An introduction to AS Level organic chemistry

Review

1.Representing organic molecules

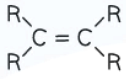
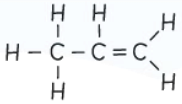
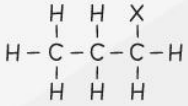
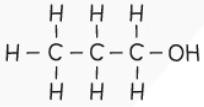
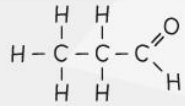
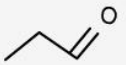
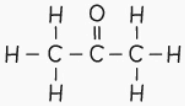
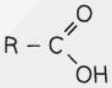
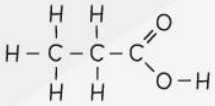
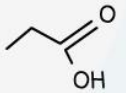
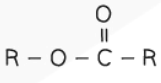
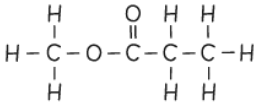
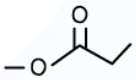
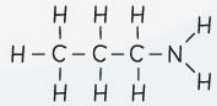
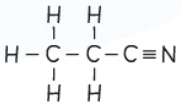
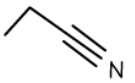
molecular formula
The number and type of atoms in a molecule

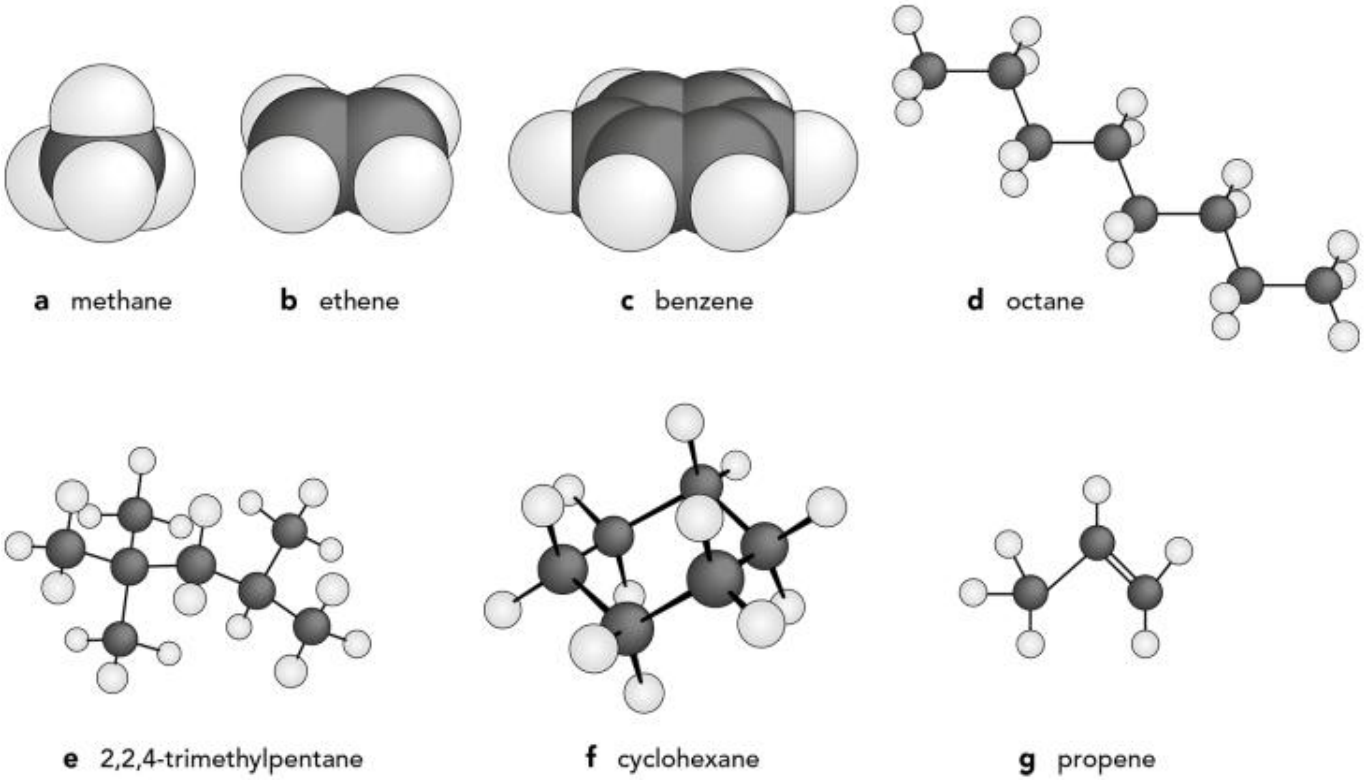
empirical formula
It tells us the simplest ratio of the different types of atoms present in the molecule

structural formula
The arrangement and connection of atoms

displayed formula
Show all bonds.

skeletal formula
Remove carbon and hydrogen atoms,
Remove carbon hydrogen bonds,
Draw all other atoms and bonds.

Homologous Series	General Formula	Structural Formula	Displayed Formula	Skeletal Formula	Name
Alkene	C_nH_{2n}				propene
Halogenoalkane	$C_nH_{2n+1}X$	R – X			halogenopropane
Alcohol	$C_nH_{2n+1}OH$	R – OH			propan–1–ol
Aldehydes	$C_nH_{2n+1}CHO$				propanal
Ketone	$C_nH_{2n}O$				propanone
Carboxylic Acid	$C_nH_{2n+1}COOH$				propanoic acid
Ester	$C_nH_{2n}O_2$				methyl propanoate
Amine	$C_nH_{2n+1}NH_2$	R – NH_2			propylamine
Nitrile	$C_nH_{2n+1}CN$	R – C ≡ N			propanitrile



a–c These hydrocarbons are shown as space-filling models. Such models show the region of space occupied by the atoms and the surrounding electrons. d–g These hydrocarbons are shown as ball-and-stick models, which enable bonds between atoms to be seen clearly

A gaseous hydrocarbon has a density of 2.42 g dm^{-3} under room conditions

What could be the skeletal formula of this hydrocarbon?

1 

2 

3 

A. 1, 2 and 3 are correct
B. 1 and 2 only are correct
C. 2 and 3 only are correct
D. 1 only is correct

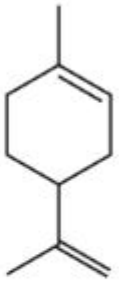
$24 \times 2.42 = 58.08$ /mol

48

C_4H_{10}

Limonene is a hydrocarbon found in the rind of citrus fruits.

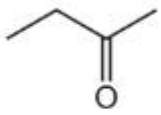
limonene

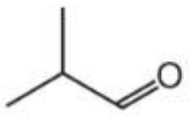


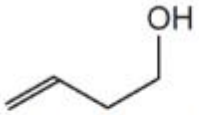
What is the molecular formula of limonene?

A. $C_{10}H_{12}$
B. $C_{10}H_{14}$
C. $C_{10}H_{16}$
D. $C_{10}H_{18}$

Which substances have molecular formula C_4H_8O?

1. 

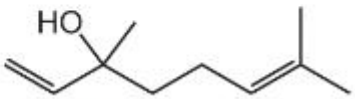
2. 

3. 

A. 1, 2 and 3 are correct
B. 1 and 2 only are correct
C. 2 and 3 only are correct
D. 1 only is correct

The skeletal formula of compound X is shown.

compound X

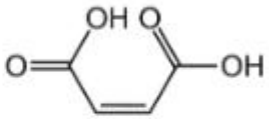


What is the molecular formula of compound X?

A. $C_{10}H_{18}O$
B. $C_{10}H_{20}O$
C. $C_{11}H_{22}O$
D. $C_{11}H_{24}O$

The diagram shows the skeletal formula of compound Y.

Y

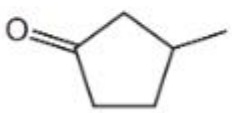


What is the empirical formula of Y?

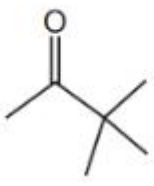
A. CHO
B. CH_2O_2
C. C_2HO_2
D. $C_4H_4O_4$

Which compound has the molecular formula $C_6H_{10}O$?

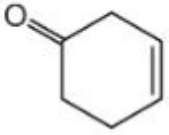
A



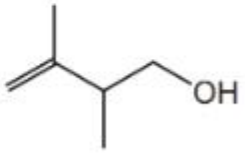
B



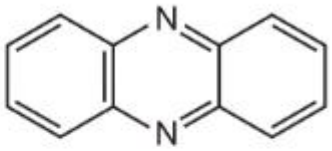
C



D



The diagram shows the skeletal formula of phenazine.



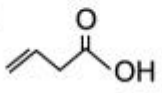
phenazine

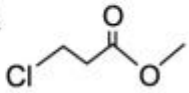
What is the empirical formula of phenazine?

A. C_6H_4N
B. C_6H_6N
C. $C_{12}H_8N_2$
D. $C_{12}H_{12}N_2$

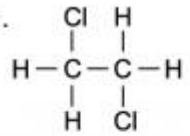
Draw the displayed formula of the following molecules:

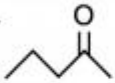
1. 

2. 

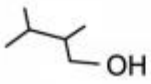
3. 

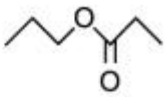
Deduce the molecular and empirical formula of the following compounds:

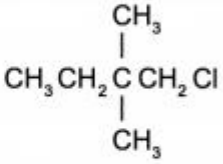
1. 

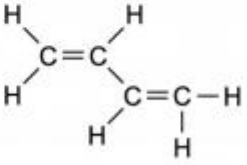
2. 

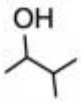
3. $CH_3CHCH_2CH_2CH_3$ with CH_2CH_3 branch

4. 

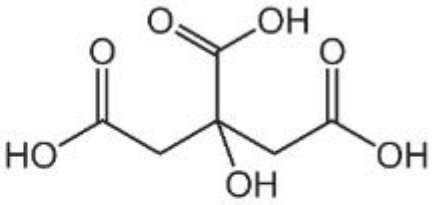
5. 

