GCE

Chemistry B

H033/02: Chemistry in depth

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.

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 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 posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

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.

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 e-mail.

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(h)** and **4(b)**.

The **only** annotation on a level of response question should be the **indication of the level.**
Please do not use ticks or highlight areas.

The appropriate level annotation should be used e.g. If a candidate has 6 marks, they would have the annotation L3 on their script.

If a candidate has achieved 5 marks then they have reached Level 3 but without the communication mark. They should have the following annotations on their script: L3 A

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

No marks (0) should have a cross.

Please place the annotations in the left-hand margin of the main answer space.

On additional pages, please annotate using 'SEEN'

11. **Annotations**

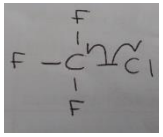
Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

12. 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
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

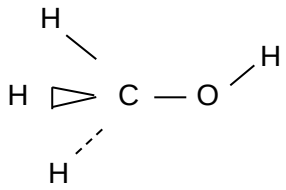
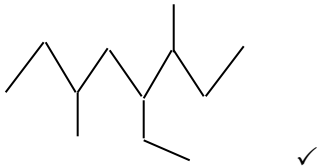
	Question		Answer	Mark	Guidance
1	(a)		Fig 1.1 Fig 1.2 Relative sizes ✓ ✓ Ions packing ✓ All ions seen ✓	2	One mark for each correct column
1	(b)		Test: flame test ✓ Result: sodium (chloride) -yellow (flame) ✓ potassium (chloride) – lilac/purple (flame) ✓	3	**DO NOT ALLOW** orange or orange/yellow
1	(c)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 60.3 award 3 marks** M (AgC*l*) = 143.4 amount AgC*l* = (2.29 / 143.4) **OR** 1.597 x 10^{-2} (mol) ✓ n (Cl^-) = 1.597 x 10^{-2} (mol) m (Cl^-) = (1.597 x 10^{-2} x 35.5) **OR** 0.5669 g ✓ % (Cl^-) = (0.5669 / 0.94) x 100 = 60.3 ✓	3	**ALLOW** two or more sf that round to 60 **ALLOW** rounding **ALLOW** ECF (Mr incorrect or mole calculation incorrect – allow ECF from this).
1	(c)	(ii)	% Cl^- would be greater (than it should be) ✓ mass of precipitate would be greater (than the dry ppt) **OR** precipitate contains water which makes the precipitate/mass greater (AW) ✓	2	**ALLOW** (because) the numerator/top line (in calculating the %) would be greater (than it should be)
1	(d)		Ion: Pb^{2+} **and** Colour of ppt: white ✓	1	**ALLOW** Hg^+; white
1	(e)	(i)	chloride ✓ Silver chloride/ppt is white ✓	2	Mark points independently

1	**(e)**	**(ii)**	Add (dilute) ammonia (solution) to the precipitate ✓ (silver) bromide – partially dissolves/soluble **AND** (silver) iodide – does not dissolve/insoluble ✓	**2**	**ALLOW** Concentrated ammonia solution –(silver) bromide will dissolve (while (silver) iodide will not). **IGNORE** ammonium
1	**(f)**	**(i)**	Iodide ✓ (Purple colour in hexane) which indicates <u>iodine</u> ✓	**2**	
1	**(f)**	**(ii)**	$Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ ✓	**1**	**ALLOW** ECF for ionic equation from answer f(i) **IGNORE** state symbols even if wrong
1	**(f)**	**(iii)**	First bullet point: correct (AW) **AND** Third bullet point: correct (AW) ✓ chlor<u>ide</u>/Cl^- is a weaker reducing agent (than brom<u>ide</u>/Br^-)/chlor<u>ine</u> stronger oxidising agent (than brom<u>ine</u>) (ORA) ✓ plus any one from: ✓ Chlor<u>ine</u> is more reactive than brom<u>ine</u>/can displace brom<u>ide</u> Brom<u>ide</u> ion is bigger/more shielding/has a lower charge density (than chlor<u>ide</u>) (ORA) therefore easier to lose an electron	**3**	mp 1 can be awarded from correct chemistry statements
			Total	**21**	

