Practice paper – Set 1

A Level Chemistry A

H432/02 Synthesis and analytical techniques

MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 100

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 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 **16(a)(iv)** and **17(c)**.

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:

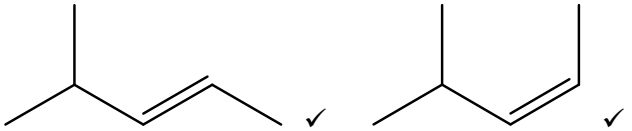
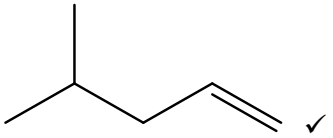
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

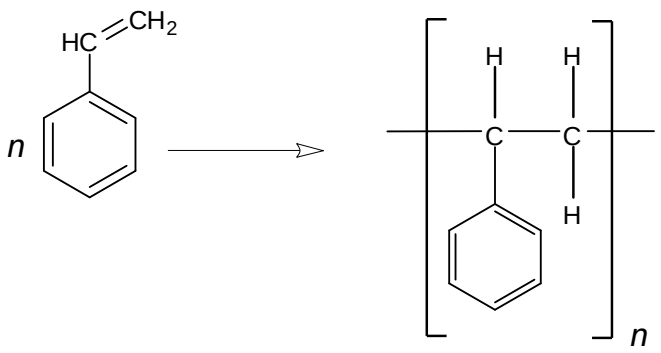
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question	Key	Marks	Guidance
1	A	1	
2	B	1	
3	B	1	
4	D	1	
5	C	1	
6	A	1	
7	B	1	
8	D	1	
9	C	1	
10	B	1	
11	B	1	
12	A	1	
13	C	1	
14	D	1	
15	B	1	

Question			Answer	Marks	Guidance
16	(a)	(i)	Elimination ✓	1	**ALLOW** Dehydration
		(ii)	Same structural formula **AND** Different arrangement (of atoms) **in space OR** different **spatial** arrangement ✓ 	3	**ALLOW** have the same structure/displayed formula/skeletal formula **DO NOT ALLOW** same empirical formula **OR** same general formula Stereoisomers have the same formula or molecular formula is **not** sufficient Reference to *E*/*Z* isomerism or optical isomerism is **not** sufficient **IGNORE** names **IF** skeletal formula is not used **ALLOW** one mark if both stereoisomers of alkene **B** are shown clearly.
		(iii)		1	**ALLOW** correct structural **OR** skeletal **OR** displayed formula **OR** mixture of the above **IGNORE** names

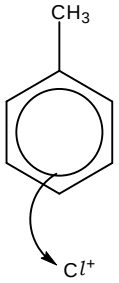
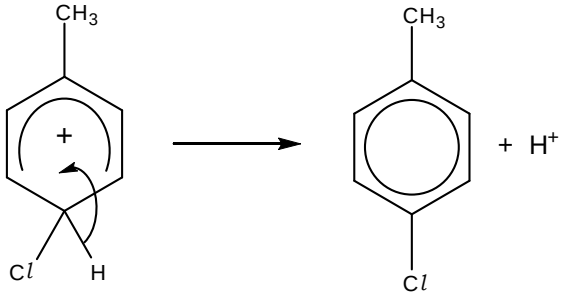
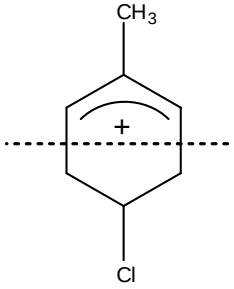
Question			Answer	Marks	Guidance
		(iv)*	*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5-6 marks)** Outlines full details of how a pure sample of **B** is obtained from the reaction mixture. **AND** Correctly calculates mass of **B** • *Purification steps are clear, in the correct order, using appropriate scientific terms.* • *Calculation shows all relevant steps and mass given to 3 significant figures.* **Level 2 (3-4 marks)** Some details of how a sample of **B** is obtained from the reaction mixture. **AND** Attempts a calculation which is mostly correct. • *Purification steps lack detail, e.g. no drying agent or no explanation of separation, or only some scientific terms used.* • *Calculation can be followed but unclear.* **Level 1 (1-2 marks)** Few or imprecise details of how a sample of **B** is obtained from the reaction mixture. **AND** Attempts to calculate the mass of **B** using mole approach but makes little progress with only 1 step correct. • *Purification step is unclear with few scientific terms and little detail, e.g. just 'separate the layers and dry'.* • *Calculation is difficult to follow and lacking clarity* **0 marks** No response or no response worthy of credit.	**6**	**Indicative scientific points, with bulleted elements, may include:** **<u>1. Purification</u>** • Use of a **separating funnel** to separate organic and aqueous layers • **Drying** with an anhydrous salt, e.g. $MgSO_4$, $CaCl_2$, etc. • **Redistillation** Incorrect purification method is **NOT** worthy of credit. **<u>2. Mass of B obtained</u>** • n(**A**) used = $\frac{9.26}{102}$ = 0.0908 (mol) = theoretical n(**B**) • **Actual** n(**B**) obtained = $n(0.908) \times \frac{75}{100}$ = 0.0681 (mol) • mass **B** = 84×0.0681 = **5.72 g** **CHECK** for extent of errors by **ECF** Alternative correct calculation may calculate the mass of **B** as 0.0908×84 = 7.63 g, followed by $7.63 \times \frac{75}{100}$ = 5.72 g Calculation must attempt to calculate n(***A***) in mol. Simply finding 75% of the initial mass of alcohol A, 9.26, is **NOT** worthy of credit.

