

11.1 Formulae, functional groups and terminology

Name: _____ Class: _____ Date: _____ **Total: 26 marks**

KEY WORDS molecular formula 分子式 • homologous series 同系物 • displayed formula 结构式
• structural formula 结构简式 • alcohols 醇

Objective

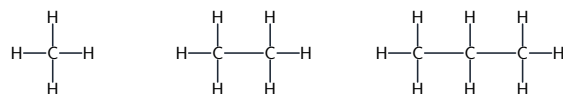
Build the skills to answer exam questions on **formulae, functional groups and terminology** 有机化学术语 — types of formula, the **homologous series** 同系物, saturated/unsaturated, and **structural isomers** 同分异构体.

You must be able to:

- use molecular, displayed, structural and general formulae
- describe a homologous series and its general formula
- recognise saturated/unsaturated and structural isomers

1 Worked examples

■ Homologous series & isomers



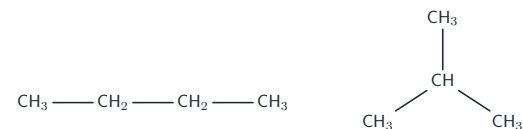
methane
CH₄

ethane
C₂H₆

propane
C₃H₈

each step adds a CH₂ unit general formula C_nH_{2n+2}

A homologous series: same functional group, differ by CH₂, general formula C_nH_{2n+2} for alkanes



butane (straight chain)

2-methylpropane (branched)

both have the formula C₄H₁₀: same formula,
different structure (structural isomers)

Structural isomers: same molecular formula, different structures

■ Naming, drawing and telling isomers apart

A **homologous series** 同系列 is a family with the same **functional group** 官能团, the same general formula, and neighbours differing by CH₂. Along a series the boiling point rises as the molecules get longer, because the intermolecular forces between the larger molecules are stronger.

Series	Functional group	General formula	First four
alkanes	none (all single bonds)	C _n H _{2n+2}	methane, ethane, propane, butane
alkenes	C = C	C _n H _{2n}	ethene, propene, butene
alcohols	–OH	C _n H _{2n+1} OH	methanol, ethanol, propanol
carboxylic acids	–COOH	C _n H _{2n+1} COOH	methanoic, ethanoic, propanoic

Three formulas, three jobs. The **molecular formula** counts the atoms (C₄H₁₀). The **structural formula** shows the order of the groups without drawing every bond (CH₃CH₂CH₂CH₃). The **displayed formula** 结构式 draws every atom and every bond, so each carbon must show four bonds and each hydrogen one.

Structural isomers 结构异构体 have the same molecular formula but different structures, so they have different physical properties (for example different boiling points) while sharing the same chemical family.

Worked example. Draw and name the two isomers of C₄H₁₀, and explain why they have different boiling points. Butane is a straight chain of four carbons; 2-methylpropane is a chain of three with a CH₃ branch on the middle carbon. Both must show every carbon with four bonds. Butane boils higher, because its unbranched molecules pack closer together, so the forces between them are stronger and more energy is needed to separate them.

2 Practice

2.1 State the general formula of the alkanes. [1]

2.2 Define a structural isomer. [1]

2.3 State the general formula of the alkenes and give the molecular formula of the alkene with four carbon atoms. [2]

2.4 State two features shared by all members of a homologous series. [2]

2.5 Explain why the boiling points rise as you go along a homologous series. [2]

3 Exam-style questions

3.1 A saturated hydrocarbon contains: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A a C=C double bond
B only single C–C bonds
C an –OH group
D a –COOH group

3.2 Members of a homologous series have similar chemical properties.

(a) State why they have similar chemical properties. [1]

(b) State how consecutive members differ. [1]

3.3 Draw the two structural isomers of C₄H₁₀ and name each. [3]

3.4 A hydrocarbon X has the molecular formula C_5H_{12} .

(a) Identify the homologous series X belongs to, and give its general formula. [2]

(b) Draw the displayed formula of the straight-chain isomer of X. [2]

(c) Draw the displayed formula of one branched isomer of X, and explain why it is described as a structural isomer of your answer to (b). [3]

(d) The straight-chain isomer boils at 36°C and the branched one at 28°C . Explain this difference. [2]

(e) A different compound, Y, has the molecular formula C_5H_{10} and decolourises bromine water. Identify the homologous series of Y and explain how the test shows this. [3]
