GCE

Chemistry B

H033/02: Chemistry in depth

AS Level

Mark Scheme for June 2023

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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: 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

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
	Blank page

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	Mark	AO Element	Guidance
1	(a)		$CaO + H_2O \rightarrow Ca^{2+} + 2OH^-$ ✓	1	1.1	**IGNORE** state symbols Allow multiplication of the balanced equation
1	(b)		the amount of white suspension/it decreases/disappears ✓ a colourless (solution) is formed or goes clear ✓	2	1.2 (x2)	**DO NOT ALLOW** it dissolves/reacts as this is a deduction NOT an observation Allow liquid
1	(c)		$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ ionic equation ✓ state symbols ✓	2	1.1 (x2)	Mark equation and state symbols separately
1	(d)		Error 1: weighing boat is not reweighed after emptying contents (into beaker) ✓ Effect on result 1: solution more dilute/less concentrated✓ Error 2: the glass/stirring rod is not rinsed (when removed) ✓ Effect on result 2: solution more dilute/less concentrated ✓	4	3.4 (x4)	**ALLOW** Error: the beaker/funnel is not rinsed into the volumetric flask Effect on result: solution more dilute/less concentrated Error: Did not wash out the weighing boat to remove solid Effect on result: solution more dilute/less concentrated

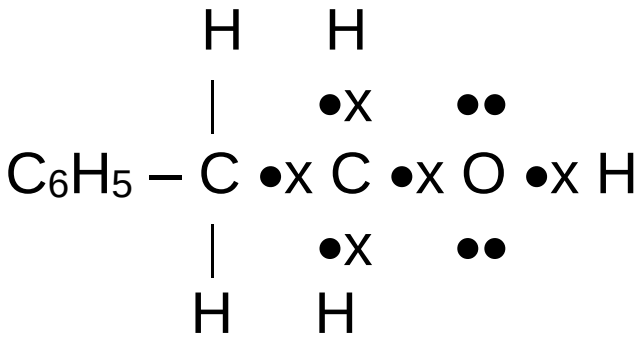
1	(e)*		Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Calculation of A_r of **X** and identification of Ca **AND** % uncertainty in mass correctly calculated and applied to M_r *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Correct calculation and identification of Ca **AND** attempt at error calculation **OR** Correct calculation of error **AND** its application to some value for M_r **OR** Some points from each 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)** Some attempt at calculation of M_r **OR** some attempt at error calculation. *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**	**2.8 (x3)** **3.2 (x3)**	**Indicative Scientific points** **AO2.8 Calculation of A_r and identification of X** • Amt of $X(OH)_2$ in 250 cm^3 = 2.65 x 10^{-3} mol • M_r = 0.2/2.65 x 10^{-3} = 75 or 75.47.... • A_r of **X** = 75-34 = 41/41.47... • **X** is Ca **AO3.2 Error calculation** • Mass is 0.20 ± 0.01 • 5% error • M_r is 76±4 (quoted as whole numbers) • Some reference to Ca being in range (eg A_r is 42±4)
			Total	**15**		

Question			Answer	Mark	AO Element	Guidance
2	(a)		(dark) red/brown **AND** liquid ✓	1	1.1	**ALLOW** 'red' or 'brown' **DO NOT ALLOW** orange as this is a colour of the aqueous solution or Orange/Brown, Orange/Red
2	(b)	(i)	chlorine (atoms) (are)/is smaller than bromine (atoms) ✓ the outer shell is closer to the nucleus in chlorine (than bromine)/chlorine has less shielding (ORA) **AND** the attraction between the nucleus and (electrons in) the outer shell is stronger in chlorine (than bromine) (ORA) ✓ chlorine gains an electron more readily/easily (than bromine) ✓	3	2.1 (x3)	**DO NOT ALLOW** ions **ORA** The comparison between chlorine and bromine must be made in at least one of the MP, otherwise 2/3 max. Comparison must occur in MP 1 or 2
2	(b)	(ii)	Oxidising agent: chlorine/Cl_2 **AND** Reducing agent: bromide/Br^- ✓	1	1.1	**DO NOT ALLOW** C*l* **DO NOT ALLOW** bromine/Br
2	(c)		add (concentrated) (aqueous) ammonia ✓ silver bromide is soluble/dissolves **AND** silver iodide is insoluble/does not dissolve ✓	2	1.2 (x2)	**ALLOW** (aqueous) ammonia partially dissolving silver bromide **IGNORE** any reference to colour of silver bromide when dissolved in ammonia
2	(d)	(i)	$Ag^+ + e^- \rightarrow Ag$ ✓	1	1.2	**IGNORE** state symbols
2	(d)	(ii)	reduced **AND** electrons are gained ✓	1	1.2	
2	(e)		**2** Ag^+ + ….$C_6H_4(OH)_2$ → **2** Ag + ….$C_6H_4O_2$ + **2** H^+ ✓	1	1.2	**ALLOW** '1' in front of organic species
2	(f)		colourless gas is a hydrogen halide/hydrogen iodide ✓ purple vapour is iodine. ✓ (iodine is formed because) hydrogen iodide is thermally unstable/decomposes. ✓	4	3.3 (x3)	

