GCE

Chemistry B

H433/03: Practical skills in chemistry

A 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 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.)*

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. 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 isn't an attempt at the question.

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

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 **2b** and **3c**.

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 ^

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.

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
	Blank page
	Ignore

12. **Subject Specific Marking Instructions**

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

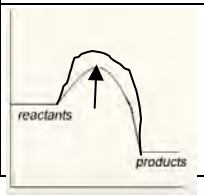
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

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

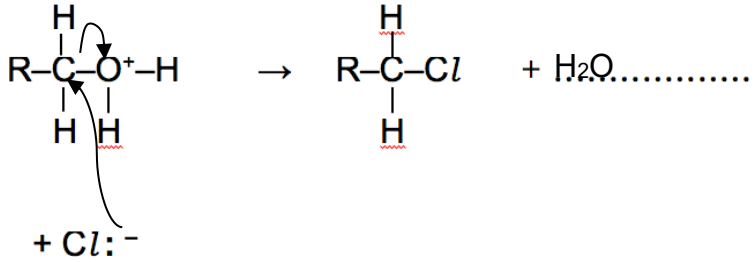
You should ensure that you have copies of these materials.

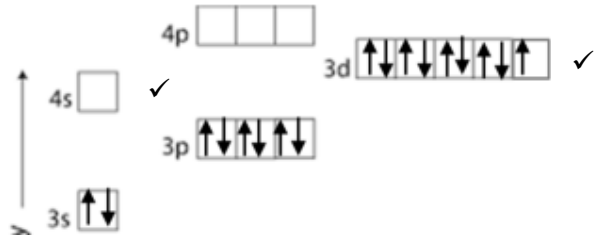
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New 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)		(photo)chemical smog/ respiration difficulties/breathing difficulties ✓	1	AO1.1	**IGNORE** global warming/greenhouse effects/acid rain/ forms free radicals **ALLOW** specific breathing difficulties e.g. asthma
1	(b)	(i)	**FIRST CHECK ANSWER LINE** **If answer = 93(%) award 2 mark** **= 92.86(etc) award 1 mark** 200/2800 x 100 = 7.14 ✓ percentage reduction = 100-7.14 = 92.86 **OR** ((2800-200)/2800) x 100 = 92.86 93(%) to two sig figs ✓	2	2 x AO2.6	**Reject** any value over 100% Any incorrect answer (e.g. from using wrong pollutant) to 2 sf gains one mark if working shown **ALLOW** ecf from **MP1** provided it is a percentage calculation (must be to 2 sf)
1	(b)	(ii)	nitrogen oxides/NOx, CO and hydrocarbons (**AW**) are (toxic and) removed... ✓ mostly/ incompletely/ but not to zero ✓ (**AW**) CO_2 is still polluting **AND** some reason e.g. greenhouse effect. ✓	3	3 x AO3.1	Looking for pollutants' name or formula – **one example is fine** **Ignore** references to sulfur compounds **ALLOW** still produced/suggestion there is still some produced If one pollutant named and reduced not to zero then **both** M1 and M2 scored
1	(b)	(iii)	 arrow allow anywhere L / R **AND** higher line for uncatalyzed curve ✓	1	AO1.2	**ALLOW** double ended/allow no point **IGNORE** E_A for uncatalyzed shown

Question			Answer	Mark	AO Element	Guidance
	(c)		Acting as a catalyst because it occurs as product in final reaction/ recycled/regenerated/not used up/chemically unchanged at end (**AW**)✓ **homogeneous** (because catalyst in same state/gas/phase as reactant(s))✓	**2**	**2 x AO3.1**	**ALLOW** Unchanged at the end **IGNOR**E not heterogeneous **IGNORE** Reactants not adsorbing onto surface of NO
	(d)	**(i)**	Conditions: **UV** radiation/**UV** light/**UV** ✓ Type of bond fission: **homolytic** ✓	**2**	**2 x AO1.2**	**IGNORE** references to temp and pressure

	(e)		 **MP1**: 2 correct arrows ✓ **MP2** H_2O ✓	**2**	**2 x AO2.1**	one curly arrow, must start from the minus sign or lone pair of chloride and finish on the carbon atom. other curly arrow, must go from the C–O bond to the oxygen atom or + sign. **NB** Both needed for **MP1**
			Total	**13**		

