OCR
Oxford Cambridge and RSA

Practice paper – Set 1

A Level Chemistry A
H432/03 Unified chemistry

MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 70

Final

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.

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.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, concentrating on elements 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 **1(b)** and **3(d)**.

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

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.

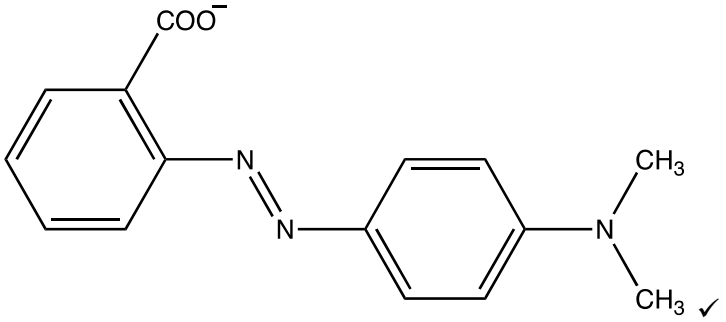
Question			Answer	Marks	Guidance
1	(a)	(i)	N_2O_4 = +4 **AND** NO_3^- = +5 **AND** NH_4^+ = –3 ✓	1	**ALL** 3 oxidation numbers required **DO NOT ALLOW** missing '+' or '–' **OR** oxidation numbers shown as charges e.g. N^{5+}
	(a)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 7.9(0) (g) award 2 marks** $n(KMnO_4) = \frac{0.200 \times 250}{1000} = 0.0500$ (mol) ✓ mass of $KMnO_4$ = 0.0500 × 158.0 = 7.9(0) (g) ✓	2	
	(a)	(iii)	$dm^6\ mol^{-2}\ s^{-1}$ ✓	1	
	(a)	(iv)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 1.54 × 10^{23} award 2 marks** n(tartaric acid) = $\frac{38.25}{150}$ = 0.255 (mol) ✓ number of molecules = 0.255 × 6.02 × 10^{23} = 1.54 × 10^{23} ✓ (***3 SF*** *required from least significant data*)	2	**ALLOW ECF** from n(tartaric acid) Common error: use of 148 *(missing 2H Structure)* → 1.56 × 10^{23}

Question	Answer	Marks	Guidance
(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)** Explains trend in melting point across Period 3 in terms of structure, particles and the relative strengths of the forces **AND** identifies that the high melting point of arsenic suggests a giant structure *There is a detailed explanation of the different melting points which is clear and logically structured.* **Level 2 (3-4 marks)** Attempts to explain all three main points but the explanations may be incomplete or may contain only some correct statements or comparisons **OR** Correctly explains two of the three main points with most elements included. *There is an explanation of the different melting points which is mostly clear and logically structured.* **Level 1 (1-2 marks)** Explains the trend in melting point across Period 3 but identifies only some of the structure, forces and particles **AND** attempts to compare strengths but does not compare correct forces *The explanation is basic and communicated in an unstructured way. The response lacks fine detail.* **0 marks:** No response or no response worthy of credit.	6	**Indicative scientific points may include:** **1. Structure and bonding/forces in Period 3** **Si:** • **Structure**: giant covalent • **Forces**: Covalent bonding • **Particles:** atoms **P–S–Cl:** • **Structure**: simple molecular • **Forces**: induced dipole-dipole interactions (London forces) **OR** van der Waals' forces • **Particles:** molecules **2. Comparison of strength in Period 3** • Covalent bonds in Si are much stronger than London forces in P–ArCl. • P–ArCl: London forces greatest with larger molecules (more electrons), i.e. $S_8 > P_4$ • (The stronger the force, the higher the melting point) **3. Period 4** • Ge, Se and Br have **similar** trend • As has much **higher melting point** (than P) suggesting giant (covalent) structure • (Ge has lower melting point suggesting weaker covalent bonds)
	Total	12	

