14. Hydrocarbons

14.2 Alkenes

Paper 2

Question Paper

1 Bromoalkanes are used widely in industry, although there is increasing concern about their environmental impact.

(a) Complete Fig. 4.2 to show the mechanism for the formation of 1,2-dibromoethane in reaction 1.

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

Fig. 4.2

[3]

2 **(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.

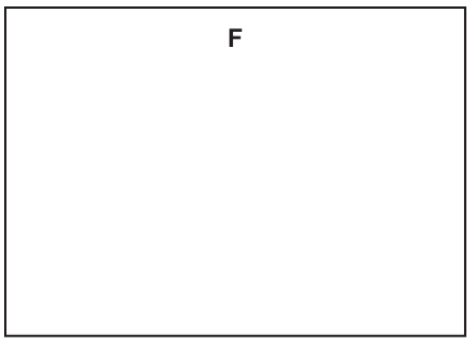
Include charges, dipoles, lone pairs of electrons and curly arrows, as appropriate.

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]

3 Lactic acid, $CH_3CH(OH)COOH$, and pyruvic acid, $CH_3COCOOH$, both contain two functional groups.

(b) Two possible syntheses of pyruvic acid are shown in Fig. 4.3 and Fig. 4.4.

Each synthesis has a total of three steps.

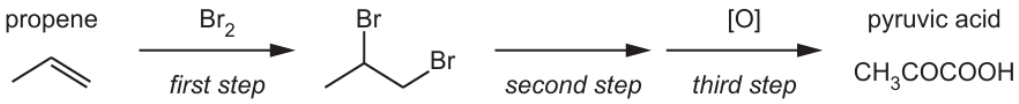


Fig. 4.3

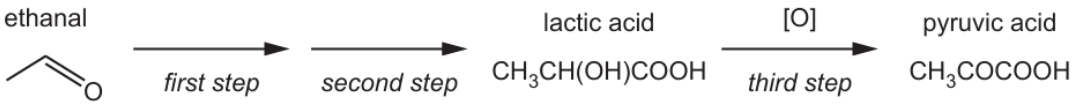


Fig. 4.4

(i) Complete the diagram in Fig. 4.5 to show the mechanism for the reaction of propene with Br_2.

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

Fig. 4.5

[3]

4 Liquids that contain molecules of **T** smell like lemons.

T

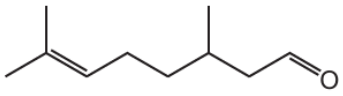


Fig. 3.1

(b) Two organic products are produced when a sample of **T** is heated under reflux with excess acidified concentrated $KMnO_4$.

Draw the structure of the two organic products, from this reaction, in the boxes.

organic product 1

organic product 2

[2]

5 **Z** is a molecule which contains the elements carbon, hydrogen and oxygen only.

Z contains only alkene and carboxyl functional groups.

(a) Complete Table 6.1 by describing the observations that occur when two different reagents are added to separate samples of **Z**(aq).

Table 6.1

reagent added to **Z**(aq)	observation
Br_2(aq)	
Na_2CO_3(s)	

[2]

6 Propene, C_3H_6, reacts with H_2O in the presence of an acid catalyst to form an alcohol with molecular formula C_3H_8O.

(a) Name this type of reaction.

..... [1]

(b) Name the catalyst used and state the conditions needed for this reaction to occur.

catalyst .....

conditions .....

[2]

(d) The reaction of propene, C_3H_6, with H_2O occurs in a two-step mechanism. In step 1 C_3H_6 reacts with the catalyst, H^+, to form a carbocation.

(i) Draw structures to identify the more stable and less stable carbocations which can form in step 1. Explain your answer.

more stable carbocation	**less** stable carbocation

explanation .....

.....

.....

.....

.....

[3]

(ii) Name the major organic product formed from the reaction of propene, C_3H_6, with H_2O.

..... [1]

7 **(b)** **W** is an alkene with formula C_4H_8. It reacts with HBr to form two possible carbocations, $CH_3C^+(H)(CH_2CH_3)$ and $H_2C^+CH_2CH_2CH_3$.

(i) Identify **W** as compound **A**, **B**, **C** or **D**.

..... [1]

(ii) Draw the skeletal formula of the major organic product formed when HBr reacts with **W**. Explain why this is the major organic product.

.....

.....

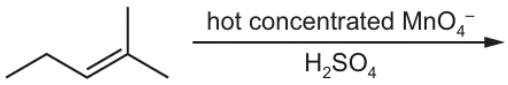
.....

