

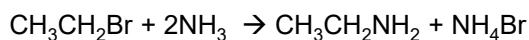


## Nucleophilic properties

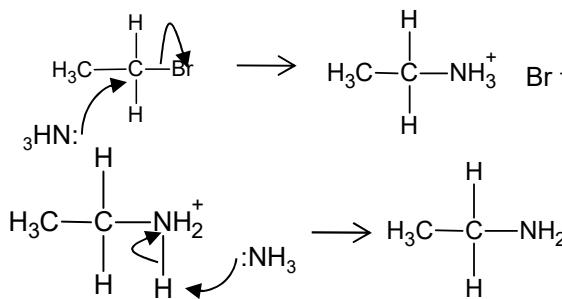
### Forming a primary amine in a one step reaction of halogenoalkanes with ammonia

Primary amines can be formed by the **nucleophilic substitution** reaction between halogenoalkanes and ammonia in a **one step reaction**. However, as the lone pair of electrons is still available on the N in the amine formed, the primary amine can react in the same nucleophilic way in a successive series of reactions forming secondary, tertiary amines and quaternary ammonium salts.

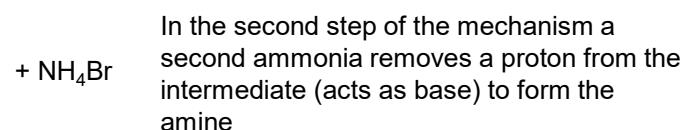
This is therefore not a good method for making a primary amine because of the further reactions. It would mean the desired product would have to be separated from the other products.



Ammonia dissolved in ethanol is the initial nucleophile



In the first step of the mechanism the nucleophile attacks the halogenoalkane to form an intermediate

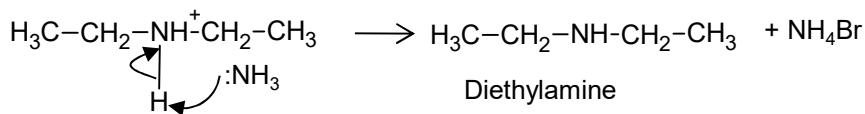
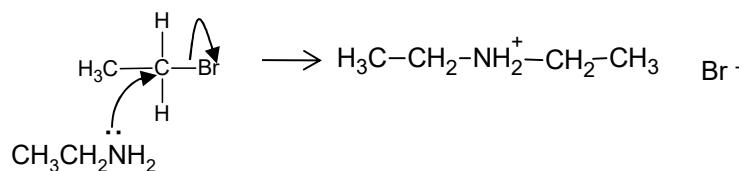


In the second step of the mechanism a second ammonia removes a proton from the intermediate (acts as base) to form the amine

### Further reactions

#### Reaction forming secondary amine

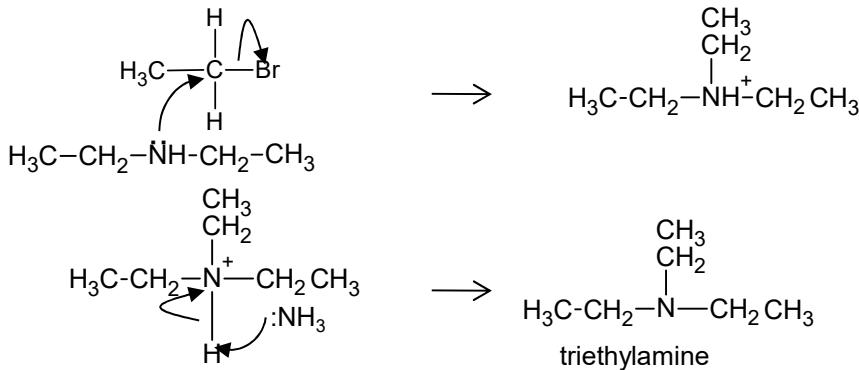
The primary amine formed in the reaction above has a lone pair of electrons on the nitrogen and will react further with the halogenoalkane.



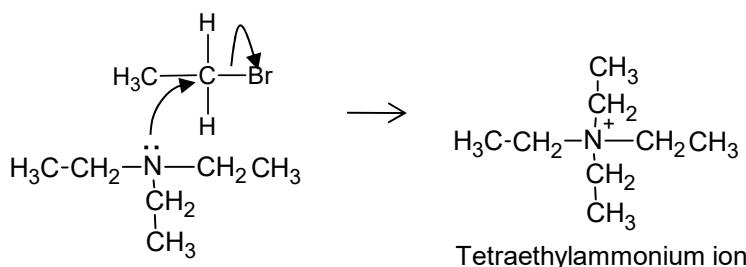
In this second step of the mechanism either ammonia or the amine can remove a proton from the intermediate (acts as base) to form the amine.

