

29.1 Formulas, functional groups and naming

Name: _____ Class: _____ Date: _____

Total: 21 marks

KEY WORDS benzene 苯 • functional group 官能团 • aromatic 芳香 • benzene ring 苯环
• systematic nomenclature 系统命名法

Objective

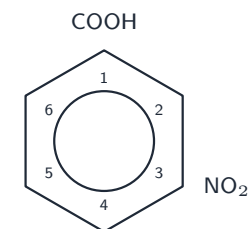
Build the skills to answer exam questions on **naming organic compounds** 有机化合物命名 — functional groups, the four kinds of formula, and **systematic nomenclature** 系统命名法 of aliphatic and **aromatic** 芳香 molecules.

You must be able to:

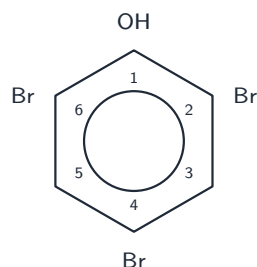
- identify the functional group that dictates a compound's properties
- interpret general, structural, displayed and skeletal formulas
- name aliphatic molecules (up to six carbons, incl. single rings)
- name simple aromatic molecules with one benzene ring (e.g. 3-nitrobenzoic acid)

1 Worked examples

■ Naming an aromatic compound

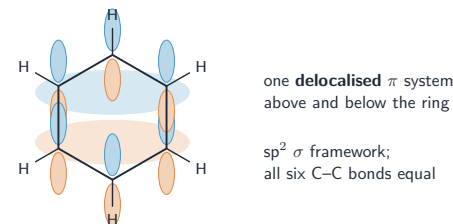


3-nitrobenzoic acid



2,4,6-tribromophenol

Number the ring from the principal group (carbon 1); the substituent positions give the name



The delocalised benzene ring

Name $\text{C}_6\text{H}_4(\text{NO}_2)(\text{COOH})$ with the groups on carbons 1 and 3.

- the $-\text{COOH}$ is the principal group $\rightarrow$ parent is **benzoic acid**, its carbon is **C1**
- the $-\text{NO}_2$ is on **C3** $\rightarrow$ prefix **3-nitro**
- name: **3-nitrobenzoic acid**

Skeletal vs displayed. A skeletal formula shows each bond as a line, with carbons at the ends/bends and hydrogens on carbon left out; a displayed formula shows every atom and bond.

2 Practice

2.1 State what is meant by a **functional group**. [1]

2.2 Name the compound: a benzene ring with an $-\text{OH}$ on C1 and $-\text{Br}$ on C2, C4 and C6. [1]

3 Exam-style questions

3.1 The skeletal formula of a compound has 5 line-ends and bends in a chain with a terminal $-\text{COOH}$. Which feature does a skeletal formula leave out? [1]

- **A** the functional group
- **B** carbon atoms
- **C** hydrogen atoms bonded to carbon
- **D** the longest chain

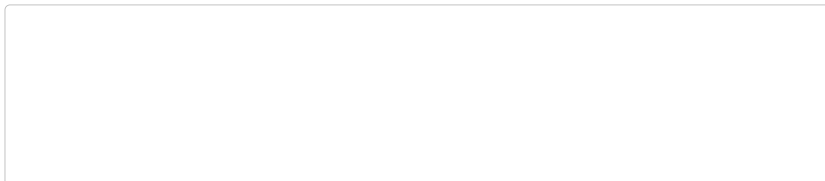
3.2 Which is the correct systematic name for the molecule with an -NH_2 on C2 of a 4-carbon carboxylic acid? [1]

- **A** 2-aminobutanoic acid
 - **B** butan-2-amine
 - **C** 2-aminobutanal
 - **D** aminobutanoic acid
-

3.3 Give the systematic name of: [3]

- (a) a benzene ring carrying one -CH_3 and one -NO_2 on adjacent carbons (methyl on C1)
(b) the cyclic alcohol cyclohexanol
(c) propanenitrile, $\text{CH}_3\text{CH}_2\text{CN}$
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-
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3.4 Draw the **skeletal** formula of 3-nitrobenzoic acid. [2]

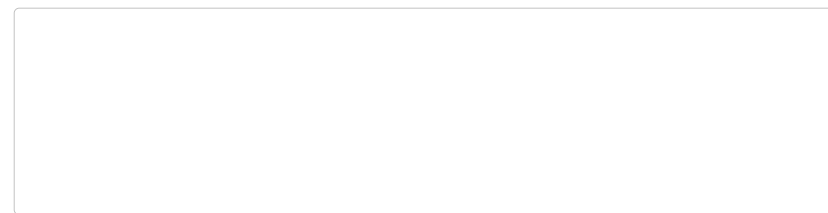


3.5 A compound **W** has the skeletal structure of a five-carbon chain with a methyl branch on carbon 2, a $\text{C}=\text{C}$ between carbons 3 and 4, and an OH on carbon 1. Its molecular formula is $\text{C}_6\text{H}_{12}\text{O}$.

(a) Give the systematic name of **W**, and explain how the position numbers are chosen.[3]

(b) Give the empirical formula and the general formula of the homologous series to which **W**'s alcohol group belongs. [2]

(c) Draw the displayed formula of **W**. [3]



(d) Name **two** functional groups present in **W**, and for each state one reagent that would react with it. [4]

Solutions

2.1 an atom or group of atoms that gives a molecule its characteristic chemical (and physical) properties.

2.2 2,4,6-tribromophenol.

3.1 C. A skeletal formula omits the hydrogen atoms bonded to carbon (and the carbons are shown only as line-ends/bends).

3.2 A. 2-aminobutanoic acid — the -COOH is C1, the -NH_2 is on C2.

3.3 (a) 2-methylnitrobenzene / 1-methyl-2-nitrobenzene

(b) cyclohexanol

(c) propanenitrile.

3.4 a benzene hexagon with -COOH drawn at C1 and -NO_2 at C3.

3.5 (a) 2-methylpent-3-en-1-ol. The chain is numbered from the end that gives the **principal functional group** — here the alcohol — the lowest number, so the OH carbon is C1; the double bond and the methyl branch are then numbered from that same end.

(b) Empirical formula $\text{C}_6\text{H}_{12}\text{O}$ — the ratio 6:12:1 has no common factor, so it equals the molecular formula; the alcohols have the general formula $\text{C}_n\text{H}_{2n+1}\text{OH}$.

(c) Every atom and every bond shown, with $\text{HOCH}_2\text{-CH(CH}_3\text{)-CH=CH-CH}_3$.

(d) Alcohol (hydroxyl) — reacts with sodium (effervescence of hydrogen), or with acidified potassium dichromate(VI). Alkene (C=C) — reacts with bromine water, decolourising it, or adds hydrogen over a nickel catalyst.