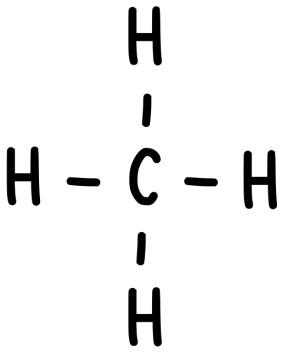
CAIE IGCSE Chemistry

11.1 Formulae, functional groups and terminology

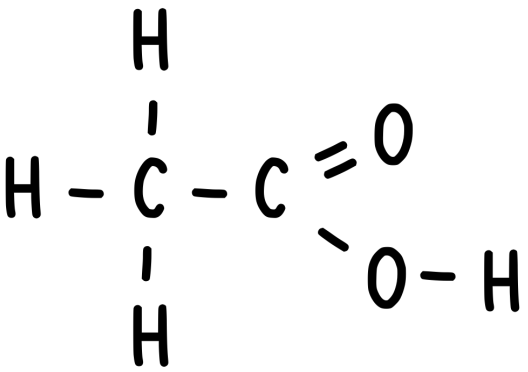
Notes

Draw and interpret the displayed formula of a molecule to show all the atoms and all the bonds

- The displayed formula shows all the atoms of each element and all the bonds in the molecule
- E.g. The molecular formula of methane is CH_4, draw the displayed formula of methane.
    - We know that each hydrogen atom can only form 1 bond whereas a carbon atom can form 4 bonds so the displayed formula of CH_4 would be:



- E.g. The molecular formula for ethanoic acid is CH_3COOH, draw the displayed formula of ethanoic acid.
    - We know that each hydrogen atom can only form 1 bond, a carbon atom can form 4 bonds and an oxygen atom can form 2 bonds so the displayed formula of CH_3COOH would be:



Write and interpret general formulae of compounds in the same homologous series, limited to:

The general formula is a formula followed by all the compounds in the same homologous series representing the composition of the atoms present in each molecule

(a) Alkanes, C_nH_{2n+2}

- The general formula for an alkane is C_nH_{2n+2}
- E.g. An alkane has 5 carbon atoms, what is the molecular formula of this alkane?
    - 5 carbon atoms means n is 5 so working out no. of H atoms: 2(5) + 2 = 12
    - The molecular formula is C_5H_{12} (pentane)

(b) Alkenes, C_nH_{2n}

- The general formula for an alkene is C_nH_{2n}
- E.g. An alkene has 4 carbon atoms, what is the molecular formula of this alkene?
    - 4 carbon atoms means n is 4 so working out no. of H atoms = 2(4) = 8
    - The molecular formula is C_4H_8 (butene)

(c) Alcohols, $C_nH_{2n+1}OH$

- The general formula for an alcohol is $C_nH_{2n+1}OH$
- E.g. An alcohol has 4 carbon atoms, what is the molecular formula of this alcohol?
    - 4 carbon atoms means n is 4 so working out no. of H atoms = 2(4) + 1 = 9
    - The molecular formula is C_4H_9OH (butanol)

(d) Carboxylic acids, $C_nH_{2n+1}COOH$

- The general formula for a carboxylic acid is $C_nH_{2n+1}COOH$
- E.g. A carboxylic acid has a total of 4 carbon atoms, what is the formula of this carboxylic acid?
    - 4 carbon atoms including the functional group COOH, so n is 3 so working out no. of H atoms = 2(3) + 1 = 7
    - The formula is C_3H_7COOH (butanoic acid)

Identify a functional group as…

- The functional group is an atom or group of atoms that determine the chemical properties of a homologous series
- E.g. The functional group of an alcohol is the hydroxyl group (-OH)

State that a homologous series is…

- A homologous series is a family or group of similar compounds with similar chemical properties due to the presence of the same functional group

State that a saturated compound…

- A saturated compound has molecules in which all carbon-carbon bonds are single bonds
- E.g. All alkanes are saturated compounds since they only have single carbon-carbon bonds.

