

**GCE**

**Chemistry B**

**H433/03: Practical skills 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.

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## 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 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 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 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 **1c** and **2c**

## 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
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	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	Guidance
1	(a)	(i)	$\begin{array}{c} \text{OH} \\   \\ \text{H}_3\text{C}-\text{C}-\text{CH}_3 \\   \\ \text{H} \end{array}$ $\checkmark$ compound A	$\begin{array}{c} \text{O} \\ \parallel \\ \text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ $\checkmark$ compound C	3	2.1 x 2  1.1	<b>ALLOW</b> bonding through H i.e. $\text{CH}_3-$  <b>NOT</b> ammonium (anything) other than hydroxide and the $\text{NH}_3$ has to be correct i.e., no charges ( $\text{NH}_3^+$ )
	(a)	(ii)	(primary) amines $\checkmark$		1	1.2	IGNORE 'secondary'
	(b)		$\begin{array}{c} \text{H} \\   \\ \text{R}-\text{N}: \\   \\ \text{H} \end{array} + \begin{array}{c} \text{H} \\ \diagup \\ \text{O} \\ \diagdown \\ \text{H} \end{array} \longrightarrow \begin{array}{c} \text{H} \\   \\ \text{R}-\overset{+}{\text{N}}-\text{H} \\   \\ \text{H} \end{array} + \text{OH}^-$ $\checkmark \qquad \qquad \qquad \checkmark$		2	2.5 x 2	MP 1: curly arrows on left  MP 2: products, not looking for lone pairs, but + and - are necessary  Curly arrows should start on lone pair or bonding pair and head should be where no bond or lone pair will be.
	(c)		Earth $\checkmark$		1	1.1	<b>ALLOW</b> (Sun's energy) (*re)radiated energy from earth's surface ( <b>AW</b> ) <b>NOT</b> reflected from Earth, <b>NOT</b> Sun (but use of Sun isn't a <b>CON</b> )

1	(d)*	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p><b>Level 3 (5 – 6 marks)</b> Procedure with most fine detail and most points from 'results and interpretation'</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p><b>Level 2 (3 – 4 marks)</b> Most main points from procedure and results and interpretation. <b>OR</b> procedure with most fine detail <b>OR</b> full account of results/interpretation</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1 – 2 marks)</b> Some points from procedure and results/interpretation <b>OR</b> procedure with some fine detail <b>OR</b> most points from results/interpretation</p> <p><i>The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 0 (no marks)</b> <i>No response or no response worthy of credit</i></p>	6	<b>3.3 x 3 2.7 x 3</b>	<p><b>Indicative scientific points may include:</b> Main points in plain text; <i>fine detail in italic</i></p> <p><b>Procedure AO3.3 (experimental design)</b></p> <ul style="list-style-type: none"> <li>• Same amounts/volumes of the three haloalkanes in test/boiling tubes</li> <li>• <i>use ethanol as solvent</i></li> <li>• <i>leave in warm water bath (~50°C)</i></li> <li>• <i>place three tubes of equal vols. of silver nitrate solution (~0.1M) in water bath</i></li> <li>• <i>when same temp reached in all tubes...</i></li> <li>• add silver nitrate from tubes to each of haloalkane solution quickly</li> <li>• shake each tube to mix contents</li> <li>• time until precipitate forms</li> </ul> <p><b>Results and Interpretation (AO2.7)</b></p> <ul style="list-style-type: none"> <li>• as hydrolysis occurs C-Hal bond breaks releasing halide ion OR  <math display="block">RX + H_2O \rightarrow ROH + H^+ + X^-</math> </li> <li>• form a silver halide precipitate with silver ions OR  <math display="block">Ag^+ + X^- \rightarrow AgX(s)</math> </li> <li>• quicker precipitate forms, the faster the rate of hydrolysis</li> <li>• precipitate should form in order of iodo before bromo before chloro</li> <li>• reaction rate in order chloro, bromo, iodo</li> <li>• reactivity appears to be dependent on bond strength</li> <li>• C-Cl bond strongest followed by C-Br then C-I</li> </ul>
Total			13		

