

# AQA Chemistry A-level

## Topic 3.11 - Amines

### Flashcards

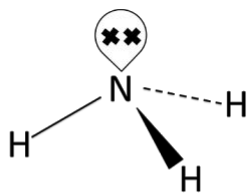
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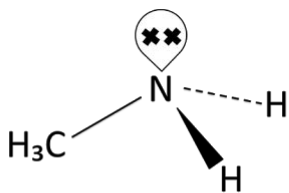
Draw the structures of  
primary, secondary and  
tertiary amines and a  
quaternary ammonium ion



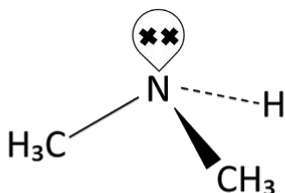
Draw the structures of primary, secondary and tertiary amines and a quaternary ammonium ion.



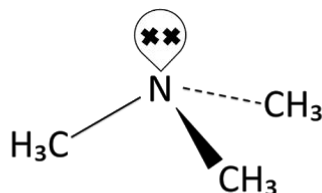
**0 carbons**  
 Ammonia  
 (unique)



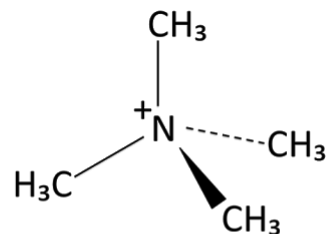
**1 carbon**  
 Primary (1°)  
 amine



**2 carbons**  
 Secondary (2°)  
 amine



**3 carbons**  
 Tertiary (3°)  
 amine



**4 carbons**  
 Quaternary (4°)  
 ammonium ion



# How do you name amines?



# How do you name amines?

-amine or amino-



# Why are amines so reactive?



# Why are amines so reactive?

The lone pair of electrons on the Nitrogen - due to polar N-H bond



What shape are amines  
around the N? Bond angle?





What shape are amines around the N? Bond angle?

Trigonal pyramidal,  $107^\circ$  due to lone pair on N



# What kind of intermolecular forces do they have? Why?



What kind of intermolecular forces do they have?

Why?

Hydrogen bonding due to polar N-H bond and lone pair of electrons on N atom.



Do amines have intermolecular forces which are stronger than or weaker than alcohols? Why?



Do amines have intermolecular forces which are stronger than or weaker than alcohols? Why?

Weaker, as N has a lower electronegativity than O → weaker hydrogen bonding



# What state are amines at 298K?



What state are amines at 298K?

Short chains are gases, longer chains are volatile liquids



# What do they smell of? Why?





# What do they smell of? Why?

Fishy smell - rotting fish/flesh releases di- and triamines



Which primary amines are soluble in water/alcohols?  
Why?



Which primary amines are soluble in water/alcohols?  
Why?

Up to 4 carbon atoms, as they can hydrogen bond to water molecules. After this, non-polarity of hydrocarbon chain makes them insoluble



What kind of solvents are most other amines soluble in?



What kind of solvents are most other amines soluble in?

Less or non-polar solvents



# Solubility of phenylamine?

## Why?



# Solubility of phenylamine? Why?

Not very soluble, due to the non-polarity of the benzene ring -  $C_6H_5$  cannot form hydrogen bonds