State that an unsaturated compound…

- An unsaturated compound has molecules in which one or more carbon-carbon bonds are not single bonds
- E.g. Alkenes are unsaturated since they all have at least one double carbon-carbon bond.

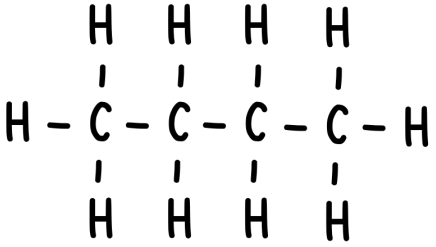
(Extended only) State that a structural formula is an unambiguous description of the way the atoms in a molecule are arranged, including $CH_2=CH_2$, CH_3CH_2OH, CH_3COOCH_3

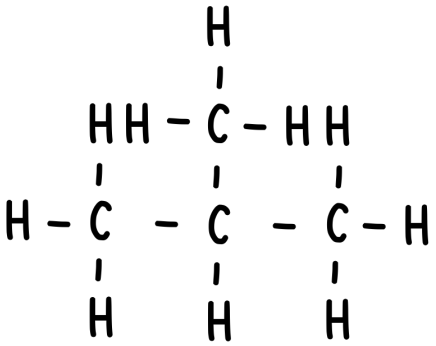
- The structural formula is a formula which shows the arrangement of atoms in the molecule of a compound but does not show all the bonds between them.
- E.g. $CH_2=CH_2$ is the structural formula for ethene (molecular formula C_2H_4) and shows where the double bond lies
- E.g. CH_3CH_2OH is the structural formula for ethanol (molecular formula C_2H_5OH)
- E.g. CH_3COOCH_3 is the structural formula for methyl ethanoate (an ester with the molecular formula $C_3H_6O_2$)

(Extended only) Define structural isomers as compounds with the same molecular formula, but different structural formulae, including C_4H_{10} as $CH_3CH_2CH_2CH_3$ and $CH_3CH(CH_3)CH_3$ and C_4H_8 as $CH_3CH_2CH=CH_2$ and $CH_3CH=CHCH_3$

- Structural isomers are compounds with the same molecular formula but different structural formula

- E.g. C_4H_{10} has 2 structural isomers:





$CH_3CH_2CH_2CH_3$

butane

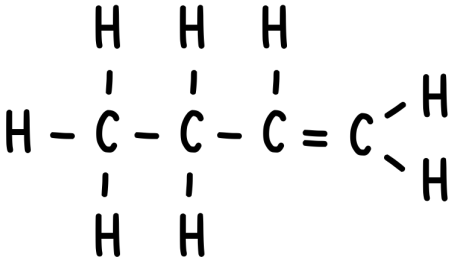
$CH_3CH(CH_3)CH_3$

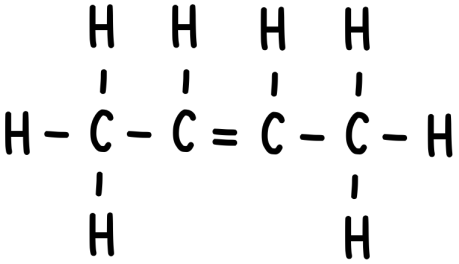
2-methylpropane

Both isomers have molecular formula C_4H_{10}

  - The structural isomers of C_4H_{10} differ in that 2-methylpropane has a side group (a methyl group) whereas butane is a straight chain molecule

- E.g. C_4H_8 has 2 structural isomers:





$CH_3CH_2CH=CH_2$

but-1-ene

$CH_3CH=CHCH_3$

but-2-ene

Both isomers have molecular formula C_4H_8

  - The structural isomers of C_4H_8 differ in where the double bond lies in the structure

(Extended only) Describe the general characteristics of a homologous series as…

- The general characteristics of a homologous series are:
  - have the same functional group
  - have the same general formula
  - differ from one member to the next by a $–CH_2–$ unit
  - display a trend in physical properties
  - share similar chemical properties