GCE

Chemistry B

H033/02: Chemistry in depth

AS 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.

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. A*ssistant 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: Not applicable in F501
    a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
    b. **To determine the mark within the level**, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)

Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

Level of response questions on this paper are **3(d)** and **4(d)**

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	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

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.

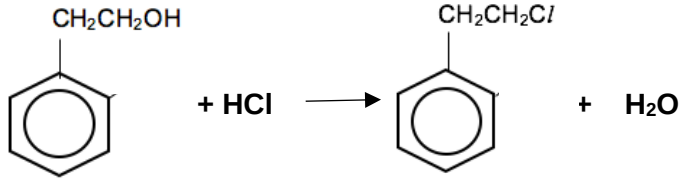
Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	similar – lines in same/similar place✓ different – black lines on coloured background ✓	2	1.1 x 2	**ALLOW** lines at same wavelength/frequency
		(ii)	electrons exist in quantised/discrete/specific energy levels/(sub) shells/energy levels ✓	1	1.1	**IGNORE** answer in terms of origin of emission spectra **IGNORE** reference to number of energy levels
	(b)	(i)	$Mg(g) \rightarrow Mg^{+}(g) + e^{(-)}$ $Mg/Mg^{+}/e^{(-)}$ ✓ state symbols ✓	2	1.2 x 2	**ALLOW** e with or without negative sign
		(ii)	(across the Period) number of protons/nuclear charge increases ✓ electrons are in same energy level/same shell/same distance (from nucleus)/have no increase in shielding ✓ the outer electrons are attracted more strongly to the nucleus **AND** gets harder to remove the outer electron ✓	3	1.1 x 3	**ALLOW** reference to electrons from the previous part of the question for MP3
	(c)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 24.33 award 2 marks** (78.60 x 24) + (10.11 x 25) + (11.29 x 26) / 100 = (1886.4 + 252.75 + 293.54) / 100 ✓ = 24.3269 = 24.33 (2 d.p.) ✓	2	2.6 x 2	ECF allowed from error in calculation for 2dp answer
	(d)		$^{12}_{6}\mathbf{C}$	1	1.2	**ALLOW** numbers before or after C

z

	(e)		(explanation) the magnesium chloride/salt will be contaminated with (excess/unreacted) magnesium oxide ✓ (correct method) <u>filter</u> (to remove excess magnesium oxide) ✓ Allow the mixture to partially evaporate/heat till half solution is removed (AW) ✓ allow (filtrate) to crystallise and air dry (AW) **OR** filter off crystals after cooling (off hydrated magnesium chloride) ✓	**4**	**3.3 x 1** **3.4 x 3**	
	(f)		*any two from* ✓✓ fast<u>er</u> effervescence/fizzing Ba disappears more quickly clear/less cloudy (white) solution higher temperature rise/value quoted > 26 °C	**2**	**2.7 x 2**	**ALLOW** 'higher pH'/ pH value quoted > 11
	(g)		correct that Sr more reactive than Mg but does not explain the trend (AW) ✓ the one that turns the limewater cloudy in the shortest time will be the magnesium carbonate/ magnesium carbonate is less thermally stable (ora) ✓ the magnesium (cat)ion is smaller (than the strontium ion) **AND** polarises/distorts the (large) carbonate ion more (than the strontium ion) (or reverse reasoning) ✓	**3**	**3.2 x 3**	**ALLOW** Sr more reactive than Mg statement if MP2 and/or 3 is correctly identified **ALLOW** reference to charge density for MP3 **DO NOT ALLOW** reference to atom
	(h)		($1s^2$) $2s^2$ $2p^6$ ✓	**1**	**1.1**	**ALLOW** non-superscript numbers
			Total	**21**		

