20.2 Synthetic Routes

Question Paper

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

Time allowed: 50

Score: /40

Percentage: /100

Question 1a

a)
A student is asked to prepare a sample of propyl propanoate using propanal.

Suggest a reaction scheme, using displayed formulae, that the student could use to prepare their sample of propyl propanoate.

Conditions and reagents are not required.

[2]

[2 marks]

Question 1b

b)
Use your answer from part (a) to help answer this question.

One of the intermediates in the reaction scheme, from part (a), has a molecular mass of 74.0 g mol^{-1}.

Give the reagents and conditions required to form this intermediate.

[1]

[1 mark]

Question 1c

c)
Propanal and the other intermediate (M_r = 60.0) in the reaction scheme, from part (a), are to be separated by distillation.

Explain which chemical will distil first.

[2]

[2 marks]

Question 1d

d)
Use your answer from part (a) to help answer this question.
Consider the intermediate in the reaction scheme, from part(a), which has a molecular mass of 60.0 g mol^{-1}.

i)
Give the reagents and conditions required to form this intermediate.

[3]

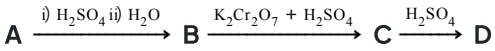
ii)
Describe how you could prove that this intermediate has been formed **without** reversing the reaction using section 26 of the data booklet.

[1]

[4 marks]

Question 2a

a)
The following three step synthesis route was carried out:



Reactant **A** is a hydrocarbon containing 85.71% carbon and shows 4 peaks in a ^{1}H NMR spectrum. Deduce the identity of A.

[2]

[2 marks]

Question 2b

b)
Intermediate **B** shows a fragment at m/z 43 in the mass spectrum and has a molecular ion at m/z 74.

Deduce the identity of **B**, giving a reason.

[2]

[2 marks]

Question 2c

c)
The question is about intermediate **C** in the synthesis.

i)
Suggest an identity for intermediate **C**.

[1]

ii)
State the reaction conditions for the conversion of **B** to **C**.

[1]

[2 marks]

Question 2d

d)
Deduce the identify of the reaction product, **D**, and give one piece of spectral data that would support your answer.

[2]

[2 marks]

Question 3a

a)
Benzene and cyclohexene are two hydrocarbons that are able to react with bromine. State the type of reactions in each case.

[2]

[2 marks]

Question 3b

b)
Benzene can be converted into nitrobenzene in a one step reaction. State the names of the reagents needed for the reaction and the formula of the electrophile in the reaction.

[2]

[2 marks]

Question 3c

c)
Outline the mechanism of the reaction between benzene and the electrophile in part c)

[4]

[4 marks]

Question 3d

d)
Aniline is useful precursor for making synthetic dyes. It can be made from nitrobenzene in a two step synthesis. Give the reagents and conditions for the reaction.

[3]

[3 marks]

Question 4a

a)
For the reaction profile outlined in the reaction profile below, state the mechanism or type of reaction for steps 1 and 2.

$$\text{Propane} \xrightarrow{\text{Step 1}} \text{1-bromopropane} \xrightarrow{\text{Step 2}} \text{Compound X} \xrightarrow{\text{Step 3}} \text{Propanal}$$

Step 1 .....

Step 2 .....

[2]

[2 marks]

Question 4b

b)
Outline the mechanism for step 2.

[3]

[3 marks]

Question 4c

c)
Compound **X** can be oxidised by the reaction with acidified potassium dichromate to give propanal. Compound **X** will oxidise to propanoic acid if allowed to fully oxidise. Explain how full oxidation can be prevented.

[3]

[3 marks]

Question 4d

d)
State the following for step 1.

Reagents and conditions .....

Mechanism .....

[4]

[4 marks]