Question			Answer	Marks	Guidance
2	(a)	(i)	Titres correct and **ALL** recorded to **2 decimal places** Titre: 22.50 21.80 22.15 21.70 **AND** mean titre = 21.75 (cm^3) ✓	1	Working not required for mean titre
	(a)	(ii)	Percentage uncertainty = $\frac{0.05 \times 2}{21.70} \times 100 = 0.46$ (%) ✓ **2 DP** required	1	**ALLOW ECF** from incorrect subtraction in **(i)**
	(a)	(iii)	(Excess KI) ensures that all I_2 is formed for titration ✓	1	**ALLOW** All Cu^{2+} converted to CuI/Cu(I)
	(a)	(iv)	Add starch ✓ Blue to colourless **AND** all I_2 has reacted ✓	2	
	(a)	(v)	$n(S_2O_3^{2-})$ in titration = $\frac{0.120 \times 21.75}{1000} = 2.61 \times 10^{-3}$ (mol) ✓ $n(I_2) = 1.305 \times 10^{-3}$ (mol) **OR** $n(Cu^{2+}) = 2.61 \times 10^{-3}$ (mol) **AND** $n(Cu^{2+})$ in original 250 $cm^3 = 10 \times 2.61 \times 10^{-3}$ $= 2.61 \times 10^{-2}$ (mol) ✓ Mass of **A** ($CuSO_4 \cdot xH_2O$) used = 17.95 – 12.35 = 5.60 (g) $M(CuSO_4 \cdot xH_2O) = \frac{5.60}{2.61 \times 10^{-2}} = 214.6$ (g mol^{-1}) ✓ $x = \frac{214.6 - 159.6}{18.0} = 3.05 = 3$ Formula = $CuSO_4 \cdot 3H_2O$ ✓	4	**ALLOW ECF** from incorrect mean titre in **(a)(i)** **ECF** from $n(S_2O_3^{2-})$ **ECF** from $n(Cu^{2+})$ **BUT DO NOT ALLOW** incorrect mass **ECF** from $M(CuSO_4 \cdot xH_2O)$ **AND** x = nearest whole number

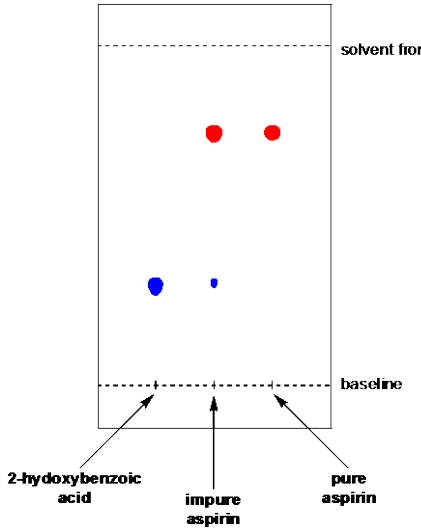
Question			Answer	Marks	Guidance
	(b)	(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$ ✓	1	**ALLOW** upper case S, P and D and subscripts, e.g. ……$3S_2 3P_6 3D_{10}$ **ALLOW** $4s^1$ before $3d^{10}$ **DO NOT ALLOW** [Ar] as shorthand for $1s^2 2s^2 2p^6 3s^2 3p^6$, i.e. **DO NOT ALLOW** [Ar]$3d^8$ Look carefully at $1s^2 2s^2 2p^6 3s^2 3p^6$ – there may be a mistake
	(b)	(ii)	$n = \frac{95.0}{24000} = 3.96 \times 10^{-3}$ (mol) ✓ *Calculation of M* $M = \frac{m}{n} = \frac{254 \times 10^{-3}}{3.96 \times 10^{-3}} = 64.2$ **OR** 64.1 (g mol^{-1}) ✓ *Gas*: sulfur dioxide **OR** SO_2 ✓ *Equation* $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$ ✓	4	**If there is an alternative answer, check to see if there is any ECF credit possible using working below** Unrounded values give 64.2; Rounded to 3 SF gives 64.1 **ALLOW** $Cu + 2H^+ + H_2SO_4 \rightarrow Cu^{2+} + SO_2 + 2H_2O$
	(c)	(i)	green solution: $Fe^{2+}(aq)$ **OR** $[Fe(H_2O)_6]^{2+}$ **AND** gas bubbles: $H_2(g)$ **AND** orange-brown solution: $Fe^{3+}(aq)$ **OR** $[Fe(H_2O)_6]^{3+}$ ✓ $Fe(s) + 2H^+(aq) \rightarrow Fe^{2+}(aq) + H_2(g)$ ✓ $4Fe^{2+}(aq) + O_2(g) + 4H^+(aq) \rightarrow 4Fe^{3+}(aq) + 2H_2O(l)$ ✓	3	State symbols are **not** required in this part **IGNORE**, even if incorrect **ALLOW** full equation: $Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$

