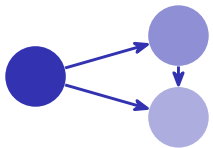
Organic Synthesis

A-Level Chemistry ▪ Topic 36

A-Level Chemistry



What we will cover

1. Identifying functional groups
2. The A Level reaction map
3. Planning a route

1 Tests and routes

Identifying functional groups

A Level identification tests:

- bromine water, no catalyst, white ppt → phenol or phenylamine
- violent with cold water, HCl fumes → **acyl chloride** 酰氯
- purple with neutral $FeCl_3$ → **phenol** 苯酚

add this	**you see**	**functional group**
bromine water (no catalyst)	white precipitate	**phenol or phenylamine**
cold water	violent, HCl fumes	**acyl chloride**
neutral $FeCl_3$	purple colour	**phenol**

The A Level reaction map

The new chains link up:

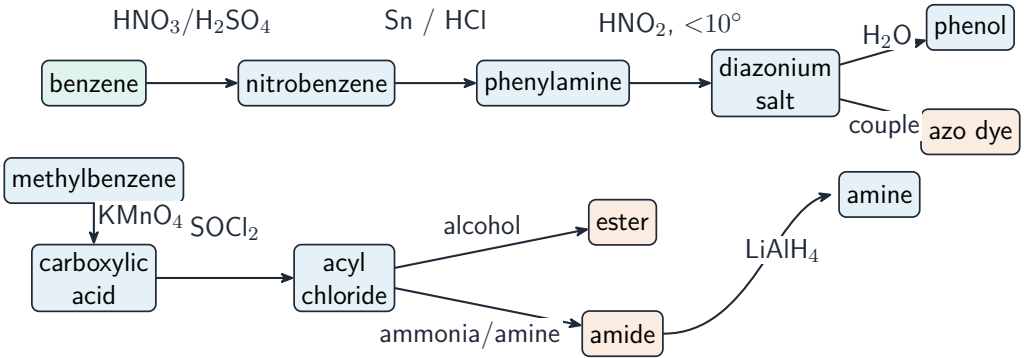
- aromatic: benzene → nitrobenzene → phenylamine → diazonium → phenol / azo dye
- acyl: acid → acyl chloride → ester / amide

The A Level reactions the map adds

halogenoalkane + KCN	gives a **nitrile** 腈 – adds one carbon
nitrile, hydrolysed	gives a **carboxylic acid** 羧酸 with that extra carbon
nitrile, reduced	gives a primary amine, also one carbon longer
arene 芳烃 reactions	**electrophilic substitution** 亲电取代 – nitration, halogenation, Friedel–Crafts
carbonyl + HCN	nucleophilic addition, giving a hydroxynitrile – again one carbon added
acyl chloride + amine	**addition–elimination** 加成-消除, giving an amide

A molecule may carry several **functional groups** 官能团. Use the test reactions to identify each one, then plan the route that changes only the group you need.

The A Level reaction map, in detail

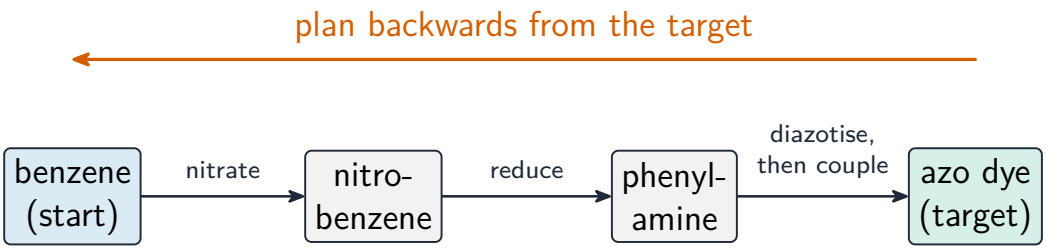


A map of the A Level reactions: the aromatic chain (top) and the acyl-chloride chain (bottom), with their feed-ins. Work backwards from your target

Planning a route

To devise a **synthetic route** 合成路线, work backwards from the target.

> State the **reaction type** 反应类型 for each step (substitution, addition–elimination, oxidation…) and watch for **by-products** 副产物.



Exam tips

- Combine AS and A-level steps and watch for **benzene-ring reactions** and **carbon-count changes**.
- State every **reagent and condition**, and note when a step produces a **racemic mixture**.
- Choose the shortest route that reaches the target functional group.

2 Recap

Worked example – benzene to phenylamine

Suggest a route from benzene to phenylamine, with reagents and conditions for each step.

- There is no way to put NH_2 straight onto the ring – it takes two steps.
- Step 1 nitrate: concentrated HNO_3 + concentrated H_2SO_4, $55°C$ $\Rightarrow$ nitrobenzene.
- Step 2 reduce: Sn + concentrated HCl, reflux; then add excess NaOH.
- The reduction gives the salt $C_6H_5NH_3^+$ first; the NaOH frees phenylamine.

Benzene $\rightarrow$ NH_2 is *always* nitrate-then-reduce. Then phenylamine + HNO_2 at $5°C$ gives the diazonium ion for azo dyes.

Topic 36 – key takeaways

1 Tests

each reagent identifies a group

2 Aromatic chain

benzene to phenylamine to phenol/azo dye

3 Acyl chain

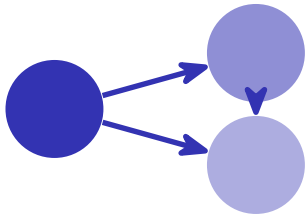
acid to acyl chloride to ester/amide

4 Plan backwards

from the target; state reagent & type

Check yourself

1. What gives a purple colour with neutral $FeCl_3$?
2. Benzene to phenylamine takes how many steps?
3. Which way should you plan a synthesis?
4. What converts an acid to an acyl chloride?



Answers **1.** a phenol **2.** two **3.** backwards from the target **4.** $SOCl_2$ or PCl_5