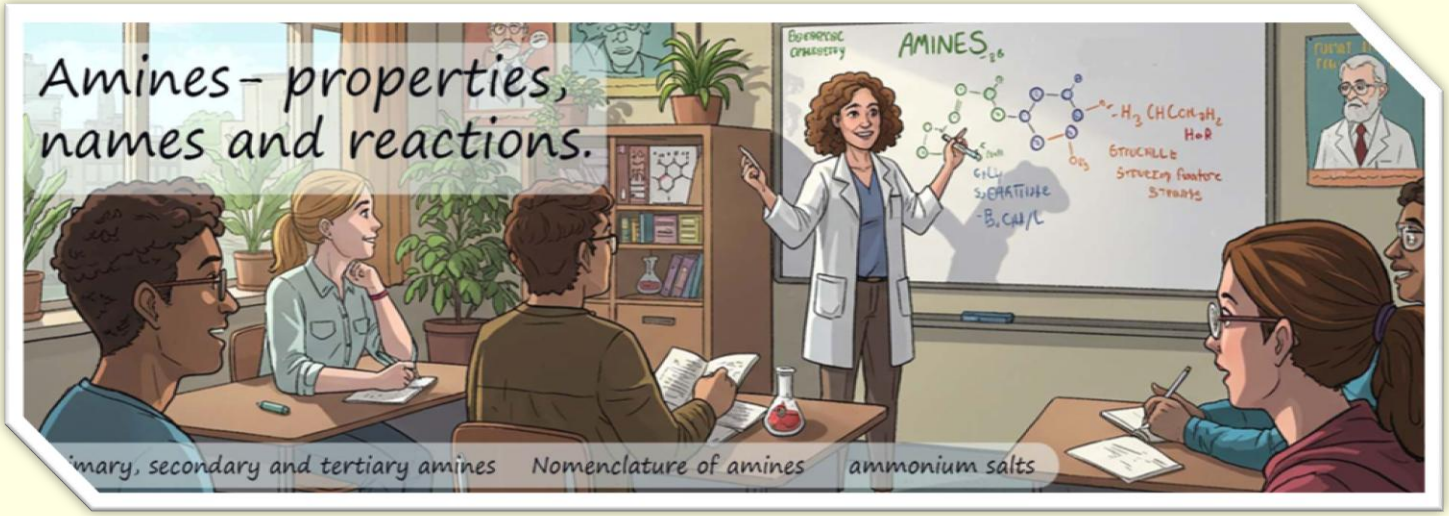

Answer the questions below then check your answers.

1. Which of the following best describes a secondary amine?

a) An amine where one hydrogen of ammonia is replaced by an alkyl or aryl group.
b) An amine where two hydrogens of ammonia are replaced by alkyl or aryl groups.
c) An amine where three hydrogens of ammonia are replaced by alkyl or aryl groups.
d) An amine where four alkyl groups are bonded to the nitrogen, forming an ionic compound.

2. Which of the following amines is likely to have the highest base strength in aqueous solution?

a) Methylamine b) Dimethylamine c) Trimethylamine d) Phenylamine

3. Why are aromatic amines weaker bases than aliphatic amines?

a) The nitrogen atom in aromatic amines lacks a lone pair.
b) The nitrogen lone pair is delocalised into the aromatic ring, reducing its availability for protonation.
c) Aromatic rings repel protons, reducing the ability of amines to act as bases.
d) Aromatic amines cannot form hydrogen bonds.

4. Explain why tertiary amines, despite having the strongest positive inductive effect, are weaker bases in aqueous solution than secondary amines.

5. Write an equation for the reaction between ethylamine and hydrochloric acid. Name the product formed.

6(a) Define a quaternary ammonium salt and give an example.

(b) Describe one industrial application of quaternary ammonium salts.

7. The following amine molecules are given: methylamine, ethylamine, and phenylamine.

(a) Arrange them in order of increasing base strength and justify your answer.

8 (a) Explain why amines generally have higher boiling points than alkanes of similar molecular mass but lower boiling points than alcohols.

