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WORKSHEET 16

School: Ba Sangam College **Year:** 13
Subject: Chemistry **Name:**

Strand	**4 - Materials**
Sub strand	**4.2- Organic Chemistry**
Content Learning Outcome	**-Classify amines into primary, secondary and tertiary amines.** **- Write the general formula of primary, secondary and tertiary amines.** **- Name primary amines using IUPAC nomenclature and also recognise the common names.**

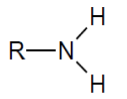
Amines

- Amines are an important class of organic nitrogen compounds.
- They are organic derivatives of ammonia in which one, two or three hydrocarbon (alkyl) groups have replaced hydrogens.
- They are used in the manufacture of many dyes, drugs and plastics.

Classes of Amines

1. **Primary Amines**

- In primary amines, only one of the hydrogen atoms in the ammonia molecule has been replaced by an alkyl group.
- The general formula of primary amines is RNH_2, where "R" is an alkyl group.



Primary amine

Note: Primary amines have one alkyl group binded to the nitrogen atom.

2. **Secondary Amines**

- In secondary amines, two of the hydrogen atoms in the ammonia molecule have been replaced by the alkyl groups.
- The general formula is R_2NH.
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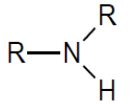
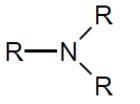


Secondary amine

Note: Secondary amines have two alkyl groups binded to the nitrogen atom.

3. **Tertiary Amines**

- In tertiary amines, all the hydrogen atoms in the ammonia molecule have been replaced by the alkyl groups.
- The general formula is R_3N.



Tertiary amine

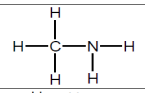
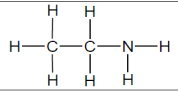
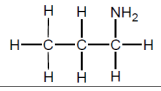
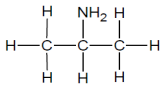
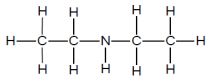
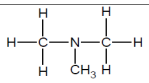
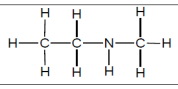
Note: Tertiary amines have three alkyl groups binded to the nitrogen atom.

Note: R represents alkyl groups. The alkyl groups in the secondary and tertiary amines do not have to be identical.

Nomenclature of Primary Amines

- In common naming system, an aliphatic amine is named by prefixing alkyl group to amine, i.e., alkylamine as one word (e.g., methylamine).
- In secondary and tertiary amines, when two or more groups are the same, the prefix di or tri is added before the name of alkyl group.
- In IUPAC naming system, amines are named as alkanamines, derived by replacement of 'e' of alkane by the word amine. For example, CH_3NH_2 is named as methanamine.
- Amines are known mostly by their common names.

Table showing some simple amines

Structure	Classification	Common Name	IUPAC Name
	Primary Amine	Methylamine	Methanamine
	Primary Amine	Ethylamine	Ethanamine
	Primary Amine	n-Propylamine	Propan-1-amine
	Primary Amine	Isopropylamine	Propan-2-amine
	Secondary Amine	Diethylamine	*N*-ethylethanamine
	Tertiary Amine	Trimethylamine	*N,N*-dimethylmethanamine
	Secondary Amine	Ethyl methylamine	*N*-methylethanamine

Physical Properties of Amines

- The very small amines like methylamine and ethylamine smell very similar to ammonia. As the amines get bigger, they tend to smell more "fishy" or the smell of decay.
- Amines boil at a lower temperature than alcohols of comparable molecular masses.
- This is because the N-H bond is not as polar as the O-H bond.
- Amines of low molecular masses are soluble in water. This is because of the **hydrogen bonding** between molecules of water and the amines.
- Solubility decreases for amines with high molecular masses due to the increase in non-polar nature as the result of increase in the size of the carbon chains.
- Primary amines have a higher boiling point than isomeric secondary and tertiary amines. This is because primary amines have two hydrogens available for hydrogen bonding.

Making amines from alkyl halides

Making a primary amine by alkylation of ammonia

- The alkyl halide is heated with a concentrated solution of ammonia in ethanol.

