20.2 Synthetic Routes

Question Paper

Course	DP IB Chemistry
Section	20. Organic Chemistry (HL only)
Topic	20.2 Synthetic Routes
Difficulty	Medium

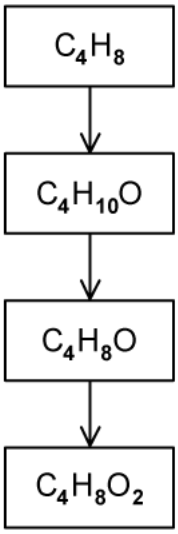
Time allowed: 60

Score: /50

Percentage: /100

Question 1a

a)
An organic reaction sequence is shown below.



State the IUPAC names of the four substances in the sequence.

[4 marks]

Question 1b

b)
Classify the reactions in (a) and give the names of the reagents in each step.

[6 marks]

Question 1c

c)
Give the reaction conditions for step 3 in (a)

[1 mark]

Question 1d

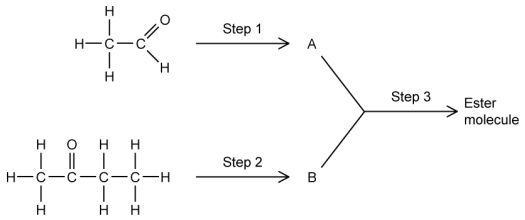
d)
Draw a displayed formula of an isomer of $C_4H_{10}O$ that gives two signals in an ^1H NMR spectrum.

[1 mark]

Question 2a

a)
The following reaction pathway is used to produce Compounds **A** and **B**, which when reacted together, form a branched ester molecule, Compound **C**.

Suggest suitable reagents and conditions for the synthesis of Compound **A** via Step 1 and give the name for this type of reaction.



[3 marks]

Question 2b

b)
In order for the ester to be produced, the ketone in part (a) must be converted to another compound, **B**.

i)
Name and draw the structure of the molecule that is produced from Step 2.

ii)
Give the name of the type of reaction that is involved in Step 2 and suggest suitable reagents and conditions for the process.

[4 marks]

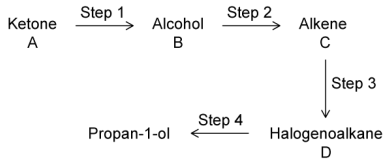
Question 2c

c)
Outline how ethanol can be synthesised from ethane in two steps. State the reaction conditions and reagents and name the type of reaction taking place.

[6 marks]

Question 2d

d)
The four step synthesis to form propan-1-ol from a ketone is outlined below.



i)
Give the names of four possible substances **A** to **D**

ii)
Give the reagents and conditions for Step 4.

[3 marks]

Question 3a

a)
Propanal is a versatile organic building block used in the synthesis of plastics and rubber chemicals.

Propanal can be produced from propanoic acid in the following two-step reaction.

State the reaction type, including suitable reagents, for Steps 1 and 2.

[2 marks]

Question 3b

b)
Suggest why it is not possible to convert propanoic acid directly to propanal using the reagent you identified for Step 1 in (a).

[1 mark]

Question 3c

c)
Explain why Step 2, in (a), is completed by distillation.

[1 mark]

Question 3d

d)
Identify, explain your reasoning, which of the three organic compounds, from the reaction scheme in (a), would be distilled first.

[2 marks]

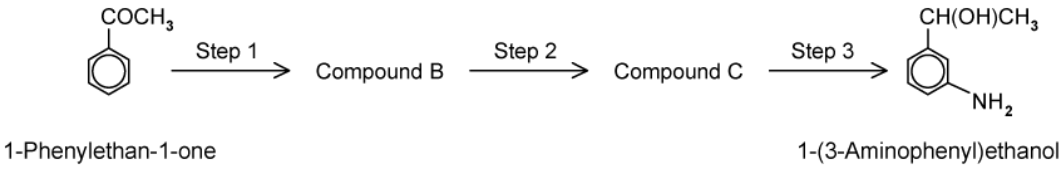
Question 4a

a)
State **four** factors that should be considered when designing a reaction scheme for the synthesis of a target molecule in industry.

[3 marks]

Question 4b

b)
1-(3-Aminophenyl)ethanol can be synthesised according to the following three-step reaction scheme.



Step 1 involves a reaction at position 3 of the benzene ring of 1-phenylethan-1-one.

State the reaction type, including suitable reagents, for Step 1.

[2 marks]

Question 4c

c)
State a suitable reagent for Step 2, in (b).

[1 mark]

Question 4d

d)
In Step 3 of the reaction scheme from (b), compound **C** is heated with hydrochloric acid in the presence of a tin catalyst to form the final product, 1-(3-aminophenyl)ethanol.

Explain why Step 3 is a reduction reaction.

[2 marks]

Question 5a

a)
Suggest a reaction scheme, using displayed formulae, that could be used to prepare a sample of propyl propanoate.

Conditions and reagents are not required.

[2 marks]

Question 5b

b)
One of the intermediates in the reaction scheme, from (a), has a molecular mass of 74.09 g mol^{-1}.

i)
State suitable reagents and conditions required to form this intermediate.

ii)
Describe how you could test that this intermediate has been formed.

[2 marks]

Question 5c

c)
Propanal and the intermediate (M_r = 74.09) in the reaction scheme, from (a), are to be separated by distillation.

Explain which chemical will distil first.

[2 marks]

Question 5d

d)
One of the intermediates in the reaction scheme, from (a), has a molecular mass of 60.09 g mol^{-1}.

i)
State suitable reagents and conditions required to form this intermediate.

ii)
Using Section 26 of the Data Booklet, describe how you could prove that this intermediate has been formed **without** reversing the reaction.

[2 marks]