

GCE

Chemistry A

H432/03: Unified chemistry

A Level

Mark Scheme for June 2023

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

© OCR 2023

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.
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. Work crossed out:
- where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
 - if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.
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 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 **Q3 and Q6f**.

The only annotation on a level of response question should be the indication of the level.

A level annotation should be used where all marks for a level have been achieved e.g. a candidate has 6 marks, so they would have this annotation on their script:

L3

If a candidate has achieved 5 marks then they have reached Level 3 but with one mark omitted. They should have the following annotations on their scripts:

L3 

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

No marks (0) should have a cross: 

Place the annotations alongside the mark for the question.

On additional pages, annotate using 

11. Annotations available in RM Assessor

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
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.

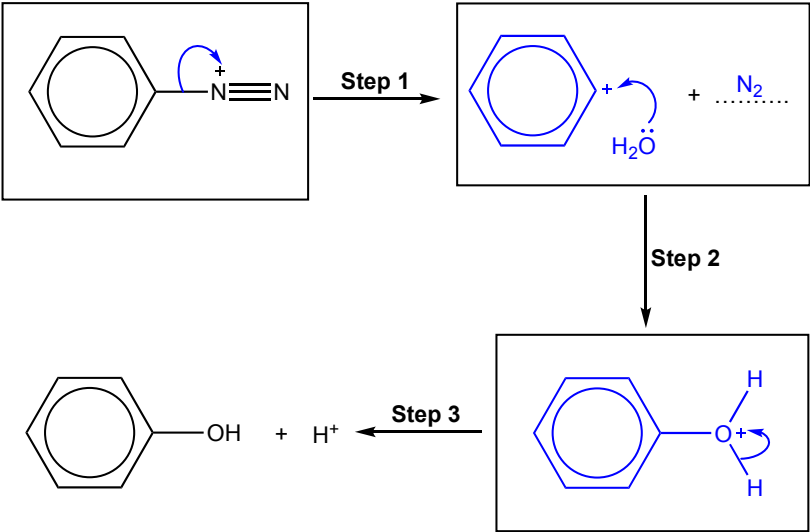
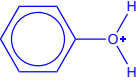
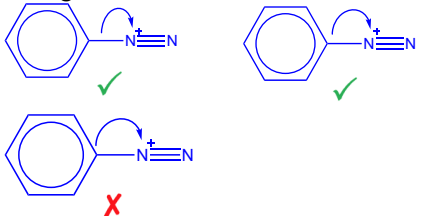
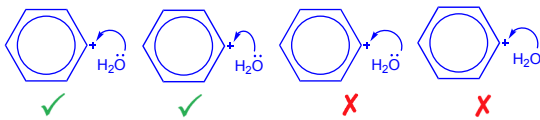
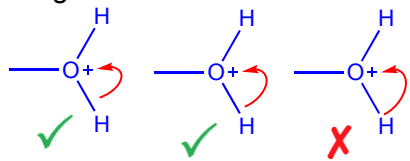
Question	Answer	Marks	AO element	Guidance
	MARKING CALCULATIONS - Candidates are encouraged to round only at the end of multi-step calculations. - We are not assessing a candidate's ability to copy calculator values onto paper. Calculator values are usually taken forwards by candidates for the next step in calculations. - DO NOT penalise intermediate rounding errors on scripts when subsequent answers have obviously used calculator values. - Every response is different. Use the final answer to guide your marks and make use of intermediate values when the final answer is wrong. - Guidance will often include Common Errors which help with marking and obtaining consistency.			
	ANNOTATIONS - Every mark awarded must be accompanied by a tick. If a calculation is correct and the mark scheme allocated all marks, add the same number of ticks alongside the answer. - It is good practice to show an annotation to every item. - RM3 supplied a useful set of annotations which help to show why you have decided on a mark. Please use them. - Every blank page should contain an annotation to show that you have seen them. - Linking: If you are unsure about how to link, contact your Team Leader for advice.			

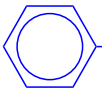
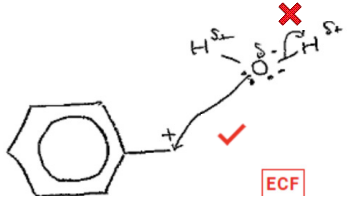
Question			Answer	Marks	AO element	Guidance
1			ALLOW upper case when it is obvious, e.g. ALLOW CR for Cr, AS for As ALLOW names for elements			
	(a)		THREE from: N O F H ✓	1	AO1.1	DO NOT ALLOW ANY OTHER ELEMENTS (CON)
	(b)		O ✓	1	AO2.1	ALLOW S BOD
	(c)		P OR S ✓	1	AO1.1	ALLOW S ₈ , P ₄ ALLOW As, Se
	(d)		Cr ✓ Mn ✓	2	AO1.2	IGNORE ions
	(e)		Si ✓	1	AO1.1	
	(f)		S ✓	1	AO2.1	ALLOW SF ₆
	(g)		F ✓	1	AO1.1	
	(h)		As ✓	1	AO2.2	