6. 

7. 

8. 

The diagram shows the skeletal formula of citric acid.



citric acid

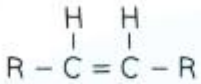
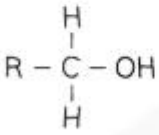
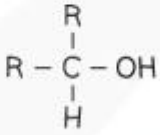
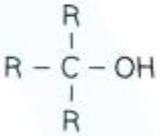
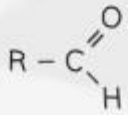
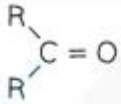
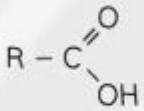
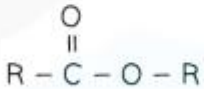
What is the molecular formula of citric acid?

A. $C_6H_8O_7$
B. $C_6H_4O_7$
C. $C_8H_8O_7$
D. $C_{10}H_8O_7$

2.Homologous series of organic compounds

There are many classes of related organic compounds called homologous series . Within each homologous series of compounds, all the compounds consist of molecules with a particular atom, or grouping of atoms, called a functional group. Different classes of compounds have different functional groups.

Functional groups determine the physical and chemical properties of molecules

Family	Functional Group
Alkene	
Halogenoalkane	R – X Where X = F, Cl Br and I
Alcohol	 Primary alcohol  Secondary alcohol  Tertiary alcohol
Aldehydes	
Ketone	
Carboxylic Acid	
Ester	
Primary Amine	$R - NH_2$
Nitrile	R – C ≡ N

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

3.Naming of Organic Compounds

Number of C atoms	Molecular formula of straight-chain alkane	Name of alkane	Stem used in naming
1	CH_4	methane	meth-
2	C_2H_6	ethane	eth-
3	C_3H_8	propane	prop-
4	C_4H_{10}	butane	but-
5	C_5H_{12}	pentane	pent-
6	C_6H_{14}	hexane	hex-
7	C_7H_{16}	heptane	hept-
8	C_8H_{18}	octane	oct-
9	C_9H_{20}	nonane	non-
10	$C_{10}H_{22}$	decane	dec-

The homologous series of hydrocarbons called alkanes provides the basis of the naming system. The stem of each name indicates how many carbon atoms are in the longest chain in one molecule of the compound.
We indicate the position of side-chains or functional groups by numbering the carbon atoms in the longest chain. The numbering starts at the end that produces the lowest possible numbers in the name.

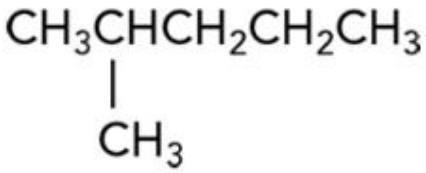
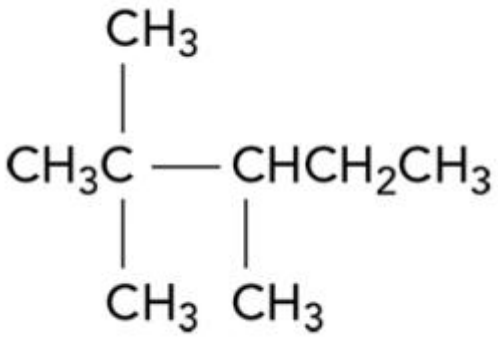
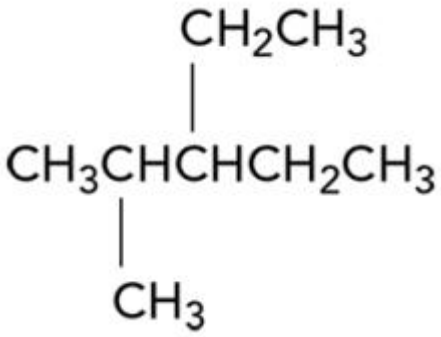


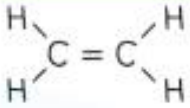
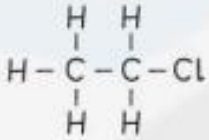
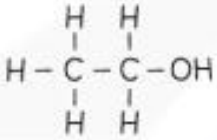
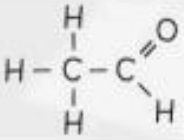
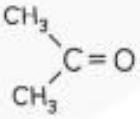
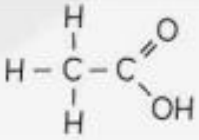
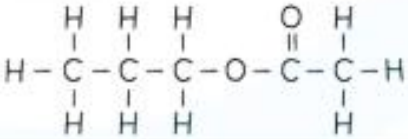
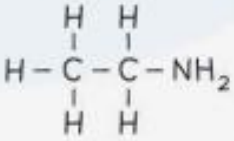
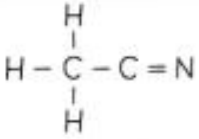
Figure 14.8: This is called 2-methylpentane, not 4-methylpentane. Its structural formula is $CH_3CH(CH_3)CH_2CH_2CH_3$.

Note that the hydrocarbon side-chain is shown in brackets in its structural formula. It is named by adding '- yl' to the normal alkane stem, in this case a methyl group. This type of group is called an alkyl group. If there is more than one of the same alkyl side-chain or functional group, we indicate how many by inserting di- (for two), tri- (for three) or tetra- (for four) in front of its name.



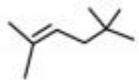
If there is more than one type of alkyl side-chain, they are listed in the name in alphabetical order



Functional Group	Nomenclature	Example	Name
Alkenes	– ene		Ethene
Halogenoalkane	chloro– fluoro– iodo– bromo–		Chloroethane
Alcohol	–ol		Ethanol
Aldehyde	–al		Ethanal
Ketone	–one		Propanone
Carboxylic Acid	–oic acid		Ethanoic acid
Ester	alkyl –cate		Propyl Ethanoate
Amine	alkyl –amine		Ethylamine
Nitrile	–nitrile		Ethane nitrile

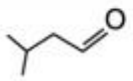
.

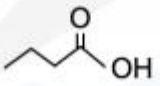
Name the following molecules using correct systematic nomenclature:

1. 

2. 

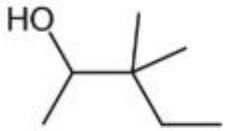
3. 

4. 

5. 

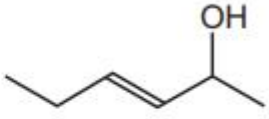
6. 

What is the correct name of the molecule with the skeletal formula shown?



A. 1,2,2-trimethylbutan-3-ol
B. 2-ethyl-2-methylbutan-2-ol
C. 3,3-dimethylpentan-2-ol
D. 4-hydroxy-3,3-dimethylpentane

What is the name of compound **X**?



compound **X**

A. *trans*-2-hydroxyhex-3-ene
B. *trans*-2-hydroxyhexene
C. *trans*-5-hydroxyhex-3-ene
D. *trans*-5-hydroxyhexene

4.Bonding in organic molecules

Hybridised Atoms: Shapes & Bond Angles in Molecules

Each carbon atom has four electrons in its outer shell (electronic configuration:1s2 2s2 2p2)

Carbon atoms share these four electrons in four covalent bonds with other atoms to achieve a full outer shell configuration These electrons are found in orbitals within the respective atoms

When forming a covalent bond,the orbitals overlap in such a way to form two types of bonds

Sigma bonds (σ)

Pi bonds (π)

Hybridisation: sp 3

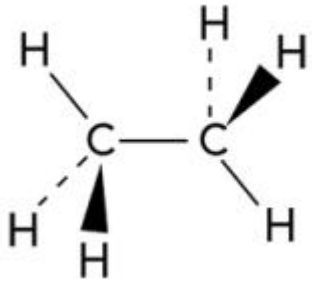
The electron pair in a σ bond is found in a region of space between the nuclei ofthe two atoms that are sharing the electrons

The electrostatic attraction between the electrons (negatively charged) and the two nuclei (positively charged) holds the two atoms together

Carbon atoms thatform four σ bonds are said to be sp3 hybridised

The four pairs of electrons around each carbon repel each otherforcing the molecule to adopt a configuration in which the bonding pairs of electrons are as far away from each other as possible

The tetrahedral bond angle is 109.5°



Hybridisation: sp 2

When carbon atoms use only three oftheir electron pairs to form a σ bond,they are said to be sp 2 hybridised

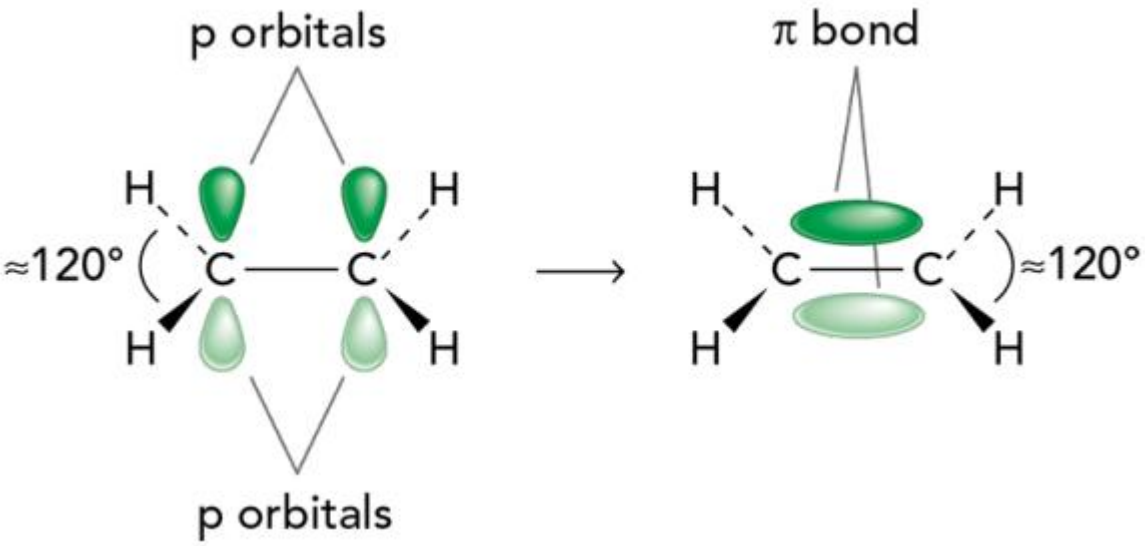
Each carbon atom will have a p orbital with contains one spare electron

