

PROSPERITY ACADEMY

AS CHEMISTRY 9701

Crash Course

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INTRODUCTION TO ORGANIC CHEMISTRY

COMPLETE NOTES



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Intro to Organic Chemistry:-

Organic Compounds:- All those compounds containing carbon except for:-

- 1) oxides of carbon CO and CO_2
- 2) Carbonates and hydrogen carbonate ions HCO_3^- , CO_3^{2-}
- 3) Carbonic acid, H_2CO_3
- 4) Hydrogen cyanide and CN^\ominus ion.

Functional Groups:- An atom or a group of atoms that replace hydrogen in an organic compound that defines the structure of a family and determines its chemical reactions.

Name	Formula	Name	Formula
1) Halogenoalkane	$-\text{X}$ ($\text{X} = \text{Cl}, \text{Br}, \text{I}$)	7) Carboxylic acid	$-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{H}$
2) Primary Alcohol	$\text{R}-\text{CH}_2-\text{OH}$	8) ester	$-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-$
3) Secondary Alcohol	$\text{R}-\overset{\text{R}'}{\underset{ }{\text{C}}}-\text{OH}$	9) Acyl chloride	$-\overset{\text{O}}{\parallel}{\text{C}}-\text{Cl}$
4) Tertiary Alcohol	$\text{R}-\overset{\text{R}'}{\underset{\text{R}''}{\underset{ }{\text{C}}}}-\text{OH}$	10) Amide	$-\overset{\text{O}}{\parallel}{\text{C}}-\text{NH}_2$
5) Aldehyde	$-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$	11) Nitrile	$-\text{C}\equiv\text{N}$
6) Ketone	$-\overset{\text{O}}{\parallel}{\text{C}}-$		

Homologous series:- Family of organic compounds that have the same general formula and successive members differ by CH_2 . They have same chemical properties.

Examples

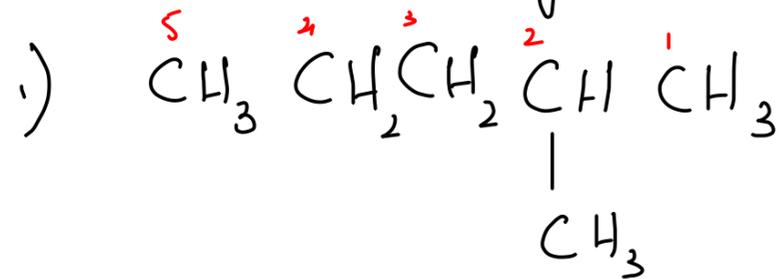
- Alkanes $\text{C}_n \text{H}_{2n+2}$
- Alkenes $\text{C}_n \text{H}_{2n}$
- Alcohols $\text{C}_n \text{H}_{2n+1} \text{OH}$
- Carboxylic acids $\text{C}_n \text{H}_{2n+1} \text{COOH}$

Naming organic compounds:-

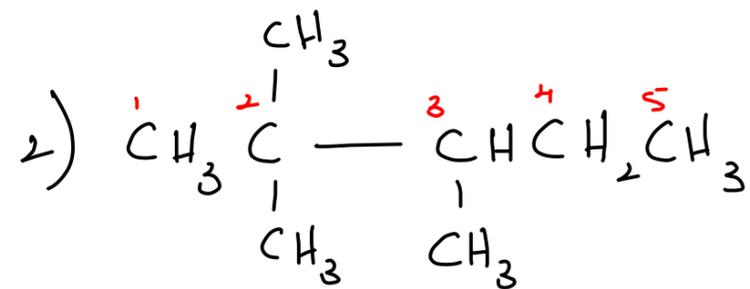
Alkane	Molecular Formula	Structural Formula	Alkyl	Molecular Formula
Methane	CH_4	CH_4	Methyl	CH_3
Ethane	C_2H_6	CH_3CH_3	Ethyl	C_2H_5
Propane	C_3H_8	$\text{CH}_3\text{CH}_2\text{CH}_3$	Propyl	C_3H_7
Butane	C_4H_{10}	$\text{CH}_3(\text{CH}_2)_2\text{CH}_3$	Butyl	C_4H_9
Pentane	C_5H_{12}	$\text{CH}_3(\text{CH}_2)_3\text{CH}_3$	Pentyl	C_5H_{11}
Hexane	C_6H_{14}	$\text{CH}_3(\text{CH}_2)_4\text{CH}_3$	Hexyl	C_6H_{13}
Heptane	C_7H_{16}	$\text{CH}_3(\text{CH}_2)_5\text{CH}_3$	Heptyl	C_7H_{15}
Oktane	C_8H_{18}	$\text{CH}_3(\text{CH}_2)_6\text{CH}_3$	Oktyl	C_8H_{17}
Nonane	C_9H_{20}	$\text{CH}_3(\text{CH}_2)_7\text{CH}_3$	Nonyl	C_9H_{19}
Dekane	$\text{C}_{10}\text{H}_{22}$	$\text{CH}_3(\text{CH}_2)_8\text{CH}_3$	Dekyl	$\text{C}_{10}\text{H}_{21}$
Undekane	$\text{C}_{11}\text{H}_{24}$	$\text{CH}_3(\text{CH}_2)_9\text{CH}_3$	Undekyl	$\text{C}_{11}\text{H}_{23}$
Dodekane	$\text{C}_{12}\text{H}_{26}$	$\text{CH}_3(\text{CH}_2)_{10}\text{CH}_3$	Dodekyl	$\text{C}_{12}\text{H}_{25}$

- 1) Choose the longest chain
- 2) Start numbering from where a branch/functional group will get the lowest number.
- 3) Numbers are separated by , whereas words and numbers are separated by -
- 4) If same groups present, use di/tri.
- 5) If different groups present, quote in alphabetical order.

