OCR
Oxford Cambridge and RSA

…day June 20XX – Morning/Afternoon

A Level Chemistry A

H432/03 Unified chemistry

SAMPLE MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 70

SPECIMEN

This document consists of 20 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris 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 scoris and mark the **required number** of practice responses ("scripts") and the **required number** of 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 scoris 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 scoris messaging system.

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5. Work crossed out:

   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks

   b. 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 scoris **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 scoris 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.

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10. For answers marked by levels of response:

Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content 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 science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme.

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 science content determines the level.**
- **The communication statement determines the mark within a level.**

Level of response questions on this paper are **2(a)** and **4(d)**.

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11. **Annotations**

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

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12. **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.

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Question			Answer	Marks	Guidance
1	(a)		Bromine has stronger/more induced dipole interactions **OR** temporary dipole interactions **OR** London forces ✓	1	**ALLOW** van der Waals' forces **OR** intermolecular forces
	(b)		Hydrogen bonds in ice hold H_2O molecules further apart (than in water) ✓	1	
	(c)		Potassium (atoms) have one more proton (than argon) ✓	1	
	(d)		Further substitution occurs ✓	1	**ALLOW** multiple substitution occurs **ALLOW** examples of further substitution products
	(e)		1 dm^3 water has a mass of 1000 g $n(H_2O)$ in 1 dm^3 = $\frac{1000}{18} \approx 56$ mol ✓	1	
	(f)		π bonds in benzene are delocalised ✓	1	
	(g)		Carboxylic acids have a broad O–H absorption at 2500–3300 (cm^{-1}) (which ketones do not) ✓	1	**ORA**
	(h)		$n = \frac{pV}{RT} = \frac{(100 \times 10^3) \times (1.00 \times 10^{-3})}{8.314 \times 400} = 0.0301$ mol **AND** mass of N_2O = $0.0301 \times 44.0 = 1.323$ g ✓	1	**AW** $n(N_2O) = 1.323 / 44.0 = 0.0301$ mol $V = \frac{0.0301 \times 8.314 \times 400}{100 \times 10^3} = 1.00 \times 10^{-3}$ m^{-3} (= 1.00 dm^{-3}) ✓ Requires evidence of use of ideal gas equation **AND** $M(N_2O) = 44.0$
	(i)		$M(C_6H_5COOCH_3)$ = 136 g mol^{-1}	1	Answer needs evidence of the 4.25, 136 and

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Question			Answer	Marks	Guidance
			$\frac{4.25}{136}$ × 6.02 × 10^{23} = 1.88 x 10^{22} ✓		6.02 × 10^{23} being used correctly
	(j)		The C–Br bond is weaker (than the C–C*l* bond) ✓	1	**ORA**
			Total	10	

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Question			Answer	Marks	Guidance
2	(a)*		*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)** **Develops a plan that allows identification of all six ions** **AND** **includes essential detail and equations for all test procedures and observations, with three anion tests in the correct sequence, CO_3^{2-}, SO_4^{2-} then Cl^-** **AND** **includes cation test with essential detail and all equations** *There is a well-developed, detailed plan which is clear and logically structured. The plan is substantiated with relevant information, e.g. justification of the sequence of anion tests. There is a clear explanation of how the observations allow the ions to be identified.* **Level 2 (3–4 marks)** **Develops a plan that allows identification of at least three ions** **AND** **includes detail of at least three test procedures and observations, and three equations** *There is an appropriate plan presented with some structure. Parts of the fine detail, correct sequence, or reference to use of both samples may be missing. There is some attempt to explain how the observations allow the ions to be identified.*	6	**Indicative scientific points may include:** Use one sample for cation test, other sample for anion tests **Details of tests** *Cation test* add Aqueous sodium hydroxide Positive observations • for Mn^{2+} : pink/buff precipitate • for Fe^{2+} : green precipitate • for NH_4^+ : litmus paper held over the opening of the tube turns blue Fine detail: • (gentle) heating for NH_4^+ test Equations: $Mn^{2+} + 2OH^- \rightarrow Mn(OH)_2$ $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ *Anion tests* CO_3^{2-}: • add nitric acid; positive observation: effervescence SO_4^{2-}: • add aqueous barium nitrate; positive observation: white precipitate Cl^-: • add silver nitrate solution; positive observation: white precipitate Fine detail for Cl^-:

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Question			Answer	Marks	Guidance
			Level 1 (1–2 marks) **Develops a plan that allows identification of at least two ions** **AND** **includes detail of at least two test procedures and observations, and one equation** *The plan is basic and communicated in an unstructured way. The response lacks fine detail and no reference to correct sequence of anion tests. There is little or no attempt to explain how the observations allow the ions to be identified.* *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.		• subsequent addition of dilute ammonia solution positive observation: precipitate dissolves. Fine detail: correct sequence of all three anion tests • carbonate test followed by sulfate test followed by halide test • justification of sequence • **ALLOW** splitting of solution over three boiling tubes/test tubes and performing each test on a different sample. Equations: $CO_3^{2-} + H^+ \rightarrow CO_2 + H_2O$ $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ $Ag^+ + Cl^- \rightarrow AgCl$
	(b)		K_w value from graph from 2.2 to 2.4 × 10^{-14} ($mol^2\ dm^{-6}$) ✓ Using 2.4 × 10^{-14}, $[H^+] = \sqrt{2.4 \times 10^{-14}}$ **OR** 1.55 × 10^{-7} ✓ pH = –log (1.55 × 10^{-7}) = 6.81 (using K_w = 2.4 × 10^{-14}) ✓	**3**	Actual K_w = 2.38 × 10^{-14} $mol^2\ dm^{-6}$ **ALLOW ECF** only if candidate uses a value between 2.0 and 2.6 × 10^{-14} ($mol^2\ dm^{-6}$), i.e. from the approximately correct region of the graph **ALLOW** 6.8 (1DP) up to calculator value **ALLOW ECF** only if candidate has generated a value of $[H^+]$ by attempting to take a square root of a value between 2.0 and 3.0 × 10^{-14}
	(c)	**(i)**	$Co : N : H : Cl = \frac{21.98}{58.9} : \frac{31.35}{14.0} : \frac{6.72}{1.0} : \frac{39.75}{35.5}$	**2**	

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Question			Answer	Marks	Guidance
			= 0.373 : 2.24 : 6.72 : 1.12 ✓ = 1 : 6 : 18 : 3 Formula = $CoN_6H_{18}Cl_3$ ✓		
		(ii)	$[Co(NH_3)_6]^{3+}$ ✓	1	
			Total	**12**	

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Question			Answer	Marks	Guidance
3	(a)	(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ ✓	1	
		(ii)	4	1	
	(b)		$[Fe(CN)_6]^{3-}$ shown as product in equation ✓ Remaining species and balancing correct balanced equation: $[Fe(H_2O)_6]^{3+} + 6CN^- \rightarrow [Fe(CN)_6]^{3-} + 6H_2O$ ✓	2	Notice different charges on complex ions: LHS 3+, RHS 3– **ALLOW** equations with KCN, i.e.: $[Fe(H_2O)_6]^{3+} + 6KCN \rightarrow [Fe(CN)_6]^{3-} + 6K^+ + 6H_2O$ $[Fe(H_2O)_6]^{3+} + 6K^+ + 6CN^- \rightarrow [Fe(CN)_6]^{3-} + 6K^+ + 6H_2O$ state symbols **not** required
	(c)	(i)	$K_a = \frac{[[Fe(H_2O)_5OH]^{2+}(aq)][H^+(aq)]}{[[Fe(H_2O)_6]^{3+}(aq)]}$ ✓	1	state symbols **not** required
		(ii)	$[H^+] = \sqrt{6.00 \times 10^{-3} \times 0.100}$ **OR** 0.0245 (mol dm^{-3}) ✓ pH = –log 0.0245 = 1.61 ✓	2	**ALLOW ECF** from calculated $[H^+]$ provided that **BOTH** 6.0×10^{-3} **AND** 0.100 only have been used **ALLOW** calculation via quadratic equation → pH 1.66
	(d)		..ClO^- + ..H_2O + **2**..e^- → ..Cl^- + **2**..OH^- ✓ Fe_2O_3 + **10**..OH^- → **2**..FeO_4^{2-} + **5**..H_2O + **6**..e^- ✓	3	**ALLOW** multiples throughout

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Question			Answer	Marks	Guidance
			Fe_2O_3 + **3**..C*l*O^- + **4**..OH^- → **2**..FeO_4^{2-} + **3**..C*l*$^-$ + **2**..H_2O ✓		
			Total	**10**	