(b) Discuss how solubility in water is influenced by the structure of an amine.

9. Compare and contrast the basicity of ammonia, aliphatic amines, and aromatic amines, considering both gaseous and aqueous phases.

Answers

1. Which of the following best describes a secondary amine?

a) An amine where one hydrogen of ammonia is replaced by an alkyl or aryl group.
b) An amine where two hydrogens of ammonia are replaced by alkyl or aryl groups.
c) An amine where three hydrogens of ammonia are replaced by alkyl or aryl groups.

d) An amine where four alkyl groups are bonded to the nitrogen, forming an ionic compound.

Answer: b) An amine where two hydrogens of ammonia are replaced by alkyl or aryl groups.

2. Which of the following amines is likely to have the highest base strength in aqueous solution?

a) Methylamine b) Dimethylamine c) Trimethylamine d) Phenylamine

Answer: b) Dimethylamine

3. Why are aromatic amines weaker bases than aliphatic amines?

a) The nitrogen atom in aromatic amines lacks a lone pair.

b) The nitrogen lone pair is delocalised into the aromatic ring, reducing its availability for protonation.

c) Aromatic rings repel protons, reducing the ability of amines to act as bases.

d) Aromatic amines cannot form hydrogen bonds.

Answer: b) The nitrogen lone pair is delocalised into the aromatic ring, reducing its availability for protonation.

4. Explain why tertiary amines, despite having the strongest positive inductive effect, are weaker bases in aqueous solution than secondary amines.

Answer: In aqueous solution, tertiary amines are more sterically hindered, making it difficult for water molecules to solvate the resulting ammonium ion. This reduces their overall base strength, despite the strong electron-donating effect of the alkyl groups.

5. Write an equation for the reaction between ethylamine and hydrochloric acid. Name the product formed.

Answer:

$C_2H_5NH_2 + HCl \longrightarrow C_2H_5NH_3Cl$

The product is ethylammonium chloride.

6(a) Define a quaternary ammonium salt and give an example.

(b) Describe one industrial application of quaternary ammonium salts.

Answer: (a) A quaternary ammonium salt is an ionic compound in which the nitrogen atom is bonded to four alkyl or aryl groups, forming a positively charged ammonium ion.

Example: Tetramethylammonium chloride .

(b) Quaternary ammonium salts are used as surfactants in detergents and fabric softeners because they help reduce surface tension and improve cleaning efficiency.

7. The following amine molecules are given: methylamine, ethylamine, and phenylamine.

(a) Arrange them in order of increasing base strength and justify your answer.

Answer: (a) Phenylamine < Methylamine < Ethylamine. Phenylamine is the weakest base because its nitrogen lone pair is delocalised into the benzene ring, making it less available for protonation. Ethylamine is stronger than methylamine due to a greater positive inductive effect from the longer alkyl chain.

8 (a) Explain why amines generally have higher boiling points than alkanes of similar molecular mass but lower boiling points than alcohols.

(b) Discuss how solubility in water is influenced by the structure of an amine.

Answer: (a) Amines have higher boiling points than alkanes due to hydrogen bonding between N-H groups, which alkanes lack. However, the N-H bond is less polar than the O-H bond in alcohols, leading to weaker hydrogen bonding and lower boiling points than alcohols.

(b) Small amines (e.g., methylamine) are soluble in water due to hydrogen bonding with water molecules. As the alkyl chain length increases, solubility decreases due to the increased hydrophobic nature of the molecule.

9. Compare and contrast the basicity of ammonia, aliphatic amines, and aromatic amines, considering both gaseous and aqueous phases.

Answer: Ammonia is a moderate base, as it has a lone pair of electrons available to accept a proton. Aliphatic amines are stronger bases due to the positive inductive effect of alkyl groups, which increase electron density on the nitrogen. In the gas phase, the trend is tertiary > secondary > primary amines. However, in aqueous solution, steric hindrance and solvation effects make secondary amines the strongest bases, followed by primary, then tertiary amines. Aromatic amines are the weakest bases because the nitrogen lone pair is delocalised into the aromatic ring, making it less available for protonation.