# How can/when do amines act as bases?





# How can/when do amines act as bases?

When they bond with a  $H^+$  ion



# How can/when do amines act as nucleophiles?



# How can/when do amines act as nucleophiles?

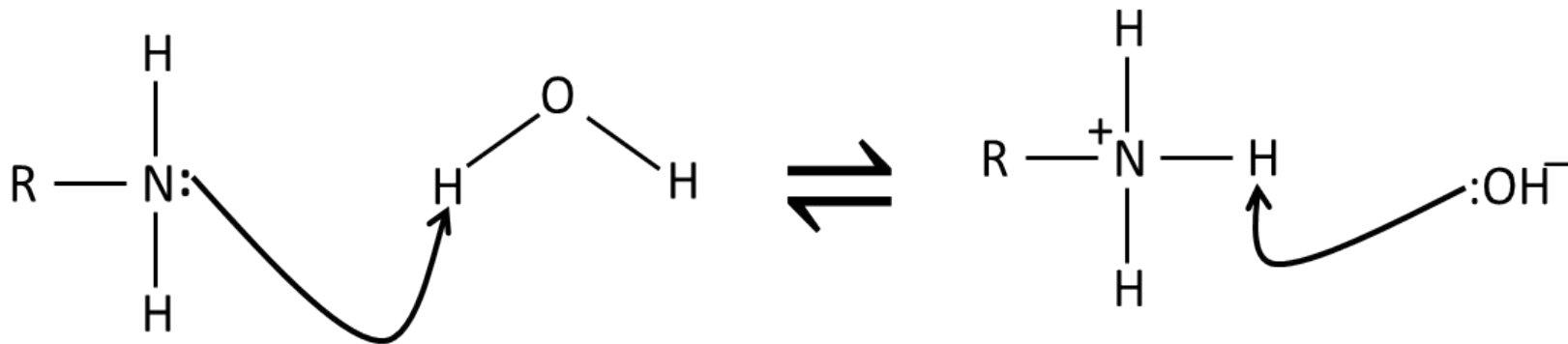
When they bond with an electron-deficient C atom (donate lone pair from N)



Draw a mechanism for the  
basic action of an amine  
with water



Draw a mechanism for the basic action of an amine with water



What is the product from the basic action of an amine with water?



What is the product from the basic action of an amine with water?

$\text{RNH}_3^+$  - ammonium ion, which forms a salt with an anion



Is the product (ammonium ion) soluble in water? Why?





Is the product (ammonium ion) soluble in water?  
Why?

Yes, as it is ionic so is attracted to the polar  
bonds in  $\text{H}_2\text{O}$



How could you regenerate the soluble amine from the ammonium salt?



How could you regenerate the soluble amine from the ammonium salt?

Add a strong base (NaOH) → removes  $H^+$  ions from ammonium ion



In order to be the strongest base, what must a particular amine have (out of a set of amines)?



In order to be the strongest base, what must a particular amine have (out of a set of amines)?

Greatest electron density around the N atom, making it a better electron pair donor (attracts protons more)



# What does positive/negative inductive effect mean?



What does positive/negative inductive effect mean?

Positive inductive effect = donate electrons,  
increase density around N

Negative means remove electrons, decrease  
density around N



What effect do alkyl groups have (on electron density and base strength)?





What effect do alkyl groups have (on electron density and base strength)?

Positive inductive effect - increase electron density around N → stronger base



What effect do aryl groups  
have (on electron density  
and base strength)?



What effect do aryl groups have (on electron density and base strength)?

Negative inductive effect - decrease electron density around N → weaker base



Why are 3<sup>o</sup> amines never  
good bases?



# Why are 3<sup>o</sup> amines never good bases?

They are insoluble in water



Place these in order of base strength (in general):  $\text{NH}_3$ ,  
 $1^\circ$  amine,  $2^\circ$  amine,  
phenylamine



Place these in order of base strength (in general):  
 $\text{NH}_3$ ,  $1^\circ$  amine,  $2^\circ$  amine, phenylamine