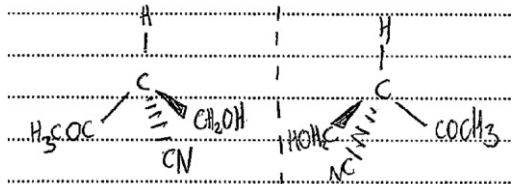
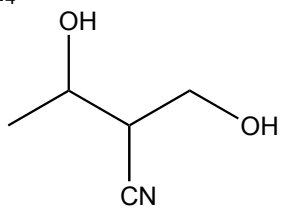
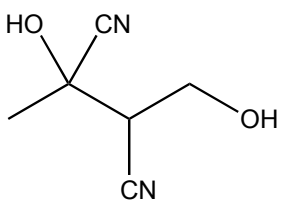
Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	Rubidium chlorate(VII) ✓	1	AO1.1	ALLOW Rubidium(I) chlorate(VII) Rubidium chlorate(VII) IGNORE Rubidium (VII)chlorate Rubidium chlorate(IV) Rubidium chlorate (7) Rubidium perchlorate
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 54.0 OR 54.1 OR 54.2 (kJ mol⁻¹) award 3 marks Energy change from $mc\Delta T$ Energy in J OR kJ = $102 \times 4.18 \times 1.5$ OR 639.54 (J) OR 0.63954 (kJ) ✓ Amount in mol of RbClO₃ $n(\text{RbClO}_3) = \frac{2.00}{169}$ OR 0.0118..... (mol) ✓ $\Delta_{\text{sol}}H(\text{RbClO}_3)$ = $\frac{0.63954}{0.0118.....} = (+) 54.0$ ✓ <i>From unrounded values, $\Delta H = 54.04113$</i> <i>Examples of mixed acceptable intermediate rounding, e.g.</i> $\frac{0.640}{0.0118} \Delta H = 54.237 \rightarrow 54.2$ $\frac{0.63954}{0.01183} \Delta H = 54.06 \rightarrow 54.1$	3	AO2.8 ×3	ALLOW ECF throughout IGNORE sign IGNORE RE and SF in 1st 2 marks 0.01183431953 unrounded ALLOW 54 (from 54.0) CARE 54.00 is a rounding error COMMON ERRORS 52.98 OR 53.14 2 marks 100 instead of 102: Energy = $100 \times 4.18 \times 1.5 = 627$ J From unrounded n, $\Delta H = \frac{0.627}{0.0118.....} = 52.98 \text{ kJ mol}^{-1}$ OR 53.0 (3SF) OR 53 From rounded 0.0118, $\Delta H = \frac{0.627}{0.0118} = 53.14$ OR 53.1

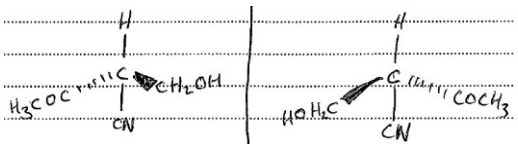
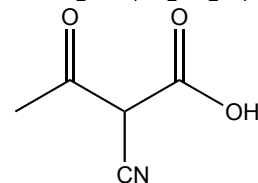
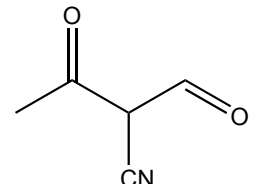
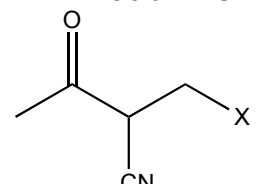
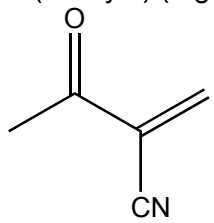
Question			Answer	Marks	AO element	Guidance
						0.02078 OR 0.0208 1 mark 102 and 2 swapped: Energy = $2 \times 4.18 \times 1.5 = 12.54 \text{ J}$ $n = \frac{102}{169} = 0.60355\ldots$ ECF $\Delta H = \frac{0.01254}{0.60355\ldots} = \mathbf{0.0208 \text{ kJ mol}^{-1}}$ ----- 1.06 2 marks 102 for n instead of 2.00: $n = \frac{102}{169} = 0.60355\ldots$ $\Delta H = \frac{0.63954}{0.60355\ldots} = \mathbf{1.06 \text{ kJ mol}^{-1}}$ OR 2 for energy instead of 102 Energy = $2 \times 4.18 \times 1.5 = 12.54 \text{ J}$ $\Delta H = \frac{0.01254}{0.0118\ldots} = \mathbf{1.06 \text{ kJ mol}^{-1}}$ ----- 107.4 – 107.7 2 marks 8.314 for c instead of 4.18: Energy = $102 \times 8.314 \times 1.5 = 1272 \text{ J}$ Energy = $102 \times 8.31 \times 1.5 = 1271.4 \text{ J}$ $\Delta H = \mathbf{107.4 – 107.7 \text{ kJ mol}^{-1}}$ <i>depends on intermediate rounding</i> CHECK ----- Apply ECF for any other comparable responses. If in doubt contact TL