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Question			Answer	Marks	Guidance
4	(a)		Measure reduction of colour of bromine ✓	1	
	(b)		Measure volume of CO_2 (produced) ✓	1	
	(c)		Concentration of HCOOH would be constant ✓	1	
	(d)*		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** A comprehensive conclusion which uses quantitative data from the graph to correctly identify and calculate initial rate **AND** half lives and reasoned order of Br_2 **AND** determination of *k* with units *There is a well-developed conclusion showing a line of reasoning which is clear and logically structured. The working for initial rate, half life and order are clearly shown. Determination of k is clear and correct.* **Level 2 (3–4 marks)** Reaches a sound, but not comprehensive, conclusion based on quantitative data from the graph. Correctly identifies and calculates initial rate **AND** half lives and reasoned order of Br_2 *The conclusion has a line of reasoning presented with some structure. The initial rate and order is relevant and supported by correct evidence from the graph. There may be errors in the calculations which prevent the correct determination of k.*	6	**Indicative scientific points may include:** **Initial rate** • Evidence of tangent on graph drawn to line at t = 0 s **AND** gradient determined in range $4 \pm 1 \times 10^{-5}$ • *initial rate* expressed as gradient value with units of mol dm^{-3} s^{-1}, e.g. *initial rate* = 4×10^{-5} mol dm^{-3} s^{-1} **Half lives and reasoned order of Br_2** • Half life measured on graph **OR** within text **OR** stated in range 180–200 s • Constant half life **OR** two stated half lives within ±20 s **AND** conclusion that Br_2 is 1st order **Determination of *k* with units** • Rate constant *k* clearly linked to initial rate **OR** half-life: $k = \frac{rate}{[Br_2]}$ **OR** $k = \frac{\ln 2}{t_{1/2}}$ • *k* determined correctly from measured initial rate or measured half life with units of s^{-1}, e.g. $k = 4 \times 10^{-3}$ s^{-1} from initial rate of 4×10^{-5} mol dm^{-3} s^{-1} **OR** $t_{1/2}$ of 175 s

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Question			Answer	Marks	Guidance
			Level 1 (1–2 marks) Reaches a simple conclusion using at least one piece of quantitative data from the graph. Attempts calculation of initial rate **OR** half lives and reasoned order of Br_2. *The information selected from the graph is basic and communicated in an unstructured way. The calculations may not be clear and the evidence used from the graph may not be clearly shown.* *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.		
			Total	**9**	

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Question			Answer	Marks	Guidance
5	(a)	(i)	reaction with bases: neutralisation **AND** reaction with metals: redox ✓	1	
		(ii)	correctly calculates n(**A**) = $\frac{1.125}{90}$ = 0.0125 (mol) ✓ volume of H_2 = $\frac{0.0125}{2}$ x 24 000 = 150 cm^3 ✓ **units** required	2	 **ALLOW** 0.15 dm^3 **ALLOW ECF** from n(**A**)
		(iii)	$C_6H_{12}O_6Mg$ ✓	1	**DO NOT ALLOW** $(C_3H_6O_3)_2Mg$
		(iv)	Type of reaction of COOH: e.g. esterification **AND** reagents and conditions e.g. CH_3OH **AND** H_2SO_4 ✓ Organic product of COOH reaction ✓ Type of reaction of –OH **AND** reagents and conditions ✓ Organic product of –OH reaction ✓	4	**ALLOW** esterification with any stated alcohol e.g. product from CH_3OH/H_2SO_4 → $CH_3(CHOH)COOCH_3$ Many possible reactions of secondary alcohol possible, e.g. oxidation with $K_2Cr_2O_7/H_2SO_4$ + heat → $CH_3(CO)COOH$ elimination with H_2SO_4/H_3PO_4 + heat → CH_2=$CHCOOH$ esterification with CH_3COOH/H_2SO_4 **OR** CH_3COCl → $CH_3(CHOOCCH_3)COOH$ bromination with $NaBr/H_2SO_4$ → $CH_3(CHBr)COOH$ **ALLOW** self-polymerisation as reaction for either