$2^\circ$  amine >  $1^\circ$  amine >  $\text{NH}_3$  > phenylamine

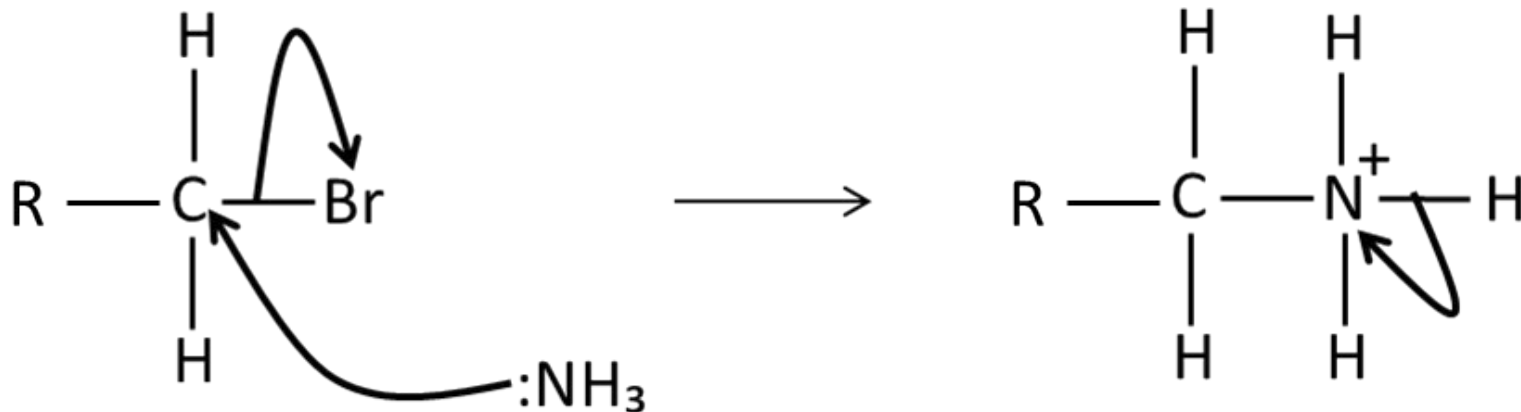


Draw a mechanism for the nucleophilic substitution of  $\text{NH}_3$  with  $\text{RCH}_2\text{Br}$  to form primary amines





Draw a mechanism for the nucleophilic substitution of  $\text{NH}_3$  with  $\text{RCH}_2\text{Br}$  to form primary amines



How can primary amines  
then form 2<sup>o</sup>, 3<sup>o</sup> amines and  
4<sup>o</sup> ammonium ions?



How can primary amines then form 2°, 3° amines and 4° ammonium ions?

Multiple substitutions; primary amine is a nucleophile that attacks the original haloalkane etc



# What are the problems with this method?



What are the problems with this method?

Not efficient as low yield of  $1^\circ$  amine due to multiple substitutions



How would you maximise  
the yield of the primary  
amine?



How would you maximise the yield of the primary amine?

Use excess ammonia



What type of mechanism is the reaction of a haloalkane with a cyanide ion?





What type of mechanism is the reaction of a haloalkane with a cyanide ion?

Nucleophilic substitution



What conditions does this reaction require? What is the product formed?



What conditions does this reaction require? What is the product formed?

Ethanol as a solvent

A nitrile is formed



How do you get from a nitrile to a primary amine?  
(name of reaction type and reagents/catalysts)



How do you get from a nitrile to a primary amine?  
(name of reaction type and reagents/catalysts)

Reduction using Nickel / Hydrogen catalyst



# Why is this a purer method of synthesising amines?



Why is this a purer method of synthesising amines?

Only the primary amine can be formed



What conditions are needed to form nitrobenzene from benzene?





What conditions are needed to form nitrobenzene from benzene?

Concentrated  $\text{H}_2\text{SO}_4$  and  $\text{HNO}_3$  to form the  $\text{NO}_2^+$  ion for electrophilic attack.



How do you form an ammonium chloride salt from nitrobenzene? What conditions are needed?



How do you form an ammonium chloride salt from nitrobenzene? What conditions are needed?

Reduce the nitrile using Tin / HCl → forms an ammonium salt with Cl<sup>-</sup> ions

Room temperature



Equation for the reaction of  
nitrobenzene  $\rightarrow$   
phenylamine?



Equation for the reaction of nitrobenzene →  
phenylamine?



What mechanism is used for forming amides from acyl chlorides and amines?