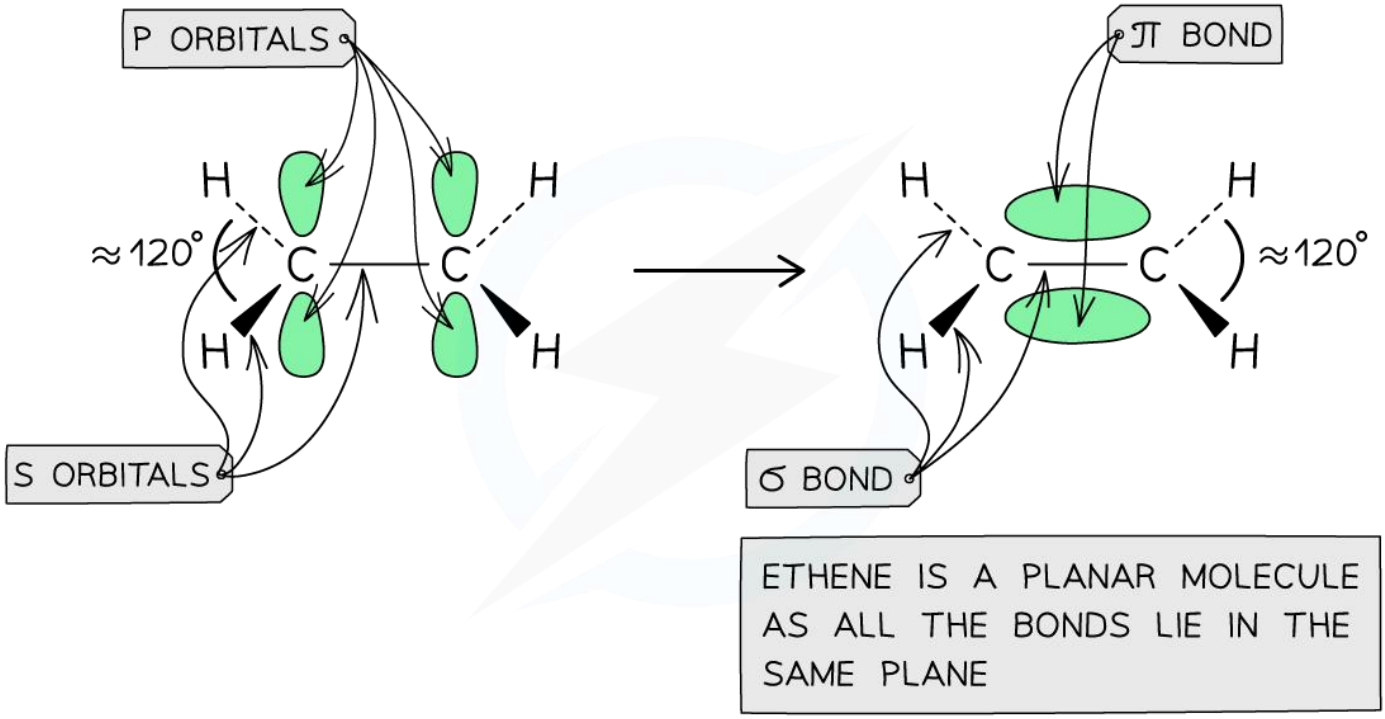
When the p orbitals oftwo carbon atoms overlap with each other, a π bond is formed (the π bond contains two electrons)

The two orbitals thatform the π bond lie above and below the plane ofthe two carbon atoms to maximise bond overlap

The three bonding pair of electrons are in the plane ofthe molecule and repel each other

The molecule adopts a planar arrangement with bond angles of 120°





Hybridisation: sp

Carbon atoms can also use only one oftheir electron pairto form a σ bond, in which case the carbon atoms are said to be sp hybridised

Each carbon atom will have two p orbitals with one spare electron each

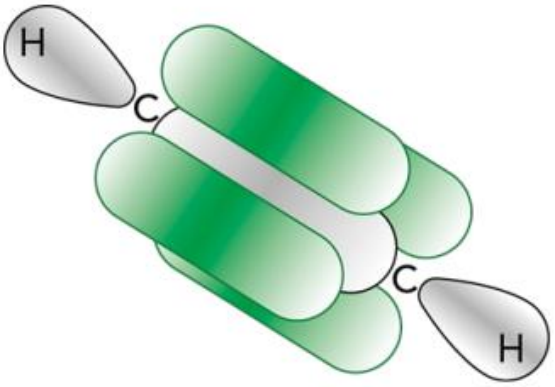
When the four p orbitals ofthe carbon atoms overlap with each other, two π bonds are formed (each π bond contains two electrons)

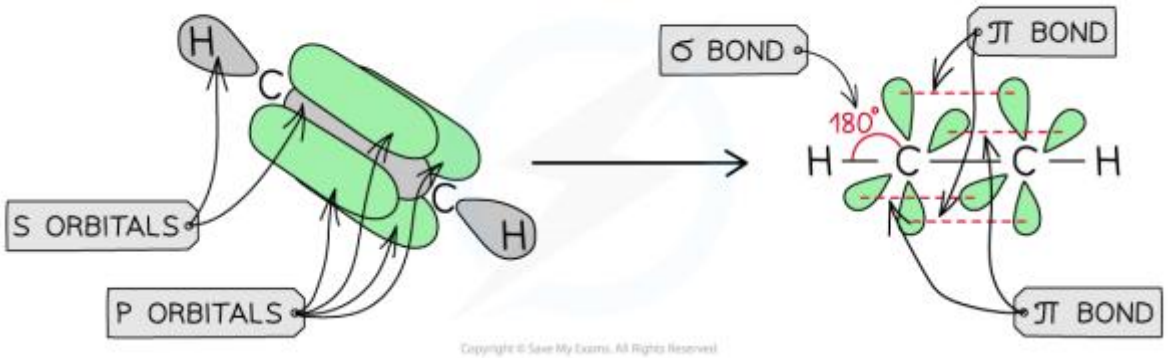
The two orbitals thatform the π bond lie above and below the plane ofthe carbon atoms

The two orbitals ofthe other π bond lie in front and behind the plane ofthe atoms

This maximises the overlap ofthe four p orbitals

The molecule adopts a linear arrangement with bond angles 180°

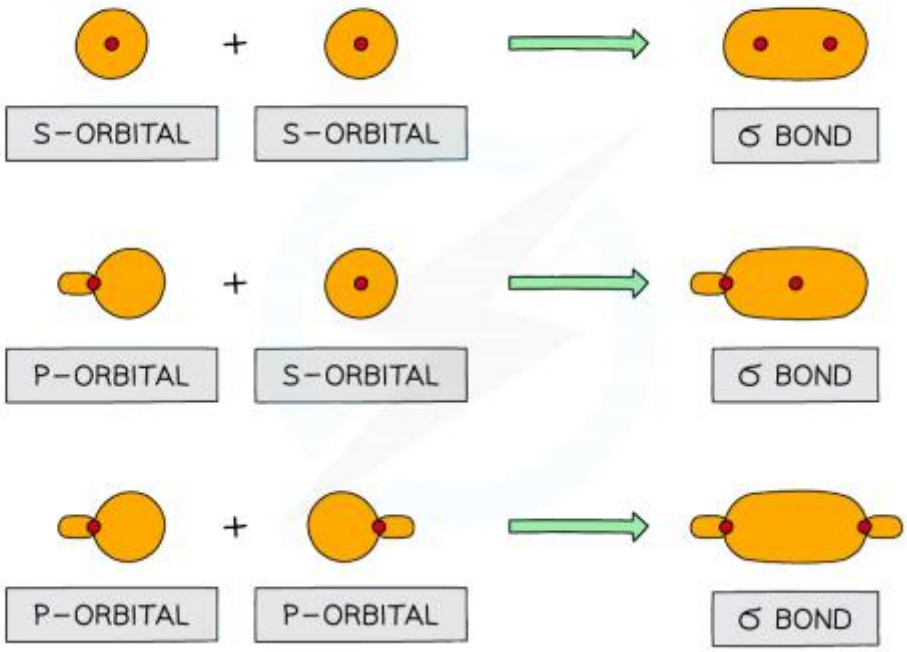




Hybridised Atoms: σ and π Bonds in Molecules

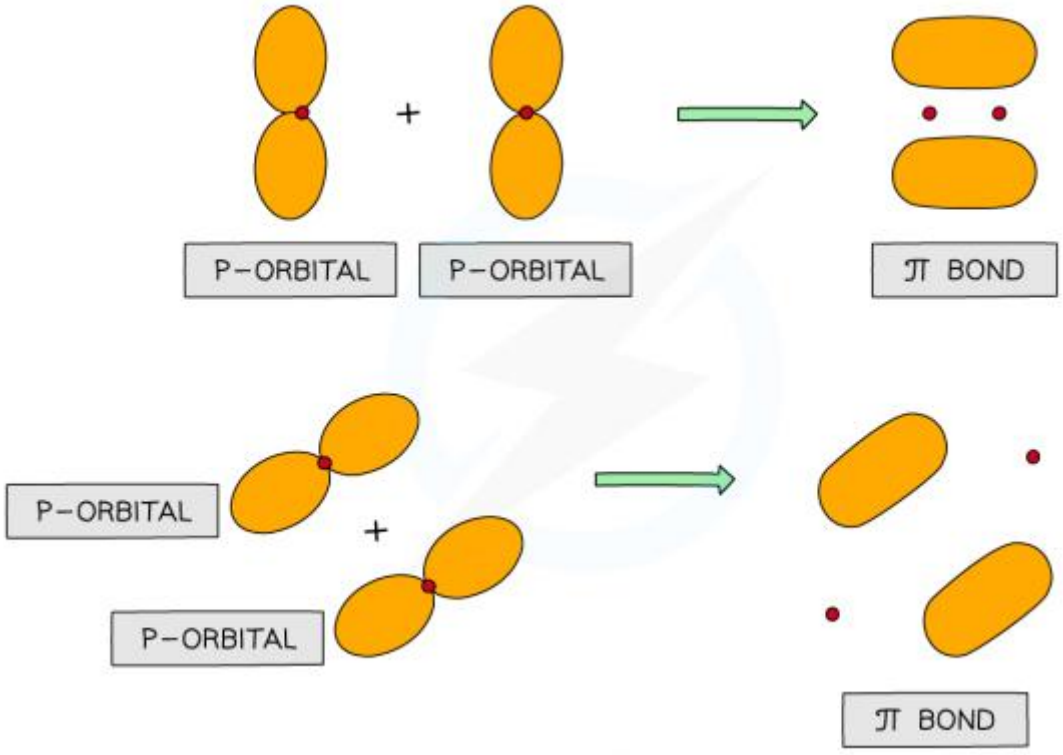
σ bonds

- Sigma bonds are formed from the end-on overlap of atomic orbitals
  - S orbitals overlap this way as well as p orbitals

