Organic synthesis

A-Level Chemistry

Organic synthesis

Like the AS synthesis topic, this asks you to **join up** known reactions to build a target molecule. Now you also have the A Level reactions of arenes, phenol, amines, amides and acyl chlorides.

Identifying functional groups

A molecule may carry several **functional group** 官能团 types. Use the test reactions to spot each one, then predict its behaviour. For example:

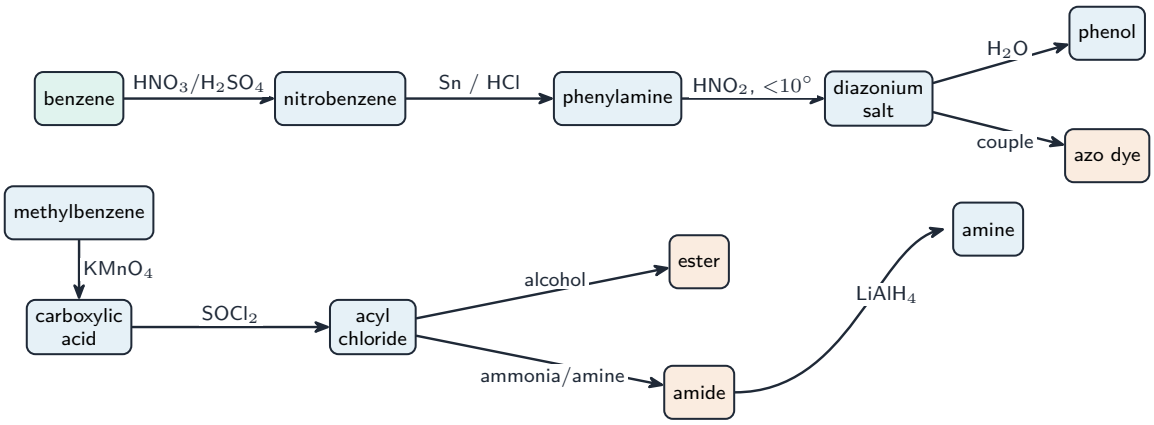
- decolourises bromine water with **no** catalyst, giving a white precipitate → a phenol or a phenylamine (the ring is activated).
- reacts violently with cold water, giving fumes of HCl → an **acyl chloride** 酰氯.
- gives a purple colour with neutral $FeCl_3$ → a **phenol** 苯酚.

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**

Identification tests added at A Level: each reagent gives a characteristic result that points to a functional group

A map of the A Level reactions

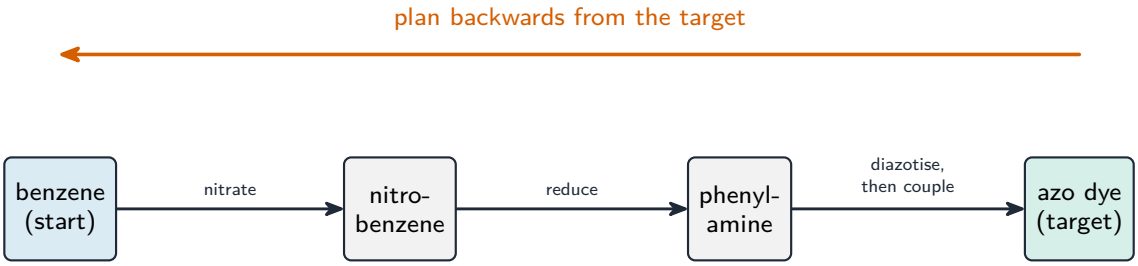
Start	Reagent and conditions	Product
benzene (an **arene** 芳烃)	HNO_3 / H_2SO_4 (**electrophilic substitution** 亲电取代)	nitrobenzene
nitrobenzene	Sn / conc HCl, then NaOH (**reduction** 还原)	phenylamine
phenylamine	HNO_2, below 10 °C	a diazonium salt
diazonium salt	warm water	phenol; or couple with phenol → azo dye
methylbenzene	hot $KMnO_4$ (**oxidation** 氧化)	benzoic acid
carboxylic acid 羧酸	$SOCl_2$ or PCl_5	acyl chloride
acyl chloride	alcohol / phenol	an **ester** 酯
acyl chloride	ammonia / **amine** 胺	an **amide** 酰胺
amide or **nitrile** 腈	$LiAlH_4$	an amine
halogenoalkane	KCN	a nitrile (adds one carbon)



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 and analysing a route

To devise a **synthetic route** 合成路线, work **backwards** from the target: which single reaction makes it, and from what? Repeat until you reach the starting material, then write each step with its **reagent** 试剂 and conditions.



Plan a route by working backwards from the target, one reaction at a time, until you reach the starting material

When you **analyse** a route, state the type of reaction for each step (for example electrophilic substitution, **addition–elimination** 加成消去, oxidation or reduction) and watch for likely **by-products** 副产物—for example, making an amine from a halogenoalkane also gives over-substituted amines, lowering the yield.

Worked example. Devise a route from benzene to phenylamine, $C_6H_5NH_2$. Work **backwards**: phenylamine comes from **reducing** nitrobenzene, and nitrobenzene comes from **nitrating** benzene - so the route is two steps. Step 1: benzene with concentrated HNO_3 and concentrated H_2SO_4 at 55 °C; electrophilic substitution gives nitrobenzene (keep below 55 °C, or further substitution follows). Step 2: reduce the nitrobenzene with **tin and concentrated HCl**, then add NaOH to free the amine from its salt. There is no direct route - you cannot put an $-NH_2$ straight onto a ring, which is exactly why this nitrate-then-reduce pair is worth knowing by heart.

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.