Question		Answer	Mark	AO	Guidance
2	(a) (i)	(moles CuSO <sub>4</sub> = 0.200 x 0.05 =) 0.01 ✓ (moles of Zn = 1.20 ÷ 65.4 = ) 0.0183 ✓ <b>and</b> CuSO <sub>4</sub> limiting reagent ✓	2	<b>2.4</b> <b>3.1</b>	Tie nomination of limiting reagent to calc of moles of Zn has to be linked to Zinc If bigger then MP2 is copper sulphate, it smaller and zinc given ecf MP2
	(a) (ii)	<b>CHECK ANSWER LINE</b> If answer = 150 (kJ mol <sup>-1</sup> ) award 3 marks  Q = mcΔT = 50 x 4.18 x 7.2 = 1504.8 ✓  per mole = 1504.8 x 100 = 150.48 kJmol <sup>-1</sup> ✓  150 (kJ mol <sup>-1</sup> ) to 3 sig figs ✓	3	<b>2.8 x 2</b>  <b>3.1</b>	3 sig fig or must come from some working/calc  Mass <b>MUST</b> be 50g MP1 doesn't score (same with use of 1.2g) <b>ALLOW</b> ecf's to MP 2 and MP 3  <b>IGNORE</b> missing minus sign
	(b)	-152.4 - 64.4 = -216.8 kJ mol <sup>-1</sup> ✓	1	<b>2.6</b>	<b>ALLOW</b> -217 kJ mol <sup>-1</sup> <b>MUST</b> have sign

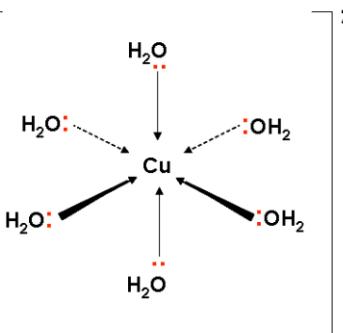
2	(c)	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p><b>Level 3 (5 – 6 marks)</b> Refers to all major points and some fine detail. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p><b>Level 2 (3 – 4 marks)</b> Refers to major points from two areas. <b>OR</b> Refers to some points from each of three areas. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1 – 2 marks)</b> Refers to points from any areas. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant and correct.</i></p> <p><b>Level 0 (no marks)</b> No response or no response worthy of credit</p>	6	3.3 x 2  <b>3.4 x 4</b>	<p><b>Indicative scientific points may include:</b> Major points in plain text - <i>fine detail points shown in italic</i></p> <p><b>Limitations in procedure and measurements (AO3.3)</b></p> <ul style="list-style-type: none"> <li>• Heat loss</li> <li>• <i>SHC of water used, solution different or mass of water, not solution used</i></li> <li>• <math>\Delta T</math> low, not used extrapolated value</li> </ul> <p><b>Refining of experimental design/interpretation of results(AO3.4)</b></p> <ul style="list-style-type: none"> <li>• Dewar flask/ lagged polystyrene container to lower heat losses</li> <li>• extrapolate cooling line back to when zinc added to give more realistic total heat change</li> </ul> <p><b>Effect on final value (AO3.4)</b></p> <ul style="list-style-type: none"> <li>• use <i>SHC of solution(s)</i> or use <i>mass of solution(s)</i> <b>or</b> <i>work out heat given to metals</i></li> <li>• heat losses (most significant and) lead to less exothermic value</li> <li>• using lower temp gives less exothermic value</li> <li>•</li> <li>• <i>using mass of water gives less exothermic value or using SHC of water gives more exothermic value or ignoring heat given to metals gives less exothermic value</i></li> <li>• <b>(ALLOW 'lower' and 'higher' for 'less/more exothermic')</b></li> </ul>
Total			12		