#### Reaction forming a tertiary amine

The same reaction mechanism occurs with the secondary amine reacting to form a tertiary amine



### Reaction forming a quaternary ammonium salt



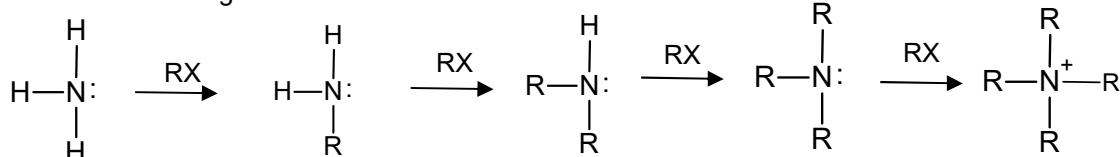
Using an **excess of the halogenoalkane** will promote the formation of the **quaternary salt**

Only the first step of the mechanism occurs when forming the quaternary salt

Quaternary ammonium salts are not amines

### Overall scheme of reactions

Where RX is the halogenoalkane

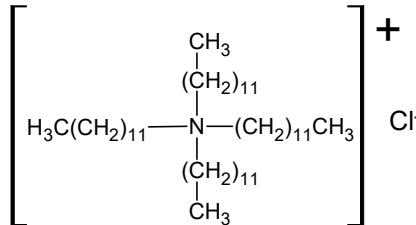


Using a large **excess of ammonia** will maximise the amount of **primary amine** formed

Using an **excess of the halogenoalkane** will promote the formation of the **quaternary salt**

### quaternary ammonium salt

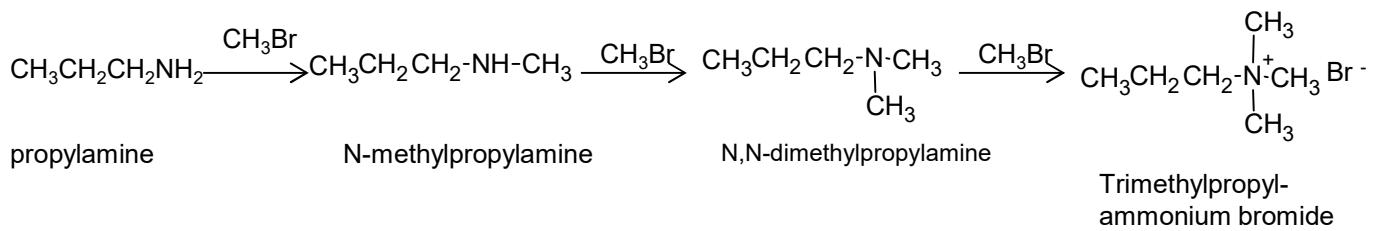
Quaternary Salts can be used as **cationic surfactants**



Surfactants reduce the surface tension of liquids

The positive nitrogen is attracted toward negatively charged surfaces such as glass, hair, fibres and plastics. This helps in their uses as fabric softeners, hair conditioners and sewage flocculants

Some questions will involve substituting an amine onto a halogenoalkane which has a different length of carbon chain from the amine



Using excess bromomethane would promote the final quaternary salt

## Preparing amines from nitriles in a 2 step reaction

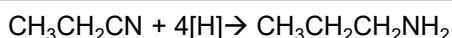
Using the method above of reacting halogenoalkanes and ammonia is not an efficient method for preparing a high yield of the primary amine because of the further substitution reactions that occur.

A better method is to use the following 2 step reaction scheme.

Step 1. convert **halogenoalkane to nitrile** by using KCN in aqueous ethanol (heat under reflux)



Step 2. reduce **nitrile to amine** by using **LiAlH<sub>4</sub>** in **ether** or by reducing with **H<sub>2</sub>** using a **Ni catalyst**



A disadvantage of this method is that it is a two step reaction that may therefore have a low yield. Also KCN is toxic.

## Reducing nitroarenes to aromatic amines

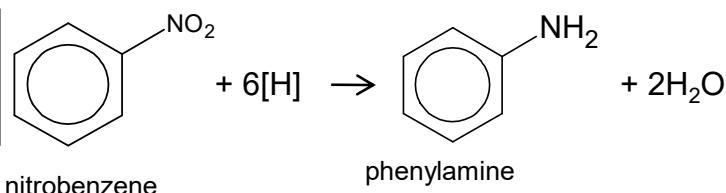
The nitro group on an arene can be reduced an amine group as follows

See the last topic for how to form nitrobenzene from benzene.

**Reagent:** Sn and HCl or Fe and HCl

### Conditions: Heating

### Mechanism: Reduction



As the reaction is carried out in HCl the ionic salt  $\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$  will be formed. Reacting this salt with NaOH will give phenylamine.

This reduction reaction can also be done with catalytic hydrogenation ( $\text{H}_2$  using a Ni catalyst).

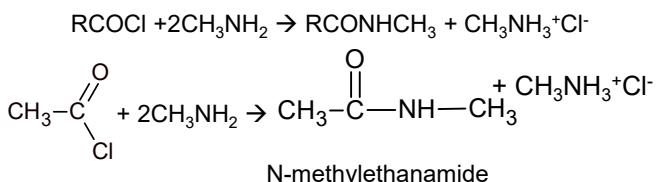
## Other reactions of amines

Aliphatic amines and phenylamine can react with acyl chlorides and acid anhydrides to form amides in a nucleophilic addition-elimination reaction- see chapter on reactions of C=O bond for more details

Change in functional group: **acyl chloride** → **secondary amide**

Reagent: **primary amine**

Conditions: room temp.



Change in functional group: **acid anhydride → secondary amide**

Reagent: **primary amine**

Conditions: room temp.

