

13. An introduction to AS Level organic chemistry

13.4 Isomerism- structural isomerism and stereoisomerism

Paper 1

Question Paper

- 5 Structural isomerism and stereoisomerism should be taken into account when answering this question.

The structure of 3-methylcyclobutene is shown.

3-methylcyclobutene



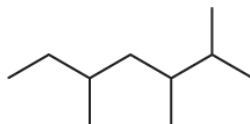
A mixture containing all stereoisomers of 3-methylcyclobutene is treated with HBr. This produces a mixture of isomeric bromomethylcyclobutanes.

How many stereoisomers does 3-methylcyclobutene have, and how many isomeric bromomethylcyclobutanes are present in the product mixture?

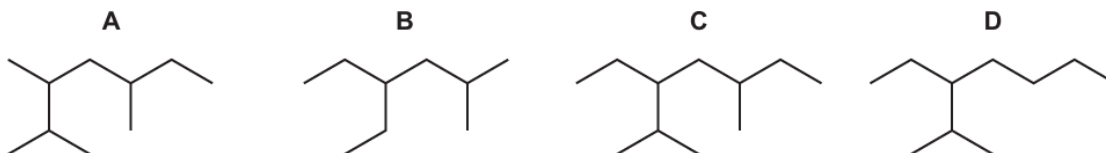
	3-methylcyclobutene	bromomethylcyclobutanes
A	2	4
B	2	6
C	4	4
D	4	8

- 6 Compound T has the skeletal formula shown.

compound T



Which structure is a structural isomer of compound T?

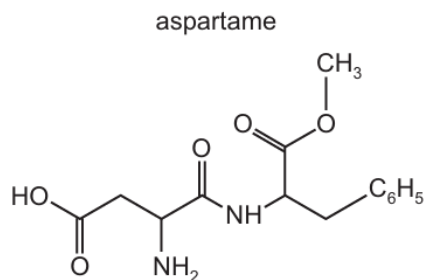


- 7 A sample of pent-2-en-4-ol, $C_5H_{10}O$, contains all the possible stereoisomers of this compound.

How many stereoisomers are there in the sample?

- A** 2 **B** 3 **C** 4 **D** 5

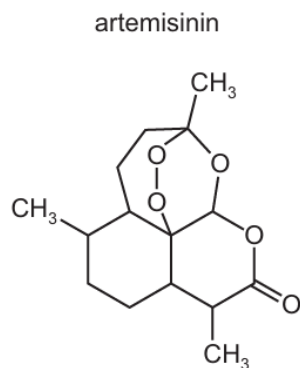
- 8 The compound *aspartame* is widely used as a sweetener in 'diet' soft drinks.



Aspartame is chiral. (There are no chiral carbon atoms in C_6H_5 .)

How many chiral carbon atoms are present in a molecule of *aspartame*?

- A 1 B 2 C 3 D 4
- 9 Artemisinin is a powerful anti-malarial drug.



How many chiral centres are there in each molecule of artemisinin?

- A 4 B 6 C 7 D 8
- 10 How many geometrical (cis/trans) isomers are there of hex-2,4-diene, $CH_3CH=CHCH=CHCH_3$?
- A none; hex-2,4-diene does **not** show geometric isomerism
- B 2
- C 3
- D 4

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

If a molecule contains two non-identical chiral carbon atoms, four optical isomers exist.

How many isomers are there with:

- molecular formula $C_7H_{14}O$ **and**
- a five-membered ring **and**
- a tertiary alcohol group?

A 4 **B** 5 **C** 9 **D** 13

12 Which reagent will react with pentan-3-ol to give a mixture of stereoisomers?

- A** acidified potassium dichromate
B concentrated sulfuric acid
C ethanoic acid in the presence of a little concentrated H_2SO_4
D hydrogen chloride

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

A set of isomeric hydrocarbons:

- all contain 14.3% by mass of hydrogen
- all react with bromine by addition, 0.280 g of each hydrocarbon reacting with 0.799 g of bromine.