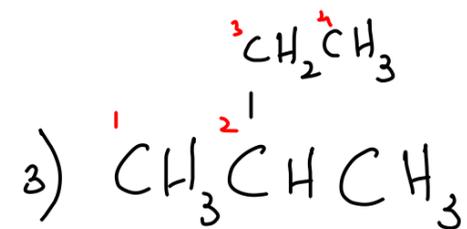
Name the following: -



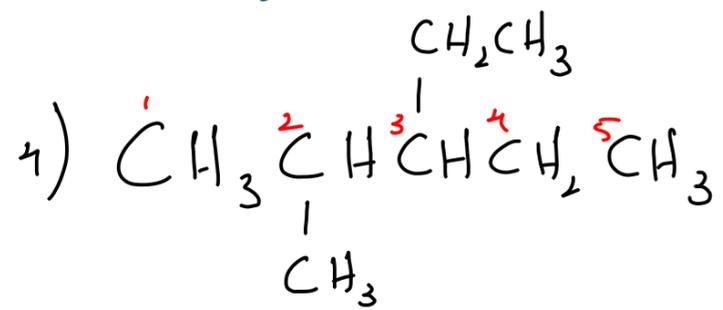
2-methyl pentane



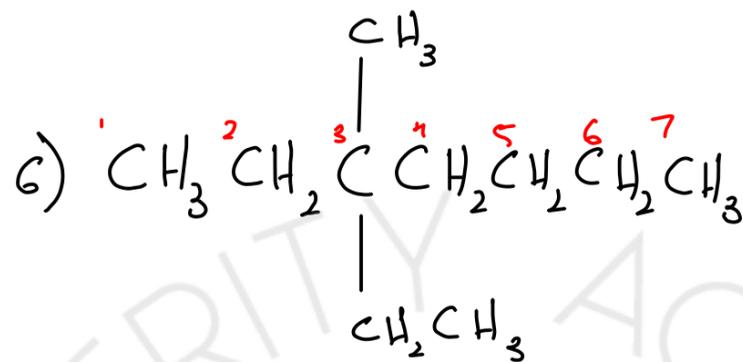
2,2,3-trimethyl pentane



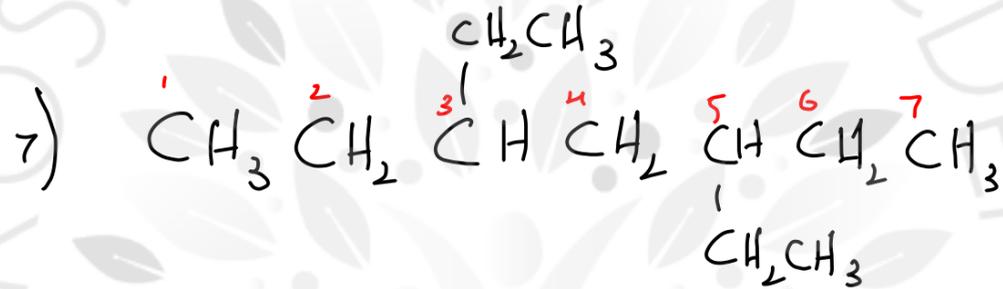
2-methyl butane



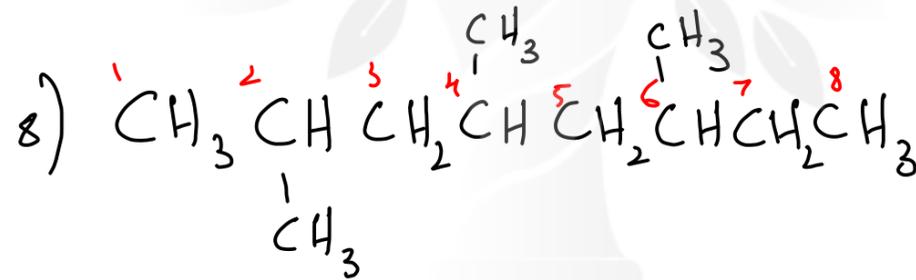
3-ethyl-2-methyl pentane



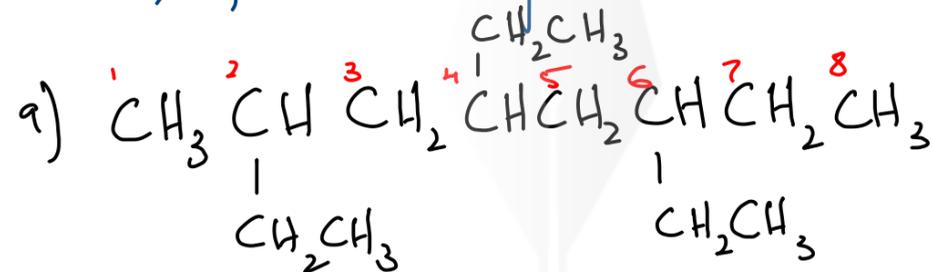
3-ethyl-3-methyl heptane



3,5-diethyl heptane



2,4,6-trimethyl octane



2,4,6-triethyl octane

Organic Formulae:-

Molecular formula:- Just gives the atoms and their number in a molecule (No information about structure)
e.g. C_2H_6O (ethanol)

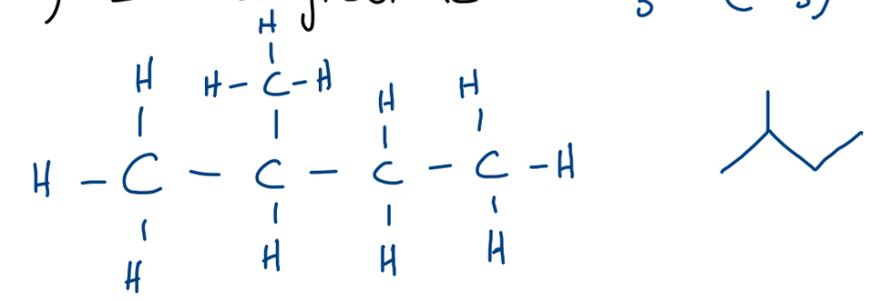
Structural formula:- Shows the order in which atoms are bonded to each other
e.g. CH_3CH_2OH (ethanol)

Displayed formula:- Shows all the atoms and bonds
e.g.
$$\begin{array}{c} \text{H} & \text{H} \\ | & | \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ | & | \\ \text{H} & \text{H} \end{array}$$
 (ethanol)

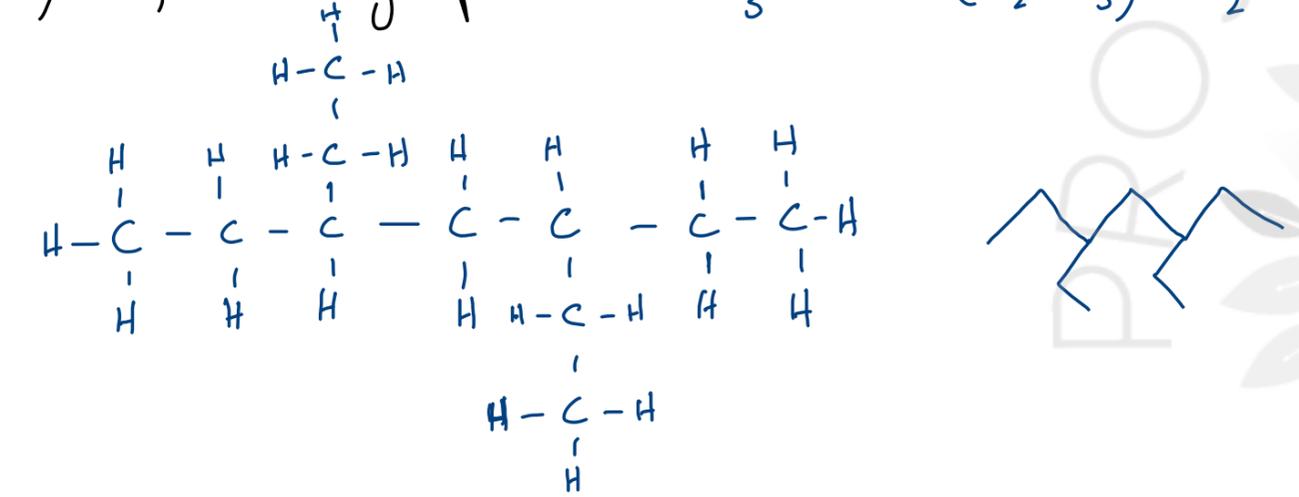
Skeletal formula:- Represents the carbon chain as a zig zag. Symbols for C & H are removed, functional groups are shown
e.g.