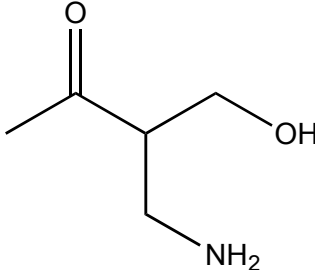
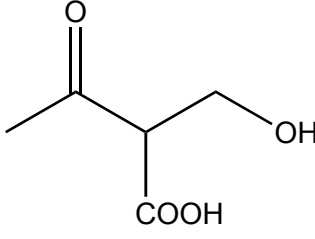
Question		Answer	Marks	AO element	Guidance
(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If range = 4.4×10^{-5} – 4.5×10^{-5} (kJ mol^{-1}) award 3 marks ----- $[\text{H}^+] = 10^{-1.50}$ OR 0.0316 ... OR 0.032 mol dm^{-3} ✓ 1 mark THEN 2 APPROACHES: EITHER: Factor that concentration changes by 1 mark Factor = $\frac{0.0316 \dots}{0.680} = 0.0465 \dots$ times OR $\frac{0.680}{0.0316 \dots} = 21.5 \dots$ times ✓ Initial rate with diluted acid 1 mark $= 0.0465 \dots \times 9.52 \times 10^{-4}$ OR $\frac{9.52 \times 10^{-4}}{21.5 \dots}$ $= 4.43 \times 10^{-5} (\text{mol dm}^{-3} \text{ s}^{-1})$ ✓ OR: Rate $\propto$ concentration (1st order) 1 mark $k = \frac{\text{rate}}{[\text{HCl}]} = \frac{9.52 \times 10^{-4}}{0.680} = 1.4(0) \times 10^{-3}$ OR Constant = $\frac{0.680}{9.52 \times 10^{-4}} = 714.2857 \dots$ ✓ Initial rate with diluted acid $= 1.4(0) \times 10^{-3} \times 0.0316 \dots$ OR $\frac{0.0316 \dots}{714.2857 \dots}$ $= 4.43 \times 10^{-5} (\text{mol dm}^{-3} \text{ s}^{-1})$ ✓	3	AO3.1 ×3	Calculator: 0.0316227766 ALLOW $10^{-1.5}$ ECF possible from incorrect $[\text{H}^+]$ From unrounded $[\text{H}^+]$, Calculator: 0.04650408324 From $[\text{H}^+] = 0.032$, Factor = 21.25 From unrounded $[\text{H}^+]$, Calculator = $4.427188724 \times 10^{-5}$ From $[\text{H}^+] = 0.032$, rate = 4.48×10^{-5} ----- ECF possible from incorrect $[\text{H}^+]$ DO NOT ALLOW ECF unless derived from concentration and rate
	SUMMARY	M1 $[\text{H}^+]$ 0.0316.... OR 0.032 1 mark M2 Working 0.0465 OR 21.5 OR 1.4×10^{-3} OR 714 1 mark M3 Initial rate Range: 4.4×10^{-5} – 4.5×10^{-5} 2 SF or more depends on intermediate rounding CHECK 1 mark			

Question	Answer	Marks	AO element	Guidance
(c)	Mechanism:  M1: Curly arrow from C–N bond to N⁺ ✓ M2:  AND N₂ ✓ M3: Curly arrow from lone pair of O of H₂O to C⁺ ✓ M4:  AND Curly arrow from O–H bond to O⁺ ✓ For all marks, treat additional curly arrows as CON ALLOW M3 shown in bottom box IGNORE partial charges	4	AO3.2 ×4	ANNOTATE ANSWER TICKS AND CROSSES NOTE: Curly arrows can be straight, snake-like, etc. but NOT half arrows 1st curly arrow must start from, OR be traced back to, any part of C–N⁺ bond and go to N OR + of N⁺  2nd curly arrow must - start from, OR be traced back to any point across width of lone pair on O of H₂O - go to the C or + of C⁺ of C₆H₅⁺  3rd curly arrow must - start from '–' of O–H of –OH₂⁺ - go to O or + of O⁺ 

Question	Answer	Marks	AO element	Guidance
	ALLOW M3 AND M4 combined e.g.  ----- For  DO NOT ALLOW M2 for carbocation BUT ALLOW for M3 and/or M4 by ECF, e.g. 			For  DO NOT ALLOW M2 for carbocation BUT ALLOW for M3 and/or M4 by ECF, e.g. 

Question	Answer	Marks	AO element	Guidance
3	Please refer to the marking instructions on page 6 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Suggests ALL of the following - Reagents and conditions for 3 functional groups - Products for 3 functional groups - Optical isomerism with description and 3D optical isomers shown <i>There is a well-developed line of reasoning which is clear and logically structured.</i> <i>The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Suggests two of the following - Reagents and conditions for 2 functional groups - Products for 2 functional groups - Optical isomerism with description OR an attempt to show 3D optical isomers <i>There is a line of reasoning presented with some structure.</i> <i>The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Suggests two of the following - Reagents and conditions for 1 functional group - Products for 1 functional group - Identifies optical isomerism with description OR an attempt to show 3D optical isomers <i>There is an attempt at a logical structure with a line of reasoning.</i> <i>The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.	6	AO3.1 ×3 AO3.2 ×3	CHECK TOP OF QUESTION FOR RESPONSES ----- <i>Indicative scientific points may include:</i> <u>Stereoisomerism</u> - Optical isomerism identified with description: e.g. chiral centre /non-superimposable mirror images 3D Optical isomers drawn, e.g.  <i>Description is subsumed in 3D diagrams</i> <u>Reactions of ketone/carbonyl e.g.</u> NaBH₄  HCN OR CN⁻/H⁺ (e.g. NaCN/H⁺) 

