

1. Nov/2023/Paper_9701/21/No.4(c, d)

(c) **C** and **D** both react with HBr.

(i) **C** reacts with HBr to form **E**.

Complete the diagram in Fig. 4.2 to show the mechanism for this reaction.

Draw the structure of the organic intermediate.

Include charges, dipoles, lone pairs of electrons and curly arrows, as appropriate.



Fig. 4.2

[3]

(ii) **D** reacts with HBr to produce **F**, a chiral bromoalkane.

Draw the structure of **F**.



[1]

(iii) Explain why the reaction of HBr with **C** and **D** produces different major products.



Fig. 4.3

.....
.....
.....
..... [2]

(d) **C** can be used to form **H**.

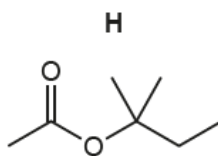


Fig. 4.4

One possible synthesis of **H** is shown in Fig. 4.5. Different portions of **C** are used in reactions 1 and 3. Some of the products are then combined to produce **H**.

Fig. 4.5 does not show any of the inorganic products of the reactions.

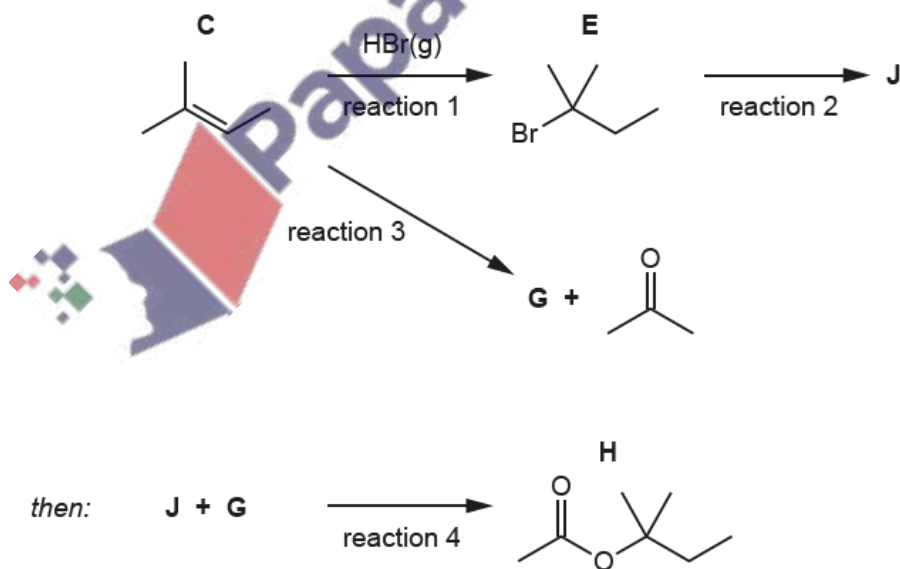



Fig. 4.5

Complete Table 4.1 with the reagents and conditions required for each of the reactions shown in Fig. 4.5.

Table 4.1

	reagent and conditions
reaction 1 $C \rightarrow E$	HBr(g)
reaction 2 $E \rightarrow J$	
reaction 3 $C \rightarrow G +$ 	
reaction 4 $J + G \rightarrow H$	

[3]

2. June/2023/Paper_9701/11/No.29

Which row describes the solvent used and type of reaction occurring when bromoethane reacts with NaOH to form ethene?

	solvent	type of reaction
A	ethanol	elimination
B	ethanol	substitution
C	water	elimination
D	water	substitution

3. June/2023/Paper_9701/11/No.31

Which statement describes what happens when 2-chloro-2-methylpropane is warmed with NaOH(aq)?

- A This secondary halogenoalkane reacts by a mixture of an S_N1 and an S_N2 mechanism.
- B This secondary halogenoalkane reacts only by an S_N2 mechanism.
- C This tertiary halogenoalkane reacts mostly by an S_N1 mechanism.
- D This tertiary halogenoalkane does **not** react with hydroxide ions under these conditions.

4. June/2023/Paper_9701/12/No.29

When bromoethane reacts with hot ethanolic sodium hydroxide a colourless gas is formed. This gas decolourises aqueous bromine.

What is the colourless gas?

- A 1,2-dibromoethane
- B ethanol
- C ethene
- D hydrogen bromide

5. June/2023/Paper_9701/12/No.30

Alkynes are hydrocarbons that contain one triple $C\equiv C$ bond.

Like alkenes, alkynes take part in addition reactions. A saturated compound can be formed.

For example, ethyne, $H-C\equiv C-H$, reacts with an excess of hydrogen to form ethane.

Propyne, C_3H_4 , undergoes an addition reaction with an excess of hydrogen bromide in two stages. Markovnikov's rule applies to the addition of HBr at each stage.

What is the main product obtained when propyne reacts with an excess of hydrogen bromide?