Question			Answer	Mark	AO Element	Guidance
2	(a)	(i)	 ✓ ✓	2	2 x AO2.5	**MP1**: 4s empty **MP2**: 3d with 9 electrons 3d last arrow can be up or down **NB** If arrows all up or all down – scores zero **ALLOW** half arrows as long as up/down **Both 3s and 3p** need full orbitals otherwise scores zero
		(ii)	forms an **ion** with an incomplete / partially filled **d** subshell/orbitals ✓	1	AO 1.2	**REJECT** empty/unfilled/half filled **IGNORE** variable oxidation states/coloured compounds

2	(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)** Addresses most **ligand** and most **formulae and shapes** points **Note**: any of connected detail points in guidance may substitute a missing point from the indicative 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)** Addresses some **ligand** and some **formulae and shape** points **OR** addresses most **ligand** points OR most **formulae and shapes** points **Note**: any of connected detail points in guidance may substitute a missing point from the indicative points *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 some 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**	**3 x AO1.2** **3 x AO2.7**	**<u>Indicative scientific points</u> include:** **ligand** • lone pair of electrons to donate to metal ion (if arrows the wrong way in diagrams– need to consider whole answer (is the odd error seriously affecting the quality?) •coordinate bond • ion (eg Cl^-) • molecule (eg NH_3) •types of ligand (e.g. monodentate; bidentate) •examples: water, ammonia chloride ion 1,2-diaminoethane **Formulae and shapes** • $CuCl_4^{2-}$ (given in Spec) • $Cu(NH_3)_4^{2+}$ (given in Spec) or $[Cu(NH_3)_4(H_2O)_2]^{2+}$ (text-book!) • ‘tetrahedral’/‘square planar’ (not expected to know which) or ‘octahedral depending on number of ligands • corresponding diagram • diaminoethane two points of attachment (bidentate)

						Other connected detail not necessarily required but could contribute to a good answer and benefit a weaker answer • how colour arises • different ligands different splitting • lower and higher electronic energy levels
			Total	**9**		

	Question		Answer	Marks	AO Element	Guidance
3	**(a)**	**(i)**	N–H / NH ✓	**1**	**AO2.5**	**IGNORE** any references to amine functional group
	(a)	**(ii)**	Hydrogen/H bonds/bonding ✓	**1**	**AO2.1**	**ALLOW** 'hydrogen' on its own
	(b)	**(i)**	**FIRST CHECK ANSWER LINE** **If answer = 203 (kJ mol^{-1}) award 3 marks** **= 2.(03) x 10^{5} award 2 marks** Rearranging equation to E = hc/λ ✓ E = 6.63 x 10^{-34} x 3.00 x 10^{8} / 5.90 x 10^{-7} = 3.37 x 10^{-19} (J/photon) ✓ E = 3.37 x 10^{-19} x 6.02 x 10^{23} /1000 = 203/202.9 (kJ mol^{-1}) ✓	**3**	**3 x AO2.4**	**ALLOW** one or more sf can be assumed from subsequent steps **ALLOW (**from E=hv) v=c/λ **ALLOW** ecf from correct equation(s) **ALLOW** rounding i.e. 200 kJ -ve sign **CON**

	(b)	**(ii)**	(indigo) absorbs yellow/orange light ✓ (delocalised) electrons promoted to excited state/ higher energy levels ✓ blue is complementary/opposite colour transmitted/reflected✓	**3**	**3 x AO2.3**	Need the specific colour, IR and other (wrong) types of radiation is a **CON** **Reject** absorbs green **NOT** just 'electrons are excited' **ALLOW** 1 mark for a general comment about colour being the complementary colour to that i.e MP's 1 and 3 score 1 mark only Release of energy implied is a **CON** to the last marking point

	Question		**Answer**	**Marks**	**AO Element**	**Guidance**
	(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)** Addresses most **structure** and **reaction key** points with some fine detail in both *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)** Addresses most **structure** and **reaction key** points with some fine detail in at least one *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	**6**	**6 x AO3.1**	**Indicative scientific points may include** **Structure** **Key points** • 'actual' benzene hexagonal with equal C-C bond lengths (between C-C and C=C) • Fig 3.2 is hexagonal • all bonds same length • Fig 3.1 not hexagon/distorted hexagon • description of delocalisation in Fig 3.2 **Fine detail** • *electron density maps* • *Three short bonds, three longer* • *C=C shorter than C-C*