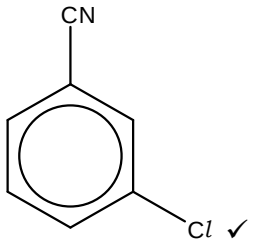
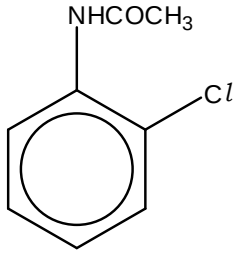
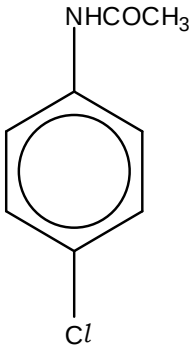
	(b)	**(i)**	 Correct polymer with side links ✓ Balanced equation for formation of correct polymer - correct use of *n* in the equation and brackets ✓	**2**	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous *n* on LHS can be at any height to the left of formula **AND** *n* on the RHS must be a subscript (essentially below the side link)
		(ii)	Use as an organic feedstock ✓ **OR** Combustion for energy production ✓	**1**	**ALLOW** the production of plastics or monomers or new polymers Combustion alone is **not** sufficient
			Total	**14**	

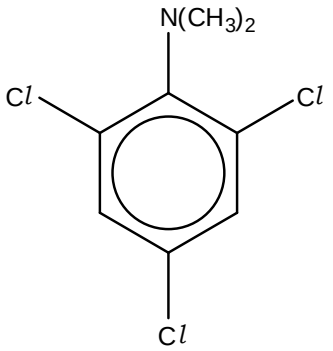
Question			Answer	Marks	Guidance
17	(a)		2,3,5-trimethyloctane ✓	1	This is the **only** acceptable response
	(b)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = 3.88×10^5 (m^3) award all five marks *Calculating moles of $C_{11}H_{24}$* (moles= $\frac{80.4 \times 10^6}{156}$) = 515385 ✓ *Use of stoichiometry to calculate moles of CO_2* $(11 \times 515385) = 5669231$ ✓ *Rearranging ideal gas equation to make V subject* **AND** *conversion to Pa and K* $V = \frac{nRT}{P} = \frac{5669231 \times 8.314 \times 218}{26.5 \times 10^3}$ ✓ 3.88×10^5 (m^3) Correct answer correctly rounded ✓ Given in standard form **AND** to 3SF ✓	5	Allow any correctly rounded value from 515000 to calculator value of 515384.6154 Allow any correctly rounded value from 5670000 to calculator value of 5669230.769 **ALLOW ECF** from incorrect moles, pressure or temperature (in K). **Common incorrect answers are shown below** **Award 4 marks for** 3.88×10^{-1} (using 80.4 g in moles calculation) 3.88×10^8 (using 26.5 Pa as pressure) 3.52×10^4 (using moles $C_{11}H_{24}$ as moles of CO_2) **DO NOT ALLOW** marking points 3, 4, and 5 for responses which have a negative value for volume of CO_2 (temperature not converted to K). i.e. max 2
		(ii)	$N_2 + O_2 \rightarrow 2NO$ ✓	1	**ALLOW** multiples