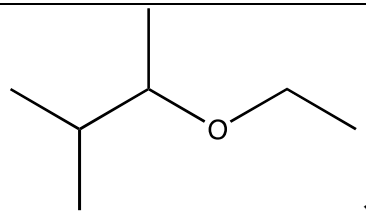
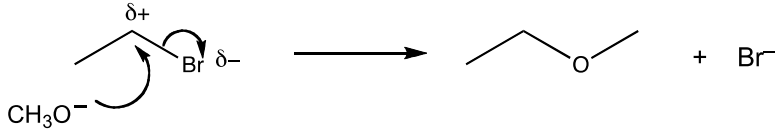
Question			Answer	Marks	Guidance
	(c)	(ii)	orange solution: $Cr_2O_7^{2-}$ **AND** green solution (anywhere) Cr^{3+} **OR** $[Cr(H_2O)_6]^{3+}$ ✓ $2Cr^{3+}(aq) + H_2O(l) + 3H_2O_2(aq) \rightarrow Cr_2O_7^{2-}(aq) + 8H^+(aq)$ H^+, H_2O and e^- all cancelled ✓✓	3	State symbols are **not** required in this part **IGNORE**, even if incorrect **IGNORE** Cr(VI) *The question asks for species* **ALLOW** 1 mark for $H^+/H_2O/e^-$ not cancelled, e.g. $2Cr^{3+}(aq) + 7H_2O(l) + 3H_2O_2(aq) + 6H^+(aq) \rightarrow Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6H_2O(l)$ ✓
			Total	20	

Question			Answer	Marks	Guidance
3	(a)	(i)	Using a pH probe on a data logger **OR** pH meter ✓	1	
	(a)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = **0.11(0)** (mol dm^{-3}), award **2 marks** --- $n(NaOH) = \frac{0.125 \times 22.0}{1000} = 2.75 \times 10^{-3}$ (mol) ✓ concentration of $CH_3COOH = \frac{2.75 \times 10^{-3} \times 1000}{25.0}$ $= 0.11(0)$ (mol dm^{-3}) ✓	2	**IF** there is an alternative answer, check to see if there is any **ECF** credit possible using working below --- **ANNOTATE WITH TICKS AND CROSSES, etc** **ALLOW ECF**: n(NaOH) × 1000/25.00
	(b)	(i)	Brilliant yellow **AND** Vertical section/rapid pH change matches the pH range/end point/colour change (of the indicator) ✓	1	**ALLOW** pH range (of the indicator) matches equivalence point **ALLOW** end point/colour change matches equivalence point **IGNORE** colour change matches end point *(colour change is the same as end point)*
	(b)	(ii)	 ✓ Explanation:	4	