- A $CH_2BrCH_2CH_2Br$
- B $CH_3CH_2CHBr_2$
- C $CH_3CHBrCH_2Br$
- D $CH_3CBr_2CH_3$

6. June/2023/Paper_9701/12/No.31

Bromine reacts with alkenes by an electrophilic addition mechanism in which a cation is formed as an intermediate.

Which mixture will produce the most stable intermediate cation?

- A 3,3-dimethylpent-1-ene + bromine
- B ethene + bromine
- C methylpropene + bromine
- D propene + bromine

7. June/2023/Paper_9701/12/No.32

Halogenoalkanes react with hot ethanolic potassium cyanide.

The reaction mechanism is either S_N1 or S_N2 .

Which statement is correct?

- A All secondary halogenoalkanes react by the S_N2 mechanism only.
- B Both the halogenoalkane and the cyanide ion are involved in the initial step of the S_N1 mechanism.
- C Chloroethane reacts with cyanide ions by the S_N1 mechanism only.
- D The S_N2 mechanism involves a short-lived negatively charged transition state.

8. June/2023/Paper_9701/13/No.27

Structural isomerism and stereoisomerism should be considered when answering this question.

2-bromopentane is heated with an excess of ethanolic sodium hydroxide.

How many different hydrocarbons are produced?

- A 1 B 2 C 3 D 4

9. June/2023/Paper_9701/13/No.30

Which type of reaction happens during the hydrolysis of 2-bromopropane?

- A electrophilic addition
- B free radical substitution
- C nucleophilic addition
- D nucleophilic substitution

Chlorine is a very reactive element.

(d) Chlorine reacts with methane in a series of reactions to produce chloroalkanes.

(i) State the conditions required for chlorine to react with methane.

..... [1]

(ii) One of the products of the reaction is CH_2Cl_2 which reacts further to produce CHCl_3 .

Complete Table 3.2 to show details of the mechanism that forms CHCl_3 from CH_2Cl_2 .

Table 3.2

name of step	equation
initiation
propagation	$\text{CH}_2\text{Cl}_2 + \text{Cl}\cdot \rightarrow$
termination $\rightarrow \text{CHCl}_3$

[3]

(e) CHCl_3 and HF are used to form CHClF_2 in a substitution reaction.

Construct an equation for this reaction.

..... [1]

(f) X is a product of the substitution reaction that occurs when CHClF_2 reacts with Br_2 .

There is only one naturally occurring isotope of fluorine, ^{19}F .

The mass spectrum of X shows molecular ion peaks at $m/e = 164, 166$ and 168 .

Complete Table 3.3 to show all the molecular ions responsible for each peak.

Table 3.3

m/e	formulae of molecular ions
164	
166	
168	$(\text{CF}_2^{37}\text{Cl}^{81}\text{Br})^+$

[2]

Fig. 3.1 describes a sequence of reactions that can be used to produce a food additive, compound **Y**, from $\text{CH}_3\text{CH}_2\text{Cl}$.

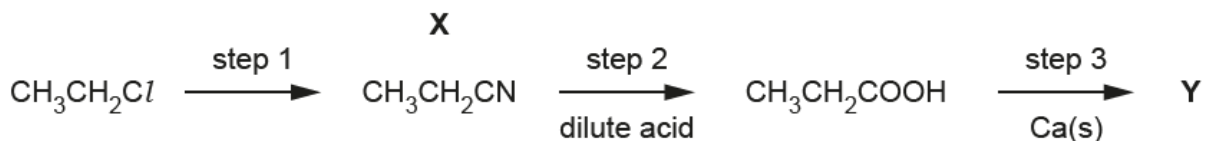


Fig. 3.1

(a) (i) State the reagent and conditions for step 1 in Fig. 3.1.

..... [1]

(ii) Give the systematic name of **X**.

..... [1]

(iii) Identify the type of reaction that occurs when dilute acid is added to **X** in step 2.

..... [1]

(iv) In step 3, **Y** and a gas are produced.
Construct an equation for step 3.

..... [2]

(b) $\text{CH}_3\text{CH}_2\text{COOH}$ can also be formed from propan-1-ol and potassium dichromate(VI).
State the conditions required.

..... [1]

(c) Complete Table 3.1 to show the number of sigma bonds (σ) and pi bonds (π) present in a molecule of **X**.

Table 3.1

type of bond	number of bonds in X
sigma (σ)	
pi (π)	

[2]

[Total: 8]

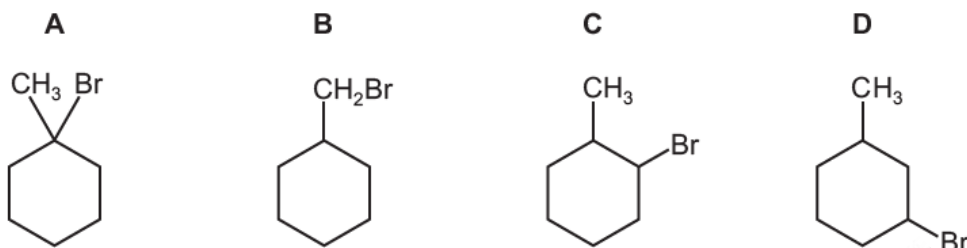
12. March/2023/Paper_9701/12/No.27

Compound X, $C_7H_{13}Br$, reacts with hot alcoholic NaOH to produce two compounds, Y and Z.