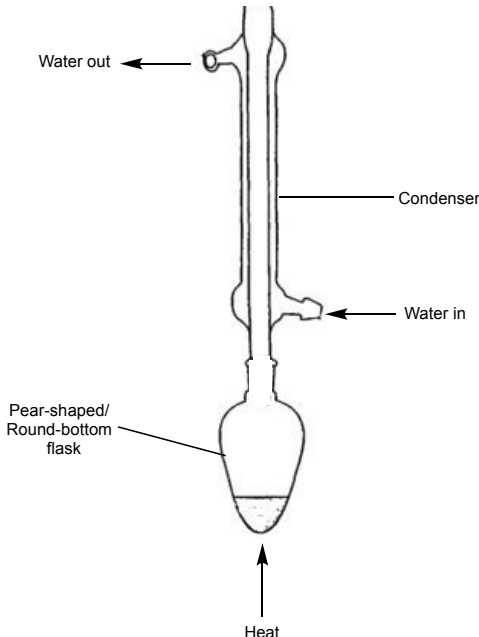
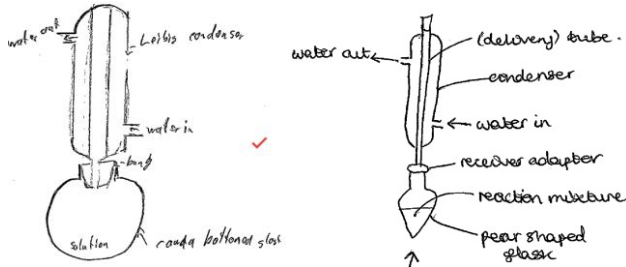
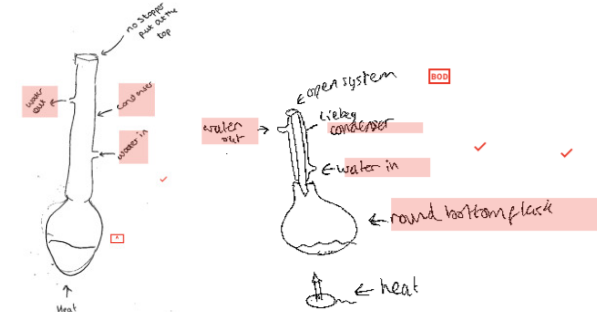
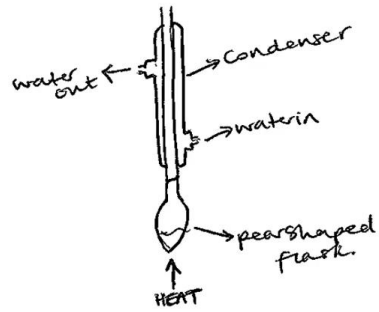
Question	Answer	Marks	AO element	Guidance
	<u>Key points to check</u> <i>CHECK TOP OF QUESTION for responses</i> <i>IGNORE CONNECTIVITY</i> <i>in 3D isomer structures</i> • <i>IGNORE bond angles</i> • <i>Wedges needed</i> • <i>ALLOW</i>  Some responses will not fit into this exact pattern and a best-fit match may be needed <u>Clear communication</u> Focus on • Clear diagrams of 3D optical isomers • Diagrams of unambiguous structures • Reagents and functional group formed are linked • Communication is more a general feel for the quality of the responses. <u>Slips and minor errors in structures</u> • Do not penalise the odd slip or omission, e.g. An extra C in a chain; a C short in a chain, C shown instead of CH₂ or skeletal • You need to judge the extent of any slip based on the whole response. Remember that each candidate response is unique.			<u>Reactions of –OH, e.g.</u> H⁺/Cr₂O₇²⁻ OR H₂SO₄/K₂Cr₂O₇ reflux  H⁺/Cr₂O₇²⁻ OR H₂SO₄/K₂Cr₂O₇ distil  NaBr/KBr/Br⁻ AND acid/H⁺ OR HBr  X = halogen Acid/H⁺ (catalyst) (e.g. H₂SO₄) 

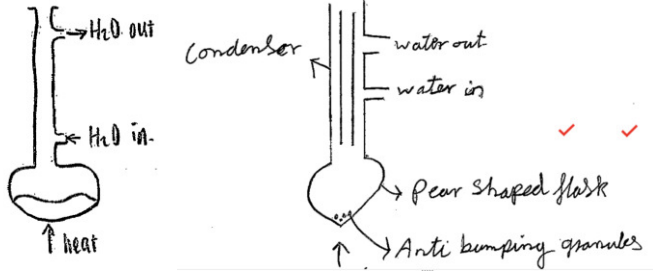
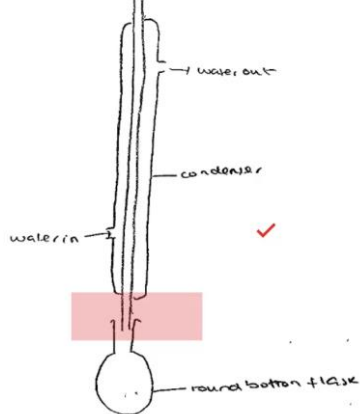
Question	Answer	Marks	AO element	Guidance
				<u>Reactions of C–CN, e.g.</u> H₂ AND metal catalyst e.g. Ni, Pt, Pd  H⁺/H₂O e.g. HCl(aq) or H₂SO₄(aq)  OTHER REAGENTS, CONDITIONS AND PRODUCTS e.g. LiAlH₄ as reagent Check with Team Leader