			Level 1 (1–2 marks) Addresses some points from **structure** or **reactions** *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.*			• *Would expect two1,2 isomers if Kekule structure but only one in actual benzene* **Reactions** **Key points** • Fig 3.1 should easily undergo addition because of C=C bonds • Actual doesn't decolorise bromine water • Fig 3.2 undergoes substitution (mainly) • because k*eeps more stable* delocalised structure • Energetics suggest actual benzene more stable than Fig 3.1 would be **Fine detail** • Actual benzene needs 'forcing' conditions to undergo addition • hydrogenation of actual benzene is much less exothermic than Kekule would be (a*bout* 150 $kJmol^{-1}$ more stable) • Example of substitution reaction

	Question		Answer	Marks	AO Element	Guidance
3	(d)	(i)	Concentrated sulfuric acid c/conc H_2SO_4 ✓ Heat under reflux✓ Electrophilic substitution ✓ (increased) solubility in water ✓	4	4 x AO1.1	**ALLOW** 'fuming' sulfuric acid, any other acid mentioned is a **CON** **IGNORE** other reagents **IGNORE** references to specific temperatures **IGNORE** benzene as reactant **ALLOW** soluble **IGNORE** colourfast
	(d)	(II)	Fe reacts with Br_2 to form **$FeBr_3$** /equation ✓ $FeBr_3 + Br_2 \rightarrow$ **$FeBr_4^-$** + Br^+ **OR** in words✓	2	2 x AO2.5	**ALLOW** $Fe + 2.5Br_2 \rightarrow FeBr_4^- + Br^+$ (or doubled) for both marks **If no marks scored ALLOW** (acts as a) halogen carrier for 1 mark
			Total	20		

Question			Answer	Mark	AO Element	Guidance
4	(a)	(i)	Titre proportional to $[I_2]$ ✓ Rate is (proportional to) slope **AND** Does not change (AW) (as $[I_2]$ changes/goes down) ✓	2	2 x AO3.1	Reject any isolated reference to zero order For **MP2** must link slope to rate (idea that **straight** line is zero order)
		(ii)	Use (large) excess of propanone ✓	1	AO3.3	
	(b)		so that concentrations (of iodine) are the same as/proportional to volumes added (**AW**)✓	1	AO3.4	**IGNORE** control (variable) NB: several AW possibilities for idea that keeping total volume same means changes in concn. of a reactant is the independent variable
4	(c)	(i)	Rate /cm^3s^{-1} | 0.035 | **0.017** | **0.017** ✓	1	AO2.8	must be 2 sf. 0.016 for Run C is **CON** – zero scored
4	(c)	(ii)	(Yes because) Expt 1 shows zero order wrt iodine (**AW**) ✓ Runs A and B: halving concentration of HCl halves rate ∴ first order wrt HCl ✓ Runs A and C: Halving concentration of propanone halves rate ∴ first order wrt propanone ✓	3	AO3.1 AO3.2 AO3.2	**ALLOW** 1 mark for MP 2 and 3 together if candidate states changing their concentrations changed rate in same proportion but doesn't quote runs (**AW**)
4	(d)	(i)	4 x 0.01 / (32 x 115) **or** $1.25 \times 10^{-3} \div 115$	1	AO2.8	
4	(d)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.8 / 1.76 x 10^{-5} award 3 marks (units MP4)** Initial [HCl] = 2.0 x 20/32 = 1.25 mol dm^{-3} Initial [prop] = 2.0 x 8/32 = 0.5 mol dm^{-3} ✓ $k = \frac{\text{rate}}{[HCl][Prop]} = \frac{1.1 \times 10^{-5}}{1.25 \times 0.5}$ ✓	4	4 x AO2.6	**ALLOW** 2 or more sf Mark units separately **ALLOW** ecf from **MP1** MP2 for correct re-arrangement of rate eqn.

Question			Answer	Mark	AO Element	Guidance
			= 1.8/1.76 x 10^{-5} ✓ **Units** dm^3 mol^{-1} s^{-1} ✓			MP3 evaluation (allow ecf's from MP1) MP4 Mark units separately
4	**(e)**		rds is slowest step ✓ must be Step1 because both acid and propanone are in rate equation ✓ one of each so both first order (**AW**) ✓ iodine must be in a later fast step (**AW**) ✓	**4**	**AO3.1** **AO3.2** **AO3.2** **AO3.2**	For MP2 and MP3 they must identify rds as step 1 otherwise no marks.
	(f)		work in fume cupboard or well-ventilated lab **OR** pour reacting solutions down sink as soon as reaction finished **OR** avoid naked flames/**lit** Bunsen burners✓	**1**	**AO3.4**	**IGNORE** references to gloves, coats, skin irritation.
			Total	**18**		

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