			(the sodium halide is the) iodide ✓		**3.1**	
			Total	**14**		

Question			Answer	Mark	AO Element	Guidance
3	**(a)**		phenol ✓	**1**	**1.1**	
3	**(b)**	**(i)**	add minimum amount/small amount of hot water (to the crude product) until it dissolves ✓ to form a solution that is nearly saturated (AW) ✓	**2**	**3.4 (x2)**	
3	**(b)**	**(ii)**	melting point **OR** thin-layer chromatography/tlc ✓	**1**	**1.2**	
3	**(c)**	**(i)**	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 68 % award 3 marks** M_r (HOC_6H_4COOH) = 138 M_r ($CH_3COOC_6H_4COOH$) = 180 ✓ 3.45 g HOC_6H_4COOH → (3.45 / 138) x 180= 4.50 g $CH_3COOC_6H_4COOH$ ✓ (% yield) = 3.06 / 4.50 x 100 = 68 % ✓	**3**	**2.4 (x3)**	**ALLOW** ECF Alternative method: 3.06 g (at 100%) comes from 3.06 x 138/180 = 2.346 g % = 2.346 x 100/ 3.45 = 68% 3.45/ 138 = 0.025 3.06 / 180 = 0.017 0.017/0.025 x 100 = 68 %
3	**(c)**	**(ii)**	M_r (CH_3COOH) = 60 (% atom economy) = M_r of aspirin x 100/ *240* = 180 x 100/ (180 + 60) = 75 % ✓	**1**	**2.2**	**ALLOW** ECF (from 3c (i))
	(d)	**(i)**	distillation ✓	**1**	**2.3**	

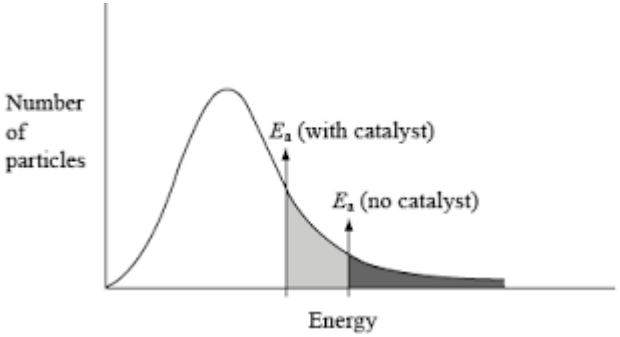
		(ii)	primary	**1**	**1.1**	
3	**(d)**	**(iii)**	$C_6H_5CH_2CH_2OOCCH_3$ ✓	**1**	**1.1**	**ALLOW** $C_6H_5CH_2CH_2OCOCH_3$ Allow full displayed formula