What mechanism is used for forming amides from acyl chlorides and amines?

Nucleophilic addition/elimination

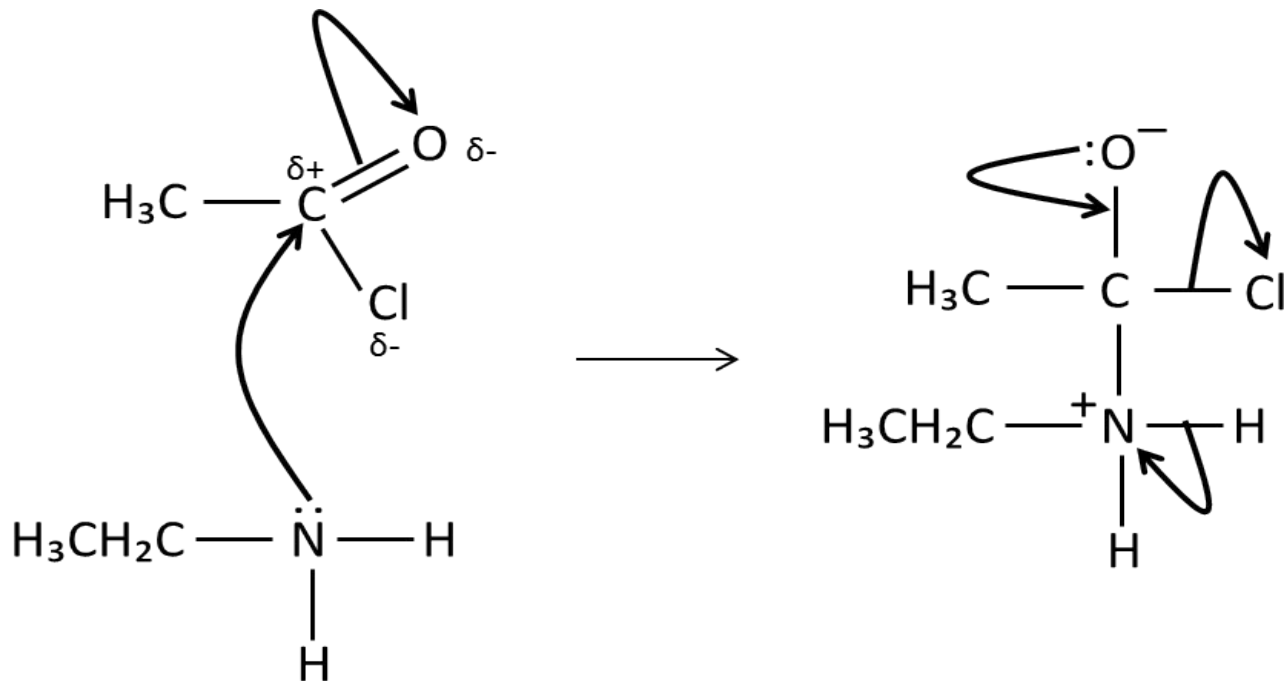


Draw a mechanism for the reaction of ethanoyl chloride with ethanamine.





Draw a mechanism for the reaction of ethanoyl chloride with ethanamine.



# In which industries/products are amines used?



In which industries/products are amines used?

Dyes, nylon, drugs, synthesis of new molecules



# What are cationic surfactants (used in fabric/hair conditioners)?



What are cationic surfactants (used in fabric/hair conditioners)?

Quaternary ammonium salts, with a cation that is charged at one end ( $N^+$ ) and non-polar at the other.



# How do cationic surfactants work in fabric/hair conditioner?



# How do cationic surfactants work in fabric/hair conditioners?

Negative charges on the surface of the fabric/hair are attracted to the cation, removing them from the surface; prevents build-up of static electricity and keeps hair flat and fabric smooth



# How do cationic surfactants sit when placed in water?





# How do cationic surfactants sit when placed in water?

Charged end in the water, non-polar end sticking out of the water/at the surface