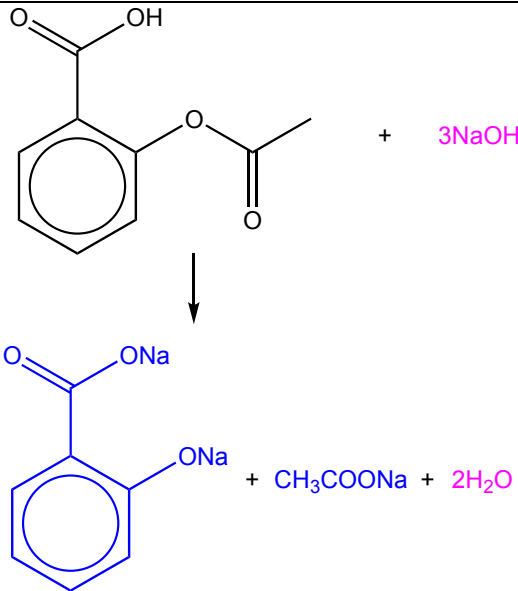
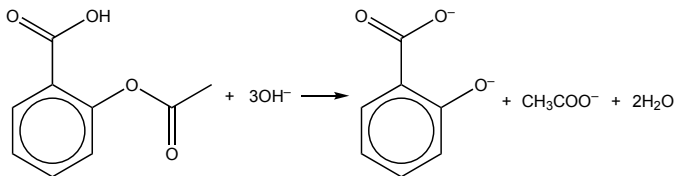
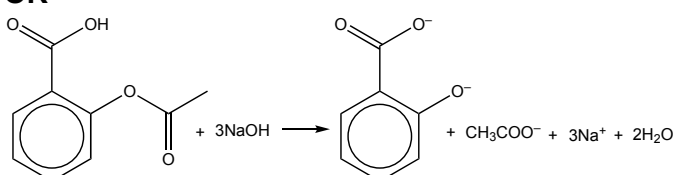
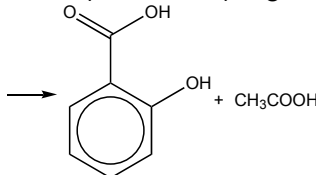
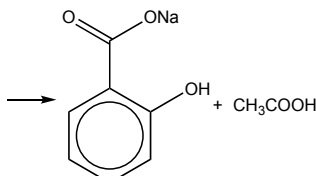
Question			Answer	Marks	AO element	Guidance
4	(a)		Any correct formula for $\text{X}_2\text{Y}(\text{ZO}_4)_2 \cdot 6\text{H}_2\text{O}$ ✓ with suitable elements for X , Y and Z using information in stem: X can be K, Rb, Cs, Fr ONLY Y can be Mg or a transition element in period 4: Ti → Ni Z must be Cr Example: $\text{K}_2\text{Mg}(\text{CrO}_4)_2 \cdot 6\text{H}_2\text{O}$	1	AO3.2	Suitable transition elements: Ti, V, Cr, Mn, Fe, Co, Ni <i>Cu in in the Tutton's salt in Q4</i> <i>Sc and Zn and not classified as transition elements</i>
	(b)	(i)	Mass $(\text{NH}_4)_2\text{SO}_4 = 3.3025 \text{ g}$ ✓ Mass $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 6.24 \text{ g}$ ✓	2	AO1.2 ×2	ALLOW 3.3, 3.30. 3.303 ALLOW 6.2
	(b)	(ii)	- Prevents water of crystallisation from being removed - Anhydrous salt would form - Prevents dehydration ✓	1	AO3.4	IGNORE all the water would be removed <i>water is the solvent</i> IGNORE prevents decomposition IGNORE increases the size of crystals
	(c)	(i)	$[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ ✓ TAKE CARE with correct brackets, numbers and 2+ charge	1	AO2.4	ALLOW +2 for charge IGNORE $[\text{Cu}(\text{NH}_3)_4]^{2+}$ H_2O and NH_3 can be in either order, i.e. $[\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+}$

Question			Answer	Marks	AO element	Guidance
	(c)	(ii)	Formula of precipitate $\text{Cu}(\text{OH})_2$ ✓ IGNORE name: copper(II) hydroxide ----- Formula of gas NH_3 ✓ IGNORE name: ammonia ----- Test for ammonia Available only from a reasonable attempt for identifying the gas as NH_3, e.g. NH_4, NH_4^+, NH_2, ammonia, ammonium (Moist/damp) indicator/litmus (paper) turns blue ✓ Moist/damp NOT required. Initial colour of litmus NOT required but <i>blue</i> is CON	3	AO2.3 ×3	ALLOW $\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4$ ALLOW charges on Cu AND OH e.g. $\text{Cu}^{2+}(\text{OH}^-)_2$ ✓ DO NOT ALLOW unbalanced charges. e.g. $\text{Cu}(\text{OH}^-)_2$ ✗ ----- DO NOT ALLOW correct test for NH_3 based on incorrect ID of the gas NO ECF for a test on the wrong gas (has to be test for NH_3) DO NOT ALLOW bleaches indicator CON
	(c)	(iii)	Reagent BaCl_2 / barium chloride (solution) OR $\text{Ba}(\text{NO}_3)_2$ / barium nitrate (solution) OR Ba^{2+} (solution/aq) / barium ions ✓ Observation white precipitate/ppt ✓ Only available from soluble Ba^{2+} reagent ALLOW minor slips in formula of Ba^{2+} reagent, e.g. BaCl, BaNO_3	2	AO2.3 ×2	ALLOW $\text{Ba}(\text{OH})_2$ or other soluble Ba^{2+} compounds ----- IGNORE test for other anions provided they do NOT interfere with SO_4^{2-} test e.g. IGNORE addition of $\text{HCl}/\text{HNO}_3/\text{H}^+$ BUT DO NOT ALLOW H_2SO_4 <i>Interferes with SO_4^{2-} test</i> IGNORE $\text{Ag}^+/\text{AgNO}_3$ after SO_4^{2-} test DO NOT ALLOW before SO_4^{2-} test IGNORE bubbling any gas through limewater IGNORE responses linked to CrO_4^{2-} <i>Not in Tutton's salt that student prepares</i>

