

# 13. An introduction to AS Level organic chemistry

13.4 Isomerism- structural isomerism and stereoisomerism

## Paper 2

Question Paper

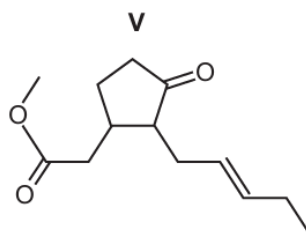
1  $\text{CH}_3(\text{CH}_2)_5\text{CHBrCH}_3$  exists as a pair of stereoisomers.

(a) Draw the three-dimensional structures of the **two** stereoisomers of  $\text{CH}_3(\text{CH}_2)_5\text{CHBrCH}_3$ .  
R can be used to represent  $\text{CH}_3(\text{CH}_2)_5$ .

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[2]

- 2 (a) **V** shows stereoisomerism.



**Fig. 6.1**

- (i) Explain what is meant by stereoisomerism.

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 .....  
 ..... [1]

- (ii) Deduce the number of stereoisomers of **V**. Explain your reasoning.

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

- (iii) Deduce the molecular formula of **V**.

..... [1]

- (iv) Name **all** the functional groups present in **V**.

.....  
 ..... [1]

- 3 (d)** Hydrated rhodium(III) chloride,  $\text{RhCl}_3 \cdot x\text{H}_2\text{O}$ , catalyses the conversion of ethene to but-2-ene.

Both stereoisomers of but-2-ene are formed in the reaction.

- (i) Hydrated rhodium(III) chloride contains 20.5% by mass of water of crystallisation.

Deduce the integer value of  $x$  in  $\text{RhCl}_3 \cdot x\text{H}_2\text{O}$ .

Show your working.

$x = \dots\dots\dots$   
[2]

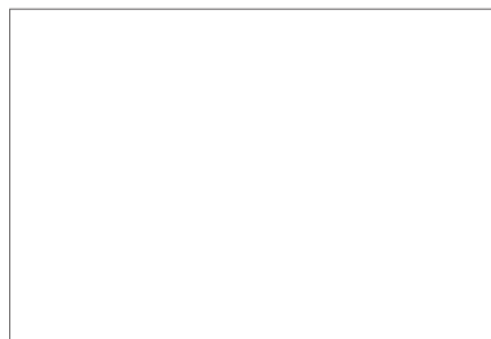
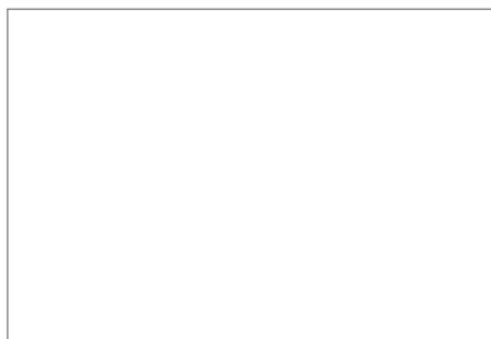
- (ii) Define stereoisomers.

.....  
..... [1]

- (iii) Explain how the conversion of ethene to but-2-ene can be described as an addition reaction.

.....  
..... [1]

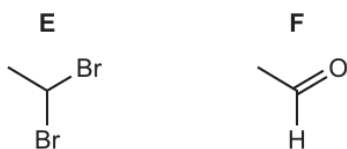
- (iv) Draw the two stereoisomers of but-2-ene.



[2]

(d) Compound **E** is the only isomer of 1,2-dibromoethane.

Alkaline hydrolysis of **E** gives compound **F**.



(i) Identify the type of isomerism shown by **E** and 1,2-dibromoethane.

..... [1]

4 (a) Describe structural isomerism.

.....  
..... [1]

- 5 (c) **C** is a structural isomer of **A** and **B**.

