Questions

Q1.

Carbonyl compounds, such as propanone, react with 2,4-dinitrophenylhydrazine in solution (Brady's reagent) to form a precipitate which can be used to identify the compound.

The precipitate can be purified by recrystallisation.

Details of the recrystallisation process are shown.

Step **1** Dissolve the precipitate in the minimum volume of hot ethanol.

Step **2** Warm a filter paper and funnel in an oven for use in Step **3**.

Step **3** Filter the solution whilst still warm to remove any undissolved solids, using gravity filtration.

Step **4** Allow the filtrate to cool and recrystallise.

Step **5** Filter the crystals under reduced pressure.

Step **6** Rinse the crystals with a small amount of ice-cold ethanol.

Step **7** Dry the crystals between filter papers and leave in a desiccator.

(i) Explain why the filter paper and funnel are warmed in an oven before Step **3**.

(2)

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Explain how Steps **4** and **5** remove impurities from the crystalline product.

(2)

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(iii) State how the purified crystals can be used to identify the carbonyl compound that reacts with 2,4-dinitrophenylhydrazine.

Detailed descriptions of practical procedures are not required.

(2)

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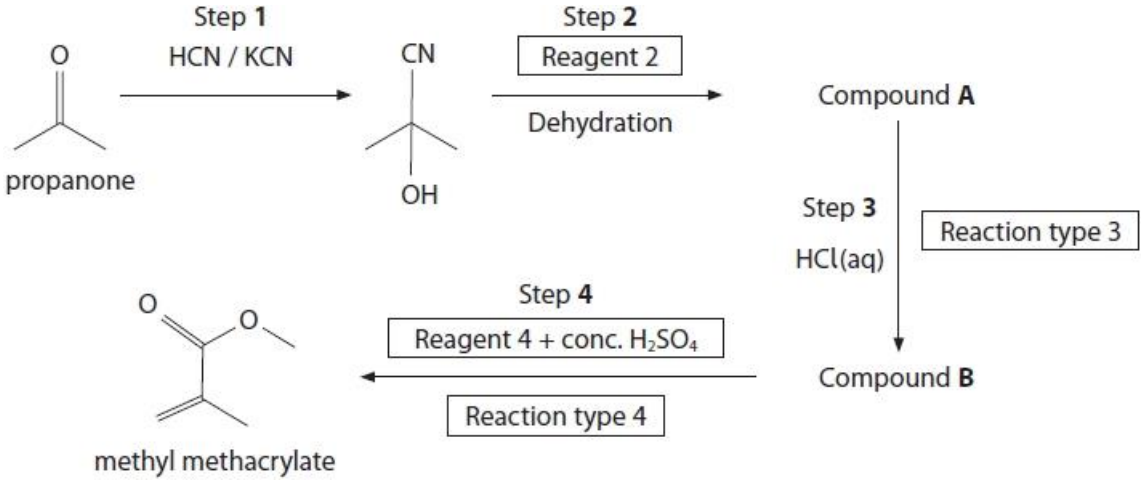
(Total for question = 6 marks)

Q2.

This question is about some reactions of carbonyl compounds.

Methyl methacrylate is the monomer used to make the polymer perspex. It can be synthesised from propanone using the reaction scheme shown.



(i) Draw the mechanism for the reaction in Step **1**.

Include curly arrows and any relevant lone pairs and dipoles.

(4)

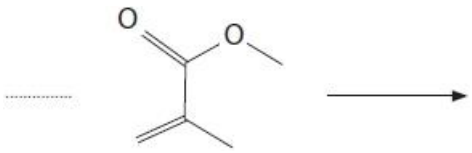
(ii) Complete the table to show the information missing from the reaction scheme.

(6)

Reagent 2	
Structure of compound **A**	
Reaction type 3	
Structure of compound **B**	
Reagent 4	
Reaction type 4	

(iii) Complete the equation for the formation of the polymer from methyl methacrylate.

(2)



(Total for question = 12 marks)

Q3.

Some organic compounds contain metals.

Grignard reagents contain a metal.

