓	4	**2.6 x 4**	Passes close to points 1, 2 and 4 (within 1 small square of each point) **ALLOW** more sf **ALLOW** ecf**.**
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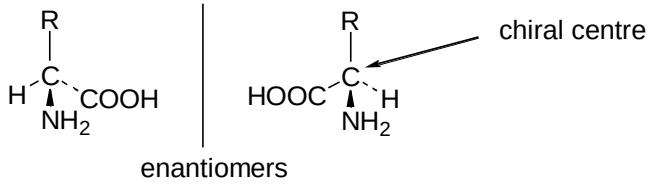
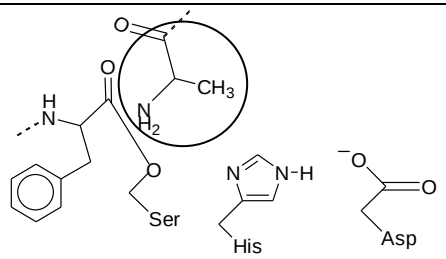
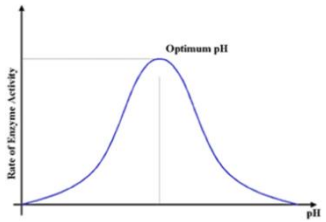
Question			Answer	Mark	AO element	Guidance
4	a	i	 structures ✓ one chiral centre labelled / indicates 4 different groups around correct carbon atom ✓ enantiomers described ✓	3	**1.1 x 3**	**ALLOW** other 3D structures that are mirror images **DO NOT ALLOW** single lines (—) at 180° **ALLOW** non-superimposable mirror images of the molecule
	a	**ii**	$^{-}OOCCH_2NH_3^{+}$	1	**1.1**	**ALLOW** any unambiguous structure.
	b	**i**	formation of peptide bond ✓ $HOOCCH_2NHCOCHRNH_2$ **and** $HOOCCHRNHCOCH_2NH_2$ ✓	2	**2.1 x 2**	**ALLOW** any unambiguous structures. MP2 can only be scored if peptide link correctly formed/drawn
	b	**ii**	condensation **and** water formed ✓	1	**1.1**	
	c	**i**	primary structure ✓	1	**1.1**	**IGNORE** ‘polypeptide structure’
		ii	secondary structure ✓ hydrogen bonds ✓	2	**1.1 x 2**	**IGNORE** covalent bonds **DO NOT ALLOW** ionic bonds/sulfur bridges/pd:pd

	d		 1. Upper fragment with NH_2 (shown circled)✓ 2. Left hand fragment attached to serine contains =O ✓ 3. his and asp structures completed as shown ✓	3	**2.5 x 3**	
	e	**i**	hydrogen bonds/imb broken in tertiary structure ✓ so **active site** destroyed/changes shape/becomes denatured ✓	2	**1.2 x 2**	**ALLOW** H-bonds/imb disrupted(AW)
		ii	 Shape with labelled axes ✓ Peak of curve above pH 8✓ At other pH values the active site becomes denatured/changes shape ✓	3	**2.7 x 3**	**y-axis** labelled as ‘activity/rate/speed’ **x-axis** labelled pH
		iii	Correct for low/initial [substrate] / first order wrt low/initial [substrate] ✓ At higher [substrate] becomes zero order/ rate does not depend on [substrate] ✓	2	**3.1 x 2**	**ALLOW** rate plateaus/levels off at higher [substrate]
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Question			Answer	Mark	AO	Guidance
5	a	i	$K_a = [H^+][F^-]/[HF]$ ✓ mol dm^{-3} ✓	2	1.1 x 2	**ALLOW** ecf
		ii	**CHECK ANSWER LINE** **If answer = 72.4, award 3 marks** $K_a = 7.24 \times 10^{-4}$ ✓ Rearrangement of K_a expression to $[F^-]/[HF] = K_a/[H^+]$ / $7.24x10^{-4}/1x10^{-5}$ ✓ Ratio = $7.24 \times 10^{-4}/10^{-5} = 72.4$ ✓	3	2.6 x 3	**ALLOW** 2 or more sf **ALLOW** ecf from (i) **ALLOW** ecf from second MP
5	b		PO_4^{3-} ✓ loss of proton/H^+ from HPO_4^{2-} ✓	2	2.1 1.1	**ALLOW** PO_4^{3-} accepts H^+ MP2 dependent on MP1
5	c		$SnF_2 + 2OH^- \rightarrow Sn(OH)_2 + 2F^-$ ✓	1	2.7	**IGNORE** state symbols
	d		tetrahedral ✓	1	2.1	
5	e	i	K_{sp} is for (concentrations in) a saturated(AW) solution ✓ IP is for any/other concentrations ✓	2	3.1 x 2	
5	e	ii	**CHECK ANSWER LINE** **If answer = 13, award 3 marks** IP = $1.43 \times 10^{-3} \times (7.9 \times 10^{-3})^2$ **or** 8.92×10^{-8} ✓ Supersaturation = cube root of ($8.92 \times 10^{-8}/3.9 \times 10^{-11}$ **or** 2.29×10^3) ✓ = 13 to nearest whole no. ✓	3	2.4 x 3	If answer = 2 or 4 award 2 marks If answer rounds to 13 award 2 marks
5	f		**CHECK ANSWER LINE** **If answer = 3.77×10^4/ 37700, award 2 marks** 19/504.5 ✓ x $10^6 = 3.77 \times 10^4$ (ppm) ✓	2	2.2 x 2	**ALLOW** 2 or more sf. **ALLOW** ecf from incorrect value for Mr

5	**g***		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)** Makes most main points for both areas with some fine detail from both areas. *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)** Makes some of the main points from both areas with some fine detail from one area. **OR** Makes all of the main points from one area *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)** Addresses both areas **OR** Addresses one area with some fine detail *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.*	**6**	**3.1 x 3** **3.2 x 3**	***Indicative Scientific points include*** *(fine detail in italic)* **AO3.1 Analyse article and** **AO3.2 Interpret and evaluate** **Improvement:** • danger is attack by acids *on hydroxylapatite/formula* • *equation;* • pptn of fluoroapatite/formula • encourages remineralisation • *this is deposition of calcium phosphate;* • *because fluoroapatite has the highest supersaturation/212;* • *F^- acts as a catalyst*; **Not protective or hard** • fluoride compounds soluble in acid • *these are calcium fluoride and fluoroapatite* • fluoroapatite is no harder (than hydroxylapatite) •*comparison with sharks' teeth*
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