Draw structural, displayed and skeletal formula for:-

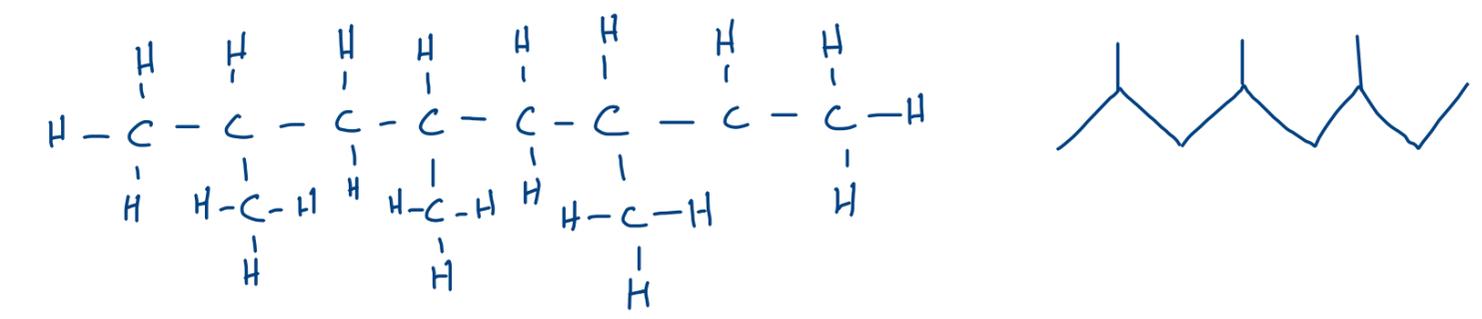
1) 2-methylbutane $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$



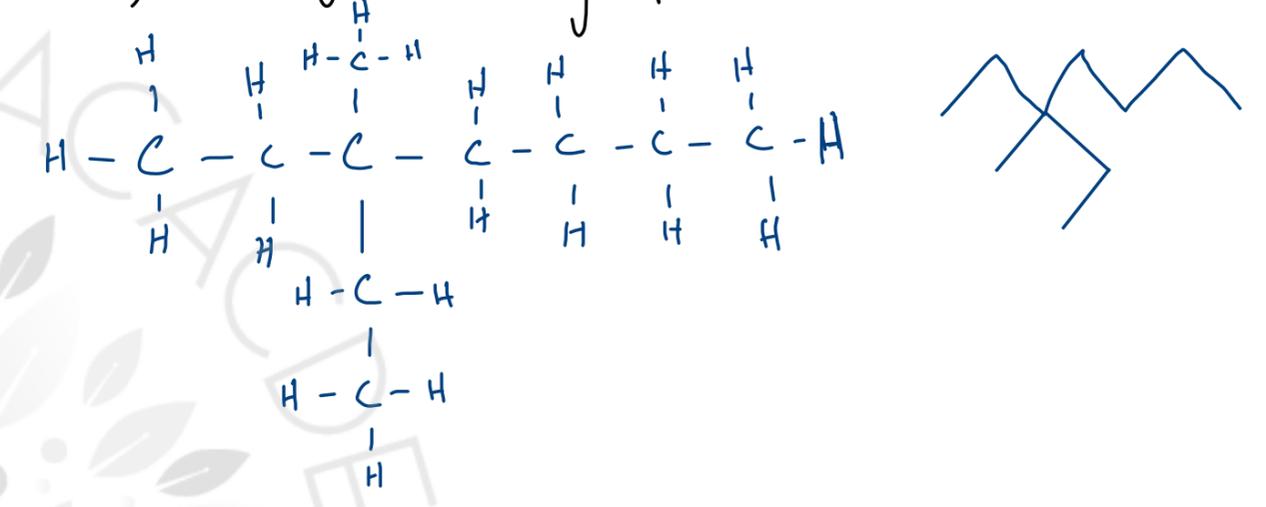
2) 3,5-diethylheptane $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_2\text{CH}_3$



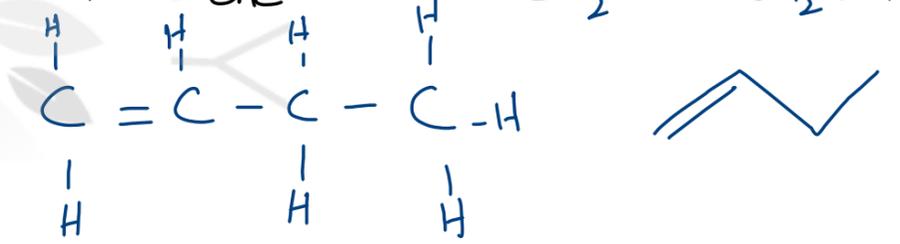
3) 2,4,6-trimethyl octane $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$



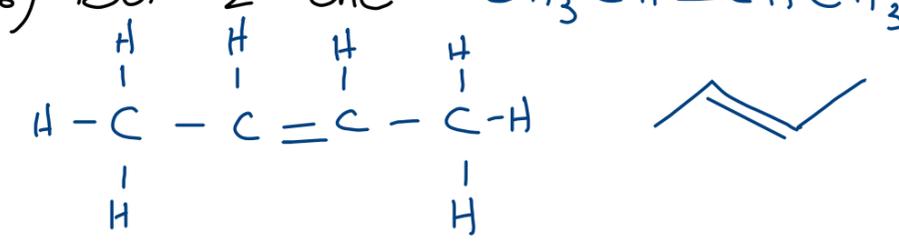
4) 3-ethyl-3-methylheptane $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)(\text{CH}_2\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$



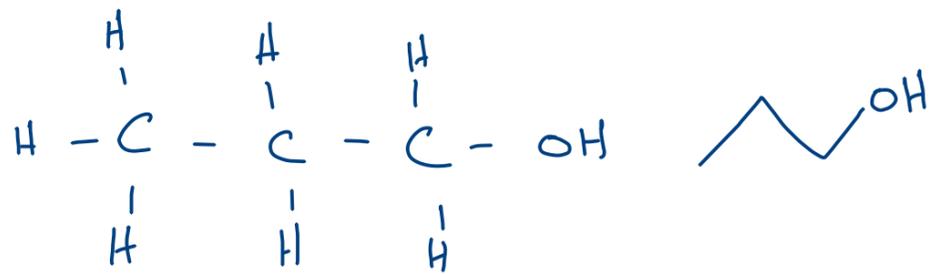
5) But-1-ene $\text{CH}_2=\text{CHCH}_2\text{CH}_3$



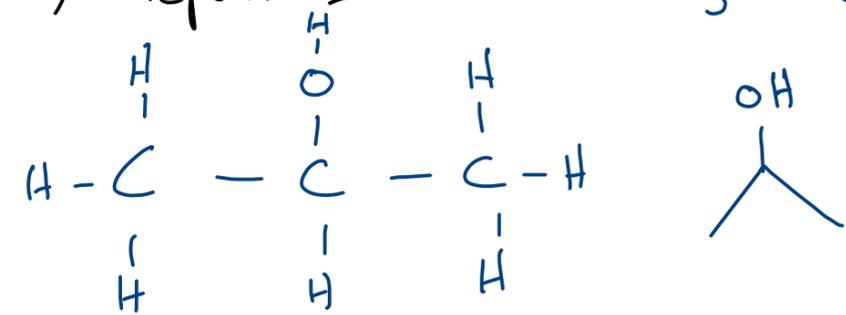
6) But-2-ene $\text{CH}_3\text{CH}=\text{CHCH}_3$