Discuss how Grignard reagents are formed and used in adding one or more carbon atoms to the carbon chain in 1-bromopropane to produce primary, secondary and tertiary alcohols and a carboxylic acid.

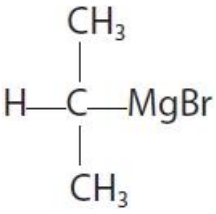
Include a suitable example for each reaction and give reagents, conditions and products. You may include equations in your answer.

(Total for question = 6 marks)

Q4.

Grignard reagents are used in organic synthesis as a way of increasing the length of the carbon chain in a molecule.

(a) The structure of the Grignard reagent formed by the reaction between 2-bromopropane and magnesium is



On the diagram, draw the permanent dipole involving the central carbon atom.

(1)

(b) The Grignard reagent in part (a) reacts with propanal.

(i) Draw the **fully displayed** formula of the final organic product of this reaction.

(1)

(ii) Name the organic product in (b)(i).

(1)

.....

(c) Identify, by using ticks, **two** boxes in the table to select appropriate terms that describe a Grignard reagent.

(2)

acid	
electrophile	
nucleophile	
oxidising agent	
reducing agent	

(d) The solvent used for Grignard reagents has to be completely **dry**.

By considering the dipole on the O—H bonds in water, predict the identity of the organic product that forms if water is added to the Grignard compound in part (a).

(1)

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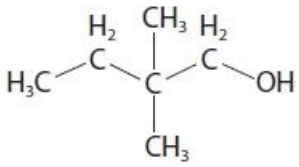
(Total for question = 6 marks)

Q5.

The alcohol 2,2-dimethylbutan-1-ol has the structure



Devise a reaction scheme for a synthesis of this alcohol starting from 2-bromo-2-methylbutane.
Include in your answer all reagents and conditions and the structures of any intermediate compounds.

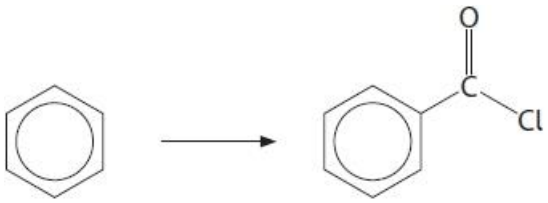
(6)

(Total for question = 6 marks)

Q6.

This question is about the synthesis of organic compounds.

Devise a four-step synthesis, involving the use of a Grignard reagent, to convert benzene into benzoyl chloride.



Include the reagents and conditions for each step in the synthesis and the structures of the intermediates.

(7)

(Total for question = 7 marks)

Q7.

Organic compounds containing nitrogen include amides, amines, amino acids and nitriles.

Propylamine, $CH_3CH_2CH_2NH_2$, may be formed from either a nitrile or a halogenoalkane.

(i) Give the reagent and essential condition for the formation of propylamine from a nitrile.

Include an equation for the reaction.

(2)

.....

(ii) Give the reagent and essential conditions for the formation of propylamine from a halogenoalkane.

Include an equation for the reaction.

(3)

.....

.....

(Total for question = 5 marks)

