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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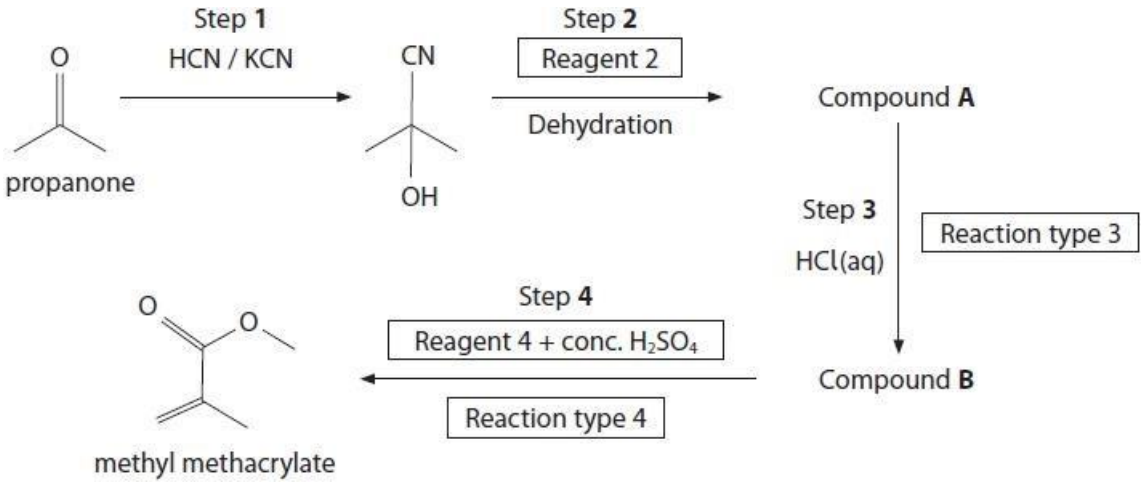
(Total for question = 6 marks)

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)

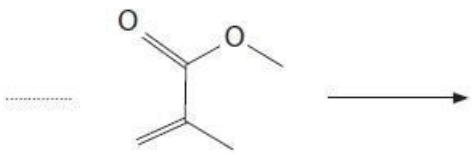
(ii) Complete the table to show the information missing from the reaction scheme.

(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.

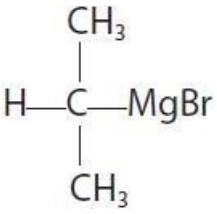
Include a suitable example for each reaction and give reagents, conditions and products. You may include equations in your answer.

(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)

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(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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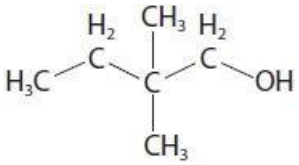
(Total for question = 6 marks)

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.

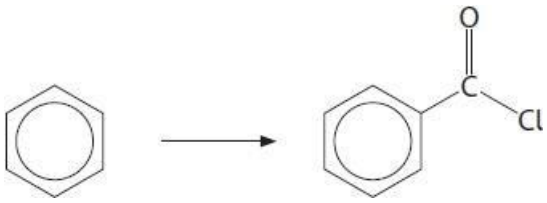
(6)

(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)

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

Include an equation for the reaction.

(3)

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(Total for question = 5 marks)

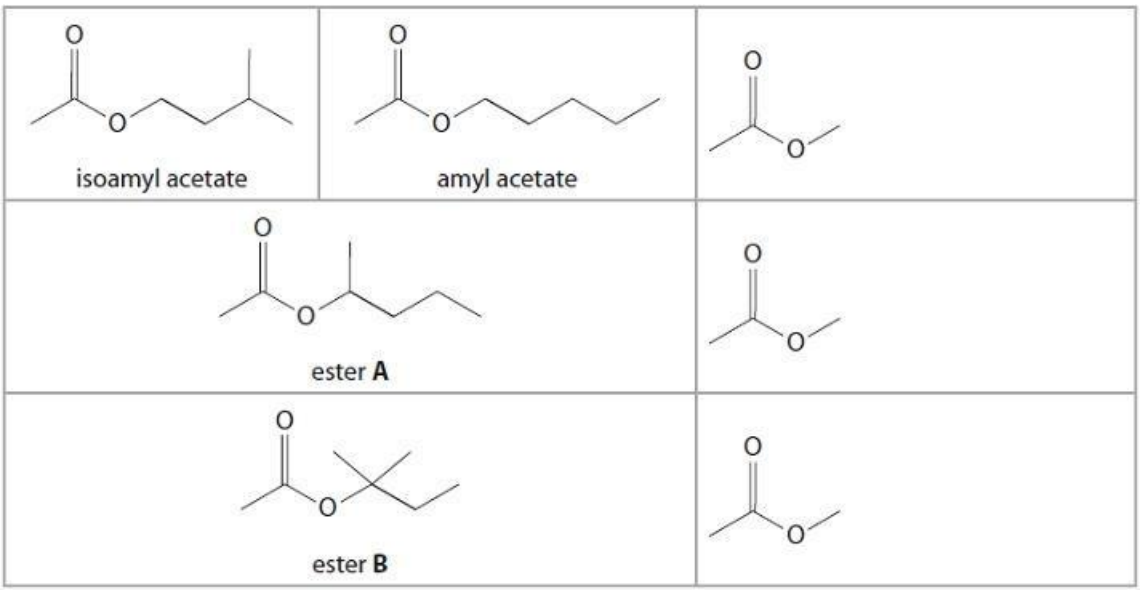
Q8.

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)



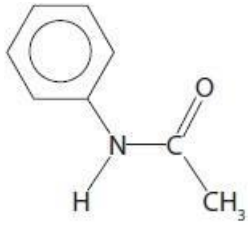
(ii) Write an equation to show the formation of ester **A** from an acyl chloride and an alcohol.

(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.

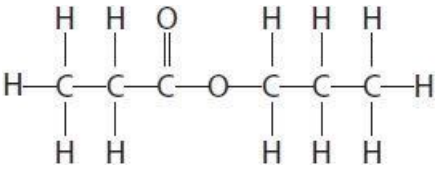
(5)

(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.

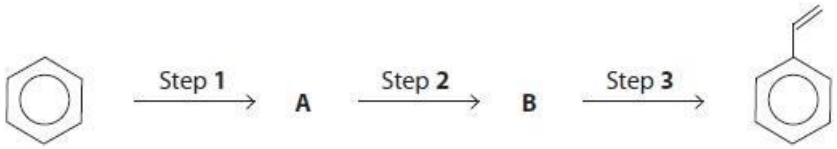
Include the reagents for each step in the synthesis, and the names or structures of the intermediate compounds.

(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)