On reaction with Br_2 , Y gives a product, $C_7H_{12}Br_2$, which exists as a mixture of four optical isomers.

On reaction with Br_2 , Z gives a product, $C_7H_{12}Br_2$, which is non-chiral.

What could X be?



13. March/2023/Paper_9701/12/No.31

Which compound reacts most rapidly with aqueous silver nitrate by an S_N1 mechanism?

- A 1-chloromethylpropane
- B 2-chloromethylpropane
- C 1-iodomethylpropane
- D 2-iodomethylpropane

Fig. 4.1 shows some reactions of compound **D**, 2-bromobutane.

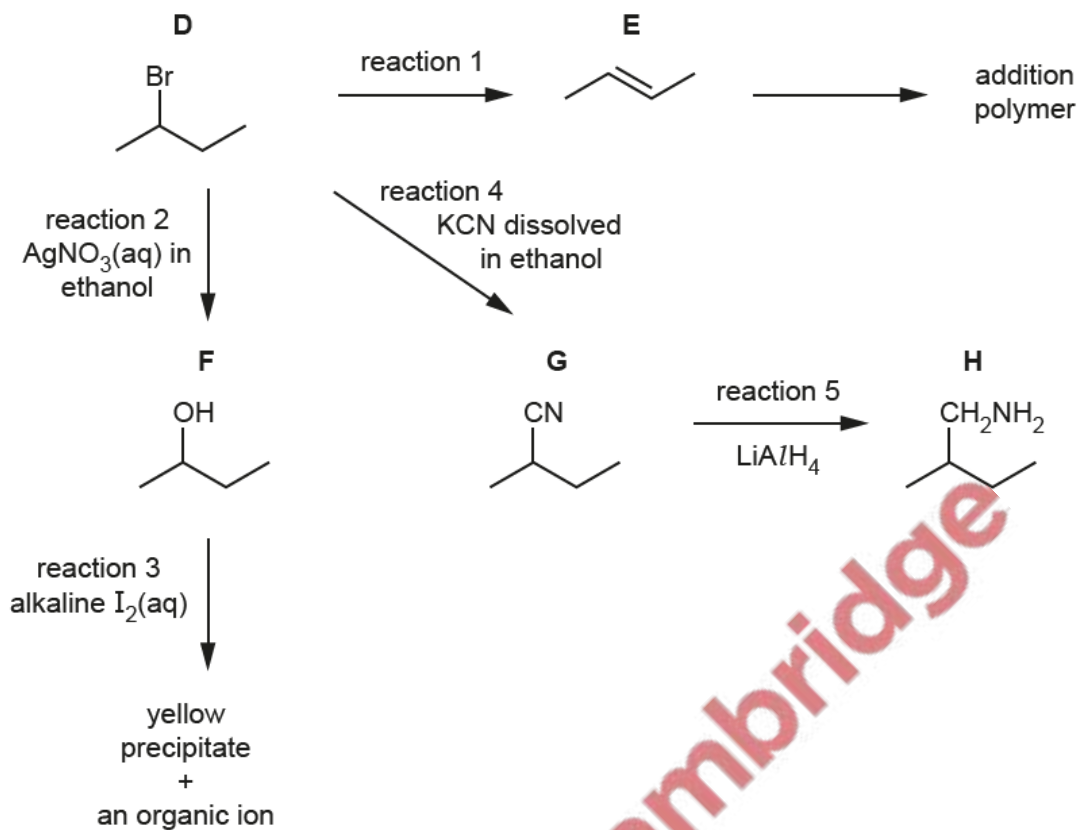
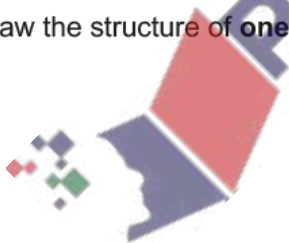


Fig. 4.1

- (a) (i) State the reagent and conditions used to form **E** in reaction 1.

..... [1]

- (ii) Draw the structure of one repeat unit of the addition polymer that forms from **E**.



[1]

- (iii) **E** also forms when **F** is heated strongly in the presence of an Al₂O₃ catalyst.

Write an equation for this reaction.

..... [1]

(b) (i) Predict what is observed in reaction 2.

..... [1]

(ii) Identify the yellow precipitate and the organic ion formed in reaction 3.

yellow precipitate

organic ion [2]

(c) (i) State the type of reaction that occurs in reaction 4.

..... [1]

(ii) Reaction 5 is similar to the reaction of LiAlH_4 with carboxylic acids to form alcohols.

Suggest the role of LiAlH_4 in reaction 5.

..... [1]