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	the catalyst/it and the reactants are in different states/phase (of matter) ✓	1	1.1	**ALLOW** the catalyst is a solid and the reactant(s) is/are (a) gas(es)
		(ii)	poison ✓	1	1.1	
		(iii)	Liquid paraffin $C_{12}H_{26}$ Liquid collected C_6H_{14} Gas collected C_2H_4 ✓ *for all three*	1	2.3	
		(iv)	(they are/contain) unsaturated/alkenes ✓	1	2.3	**ALLOW** contains C=C bond
	(b)	(i)	(it) provides an alternative reaction pathway of lower activation energy ✓	1	1.1	**ALLOW** new route
		(ii)	Stage 2 (reactant) bonds (weaken and) break Stage 3 product/new bonds form ✓ *for both*	1	1.1	
		(iii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 0.0027/2.7 x 10^{-3} (m^3) award 4 marks** M (C_4H_{10}) = 58 g mol^{-1} n (C_4H_{10}) = (1.0 / 58) = 1.7(24) x 10^{-2} mol ✓ n (O_2) = (6½ x 1.7(24) x 10^{-2}) = 1.1(21) x 10^{-1} vol (O_2) = (1.1(21) x 10^{-1} x 24) = 2.7 dm^3✓ vol (O_2) = 0.0027 (any sf) ✓ 0.0027/2.7 x 10^{-3} (m^3) 2 sf ✓	4	2.2 x 4	**ALLOW** ECF Throughout 2.69 scores 2 marks

	(c)	**(i)**	$O_3 + O \rightarrow 2O_2$ ✓	**1**	**2.5**	**ALLOW** $O_3 + O \ \ O_2 + O_2$ **IGNORE** dots on radicals and state symbols
		(ii)	chlorine/*Cl* **AND** homogeneou ✓	**1**	**2.1**	**ALLOW** atom/radical with/without 'dot'
	(d)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = $C_2F_2Cl_4$ award 3 marks** n /mol C : F: C*l* = (11.7 / 12) : (18.8 / 19) : (69.5 / 35.5) n /mol C : F: C*l* = 0.975 : 0.989 : 1.96 ✓ n /mol C : F: C*l* = 1.00 : 1.01 : 2.01 empirical formula = $CFCl_2$ ✓ relative mass of empirical formula = 102 molecular formula = $C_2F_2Cl_4$ ✓	**3**	**2.2 x 3**	**ALLOW** ECF throughout
			Total	**15**		

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	the hydroxyl/OH/functional group is bonded/attached /joined to a carbon/C (atom) that has two/2 hydrogen/H (atoms) attached **OR** OH groups is attached to a C atom that is attached to one other C atom (AW) ✓	1	1.1	
		(ii)	potassium/sodium dichromate(VI) in (dilute) sulfuric acid **AND** (heat under) reflux ✓	1	1.2	**ALLOW** acid(ified) dichromate Ignore oxidation states **DO NOT ALLOW** concentrated sulphuric acid
		(iii)	the reaction has (started but) not gone to completion ✓ (because) (the sharp peak) at 1730 (cm^{-1}) **AND** is a C=O in an aldehyde (so some aldehyde present) ✓ (but) (the broad peak) at 3300 (cm^{-1}) **AND** O-H in -COOH (so some carboxylic acid/product also present) ✓	3	3.1 x 3	**MP1** must be linked to attempted evidence to show the reaction has not gone to completion Only allow MP1 if MP2 has been achieved **ALLOW** 1710 cm^{-1} **AND** C=O in COOH (for MP3)
	(b)		elimination ✓	1	1.1	**DO NOT ALLOW** dehydration
	(c)		 ✓ for HCl (reactant) **AND** H_2O (product)	1	2.2	**IGNORE** incorrect formulae of organic reactant and product

	(d)*		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)** Running the chromatogram is described in detail **AND** Analysis in detail and a correct conclusion based on the analysis *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)** Running the chromatogram is described in outline **AND** Analysis is described in outline **OR** Running the chromatogram is described in detail. **OR** Analysis in detail and a correct conclusion based on the analysis *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)** Running the chromatogram **AND** Analysis is described in outline **OR** Running the chromatogram is described in outline. **OR** Analysis is described in outline	**6**	**2.7 x3** **3.2 x3**	**Indicative scientific points include***:* *fine detail in italic* **Running the chromatogram AO2.7** • place plate in a beaker of solvent • *solvent below line* • *cover the beaker* • remove plate when solvent front is near to top of plate • *mark (in pencil) how far solvent has reached* • *allow plate to dry* • locate the spots • *using iodine or under a u.v. lamp* • ***ALLOW** labelled/annotated diagram* **Analysing the chromatogram and drawing conclusions AO3.2** • Both ethanoic acid and ethanoic anhydride have produced compound D • when using ethanoic acid, the product has some compound **A** remaining • Sample X also contains W • *Sample X has 3 components/all reactants and products* • *Sample Y contains 2 components/one reactant and product* • Ethanoic acid producing a smaller/less yield of D • *the spot in line with D from Y is bigger/darker than from X*