Question			Answer	Mark	Guidance
2	(a)		0.21 (ppm) ✓	1	
2	(b)		promoting electrons to higher energy levels/excitation ✓	1	**ALLOW** ionising; producing radicals
2	(c)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 1.18 x 10^{15} (Hz) award 2 marks** $\nu = c / \lambda$ ✓ $\nu = (3.00 \times 10^{8} / 2.55 \times 10^{-7}) = 1.18 \times 10^{15}$ (Hz) ✓	2	1 mark for 1.18×10^{13} **ALLOW** any arrangement of the correct equation **ALLOW** 2 or more significant figures
2	(d)	(i)	 → C*l* + F_3C One half curly arrow from C – C*l* bond to C*l* Another half curly arrow from C – C*l* bond to C ✓	1	
2	(d)	(ii)	The C — C*l* bond is weaker (than the C — F bond) ✓ (**ORA**)	1	**ALLOW** lower bond enthalpy/easier to break Must be a comparison **IGNORE** reasons for comparisons of bond strength
2	(d)	(iii)	C*l* + $O_3 \rightarrow$ **C*l*O** + O_2 **C*l*O** + **O** → C*l* + O_2 Both equations ✓	1	**IGNORE** radical notations
2	(d)	(iv)	**One** from ✓ <u>Photochemical</u> smog	1	**ALLOW** toxic/poisonous/lung damage/breathing problems

			Respiratory problems Damages plants/rubber		
2	**(e)**		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 121 award 5 marks** pV = nRT n = pV/RT ✓ 65 cm^3 = 6.5 x 10^{-5} m^3 (allow 65 x 10^{-6}) ✓ n = $\frac{(101\,000 \times 65 \times 10^{-6})}{8.314 \times 293}$ **OR** 2.695 x 10^{-3} (mol) ✓ M = m/n M = 0.327 / 2.695 x 10^{-3} **OR** M = 121.... ✓ M = 121✓ (3 sig figs)	**5**	**ALLOW** ECF throughout Mark for rearranging eqn. can be awarded from values substituted into expression, even if unit conv. of cm^3 to m^3 has not been carried out. Note: Calculation can be written as: Mr = mRT/PV to calculate Mr Award last marking point for any calculated answer to 3 sf.
2	**(f)**		**ANY TWO FROM** ✓ ✓ - water should go in at the bottom and out at the top (AW) - the top of the condenser should not be sealed (AW) - need to add anti bumping granules (AW)	**2**	
			Total	**17**	

Question			Answer	Mark	Guidance
3	(a)		$C_{12}H_{26} + 9½O_2 \rightarrow 6CO + 6C + 13H_2O$ ✓	1	**ALLOW** doubled
3	(b)		**FIRST CHECK ANSWER ON ANSWER LINE** **IF vol = 4.24 dm^3 award 2 marks** amt $C_{14}H_{30}$ 2.5/198 **OR** 0.01263 ✓ vol CO_2 = 0.01263 x 24 x 14 = 4.24 dm^3 ✓	2	**ALLOW** 2 or more sf. **ALLOW** 4.23 due to early rounding (or any answer that rounds to 4.2) **ALLOW** ecf.
3	(c)		combustion of sulfur <u>compounds</u> in diesel ✓	1	
3	(d)		Sustainable: (because) plant growth is renewable/regrown ✓ carbon neutral: if energy used to produce/distribute it is not based on fossil fuels (AW) ✓ **OR** if CO_2 given out when it burns is equal to CO_2 used by the plants	2	**ALLOW** CO_2 released during production/distribution
3	(e)	(i)	C — O — H bond angle = 104-105 ° ✓ Explanation: 4 electron pairs/ 2 bonding pairs and 2 lone pairs (around oxygen atom) ✓ repulsion of electron pairs (as far as possible)/electron pairs repel ✓ lone pairs have greater repulsion/take up more room than bonding pairs/repel more than bonding pairs ✓	4	**ALLOW** 4 electron dense areas/groups/regions **DO NOT ALLOW** electrons repel