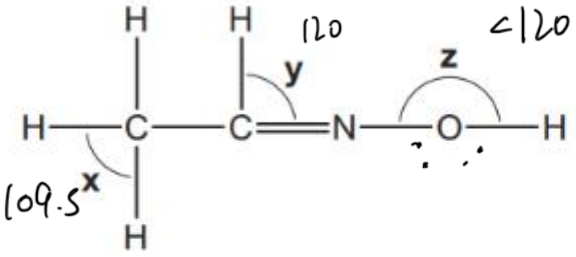


π bonds

- Pi (π) bonds are formed from the sideways overlap of p orbitals
- The two lobes that make up the π bond lie above and below the plane of the atoms
  - This maximises overlap of the p orbitals



Ethanal reacts with hydroxylamine, NH_2OH, to form the molecule shown.



What is the order of **increasing** bond angle in this structure from smallest to largest?

A. **z, x, y**
B. **y, z, x**
C. **x, z, y**
D. **z, y, x**

Compound X is a straight chain hydrocarbon with an M_r of 84.

What can be determined about X?

1. empirical formula
2. molecular formula
3. whether X contains a C=C bond or not

A. 1, 2 and 3 are correct
B. 1 and 2 only are correct
C. 2 and 3 only are correct
D. 1 only is correct

Chlorine atoms in the upper atmosphere cause the breakdown of ozone.

$$Cl + O_3 \rightarrow O_2 + ClO$$

$$ClO + O \rightarrow Cl + O_2$$

Which statements about these chlorine atoms are correct?

1. The chlorine atoms act as catalysts.
2. The chlorine atoms are free radicals.
3. The chlorine atoms are formed by heterolytic fission of a covalent bond in chlorofluorocarbons.

A. **1**, **2** and **3** are correct

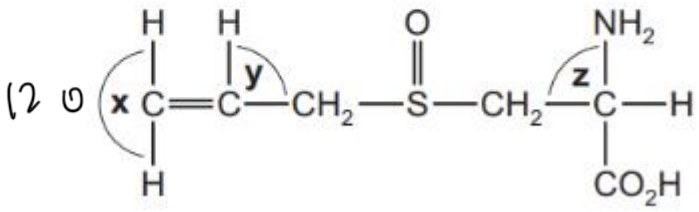
B. **1** and **2** only are correct

C. **2** and **3** only are correct

D. **1** only is correct

The structural formula of alliin is shown.

alliin



What are the approximate bond angles **x**, **y** and **z** in a molecule of alliin?

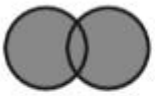
	x	y	z
A	90°	90°	109°
B	120°	109°	90°
C	120°	120°	109°
D	180°	109°	109°

When considering one molecule of ethene, which row describes both the hybridisation of the atomic orbitals in the carbon atoms and the overall bonding?

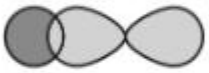
	hybridisation	bonding
A	SP^2	4 σ bonds 1 π bond
B	SP^2	5 σ bonds 1 π bond
C	SP^3	4 σ bonds 1 π bond
D	SP^3	5 σ bonds 1 π bond

A σ bond is made between two carbon atoms in a molecule of ethene.
Which diagram shows the orbital overlap that occurs to form this bond?

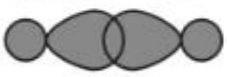
A.



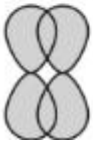
B.



C.



D.



Which statement describes the bond between carbon and hydrogen in an ethene molecule?

A. a π bond between an s orbital and an sp^2 orbital
B. a π bond between an s orbital and an sp^3 orbital
C. a σ bond between an s orbital and an sp^2 orbital
D. a σ bond between an s orbital and an sp^3 orbital

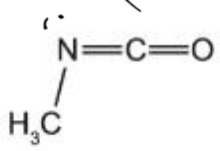
Which molecule does **not** have any 90° or 180° bond angles?

A. C_2H_6
B. CO_2
C. PF_5
D. SF_6

Methyl isocyanate, CH_3NCO, is a toxic liquid which is used in the manufacture of some pesticides.

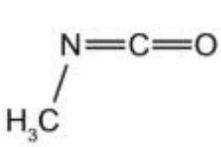
What is the approximate angle between the bonds formed by the N atom in a molecule of methyl isocyanate?

A



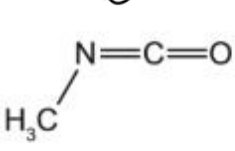
104°

B



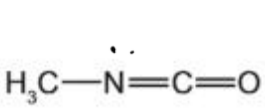
109°

C



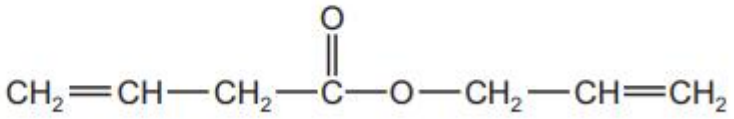
120°

D



180°

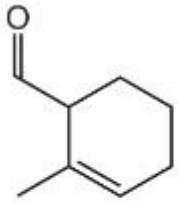
The diagram shows a molecule that has σ bonds and π bonds.



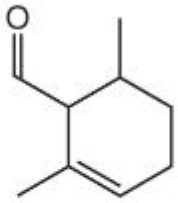
How many σ bonds are present in this molecule?

A. 15
B. 17
C. 18
D. 21

The diagrams show two different compounds.



1

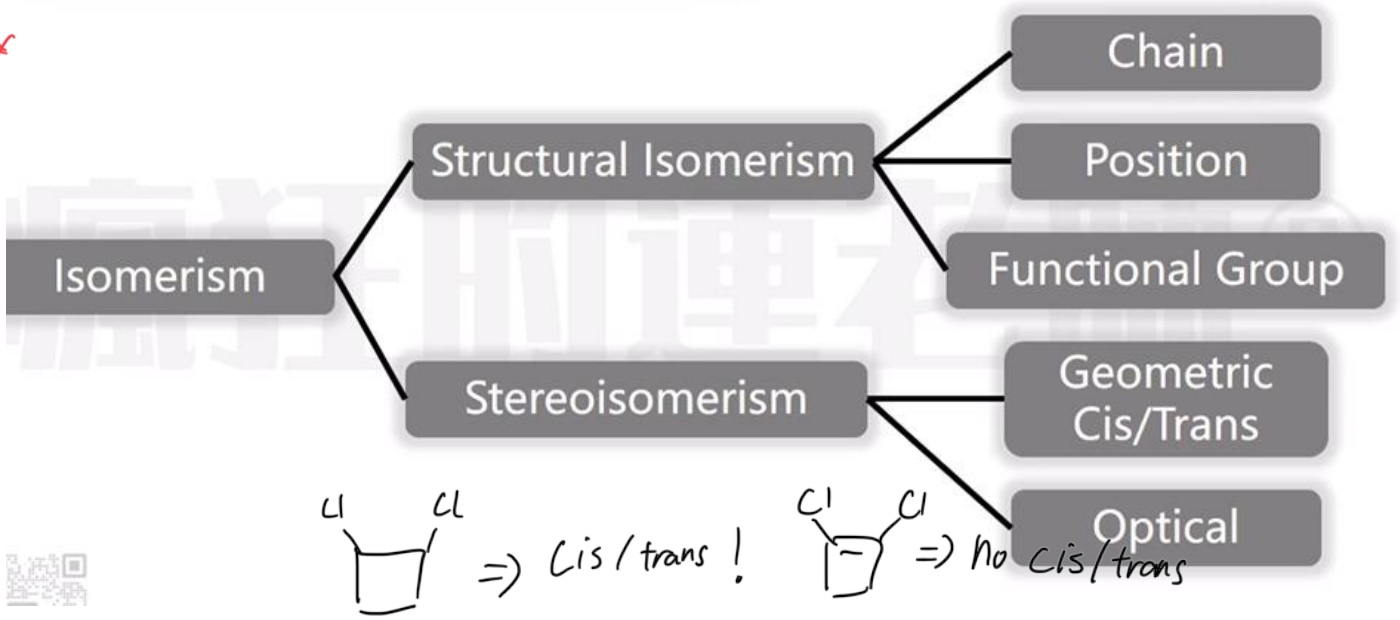


2

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?