What is the maximum number of isomeric compounds in the set?

A 1 **B** 3 **C** 4 **D** 5

14 The general formula for a non-cyclic alcohol is $C_nH_{2n+1}OH$.

How many different structural isomers are there for $n = 3$ and $n = 4$?

	$n = 3$	$n = 4$
A	2	2
B	2	4
C	3	4
D	3	8

15 Which pair of alcohols are isomers of each other?

- A butan-1-ol and 2,2-dimethylpropan-1-ol
 B butan-2-ol and 2-methylpropan-2-ol
 C pentan-1-ol and 2-methylpropan-2-ol
 D propan-2-ol and 2-methylpropan-2-ol

16 How many chiral carbon atoms are there in one molecule of 2,2,4,5-tetramethylhexan-3-ol?

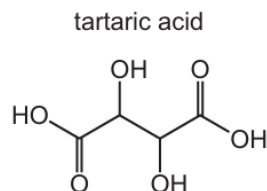
- A 1 B 2 C 3 D 4

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

How many isomeric compounds with molecular formula $C_5H_6O_4$ contain two $-CO_2H$ groups and one $C=C$ double bond?

- A 5 B 6 C 7 D 8

18 The structure of tartaric acid is shown.



Which statements about tartaric acid are correct?

- 1 A molecule of tartaric acid has more than one chiral centre.
- 2 The molecular formula of tartaric acid is $C_4H_4O_6$.
- 3 One molecule of tartaric acid produces four hydrogen ions in aqueous solution.

- A 1, 2 and 3 B 1 and 2 only C 2 and 3 only D 1 only

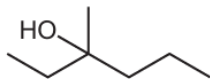
19 Which pair includes a hydrocarbon without a chiral centre?

- A $CH_3CH_2CH_2CH(CH_3)CH_2CH_3$ $CH_3CH(CH_3)CH(CH_3)CH_2CH_3$
 B $CH_3CH_2CH_2CH(CH_2CH_3)CH_3$ $CH_3CH_2CH_2CH(CH_3)CH_2CH_3$
 C $CH_3CH_2CH_2CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH(CH_3)_2$
 D $CH_3CH(CH_2CH_3)CH(CH_3)CH_3$ $CH_3CH(CH_3)CH_2CH(CH_3)_2$

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

3-methylhexan-3-ol reacts with hot concentrated sulfuric acid to form several isomeric compounds with the molecular formula C_7H_{14} .

3-methylhexan-3-ol



How many isomeric compounds could be formed in this reaction?

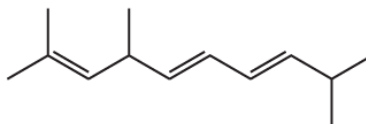
- A** 3 **B** 4 **C** 5 **D** 6
- 21** Which compound will react with $LiAlH_4$ to form two optical isomers?
- A** $CH_3CH_2COCH_3$
B $CH_3CH_2CH_2CHO$
C $CH_3CH_2COCH_2CH_3$
D $CH_3CH(CH_3)CH_2CO_2H$

- 22** Structural isomerism and stereoisomerism should be taken into account when answering this question.

How many isomeric alkenes with formula C_5H_8 are present in the mixture produced when 1,4-dibromopentane is reacted with NaOH in ethanol?

- A** 1 **B** 2 **C** 3 **D** 4

- 23** A skeletal formula is shown.

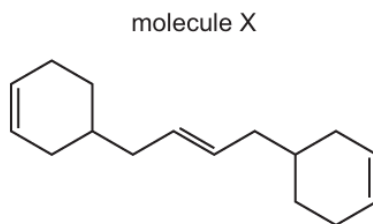


What is the total number of stereoisomers including the one shown?

- A** 4 **B** 6 **C** 8 **D** 16

- 24 Structural isomerism **only** should be considered when answering this question.

Molecule X contains three C=C double bonds. One mole of X is reacted with three moles of HBr. The carbon skeleton is unchanged.