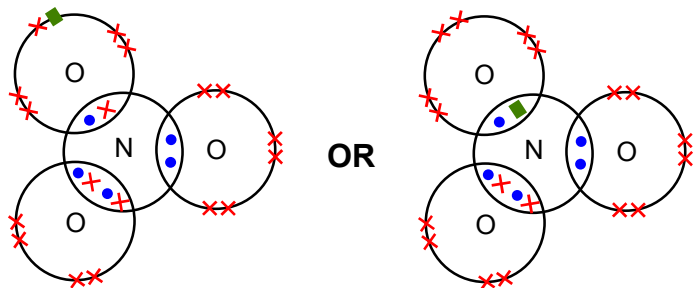
Question			Answer	Marks	AO element	Guidance
5	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If Mass = 318 (mg) award 6 marks Mean titre 1 mark $= \frac{(22.30 + 22.40)}{2} = 22.35(0) \text{ (cm}^3\text{)} \checkmark$ Analysis of results 5 marks $n(\text{HCl}) = 0.200 \times \frac{22.35}{1000} = 4.47 \times 10^{-3} \text{ (mol)} \checkmark$ $n(\text{NaOH}) \text{ remaining in } 25.0 \text{ cm}^3 = n(\text{HCl})$ $n(\text{NaOH}) \text{ remaining in } 250 \text{ cm}^3$ $= 4.47 \times 10^{-3} \times 10 = 4.47 \times 10^{-2} \text{ OR } 0.0447 \text{ (mol)} \checkmark$ $n(\text{NaOH}) \text{ that reacted with aspirin}$ $= 0.0500 - 4.47 \times 10^{-2} = 5.30 \times 10^{-3} \text{ (mol)} \checkmark$ $\text{mass in 3 tablets} = 5.30 \times 10^{-3} \times 180 = 0.954 \text{ g} \checkmark$ $\text{Mass in 1 tablet} = 318 \text{ mg} \checkmark$	6	AO2.8 ×6	FULL ANNOTATIONS MUST BE USED Common error: Incorrect mean from all 3 titres = 22.6 cm³ CHECK BELOW TITRATION TABLE Use ECF throughout Intermediate values for working to at least 3 SF. ALLOW scaling for 1 aspirin tablet early in calc, e.g. for final 2 marks: $n(\text{aspirin}) \text{ in 1 tablet} = \frac{5.30 \times 10^{-3}}{3} = 1.77 \dots \times 10^{-3} \text{ (mol)} \checkmark$ $\text{Mass in 1 tablet} = 1.77 \dots \times 10^{-3} \times 180 = 0.318 \text{ g}$ $= 318 \text{ mg} \checkmark$
			COMMON ERRORS: <i>No scaling × 10</i> $0.05 - 4.47 \times 10^{-3} \rightarrow 4.553 \times 10^{-2} \checkmark$ $4.553 \times 10^{-2} \times 180 \rightarrow 8.1954 \text{ g in 3 tablets} \checkmark$ $\rightarrow \mathbf{2731.8/2732/2730 \text{ mg in 1 tablet} \checkmark}$ 5 marks <i>No scaling × 10 before subtraction but scaling after</i> 4 marks $0.05 - 4.47 \times 10^{-3} \rightarrow 4.553 \times 10^{-2} \checkmark$ $4.553 \times 10^{-2} \times 10 \times 180 \rightarrow 81954 \text{ g in 3 tablets} \times$ $\rightarrow \mathbf{27318 / 27320 / 27300 \text{ mg in 1 tablet} \checkmark}$			<i>No subtraction from 0.05</i> 5 marks $\rightarrow 4.47 \times 10^{-2} \times 180 \rightarrow 8.046 \rightarrow \mathbf{2682/2680 \text{ mg in 1 tablet}}$ <i>Omitting initial titration calculation</i> 2 marks $0.05 \times 180 \rightarrow 9 \text{ g in 3 tablets} \checkmark \rightarrow \mathbf{3000 \text{ mg in 1 tablet} \checkmark}$ <i>Mean of 22.60 (use of all 3 titres)</i> 5 marks $\text{Mean} = 67.8/3 = 22.60 \text{ X} \rightarrow 4.52 \times 10^{-3} \checkmark \times 10 \rightarrow 4.52 \times 10^{-2} \checkmark$ $0.05 - 4.52 \times 10^{-2} \rightarrow 4.80 \times 10^{-3} \checkmark$ $4.80 \times 10^{-3} \times 180 \rightarrow 0.864 \text{ g in 3 tablets} \checkmark$ $\rightarrow \mathbf{288 \text{ mg in 1 tablet} \checkmark}$

Question	Answer	Marks	AO element	Guidance
(b) (i)	 Reaction apparatus (Labels NOT required) flask AND upright condenser AND open system at top ✓ <i>(Could be labelled)</i> Labels AND direction of water flow Pear-shaped/round-bottom flask AND condenser AND water in at bottom and out at top ✓ Heat NOT required DO NOT ALLOW flask, conical flask, volumetric flask DO NOT ALLOW thermometer DO NOT ALLOW condensing tube as label	2	AO3.3 ×2	For open system, DO NOT ALLOW  For open system, ALLOW label. e.g. 'open at top'  ALLOW line across flask 

Question	Answer	Marks	AO element	Guidance
				 ALLOW small gap between flask and condenser BOD, e.g.  If in doubt, ask Team Leader

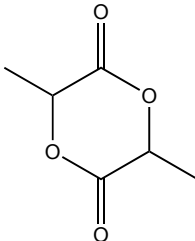
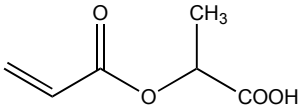
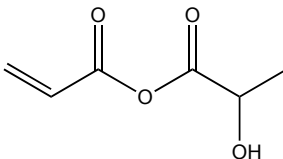
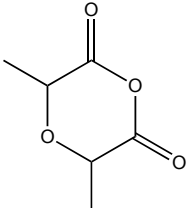
Question	Answer	Marks	AO element	Guidance
(b) (ii)	 Organic products ✓ ✓ 2 marks 3NaOH AND 2H₂O ✓ 1 mark NOTE: ALLOW O⁻Na⁺ for ONa throughout SCROLL DOWN FOR PRODUCTS	3	AO2.6 ×3	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous IGNORE annotations of provided structure of aspirin at top left ALLOW equation with 3OH⁻ OR 3NaOH giving anions for organic products, i.e. i.e.  OR  ALLOW 1 of the 2 organic products mark for BOTH structures as COOH and OH (or mixture) e.g  