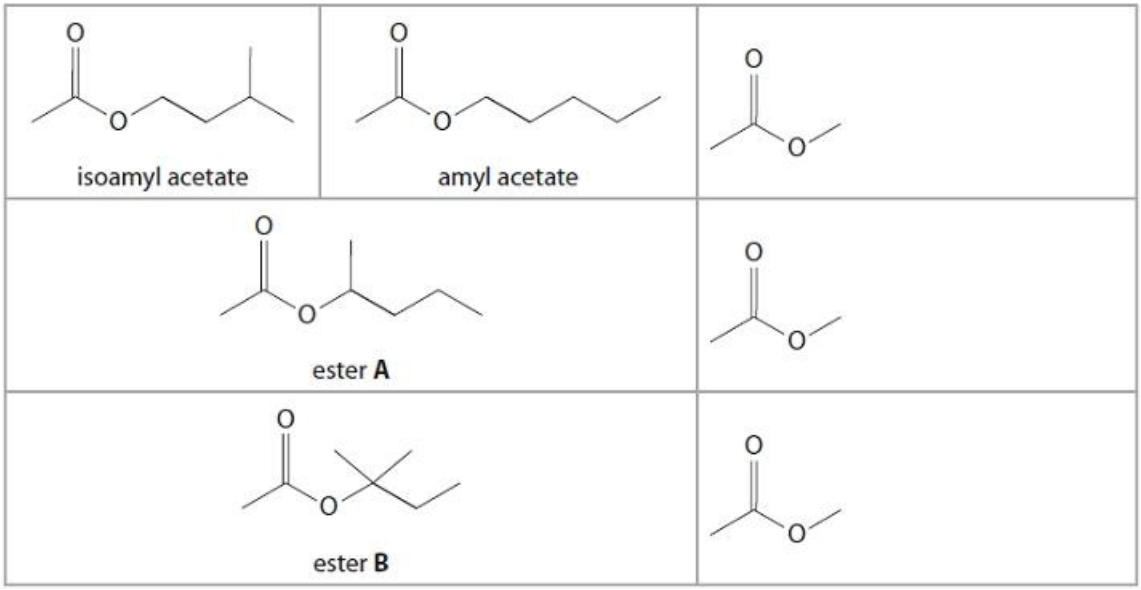
Q8.

Esters have many uses due to their characteristic aromas and often have common names. For example, isoamyl acetate is referred to as banana oil and amyl acetate has a scent similar to apples.

The carboxylic acid used to make isoamyl acetate and amyl acetate can also be used to make six further ester isomers. The structures of two of these esters, **A** and **B**, are shown.

(i) Complete the **skeletal** formulae of **three** of the remaining esters. Names are **not** required.

(3)



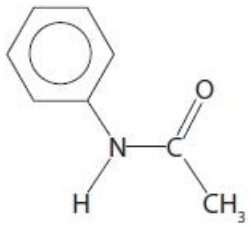
(ii) Write an equation to show the formation of ester **A** from an acyl chloride and an alcohol.

(2)

(Total for question = 5 marks)

Q9.

Antifebrin was the trade name for N-phenylethanamide which was used as a painkiller until paracetamol was discovered.



Antifebrin

Some of the following reagents can be used to produce Antifebrin from benzene.

- Aluminium chloride
- Ammonia, concentrated
- Benzene
- Ethanal
- Ethanoic acid
- Ethanol
- Ethanoyl chloride
- Hydrochloric acid, concentrated
- Hydrochloric acid, dilute
- Iron
- Nitric acid, concentrated
- Nitric acid, dilute
- Propanone
- Sodium chloride
- Sulfuric acid, concentrated
- Tin

Selecting from only these reagents, devise a **three-step** synthetic pathway to convert benzene into Antifebrin. You should include the structures of the two intermediate compounds and the reaction conditions.

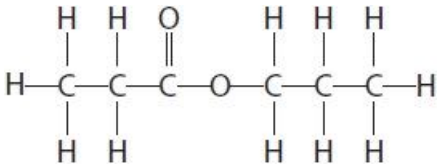
(5)

(Total for question = 5 marks)

Q10.

This question is about esters with the molecular formula $C_6H_{12}O_2$.

Propyl propanoate has the structure shown.



Devise a synthetic pathway to prepare propyl propanoate starting with 1-bromopropane as the **only** organic compound.

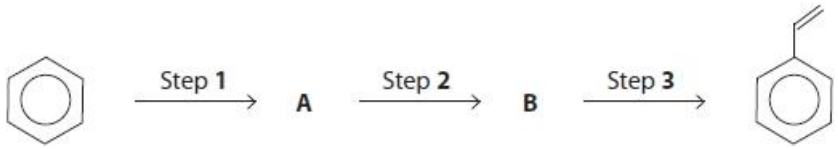
Include the reagents for each step in the synthesis, and the names or structures of the intermediate compounds.

(5)

(Total for question = 5 marks)

Q11.

Phenylethene, commonly known as styrene, is an important substance in the production of polystyrene which is used for some types of plastic packaging. Phenylethene can be made from benzene in a three-step synthesis.