Question			Answer	Mark	AO	Guidance
3	(a)	(i)	oxidation $\text{Zn(s)} \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \checkmark$ reduction $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu(s)} \checkmark$	2	2.3 x 2	Reactions reversed (Cu oxidised and Zn reduced) scores 1 if equations are otherwise correct.  <b>IGNORE</b> Use of equilibrium sign <b>IGNORE</b> state symbols on electrons. Charge on e not necessary.
	(a)	(ii)	allows ion flow between half-cells ✓ completes circuit ✓	2	2.3 x 2	<b>CON</b> use of electrons for this mark
	(a)	(iii)	1.1(0) V✓	1	2.2	Negative sign is a <b>CON</b> <b>Ignore</b> + sign
	(b)	(i)	No reaction <b>and</b> silver can only lose electrons to more positive $E^\circ$ (AW) ✓	1	3.1	<b>ALLOW</b> reverse argument providing the equation shown is $2\text{Ag}^+(\text{aq}) + \text{Fe(s)} \rightarrow 2\text{Ag(s)} + \text{Fe}^{2+}(\text{aq})$ (state symbols <b>NOT</b> necessary)
	(b)	(ii)	Yes reaction✓  chlorine produced/chloride ions oxidised to chlorine by acidified manganate ions <b>OR</b> $\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{Cl}^-(\text{aq}) \rightarrow 2\frac{1}{2}\text{Cl}_2(\text{g}) + \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O(l)}$ <b>OR</b> Reaction because chloride ion half reaction is less positive ( <b>ORA</b> ) than permanganate half reaction ✓	2	3.1 x 2	<b>first</b> marking point for reaction occurs  <b>second</b> for some reference to a product <b>OR</b> correct reference to $E_{\text{cell}}$ values  <b>ALLOW</b> electrons lost to more positive half reaction
	(c)	(i)	Standard conditions are $[\text{Zn}^{2+}] = 1$ ✓ $\log(1) = 0$ ✓ (L2 logs)	2	2.8 x 2	<b>NOT</b> just the conditions are standard  $0.059 \times \log_{10}[\text{Zn}^{2+}]/n = 0$ gains MP 2 only
	(c)	(ii)	<b>CHECK ANSWER LINE</b> If answer = <b>-0.78 (V)</b> , award 2 marks.  $\{-0.76 + 0.059 \times \log 0.2\} \checkmark$	2	2.4 x 2	<b>ALLOW</b> ecf. Look for missing -0.76  If there's an error in the calc e.g. used 0.054 (i.e. mis-read their writing then ECF

		correct evaluation = $-0.78$ (V)			sign and magnitude. Look for missing $-0.76$ needed
	(d)	<p><u>Interpretation</u>            No blue/Fe<sup>2+</sup> around nail wrapped with Zn, so no rusting            but blue/Fe<sup>2+</sup> around nail wrapped with Cu shows            rusting ✓</p> <p>Presence of pink (in both) <b>shows hydroxide ions</b>            formed ✓</p> <p><u>Half reactions</u>  <math>\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-</math> ✓</p> <p>other half reaction in both</p> $\frac{1}{2}\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{OH}^-(\text{aq})$ ✓	4	<p><b>3.1 x 2</b></p> <p><b>3.2 x 2</b></p>	<p>There needs to be some comparison between zinc and copper</p> <p><math>\text{OH}^-</math></p>
Total			16		

Question		Answer	Mark	AO	Guidance
4	(a)	<p>Idea of dilution by 4/3 with glassware likely to be available e.g. 75 cm<sup>3</sup> to 100 cm<sup>3</sup> ✓</p> <p>Pipette out 0.4M ✓</p> <p>make up in volumetric flask ✓</p>	3	3.3 x 3	<p><b>OR</b> 7.5 cm<sup>3</sup> to 10cm<sup>3</sup> etc. i.e., make the total volume 4/3 of volume of 0.400 mol dm<sup>-3</sup> taken <b>OR</b> 3 parts solution to one part water</p> <p><b>NOT</b> dropping pipette</p> <p><b>ALLOW</b> 75 cm<sup>3</sup> pipette or three x 25 cm<sup>3</sup></p>
4	(b)	(i)			<p><b>marking points</b></p> <p>labelling axes and scale to use of at least 50% of graph area ✓ (axes and scale) <b>ALLOW</b> just concentration. Non-linear scales <b>CON</b> this point. Absorbance <b>MUST</b> be Y axis</p> <p>points within half a square ✓ (plotting) <b>ecf</b> for non-linear scales</p> <p>sensible straight line of best fit going through 0.0 ✓ (best fit) <b>ecf</b> for non-linear scales; might be a curve</p> <p>To score there <b>MUST</b> be a line to the x axis i.e., doesn't stop short.</p>

