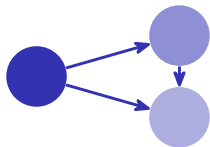


Organic Synthesis

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



Identifying functional groups

A Level identification tests:

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

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 $\rightarrow$ nitrobenzene $\rightarrow$ phenylamine $\rightarrow$ diazonium $\rightarrow$ phenol / azo dye
- acyl: acid $\rightarrow$ acyl chloride $\rightarrow$ ester / amide

The A Level reactions the map adds

halogenoalkane + KCN

gives a **nitrile** – adds one carbon

nitrile, hydrolysed

gives a **carboxylic acid** with that extra carbon

nitrile, reduced

gives a primary amine, also one carbon longer

arene reactions

electrophilic substitution – nitration, halogenation, Friedel–Crafts

carbonyl + HCN

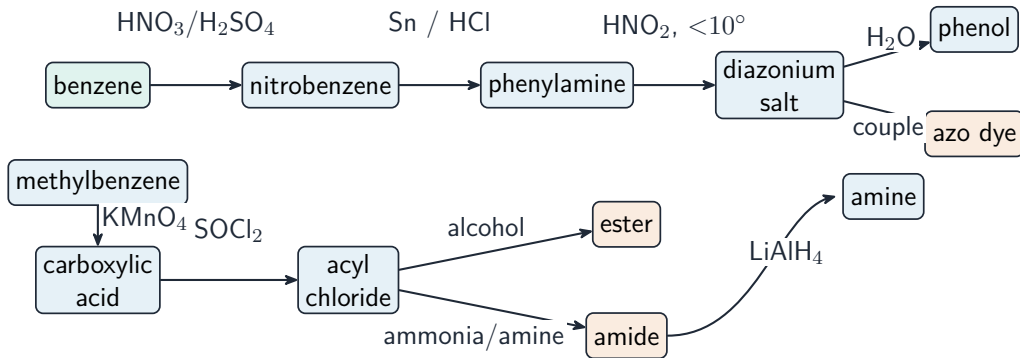
nucleophilic addition, giving a hydroxynitrile – again one carbon added

acyl chloride + amine

addition–elimination –, giving an amide

A molecule may carry **several functional groups** . 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



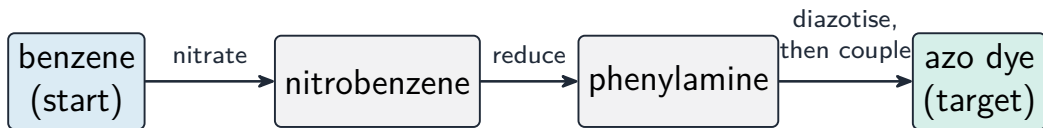
A map of the A Level reactions: the aromatic chain (top) and the acyl-chloride chain (bottom), with their feed-ins. Work backwards from your target

Planning a route

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

State the **reaction type** for each step (substitution, addition–elimination, oxidation...) and watch for **by-products** .

plan backwards from the target



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.



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 , $55^\circ\text{C} \Rightarrow$ nitrobenzene.
- Step 2 **reduce**: Sn + concentrated HCl , reflux; then add **excess NaOH** .
- The reduction gives the salt $\text{C}_6\text{H}_5\text{NH}_3^+$ first; the NaOH frees **phenylamine**.

Benzene $\rightarrow \text{NH}_2$ 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

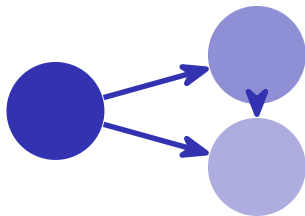
4

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