Some of the following compounds can be used to make phenylethene from benzene.

Aluminium chloride	Chloroethane	Ethanal	Ethanol
Ethanoic acid	Ethanoyl chloride	Ethene	Ether
Hydrochloric acid, concentrated	Lithium tetrahydridoaluminate(III)	Phosphoric acid, concentrated	Sulfuric acid, concentrated

Selecting **only** from these compounds, devise a synthetic pathway for converting benzene into phenylethene, clearly identifying compounds **A** and **B** and stating the appropriate conditions for each step.

(5)

(Total for question = 5 marks)

Q12.

This question is about lactic acid (2-hydroxypropanoic acid), $CH_3CH(OH)COOH$.
Lactic acid is used to make biodegradable polymers.

Lactic acid can be made in a two-step synthesis starting from ethanal, CH_3CHO.

Devise a reaction scheme for a two-step synthesis.

Include in your answer all reagents and conditions, the type of reaction occurring at each step, and a balanced equation for each reaction.
State symbols are **not** required.

(7)

(Total for question = 7 marks)

Mark Scheme

Q1.

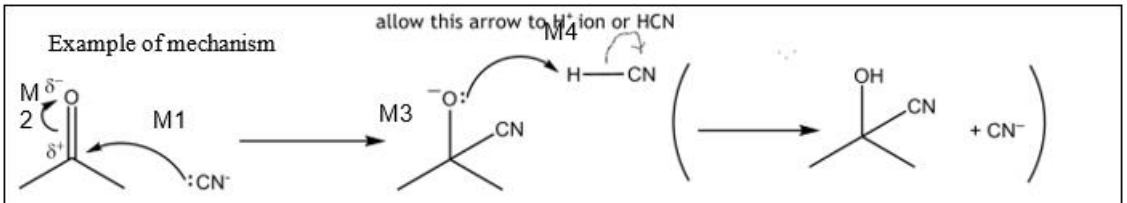
Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to any **two** of the following points: • to make sure the solution doesn't cool down (significantly) **(1)** • to prevent (premature) crystallization taking place (in funnel / on filter paper) **(1)** • which would reduce yield (of product) **(1)**	Ignore general references to removing impurities Allow crystals / solid / precipitate forming for crystallisation Allow to keep the solution warm Accept to prevent crystals forming during filtration Allow to make sure the substance stays in solution	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to any two of the following points: • Step 4: product less soluble in cooler solvent (than hot solvent, so product crystallises out) **(1)** • Step 4 : (soluble) impurities present (in small amount so) stay in solution / remain dissolved (while product crystallises) **(1)** • Step 5: filtering under reduced pressure removes more of the soluble impurities / removes the soluble impurities faster / produces a drier product **(1)**	Allow crystals / solid / precipitate for product Allow product is insoluble in cold solvent Allow filtration removes the solution containing the impurities / separates the crystals from the soluble impurities Allow filtering under reduced pressure is faster (than gravity filtration) Ignore just 'use a Buchner funnel'	**(2)**

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following points: • (measure) melting temperature (of purified crystals) **(1)** • compare to literature value (matched to original carbonyl compound) **(1)**	Allow compare to data book value / compare to value from (credible) internet source / compare to known melting temperature / compare to values in a database	**(2)**

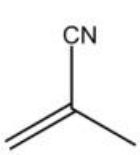
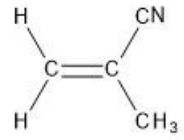
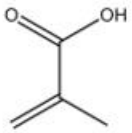
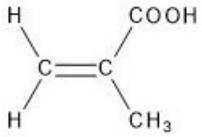
Q2.