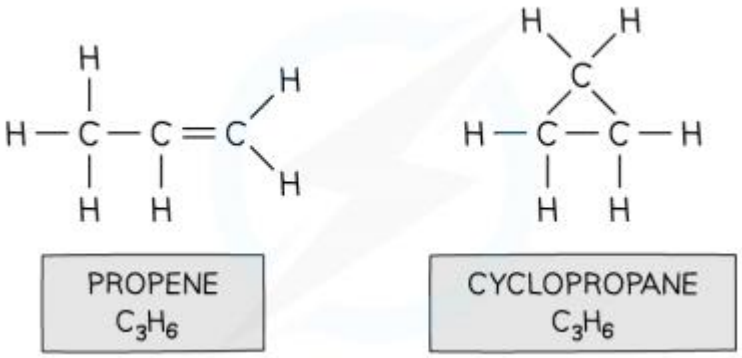
	number of isomers	number of π electrons
A	3	2
B	3	4
C	5	2
D	5	4



Terms	Key words	Definition
stereoisomerism	• same atoms bonded to each other • different arrangement of atoms in space • can not superimpose	Compounds whose molecules have the same atoms bonded to each other in the same way, but with a different arrangement of atoms in space so that the molecules can not superimposed on each other.
geometrical isomerism	• unsaturated or ring • same molecular formula and order • different shapes	Displayed by unsaturated or ring compounds with the same molecular formula and order of atoms but different shapes.

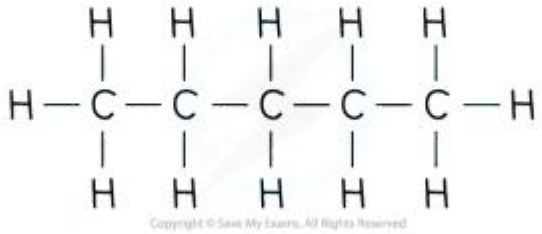
5. Structural isomerism

Definition: Structural isomers are compounds with the same molecular formula but different structural formulae



Straight-chain

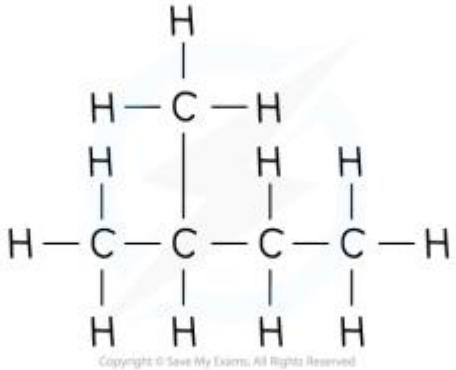
- **Straight-chain** organic molecules are those in which the carbon atoms are connected to each other in one continuous chain



Pentane is a straight-chain organic molecule as the carbon atoms are connected in a straight line

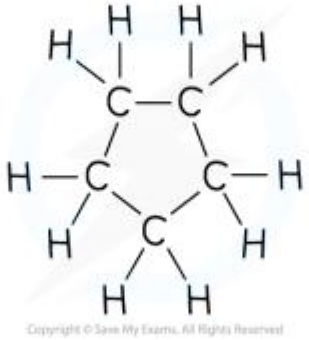
Branched

- **Branched** organic molecules have side groups attached to the main chain of carbon atoms



2-methylbutane is a branched organic molecule as the main chain (consisting of 4 carbon atoms) has a methyl branch

- **Cyclic** organic molecules are those in which the carbon atoms are connected to each other in a ring shape



Cyclopentane is a cyclic organic molecule as the carbons are attached to each other in a ring structure

There are three differenttypes of structural isomerism:

Chain isomerism

Positional isomerism

Functional group isomerism

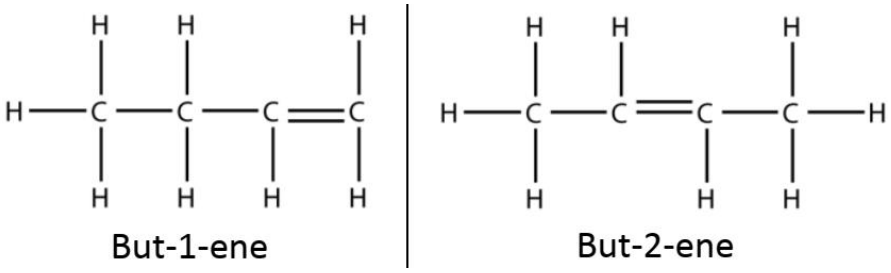
Chain isomerism

compounds have the same molecularformula, buttheir longest hydrocarbon chain is notthe same

Positional isomerism

Positional isomers arise from differences in the position of a functional group in each isomer

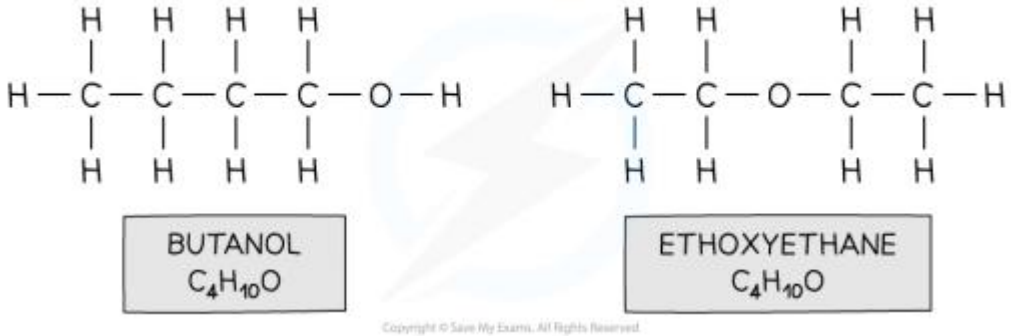
The functional group can be located on different carbons



Functional group isomerism

When differentfunctional groups resultin the same molecularformula, functional group isomers arise

The isomers have very different chemical properties as they have differentfunctional groups



6. Stereoisomerism

There are two types of stereoisomerism:

Geometrical (cis/trans) isomerism

Optical isomerism

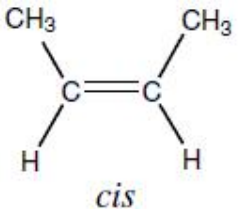
Geometrical(cis/trans)isomerism

Geometrical isomerism is seen in unsaturated (double bond containing) or ring compounds that have the same molecularformula and order of atoms (the atoms are connected similarly to each other) but different shapes

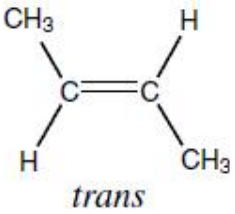
Cis/trans nomenclature is used to distinguish between the isomers

Cis isomers have functional groups on the same side ofthe double bond/carbon ring

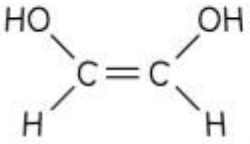
Trans isomers have functional groups on opposite sides ofthe double bond/carbon ring



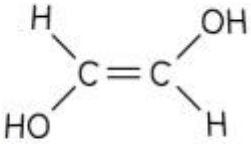
cis



trans



CIS–1, 2 – ETHENEDIOL



TRANS–1, 2 – ETHENEDIOL

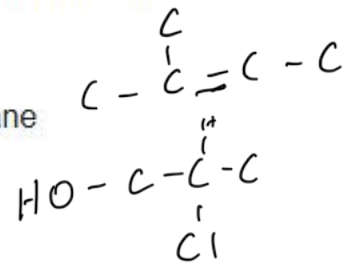
Which compound shows stereoisomerism?

~~A. 2-methylbut-2-ene~~

B. 2-chloropropan-1-ol

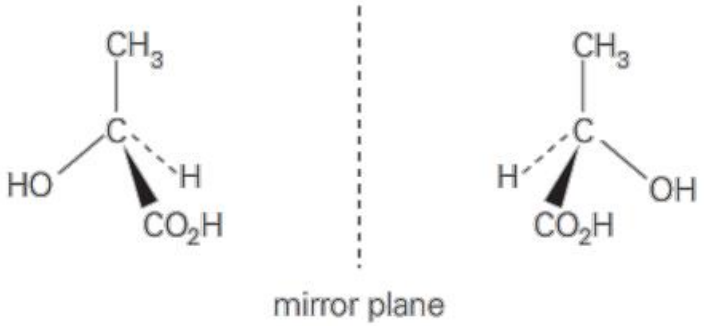
~~C. difluorochlorobromomethane~~

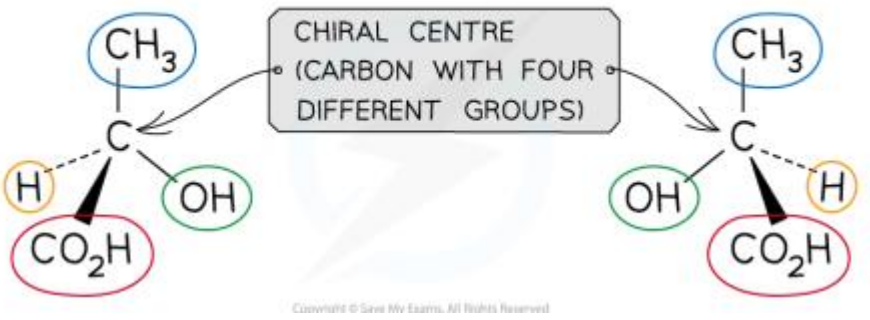
~~D. pent-1-ene~~



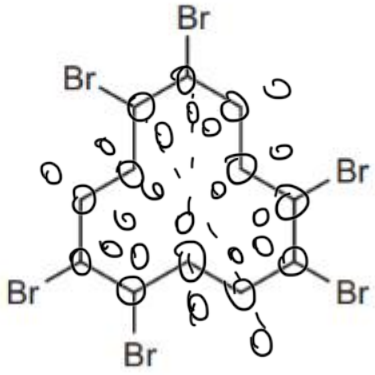
Optical isomerism

- 4 different atoms or groups connected to the same carbon atom
- Have same physical and chemical properties
- No. of optical isomers in a molecule containing n chiral carbons = 2^n





The diagram shows a molecule of a compound used as a flame retardant.



Which statements about this structure are correct?

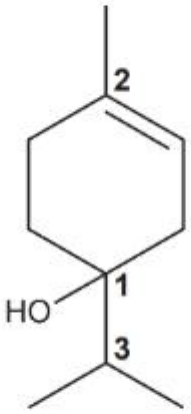
1. Each brominated C atom is chiral.
2. The molecular formula is $C_{12}H_{20}Br_6$.
3. The C–C–C bond angles are all 120°.