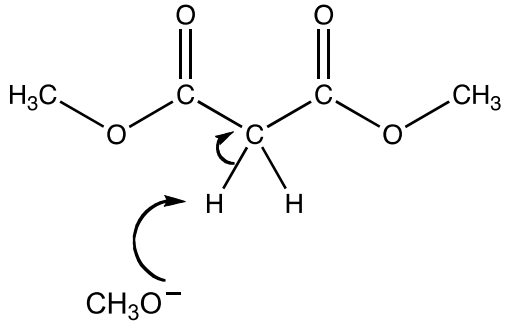
Question			Answer	Marks	Guidance
			Acid/H^+ reacts with A^- **AND** equilibrium (position) shifts towards HA (to give a red colour) ✓ Alkali/OH^- reacts with HA/H^+ **AND** equilibrium (position) shifts towards A^- (to give a yellow colour) ✓ At end point, equal amounts of HA and A^- **AND** orange colour ✓		**ALLOW** direction of equilibrium shift if equilibrium shown: $HA \rightleftharpoons H^+ + A^-$ i.e. 'towards HA' is equivalent to 'to left' i.e. 'towards A^-' is equivalent to 'to right' **ALLOW** yellow–red colour
	(c)	**(i)**	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If** answer = 2.33 **award 4 marks** $K_a = 10^{-3.40} = 3.98 \times 10^{-4}$ (mol dm^{-3}) ✓ Concentration of aspirin $= \frac{1.00 \times 10^{-2}}{180} \times 1000$ $= 0.0556$ (mol dm^{-3}) ✓ $[H^+] = \sqrt{(K_a \times [HA])}$ $= \sqrt{(3.98 \times 10^{-4} \times 0.0556)}$ $= 4.70 \times 10^{-3}$ (mol dm^{-3}) ✓ pH = –log $4.70 \times 10^{-3} = 2.33$ ✓	**4**	**ALLOW ECF** **ALLOW ECF only** from $[H^+]$ calculation using $[H^+] = \sqrt{(K_a \times [HA])}$
	(c)	**(ii)**	Salts are ionic **AND** attracted to polar H_2O ✓	**1**	
	(c)	**(iii)**	COO^- reacts with H^+ forming COOH ✓ Aspirin precipitates out ✓	**2**	**ALLOW** equilibrium shifts to left
	(d)		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*	**6**	**Indicative scientific points, with bulleted elements, may include:**

Question			Answer	Marks	Guidance
			Level 3 (5-6 marks) Correctly calculates mass of 2-hydroxybenzoic acid. **AND** Outlines full details of the two steps to obtain a pure sample of aspirin from the hot reaction mixture • *Calculation shows all relevant steps.* • *Purification steps are detailed and clear, in the correct order, using appropriate scientific terms, e.g. filter under reduced pressure/using a Buchner flask; dissolve in the minimum volume of solvent* **Level 2 (3-4 marks)** Attempts a calculation which is mostly correct **AND** Some details of steps to obtain impure aspirin from the hot reaction mixture and recrystallisation • *Calculation can be followed but lacks clarity.* • *Purification steps lack detail, e.g. filter without reduced pressure; dissolve without minimum volume of solvent* **Level 1 (1-2 marks)** Attempts to calculate the mass of **B** using mole approach but makes little progress with only 1 step correct. **AND** Few or imprecise details about steps to obtain impure aspirin from hot reaction mixture and recrystallisation • *Calculation is difficult to follow and lacks clarity* • *Purification steps are unclear with few scientific terms and little detail, e.g. just 'filter and crystallise'* **0 marks:** No response or no response worthy of credit.		**1. Mass of 2-hydroxybenzoic acid** • n(aspirin) needed = $\frac{8.10}{180}$ = 0.0450 (mol) • n(2-hydroxybenzoic acid) needed = $0.0450 \times \frac{100}{90}$ = 0.0500 (mol) • Mass = 0.0500×138 = 6.9(0) g --- **2. Purification** **Impure aspirin from hot reaction mixture** • **Cool** reaction mixture • **Filter** product under **reduced pressure** **Recrystallisation of impure aspirin**: • Dissolve impure solid in **minimum volume of hot** water/solvent • **Cool** solution and **filter** solid • **Wash** with cold water/solvent and **dry** **NOTE** *Filtration of hot solution to remove solid particles is **not** required*