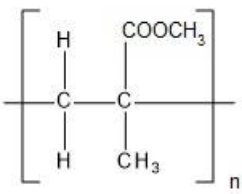
Question Number	Answer	Additional Guidance	Mark
(i)	• curly arrow from lone pair on C of CN^- ion to C of C=O **(1)** • dipole on C=O **and** curly arrow from C=O bond to or just beyond O **(1)** • intermediate structure **(1)** • curly arrow from lone pair on O to H of HCN **and** curly arrow from H-C bond to anywhere on CN **(1)**	Penalise omission of lone pair once in M1 and M4 Penalise use of single-headed arrows only once Penalise use of incorrect nucleophile once only in M1 e.g. OH^- Allow skeletal, displayed or structural formulae Allow CN^- to attack from any angle Allow CN triple bond displayed Do not award curly arrow from lone pair on N Do not award $CN^{\delta-}$ Ignore missing lone pair on O Ignore connectivity for vertical CN group if M1 awarded Do not award O^{n-} Allow curly arrow from lone pair on O^- to H^+ Ignore dipole on HCN Ignore products, even if incorrect	**(4)**



Allow straight arrows
Curly arrows in M1 and M4 must start from, or close to, at least 1 of the electrons in the lone pair, but penalise this once only
If candidate shows dipole on C=O and curly arrow first, allow M2 but if CN− then attacks C+, do not allow M1. M3 can score for the correct intermediate and M4 as per MS

uestion umber	Answer	Additional Guidance	Mark
(ii)	[redacted]	Ignore connectivity of groups All marks are stand alone Allow 'alumina' Do not award steam / water Do not award dilute for either acid Allow structural, displayed or any combination of structural, displayed or skeletal for Compounds **A** and **B** Do not award hydration / halogenation for M3 Allow TE for M4 based on incorrect M2 structure provided the nitrile group has been hydrolysed correctly and no other changes Allow additionelimination for condensation in M6	**(6)**

Reagent 2	(conc) phosphoric acid / H_3PO_4 (conc) sulfuric acid/ H_2SO_4 aluminium oxide / Al_2O_3 (1)
Structure of compound **A**	 (1) 
Reaction type 3	(acid) Hydrolysis (1)
Structure of compound **B**	 (1) 
Reagent 4	CH_3OH / methanol **(1)**
Reaction type 4	Esterification / condensation **(1)**

Question Number	Answer	Additional Guidance	Mark
(iii)	correct • repeat unit shown • **(1)** equation balanced **(1)**	 Allow displayed or structural formulae or a combination of these e.g.  Do not award 2 as the balancing number	**(2)**

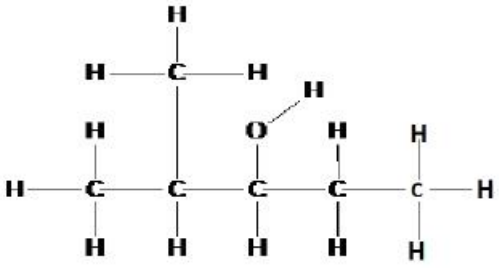
Q3.

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td></td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table><tr><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></tr><tr><td>6</td><td>4</td></tr><tr><td>5–4</td><td>3</td></tr><tr><td>3–2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table>The following table shows how the marks should be awarded for structure and lines of reasoning.</td><td>Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</td><td>(6)</td></tr>
<tr><td></td><td><table><tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr></table></td><td>In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.</td><td></td></tr>
</table>

	Indicative content • **IP1 - Reagents and conditions** magnesium **and** dry ether / dry ethoxyethane / dry $(CH_3CH_2)_2O$ • **IP2 - Hydrolysis of product** add dilute (hydrochloric) acid / $H^+(aq)$ /HCl(aq) (to hydrolyse the intermediate / protonate ...O–) • **IP3 – Primary alcohol** react with methanal to form butan-1-ol / $CH_3CH_2CH_2CH_2OH$ • **IP4 – Secondary alcohol** react with ethanal to form pentan-2-ol / $CH_3CH_2CH_2CH(OH)CH_3$ • **IP5 – Tertiary alcohol** react with propanone to form 2-methylpentan-2-ol / $CH_3CH_2CH_2C(CH_3)(OH)CH_3$ • **IP6 – Carboxylic acid** react with carbon dioxide to form butanoic acid / $CH_3CH_2CH_2COOH$	This may be shown as part of any specific reaction. Ignore errors in an equation to make the Grignard. This only needs to be mentioned once Do not award this point if acid is clearly added at the same time as magnesium / dry ether / a reactant Allow other specific aldehydes with corresponding product Allow other specific ketones with corresponding product	

Q4.