	<p><b>(b)</b> (ii) <b>CHECK ANSWER LINE</b>  <b>If answer = 71(%), award 3 marks</b></p> <p>correct reading of graph to give concentration = 0.18 mol dm<sup>-3</sup> (0.17 – 0.19)✓</p> <p>amount in 250cm<sup>3</sup> = 0.18 ÷ 4 = 0.045 mol  mass = 0.045 x 63.5 = 2.86 g (in 250 cm<sup>3</sup>) ✓</p> <p>percentage = (2.86 ÷ 4.04) x100 = 71/70.7(3)%✓</p> <p><b>OR</b></p> <p>4.04 x 4 = 16.16 g brass in 1.0 dm<sup>3</sup>  0.18 x 63.5 = 11.43 mass of copper (in 1.0 dm<sup>3</sup>) ✓</p> <p>percentage = (11.43 ÷ 16.16) x100 = 71/70.7(3)% ✓</p>	3	<p><b>3.1</b></p> <p><b>2.4</b></p> <p><b>2.4</b></p>	<p><b>ALLOW</b> 2 or more sf.  <b>ALLOW</b> ecfs from graph value</p> <p>MP1 for <u>reading value</u> of conc. at 0.44 absorbance</p> <p>MP2 for <u>mass of copper</u> in 250cm<sup>3</sup> <b>OR</b> in 1.0dm<sup>3</sup></p> <p>MP3 for <u>% calculation</u>, either for masses in 250cm<sup>3</sup> <b>OR</b> in 1dm<sup>3</sup></p> <p><i>Look for other ways of saying divide by 4 e.g. 2500/1000</i></p> <p><b>ALLOW</b> range 66.8/67 to 74.6/75) scores MP2 and if on answer line.</p> <p>68.77% is a common correct answer from 0.175 mol dm<sup>-3</sup></p>
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	(b)	(iii)	complementary/opposite colour of solution ✓ this will give maximum absorption values ✓	2	1.2	
	(c)	(i)	ion/molecule with coordinate/dative bond to (central) metal ion ✓	1	1.1	<b>ALLOW</b> electron pair donated instead of dative/coordinate bond
		(ii)	 <p>Six water molecules around the central copper.✓ Water molecules oxygen atoms donating lone pairs <b>AND OR</b> arrow from oxygen✓ shape ✓</p>	3	1.1 x 3	<p>MP2 must show dative bonds i.e. arrowhead to Cu and start of arrow from O atoms</p> <p><b>ALLOW</b> any attempt (wedges, lines, dots) to show <u>correctly</u> 3D nature of complex ion even if other than 6 ligands Wedges and dashes should be adjacent to each other as in diagram</p>
	(d)		<p>(d orbital) energy levels split <b>by ligands</b>✓ light absorbed when electrons excited, with energy equivalent to energy gap ✓ colour results from wavelengths/frequencies not absorbed ✓ <b>ORA</b> different gaps for different ligands✓</p>	4	1.1 x 4	<p><b>ALLOW</b> d orbitals split by ligands. <b>DO NOT</b> allow d block split by ligands</p> <p><b>ALLOW</b> <math>\Delta E = hv</math> for second part of marking point</p> <p><b>ALLOW</b> colour seen is complementary to wavelength/frequency absorbed Any mention of light being emitted is a <b>CON</b> to MP3?</p>
			Total	18		

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