3	**(e)**	**(ii)**	1 x solid, 1 x wedge, 1 x dashed/dashed wedge ✓ 	**1**	H-C-O solid line should be less than 180
3	**(f)**		secondary/2°✓ the OH/hydroxyl/functional group is attached to a C-atom: that has only one H-atom attached to it/ has two carbon atoms attached ✓	**2**	Mark mp 1 and mp 2 independently
3	**(g)**	**(i)**	 ✓	**1**	
3	**(g)**	**(ii)**	2,2,3-trimethylpentane ✓	**1**	**IGNORE** dashes and gaps
3	**(g)**	**(iii)**	saturated aliphatic ✓	**1**	

3	**(h)***		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)** Gives correct structural formula, correct calculation and most points from both spectra including some fine points *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)** Gives correct formula and gives some evidence from both spectra **OR** Error in formula calculation but makes some points from both spectra *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)** Makes some points from one or more areas (calculation or spectra) *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**	**Indicative scientific points include:** **Calculation of formula** • mass O = (3.7 – 2.1) = 1.6 g • ratio of moles C:H:O = (1.8 / 12) : (0.3 / 1) : (1.6 / 16) = 0.15 : 0.3 : 0.1 = 3 : 6 : 2 • emp formula = $C_3H_6O_2$ (subsumes points above) **Use of Mass Spectrum** • Mr = 74 from M^+ in mass spectrum • molecular formula = $C_3H_6O_2$ • *CH_3CO^+ means this is a fragment of the molecule (ester is as shown and not $HCOOC_2H_5$)* **Use of IR spectrum** • 1750 cm^{-1} is C=O • 1250 cm^{-1} is C-O • *no O-H (2500 – 3600)* • *ester* **Structure** • structural formula is CH_3COOCH_3 *Aspects of the communication statement:* *Might typically have been met when sentences are clearly structured in a logical order with correct values included and technical terminology used correctly where appropriate.*
			Total	**22**	

Question			Answer	Mark	Guidance
4	(a)	(i)	(K_c =) $[N_2O_4]$ / $[NO_2]^2$ ✓	1	**IGNORE** state symbols **Ensure square brackets**
4	(a)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 1.2 x 10^{-2} (mol dm^{-3}) award 2 marks** 285 = 4.2 x 10^{-2}/ $[NO_2]^2$ $[NO_2]$ = √(4.2 x 10^{-2} / 285) ✓ = 1.2 x 10^{-2} (mol dm^{-3}) ✓	2	**ALLOW** 2 or more sf. **ALLOW** ecf from (i) and between marking points
4	(a)	(iii)	(Forward) reaction is exothermic/ΔH is negative (ORA) ✓ On heating, position of <u>equilibrium</u> shifts to left/ in endothermic/ΔH positive direction (to oppose change) **OR** favours the endothermic direction✓ K_c smaller/decrease ✓	3	**DO NOT ALLOW** comments relating the rates of reaction affecting the equilibrium shift **ALLOW** ECF from 4ai

4	**(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)** Explains all three areas, giving most main points and 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)** Explains all three areas giving most main points **OR** two areas giving some main points and some fine detail in 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)** Explains one or two areas giving some main points. *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**	**Indicative scientific points include:** (main points + *fine detail in italics)* **Why reaction is quite slow** • molecules collide to react • only a fraction (AW) of molecules have activation energy/enough energy to react on collision • *equilibrium is not re-established immediately/established slowly (AW)* **Why the mixture becomes lighter brown** • fewer moles/molecules on right of equation (ORA) • (position of) equilibrium shifts to right • more colourless N_2O_4 formed (ORA) • *fewer molecules mean lower pressure* • *increasing the pressure means (position of) equilibrium shifts to oppose this change (AW)* **Why the mixture does not change** • Rate of forward reaction = rate of back reaction (AW) • *Equilibrium re-established (AW)* • *[NO_2] constant* *Aspects of the communication statement:* *Might typically have been met when sentences are clearly structured in a logical order with correct values included and technical terminology used correctly where appropriate.*
			Total	**12**	

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