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)	C atom of C–Mg bond labelled as δ– **and** Mg labelled as δ+	Do not award full + or – charge Ignore δ- on Br	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)(i)		Ignore other structures Allow non-displayed formula	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)(ii)	• 2-methylpentan-3-ol	Allow 2-methyl-3-pentanol No TE on incorrect formula from 5(b)(i)	(1)

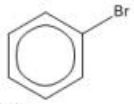
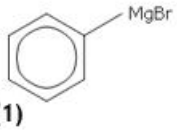
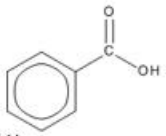
Question Number	Acceptable Answers	Additional Guidance	Mark
(c)	• ✓ next to nucleophile **(1)** • ✓ next to reducing agent **(1)**	If more than two boxes ticked scores (0)	(2)

Question Number	Acceptable Answers	Additional Guidance	Mark
(d)	• propane / C_3H_8	Accept name or formula or structural / skeletal / displayed formula Ignore additional inorganic products Do not award just 'alkane' If name and formula given then they both must be correct	(1)

Q5.

Question Number	Answer	Additional Guidance	Mark
	• 2-bromo-2-methylbutane reacts with Mg (1) • Dry ether (1) • $CH_3CH_2C(MgBr)(CH_3)CH_3$ (1) • react Grignard reagent with HCHO (1) • $CH_3CH_2C(CH_3)_2CH_2OMgBr$ (1) • (hydrolyse) with (dilute) acid (1) OR • 2-bromo-2-methylbutane reacts with KCN (1) • ethanol (as solvent) (1) • $CH_3CH_2C(CN)(CH_3)CH_3$ (1) • nitrile (hydrolysed) with (dilute) acid (1) • $CH_3CH_2C(COOH)(CH_3)CH_3$ (1) • carboxylic acid (reduced) with $LiAlH_4$ (in dry ether) (1)	Note – award of reagent or solvent marks must be in context of attempt to carry out an appropriate reaction e.g. use of **ethanolic** KCN to react with a ketone would not score OR M2 do not award HCOH Allow with water / H^+ Ignore HCN Allow methanol Allow H^+	(6)

Q6.

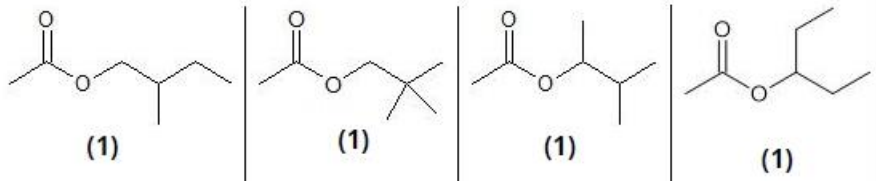
Question Number	Answer	Additional Guidance	Mark
	Step 1 • bromine **and** iron / iron(III) bromide **or** chlorine and aluminium chloride **(1)** •  **(1)** **Step 2** • magnesium **and** dry ether **(1)** •  **(1)** **Step 3** • carbon dioxide followed by a dilute acid **(1)** •  **(1)** **Step 4** • phosphorus(V) chloride / phosphorus pentachloride **(1)**	Allow names or formulae for reagents but if both are given, both must be correct Allow these drawn as a reaction scheme with reagents and conditions on arrows and intermediates in unbalanced equations The marks for the intermediate structures are stand-alone Allow carbon dioxide and dilute acid Ignore just carbon dioxide and water	**(7)**

Q7.

