

Exercise walk-through

29.1

Formulas, functional groups and the naming of organic compounds

A-Level Chemistry

Why chirality matters for a drug

A **chiral centre** is a carbon carrying **four different** groups. Its two **enantiomers** are mirror images – and a living body is not symmetric, so they can have **different biological activity**: one active, the other useless or harmful.

- make both and **separate** them – slow and wasteful
- or use a **chiral catalyst** to make only the one you want

Which of these is chiral?

butan-1-ol – no

butan-2-ol – yes: its C2 carries H, OH, CH₃ and C₂H₅

2-methylpropan-2-ol – no, two methyls are the same

Look for one carbon with four **different** groups. Count carefully – two identical branches kill it.

New functional groups at A Level

A **functional group** is the reactive part that names the family and fixes how the molecule behaves. Two join the list:

amide

–CONH₂ – a carbonyl bonded straight to nitrogen; the link in proteins and nylon

aromatic

anything built on a benzene ring, with its delocalised electrons and its own chemistry

As before, name the parent chain, then the substituents – and number so the functional group gets the **lowest** locant.

Worked example – spotting a chiral centre

Explain why lactic acid $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$ is optically active but propanoic acid is not.

- Look for one carbon carrying **four different groups**.
- In lactic acid the middle C has CH_3 , OH, COOH and H – all different $\Rightarrow$ a **chiral centre**.
- Its mirror image cannot be superimposed $\Rightarrow$ two **enantiomers**, rotating polarised light oppositely.
- $\text{CH}_3\text{CH}_2\text{COOH}$ has no such carbon (the middle C has two H) $\Rightarrow$ not chiral.

One carbon, **four different groups**. Enantiomers are identical in every physical and chemical property *except* optical rotation and reactions with other chiral molecules.

Exercises 2.1·2.2

2.1 State what is meant by a **functional group**.

[1]

2.2 Name the compound: a benzene ring with an -OH on C1 and -Br on C2, C4 and C6.

[1]

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2.1

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

2.2 Name the compound: a benzene ring with an –OH on C1 and –Br on C2, C4 and C6. [1]

2.2

- 2,4,6-tribromophenol

Exercise 3.1

3.1 The skeletal formula of a compound has 5 line-ends and bends in a chain with a terminal -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

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3.1 C

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

Exercise 3.2

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

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A 2-aminobutanoic acid

B butan-2-amine

C 2-aminobutanal

D aminobutanoic acid

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C 2-aminobutanal

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3.2 A

- 2-aminobutanoic acid – the -COOH is C1, the -NH_2 is on C2

Exercise 3.3 (a)

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(a) a benzene ring carrying one $-\text{CH}_3$ and one $-\text{NO}_2$ on adjacent carbons (methyl on C1)

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(a)

- 2-methylnitrobenzene / 1-methyl-2-nitrobenzene

Exercise 3.3 (b)

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Exercise 3.4

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[2]

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3.4

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

Exercise 3.5 (a)

3.5 A compound **W** has the skeletal structure of a five-carbon chain with a methyl branch on carbon 2, a C=C between carbons 3 and 4, and an OH on carbon 1. Its molecular formula is C₆H₁₂O.

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- 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

Exercise 3.5 (b)

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(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 $\text{C}_n\text{H}_{2n+1}\text{OH}$

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(c) Draw the displayed formula of **W**.

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(c)

- Every atom and every bond shown, with HOCH₂–CH(CH₃)–CH = CH–CH₃

Exercise 3.5 (d)

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

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(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