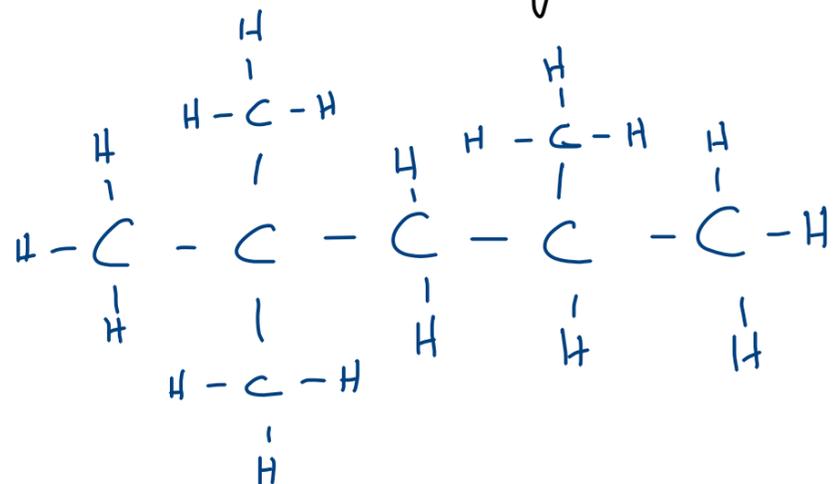
7) Propan-1-ol $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$



8) Propan-2-ol $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$



9) 2,2,4-trimethylpentane $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{CH}(\text{CH}_3)_2$



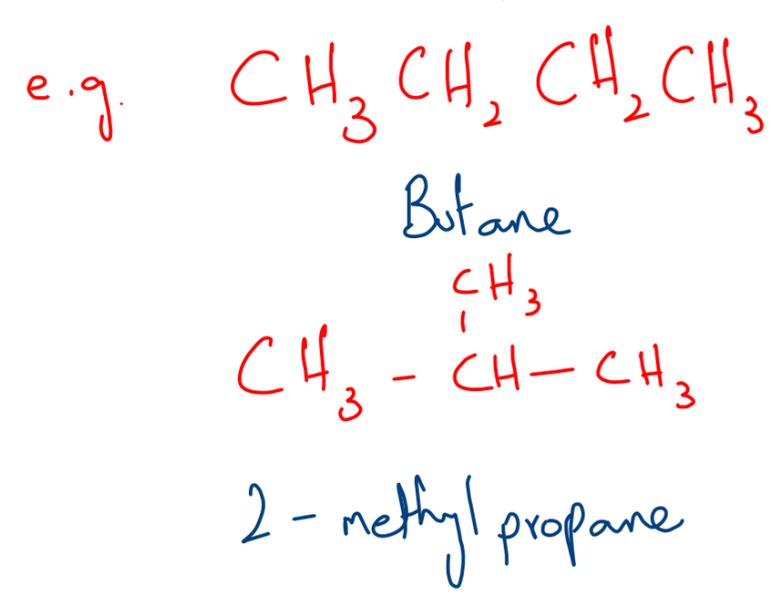
Isomerism

Isomers:- Compounds that have the same molecular formula but the atoms are bonded to each other differently.

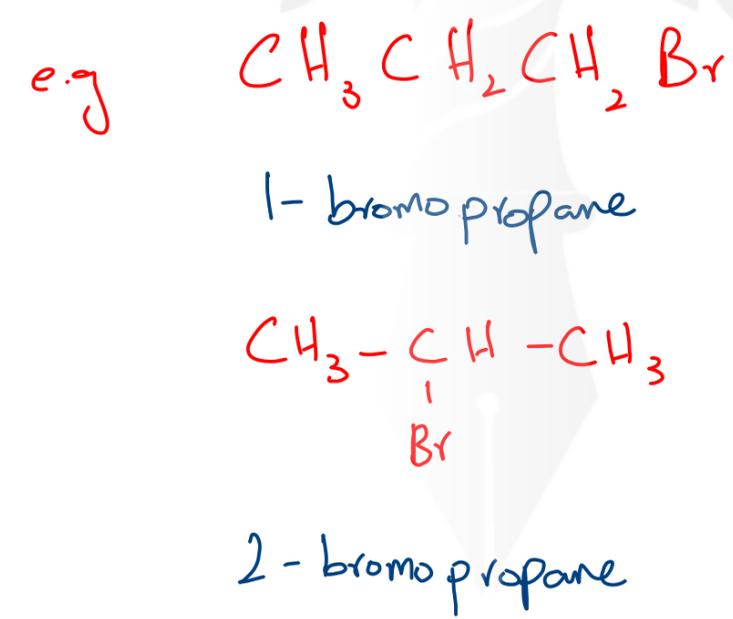
- Structural isomerism:- Same molecular formula but different structural formula
- Stereo isomerism:- Same structural formula but atoms are differently arranged in 3D space.

Structural isomerism

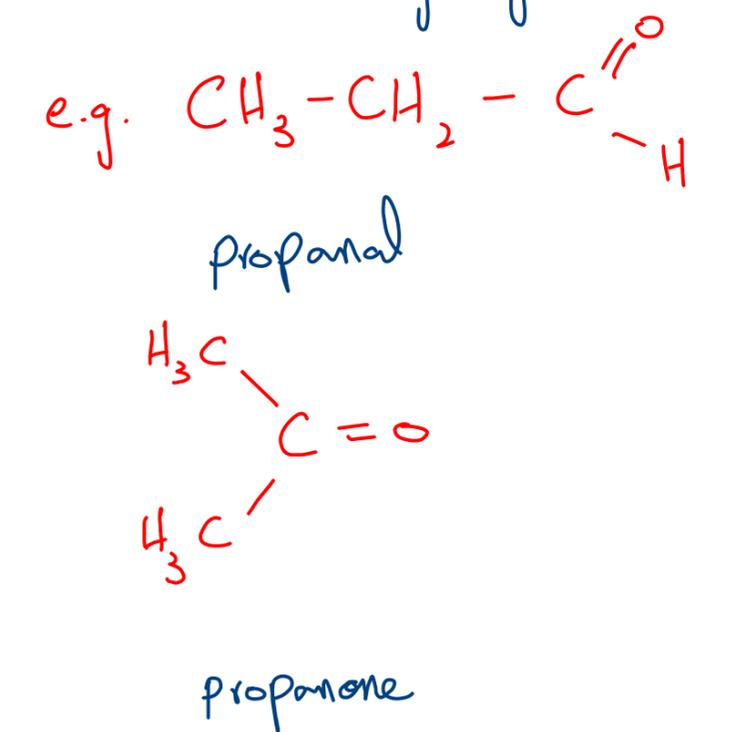
Chain isomerism
Arise due to branching of alkyls