Allow annotated equations to score these marks in both (i) and (ii) **Allow any unambiguous formulae for the organic molecules in both (i) and (ii) such as C_2H_5CN for CH_3CH_2CN**			
Question Number	**Answer**	**Additional Guidance**	**Mark**
(i)	A description which includes • equation **(1)** • $LiAlH_4$ in (dry) ether (followed by dilute acid) or H_2 with Ni / Pt / Pd **(1)**	Example of equation $CH_3CH_2CN + 4[H] \rightarrow CH_3CH_2CH_2NH_2$ $CH_3CH_2CN + 2H_2 \rightarrow CH_3CH_2CH_2NH_2$ Allow names or formulae but both must be correct if given together Allow Lithal Allow hydrogen to be given in the equation or written over the arrow Ignore references to heat or a temperature	**(2)**

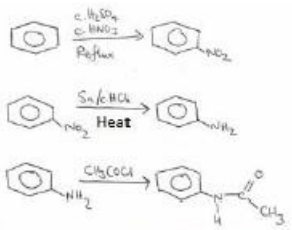
Question Number	**Answer**	**Additional Guidance**	**Mark**
(ii)	A description which includes • equation from any halogenoalkane **(1)** • ethanolic/alcoholic ammonia **(1)** • heat **and** under pressure **(1)**	Example of equation $CH_3CH_2CH_2Br + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HBr$ or $CH_3CH_2CH_2Br + 2NH_3 \rightarrow CH_3CH_2CH_2NH_2 + NH_4Br$ Allow use of state symbol (alc)/(EtOH)/(eth) with NH_3 Allow ammonia to be given in equation or written over the arrow Accept heat **and** in a sealed tube Ignore mechanisms If a contradictory chemical is stated then penalise once against M2 or M3	**(3)**

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	Any three of the following four structures  (1) (1) (1) (1)	Accept formulae in any order Award (2) if 3 correct displayed/structural formulae given Award (1) if 2 correct displayed/structural formulae given	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An equation that has • ethanoyl chloride **(1)** • alcohol **and** ester+ HCl product **(1)**	Example of equation  Allow structural, displayed formulae in any combination Ignore connectivity to OH except horizontal Ignore state symbols even if incorrect If molecular formulae used then allow (1) for correct equation Allow (1) for a correct equation to form ester A from ethanoic acid e.g. $CH_3COOH + CH_3CH(OH)CH_2CH_2CH_3 \rightleftharpoons CH_3COOCH(CH_3)\,CH_2CH_2CH_3 + H_2O$	(2)

Q9.

Question Number	Answer	Additional Guidance	Mark
		Example of synthetic pathway  The compounds used can be stated or given within equations. Ignore any unbalanced, incorrect equations or reaction mechanisms	**(5)**
	A synthetic pathway that consists of:		
	• (reagents and conditions for the nitration of benzene) conc. Nitric (HNO_3) and sulfuric acids (H_2SO_4) **and** 55°C/heat/reflux **(1)**	Allow any single value or range between 50-60°C/warm/ <55 °C	
	• structure of nitrobenzene **(1)**	Intermediate marks are standalone	
	• (reduction of nitrobenzene) tin and conc. hydrochloric acid and heat/reflux **(1)**	Allow iron & c.HCl Do not award dilute Ignore subsequent addition of NaOH Penalise lack of heat once only in M1 and M3	
	• structure of phenylamine **(1)**	Penalise just the names of intermediates once only	
	• (reaction of phenylamine with) ethanoyl chloride **(1)**	Ignore heat Do not award use of $AlCl_3$	

Q10.

