

Organic synthesis

A-Level Chemistry

Organic synthesis

This topic does not add new reactions. Instead it asks you to **join up** the reactions you already know, so you can build a target molecule in several steps.



Medicines are built up from simple starting materials by multi-step organic synthesis

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Identifying functional groups

A molecule may have more than one **functional group** 官能团. Use the test reactions from the syllabus to identify each one, and then predict how the molecule will behave. For example:

- decolourises bromine water → a C=C double bond (an **alkene** 烯烃).
- gives a precipitate with silver nitrate → a **halogenoalkane** 卤代烷.
- orange $K_2Cr_2O_7$ turns green → a primary or secondary **alcohol** 醇.
- orange precipitate with 2,4-DNPH → an **aldehyde** 醛 or **ketone** 酮.
- fizzes with a carbonate → a **carboxylic acid** 羧酸.

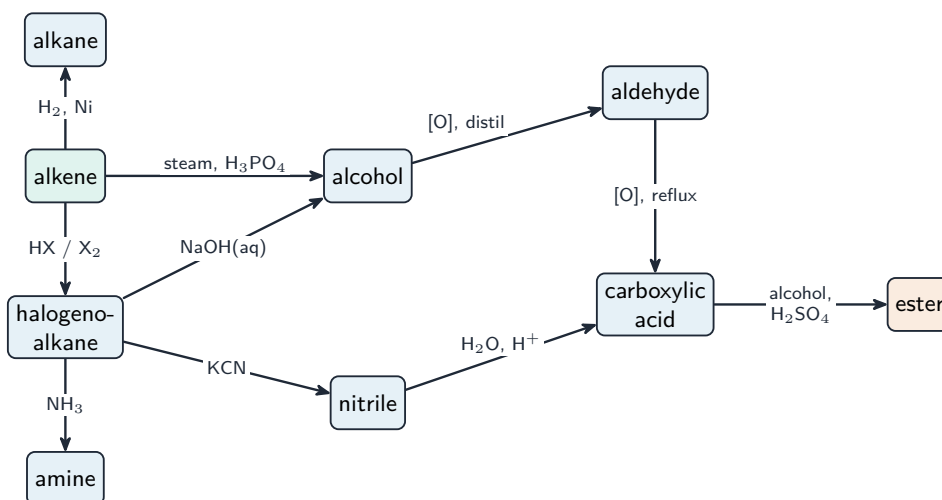
add this	you see	functional group
bromine water	orange → colourless	C=C (alkene)
silver nitrate	a precipitate forms	halogenoalkane
acidified K ₂ Cr ₂ O ₇	orange → green	1°/2° alcohol
2,4-DNPH	orange precipitate	aldehyde / ketone
a carbonate	fizzes (CO ₂ given off)	carboxylic acid

The standard identification tests: each reagent gives a characteristic observation that points to one functional group

A map of the AS reactions

Each row turns one functional group into another. Learn it as a map you can travel around:

Start	Reagent and conditions	Product
alkene	H ₂ , Ni	alkane
alkene	HX, or X ₂	halogenoalkane
alkene	steam, H ₃ PO ₄	alcohol
halogenoalkane	NaOH(aq), heat	alcohol
halogenoalkane	KCN in ethanol, heat	a nitrile 腈 (adds one carbon)
halogenoalkane	NH ₃ in ethanol, pressure	an amine 胺
alcohol	K ₂ Cr ₂ O ₇ , distil / reflux	aldehyde / carboxylic acid
alcohol	concentrated acid, heat	alkene
aldehyde or ketone	NaBH ₄	alcohol
aldehyde or ketone	HCN, KCN	hydroxynitrile
nitrile	dilute acid, heat	carboxylic acid
carboxylic acid + alcohol	concentrated H ₂ SO ₄	an ester 酯



A map of the AS reactions: each arrow turns one functional group into another. Work backwards from your target to plan a route

Planning a multi-step route

To devise a **synthetic route** 合成路线:

1. compare the target with the starting material —what has changed (the functional group, the number of carbons)?
2. work **backwards** from the target: which single reaction could make it, and from what?
3. repeat until you reach the starting material.
4. write each step with its **reagent** 试剂 and conditions.

If you need to add a carbon, the KCN step is the key —it is the only AS reaction that lengthens the chain.

Analysing a route

When you are given a route, for each step state the **type of reaction** (such as **oxidation** 氧化, **reduction** 还原, substitution, addition or elimination) and the reagent used. Also think about possible **by-products** 副产物—for example, making an amine from a halogenoalkane also gives a mixture of further-substituted amines, so the yield of the simple amine is low.