A. **1**, **2** and **3** are correct
B. **1** and **2** only are correct
C. **2** and **3** only are correct
D. **1** only is correct

One of the active ingredients in tea-tree oil is terpinen-4-ol.

In the diagram of the skeletal formula of terpinen-4-ol, three of the carbon atoms are labelled **1**, **2** and **3.**

Which of the labelled carbon atoms are chiral?



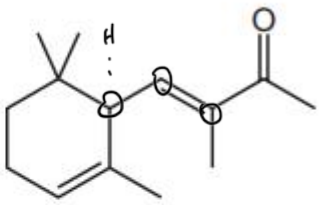
terpinen-4-ol

A. 1, 2 and 3 are correct
B. 1 and 2 only are correct
C. 2 and 3 only are correct
D. 1 only is correct

Which compound does **not** exhibit stereoisomerism?

A. $CH_3CHClCH_2CHO$
B. $CH_3CHCHCH_3$
C. $CH_2ClCH_2CCl_2H$
D. $CHClCHCl$

The structural formula of compound Q is shown.



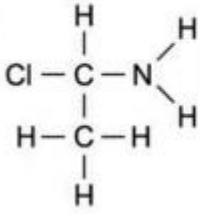
Q

How many stereoisomers exist with this structural formula?

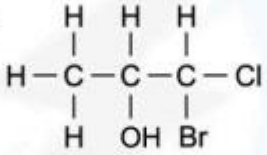
A. 1
B. 2
C. 4
D. 8

Draw the optical isomers of the following compounds:

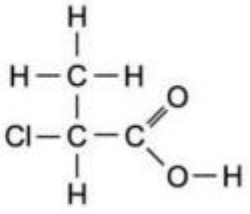
1.



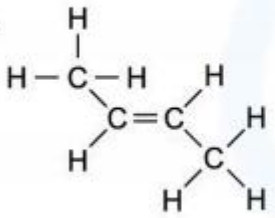
2.

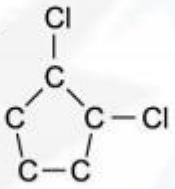


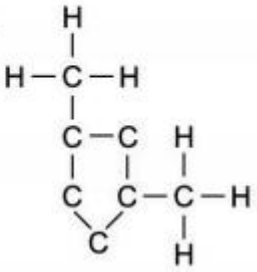
3.



Draw the geometrical isomers of the following compounds:

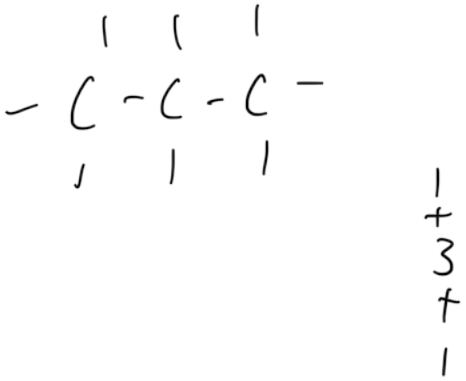
1. 

2. 

3. 

How many structural isomers are there of trichloropropane, $C_3H_5Cl_3$?

A. 3
B. 4
C. 5
D. 6

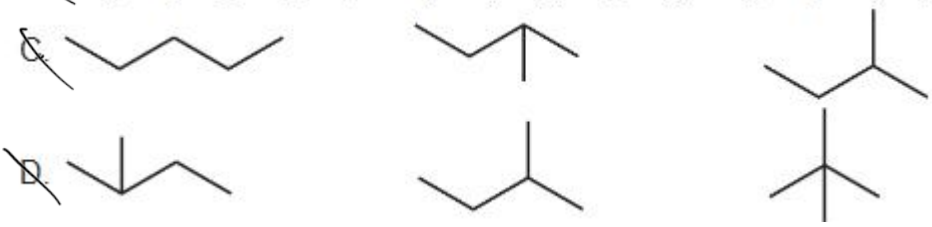


There are three structural isomers with the formula C_5H_{12}.

Which formulae correctly represent these three structural isomers?

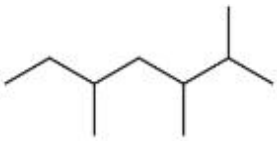
A $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $C(CH_3)_4$

B $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$

C 

D

Kerosene is used as an aircraft fuel. Q is one of the molecules in kerosene and has the skeletal formula shown.

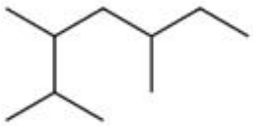


Q

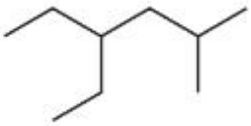
Other structural isomers of this molecule are also found in kerosene.

Which structure is a structural isomer of Q?

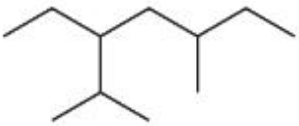
A



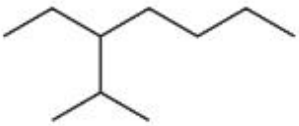
B



C



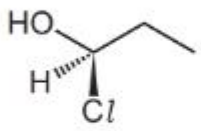
D



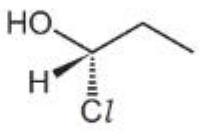
Structural and stereoisomerism should be considered when answering this question.

Compounds X, Y and Z are shown.

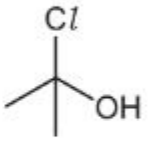
X



Y

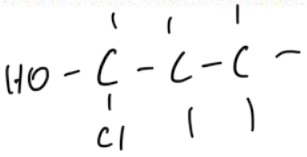


Z



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

A. 2
B. 3
C. 4
D. 5



2 + 1 + 1 + 1 + 1

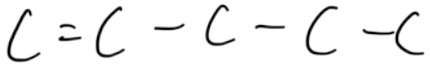
2 2

= 8 - 3 = 5

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

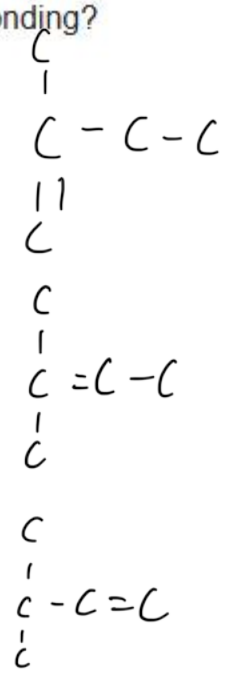
How many isomers with the formula C_5H_{10} have structures that involve π bonding?

A. 3
B. 4
C. 5
D. 6



1 + 2

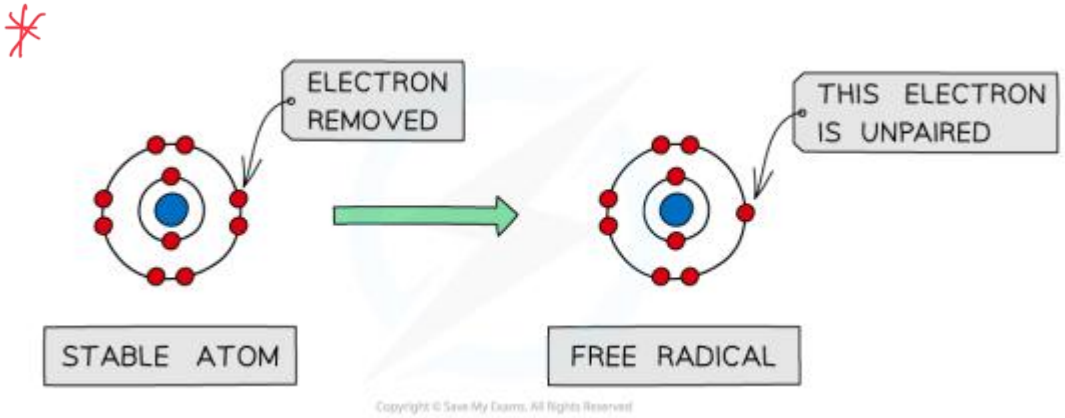
+ 3



How many isomers are there of dibromopropane, $C_3H_6Br_2$?

How many isomers are there of the compound with molecular formula $C_2H_2Cl_2$?

7. Types of organic reaction and reaction mechanisms

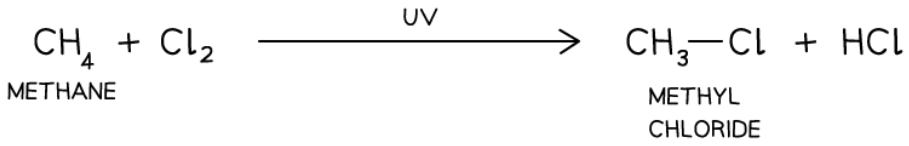


A free radical is a species with one (or more than one) unpaired electrons

The three steps in a free-radical reaction are:
initiation step: the formation of free radicals to start a reaction off
propagation steps: steps in a mechanism that regenerate more free radicals
termination step: the final step in a mechanism, when two free radicals meet and form a product molecule.

