OCR
Oxford Cambridge and RSA

day June 20XX – Morning/Afternoon

A Level Chemistry B (Salters)

H433/02 Scientific literacy in chemistry

SAMPLE MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 100

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.

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 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 **3(c) and 5(d)(iv)**.

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
✓	Marking point

12. **Subject-specific Marking Instructions**

INTRODUCTION

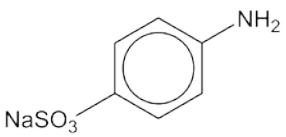
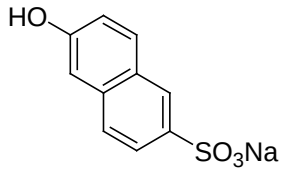
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

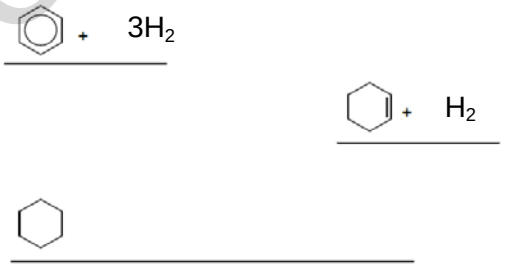
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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)		Compound **A**:  ✓ *First reaction:* *Reagents:* HC*l*/H^+ and $NaNO_2$ **OR** HNO_2 ✓ *Condition:* below 5 ^oC ✓ *Second reaction:* *Reagents/conditions:*  ✓ NaOH ✓	5	**ALLOW** names (including 'nitrite', 'nitrous acid') **ALLOW** $–O^–$ for –OH **ALLOW** NaOH as reagent or condition **IGNORE** temperature for second reaction
	(b)		$–SO_3^–$ groups (formed by dissociation of $NaSO_3$) ✓ form ion–dipole bonds with water ✓ energy released by bond formation greater than required for bonds broken (**AW**) ✓ (these are) hydrogen bonds between water molecules **OR** ionic bonds between ions ✓	4	

Question			Answer	Marks	Guidance
	(c)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE** Energy change = 266 (kJ mol^{-1}) award 3 marks ΔE for absorption by 1 atom = hc/λ ΔE for absorption in kJ mol^{-1} = $hcN_A/1000\lambda$ ✓ $= \frac{6.63\times10^{-34}\times3.00\times10^{8}\times6.02\times10^{23}}{10^{3}\times450\times10^{-9}}$ ✓ = 266 (kJ mol^{-1}) ✓	3	**First and second marks can be scored by correctly substituted figures into the expressions.**
	(d)		$3H_2$ on top left line and H_2 on top right line ✓ indication that left-hand side is less than 3 × right-hand side **OR** that gap between benzene and cyclohexene is less than three times value for cyclohexene ✓	2	
	(e)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** rate =4.35 × 10^{-5} award 2 marks rate =4.35 × 10^{-5} **AND** units = s^{-1} award 3 marks rate doubles with concentration so reaction 1st order to $C_6H_5N_2Cl$ rate = $k[C_6H_5N_2Cl]$ ✓ k = rate / $[C_6H_5N_2Cl]$ = 4.35 × 10^{-5} ✓ s^{-1} ✓	3	Answer can be calculated using either data set.
		(ii)	only know concentration at start/initial concentration ✓ (therefore) collecting larger volumes would not give initial rate ✓	2	**IGNORE** references to actual percentages

Question			Answer	Marks	Guidance
		(iii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** pH = 1.68 (2 d.p.) award 2 marks $n(N_2)$ = 0.050 / 24.0 = 0.00208 mol concentration HC*l* = 0.00208 × 10 = 0.0208 mol dm^{-3} ✓ pH = 1.68 (2 d.p.) ✓	**2**	
		(iv)	*One from* ✓ (Measure) loss of mass Titrate HC*l*	**1**	
		(v)	two missing values: 3.36 × 10^{-3} and –8.52 ✓ axes drawn, labels correct *x*-axis: 1/*T* / K^{-1} *y*-axis: ln *k* scales that use over half of each axis ✓ all points plotted correctly with best straight line drawn through points ✓ measurement of slope (1.33 ± 0.05 × 10^4) ✓ multiplication by 8.314, division by 10^3 and change of sign to give E_a in kJ units [+111 (kJ mol^{-1})] ✓	**5**	units of 1/*T* can be missing **ALLOW** no sign but not minus sign for last mark **ALLOW** 2 or more sig figs **ALLOW** any answer rounding to 106–115 (calculated correctly from slope)
			Total	**27**	