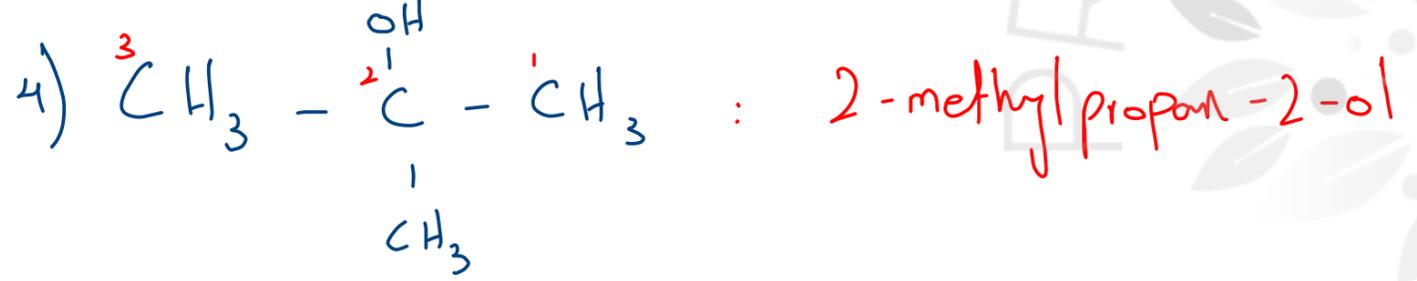
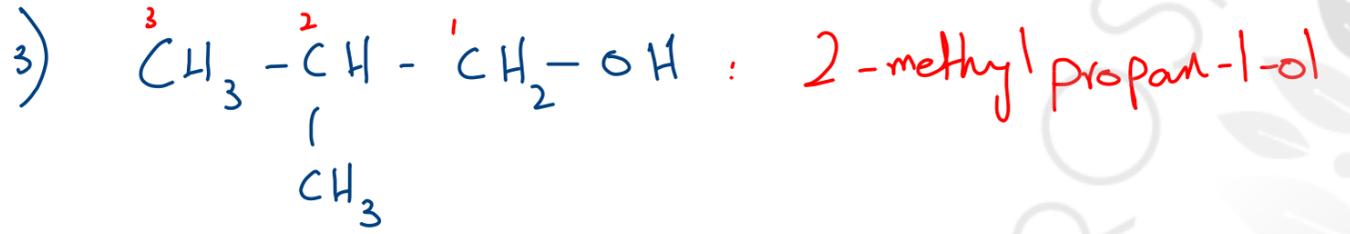
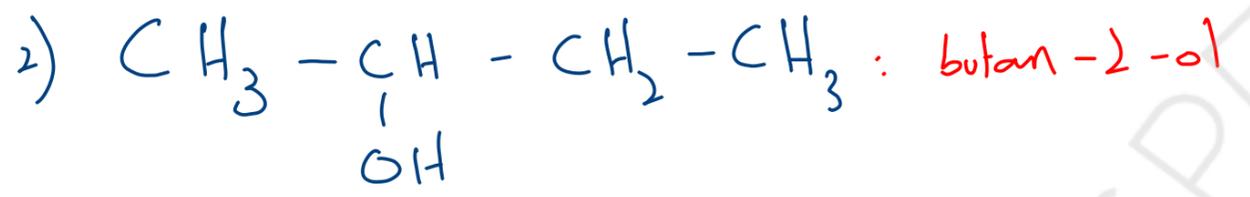
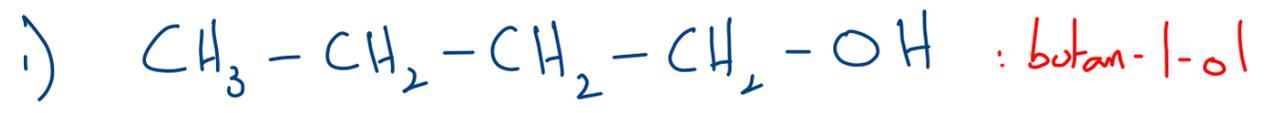
Position isomerism
Arise due to change in position of functional group



Functional group isomerism
Arise due to a change of functional group

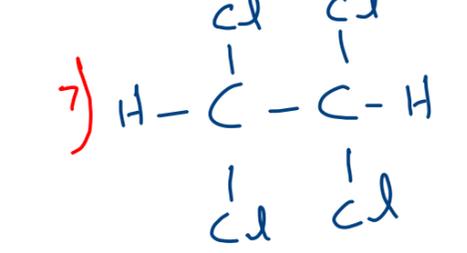
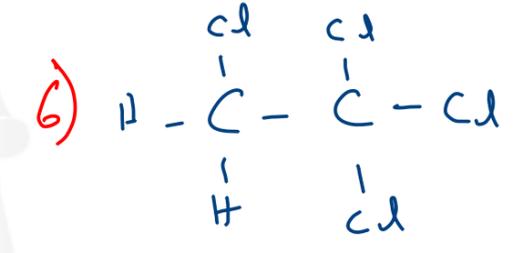
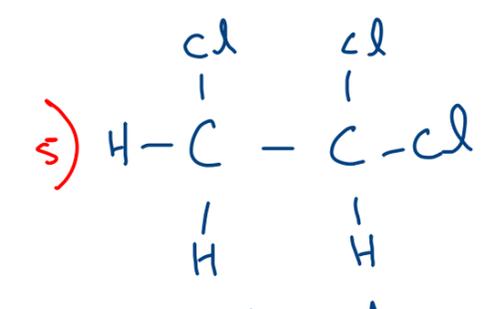
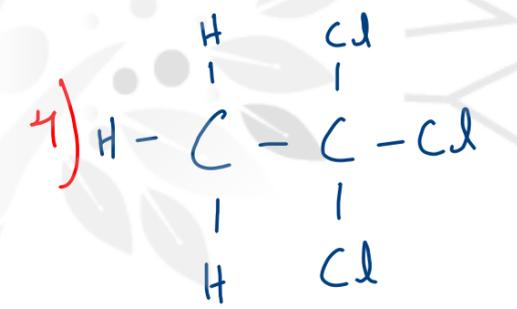
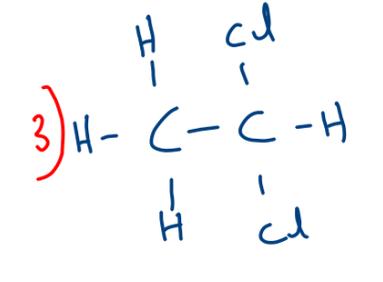
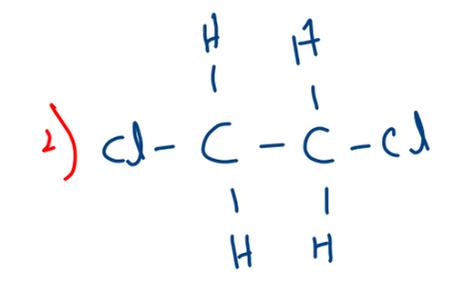
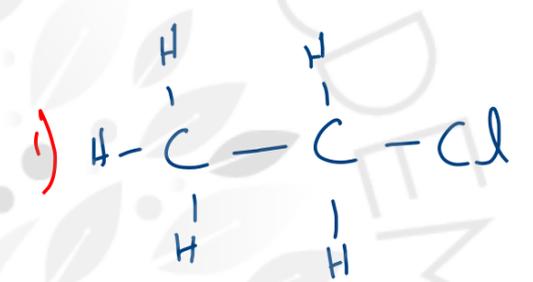
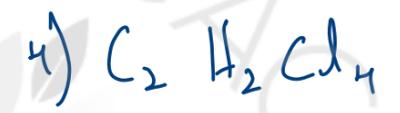
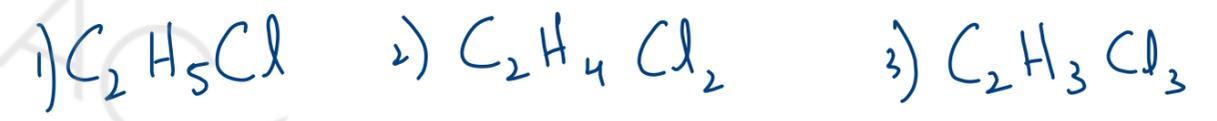