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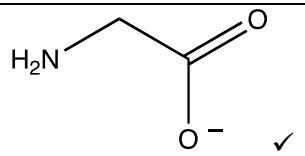
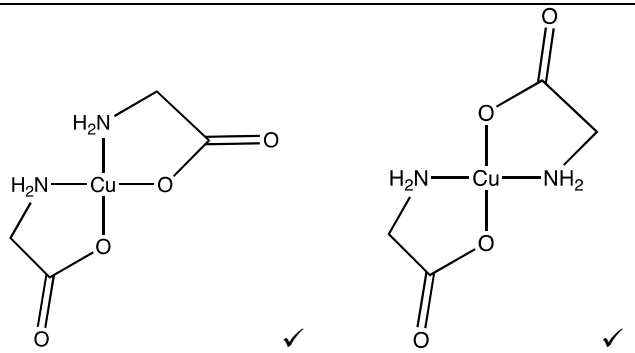
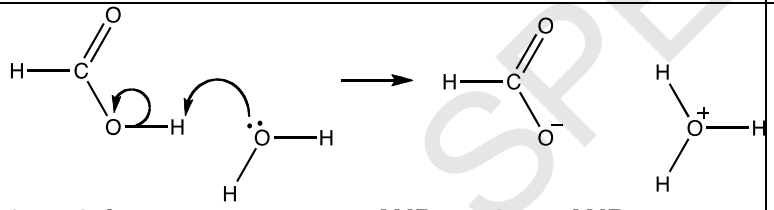
Question			Answer	Marks	Guidance
					group (if another reaction example given) condensation polymerisation with H_2SO_4 $\rightarrow [OCH(CH_3)CO]_n$
	(b)	(i)	 ✓	1	Must be skeletal formula
		(ii)	 ✓ ✓	2	**IGNORE** charges **ALLOW** Cs and Hs labelled on structures *Marks are for correct connectivity*
		(iii)	Alanine has a chiral C atom/centre ✓	1	
	(c)		 1 mark for correct reactants **AND** products **AND** correct positioning of + and – charges on products ✓ 1 mark for two correct curly arrows **AND** H_2O curly arrow starting from O lone pair ✓	2	

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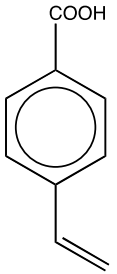
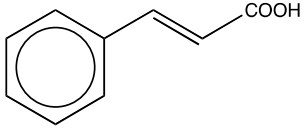
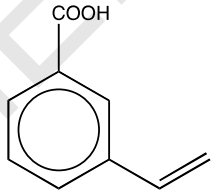
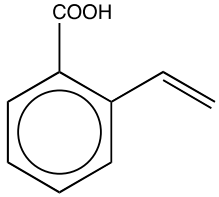
Question			Answer	Marks	Guidance
	(d)		Electrophilic substitution means benzene ring ✓ Electrophilic addition means alkene / C=C ✓ Isomer of $C_9H_8O_2$ containing C=C, benzene ring **AND** COOH ✓ Correct isomer:  **OR**  ✓ justification in terms of number of carbon environments ✓	**5**	Concluded using data provided and conclusions from 1st two marks. **ALLOW** 1 mark for:  **OR**  (does not gain final justification mark)
			Total	**19**	

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Question			Answer	Marks	Guidance
6	(a)		$n(NH_2OH) = 4.32 \times 10^{-2} \times 0.0250 = 1.08 \times 10^{-3}$ mol ✓ $n(Fe^{3+}) = 3 \times 1.08 \times 10^{-3} = 3.24 \times 10^{-3}$ mol (assuming Equation 3) ✓ volume = $\frac{3.24 \times 10^{-2} \times 1000}{0.0400}$ = 81.0 cm^3 ✓ Explanation: minimum amount of Fe^{3+} required is maximum amount theoretically required to react with all NH_2OH, i.e. if Equation 3 is correct (greatest amount of Fe^{3+} required) (*owtte*) ✓	4	Factor **3** must be included in second mark for **ECF** on third mark. **ALLOW** 2 sig figs
	(b)		$n(MnO_4^-) = 2.00 \times 10^{-2} \times \frac{21.6}{1000} = 4.32 \times 10^{-4}$ (mol) ✓ $n(Fe^{2+}) = 4.32 \times 10^{-4} \times 5 = 2.16 \times 10^{-3}$ (mol) ✓ Ratio NH_2OH: Fe^{2+} **OR** NH_2OH: Fe^{2+} $= 1.08 \times 10^{-3} : 2.16 \times 10^{-3} = 1 : 2$ **AND** Equation 2 is correct ✓	3	**Working must be to at least 3 sig figs throughout until final numerical answer** **BUT** ignore trailing zeroes, e.g. for 0.490 allow 0.49 **ECF** answer above × 5 This mark is only possible from correct answers above, i.e. **no ECF**
	(c)	(i)	Boiling speeds up the reaction **OR** Ensures that reaction is complete ✓ (Titre is less because) there is less Fe^{2+} ✓	2	

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Question			Answer	Marks	Guidance
		(ii)	In **Stage 1**, increase quantities so that there is sufficient solution for more than one titration ✓	1	**ALLOW** increase scale of **Stage 1**
			Total	10	

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Summary of updates

Date	Version	Change
January 2019	2.0	Minor accessibility changes to the paper: i) Additional answer lines linked to Level of Response questions ii) One addition to the rubric clarifying the general rule that working should be shown for any calculation questions