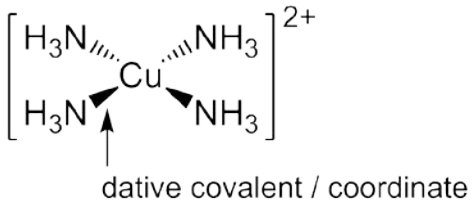
Question			Answer	Marks	Guidance
2	(a)	(i)	$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$ ✓	1	**IGNORE** state symbols
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** mass = 0.0625 award 1 mark mass = 0.063 g to 2 sig figs award 2 marks moles CO_2 = 15/24000 **OR** 6.25×10^{-4} ✓ mass $CaCO_3$ = ($6.25 \times 10^{-4} \times 100$) = 0.063 g to 2 sig figs ✓	2	**ALLOW ECF** from first marking point
	(b)	(i)	$CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$ **OR** $CO_3^{2-} + H_2O \rightarrow CO_2 + 2OH^-$ ✓	1	**ALLOW** equilibrium signs **IGNORE** state symbols
		(ii)	$CaCO_3$ is less soluble/weaker base than $Ca(OH)_2$ ✓ so fewer $OH^-(aq)$ ions are present (as $Ca(OH)_2$ reacts / $CaCO_3$ forms) ✓	2	
	(c)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** pH = 11.6 award 3 marks $[OH^-] = 2 \times 0.002 = 0.004$ (mol dm^{-3}) ✓ $[H^+] = (1 \times 10^{-14}/4 \times 10^{-3} =) 2.5 \times 10^{-12}$ (mol dm^{-3}) ✓ pH = 11.6 ✓	3	**ALLOW ECF** on third marking point from a given $[H^+]$, provided pH is between 10 and 13
		(ii)	$[H^+] = 2.1 \times 10^{-5}$ (mol dm^{-3}) ✓ pH = 4.7 ✓	2	
		(iii)	contribution of $[H^+]$ from water ✓ 1×10^{-7} insignificant compared to (**AW**) 2×10^{-5} ✓	2	

Question			Answer	Marks	Guidance
	(d)	(i)	$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$ ✓ $Fe \rightleftharpoons Fe^{2+} + 2e^-$ ✓	2	**ALLOW** 'e' without minus **IGNORE** state symbols **ALLOW** ½ or ¼ equation for OH^-
		(ii)	high $[OH^-]$ pushes first equilibrium to left (**AW**) ✓ electrons (formed) push second equilibrium to left ✓ so less Fe^{2+} (and hence rust) formed ✓	3	
	(e)	(i)	(normal) pink; (after carbonatation) colourless ✓	1	both answers required for mark
		(ii)	CO_2 from air is reacting with water to form H^+ ✓ turning (the structure of phenolphthalein) from **E** to **D** ✓	2	
			Total	21	

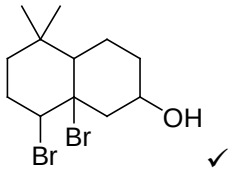
Question			Answer	Marks	Guidance
3	(a)	(i)	$C_5H_8O_2 + 6O_2 \rightarrow 5CO_2 + 4H_2O$ Correct molecular formula of GMV ✓ Balanced equation (with **ECF**) ✓	2	**IGNORE** state symbols
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** ratio = 1 : 1.4 or more sig figs (1.395 .) award 3 marks mass CO_2 per mole GMV = 5 × 44 = 220 g mass CO_2 per mole hexane = 6 × 44 = 264 g ✓ M_r values GMV 100; hexane 86 ✓ ratio (220/100) : (264/86) = 1 : 1.40 ✓	3	**OR** moles CO_2 per mole fuel **ALLOW ECF** from first marking point
		(iii)	Comparison of CO_2 is important as it is a greenhouse gas/contributes to global warming ✓ Should be CO_2 per kJ released on burning (**AW**) ✓	2	
	(b)		$CH_3CH(OH)CH_2CH_2COOH$ ✓ internal ester formation (**AW**) ✓	2	**ALLOW** any unambiguous representation of structure

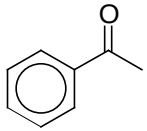
Question	Answer	Marks	Guidance
(c)*	*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Candidate identifies the structure of the compound correctly, the evidence for this identification uses information from composition by mass **AND** IR spectrum **AND** proton NMR spectrum. *The identification is clear and logically structured. The evidence selected is relevant and fully supports the identification.* **Level 2 (3–4 marks)** Candidate identifies the compound as a keto-acid, the evidence for this identification uses information from composition by mass **AND EITHER** IR spectrum (both points) **OR** proton NMR spectrum **OR** using information from IR spectrum **AND** proton NMR spectrum. *The identification has a logical structure. The evidence selected is in the most-part relevant and supports the identification.* **Level 1 (1–2 marks)** Candidate makes an attempt at identifying the compound and the evidence to support this identification uses **EITHER** information from composition by mass **OR** IR spectrum **OR** proton NMR spectrum. *The identification is basic and communicated in an unstructured way. The evidence selected is limited and the relationship to the identification may not be clear.*	**6**	**Indicative scientific points may include:** Compound is $CH_3COCH_2CH_2COOH$ **Composition by mass**: • $C_5H_8O_3$ calculated. **IR spectrum:** • COOH from IR at 3200–3600 (• no OH at 3200–3600/3640). **Proton NMR: (any 3)** • 4 proton environments • peak at 10.5 indicates COOH • peaks at 2.2–2.7 indicate (three) Cs next to (a single) C=O • singlet at 2.2 indicates C with no Hs on adjacent carbons **AND** triplets at 2.6 and 2.8 indicate Cs with one adjacent CH_2.