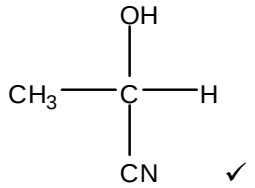
	(c)*		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** A comprehensive description with all three scientific points explained thoroughly with few omissions. *There is a well-developed and detailed description, including correct names of all steps and radicals identified using • consistently; limitations illustrated with examples.* **Level 2 (3–4 marks)** Attempts to describe all three scientific points but explanations may be incomplete. **OR** Explains two scientific points thoroughly with few omissions. *The description has some structure including names of some steps linked to correct equations and some radicals identified using •* **Level 1 (1–2 marks)** A simple description based on at least two of the main scientific points. **OR** Explains one scientific point thoroughly with few omissions. *The description is communicated in an unstructured way, including some use of names or dots.* **0 marks** No response or no response worthy of credit.	**6**	**Indicative scientific points may include:** **1. Overall equation and conditions** • $C_3H_8 + Cl_2 \longrightarrow C_3H_7Cl + HCl$ • Conditions: UV • Initiation: $Cl_2 \longrightarrow 2Cl\bullet$ **2. Propagation and termination** **Step names** / **Equation** Propagation: $C_3H_8 + Cl\bullet \longrightarrow C_3H_7\bullet + HCl$; $C_3H_7\bullet + Cl_2 \longrightarrow C_3H_7Cl + Cl\bullet$ Termination: $C_3H_7\bullet + Cl\bullet \longrightarrow C_3H_7Cl$; $C_3H_7\bullet + C_3H_7\bullet \longrightarrow C_6H_{14}$; $Cl\bullet + Cl\bullet \longrightarrow Cl_2$ **3. Limitations** • Further substitution, e.g. $C_3H_6Cl_2$ • Substitution at different positions on chain, e.g. $CH_3CH_2CH_2Cl$ **IGNORE** state symbols throughout
			Total	**13**	

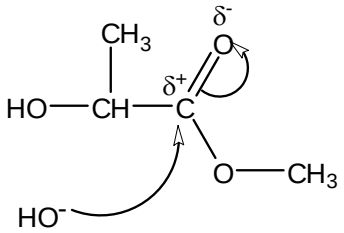
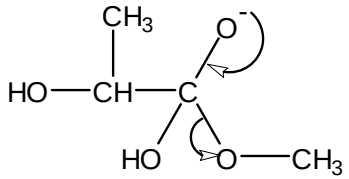
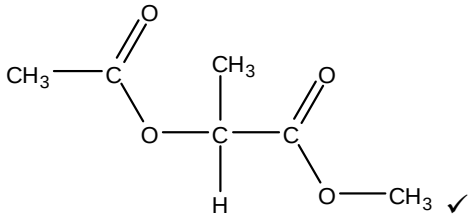
Question			Answer	Marks	Guidance
18	(a)		**Experimental evidence – ANY TWO from** carbon–carbon bond lengths are the same in benzene ✓ Enthalpy change of hydrogenation is less (exothermic) for benzene (than for Kekulé model) ✓ Discussion of named reaction to highlight greater stability, e.g. chlorination of benzene requires a catalyst whereas no catalyst is needed for alkenes ✓ **Bonding in modern model** p-orbitals overlap to form π bonds ✓ (π-)electrons are delocalised ✓	4	**ALLOW** both marks for correctly labelled diagrams showing overlap of p-orbitals to form delocalised π–electrons

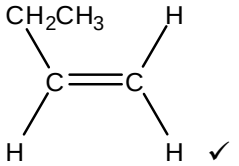
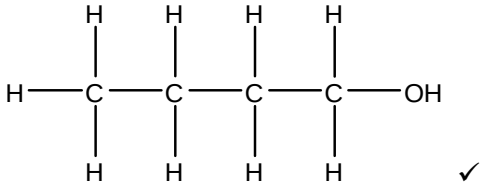
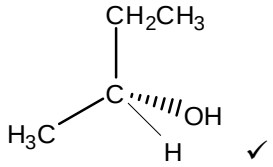
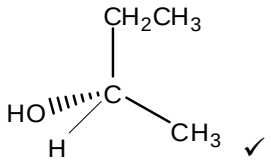
	(b)		**Generation of electrophile** $AlCl_3 + Cl_2 \longrightarrow AlCl_4^- + Cl^+$ ✓ **Electrophilic substitution** Curly arrow from π-bond to Cl^+ ✓  --- Correct intermediate ✓ Curly arrow back from C-H bond to reform π-ring **AND** H^+ as product ✓  **Regeneration of catalyst** $H^+ + AlCl_4^- \longrightarrow AlCl_3 + HCl$ ✓	**5**	**ANNOTATE ANSWER WITH TICKS AND CROSSES** **DO NOT ALLOW** the following intermediate:  π-ring must be more than 1/2 way down **AND** 'horseshoe' the right way, *i.e.* gap towards C with Cl **ALLOW** + sign anywhere inside the 'hexagon' of intermediate