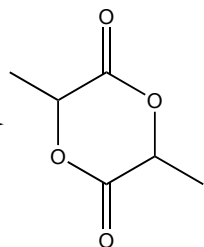
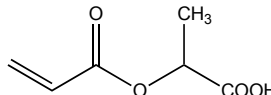
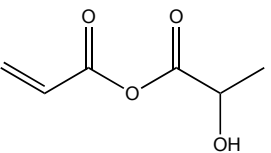
Question			Answer	Marks	AO element	Guidance
6	(a)		H–O–N 104.5° ✓ 2 bonded pairs/regions AND 2 lone pairs (around O) AND lone pairs repel more ✓ <i>Independent of bond angle</i> O–N–O 120° ✓ 3 bonded regions/pairs (around N) ✓ <i>Independent of bond angle</i>	4	AO1.2 AO2.1 AO1.2 AO2.1	Throughout, IGNORE names of shapes (even if wrong) IGNORE 'electrons repel' DO NOT ALLOW 'atoms repel' ----- ALLOW 104–105° ALLOW lp for lone pair (of electrons) bp for bonding pair (of electrons) 'bond' for 'bonded pair' IGNORE electron density ALLOW 115–125° ALLOW 3 bonded areas/environments 3 regions/areas of electron density 3 bonded groups ALLOW 2 bonded pairs and 1 double bond OR 2 bonded pairs and 1 bonded region
	(b)	(i)	$\text{Al}_2\text{O}_3 + 6\text{HNO}_3 \rightarrow 2\text{Al}(\text{NO}_3)_3 + 3\text{H}_2\text{O}$ Any THREE species correct ✓ Correct balanced equation ✓ DO NOT ALLOW more than 4 species in equation	2	AO2.5 AO2.6	ALLOW multiples IGNORE state symbols (even if wrong) ALLOW ionic equation $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$ Mark using same criteria

Question	Answer	Marks	AO element	Guidance
(b) (ii)	Always 5 ● around N ■ unbonded ■ paired in O–N  OR 3 x around N 2 x + 1 ■ around N x = N electron x = O electron ■ = extra electron 1st mark: 8 Electrons around N as above 1 single covalent bond, 1 dative covalent bond 1 double bond 2nd mark: 8 electrons around each O AND 6 O electrons around each O Only award 2nd mark if 1st mark awarded NO ECF	2	AO2.1 AO2.5	NOT REQUIRED • Charge ('-') • Brackets • Circles • N and O symbols IGNORE inner shells ALLOW rotated diagram In N=O bond, ALLOW sequence x x • • ALLOW non-bonding electrons unpaired ALLOW dot and cross labels swapped: i.e. • for O electrons and x for N electrons

Question			Answer	Marks	AO element	Guidance
	(c)	(i)	$\text{Au} + 4 \text{HCl} \rightarrow 4 \text{H}^+ + \text{AuCl}_4^- + 3 \text{e}^- \checkmark$	1	AO1.2	
	(c)	(ii)	Formulae $\text{X} = \text{NO} \checkmark$ $\text{Z} = \text{H}_2\text{O} \checkmark$ Equation Independent from ID of X and Z $\text{HNO}_3 + 3 \text{H}^+ + 3 \text{e}^- \rightarrow \text{NO} + 2 \text{H}_2\text{O}$ OR $\text{NO}_3^- + 4 \text{H}^+ + 3 \text{e}^- \rightarrow \text{NO} + 2 \text{H}_2\text{O} \checkmark$ CHECK BELOW ANSWER SPACE FOR RESPONSES	3	AO3.1 ×3	If X and Z in wrong order award 1 out of 2 formula marks i.e. X = H₂O and Z = NO 1 mark ALLOW multiples

Question	Answer	Marks	AO element	Guidance
(d)	FIRST CHECK THE ANSWERS ON ANSWER LINE If K_c value = 2931 OR 2930 award 4 calc marks If units = $\text{dm}^3 \text{mol}^{-1}$ OR $\text{mol}^{-1} \text{dm}^3$ award 1 unit mark SO_2 and O_2 equilibrium moles $n(\text{SO}_2) = 6.20 \times 10^{-3}$ ($5.82 \times 10^{-2} - 5.20 \times 10^{-2}$) AND $n(\text{O}_2) = 4.80 \times 10^{-2} \checkmark$ ($7.4 \times 10^{-2} - \frac{5.20 \times 10^{-2}}{2}$) Equilibrium concentrations (moles $\div$ 2) $[\text{SO}_2] = 3.10 \times 10^{-3}$ $\frac{6.20 \times 10^{-3}}{2}$ (mol dm^{-3}) AND $[\text{O}_2] = 2.40 \times 10^{-2}$ $\frac{4.80 \times 10^{-2}}{2}$ (mol dm^{-3}) AND $[\text{SO}_3] = 2.60 \times 10^{-2} \checkmark$ $\frac{5.20 \times 10^{-2}}{2}$ (mol dm^{-3}) K_c calculation $K_c = \frac{(2.60 \times 10^{-2})^2}{(3.10 \times 10^{-3})^2 (2.40 \times 10^{-2})} \checkmark$ $= 2,930 \text{ OR } 2,931 \checkmark$ At least 3 SF required <i>Calc value from unrounded values: 2,930.974679</i> Units $\text{dm}^3 \text{mol}^{-1} \checkmark$ DO NOT ALLOW $\text{dm}^3 \text{mol}^{-}$ For units, ALLOW ECF using incorrect K_c expression Units must match K_c expression used	5	AO2.6 $\times 3$ AO1.2 $\times 2$	Use of fractions is fine but final answer MUST be shown using normal numbers COMMON ERRORS $K_c = 1,465$ (2,930/2) $\rightarrow$ 3 calc marks Moles not converted to concentration (No $\div 2$) $\frac{(5.20 \times 10^{-2})^2}{(6.2 \times 10^{-3})^2 (4.80 \times 10^{-2})}$ $K_c = 21.6$ $\rightarrow$ 3 calc marks Original values used, $\frac{(2.60 \times 10^{-2})^2}{(2.91 \times 10^{-2})^2 (3.70 \times 10^{-2})}$ $K_c = 10.8$ $\rightarrow$ 2 calc marks Original values used and no $\div 2$, $\frac{(5.20 \times 10^{-2})^2}{(5.82 \times 10^{-3})^2 (7.40 \times 10^{-2})}$ $K_c = 732.74$ $\rightarrow$ 3 calc marks $\times 2$ instead of $\div 2$ for concentration $\frac{(0.104)^2}{(0.0124)^2 (0.096)}$ $K_c = 112729.8$ $\rightarrow$ 3 calc marks 2.60×10^{-2} not squared $\frac{(2.60 \times 10^{-2})}{(3.10 \times 10^{-3})^2 (2.40 \times 10^{-2})}$ $K_c = 3.41... \times 10^{-4}$ Calculator $3.41183432 \times 10^{-4}$ Inverted K_c $\rightarrow$ 3 calc marks $\frac{(3.10 \times 10^{-3})^2 (2.40 \times 10^{-2})}{(2.60 \times 10^{-2})^2}$ Units mol dm^{-3}