Q. Draw the isomers of butanol



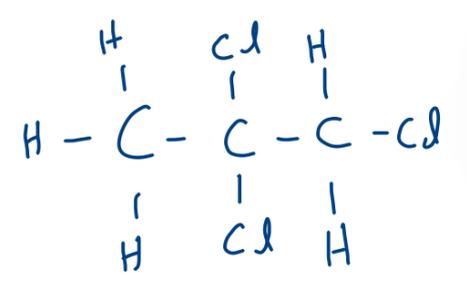
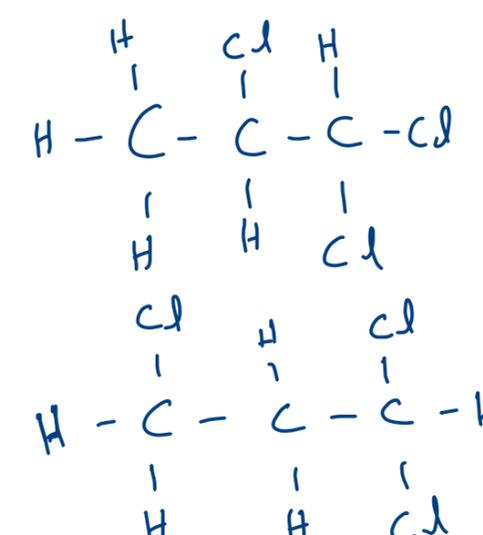
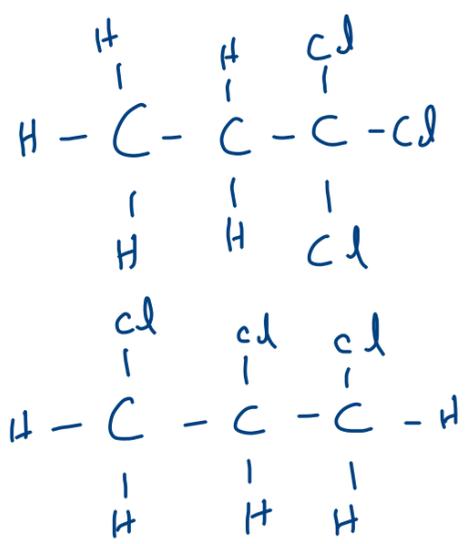
8 What is the total number of different chloroethanes, formula $\text{C}_2\text{H}_{6-n}\text{Cl}_n$, where n can be any integer from 1 to 4?

- A 4 B 6 C 7 D 8

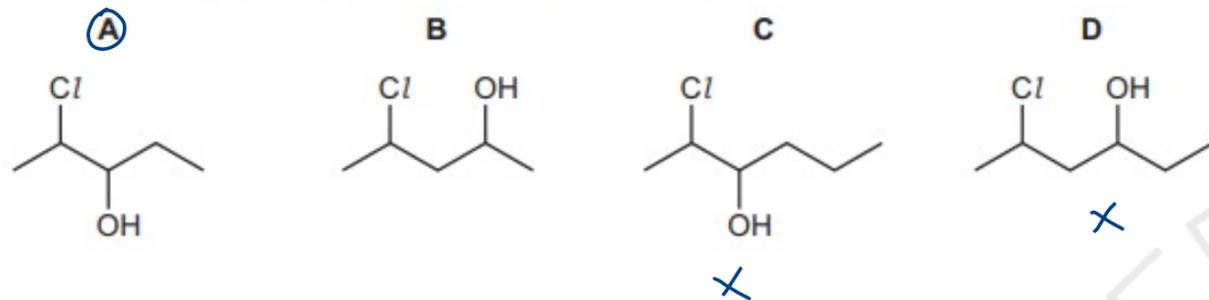


20 How many structural isomers are there of trichloropropane, $\text{C}_3\text{H}_5\text{Cl}_3$?

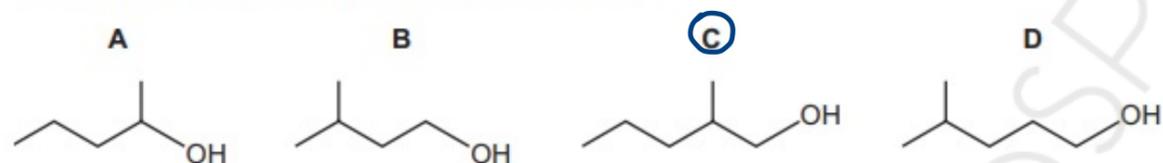
- A 3 B 4 C 5 D 6



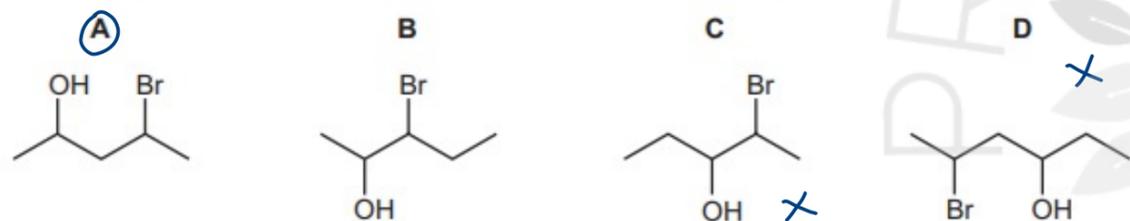
30 Which diagram gives the skeletal formula of 2-chloropentan-3-ol?



34 What is the skeletal formula of 2-methylpentan-1-ol?



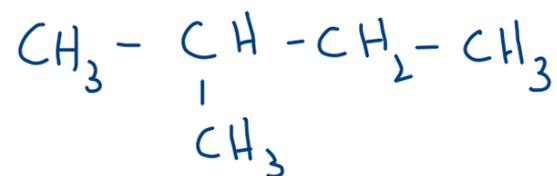
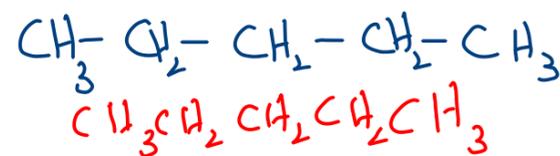
38 Which diagram gives the skeletal formula of 2-bromopentan-4-ol?



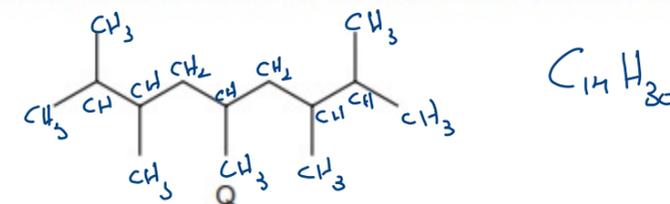
40 There are three structural isomers with the formula C_5H_{12} .

Which formulae correctly represent these three structural isomers?