[3]

8 Phosphorus is a reactive Period 3 element.

(d) Identify the organic products formed when compound **J**, shown below, is heated with hot concentrated acidified manganate(VII) ions.

J



[2]

9 Hydrogen iodide, HI, is a colourless gas at room temperature.

(g) HI(g) reacts with propene, $CH_3CH=CH_2(g)$ to form a mixture of 1-iodopropane and 2-iodopropane.

(i) Identify which of 1-iodopropane and 2-iodopropane is the major product of this reaction.

Explain your answer.

.....

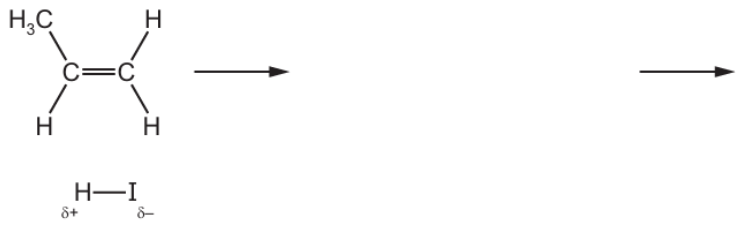
.....

.....

..... [2]

(ii) Complete the diagram to show the mechanism of the reaction between HI and $CH_3CH=CH_2$ that forms the major product identified in **(g)(i)**.

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



[3]

10 **(a)** Below is a list of species which can react with organic compounds.

CN^- HCl Cl H_2O CO_3^{2-}

(ii) From the list, identify **two** species which can attack the π bond in ethene.

..... [1]

11 **(d)** But-1-ene reacts with steam in the presence of concentrated phosphoric acid to form two isomers of molecular formula $C_4H_{10}O$.

Each reaction occurs via a different intermediate ion.

(i) Draw the structure of both intermediate ions.

[2]

(ii) Circle the more stable intermediate ion drawn in **(d)(i)**. Explain your answer.

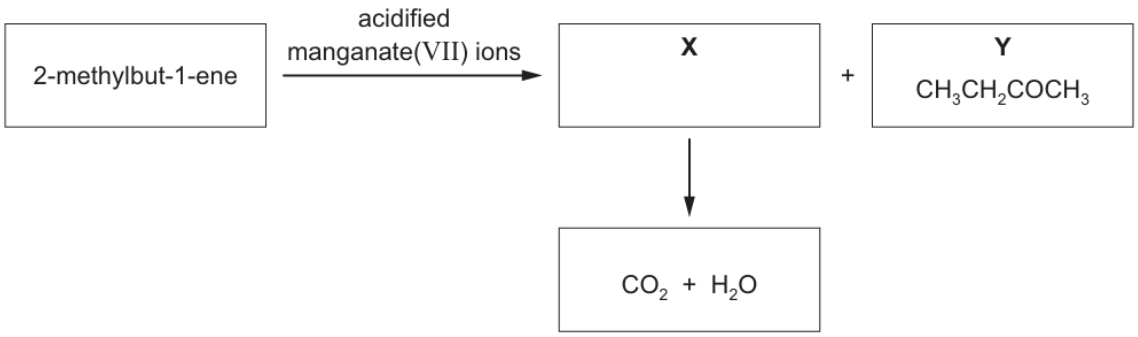
.....

.....

..... [2]

12 2-methylbut-1-ene reacts with acidified manganate(VII) ions, under specific conditions, to produce two organic compounds **X** and **Y**.

X immediately reacts with the acidified manganate(VII) ions to form carbon dioxide and water. **Y** has the structural formula $CH_3CH_2COCH_3$.



(b) (i) State the specific conditions required for the acidified manganate(VII) ions to react with 2-methylbut-1-ene in this way.

..... [1]