How many different products are formed?

- A 3 B 4 C 6 D 8
- 25 Structural isomerism **and** stereoisomerism should be considered when answering this question.

A colourless liquid, $C_5H_{11}Cl$, exists as a mixture of two optical isomers.

When heated with sodium hydroxide in ethanol, a mixture of **only two** alkenes is formed.

What could the colourless liquid be?

- A $(CH_3CH_2)_2CHCl$
 B $CH_3CH_2CH_2CHClCH_3$
 C $CH_3CH_2CCl(CH_3)_2$
 D $(CH_3)_2CHCHClCH_3$
- 26 Structural and stereoisomerism should be taken into account when answering this question.

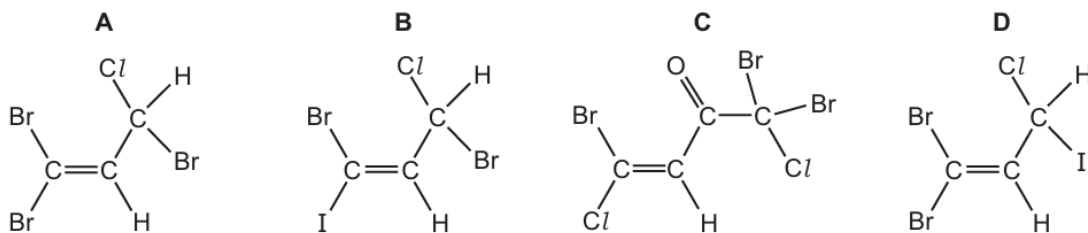
Y is a gaseous hydrocarbon which decolourises aqueous bromine. It contains no rings.

10.0 g of Y occupies a volume of 3.43 dm^3 under room conditions.

How many isomeric structures are possible for Y?

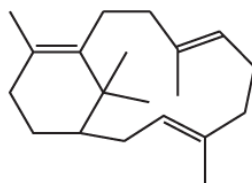
- A 4 B 5 C 6 D 7

27 Which compound could show **both** *cis-trans* isomerism and optical isomerism?



28 Compound P is treated with an excess of hydrogen gas in the presence of a nickel catalyst. The product Q is fully saturated.

compound P

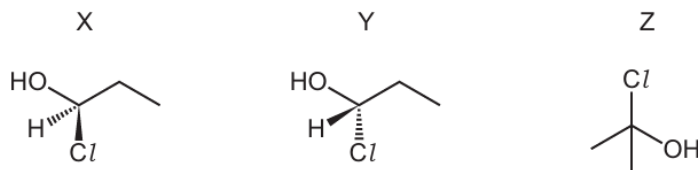


What is the number of chiral carbon atoms in the product Q?

- A** 4 **B** 5 **C** 6 **D** 7

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

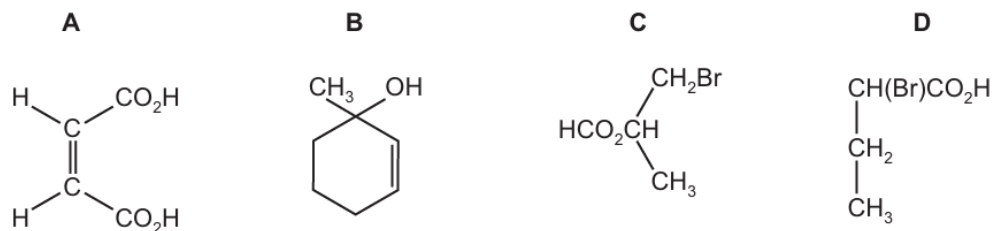
Compounds X, Y and Z are shown.



How many other isomers of C_3H_7ClO are there that are alcohols?