**C** is straight chained and has two functional groups.

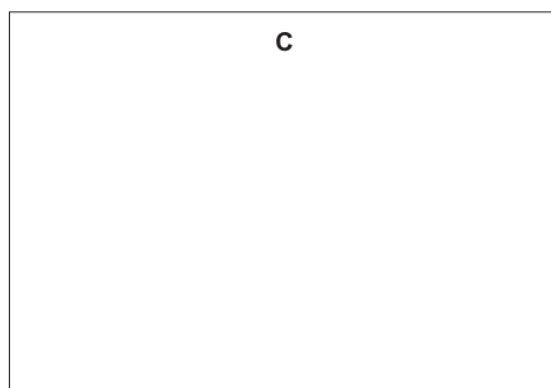
**C** shows only one type of stereoisomerism.

Table 5.2 describes observations when separate samples of **C** are added to different reagents.

**Table 5.2**

reagent	<b>C</b>
2,4-dinitrophenylhydrazine (2,4-DNPH reagent)	no reaction
Br <sub>2</sub> (aq)	orange to colourless
alkaline I <sub>2</sub> (aq)	yellow precipitate appears

- (i) Draw the structure of **C** in the box.



[2]

- (ii) Name the type of stereoisomerism shown by molecules of **C**.

..... [1]

- 6 Compounds **C** and **D** are alkenes with the same molecular formula,  $C_5H_{10}$ .



Fig. 4.1

- (a) (i) Give the systematic name of **D**.

..... [1]

- (ii) Explain why **C** and **D** do not show geometrical (*cis/trans*) isomerism.

.....  
 ..... [1]

- (iii) Draw the structure of a molecule that is a positional isomer of **C** and **D**.

[1]

- 7 Lactic acid,  $CH_3CH(OH)COOH$ , and pyruvic acid,  $CH_3COCO_2H$ , both contain two functional groups.

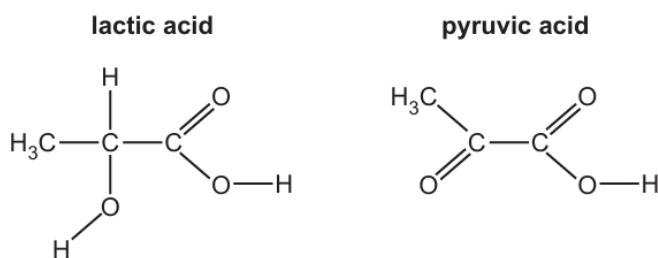
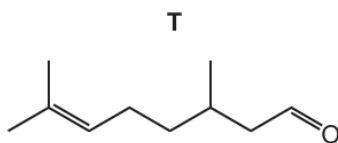


Fig. 4.1

- (a) (i) Explain why lactic acid exists as optical isomers.

.....  
 .....  
 ..... [1]

- 8 Liquids that contain molecules of **T** smell like lemons.



**Fig. 3.1**

- (a) Molecules of **T** exist as a pair of stereoisomers.

Name the type of stereoisomerism shown by molecules of **T**. Explain your answer.

.....

..... [2]

- 9 (a) Bromine reacts with butane in the presence of ultraviolet light to form bromobutane.

Two structural isomers with the molecular formula  $C_4H_9Br$  are produced during this reaction.

- (i) Draw the two structural isomers and state the systematic name of each isomer.

structural isomer 1

name .....

structural isomer 2

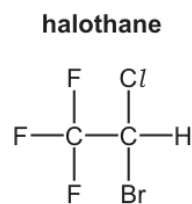
name .....

[2]

- (ii) Identify the type of structural isomerism shown in (a)(i).

..... [1]

- (b) Halothane is an anaesthetic.



**Fig. 4.1**

- (i) Identify the chiral centre in halothane and mark it with an asterisk (\*). [1]

When halothane reacts in ultraviolet light, homolytic fission occurs and the C–Br bond is broken.

- 10** Some of the common chlorides of Period 3 elements are shown in the list.



- (d) Sulfur,  $\text{S}_8$ , reacts with chlorine to form several different chlorides. The most common are  $\text{S}_2\text{Cl}_2$  and  $\text{SCl}_2$ .  $\text{SCl}_2$  forms when sulfur reacts with an excess of chlorine.