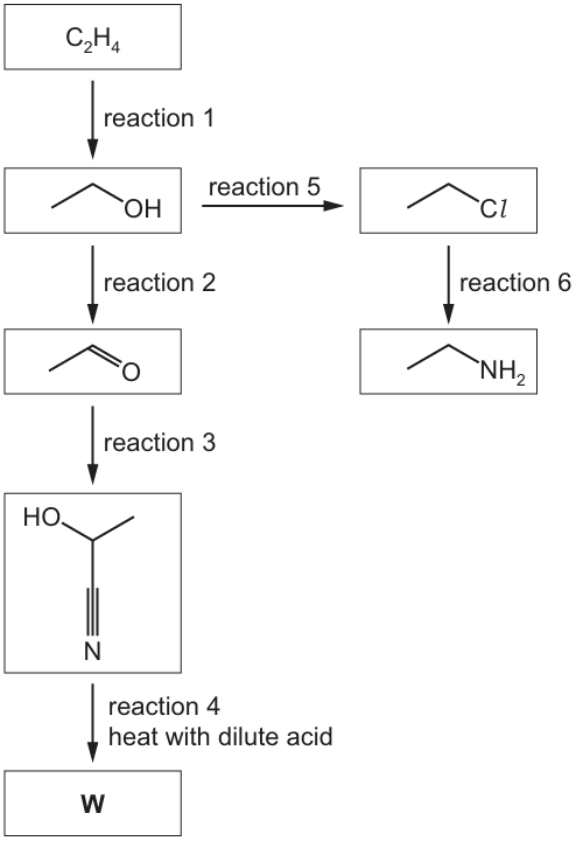
(ii) Name the type of reaction occurring to the functional group in 2-methylbut-1-ene in the reaction in **(b)(i)**.

..... [1]

(c) Draw the structural formula of **X**.

..... [1]

13 The reaction sequence shows how ethene, C_2H_4, can be converted into other organic molecules.

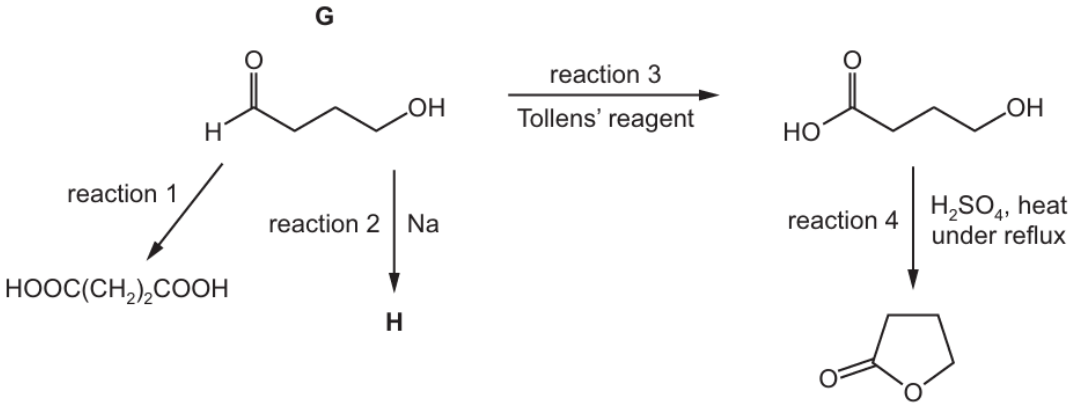


(a) Complete the table to give
- the name of the reaction mechanisms of reactions 1 and 6
- the reagents and conditions required for reactions 1, 2 and 6.

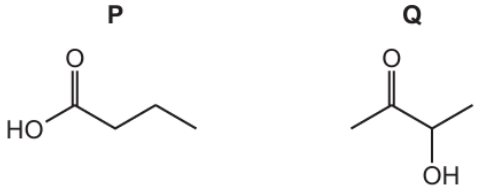
reaction	name of mechanism	**name** of reagents and conditions
1		
2		
6		

[6]

14 Some reactions of compound **G** are shown.



(c) **P** and **Q** have the same molecular formula as **G**.



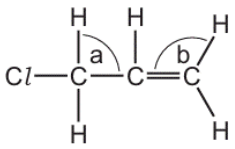
Complete the table with the expected observations for the reactions of **P** and **Q** with the named reagents.

reagent	result with **P**	result with **Q**
$Br_2(aq)$		
2,4-dinitrophenylhydrazine		
aqueous sodium carbonate		

[3]

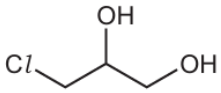
15 The structure of compound **Y** is shown.

Y



(c) When **Y** reacts with cold, dilute, acidified manganate(VII) ions, compound **Z** is produced.

Z



(i) State the molecular formula of **Z**.

..... [1]

(ii) Name the type of reaction occurring when **Y** is converted into **Z**.

..... [1]

(iii) Alcohols can be classified as primary, secondary or tertiary.

Identify with a tick (✓) the alcohol group(s) present in **Z**.

	alcohol group present in **Z**
primary	
secondary	
tertiary	

[1]