Question			Answer	Marks	Guidance
			0 marks No response or no response worthy of credit.		
			Total	**15**	

Question			Answer	Marks	Guidance
4	(a)		 Structure ✓ Bond name ✓	2	**IGNORE** 2+ **ALLOW** a flat structure, i.e. viewed from above
	(b)	(i)	intensity of colour **OR** absorbance of (suitable wavelength) light ✓ gives a measure of concentration (of complex/ammonia) **OR** (directly) proportional to concentration (of complex/ammonia) ✓	2	
		(ii)	$= \frac{[[Cu(NH_3)_4]^{2+}]}{[Cu^{2+}][NH_3]^4}$ ✓	1	
		(iii)	$\frac{x}{(0.1-x)(0.4-4x)^4}$ correct apart from a wrong value for $[NH_3]$ ✓ $(0.4 – 4x)$ for $[NH_3]$ ✓	2	**ALLOW ECF** from **(ii)**
		(iv)	Inaccurate / second student correct because Reaction of (OH^- in) ammonia solution with H_2SO_4 causes equilibrium to move so all the ammonia is neutralised (**AW**) **OR** equilibrium **4.1** shifts to the left as the acid reacts with the ammonia ✓ so titre / measured concentration will be too large ✓	2	

Question			Answer	Marks	Guidance
	(c)		$Cu(C_2H_8N_2)_2^{2+}$ ✓ 4 ✓	2	**ALLOW** a more structured formula for ethane diamine 2+ must be present **ALLOW** $Cu(C_2H_8N_2)_3^{2+}$ ✓ 6 ✓
	(d)	(i)	$Cu^{2+} + 2I^- \rightarrow CuI + ½ I_2$ **OR** doubled ✓	1	**IGNORE** state symbols
		(ii)	copper(I) iodide ✓	1	**ALLOW** a gap between 'copper' and '(I)'
			Total	13	

Question			Answer	Marks	Guidance
5	(a)	(i)	 ✓	1	**ALLOW** any unambiguous formula clearly displaying the structure of the compound.
		(ii)	11 ✓	1	
		(iii)	two ✓ (because ambrinol has two) asymmetric carbon atoms / carbon atoms surrounded by 4 different groups ✓	2	
		(iv)	yes, because same bonds ✓ hence same vibrations ✓	2	**ALLOW**: no, based on analogy with named compound ✓ (e.g. carvone) for which enantiomers smell different ✓
	(b)		vanillin and guaiacol are phenols ✓ purple colour with $FeCl_3$ ✓ benzaldehyde and vanillin are aldehydes ✓ acid dichromate goes green **OR** Tollens' reagent **OR** $AgNO_3$ and NH_3 ... give silver (mirror) **OR** Fehlings solution gives red precipitate ✓	4	
	(c)		IR spectrum that shows how bonds vibrate ✓ Shows similarity between spectra of vanillin and combination of guaiacol and benzaldehyde (**AW**) ✓ C–H in arenes ✓	3	

Question			Answer	Marks	Guidance
	(d)	(i)	(atoms with) same atomic number **AND** different mass number ✓ 1 and 7 ✓	2	must mention both terms
		(ii)	12.01 ✓	1	
		(iii)	 ✓ all hydrogen atoms replaced with deuterium atoms ✓	2	Correct **skeletal** formula required. **ALLOW** 'H'/'proton' for 'hydrogen atom' and 'D' for deuterium atom To score, answer must state that all the atoms are replaced.
		(iv)*	*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)** Supporting evidence for Turin's theory **AND** evidence to discredit the lock and key theory have been correctly identified. There is a clear discussion related to both theories. *The evidence selected is relevant and substantiated. The discussion shows a well-developed line of reasoning for the choices of evidence, which is clear and logically structured.* *Candidate demonstrates a clear and confident knowledge of relevant technical language (names of compounds, 'deuterated', 'vibrate').* **Level 2 (3–4 marks)**	6	**Indicative scientific points may include:** **Statements to support Turin's theory** • deuterated acetophenone smells different (from non-deuterated form) • deuterated benzaldehyde smells different (from non-deuterated form) • because H and D have different masses and hence C–D and C–H vibrate differently • C^{12} and C^{13} exchange does not affect smell, since masses only differ slightly • structures of deuterated acetophenone and benzaldehyde given.

Question			Answer	Marks	Guidance
			Supporting evidence for Turin's theory **AND** evidence to discredit lock and key theory have been correctly identified although there is a limited attempt to discuss them. *The evidence selected is in the most-part relevant.* *The discussion has some structure but is limited in scope.* *Candidate demonstrates a sound grasp of technical language (one spelling error).* **Level 1 (1–2 marks)** Evidence for Turin's theory has been identified **OR** Evidence against lock and key theory *The information is supported by limited evidence and the relationship to the evidence may not be clear. The discussion is basic and communicated in an unstructured way.* *Candidate demonstrates a basic grasp of relevant technical language (several spelling errors).* **0 marks** No response or no response worthy of credit.		**Statements to discredit Lock and Key** • since structures are similar, lock and key theory would not predict difference (**AW**). • structurally related molecules can smell utterly different.
			Total	**24**	