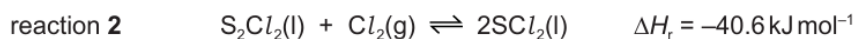
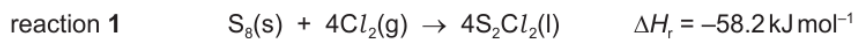
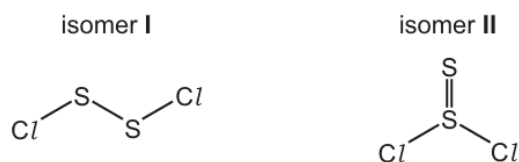


Fig. 3.1 shows the two structural isomers of  $\text{S}_2\text{Cl}_2$ .

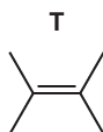


**Fig. 3.1**

- (iv) Define the term structural isomer.

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

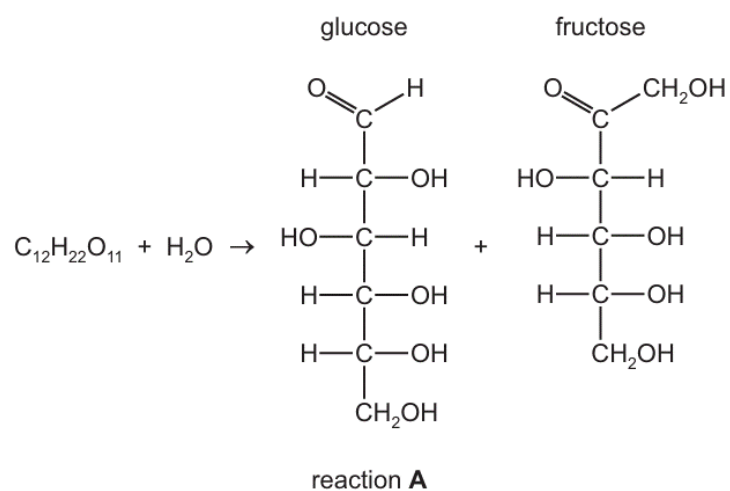
- 11** Compound **T** is an isomer of  $\text{C}_6\text{H}_{12}$ .



- (b) Draw the skeletal formula of a structural isomer of **T** that shows *cis-trans* (geometrical) isomerism.

[1]

**12** Sucrose,  $C_{12}H_{22}O_{11}$ , reacts with water to form glucose and fructose in reaction **A**.



(b) Explain in detail, why glucose and fructose are a pair of structural isomers. Your answer should refer specifically to these two molecules.

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..... [2]

**13** Ethanal reacts with a mixture of HCN and NaCN to make 2-hydroxypropanenitrile,  $\text{CH}_3\text{CH}(\text{OH})\text{CN}$ .

The reaction mechanism is nucleophilic addition.

**(b)**  $\text{CH}_3\text{CH}(\text{OH})\text{CN}$  exists as a pair of stereoisomers.

**(i)** Name the type of stereoisomerism shown by  $\text{CH}_3\text{CH}(\text{OH})\text{CN}$ .

..... [1]

**(ii)** Draw three-dimensional diagrams of this pair of stereoisomers.

Indicate with an asterisk (\*) the chiral centre on one of the structures drawn.

[3]

**(c)** Give the structure of the organic product of the reaction of  $\text{CH}_3\text{CH}(\text{OH})\text{CN}$  with dilute sulfuric acid.

..... [1]

**14** Methylpropane,  $(\text{CH}_3)_2\text{CHCH}_3$ , is an isomer of butane,  $\text{CH}_3(\text{CH}_2)_2\text{CH}_3$ .

**(a) (i)** Explain why methylpropane and butane are a pair of isomers.

.....

..... [2]

**(ii)** Identify the type of isomerism shown by methylpropane and butane.

..... [1]