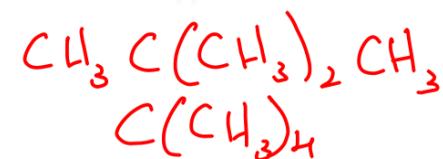
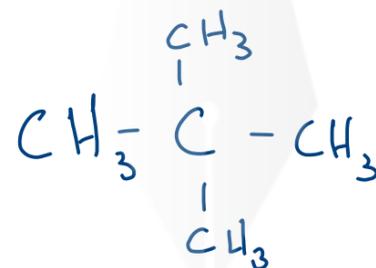
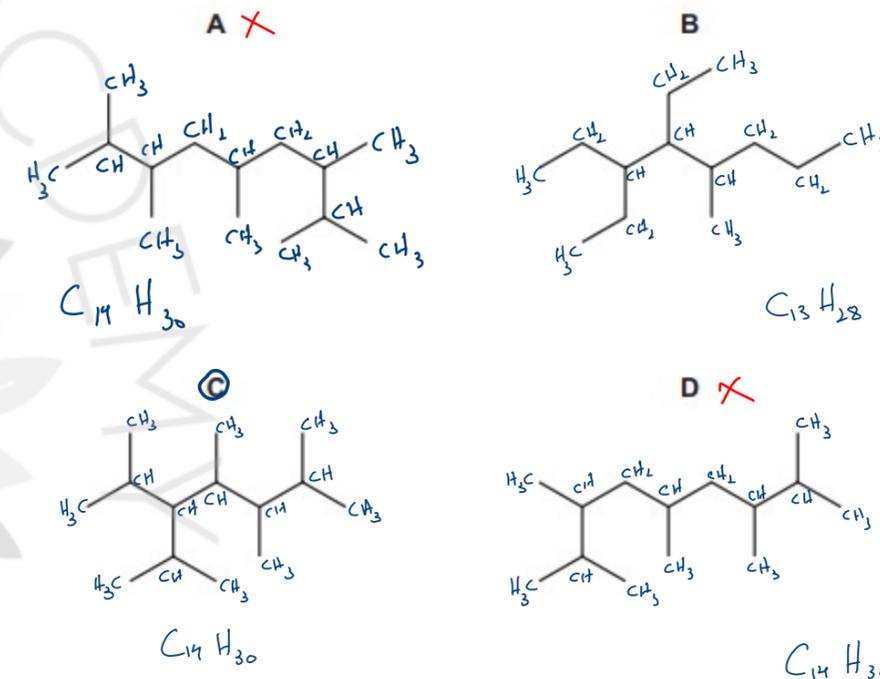
- A $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$ $CH_3CH_3C(CH_3)CH_3$
 B $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2(CH_2)CH_3CH_3$ $C(CH_3)_4$
 C $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3C(CH_3)_2CH_3$ ✓
 D $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$ ✗



53 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?

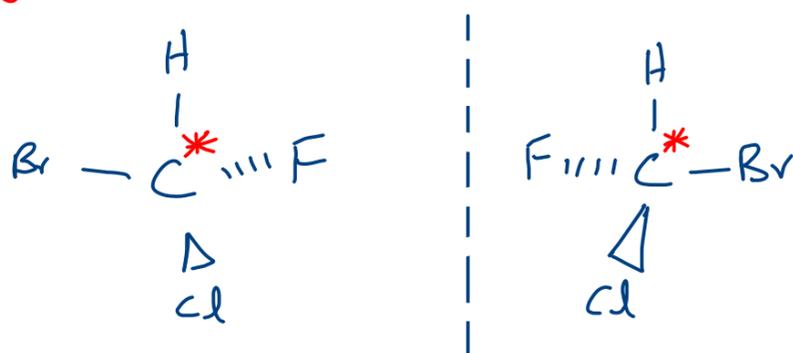


Stereo isomerism

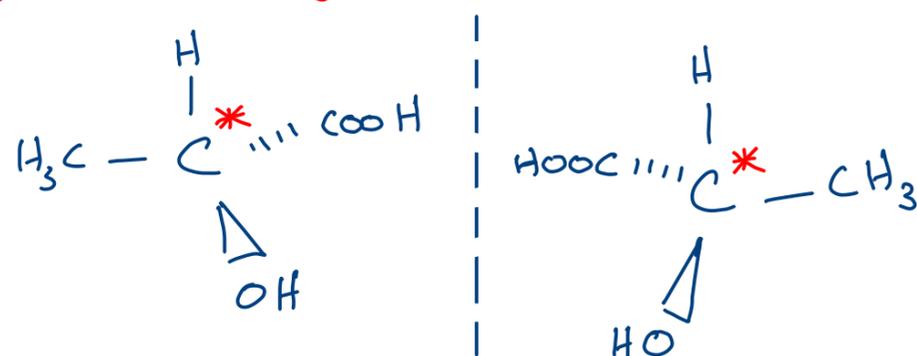
Optical isomerism

- Arises when a carbon is bonded to 4 different atoms
- Such a carbon is known as a chiral centre
- isomers are non superimposable images of each other
- They rotate plane polarised light in opposite directions

e.g. CHBrClF



e.g. 2-hydroxypropanoic acid

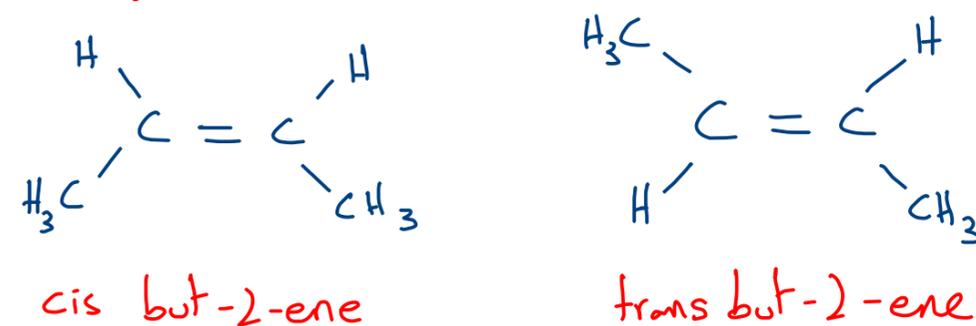


- If a compound has n chiral centres, it usually has 2^n chiral centres (not always!)
- A carbon that has a double bond or is CH_2 or CH_3 can never be chiral

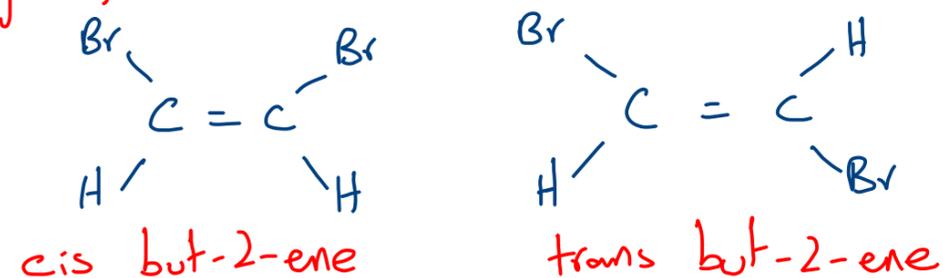
Geometric / cis-trans isomerism

- Arises due to $\text{C}=\text{C}$, as π bond prevents rotation about it.
- 2 different groups must be attached to each carbon

e.g. but-2-ene



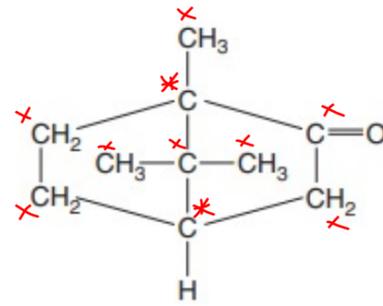
e.g. 1,2-dibromoethene



- A compound that has n $\text{C}=\text{C}$ with different groups on each carbon, will have 2^n geometric isomers.

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Camphor is used for medical purposes, the diagram shows its structure.