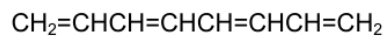
- A** 2 **B** 3 **C** 4 **D** 5

30 Which compound is chiral and reacts with Na_2CO_3 to give CO_2 ?



- 31** The unsaturated hydrocarbon octa-1,3,5,7-tetraene, C_8H_{10} , can display geometric isomerism.

octa-1,3,5,7-tetraene

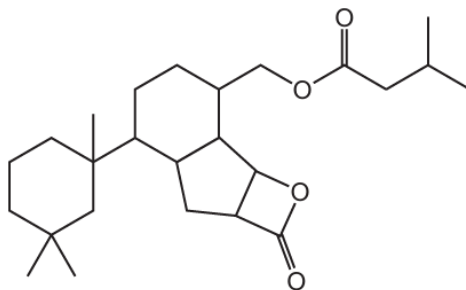


How many isomers exist?

- A** 2 **B** 3 **C** 4 **D** 8
- 32** Which statement is correct?
- A** 2,2-dimethylpropanoic acid is an isomer of propyl methanoate.
- B** 2-methylbutan-2-ol is an isomer of hexan-3-ol.
- C** 3-methylbutan-2-one is an isomer of pentanal.
- D** 3,3-dimethylbutan-2-one is an isomer of pentan-3-one.

- 33** The structure of compound Q is shown.

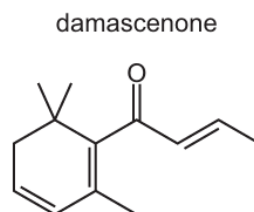
compound Q



How many chiral centres are present in a molecule of Q?

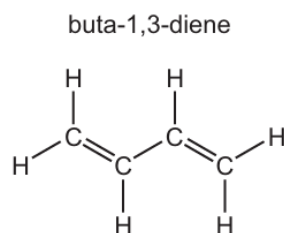
- A** 4 **B** 5 **C** 6 **D** 7

- 34 The structure of damascenone is shown.



Including damascenone, how many stereoisomers exist with this structural formula?

- A** 1 **B** 2 **C** 4 **D** 8
- 35 The diagram shows the structure of buta-1,3-diene.

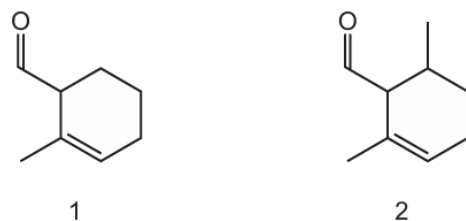


The addition reaction between buta-1,3-diene and two molecules of hydrogen bromide can produce three structurally isomeric products.

How many of these products have at least one chiral centre?

- A** 0 **B** 1 **C** 2 **D** 3
- 36 Structural isomerism and stereoisomerism should be considered when answering this question.
- How many isomers with the formula C_5H_{10} have structures that involve π bonding?
- A** 3 **B** 4 **C** 5 **D** 6

37 The diagrams show two different compounds.



What is

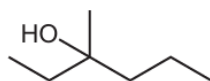
- the total number of structural isomers, including compound 2, that could be formed by adding a second methyl group to the ring of compound 1,
- the number of π electrons in each compound?

	number of isomers	number of π electrons
A	3	2
B	3	4
C	5	2
D	5	4

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

3-methylhexan-3-ol reacts with hot, concentrated sulfuric acid to form several isomeric compounds with the molecular formula C_7H_{14} .

3-methylhexan-3-ol



How many isomeric compounds could be formed in this reaction?

- A** 3 **B** 4 **C** 5 **D** 6

39 Which compound is chiral?

- A** 1-chloro-3-methylbutane
B 2-chloro-2-methylbutane
C 2-chloro-3-methylbutane
D 3-chloropentane

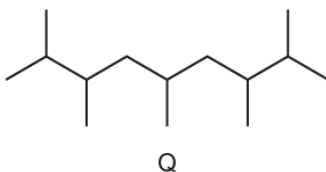
- 40 Compound X does **not** show cis-trans isomerism.

What could be the identity of compound X?

