Class 12 Chemistry – Amines | Study Guide

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1. Theory in Simple Words with Visuals

1.1 What are Amines?

Amines are **derivatives of ammonia (NH_3)** where one or more hydrogen atoms are replaced by **alkyl or aryl groups**.

Type	General Formula	Example	Visual Analogy
Primary (1°)	R–NH_2	CH_3NH_2 (Methylamine)	One arm of ammonia replaced
Secondary (2°)	R_2NH	$(CH_3)_2NH$ (Dimethylamine)	Two arms replaced
Tertiary (3°)	R_3N	$(CH_3)_3N$ (Trimethylamine)	All three arms replaced

Mnemonic:
"1, 2, 3 Arms of Nitrogen" → Primary = 1 R group, Secondary = 2, Tertiary = 3

1.2 Classification of Amines

- **Aliphatic Amines**: Nitrogen attached to alkyl groups.
- **Aromatic Amines**: Nitrogen attached to an aromatic ring (e.g., aniline, $C_6H_5NH_2$).
- **Heterocyclic Amines**: Nitrogen is part of a ring (e.g., pyridine).

1.3 Physical Properties

Property	Observation
Boiling Point	↑ H-bonding → ↑ BP (Primary > Secondary > Tertiary)
Solubility	Small amines soluble in water due to H-bonding
Odor	Fishy smell (common for amines)

1.4 Chemical Reactions

1. Basic Nature: Amines are **basic** due to lone pair on N.

- $R–NH_2 + HCl \rightarrow R–NH_3^+Cl^-$
- Aromatic amines (aniline) are **less basic** due to lone pair delocalization into benzene ring.

2. Acylation:

- $R–NH_2 + CH_3COCl \rightarrow R–NHCOCH_3$ (amide formation)

3. Diazotization (Aromatic Amines):

- $C_6H_5NH_2 + NaNO_2 + HCl$ (0–5°C) $\rightarrow C_6H_5N_2^+Cl^-$
- Used to prepare azo dyes.

4. Hoffmann Bromamide Degradation (Primary Amine → Amine with 1 less C):

- $R–CONH_2 + Br_2 + NaOH \rightarrow R–NH_2 + Na_2CO_3$

5. Reaction with Nitrous Acid (for 1° aliphatic amines):

- $R–NH_2 + HNO_2 \rightarrow R–OH + N_2 + H_2O$

1.5 Important Mechanistic Notes

- Lone pair on N is **key for reactivity**.
- Aromatic vs aliphatic amines differ in basicity due to **resonance in aromatic ring**.

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2. Key Concepts & Formulas

Concept	Key Points	Mnemonics / Tricks
Basicity of Amines	Aliphatic > Aromatic (due to lone pair availability)	"Aliphatic N = free lone pair, Aromatic N = shy lone pair"
Diazotization Temp	0–5°C	"Keep it cool to freeze the diazo"
Hoffmann Degradation	$R–CONH_2 \rightarrow R–NH_2$ (1 C less)	"Hoffmann chops one carbon"
Acylation	$R–NH_2 + CH_3COCl \rightarrow R–NHCOCH_3$	Protects N for reactions
Salt Formation	$R–NH_2 + HCl \rightarrow R–NH_3^+Cl^-$	Basicity test

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3. Solved Numerical / Reaction Problems

Example 1: Diazotization Reaction

Problem: $C_6H_5NH_2 + NaNO_2 + HCl \rightarrow ?$
Solution:

- Reaction at 0–5°C $\rightarrow C_6H_5N_2^+Cl^-$ (diazonium salt)
- Stepwise: Draw benzene ring → N group attached → N_2^+ formed.

Example 2: Hoffmann Bromamide Degradation

Problem: $CH_3CONH_2 + Br_2 + NaOH \rightarrow ?$
Solution:

- $CH_3CONH_2 \rightarrow CH_3NH_2 + Na_2CO_3$
- Tip: Primary amide loses **one carbon** to give primary amine.

Example 3: Formation of Amide

Problem: $C_2H_5NH_2 + CH_3COCl \rightarrow ?$
Solution:

- $C_2H_5NH_2 + CH_3COCl \rightarrow C_2H_5NHCOCH_3$

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4. Previous Years' Board Questions (Solved)

- **High-weightage topics:**
  - Basicity of amines (aliphatic vs aromatic)
  - Diazotization & azo dye formation
  - Hoffmann degradation
  - Reaction with nitrous acid
  - Preparation of amines
- **Common questions:**
  - Reaction of primary amine with nitrous acid
  - Electrophilic substitution on aromatic amines
  - Basicity comparison with reasons

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5. Quick Revision Notes / Important Points

- **Functional group:** $-NH_2$
- **Classification:** Primary, secondary, tertiary
- **Basicity trend:** 1° > 2° > 3° (aliphatic), Aromatic < Aliphatic
- **Key reactions:**
  - Diazotization
  - Acylation
  - Hoffmann bromamide degradation
  - Salt formation
- **Important tests:**
  - $NaNO_2 + HCl \rightarrow$ diazonium salt
  - HCl addition → ammonium salt

Visual Table:

Amines	Reactions	Observation/Test
Aliphatic 1°	$R–NH_2 + HNO_2 \rightarrow R–OH + N_2$	Gas evolved, alcohol formed
Aromatic 1°	$C_6H_5NH_2 + HNO_2 \rightarrow C_6H_5N_2^+Cl^-$	Diazonium salt (0–5°C)
Primary amide	$R–CONH_2 + Br_2/NaOH \rightarrow R–NH_2$	Carbon lost

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6. Predicted / Likely Questions

1. Compare basicity of amines (aliphatic vs aromatic)
2. Diazotization reaction & uses
3. Hoffmann degradation of amides
4. Preparation of aliphatic and aromatic amines
5. Electrophilic substitution of aromatic amines

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7. Exam Tips & Tricks

- **Basicity:** Draw resonance to check lone pair availability
- **Diazonium salts:** Remember **0–5°C only**
- **Hoffmann rule:** 1 C less in product
- **Mnemonic:**
  - **"Diazo needs chill"** → cold for diazotization
  - **"Hoffman chops one carbon"** → degradation
- **Flowchart idea:**
  1° amine → Nitrous acid → Alcohol/N_2
  Aromatic 1° → Diazotization → Azo dyes

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8. Visual & Kid-Friendly Learning Style

- **Nitrogen lone pair = superhero attacking acids**
- **Aliphatic amines = free nitrogen superhero** → strong base
- **Aromatic amines = sleepy nitrogen** → less basic
- **Flowcharts for reactions:**
  - Primary amine → Diazotization → Alcohol / Diazonium
  - Amide → Hoffmann → Primary amine