			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.*			• ethanoic anhydride reacts completely with compound **A/**no evidence of Z but ethanoic acid reacts incompletely **IGNORE** references to ethanoic acid being present in the right-hand chromatogram.
			Total	**13**		

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$ ✓	1	1.2	**ALLOW** $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$
		(ii)	high temperature ✓	1	1.2	**IGNORE** high pressure **ALLOW** 1000 C or higher
	(b)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 86 award 4 marks** (pV = nRT) n = pV / RT ✓ n = (250 x 10^3) x (554 x 10^{-6}) / 8.314 x (60 + 273) ✓ n = 0.050 ✓ M_r = (4.3 / 0.050) = 86 ✓	4	2.2 x 4	**ALLOW** ECF throughout MP1 can be awarded if p, V, R and T are in the correct expression (or allow from calculation) MP2 is for unit conversions for p, V and T MP3 is for correct evaluation of n MP4 is for correct evaluation of M_r **ALLOW** 2 or more sf
	(c)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = (+)407 (kJ mol^{-1}) award 3 marks** ($\Delta_c H$ = Σ[average bond enthalpies of reactants] - Σ[average bond enthalpies of products]) (-676 = [3(x) + (C-O) + (O-H) + 1½(O=O)] - [2(C=O) + 4(O-H)]) (where x = average bond enthalpy of C-H) -676 = -[3(x) + (358) + (464) + 1½(498)] - [2(805) + 4(464)] -676 = [1569 + 3x – 3466] 3x = 1221 x = (+) 407(kJ mol^{-1}) ✓ for 1569 (bonds broken [without 3x]) ✓ for 3466 (bonds made) ✓ for (+)407 (rearranging eqn, substituting, dividing by 3)	3	2.2 x 3	**ALLOW** ECF throughout **IGNORE** signs in calculations -407 award 2 marks

		(ii)	energy is required to turn methanol and/or water into gases ✓	**1**	**3.2**	**ALLOW** bond enthalpies are (calculated) in the gas state **ALLOW** methanol and/or water are liquids under standard conditions **ALLOW** average bond enthalpies used
		(iii)	there are more electrons between the atoms of the double bond/in the double bond ✓ giving greater attraction between the (bonded) nuclei/atoms or nuclei/atoms are pulled closer together ✓	**2**	**2.1 x 2**	
	(d)		**CHECK ANSWER ON ANSWER LINE** **If answer = -390 (kJ mol^{-1}) award 3 marks** (q = mcΔT) q = [100 x 4.18 x (45.0-17.0)] = 11704 J / 11.704 KJ ✓ M_r CH_3OH = 32.0 (12.58 – 11.62) = 0.96 g CH_3OH amount of methanol = (0.96 / 32.0) = 0.030 mol ✓ ΔH = [-(1 / 0.030) x 11704] = 390133 J (Alternative) = [-(1/0.030) x 11.704] = 390.133 KJ ΔH = -390 (kJ mol^{-1}) ✓	**3**	**2.8 x 3**	**ALLOW** ECF throughout *Award 2 marks if answer line shows:* *-49.1* *-45.4* *-3.75* Negative sign needed for last MP **ALLOW** 2 or more significant figures

	(e)*		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)** Most refinements are suggested and justified to improve accuracy in 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)** Some refinements are suggested and justified to improve accuracy. *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)** A few refinements are suggested/justified to improve accuracy. *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**	**3.4 x 6**	**Indicative scientific points include:** Refinements/*justifications in italic* • weight out or measure the (100 cm^3) water using a (100 cm^3) measuring cylinder or pipette • *the balance/measuring cylinder has less uncertainty/more accurate than the beaker* • Place a lid on the calorimeter • *To reduce evaporation of the water/heat loss* • pour water into a copper can • *copper better thermal conductor than glass/lower specific heat capacity* • fit the spirit burner with a cap • *reduces loss of methanol <u>before</u> burning* • arrange for less distance between top of flame and bottom of can/beaker (or top of flame touches bottom of can) • *less heat transferred/'lost' to surroundings* • arrange a draught shield around apparatus • *less heat transferred/'lost' to surroundings* • stir water throughout heating • *ensures even distribution of heat* • replace cap on burner and find mass after burning • *reduces loss of methanol <u>after</u> combustion* • record the highest temperature reached by the water • *heat continues transfer from can to water*

						• Use of a Bomb Calorimeter • *Removes errors in heat loss, better conductivity, greater heat transfer, more even distribution*
			Total	**21**		

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