3	**(d)**	**(iv)**	Equation: $C_6H_5CH_2CH_2OH \rightarrow C_6H_5CH=CH_2 + H_2O$ ✓ Type of reaction: elimination ✓ Explanation: In phenylmethanol the carbon next to the CH_2 does not have a hydrogen/ or CH_2OH is directly bonded to the benzene ring (AW)	**3**	**2.7** **1.1** **2.1**	**ALLOW** full displayed formula **ALLOW** $C_6H_5CHCH_2$ **DO NOT ALLOW** dehydration
3	**(e)**		 ✓ for all five bond pairs **AND** both lone pairs C – O – H bond angle = 104.5 (°) ✓ Explanation: 2 bond pairs **AND** 2 lone pairs / 4 groups of electron(s) (density) (around O) ✓ (electron pairs arrange to) minimise repulsion (AW) ✓ lone pairs repel more than bonding pairs ✓	**5**	**2.1 (x5)**	**ALLOW** dots and crosses reversed **ALLOW** 104 to 105

3	(f)*		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)** All main points and most fine detail points for each area. *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)** Main points and some fine detail points for one molecule **AND** Correct order of strength of imb, hence b.p. for at least two molecules deduced **OR** Main points with some fine detail for all molecules *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)** Outline explanation of the origin of the imb for two molecules **OR** Detailed explanation for one molecule **OR** Correct order of strength of imb, hence b.p. for all three molecules stated *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**	**2.1 (x3)** **3.2 (x3)**	***indicative scientific points include:*** *fine detail in italic – allow diagrams* **methanol, CH_3OH** • hydrogen bonding • *$H^{\delta+}$ attracts* • *$O^{\delta-}$/ lone pair on O* • *O is more electronegative than H* • *O-H bond is highly polar* • *H is small and can get close to O in neighbouring molecule forming strong imb* **methanal, HCHO** • permanent dipole – (permanent) dipole) (allow 'pd-pd') • *imb between $O^{\delta-}$ in one molecule and $C^{\delta+}$ in neighbouring molecule(AW)* • *O is more electronegative than C* • *C=O bond is polar* **methane, CH_4** • instantaneous (dipole) – induced dipole bonds • *transient (AW) movement of electrons within one molecule* • *induces a dipole in an adjacent molecule* • *and attracts it* **Strength of imb** H-bond > pd-pd > id-id **Order of b.p.** methanol > methanal > methane
			Total	**25**		

Question			Answer	Mark	AO Element	Guidance
4	(a)		it is not true that the forward and reverse reactions have stopped (AW) ✓ they are now (occurring) at the same/equal rates ✓ it is true that the concentrations of reactants and products remain constant ✓	3	3.2 (x3)	
4	(b)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 2.94 x 10^{-3} (mol dm^{-3}) award 3 marks** $[NH_3]$ = √ 4.02 x 10^{-2} x (1.27 x 10^{-1})^3 x 0.105 ✓ = √ 8.646 x 10^{-6} = 2.94 x 10^{-3} (mol dm^{-3}) ✓ ✓ 3 sig figs	3	2.6 (x3)	**ALLOW** ECF **ALLOW** 3sf mark for any calculated number
4	(c)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 130 (kg) award 2 marks** 1. (pV = nRT) n = pV / RT ✓ 2. 4.8 x 10^7 cm^3 = 48 m^3 ✓ 3. 500 kPa = 5.0 x 10^5 Pa ✓ 4. n = 5.0 x 10^5 x 48 / 8.314 x 900 = 3207 (mol NH_3) mass of O_2 = 3207 x 32 x 5/4 = 130 (kg) ✓	4	2.2 (x4)	**ALLOW** ECF from MPs 2 and 3 to MP4 **ALLOW** 2 or more sig figs 3207 scores first three MPs

4	**(d)**		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 213/212.5 award 2 marks** amount NH_4NO_3 = (1 x 10^6 / 80) = 12500 (mol) ✓ mass NH_3 = 12500 x 17 = 212500 g) = 213/212.5 kg ✓	**2**	**2.6 (x2)**	**ALLOW** ECF
4	**(e)**	**(i)**	heterogeneous ✓	**1**	**1.1**	
4	**(e)**	**(ii)**	Stage 2 … bonds (in N_2 & H_2 / reactants) (weaken and) break **AND** Stage 3 … bonds (in NH_3 / product) form ✓	**1**	**1.2**	

4	(f)		 both axes labelled **AND** correct general shape for distribution curve ✓ E_a (with and without catalyst) ✓	**2**	**2.5 (x2)**	**ALLOW** 'molecules' for 'particles' shading not necessary **ALLOW** Enthalpy for x axis label
			Total	**16**		

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