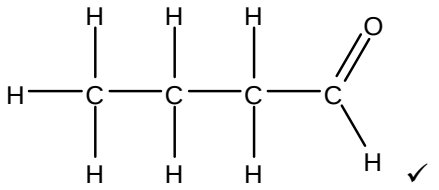
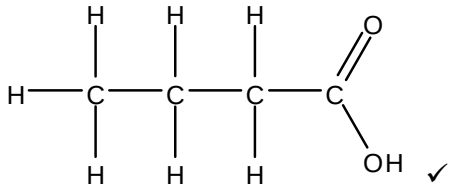
	(c)	**(i)**	 ✓  ✓  ✓	**3**	**IGNORE** names throughout **DO NOT ALLOW** poly-substituted products **DO NOT ALLOW** 2-chloro or 4-chloro products **DO NOT ALLOW** 3-chloro product

		(ii)	 ✓	**1**	
		(iii)	(In $C_6H_5N(CH_3)_2$) (lone) pair of electrons on N is (partially) **delocalised** into the ring ✓ electron density increases/is higher (than in benzene) ✓ **ORA** Cl_2/electrophile is (more) polarised ✓ **ORA**	**3**	**ALLOW** diagram to show movement of lone pair into ring but **delocalised** ring must be mentioned **ALLOW** lone pair of electrons on N is (partially) drawn/attracted/pulled into **delocalised** ring **DO NOT ALLOW** charge density or electronegativity **ALLOW** Cl_2 is (more) attracted **OR** Cl_2 is not polarised by benzene **OR** induces dipoles (in chlorine/electrophile)
			Total	**16**	

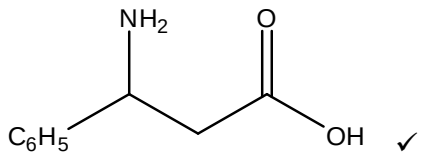
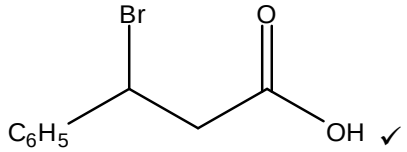
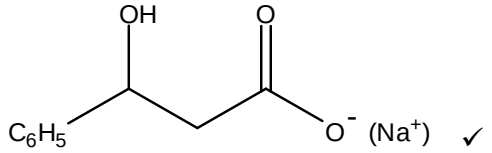
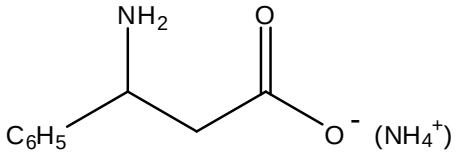
Question			Answer	Marks	Guidance
19	(a)	(i)	 ✓	1	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous
		(ii)	**aqueous** acid **OR** H^+/**H_2O** ✓	1	**ALLOW** $H^+(aq)$ / $H_2SO_4(aq)$ / HC*l*(aq)
		(iii)	Angle a = 109.5º Angle b = 104.5º Angle c = 120º **Two** correct ✓ All **three** correct ✓✓	2	**ALLOW** 109–110º **ALLOW** 104–105º
	(b)	(i)	It is an electron pair donor **OR** donates a lone pair ✓	1	