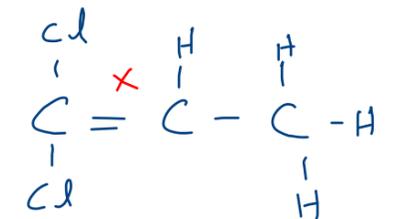
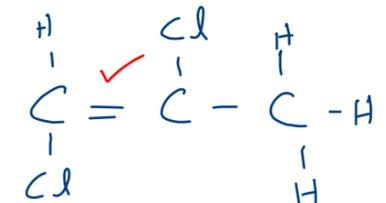
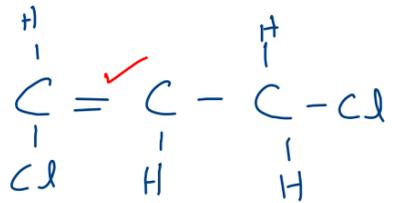
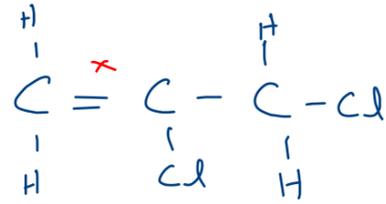
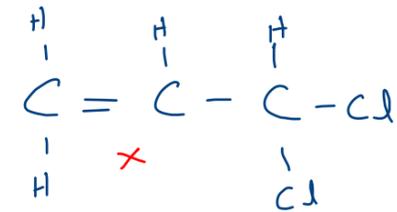


How many chiral centres are present in one molecule of camphor?

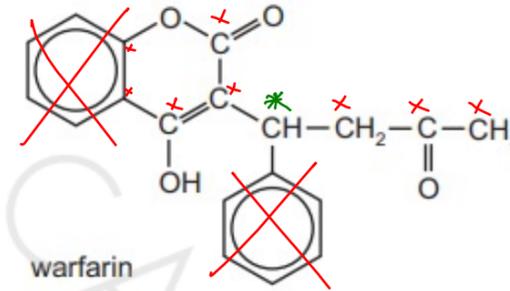
- A** 0 **B** 1 **C** 2 **D** 3

3 How many structural and *cis-trans* isomers are there for dichloropropene, $C_3H_4Cl_2$?

- A** 3 **B** 5 **C** 6 **D** 7



4 Warfarin is used as a rat poison.

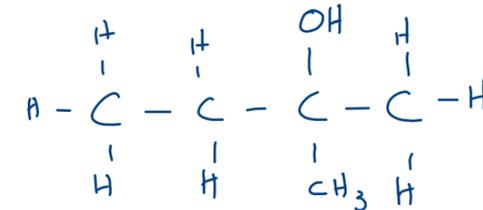
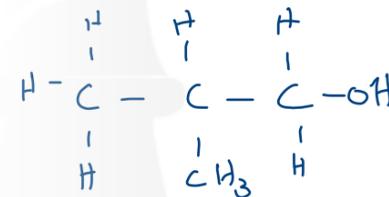
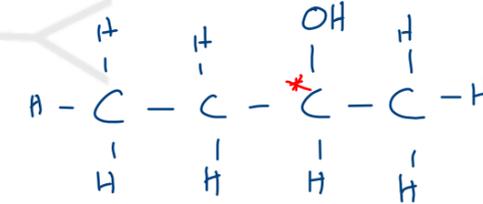
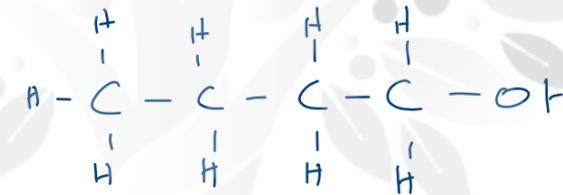


How many chiral centres are present in the warfarin molecule?

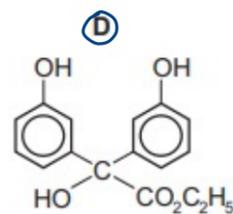
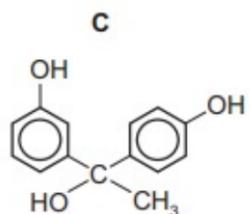
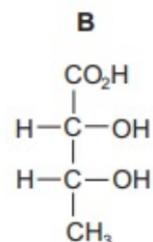
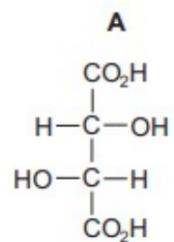
- A** 0 **B** 1 **C** 2 **D** 3

5 How many alcohols (including both structural isomers and stereoisomers) can have the molecular formula $C_4H_{10}O$?

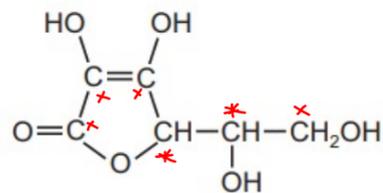
- A** 3 **B** 4 **C** 5 **D** 6



6 Which molecule does not have a chiral centre?



10 The diagram shows the structure of vitamin C.



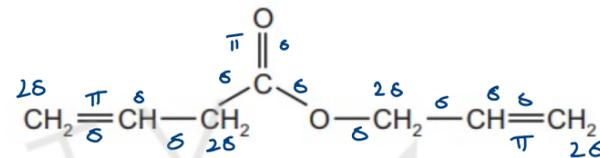
How many chiral centres are there in one molecule?

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

11 Which alkene could exist in *cis* and *trans* forms?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$ ✗
B $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ ✓
 C $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$ ✗
 D $\text{CH}_3\text{CH}(\text{CH}_3)=\text{CCH}_3$ ✗

22 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

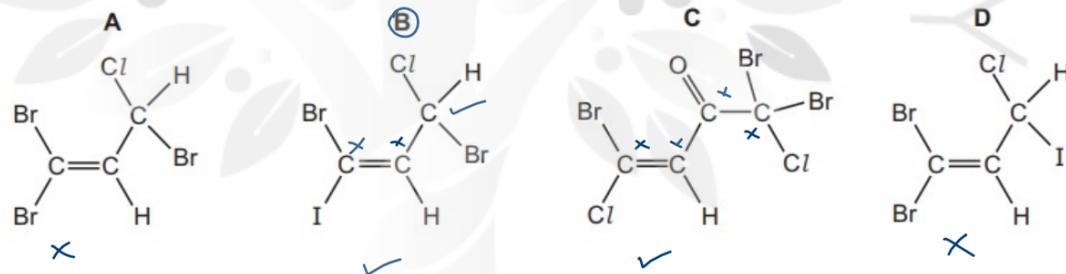
26 An alkene has the formula $\text{CH}_3\text{CH}=\text{CRCH}_2\text{CH}_3$ and does not possess *cis-trans* isomers.

What is R?

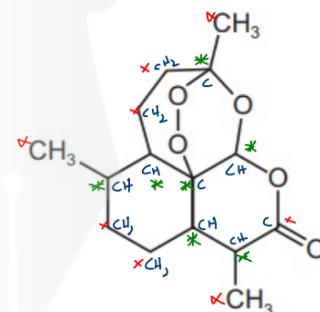
- A H B Cl C CH_3 **D** C_2H_5

32 The following compounds are found in the seaweed *Asparagopsis taxiformis*.

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



43 Artemisinin is a powerful anti-malarial drug.



artemisinin

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

- A 4 B 6 **C 7** D 8

39 Including structural and stereoisomers, how many isomers are there of $\text{C}_2\text{H}_2\text{Br}_2$?

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