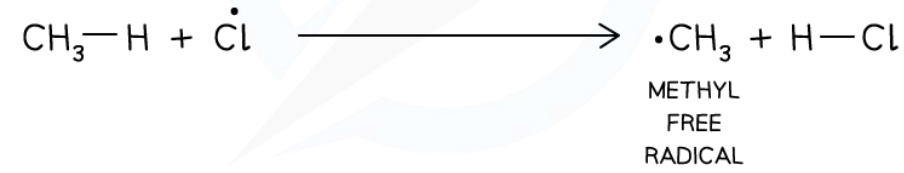
FREE-RADICAL SUBSTITUTION REACTIONS

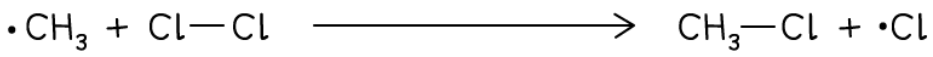
OVERALL REACTION



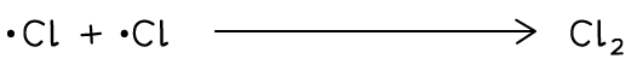
STEP 1: INITIATION

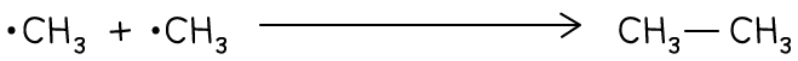
STEP 2: PROPAGATION





STEP 3: TERMINATION





•Cl + •CH3 → CH3Cl

Nucleophiles & electrophiles

A nucleophile is an electron-rich species that can donate a pair of electrons

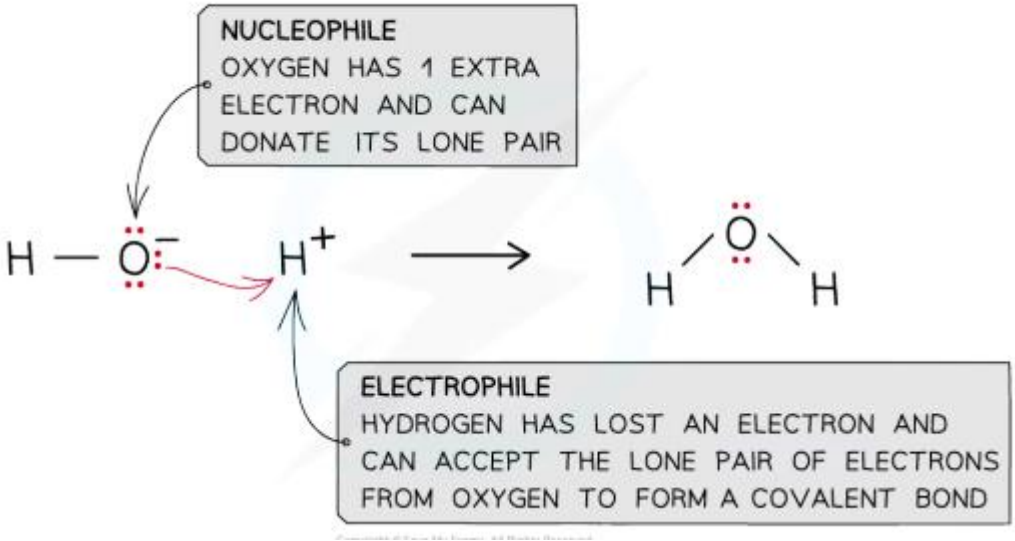
'Nucleophile' means 'nucleus/positive charge loving' as nucleophiles are attracted to positively charged species

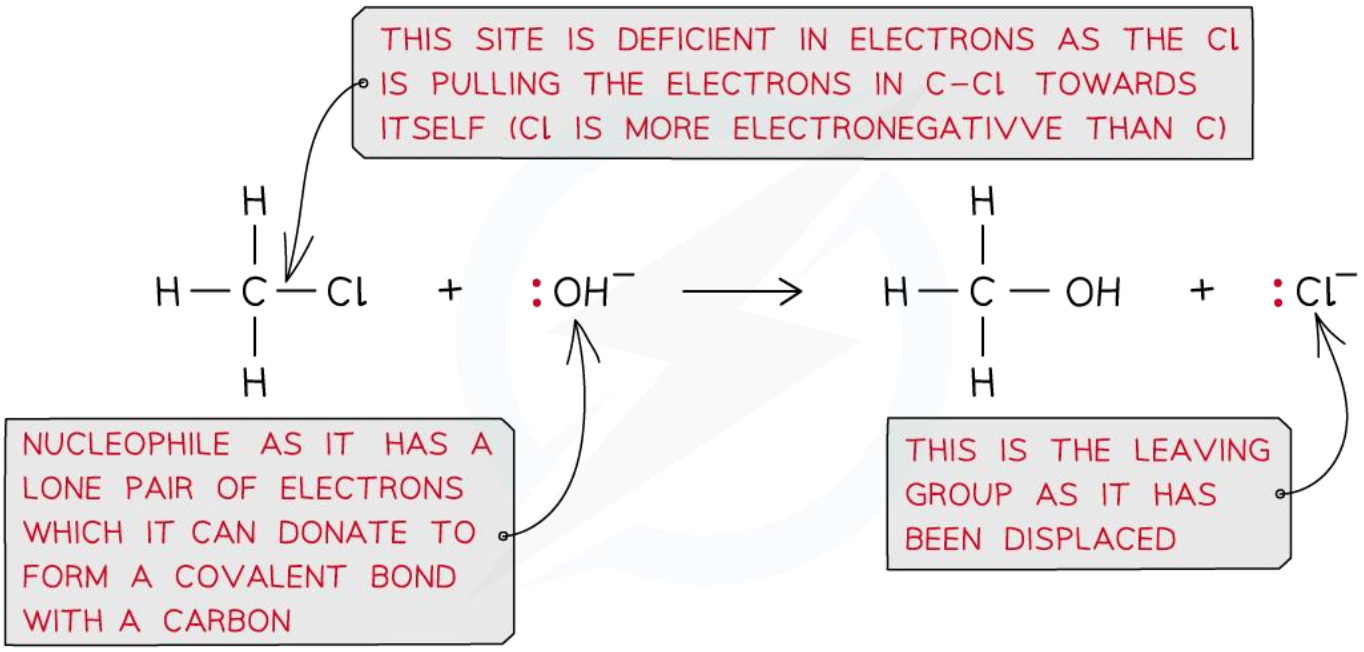
Nucleophilic refers to reactions thatinvolve a nucleophile

An electrophile is an electron-deficient species that can accept a pair of electrons

'Electrophile' means 'electron/negative charge loving' as electrophiles are attracted to negatively charged species

Electrophilic refers to reactions thatinvolve an electrophile





What is true of **every** nucleophile?

A. It attacks a double bond.
B. It donates a lone pair of electrons.
C. It is a single atom.
D. It is negatively charged.

The chlorine oxide free radical, ClO•, is produced by the reaction between chlorine atoms and ozone.

$$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$$

Which features are present in the chlorine oxide free radical?

1. an odd number of electrons
2. a single covalent bond
3. a dative covalent bond from oxygen to chlorine

A. **1, 2** and **3** are correct
B. **1** and **2** only are correct
C. **2** and **3** only are correct
D. **1** only is correct

8. Types of organic reaction

Reactions can be classified as:

- Addition
- Elimination
- Substitution
- Oxidation
- Reduction => $LiAlH_4$, $NaBH_4$
- Hydrolysis
- Polymerisation

Addition reactions

- These involve two reactants combining to form one product
- The most common example of an addition reaction involves alkenes, e.g.

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

Elimination reactions

- These are usually identified by one or two reactants forming more products
    - The products often include an alkene and a smaller molecule that has been eliminated from the reactant, e.g.

$$CH_3CH_2Br + OH^- \quad C_2H_4 + H_2O + Br^-$$

Substitution reactions

- An atom or group of atoms in a compounds is replaced by another atom or group of atoms, e.g.

$$CH_3CH_2Br + OH^- \rightarrow C_2H_5OH + Br^-$$

Oxidation reactions

- This can involve the loss of hydrogen or the gain of oxygen
- A reactant is oxidised by another chemical species, usually an inorganic reagent, e.g.

$$CH_3CHO + [O] \rightarrow CH_3COOH$$

- In this example, the oxidising agent [O] could be acidified potassium dichromate(VI) solution, Fehling's solution or Tollens' reagent

Reduction reactions

- This can involve the gain of hydrogen or the loss of oxygen
- A reactant is reduced by another chemical species
    - This can often be completed using a catalyst and a small reactant molecule such as H_2 or HCl, e.g.

$$CH_3CHO + [H] \rightarrow CH_3CH_2OH$$

- In this example, the oxidising agent [H] could be lithium aluminium hydride

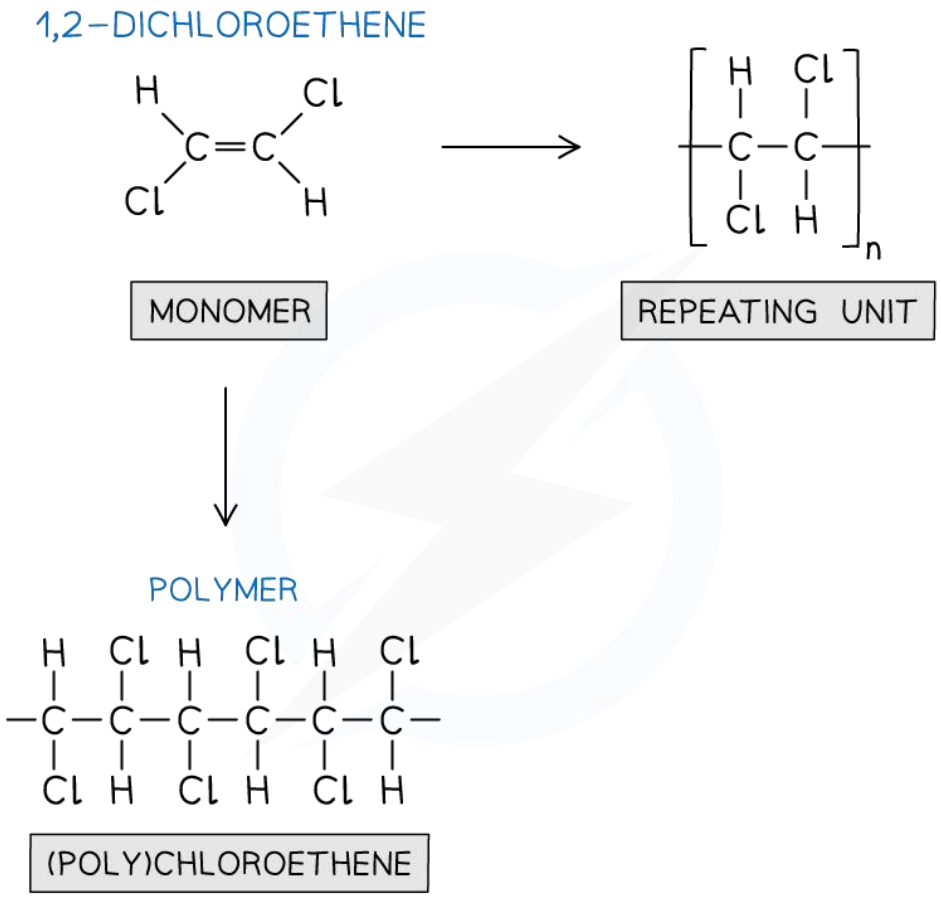
Hydrolysis reactions

- The name can be misleading as hydrolysis suggests that water is being used to split (or lyse) a compound
- Hydrolysis reactions are a specific reaction with water, e.g.

$$CH_3Cl + H_2O \rightarrow CH_3OH + HCl$$

Polymerisation reactions

- At AS level, you should know about **addition polymerisation**
- This is where the carbon-carbon double bond of an alkene monomer breaks open and forms a polymer chain, e.g.