Question Number	Acceptable Answers	Additional Guidance	Mark
	A synthetic pathway that includes:	Allow names or formulae for reagents but if both are given, both must be correct Allow correct species in unbalanced equations Allow any combination of structural, displayed or skeletal formulae for the intermediates Penalise missing H once only Ignore conditions e.g. heat / reflux	**(5)**
	Conversion to alcohol • (aqueous ethanolic) potassium / sodium hydroxide **(1)**	Allow hydroxide ions / OH^- Ignore concentration Do not award just ethanol / ethanolic	
	• name or structure of propan-1-ol **(1)**	Stand alone mark e.g. $CH_3CH_2CH_2OH$ Allow propanol if correct structure shown somewhere	
	EITHER ROUTE 1 **Conversion to carboxylic acid** • (oxidise some of the propan-1-ol using) potassium dichromate((VI)) **and** (dilute) sulfuric acid **(1)**	Allow acidified potassium dichromate((VI)) / $Cr_2O_7^{2-}$ **and** H^+ Allow acidified manganate((VII)) Ignore concentration of acid / formation of aldehyde Do not award hydrochloric acid / HCl	
	• name or structure of propanoic acid **(1)**	Stand alone mark e.g. CH_3CH_2COOH	
	Formation of ester • react propan-1-ol and propanoic acid together **and** using (concentrated) sulfuric acid (catalyst) **(1)** **PTO for ROUTE 2**	Stand alone mark for C_3 compounds Allow (concentrated hydrochloric) acid / H^+ / H_3O^+ instead of sulfuric acid Ignore concentration of acid Ignore incorrect structure of ester e.g. with H or O missing	

	OR ROUTE 2 **Conversion to acyl chloride** • (oxidise some of the propan-1-ol using) potassium dichromate((VI)) **and** (dilute) sulfuric acid **and** add phosphorus(V) chloride to propanoic acid **(1)** • name or structure of propanoyl chloride **(1)** **Formation of ester** • react propan-1-ol and propanoyl chloride together **(1)**	Allow acidified potassium dichromate((VI)) / $Cr_2O_7^{2-}$ **and** H^+ Allow acidified manganate((VII)) Ignore concentration of acid / formation of aldehyde Do not award hydrochloric acid / HCl Stand alone mark e.g. CH_3CH_2COCl Stand alone mark for C_3 compounds Ignore incorrect structure of ester e.g. with H or O missing	

Q11.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following: synthetic pathway that consists of: (Step 1) • (acylation of benzene) using ethanoyl chloride **(1)** • use of aluminium chloride (and heat) **(1)** (Step 2) • (reduction of) **A** with $LiAlH_4$ in ether (dry) **(1)** (Step 3) • (dehydration of) **B** with (conc.) phosphoric acid/H_3PO_4 **(1)** (Intermediates) • identification of **A** as phenylethanone and **B** as (1-)phenylethanol	The compounds used can be stated or given within equations. Only award if part of a Friedel-Crafts reaction Only award if given to reduce an aromatic carbonyl or carboxylic acid Allow (conc.) sulfuric acid/ H_2SO_4 Only award if given to dehydrate an aromatic alcohol Accept formulae for names, but if both given, then both must be correct This also applies to reagents	**(5)**

	 **(1)**	Do not award use of other reagents not in the table.	

Q12.

Question Number	Acceptable Answers	Additional Guidance	Mark
	An answer that makes reference to the following points: (1st Step)	Ignore references to other conditions / solvent in step 1	**(7)**
	• HCN (and KCN) **(1)**	Allow HCN and CN^- / H^+ and CN^- / H^+ and KCN **or** KCN and H_2SO_4 / KCN and HCl **or** HCN at pH 8 – 9 M1 can be scored for the appearance of HCN in M3	
	• Nucleophilic addition **(1)**	Do not award additional incorrect reaction types e.g. nitrification Allow skeletal formulae in equations	
	• $CH_3CHO + HCN \rightarrow CH_3CH(OH)CN$ **(1)**	M4, 5 & 6 dependent on the formation of any nitrile in step 1	
	(2nd Step)		
	• Any identified (dilute) strong acid / H^+ **(1)**	Allow sodium hydroxide followed by acid Do not award conc. acid / just "acidify" / just "acid"	
	• Heat (under reflux) / reflux **(1)**	Allow warm	
	• Hydrolysis **(1)**	Do not award additional incorrect reaction types	
	• $CH_3CH(OH)CN + 2H_2O + H^+ \rightarrow CH_3CH(OH)COOH + NH_4^+$ **or** $CH_3CH(OH)CN + 2H_2O \rightarrow CH_3CH(OH)COOH + NH_3$ **(1)**	Allow two equations involving NaOH and H^+ Allow $CH_3CH(OH)CN + 2H_2O + HCl \rightarrow CH_3CH(OH)COOH + NH_4Cl$	