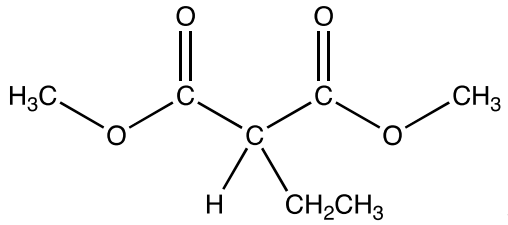
Question			Answer	Marks	Guidance
	(e)	(i)	 Pure aspirin and 2-hydroxybenzoic acid correct ✓ Impure aspirin with 2 spots in line with aspirin and 2-hydroxybenzoic acid spots **AND** 2-hydroxybenzoic acid spot fainter than aspirin spot ✓	**2**	Check measurements on diagram using online measuring tool. Distance from baseline to top of spot for aspirin = 70–80% of baseline → solvent front Distance from baseline to top of spot for aspirin = 25–35% of baseline → solvent front
	(e)	**(ii)**	Melting point range between 130–140°C **AND** Range ≥ 2°C ✓	**1**	Range that starts <138 and finishes ≤140
			Total	**24**	

Question			Answer	Marks	Guidance
4	(a)		 ✓	1	
	(b)	(i)	$2Na + 2CH_3OH \rightarrow 2Na^+ + 2CH_3O^- + H_2$ ✓	1	**ALLOW** $2Na + 2CH_3OH \rightarrow 2CH_3ONa + H_2$
	(b)	(ii)	 Curly arrow from CH_3O^- to carbon atom of C–Br bond ✓ Dipole shown on C–Br bond, $C^{\delta+}$ and $Br^{\delta-}$ **AND** curly arrow from C–Br bond to the Br atom ✓ Products of reaction (must not be ambiguous) ✓	3	**ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above as long as non-ambiguous The curly arrow must start from **O atom** of CH_3O^- **AND** must start either from a lone pair or from the negative charge. No need to show lone pair if curly arrow comes from negative charge **ALLOW** S_N1 Dipole shown on C–Br bond, $C^{\delta+}$ and $Br^{\delta-}$, and curly arrow from C–Br bond to the Br atom. Correct carbocation drawn **AND** curly arrow from CH_3O^- to carbocation. The curly arrow must start from the oxygen atom of the CH_3O^-, and must start either from a lone pair or from the negative charge.
	(b)	(iii)	CH_3O^- donates an electron pair **AND** heterolytic fission ✓	1	**ASSUME** 'it' refers to CH_3O^-

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td></td><td>
<table>
<tr><th>Chemical shift, δ/ppm</th><th>Relative peak area</th><th>Splitting pattern</th><th></th></tr>
<tr><td>0.5–1.9</td><td>3</td><td>Triplet</td><td>✓</td></tr>
<tr><td>3.0–4.3</td><td>2</td><td>Quartet</td><td>✓</td></tr>
<tr><td>0.5–1.9</td><td>6</td><td>Doublet</td><td>✓</td></tr>
<tr><td>3.0–4.3</td><td>1</td><td>Heptet</td><td>✓</td></tr>
</table>
</td><td>4</td><td>ALLOW δ values ± 0.2 ppm, as a range or a value within the range

ALLOW multiplet for heptet</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td> 
Curly arrow from CH_3O^- to H of CH_2 ✓

Curly arrow from C–H bond to C of CH_2 ✓

  ✓</td><td>3</td><td>The curly arrow must start from O atom of CH_3O^- AND must start either from a lone pair or from the negative charge.

No need to show lone pair if curly arrow comes from negative charge

ALLOW any unambiguous structure, skeletal, displayed, structural or combination</td></tr>
<tr><td></td><td>(d)</td><td>(ii)</td><td>CH_3O^- accepted a proton ✓</td><td>1</td><td>ASSUME ‘it’ refers to CH_3O^-</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>14</td><td></td></tr>
</table>