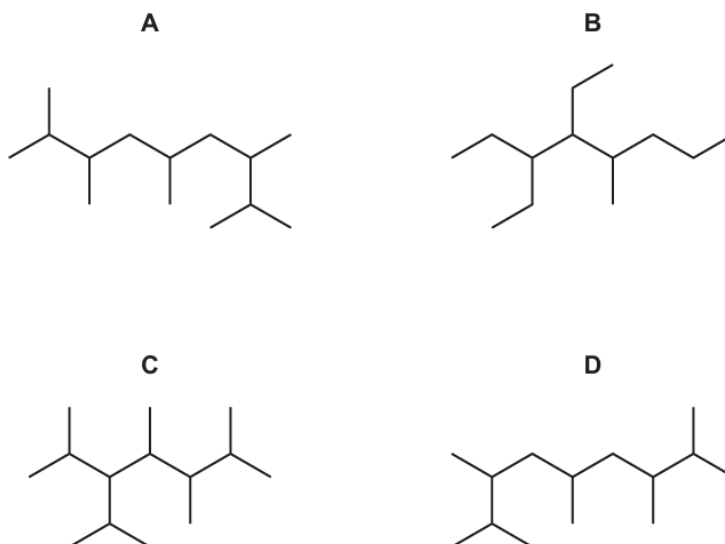
- A 1,1,2-trichloropropene
 B 1,2,3-trichloropropene
 C 1-chlorobut-1-ene
 D 1-chlorobut-2-ene
- 41 X has the molecular formula $C_5H_{12}O$. X has a branched carbon skeleton and a secondary alcohol functional group.

How many **structural** isomers fit this description of X?

- A 1 B 2 C 3 D 4
- 42 A new jet fuel has been produced that is a mixture of different structural isomers of compound Q.



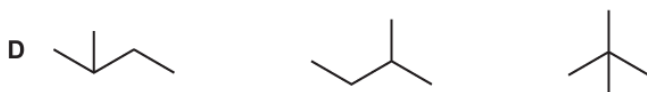
Which skeletal formula represents a **structural isomer** of Q?



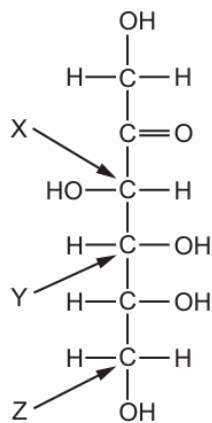
43 There are three structural isomers with the formula C_5H_{12} .

Which formulae correctly represent these three structural isomers?

- A $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $C(CH_3)_4$
 B $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$



44 Fructose is a sugar with more than one chiral centre. The fructose molecule is shown with X, Y and Z indicating three carbon atoms.



fructose

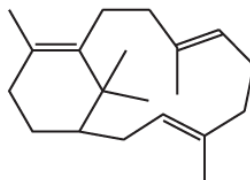
Which carbon atoms are chiral centres?

- A X, Y and Z B X and Y only C X only D Y only

45 Which pair of alcohols are isomers of each other?

- A butan-1-ol and 2,2-dimethylpropan-1-ol
 B butan-2-ol and 2-methylpropan-2-ol
 C pentan-1-ol and 2-methylpropan-2-ol
 D propan-2-ol and 2-methylpropan-2-ol

- 46 Compound Y is treated with an excess of hydrogen gas in the presence of a nickel catalyst. The product is fully saturated.



compound Y

What is the number of chiral carbon atoms in the product?

- A 5 B 6 C 7 D 8
- 47 Structural isomerism and stereoisomerism should be considered when answering this question.
- A colourless liquid, $C_5H_{11}Cl$, exists as a mixture of two optical isomers.
- When heated with sodium hydroxide in ethanol, a mixture of **only** two alkenes is formed.
- What could the colourless liquid be?

- A $(CH_3CH_2)_2CHCl$
- B $CH_3CH_2CH_2CHClCH_3$
- C $(CH_3)_2CHCHClCH_3$
- D $CH_3CH_2CCl(CH_3)_2$