Question	Answer	Marks	AO element	Guidance
(e)*	<i>Please refer to the marking instructions on page 6 of this mark scheme for guidance on how to mark this question.</i> Level 3 (5–6 marks) - Reaches a comprehensive conclusion to determine all three correct formulae of D, E AND F AND constructs most equations with few errors <i>There is a well-developed line of reasoning which is clear and logically structured.</i> <i>The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) - Reaches a comprehensive conclusion to determine two correct formulae of D, E AND F AND constructs some equations with some errors <i>There is a line of reasoning presented with some structure.</i> <i>The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) - Determines a correct formula for one of D, E AND F AND provides some evidence to support the formula <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit. EQUATIONS SHOULD BE USED TO INFORM THE COMMUNICATION STRAND <i>See next page for details</i> <i>CHECK TOP OF QUESTION FOR RESPONSES</i> <i>IGNORE CONNECTIVITY FOR F</i>	6	AO3.1 ×3 AO3.2 ×3	Indicative scientific points may include: Identify of D, E and F D: $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ OR $\text{NiSO}_4(\text{H}_2\text{O})_6$ OR $\text{NiSO}_{10}\text{H}_{12}$ E: SO_2 F: Cyclic diester  OR unsaturated ester/acid  OR unsaturated acid anhydride  OR cyclic acid anhydride 

Question	Answer	Marks	AO element	Guidance																																								
	<u>SUMMARY</u> <u>Setting the level</u> For Level 3 (5–6 marks), • All 3 identified: D, E and F • Most equations For Level 2 (3–4 marks), • 2 identified from D, E and F • 2 equations For Level 1 (1–2 marks), • 1 identified from D, E and F • Evidence ----- Evidence to support a formula for Level 1 Molar ratios of D <table><tr><td>Ni</td><td>:</td><td>S</td><td>:</td><td>O</td><td>:</td><td>H</td><td></td></tr><tr><td>22.33</td><td>:</td><td>12.20</td><td>:</td><td>60.87</td><td>:</td><td>4.60</td><td></td></tr><tr><td>58.7</td><td>:</td><td>32.1</td><td>:</td><td>16.0</td><td>:</td><td>1.0</td><td></td></tr><tr><td>0.38</td><td>:</td><td>0.38</td><td>:</td><td>3.80</td><td>:</td><td>4.60</td><td></td></tr><tr><td>1</td><td>:</td><td>1</td><td>:</td><td>10</td><td>:</td><td>12</td><td>OR NiSO₁₀H₁₂</td></tr></table> ----- Molar mass of E Molar mass = 2.67 × 24 = 64(.08) g mol⁻¹	Ni	:	S	:	O	:	H		22.33	:	12.20	:	60.87	:	4.60		58.7	:	32.1	:	16.0	:	1.0		0.38	:	0.38	:	3.80	:	4.60		1	:	1	:	10	:	12	OR NiSO₁₀H₁₂			<u>Equations</u> H₂SO₄ + Ni(OH)₂ → NiSO₄ + 2H₂O OR H₂SO₄ + Ni(OH)₂ + 4H₂O → NiSO₄•6H₂O For equation ALLOW NiSO₄•6H₂O OR NiSO₄(H₂O)₆ ----- H₂SO₄ + 2HBr → Br₂ + SO₂ + 2H₂O 2CH₃CH(OH)COOH →  + 2H₂O OR 2CH₃CH(OH)COOH →  + 2H₂O OR 2CH₃CH(OH)COOH →  + 2H₂O If structure of F is shown, ALLOW equation using molecular formulae, e.g. 2 C₃H₆O₃ → C₆H₈O₄ + 2H₂O
Ni	:	S	:	O	:	H																																						
22.33	:	12.20	:	60.87	:	4.60																																						
58.7	:	32.1	:	16.0	:	1.0																																						
0.38	:	0.38	:	3.80	:	4.60																																						
1	:	1	:	10	:	12	OR NiSO₁₀H₁₂																																					

BLANK PAGE

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on

01223 553998

Alternatively, you can email us on

support@ocr.org.uk

For more information visit



ocr.org.uk/qualifications/resource-finder



ocr.org.uk



Twitter/ocrextams



/ocrextams



/company/ocr



/ocrextams



CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored. © OCR 2023 Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England. Registered office The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA.

Registered company number 3484466. OCR is an exempt charity.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up-to-date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please [contact us](#).

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our [Expression of Interest form](#).

Please [get in touch](#) if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.