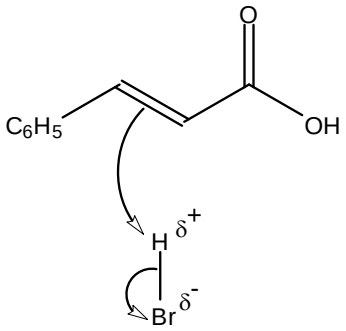
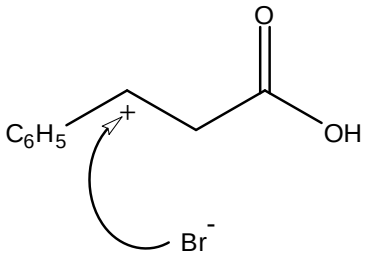
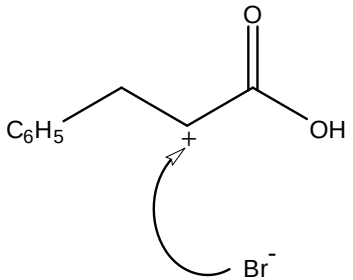
Question			Answer	Marks	Guidance
		(ii)	 Curly arrow from HO^- to carbon atom of C=O bond ✓ Correct dipole **AND** curly arrow from C=O bond to $O^{\delta-}$ ✓ ---  Curly arrow from negative charge on oxygen to C–O bond (to reform carbonyl π–bond) ✓ Curly arrow from C–O single bond to oxygen atom (to form methoxide ion) ✓	**4**	Curly arrow must come from lone pair on O of HO^- **OR** OH^- **OR** from minus sign on HO^- ion (No need to show lone pair if curly arrow came from negative charge on O) **IGNORE** dipole on C–O single bond Curly arrow must come from lone pair on O **OR** from minus sign on O^- ion (No need to show lone pair if curly arrow came from negative charge on O)
		(iii)	Correct organic product:  ✓ HC*l* ✓	**2**	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous
			Total	**11**	

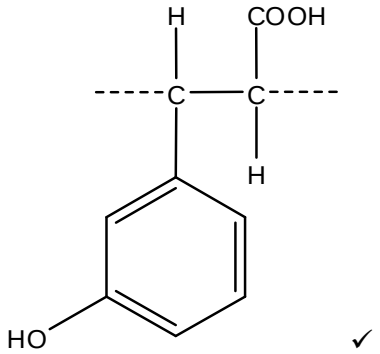
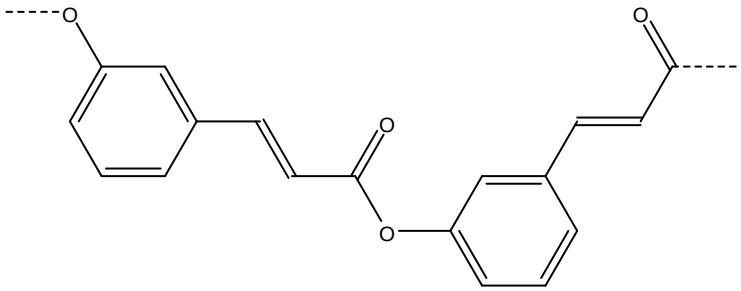
Question			Answer	Marks	Guidance
20	(a)		**F–K** clearly identified **Compound F:**  ✓ **Compound G:**  ✓ **Compounds H and I:**  ✓  ✓	6	**ANNOTATE ANSWER WITH TICKS AND CROSSES** **ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **IGNORE** names **H** and **I** can be identified either way round

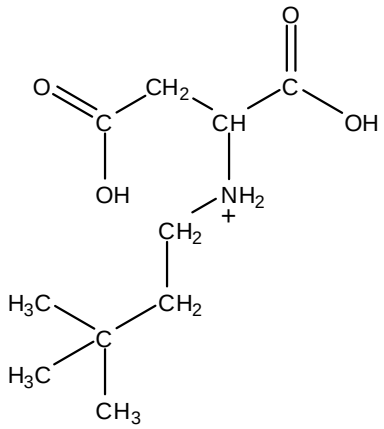
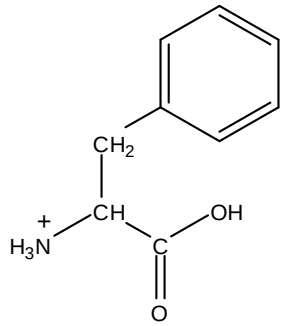
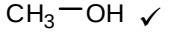
			Compound J:  ✓ **Compound K:**  ✓		

	(b)		(Add) 2,4-dinitrophenylhydrazine **AND** orange/yellow/red precipitate ✓ Take melting point of crystals ✓ Compare to known values ✓	**3**	**NOTE**: **(b)** is marked completely independently of **(a)** **ALLOW** errors in spelling **ALLOW** 2,4(-)DNP **OR** 2,4(-)DNPH **ALLOW** Brady's reagent or Brady's Test **ALLOW** solid **OR** crystals **OR** ppt as alternatives for precipitate **Mark second and third points independently of response for first marking point** **DO NOT ALLOW** 2nd and 3rd marks for taking and comparing boiling points **OR** chromatograms
			Total	**9**	