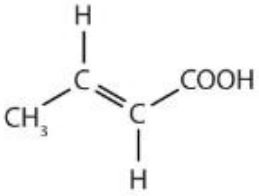


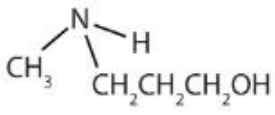
Which row describes the type of reaction that occurs when propan-1-ol reacts to form the named carbon- containing product?

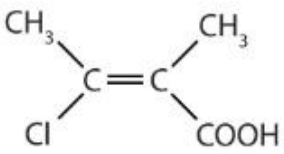
	carbon-containing product	type of reaction
A	1-chloropropane	addition to propan-1-ol
B	carbon monoxide	complete combustion of propan-1-ol
C	propene	dehydration of propan-1-ol
D	propanal	reduction of propan-1-ol

Identify the functional group(s) in each molecule as a double bond, a triple bond, an alcohol, or a carboxyl.

1. $CH_3CH_2CH_2CH_2OH$

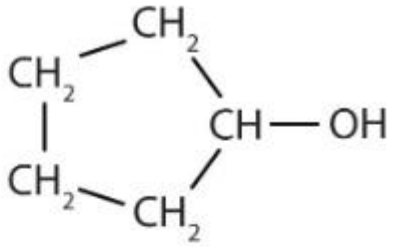
2. 

3. 

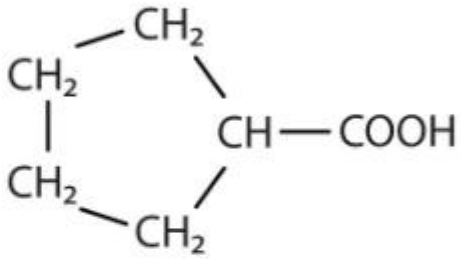
4. 

5. Identify the functional group(s) in each molecule.

1.



2.



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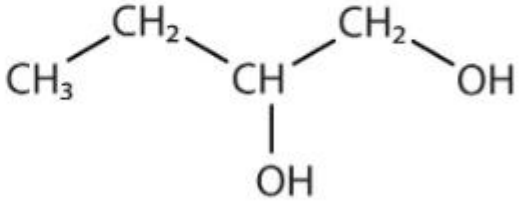

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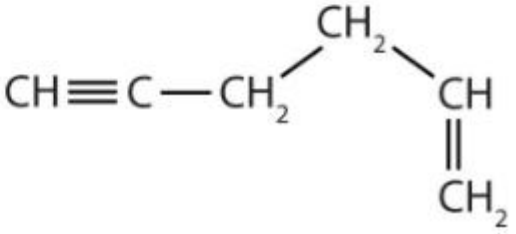
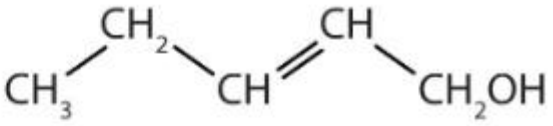
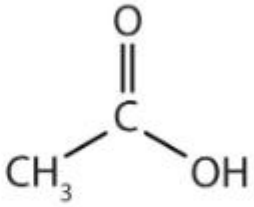
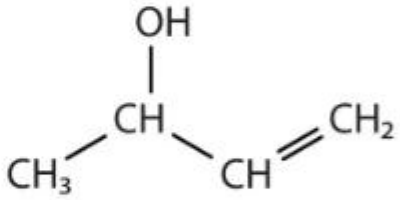
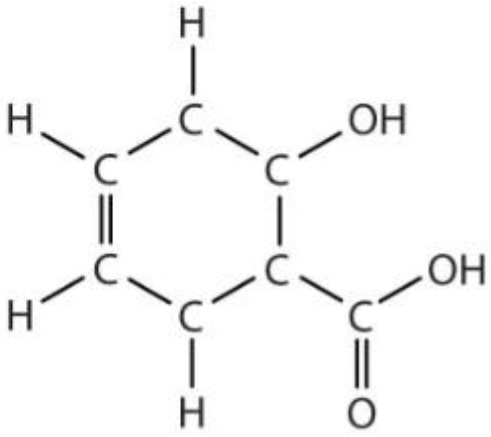


6. Identify the functional group(s) in each molecule.

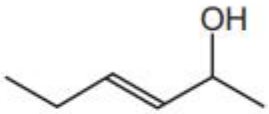
1. 

2. 

3. 

4. 

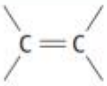
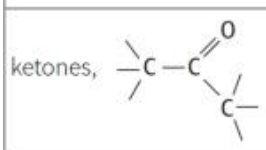
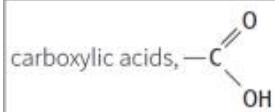
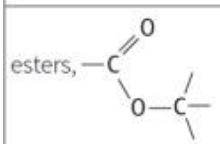
What is the name of compound **X**?

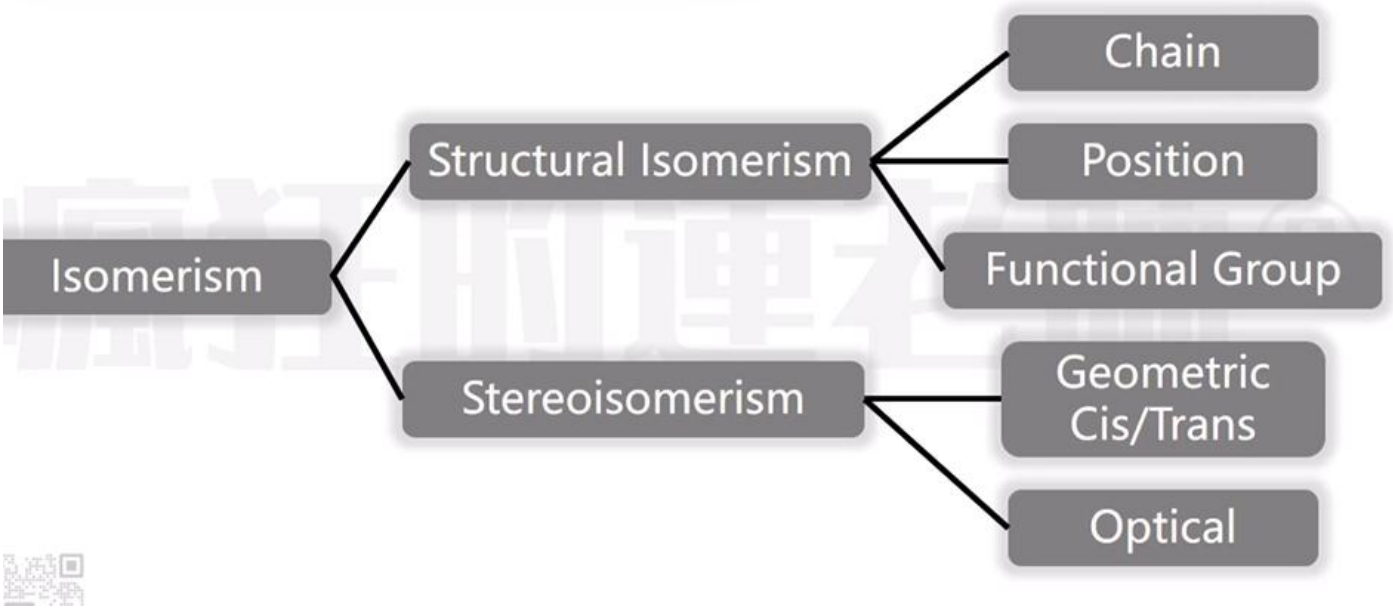


compound **X**

A. *trans*-2-hydroxyhex-3-ene
B. *trans*-2-hydroxyhexene
C. *trans*-5-hydroxyhex-3-ene
D. *trans*-5-hydroxyhexene

9.summary

Structure of functional group	General formula	Name of an example	Structural formula of the example
alkenes, 	C_nH_{2n}	ethene	$CH_2{=}CH_2$
arenes, 	C_6H_5-	benzene	
halogenoalkanes, —X, where X = F, Cl, Br, I	$C_nH_{2n+1}X$	chloromethane	CH_3Cl
alcohols, —OH	$C_nH_{2n+1}OH$	methanol	CH_3OH
aldehydes, 	$C_nH_{2n+1}CHO$	ethanal	CH_3CHO
ketones, 	$C_nH_{2n+1}COC_mH_{2m+1}$	propanone	CH_3COCH_3
carboxylic acids, 	$C_nH_{2n+1}COOH$	ethanoic acid	CH_3COOH
esters, 	$C_nH_{2n+1}COOC_mH_{2m+1}$	ethyl ethanoate	$CH_3COOC_2H_5$
amines, $-NH_2$	$C_nH_{2n+1}NH_2$	methylamine	CH_3NH_2
nitriles, —C≡N	$C_nH_{2n+1}CN$	ethanenitrile	CH_3CN


Isomerism
Structural Isomerism
Chain
Position
Functional Group
Stereoisomerism
Geometric
Cis/Trans
Optical