The reaction happens in two stages. In the first stage, a salt is formed - in this case, ethylammonium bromide.

$$\underset{\text{Bromoethane}}{CH_3CH_2Br} + NH_3 \rightarrow \underset{\text{Ethylammonium bromide}}{CH_3CH_2NH_3^+Br^-}$$

Then a reversible reaction occurs between the salt and excess ammonia in the mixture.

$$\underset{\text{Ethylammonium ion}}{CH_3CH_2NH_3^+Br^-} + NH_3 \rightleftharpoons \underset{\text{Ethanamine}}{CH_3CH_2NH_2} + NH_4^+ + Br^-$$

The ammonia removes a hydrogen ion from the ethylammonium ion leaving a primary amine - ethanamine. The more ammonia there is in the mixture, the more the forward reaction is favoured.

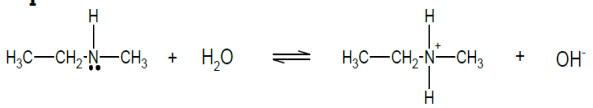
Overall Equation

$$CH_3CH_2Br + NH_3 \rightarrow CH_3CH_2NH_2 + HBr$$

Basicity of Amines

- The lone pair of electrons on the nitrogen atom give amine its basic properties.
- Amines behave much the same as ammonia in all cases where the lone pair of electrons are involved.
- Behaving like ammonia, amines that dissolve in water establish an equilibrium in which a low concentration of hydroxide ions exist.
- Therefore, amines are Bronsted bases.

Example



Thus, aqueous solutions of amines are basic and have pH values above 7.

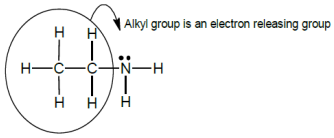
Two factors which influence the strength of a base are:

- The ease with which the lone pair picks up a hydrogen ion.
- The stability of the cation being formed.

Comparing Basicity of Ammonia and Primary Amines

The nitrogen atom in both primary amines and ammonia have a lone pair of electrons. In the case of primary amines, the presence of the alkyl group makes the primary amine more basic. **Alkyl groups have the ability to donate electrons to the more electronegative nitrogen in the primary amine.** This makes the electron density on the nitrogen of primary amine greater than the nitrogen of ammonia.

This can be explained as the electron releasing property of the alkyl groups. Due to this property of the alkyl group attached to the nitrogen of the amine, the electron density around the nitrogen atom increases, thus its electron releasing ability increases. Due to the greater and easier release of electrons in the alkyl amine, the molecule becomes more basic than ammonia. The electron donating ability of alkyl groups also helps stabilise the cation being formed.

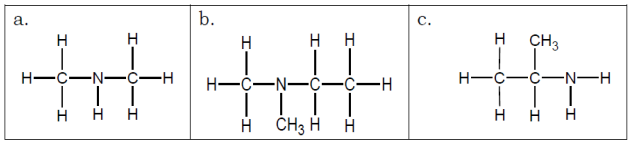


Primary Amine **Ammonia**

Note: In ammonia, there is no such electron releasing group attached. Thus, the basicity of ammonia is much less than that of a primary amine.

Exercise

1. Classify the following as primary, secondary or tertiary amines. **(3 marks)**



a. _____ b._____

c. _____

2. Name the following amines. **(2 marks)**
   a. $CH_3CH_2NH_2$ - _____
   b. $CH_3CH_2NHCH_3$ - _____

3. Comment on the solubility of amines in water. **(1 mark)**
   _____
   _____
   _____
   _____
   _____

4. Write an equation for the reaction of chloroethane with excess ammonia to form ethanamine. **(1 mark)**
   _____
   _____
   _____

5. Explain why amines have basic properties.
   _____
   _____
   _____
   _____
   (1 mark)

6. Give the structural formula of the organic products of the following reactions.

a. $CH_3CH_2CH_2Br + NH_3 \rightarrow$ _____

b. $CH_3CH_2Cl + NH_3 \rightarrow$ _____

(2 marks)