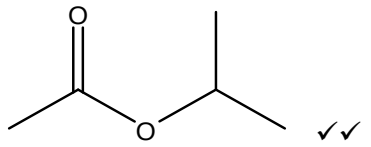
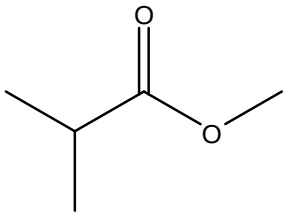
Question			Answer	Marks	Guidance
21	(a)		**Product from NH_3/ethanol**  ✓ --- **Product from Reaction 1**  ✓ --- **Product from NaOH(aq)**  ✓	3	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **ALLOW**  **ALLOW ECF** from 2-bromo compound as product from Reaction 1 --- **DO NOT ALLOW** 2-bromo compound *(inconsistent with final product shown)* --- **DO NOT ALLOW ECF** from 2-bromo compound as product from Reaction 1 *(inconsistent with final product shown)*

	(b)		Curly arrow from C=C bond to H of H-Br ✓ Correct dipole shown on H–Br **AND** curly arrow showing the breaking of H-Br bond ✓  --- Correct carbocation **AND** curly arrow from Br^- to C^+ of carbocation ✓  --- Electrophilic addition ✓	**4**	**ANNOTATE ANSWER WITH TICKS AND CROSSES** **ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **DO NOT ALLOW** partial charges shown on C=C double bond **DO NOT ALLOW** $\delta+$ on C of carbocation **ALLOW** formation of the 2-bromo isomer  Curly arrow must come from a lone pair on Br^- **OR** from the negative sign of Br^- ion (then lone pair on Br^- ion does not need to be shown)

	(c)	**(i)**	 ✓	**1**	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous 'End bonds' **MUST** be shown (do not have to be dotted) **IGNORE** brackets **IGNORE** *n*
		(ii)	 Ester link ✓ Rest of structure ✓	**2**	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous 'End bonds' **MUST** be shown (do not have to be dotted)

	(d)		 **OR** structure with NH rather than NH_2^+ ✓  **OR** structure with NH_2 rather than NH_3^+ ✓  ✓ Correct charge and number of protons on both nitrogen atoms ✓	**4**	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous
			Total	**14**	

Question	Answer	Marks	Guidance
22	**Elemental analysis and molecular formula** Use of percentages to give empirical formula $C_5H_{10}O_2$ ✓ Evidence of using empirical formula **AND** 102 to give molecular formula = $C_5H_{10}O_2$ ✓ **IR Spectrum** Peak at ~1750 **OR** 1630–1820 (cm^{-1}) **AND** C=O ✓ **NMR analysis** Peak(s) at (δ) 4.9 shows HC–O **AND** 1 H in environment (peak area) **OR** 6H on adjacent C as peak is multiplet/heptet/septet ✓ Peak at (δ) 2.2 shows HC–C=O **AND** 3 H in environment (peak area) **OR** No H on adjacent C as peak is singlet ✓ Peak(s) at (δ) 1.3 shows HC–R **AND** 6 H (or 2 × CH_3) in environment (peak area) **OR** 1H on adjacent C as peak is doublet ✓	8	**ANNOTATE ANSWER WITH TICKS AND CROSSES** C : H : O = 58.80/12 : 9.87/1 : 31.33/16 4.90 : 9.87 : 1.96 2.5 : 5.04 : 1 5 : 10 : 2 Alternative method: carbon: (102 × 58.80/100)/12 = 5 hydrogen: (102 × 9.87/100)/1 = 10 oxygen: (102 × 31.33/100)/16 = 2 **ALLOW** C=O peak labelled on spectrum **IGNORE** reference to C–O peak **NOTE** each peak can be identified from: • its δ value • a range *e.g.* 'the peak between 1.3–1.4' • its relative peak area • its splitting • labelling on spectrum

Question			Answer	Marks	Guidance
			Structure Correct structure:  ✓✓ Allow one mark for  ✓		**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **DO NOT ALLOW ECF** from incorrect molecular formula
			Total	**8**	